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Nuclear Power Demonstration Closure Project

Rolphton, Renfrew County, Ontario

Canadian Nuclear Laboratories
Laboratoires Nucléaires Canadiens

ENVIRONMENTAL IMPACT STATEMENT


NPD Existing Condition






NPD Proposed Condition

Revision 0

Prepared by:

ARCADIS Design & Consultancy for natural and built assets

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Project Number: 351240-000-005

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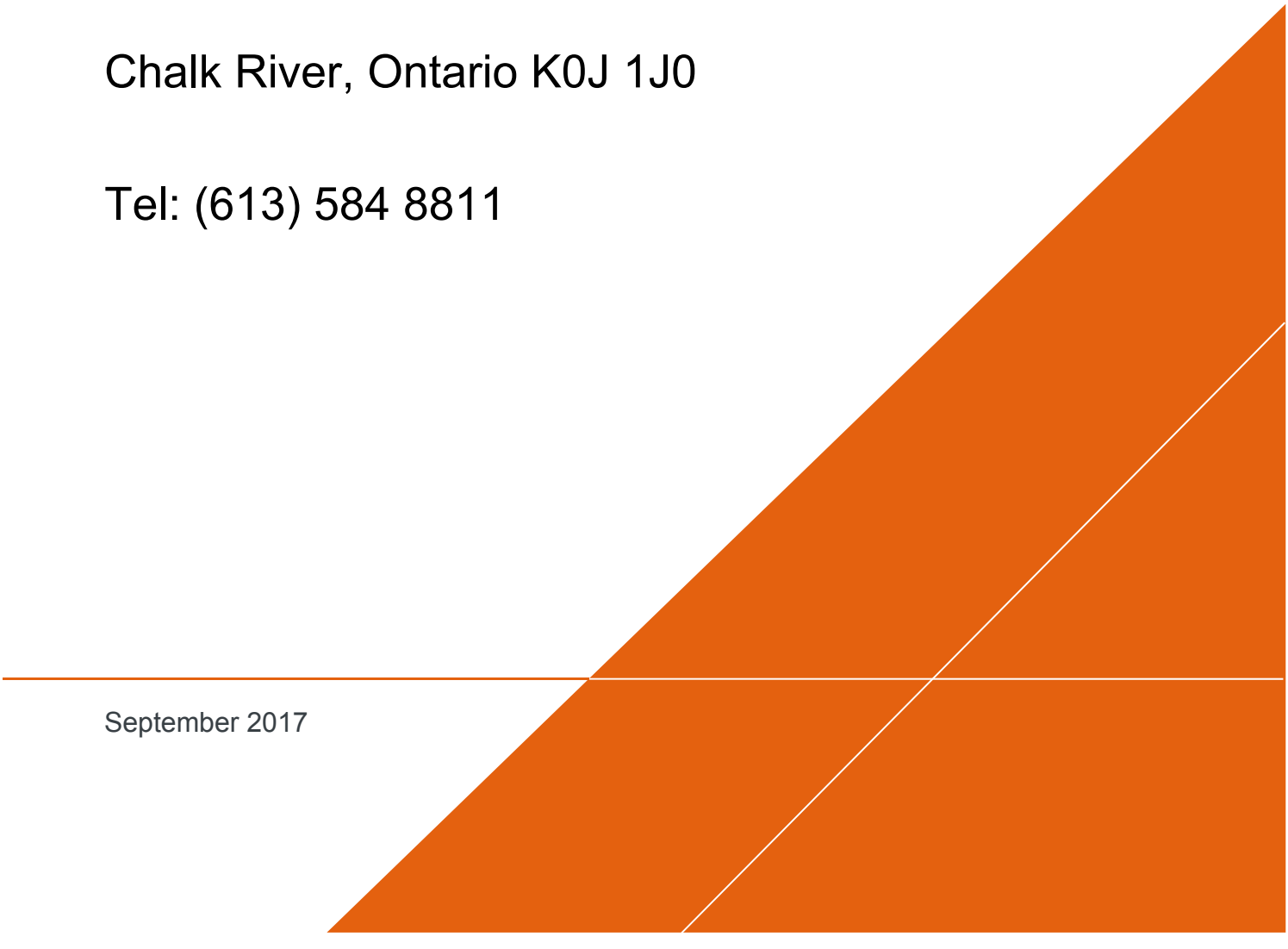
Environmental Impact Statement

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September 2017

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ENVIRONMENTAL IMPACT STATEMENT - NPD CLOSURE PROJECT

NPD DECOMMISSIONING

64-509200-ENA-004

Revision 0

	CNL	LNC

☐ ACCEPTED AS NOTED ☒ ACCEPTED ☐ NOT ACCEPTED

Signature	Representing	Date
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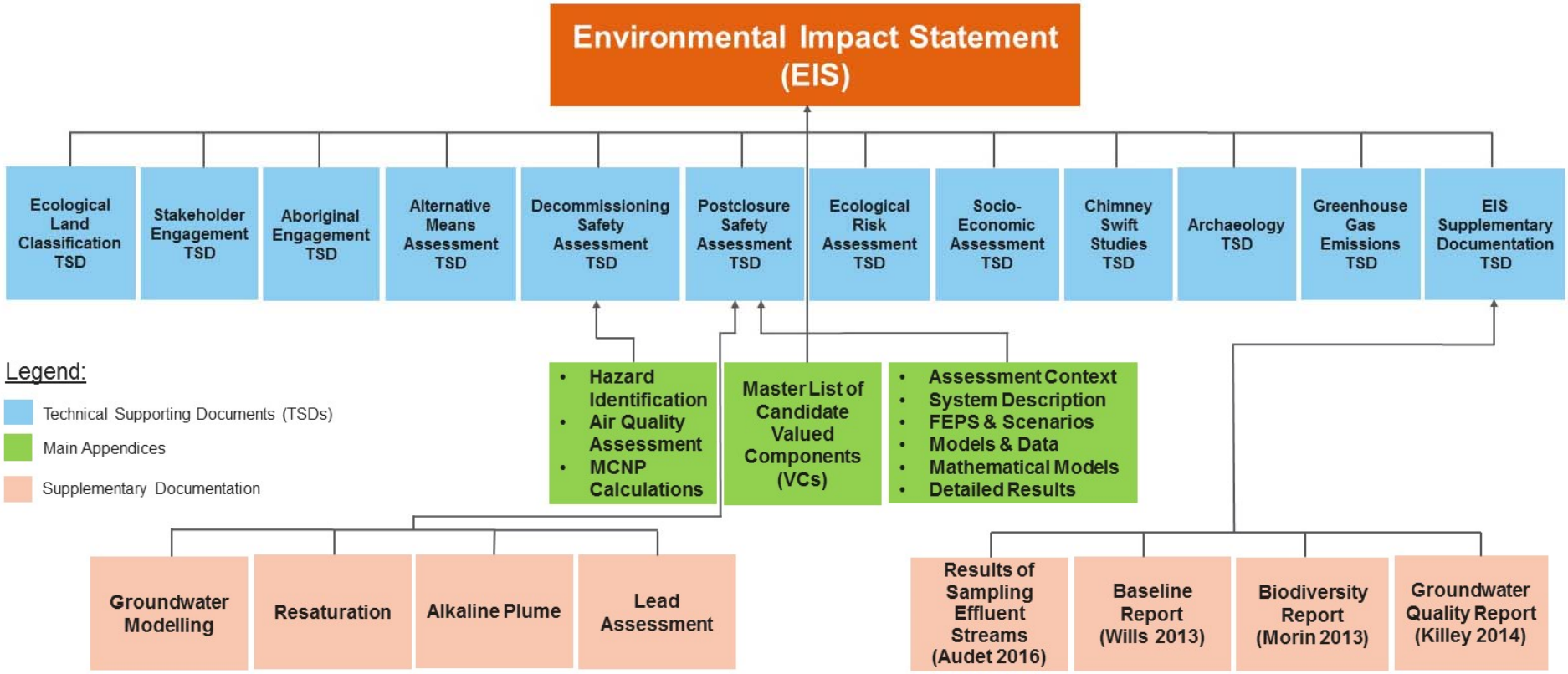
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This Environmental Impact Statement (EIS) has been prepared as part of the Environmental Assessment process, in support of the Nuclear Power Demonstration (NPD) Closure Project.

The following figure shows the various documents associated with the EIS, and their relationships.



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APPENDICES

APPENDIX A: MASTER LIST OF CANDIDATE VALUED COMPONENTS (VCs) FOR NPD

1 GLOSSARY

GLOSSARY of Technical Words, Acronyms and Abbreviations

µSv	Microsievert (see Sievert)
Abatement	The ending, reduction, or lessening of something.
Activation product	Materials made radioactive by neutron activation
ACR	Annual Compliance Report
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AEGL	Acute Exposure Guideline Levels
Ag-108m	Metastable isotope Silver-108
ALARA	“As Low As Reasonably Achievable” -A principle of radiation protection that holds that exposures to radiation are kept as low as reasonably achievable, social and economic factors taken into account.
Albedo	A measure of the reflectivity of the earth’s surface
Alluvial	Made up of or found in the materials that are left by the water of rivers, floods, etc.
Am-241	Isotope Americium-241
Am-242m	Metastable isotope Americium-242
Am-243	Isotope Americium-243
Amphibolite	Amphibolite is a coarse-grained metamorphic rock.
Anthropogenic	Coming from, or having been caused by humans
asl	Above sea level
Best practice	An industry-accepted approach (for example, toward a design, process or procedure) that is acknowledged as consistently producing superior results.
Biota	All living organisms, including humans.
Biotite	A large group of black mica minerals that are commonly found in igneous and metamorphic rocks.
Bowen Ratio	A mathematical method generally used to calculate heat lost (or gained) in a substance
Bq	Becquerel – The SI (International System) unit of radioactivity, corresponding to one disintegration per second.
BV	Benchmark Value
C-14	Isotope Carbon-14
Ca-41	Isotope Calcium-41
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment

Cd-113m	Metastable isotope Cadmium-113
CEAA	Canadian Environmental Assessment Act
CEQG	Canadian Environmental Quality Guidelines
CEPA	Canadian Environmental Protection Act
CH_4	Methane
CHC	Center for Hearing and Communication
Cl-36	Isotope Chlorine-36
Class I Nuclear Facility	A Class IA nuclear facility and a Class IB nuclear facility. Class IA nuclear facilities are any of the following: (a) a nuclear fission or fusion reactor or subcritical nuclear assembly; and (b) a vehicle that is equipped with a nuclear reactor. Class IB nuclear facilities are any of the following: (a) a facility that includes a particle accelerator, other than a particle accelerator described in paragraphs (d) and (e) of the definition “Class II prescribed equipment” in section 1 of the Class II Nuclear Facilities and Prescribed Equipment Regulations; (b) a plant for the processing, reprocessing or separation of an isotope of uranium, thorium or plutonium; (c) a plant for the manufacture of a product from uranium, thorium or plutonium; (d) a plant, other than a Class II nuclear facility as defined in section 1 of the Class II Nuclear Facilities and Prescribed Equipment Regulations, for the processing or use, in a quantity greater than 10^{15} Bq per calendar year, of nuclear substances other than uranium, thorium or plutonium; (e) a facility for the disposal of a nuclear substance generated at another nuclear facility; and (f) a facility prescribed by paragraph 19(a) or (b) of the General Nuclear Safety and Control Regulations.
Clinopyroxene	A subgroup of pyroxenes, a group of important rock-forming inosilicate minerals found in many igneous and metamorphic rocks.
Cm-243	Isotope Curium-243
Cm-244	Isotope Curium-243
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
Co-60	Isotope Cobalt-60
CO_2	Carbon Dioxide
COPC	Contaminant of Potential Concern

1 Glossary

COSEWIC	Committee on the Status of Endangered Wildlife in Canada.
CRL	Chalk River Laboratories
Crown Corporation	A corporation that is established and regulated by a country's state or government.
Cs-134	Isotope Cesium-134
Cs-135	Isotope Cesium-135
Cs-137	Isotope Cesium-137
CSA	Canadian Standards Association
CWQG	Canadian Water Quality Guidelines
dBA	A-Weighted Decibels
DE	Decommissioning Execution – a phase of the NPD closure project which includes all activities associated with decommissioning of the facility including setup and operation of the batch mixing plant, grouting and demolition activities, installation of the concrete cap and engineered barrier, as well as site restoration and demobilization.
DecomSA	Decommissioning Safety Assessment – a Technical Supporting Document prepared for the NPD Closure Project.
Derived Release Limit	The release rate that would cause an individual of the most highly exposed group to receive and be committed to a dose equal to the regulatory annual dose limit due to release of a given radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year.
Design basis	The range of conditions and events taken explicitly into account in the design of a nuclear facility, according to established criteria, such that the facility can withstand this range without exceeding authorized limits.
DFO	Fisheries & Oceans Canada
DOE	U.S. Department of Energy
Dose limit	A maximum allowable radiation dose (effective dose or equivalent dose) which is in place to minimize the risk of adverse health effects due to radiation exposure.
Dosimeter	A device for measuring a dose of radiation that is worn or carried by an individual.
DRL	See Derived Release Limit
DWM	Decommissioning and Waste Management
EA	Environmental Assessment
EcoRA	Ecological Risk Assessment – a Technical Supporting Document prepared for the NPD closure project.
EER	Environmental Effects Review

1 Glossary

Effluent	Fluids discharged into a river, lake or sea (generally refers to fluids discharged into surface waters).
EHC	Extractable Hydrocarbons
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EMP	Environmental Monitoring Program
Entrainment	The incidental uptake of aquatic species small enough to pass through the filter (e.g., screen or grate) of a water intake pipe.
ECCC	Environment and Climate Change Canada
EQG	Environmental Quality Guidelines
EPRGs	Emergency Response Planning Guidelines
ERA	Environmental Risk Assessment
Eu-152	Isotope Europium-152
Eu-154	Isotope Europium-154
Eu-155	Isotope Europium-155
Fe-55	Isotope Iron-55
Feldspar	An abundant rock-forming mineral typically occurring as colorless or pale-colored crystals and consisting of aluminosilicates of potassium, sodium, and calcium.
Fission	The division of a heavy nucleus into two or more parts with masses of equal order of magnitude; usually accompanied by the emission of neutrons and gamma radiation.
Gamma radiation	A penetrating electromagnetic radiation of a kind arising from the radioactive decay of atomic nuclei.
Garnet	A group of silicate minerals.
GHG	Greenhouse Gas
GoCo	Government-owned, Contractor-operated
Gneiss	A high grade metamorphic rock, meaning that it has been subjected to higher temperatures and pressures than schist. It is formed by the metamorphosis of granite, or sedimentary rock.
GPR	Ground-penetrating radar
Granulite	A class of high-grade metamorphic rocks.
Grey water	Relatively clean waste water (e.g., from sinks and showers).
Grout	a mixture of Portland Cement and water that produces a pourable, concrete-like, mixture.
H-3	Isotope Hydrogen-3 (see Tritium)

1 Glossary

Hazardous waste	Waste that is potentially hazardous to human health and/or the environment due to its nature and quantity and that require special handling and storage techniques.
Ho-166m	Metastable isotope Holmium-166
Hornblende	A complex inosilicate series of minerals.
HTO	Tritiated Water
Hydraulic conductivity	A measure of the ease with which a fluid (usually water) can move through pore spaces or fractures.
I-129	Isotope Iodine-129
IAEA	International Atomic Energy Agency
IC	See Institutional Controls phase
IDLH	Immediately Dangerous to Life or Health
IEMP	Independent Environmental Monitoring Program
ILW	See Intermediate Level Waste
Impingement	The retention of aquatic organisms against the filter (e.g., screen, grate) of a water intake pipe.
In-situ decommissioning	A method of carrying out decommissioning “in place”.
Institutional Controls phase	A phase of the NPD closure project, assumed to extend at least 100 years following the Decommissioning Execution phase. This involves the control of residual risks at a site after it has been decommissioned, as defined in G-320 (CNSC 2006). The Institutional Controls phase may include active measures (such as surveillance and monitoring) and passive measures (such as access controls).
Intermediate Level Waste	Radioactive solid waste that typically exhibits levels of penetrating radiation sufficient to require shielding during handling and interim storage.
ISAM	Improving Safety Assessment Methodologies
ISQG	Interim Sediment Quality Guidelines
IWS	Integrated Waste Strategy
L1	Landfill 1
L2	Landfill 2
Lacustrine	Relating to or associated with lakes.
LCV	Lowest Chronic Value
Light ballast	A device placed in line with the light to limit the amount of current in an electrical circuit.
Liquefaction	A phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, causing it to behave like a liquid.
LLD	Lessons learned

LLW	See Low Level Waste
Low Level Waste	Radioactive solid waste that contains material with radionuclide content above established clearance levels and exemption quantities, but that generally has limited amounts of long-lived activity.
M	metre
MAC	Maximum Acceptable Concentration
Macrophyte	A plant, especially an aquatic plant, large enough to be seen by the naked eye.
Mafic	An adjective describing silicate mineral or igneous rock that is rich in magnesium and iron.
MAM2-10	Forb-mineral meadow marsh Ecological Land Classification designation.
MAS2-1	Cattail mineral shallow marsh Ecological Land Classification designation.
MAS2-3	Narrow-leaved sedge mineral shallow marsh Ecological Land Classification designation.
MAS2-9	Forb mineral shallow marsh Ecological Land Classification designation.
masl	Metres above sea level
Masonite	Steam-cooked and pressure molded wood fibers
mbgs	Metres below ground surface
MDA	Minimum Detectable Activity
MH	Manhole
MNRF	Ontario Ministry of Natural Resources and Forestry
MOECC	Ontario Ministry of the Environment and Climate Change.
MOL	Ontario Ministry of Labour
Monzonite/Monzodiorite	An igneous intrusive rock.
MP	Member of Parliament
mSv	Millisievert (see Sievert)
MWe	Megawatt electric – electric output of a power plant in megawatts.
Nb-93m	Metastable isotope Niobium-93
Nb-94	Isotope Niobium-94
NDT	Non-Destructive Testing
NEC	No-effects concentration
NEW	Nuclear Energy Worker
NGO	Non-governmental organization
NGS	Nuclear Generating Station
Ni-59	Isotope Nickel-59

Ni-63	Isotope Nickel-63
NNSA	National Nuclear Security Administration
N_2O	Nitrous Oxide
NO_x	Nitrogen Oxides
Np-237	Isotope Neptunium-237
NPD	Nuclear Power Demonstration
NPDNGS	Nuclear Power Demonstration Nuclear Generating Station.
NPDWF	Nuclear Power Demonstration Waste Facility
NPRI	National Pollutant Release Inventory
NSCA	Nuclear Safety and Control Act
NSDF	Near Surface Disposal Facility
OBT	Organically Bound Tritium
Oligotrophic	(Especially of a lake) relatively low in plant nutrients and containing abundant oxygen in the deeper parts.
OMC	Ontario Ministry of Culture
OPG	Ontario Power Generation
Orthopyroxene	A subgroup of pyroxenes, a group of important rock-forming inosilicate minerals found in many igneous and metamorphic rocks.
Outfall	The discharge point of a waste stream into a body of water.
Overburden	Rock or soil overlying a mineral deposit, archaeological site, or other underground feature.
OVF	Ottawa Valley Forest
PAC	Protective Action Criteria
PCB	Polychlorinated Biphenyl
Pd-107	Isotope Palladium-107
PHAC	Public Health Agency of Canada
PHC	Petroleum Hydrocarbons
PIC	See Post-Institutional Controls phase
Plagioclase	A series of silicate minerals.
Pm-147	Isotope Prometheium-147
$PM_{2.5}$	Particulate matter <2.5 µm
PM_{10}	Particulate matter <10 µm
Porosity	A measure of the empty space in a material (as a proportion of the total volume).

Postclosure period	“Postclosure” refers to the period after decommissioning is complete. For this EIS, the postclosure period includes (1) the Institutional Controls phase which may involve the control of residual risks at a site after it has been decommissioned, as defined in G-320 (CNSC 2006). The Institutional Controls phase may include active measures (such as surveillance and monitoring) and passive measures (such as access controls), and (2) the Post-Institutional Controls phase, which begins after the Institutional Controls phase ceases; it is assumed that no further management and monitoring will take place during the Post-Institutional Controls phase.
Post-Institutional Controls phase	a phase of the NPD closure project which includes abandonment of the site after the cessation of the Institutional Controls phase; it is assumed that no further management and monitoring will take place during this phase.
PostSA	Postclosure Safety Assessment – a Technical Supporting Document prepared for the NPD closure project.
PPE	Personal Protective Equipment
Pu-238	Isotope Plutonium-238
Pu-239	Isotope Plutonium-239
Pu-240	Isotope Plutonium-240
Pu-241	Isotope Plutonium-241
Pu-242	Isotope Plutonium-242
PWQO	Provincial Water Quality Objectives
R	Roentgen – a unit of measurement for the exposure of X-rays or gamma rays.
Radioactive decay	Radioactive decay is the spontaneous breakdown of the nucleus of an unstable atom resulting in the emission of radiation via the release of energy and matter by from the nucleus.
Radioactive waste	For the purposes of waste management, any material (liquid, gaseous, or solid) that contains a radioactive nuclear substance and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive hazardous substances.
REGDOC	Regulatory Document
Ru-106	Isotope Ruthenium-106
SAF1-1	Water lily-bullhead lily floating-leaved shallow aquatic Ecological Land Classification designation.
SAM1-7	Water milfoil mixed shallow aquatic Ecological Land Classification designation.

SAM1	Mixed shallow aquatic Ecological Land Classification designation.
SAR	Species at Risk
SARA	Species at Risk Act
Sb-125	Isotope Antimony-125
Screening Index	The ratio (i.e., unitless) of an estimated exposure level (or estimated environmental concentrations) divided by a corresponding toxicity reference value or benchmark value.
Se-79	Isotope Selenium-79
SI	See Screening Index
Sievert	The SI unit of absorbed radiation dose in living organisms modified by radiation type and tissue weighting factors. The Sievert is the unit of dose measuring the “equivalent dose” and “effective dose”. Multiples of Sievert used in practice include millisievert (mSv) and microsievert (µSv).
Sm-151	Isotope Samarium-151
Sn-121m	Metastable isotope Tin-121
Sn-126	Isotope Tin-126
SO_2	Sulphur Dioxide
Sr-90	Isotope Strontium
Stage 1 Archaeological Assessment	A study to identify areas where potential archaeological resources may exist. A Stage 1 Archaeological Assessment for the NPD site is included in the Archaeology Technical Supporting Document.
Subsidence	The settling or sinking of a surface due to sub-surface movement.
Substrate	The earthy material that exists in the bottom of an aquatic habitat, like dirt, rocks, sand, or gravel.
Sv	See Sievert ””
SwS	Storage with Surveillance
Ta-182	Isotope Tantalum-182
Tc-99	Isotope Technetium-99
Te-125m	Metastable isotope Tellurium-125
TEEL	Temporary Emergency Exposure Limits
TEQ	Toxic Equivalence Factors
THC	Total Hydrocarbons

TLD	Thermoluminescent Dosimeter - A type of dosimeter used to monitor exposure to radiation. A TLD measures ionizing radiation exposure by measuring the intensity of visible light emitted from a crystal in the detector when the crystal is heated. The intensity of light emitted is dependent on the radiation exposure.
Transite	Fireproof composite material, historically composed of asbestos-cement.
Tritium	An isotope that occurs both naturally and as a by-product in nuclear reactors. Tritium is a radioactive isotope of hydrogen having two neutrons and one proton in its nucleus; hydrogen, by comparison, has only one proton. Tritium has a half-life of 12.33 years.
TSD	Technical Supporting Document
TSP	Total Suspended Particulate
U-232	Isotope Uranium-232
U-234	Isotope Uranium-234
U-235	Isotope Uranium-235
U-236	Isotope Uranium-236
U-238	Isotope Uranium-238
VC	Valued Component (used instead of VEC)
WAS	Wells Area Sump
VEC	Valued Ecosystem Component (not used in this EIS; VC is used instead).
VOC	Volatile Organic Compound
ZEC	A controlled harvesting zone (Zone d'exploitation controlée).
Zr-93	Isotope Zirconium-93

2 EXECUTIVE SUMMARY

2.1 Introduction

The NPD Nuclear Generating Station (NGS) was operated by Ontario Hydro from 1962 until being permanently shut down in 1987, when the responsibilities were transferred to Atomic Energy of Canada Limited (AECL), a federal corporation. It is now referred to as the Nuclear Power Demonstration Waste Facility (NPDWF). Under the federal Nuclear Safety and Control Act, the NPDWF is a Class I nuclear facility presently in interim storage and has a Decommissioning Waste Facility License that was issued in 2014 by the Canadian Nuclear Safety Commission (CNSC).



The NPDWF as it appears today

The Nuclear Power Demonstration (NPD) site is located in Rolphton Township, in the Town of Laurentian Hills in Renfrew County, Ontario, Canada, on the south bank of the Ottawa River, about 25 km upstream of the Chalk River Laboratories (CRL) site (Figure 2.1-1), and approximately 200 km northwest of Ottawa.

The purpose of the proposed project is to safely decommission the NPDWF, ensuring a reduction of Canadian legacy long-term liabilities and eliminating interim waste storage, while reducing worker risk and transport/waste handling risk. The Government of Canada is interested in an approach to completing the decommissioning the NPDWF that protects the public and the environment.

Figure 2.1-1. NPD Site Location



The project is proposed to begin in 2019, with final site restoration occurring in 2020, and long-term care and maintenance activities proceeding from 2020 onwards. The project phases and schedule are presented in Table 2.1-1.

Table 2.1-1. Project Phases and Schedule

Decommissioning Phase	Associated Activities	Duration
Decommissioning Execution	Assembly and operation of batch mixing plant	2019
	Grouting of below-grade structures	2019
	Removal of above-grade structures and use as backfill	2019-2020
	Installation of concrete cap and engineered barrier	2019-2020
	Final site restoration	2020
Institutional Controls	Long-term care and maintenance activities	2020 – 2120
Post-Institutional Controls	Facility performance during the Post-Institutional Controls phase	>2120

Canadian Nuclear Laboratories (CNL), a private sector company contractually responsible for nuclear sites, facilities and assets owned by AECL, is proposing to safely carry out the decommissioning of the NPDWF. As such, CNL is the proponent for the NPD closure project.

Under Section 15 of the Canadian Environmental Assessment Act (CEAA), 2012, the CNSC is considered to be the Responsible Authority for the proposed project.

The Environmental Assessment (EA) is being carried out based on the *Canadian Environmental Assessment Act* (2012) and the CNSC (2016) Regulatory Document REGDOC-2.9.1 on *Environmental Protection: Environmental Policy, Assessments and Protection Measures*. This Environmental Impact Statement (EIS), a required component of the EA process, has been prepared to document the findings of the EA process.



Chimney swifts (*Chaetura pelagica*) entering the NPD ventilation stack at sunset

2.2 Description of the Project

2.2.1 Purpose

The purpose of the project is to safely carry out the decommissioning of the NPDWF using the in-situ decommissioning approach to isolate the contaminated systems and components inside the below-grade structure. All below-grade areas will be sealed with grout and concrete from an on-site batch mixing plant. Grouting is the process of placing, by pumping, a mixture of Portland Cement and water that produces a pourable, concrete-like, mixture to ensure filling of gaps and crevices throughout the facility. All above-grade structures will be demolished, size reduced and placed into the below-grade structure as backfill prior to final grouting. The footprint above the reactor vessel will be capped with reinforced concrete and the entire NPDWF covered with an engineered barrier and the ventilation stack will be retained. The NPD site will then be restored and prepared for long-term care and maintenance activities, carried out under an amendment of the current decommissioning licence.

2.2.2 Alternatives

The in-situ decommissioning described above is the preferred approach proposed by the project to carry out the decommissioning of the NPDWF. Three additional alternative means for decommissioning the NPDWF were considered for the project:

- Continued storage with surveillance – this alternative involves deferral of decommissioning by maintaining the current state, allowing for further radioactive decay and involving continued maintenance and monitoring at the site.
- Partial dismantling and removal – this alternative involves the removal of the reactor system and components to be transported off the NPD site and placed in interim waste storage at CRL until disposal facilities are available. The remaining above-ground structures would be demolished, emplaced in the below grade structures before grouting, as in in-situ decommissioning.
- Full dismantling and removal – this alternative involves removal of all radioactive material to be transported off the NPD site and placed in interim waste storage at CRL until disposal facilities are available. The facility structures would be demolished and removed from the site.

Although each of the four alternative means were determined to be technically feasible based on the use of reliable technology, regulatory compliance, and cost, the in-situ decommissioning offers a lower risk option than all other alternatives. This is because differences between the other alternative means are more pronounced during future time periods where disruptive events and long-term environmental processes occur. These alternative options have greater risks of effects from these events or processes since the waste would be stored above ground. In-situ decommissioning involves emplacement and grouting of waste below ground, thereby limiting the risks.

2.2.3 Wastes and Emissions

The forms of waste generated by the project can be divided into existing waste (e.g., materials such as concrete and stainless steel in the reactor vault, containing radiological and non-radiological contamination) and generated waste (e.g., worker protective equipment and discharge water from equipment wash out).

Radionuclides will be present in these materials in two forms:

- radionuclides embedded within metals and other materials, present due to the interaction of neutrons from the reactor operation with the structures; and
- as contamination on surfaces, mainly resulting from the handling of fuel elements which had suffered failure of their protective cladding, enabling the release of some radionuclides.

The radionuclide inventory of the reactor was estimated using mathematical models representing the reactor materials and geometry. CNL has also taken samples of reactor components to verify the estimated inventory. Contamination in other areas of the NPDWF has been estimated based on previous measurements. These data have been combined with estimates of the amount of material that is contaminated in each room to derive an inventory for the main system, components or stored waste in NPDWF.

The inventory of non-radiological contaminants is dominated by those typically associated with 50-year-old industrial facilities, including:

- Lead: from lead paint and lead bricks, previously used as shielding;
- Mercury: from instruments, such as residual contamination;
- Asbestos: from pipe insulation, floor tiles and building cladding;
- PCBs: from light ballasts which will remain due to inaccessibility; and
- Oils: Evidence of a historical oil leak was found in the tile drains and remediation was undertaken.

The project will also generate emissions, including:

- dust (from demolition, equipment sizing and on-site trucking);
- noise (from machinery, demolition and vehicles);
- diesel emissions (from machinery and vehicles);

- water (from runoff, wash out pit discharges and equipment decontamination); and,
- contaminated air (displaced from the facility during grouting and emplacement).

2.2.4 Scope Changes

The main change that has been made to the original project scope (i.e., since submission of the Project Description), is to retain the existing ventilation stack. After reactor shutdown, the NPD ventilation stack became home to a large number of chimney swifts who roost annually in the chimney-like structure. The ventilation stack is a significant roost during the spring migration and the number of chimney swifts can reach more than 2,000 birds. CNL considered the construction of an alternative roost structure, but based on the recommendation of an expert working group, decided to retain the existing ventilation stack. The ventilation stack is expected to remain structurally sound and capable of continuing to function as a chimney swift habitat for another 50 years. This is expected to complement the timeline for recovery of the species.

2.2.5 Government Communications

CNL has initiated communications with Environment and Climate Change Canada (ECCC) regarding the entombment of a small number of PCB-containing light ballasts in the NPDWF, which pose significant occupational risks to remove, however in this assessment, these ballasts have been demonstrated to have no residual environmental effect by grouting in place.

CNL has also initiated communications with ECCC regarding the submittal of a request for a permit under the *Species at Risk Act (SARA)* to undertake project activities which may affect chimney swifts that use the ventilation stack at the NPD site as a roosting site.

The Ontario Ministry of Transportation (MTO) reviewed the potential traffic implications of the project and expressed no concerns.

2.3 Scope of the Environmental Assessment

In accordance with *CEAA* (2012) and the CNSC 2016 EIS Guidelines, this EIS takes into account:

- *the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project, and any cumulative environmental effects likely to result from the designated project in combination with other physical activities that have been or will be carried out;*
- *the significance of the effects referred to in paragraph (a);*
- *comments from the public — or, with respect to a designated project that requires that a certificate be issued in accordance with an order made under section 54 of the National Energy Board Act, any interested party — that are received in accordance with this Act [CEAA];*
- *mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;*

- *the requirements of the follow-up program in respect to the designated project;*
- *the purpose of the designated project;*
- *alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means;*
- *any changes to the designated project that may be caused by the environment;*
- *the results of any relevant study conducted by a committee established under section 73 or 74 [of CEAA]; and,*
- *any other matter relevant to the environmental assessment that the responsible authority [CNSC], or — if the environmental assessment is referred to a review panel — the Minister, requires to be taken into account.*

The EIS considers these factors for three spatial boundaries: the Site, Local and Regional Study Areas. The Site Study Area extends 50 m into the Ottawa River and includes areas within the NPDWF fenceline and the surrounding paved areas, the building foundations and non-essential roadways, the two landfills on the NPD site and also includes areas that will not necessarily be affected during decommissioning activities but will require work during the site restoration (e.g., due to prior contamination).

The Local Study Area (Figure 2.3-1) goes beyond the Site Study Area and includes the entire NPD property, and also extends 50 m into the Ottawa River. The Local Study Area is defined to encompass any measurable effects of the project. The larger Regional Study Area varies between environmental components to capture the interaction of effects from the project with the effects of other projects within each component.

Figure 2.3-1. Local Study Area



The EIS also considers three different project phases:

- **Decommissioning Execution**, or the first one to two years during which all activities associated with decommissioning of the facility including setup and operation of the batch mixing plant, grouting and demolition activities, installation of the concrete cap and engineered barrier, as well as site restoration and demobilization.
- **Institutional Controls**, or an estimated period of about 100 years following the Decommissioning Execution phase, where long-term care and maintenance and oversight would be performed by CNL in order to ensure that the disposal system performs as expected, that human safety is ensured until the short lived nuclear wastes decay to below the acceptance criteria and that problems that may impact the long-term stability of the facility can be rectified; and
- **Post-Institutional Controls**, or abandonment of the site following the Institutional Controls phase.

2.4 Public and Stakeholder Engagement

CNL has conducted and continues to conduct EA-related public and stakeholder engagement activities, including:

- presentations, information sessions and site visits;
- project information (e.g., web content, fact sheets, etc.);
- participation in public events;
- advertising campaigns and distribution of factsheets and comment cards.

These activities have helped inform stakeholders, and have enabled the public to provide valuable feedback into the project, which helps CNL understand areas of public concern and improve the project design and EIS. Key concerns voiced from the outreach activities are listed below, along with CNL's plan to address these issues:



CNL staff member answering questions at a public information session

Issue	Incorporation into Project Design, EIS and/or Engagement
Species at Risk: How will the decommissioning affect the chimney swifts roosting in the NPD Stack?	• In order to minimize the risk to the chimney swifts, CNL decided to retain the existing ventilation stack, instead of demolishing it and replacing it with an alternative habitat. This decision was made with input from a panel of experts composed of academia, government agencies and Non-Governmental Organizations. • Since their current roost will be retained, the project predicts that effects on chimney swifts from project activities (e.g. noise, dust, vibration and light) will be minimal, given project activities will occur between 7 am and 7 pm (i.e., during daylight hours when the chimney swifts are out foraging) wherever possible. • A subject matter expert on chimney swifts provided advice to CNL on how to protect the chimney swifts during decommissioning activities using best practices, mitigation measures and how to monitor the impacts to the birds.
Ottawa River: How will the Ottawa River be protected?	• The Ottawa River is important for many reasons (water quality, flow, recreational use, fishing, ecology). We have captured these aspects through other VCs, including aquatic biota, fishing and residents use and enjoyment of land. The EIS assesses the impact of the project on these VCs. • Consideration was given to the benefit of in-design mitigation measures in preventing or reducing environmental effects. “In-design” mitigation measures are features included in the project design for the purpose of pre-empting possible environmental effects, based on good practice and CNL experience. For example, the use of grout to fill the structure is expected to slow down the release of contaminants to groundwater and subsequently to the Ottawa River, and allow more time for radioactive decay.
Effects of the environment on the project: Has this project examined the potential effects of an earthquake or climate change or other natural disasters on the NPD?	• The EIS assesses the effects of the environment on the project (e.g., earthquakes, tornados, climate change). • Preliminary results have indicated that the potential radiological doses to both human and non-human biota receptors are magnitudes less than the CNSC established dose criteria which protects the public and environment under all plausible conditions.
Monitoring: How will monitoring occur around the site and how long will the NPD site be monitored post-decommissioning?	• The EIS presents a conceptual description of proposed follow-up monitoring activities for the Decommissioning Execution and Institutional Controls phases. The detailed follow-up monitoring program will be developed incorporating federal reviewer and stakeholder feedback from the draft EIS review. • The proposed follow-up monitoring during demolition and grouting activities will include emission and effluent monitoring as well as regular chimney swift counts during their seasonal presence at NPD. • The proposed follow-up monitoring during the Institutional Controls phase will include visual inspections and monitoring the groundwater for parameters that would be indicative a failure of a safety feature.
Financial: What is the cost of this option in comparison to alternative methods, and who is funding this project?	• A high-level cost analysis of the in-situ decommissioning option compared to other alternatives was conducted. • Funding for the project is provided by AECL, a federal corporation.

Issue	Incorporation into Project Design, EIS and/or Engagement
	• In response to earlier public feedback, at the October public information sessions CNL included information on the approximate costs of alternative methods.
Land Use: How will the unaffected land be released after the project is finished?	• As clarified in previous open houses and within the EIS, AECL is the federal corporation that owns the site and CNL is the operator of the NPD site contracted by AECL to perform the closure of the NPD Site. • The final decision on dispositioning of non-impacted land on the NPD site rests with AECL.

As seen in the table above, while most of the key issues that stakeholders have brought forth have been resolved or incorporated into the design of the project, one outlier is with regards to land use of the unaffected areas of the NPD site. To address this issue, CNL has clarified through consistent messaging and communications with stakeholders that the NPD property belongs to AECL, a federal corporation. Once CNL completes the decommissioning of the NPDWF, AECL will look at the future of the lands. AECL will take into account consideration for stakeholder engagement, as appropriate, and the duty to consult with Aboriginal peoples.

2.5 Aboriginal Engagement

CNL has conducted and continues to conduct engagement activities with First Nations and Métis communities through:

- project notifications and newspaper advertisements;
- letters, email correspondence and/or phone calls to First Nation and Métis communities and/or organization representatives (accompanied by follow-up calls);
- meetings with First Nation and Métis community and/or organization representatives to discuss the project and potential impacts;
- Environment Stewardship Council Meetings (for ESC member communities);
- public information sessions, including display materials and hand-outs;
- media notifications/releases;
- webpage content;
- presentations to First Nation and Métis communities upon request;
- distributing copies of technical studies or reports upon request;
- technical meetings, upon request, to provide interested communities an opportunity to discuss more detailed technical information concerning the project;
- targeted community initiatives;
- project site visits;
- work plan development to formalize engagement processes with communities; and,

- capacity assistance, as appropriate, such as basic costs to support meetings such as hall rental or production of print materials, in-kind access to the technical expertise of CNL staff, reimbursement for some out-of-pocket expenses to participate in engagement activities such as site visits, tours, etc.

Based on the potential or established Aboriginal or treaty rights of First Nation and Métis communities in the vicinity of the project, as identified by the CNSC, the communities engaged are: Algonquins of Ontario, Algonquin Anishinabeg Nation, Métis Nation of Ontario, Williams Treaties First Nations, Union of Ontario Indians and Algonquin Nation Secretariat.

Through these engagement activities, biodiversity and cultural heritage studies have been identified as topics of interest. In response, CNL has:

- Provided copies to communities, where an interest has been expressed, of project documents related to biodiversity, archaeology and the NPD site in general, as well as images and topographical maps of the site;
- Shared informational posters with all identified communities and/or organizations; and,
- Shared updated project information with communities and/or organizations at periodic intervals.

CNL has also provided opportunities for participation of First Nations community members in archaeological assessment field studies undertaken as part of the project.

2.6 Baseline Environment (Description of the Existing Environment)

This description of baseline conditions characterizes the existing environment and processes that may be affected by the project, and trends within the study areas. It serves as the basis for determining changes and potential environmental effects associated with the project.

2.6.1 Atmospheric Environment

The climate in the region surrounding the NPD site is classified as humid continental, with warm summers, cold winters, and no distinct dry season. The average daily temperature ranges from a high of 20.2°C in July to a low of -12.0°C in January, with an average annual temperature of 5.6°C. The wind conditions at the NPD site are considered to travel predominantly along the Ottawa River valley. From 2011-2015, the region received an average of 779 mm of precipitation annually, with average monthly precipitation ranging from 24.7 mm to 96.9 mm per month.

Current releases to air at the NPD site are via operation of the ventilation system, generally only for short periods of time such as during the entry of personnel into the facility which requires purging the nuclear area for inspection and maintenance. These releases are below applicable guidelines. Current emissions of greenhouse gases as well as emissions from unpaved road dust, diesel combustion products, and solvent use are minimal.

2.6.2 Surface Water Environment

The facility currently samples and analyses water from subsurface drains located around the NPD site semi-annually for radiological and non-radiological contaminants. The facility has also characterized surface water and sediment quality in the Ottawa River. The facility samples effluent from the wells area sump prior to discharge to ensure that effluent is below release limits.



The large wetland complex on the NPD property, west of the Site Study Area

All surface drainage on the NPD site ultimately drains to the Ottawa River. The NPD property contains some wetlands (visible in Figure 2.3-1 above) and no major tributaries. A network of ditches and drains on-site directs water flow away from the facility and into the river. The Ottawa River adjacent to NPD is about 0.5 km wide and deep with a mean flow rate of 807 m^3/s. The banks of the Ottawa River generally have low to moderate slopes, although there are steep granite cliffs in sections of the Quebec shoreline. There are numerous lakes in the region and due to regional topography, these lakes eventually drain into the Ottawa River. The EIS summarizes radionuclide content of sediment in the Ottawa River near the NPD site.

2.6.3 Aquatic Environment

There are wetlands on the site; however, they are at a higher elevation than the NPDWF and are not the focus of the characterization of the aquatic environment. The Ottawa River near the NPD site provides habitat for a number of fish species. The stretch of the Ottawa River between the Des Joachims Dam and La Passe contains several lake-like sections separated by short rapids. Some sections of the Ottawa River near NPD reach depths of over 60 m, and the water can become thermally stratified. In this area, the Ottawa River supports diverse warmwater and coolwater fish communities, consisting of at least 55 documented species. The provincially-rare fish species includes the river redhorse.

2.6.4 Geological and Hydrogeological Environment

The surface of the NPD site is covered by a boulder pavement (i.e. large boulders) which, in most areas, has been left as a result of water scouring the area and removing the finer fraction of the river-lain sediments. The base rock in the Site Study Area is quartz and granite gneiss with some overburden (1.5 to 7.5 m) of alluvial sand and gravel. The small amount of overburden and relatively steep incline of the base rocks makes ground and subsurface water run off very quickly to the river. The water table position is near the top of the bedrock, and flow directions are expected to reflect topography. The Site Study Area is at an elevation of approximately 125 m above sea level (asl). The NPD site at Highway 17 has an

approximate elevation of 160 m asl and continues down to the Ottawa River which has an average elevation of 111 m asl.

Groundwater sampling was conducted on the site using existing monitoring wells. Analyses were conducted for tritium, alpha and beta activity concentrations. All samples were well below the applicable benchmarks. However, exceedances of applicable guidelines were reported for manganese. CNL also monitors tritium levels in soil and vegetation.

2.6.5 Terrestrial Environment

The Site Study Area consists primarily of areas previously disturbed by human activity and contains various cultural vegetation communities. These cultural communities provide little suitable habitat to support resident terrestrial species. The Local Study area supports diverse mixed upland areas with some wetland areas scattered throughout.

A number of Species at Risk (SARs) are known to be present at the NPD site including: chimney swift, eastern milksnake, bald eagle, common nighthawk, eastern wood pewee, eastern small-footed bat, little brown myotis, northern myotis and monarch butterfly.



Forest on the NPD property

2.6.6 Ambient Radioactivity

Since the NPDNGS was permanently shut down in 1987, ambient radiation fields in the Site and Local Study Areas have been characteristic of those observed in regions with similar terrestrial and cosmic conditions that are unaffected by nuclear facilities.

2.6.7 Human Health

Within the Site and Local Study Areas, CNL monitors doses to employees and visitors at the NPD site. Data on baseline human health in the Regional Study Area (i.e., the Renfrew County and District and Region de l'Outaouais Health Units) were compiled from 2013 Statistics Canada health profiles, which provide statistics on indicators such as well-being, health conditions and health behaviours. Some differences were noted between the Regional Study Area and the larger population (i.e., the entire province) that were determined to be statistically significant. For example, although more physically active, the residents in the Renfrew County and District Health Unit are less likely to use a bike helmet and consume less fruit and vegetable than the average residents in Ontario. A higher percentage in perceived well-being (health) was observed in the Région de l'Outaouais Health Unit when compared to percentages for the province of Quebec.

2.6.8 Aboriginal Land and Resource Use

While access to the NPD site is currently restricted, it is likely that Aboriginal people and possibly their ancestors living in the Ottawa Valley undertook traditional activities such as: hunting, fishing, trapping, and gathering. CNL has assumed that those activities may also occur in the future.

2.6.9 Socio-Economic Environment

The nearest population centre to the Site Study Area is Rapides-des-Joachims in Aberdeen Township, Pontiac County, Quebec. The village occupies an island in the Ottawa River just upstream from Rapides-des-Joachims. The NPD property is in Renfrew County at the northern end of County boundaries. Renfrew County had an estimated population of 86,966 in 2011. There are five towns within Renfrew County: Arnprior, Deep River, Laurentian Hills, Petawawa, Pembroke and Renfrew. Key employers include Garrison Petawawa, CNL, Renfrew County District School Board and the County itself. Hunting, trapping and angling are important activities in the Regional Study Area. Economic activities generally include forestry, resource mining, agriculture, retail, service, manufacturing and government activities, with some high-tech industry expanding in to the area more recently as well. Highway 17 is the primary transportation route in the vicinity of NPD.

2.7 Assessment and Mitigation of Environmental Effects

The assessment of effects presents an evaluation of how the project may impact the environment, how potential effects can be mitigated and how monitoring can be used to verify the EA predictions.

2.7.1 Effects Assessment Approach

Valued components (VCs) are environmental features considered that may be affected by the project and were identified to be of importance by the proponent, government agencies, Aboriginal peoples, and/or members of the public. VCs selected for the project are listed in Figure 2.7-1 below.



Chimney Swift (*Chaetura pelagica*)



Lady's Slipper
(*Cypripedium acaule*)

Figure 2.7-1. Valued Components Selected for the EIS, by Environmental Component



In this study, some environmental components (e.g., the atmospheric environment etc.) were identified as pathways, meaning that changes in those environmental components could result in effects to VCs in other environmental components.

For project-related effects, potential project-environment interactions were identified for each environmental component and evaluated to identify the likely effect of the change on a VC or on a pathway to VCs in other environmental components. Effects that have the potential to occur after mitigation measures have been applied are referred to as residual effects. If an adverse residual effect was identified, additional mitigation measures were developed and outlined within each environmental component. Monitoring and follow-up activities were also identified to verify the accuracy of the EA predictions and to determine the effectiveness of the implemented mitigation measures.

Any adverse residual effects identified would be subjected to an analysis of significance based on a series of criteria, as follows:

- magnitude;
- spatial (geographic) extent;
- duration/timing;
- frequency/probability;
- reversibility;
- effect on human health; and
- ecological importance of VC.

Then, depending on the rating (low, moderate, high) assigned to each of those criteria, an adverse residual effect would be classified as either a minor or significant adverse residual effect.

2.7.2 Atmospheric Environment

Project activities will result in vehicle and equipment exhaust and greenhouse gas emissions, as well as noise and dust generation, and air displacement from within the facility. These activities have the potential to affect air quality and noise and are expected to be most prominent during the Decommissioning Execution phase. Example mitigation measures include dust suppression techniques to minimize dust generation, regular vehicle and equipment maintenance and idling restrictions to reduce emissions.

Changes in the atmospheric environment were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use (described below). These changes are not expected to result in any adverse residual effects on VCs.

Monitoring for parameters of concern in air, as well as air emissions and greenhouse gas estimates will be carried out to verify the accuracy of EA predictions and the effectiveness of mitigation measures. Monitoring will occur primarily in the Decommissioning Execution phase, since this is when the most air emissions and noise are expected to occur.

2.7.3 Surface Water Environment

During the Decommissioning Execution phase, project activities such as equipment wash out, levelling areas and establishing the project footprint, have the potential to affect site drainage and surface water quality through potential contamination of runoff. Example mitigation measures include runoff diversion and containment, proper washout pit design and operation, and the use of control measures for aggregate, sand and cement stockpiles, and material laydown to reduce infiltration.



Environmental monitoring of the Ottawa River

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially reach the surface water environment. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for the release of soluble contaminants to groundwater and eventually surface water.

Changes in the surface water environment were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and

resource use (described below). These changes are not expected to result in any adverse residual effects on VCs.

Monitoring for significant changes to surface drainage and/or water quality will be carried out to verify the accuracy of EA predictions and the effectiveness of mitigation measures. CNL will continue to monitor surface water quality in the Ottawa River during the Decommissioning Execution and Institutional Controls phase.

2.7.4 Aquatic Environment

In the Decommissioning Execution phase, project activities such as equipment wash out and demolition have the potential to affect aquatic biota through potential contamination of runoff. Example mitigation measures include dust suppression and runoff diversion.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect aquatic VCs. Interactions in other environmental components also have the potential to result in changes to the aquatic environment. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for the release of soluble contaminants to groundwater and eventually to the aquatic environment.

No adverse residual effects were identified for VCs (e.g., lake sturgeon, emerald shiner) in the aquatic environment.

Monitoring and follow-up activities in other environmental components will verify the accuracy of EA predictions and the effectiveness of mitigation measures in the aquatic environment.

2.7.5 Geological and Hydrogeological Environment

In the Decommissioning Execution phase, project activities, such as demolition and material sizing, could affect soil quality through the potential release of contaminated particulate. Example mitigation measures include dust suppression.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for the release of soluble contaminants to groundwater.

Changes in the geological and hydrogeological environment were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use. These changes are not expected to result in any adverse residual effects on VCs.

Monitoring activities such as the measurement of groundwater quality, flow and direction will be carried out during the Decommissioning Execution and Institutional Controls phases to verify the accuracy of the EA predictions and the effectiveness of mitigation measures.

2.7.6 Terrestrial Environment

Project activities, such as demolition and operation of machinery and vehicles, have the potential to affect terrestrial biota, through creation of dust, noise, vibration and encroachment and potentially mortality from transportation (i.e., roadkill). These interactions are expected to be most prominent during the Decommissioning Execution phase. Emissions from machinery and vehicles, and displacement of contamination in air displaced from the facility has the potential to result in exposure effects to terrestrial biota. Interactions in other environmental components also have the potential to result in changes to the terrestrial environment. Example mitigation measures include dust and noise suppression, delineation of work areas and site sweeps for the presence of SARs.

No adverse residual effects were identified for VCs (e.g., chimney swift) in the terrestrial environment.

Monitoring activities, such as checks for SAR species on a per-event basis, and chimney swift monitoring will be carried out to verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects.

2.7.7 Ambient Radioactivity

Project activities, such as grouting the below grade structure and demolition, have the potential to affect ambient radioactivity, through the release of volatile radionuclides in air displaced from the facility and from surface contamination. These are expected to occur primarily during the Decommissioning Execution phase. Example mitigation measures include dust suppression.

Potential changes in ambient radioactivity were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use (described below). These changes are not expected to result in any adverse residual effects on VCs.

Monitoring activities such as routine radiation protection surveys and passive ambient air sampling will be carried out to verify the accuracy of the EA predictions and the effectiveness of mitigation measures.

2.7.8 Human Health

Project activities have the potential to increase radiation dose to workers, e.g., from the release of dust and contamination in air displaced from the facility. Mitigation measures in other environmental components, as well as work control documents and personal protective equipment will be used to reduce potential effects on worker health.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect members of the public. The assessment of human health effects incorporates local food consumption and waste use characteristics. Interactions in other environmental components also have the potential to result in changes to human health. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for release of soluble contaminants to groundwater and eventually to human health.

No adverse residual effects were identified for public or worker health.

Monitoring and follow-up activities such as radiation dose monitoring and indoor air quality monitoring, as well as activities in other environmental components will be carried out to verify the accuracy of EA predictions and the effectiveness of mitigation measures in human health.

2.7.9 Aboriginal Land and Resource Use

Decommissioning Execution activities could produce nuisance effects (i.e., noise and dust) for nearby hunting, trapping, fishing and gathering activities. Mitigation measures in other environmental components, such as dust suppression, timing decommissioning activities and periodic communication updates will be carried out to reduce potential effects on Aboriginal land and resource use.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect Aboriginal land and resource use VCs. Any potential effects on non-human biota could also impact these VCs. Interactions in other environmental components also have the potential to result in changes to Aboriginal land and resource use. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for release of soluble contaminants to groundwater and eventually to Aboriginal land and resource use VCs via surface water.

No adverse residual effects were identified for Aboriginal land and resource use VCs (e.g., gathering).

Ongoing Aboriginal Engagement activities will be used to identify any changing concerns or perceptions related to the project, develop a greater understanding of Aboriginal traditional knowledge and verify the accuracy of EA predictions related to Aboriginal land and resource use.

2.7.10 Socio-Economic Environment

Decommissioning Execution activities could produce nuisance effects (i.e., noise, dust and traffic) for nearby residents and land users. The project footprint could affect landscape and visual setting from the Ottawa River. Mitigation measures in other environmental components, such as dust suppression, timing of decommissioning activities and periodic communication updates will be carried out to reduce potential effects on the socio-economic environment.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect sportfish

and game species (i.e., walleye and white-tailed deer). Interactions in other environmental components also have the potential to result in changes to the socio-economic environment. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for release of soluble contaminants to groundwater and eventually to socio-economic VCs via surface water.

No residual effects were identified for VCs (e.g., walleye) in the socio-economic environment.

Ongoing public and stakeholder engagement activities will be used to identify any changing concerns or perceptions related to the project and will verify the accuracy of EA predictions in the socio-economic environment.

2.7.11 Accidents and Malfunctions

To identify potential accident and malfunction scenarios, decommissioning activities were reviewed to identify hazards, which were assigned frequency, severity and risk ratings. Credible scenarios were grouped based on similar consequence types. Within these groups, the scenario with the greatest potential (a bounding scenario) was identified, and these were used to encompass or bound the effects of other scenarios within the group. A total of ten bounding scenarios were identified (as listed below). Of these, only scenarios 1, 2, 6, 7, 8, 9 and 10 are considered to be accidents and malfunctions. Bounding scenarios 1, 2, 3, 4, 5 are discussed as part of effects of the environment on the project.

1. Forest fire – potential release of radiological contaminants;
2. Forest fire – potential release of non-radiological contaminants;
3. Tornado – potential release of radiological contaminants (considered in Effects of the Environment on the Project below);
4. Tornado – potential release of non-radiological contaminants (considered in Effects of the Environment on the Project below);
5. Flood – potential release of radiological contaminants (considered in Effects of the Environment on the Project below);
6. Accidental exposure to radioactivity - worker;
7. Accidental exposure to chemicals – worker;
8. Underground fire (including equipment fire) – potential release of radiological contaminants;
9. Underground fire (including equipment fire) – potential release of non-radiological contaminants;
10. Collapse of ventilation stack.

Each of these bounding scenarios underwent an analysis to determine the dose estimates for receptors. Based on the severity of the dose, and the probability of occurrence, all bounding scenarios were determined to have negligible risk.

2.7.12 Effects of the Environment on the Project

The EIS includes an evaluation of how climate change, severe weather conditions and other environmental events may interact with and potentially alter the condition and function of the project, such that there would be resultant effects on the environment or human health and safety. The events considered include:

- climate change;
- glaciation;
- forest fires;
- tornados;
- flood;
- earthquake;
- lightning strike;
- ice storm; and,
- changes to the Ottawa River.

No exceedances of relevant criteria were noted for any potential effects of the environment on the project.

2.8 Conclusion

2.8.1 Summary of Findings

Based on the assessment summarized in this EIS, no adverse residual effects were predicted from the NPD closure project for:

- any of the selected VCs;
- the Site, Local or Regional Study Areas; and
- any of the three phases of the project.

Cumulative effects assessments are conducted when residual effects are identified for a given project. They consider the relevant spatial and temporal boundaries and other past, present and future projects or activities whose effects could potentially overlap with the proposed project. As there are no adverse residual effects predicted (including: effects from accidents and malfunctions and effects of the environment on the project), there is no potential for cumulative effects driven by the NPD closure project.

CNL's Aboriginal, and public and stakeholder engagement programs identified interest in a number of VCs, including: water quality in the Ottawa River, chimney swift, and land use and planning. No adverse residual effects were identified for these VCs. Engagements are on-going through the EA process.

2.8.2 Why are there No Adverse Residual Effects?

In-situ decommissioning provides containment and isolation of the NPDWF inventory for a sufficiently long time to ensure that the long-term environmental concentrations do not cause adverse effects to human health or the environment. The engineered barriers restricting contaminant releases from the NPDWF are:

- the majority of the existing radioactivity is embedded within metals that will corrode very slowly in the chemical environment of the decommissioned NPDWF;
- the thick concrete walls of the reactor vault and structure provide barriers that slow the movement of contamination; and

- the use of grout backfill will slow groundwater movement and create an alkaline environment that limits the solubility of key contaminants.

The isolation of contaminants is achieved by:

- historic siting of the facility in bedrock;
- active controls in the short term (e.g., limiting access to site);
- filling much of the NPDWF with grout; and
- placing a concrete slab over the NPDWF, which lowers the probability of future inadvertent intrusion.

On a short time scale, the facility has been in storage with surveillance for over 30 years, with no impact on the environment. All of the proposed operations are known and proven technologies. In-situ decommissioning has been in use for at least 50 years.

In the long term, following the defence-in-depth principle, the assessment has demonstrated that the failure of any of the physical engineered barriers will not compromise the performance of the system. It should be noted that while time is elapsing and eventually leading to the degradation of the engineered barriers (which is taken into account in the assessment), the radioactivity is progressively decaying. The assessment has shown that the effectiveness of the engineered barriers over time and as they progressively degrade is adequate to protect the ever-decreasing radiological hazard at any given point in time.

The EIS highlights areas of uncertainty (e.g., contaminant concentrations, contaminant transport characteristics, land use near NPD, etc.) that could affect the EIS findings. Therefore, consistent with regulatory and international best practices, these uncertainties are addressed for NPDWF as follows:

- Process: it uses a systematic, transparent and auditable process for developing and analysing safety in all phases of the project;
- Comparison with regulatory safety criteria: The safety assessment results are generally orders of magnitude below these criteria; and
- Range of performance indicators: a wide range of indicators (e.g., releases, environmental concentrations, doses, etc.) has been used.

In addition, a range of scenarios has been assessed, to encompass possible conditions during all project phases. The results for the various scenarios is a very valuable confidence-building measure, as it demonstrates that even under a range of different assumptions and conditions, the safety criteria are met. This illustrates the intrinsic robustness of the system, and is further supported by observations of these engineered barriers' durability under natural conditions.

2.8.3 Natural Analogues

The EA of the NPDWF in-situ disposal is a challenging undertaking because of the very long time periods involved. Natural analogues can be used to provide understanding and enhance confidence in the

behaviour of the NPDWF over time. Natural analogues are natural or anthropogenic features that are similar to the features being assessed (e.g., isolation and containment). For the NPDWF, some of the examples of natural analogues include:

- Iron-based materials: It is assumed (in the NPDWF Postclosure Safety Assessment) that the inventory embedded in iron-based materials is released gradually. Reports of corrosion of iron-based archaeological artifacts, native metals and meteorites from various locations under a wide range of environmental conditions were consistent with the assumed range of corrosion in the Postclosure Safety Assessment.
- Concrete/grout/cement: It is assumed that the grout will gradually degrade as the cement constituents are slowly leached out upon contact with groundwater. The cement being considered for radioactive disposal systems is similar to early cements used by the Romans in the 3rd century or those used in Tiryns and Mycenae approximately 1,000 years earlier. These cements demonstrate little degradation over approximately 2,000 years.
- The cap: It is assumed that the cap starts to degrade 100 years after its emplacement and is assumed to have fully degraded (in terms of hydraulic performance) by 1,000 years after decommissioning is complete. Ancient tombs with wooden coffins have stayed dry when covered by such layers for approximately 1300 to 1500 years and are generally well preserved.



Conceptual depiction of the NPDWF after decommissioning is complete. The ventilation stack is retained as a habitat for chimney swifts

These examples illustrate similar long-term behavior of natural systems and support the concepts of the long-term containment provided by the NPDWF.

3 INTRODUCTION

3.1 Location of the Project

The Nuclear Power Demonstration (NPD) site is located in Rolphton Township, in the Town of Laurentian Hills in Renfrew County, Ontario, Canada. It is on the south bank of the Ottawa River, about 3 km downstream of the Des Joachims Dam, approximately 25 km upstream of the Chalk River Laboratories (CRL) site, and approximately 200 km northwest of Ottawa. The other side of the river is the province of Quebec. The centre of the site is located at approximately latitude 46°11'12" N, and longitude 77°39'28" W. The activities of the project occur on federally-owned lands. Other nearby federal lands include Chalk River Laboratories (CRL) and Garrison Petawawa, which are located approximately 25 and 32 km from the NPD site respectively (Figure 3.1-1).



Aerial view of the NPDWF and the Ottawa River, looking east

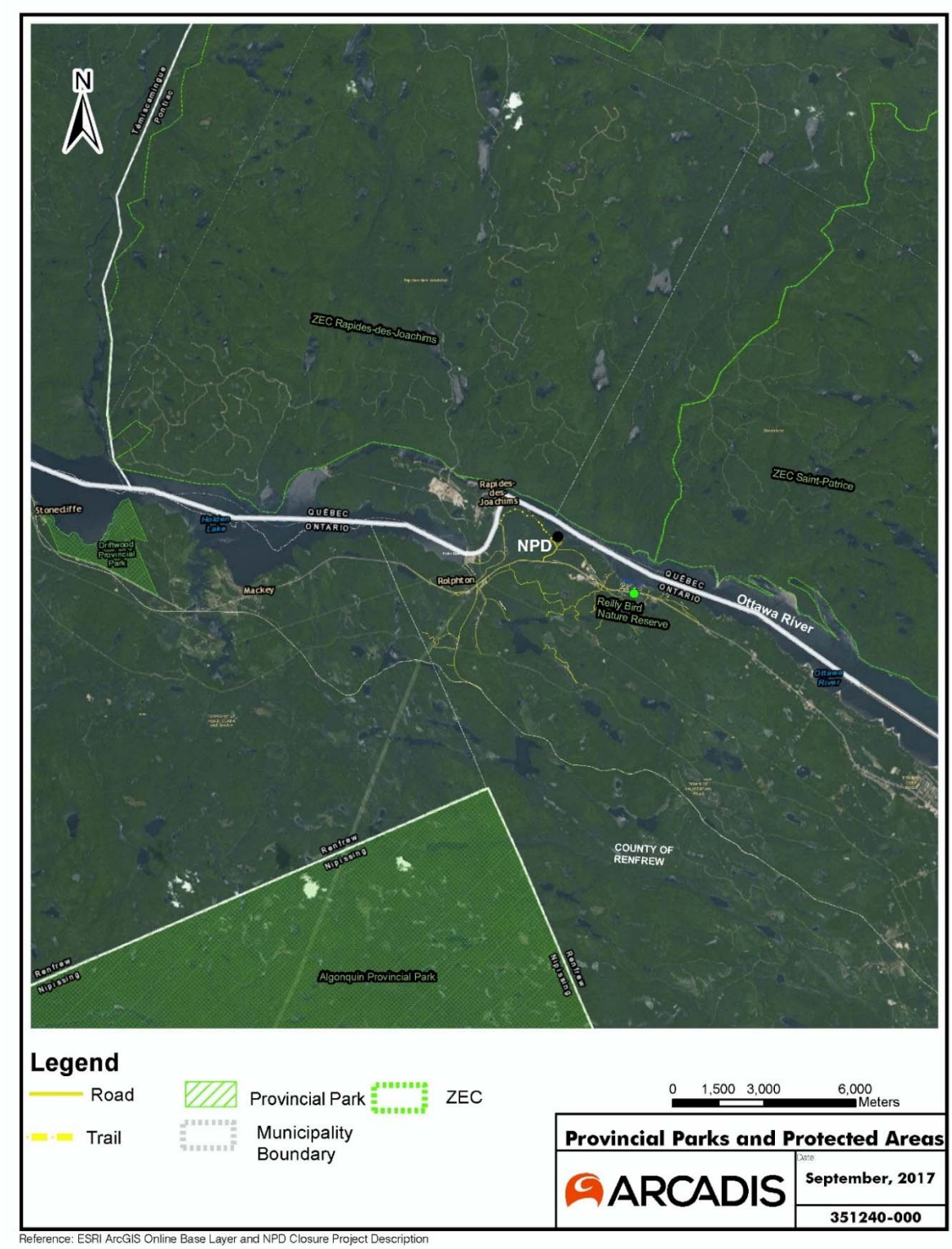
Figure 3.1-1. NPD Site Location



The site is in a remote area, with relatively low population density. The Town of Laurentian Hills has a population of approximately 2,800 distributed over an area of 640 km^2 and contains the former village of Chalk River and the former hamlets of Point Alexander and Rolphton. The nearest population centres are Rapides-des-Joachims, QC (population roughly 170, 3 km northwest) and Deep River, ON (population roughly 4,200, 17 km southeast) (Wills 2013). The nearest individual residents of Laurentian Hills live approximately 1 km from the facility boundary (Wills 2013). The surrounding land is primarily forested. The NPD Site is within the general area of the Algonquins of Ontario Settlement Boundary. More information on Aboriginal communities and traditional Aboriginal territories, treaty and reserve lands, and Métis harvesting regions are discussed in greater detail in Section 7 of this EIS.

The presence of large areas of provincial and federal land within the area present numerous opportunities for activities such as forestry, hunting, fishing recreation and tourism. Nearly half of the land area of Renfrew County is provincial and federal land. The provincial land is dominated by resource uses such as forestry, mineral exploration, fishing and hunting, etc. and is open to the public. The federal land is reserved for the specific uses such as Garrison Petawawa and CNL which are Restricted Access Crown Land. Numerous lakes, river systems and other natural features provide opportunities for recreational and tourist activities. As well, a large stretch of the County's border abuts Algonquin Provincial Park in the west and northwest and the Ottawa River along its full northeast extent providing further access to extensive tracts of recreational opportunity beyond County limits (Renfrew County 2016a). Nearby provincial parks and other protected areas are shown in Figure 3.1-2. The NPD Site contains habitat for a number of federal and provincial Species at Risk (SARs), including: chimney swifts which roost in the NPD ventilation stack, bald eagles and monarch butterflies.

Figure 3.1-2. Provincial Parks and Protected Areas



Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Areas in the immediate vicinity of the facility were originally cleared during construction. Some of these areas are remain disturbed cultural communities. Other areas were revegetated with native trees and shrubs, resulting in healthy, mixed vegetation communities. The property outside the immediate vicinity consists largely of natural areas, such as forest and different wetland types and these areas have remained largely untouched. (Ecological Land Classification (ELC) Technical Supporting Document (TSD)).

3.1.1 Description of Site and Vicinity

The NPD site location and vicinity are shown in Figures 3.1-1 and 3.1-2 respectively. The area of the facility within the NPD site is outlined in Figure 3.1-2, and shown in more detail in Figure 3.1-3. As seen in Figure 3.1-2, the facility occupies a small percentage, i.e., less than 1 percent, of the total NPD site area.

The Nuclear Power Demonstration Nuclear Generating Station (NPDNGS), consisting of a 20 MWe CANDU® (short for CANada Deuterium Uranium) reactor, was placed in service in 1962 and operated by Ontario Hydro. The reactor was heavy water moderated, cooled by pressurized heavy water and fuelled with natural uranium. The main systems of the NPDNGS were the reactor, primary heat transport and moderator systems, turbine, and electrical power generator equipment (Seto 2015). The NPDNGS was shut down in 1987 and placed into a safe interim storage condition. Ontario Hydro then turned over ownership of the facility and compliance responsibilities to Atomic Energy of Canada Limited (AECL), a federal corporation in September 1988 (Wills 2013), and it is now referred to as the Nuclear Power Demonstration Waste Facility (NPDWF). Under the Nuclear Safety and Control Act, the NPDWF is currently a Class I nuclear facility and has a federal Decommissioning Waste Facility License authorized for storage with surveillance activities by the Canadian Nuclear Safety Commission (CNSC). The licensed boundary of NPDWF is outlined in Figure 3.1-4 and represents the area within which activities authorized by the CNSC may occur.

Following permanent shutdown of the NPDNGS, all process systems not required during safe storage were drained and shut down, including the heavy water moderator and heat transport system. The spent fuel was transferred to fuel storage facilities at the CRL site. Any mobile material such as demineralizer equipment was removed for re-use and the entire turbine system, control room and support facilities were cleared out and demolished where possible. Some hazardous materials have been removed such as asbestos insulation and floor tiles. Any redundant buildings and non-nuclear systems were removed (i.e., power house components). The NPDWF currently consists of a limited number of structures including the main building storing the reactor and its associated systems, a diesel-generator, the ventilation stack and the guardhouse.

Outside of the NPDWF, but within the NPD site, there are also two closed landfills, as shown in Figure 3.1-3. The project includes measures to ensure both landfills have been assessed and are prepared for the postclosure period. In addition, three underground storage tanks, used for diesel, heating furnace oil, and radiological liquid waste, were located on the NPD site, but have since been removed and the surrounding soil remediated (King 2016).

The Site, Local and Regional Study Areas for the project are described in Section 5.2.1 of this document.

Figure 3.1-3. NPD Site Vicinity (Source: Seto 2015)

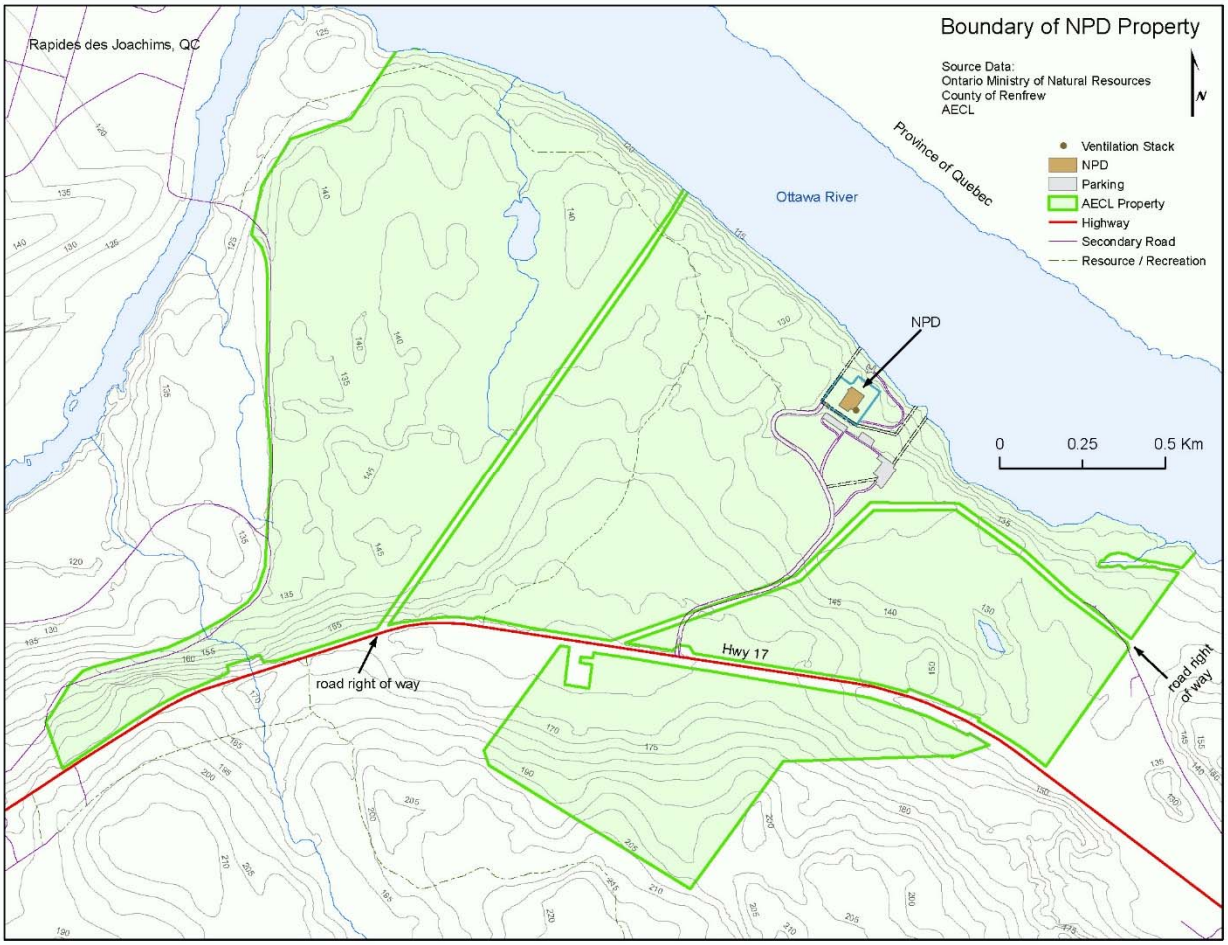


Figure 3.1-4. NPDWF and Surrounding Area (Source: King 2016)

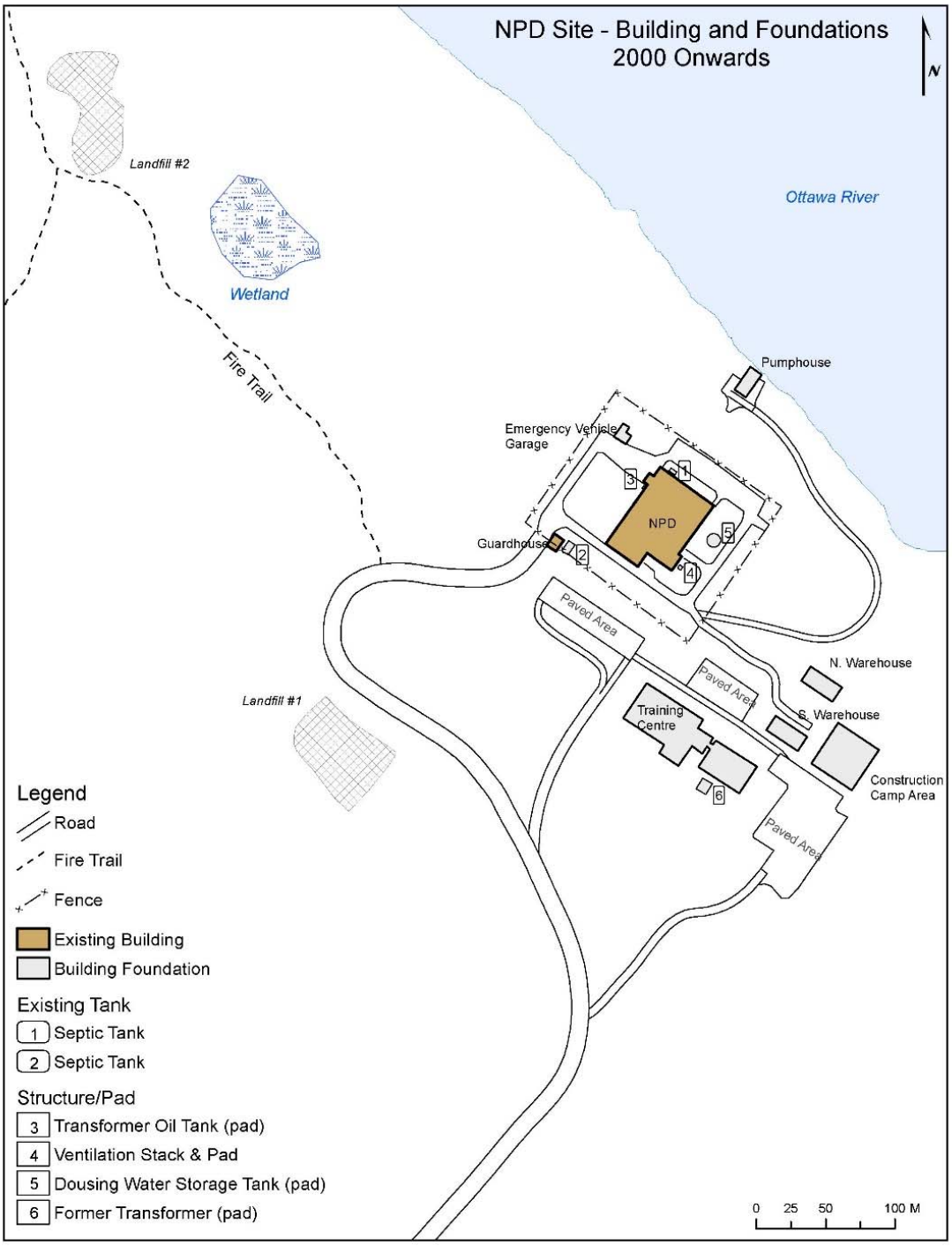
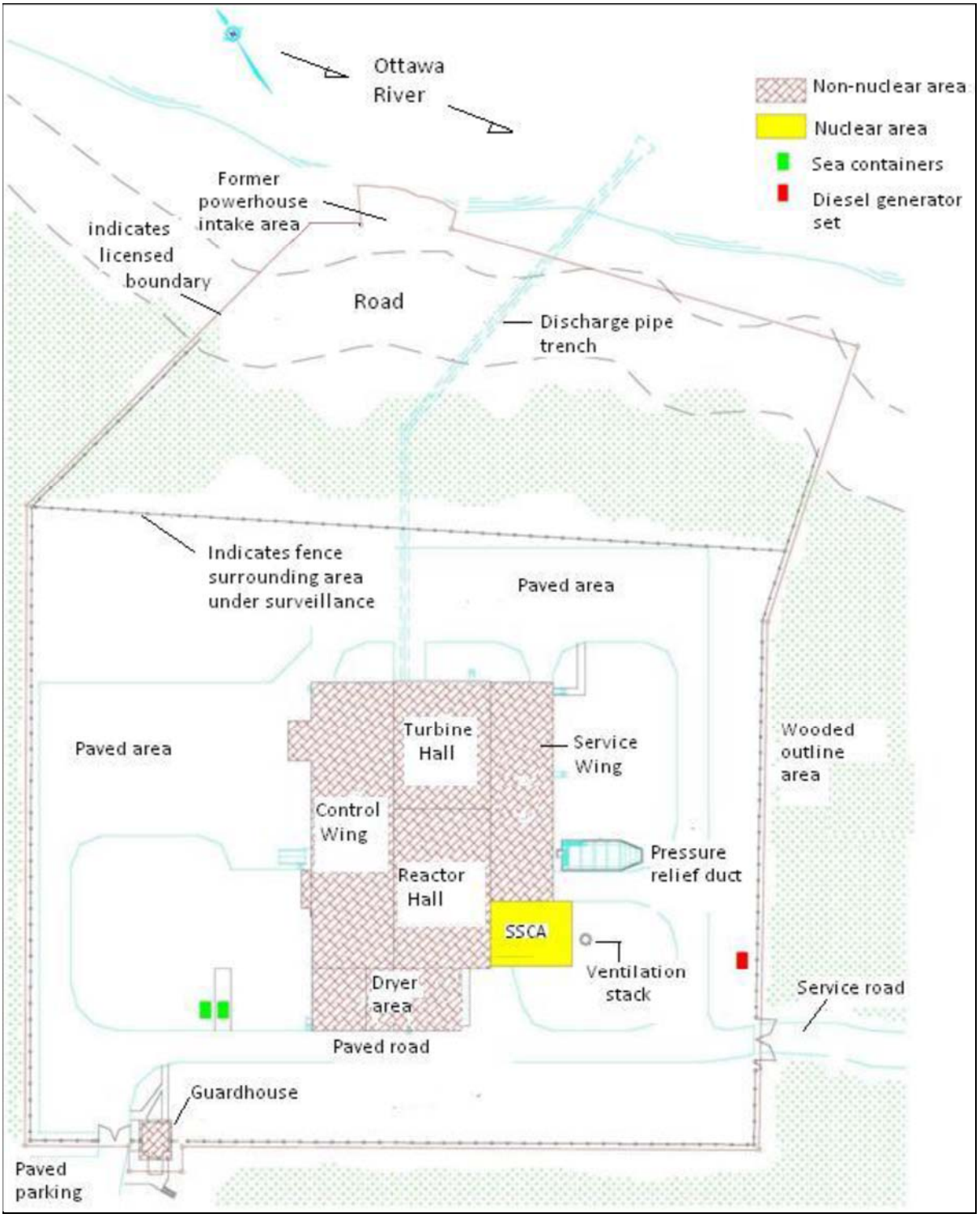


Figure 3.1-5. NPDWF Licensed Boundary (Seto 2015)



3.2 Project Overview

The proposed project is titled the "*Nuclear Power Demonstration Closure Project*", and is hereafter referred to as "the project" or "the NPD closure project". The purpose of the project is to safely carry out the decommissioning of the NPDWF.



The NPD ventilation stack has become a significant migratory roost for chimney swifts (*Chaetura pelagica*), a listed Species at Risk

At the time of the NPDNGS permanent shutdown, the preferred decommissioning strategy for the reactor was one of deferred decommissioning. A deferral period allowed the significant reduction of radiation fields emanating from the reactor and associated process systems as a result of radioactive isotopes decay. In 1988, after the facility was shut down, total residual radioactivity in the NPD reactor system was estimated to be 2×10^{15} Bq. Since shut down, 29 years of radioactive decay have reduced radioactivity considerably as the majority of the short-lived radionuclides have decayed. The total residual radioactivity by 2018 will have decayed to 4.7×10^{13} Bq and is dominated by long-lived beta and gamma radionuclides.

The Government of Canada is interested in an approach to completing the decommissioning the NPD reactor that protects the public and the environment; however, disposal capabilities for the reactor systems and components present at NPDWF are limited.

The project proposes in-situ decommissioning of the NPDWF, which isolates the contaminated systems and components inside the below-grade structure thus creating a waste disposal facility on the NPD site. All below-grade areas will be filled with grout. A grout and concrete batch mixing plant will be assembled on site, to produce the required grout and concrete. The above-grade structures will be demolished, size reduced and placed into the below-grade structure as backfill prior to final grouting. The ventilation stack, a current roosting structure for chimney swifts, will be retained. The grouted reactor system and components will then be capped with a concrete cap and covered with an engineered barrier. The NPDWF area will be restored and prepared for long-term care and maintenance activities. These activities are to be carried out under an amendment of the current decommissioning licence to allow for disposal of nuclear wastes.

The proponent of the project, CNL, is proposing to carry out a designated project on federal land. Proponent contact information is provided in Section 3.4 of this document. CNL has prepared a Project Description (Titterington 2016), which provides general information on the site and location of the project. In addition, Section 3.1 above provides details on the NPD site and vicinity, and the NPDWF within the NPD site.

The project is proposed to begin in 2019, with final site restoration occurring in 2020, and long-term care and maintenance activities proceeding from 2020 onwards. The project phases and schedule are presented in Table 3.2-1.

Table 3.2-1. Project Phases and Schedule

Decommissioning Phase	Associated Activities	Duration
Decommissioning Execution	Assembly and operation of batch mixing plant	2019
	Grouting of below-grade structures	2019
	Removal of above-grade structures and use as backfill	2019-2020
	Installation of concrete cap and engineered barrier	2019-2020
	Final site restoration	2020
Institutional Controls	Long-term care and maintenance activities	2020 – 2120
Post-Institutional Controls	Facility performance during the Post-Institutional Controls phase	>2120

Source: Detailed Decommissioning Plan NPD Closure Project (Aikens 2017).

3.3 NPD Site and Facility Description

3.3.1 Structures at the NPD Site

The current layout of buildings and foundations at NPDWF is illustrated in Figures 3.1-3 and 3.1-4 above (Seto 2015). The remaining permanent structures at the NPD site are:

- Main Building – The former purpose of the Main Building substructure was to house the reactor, its associated equipment, and to provide shielding and containment. It has a one-storey above ground structure with five levels below grade, and has a building footprint of approximately 2,600 m^2.
- Ventilation stack – The former purpose of the ventilation stack was to discharge airborne effluent from the Main Building. The ventilation stack is a reinforced concrete structure 45.7 m high.
- Guardhouse – The purpose of the guardhouse is to serve as an access control point into the NPDWF. It is a standalone building at the entrance to the fenced area. It is a one-storey above ground structure with a building area of 80 m^2.
- Pressure Relief Duct – The former purpose of the pressure relief duct was to provide an emergency relief for steam from the boiler package. It is a reinforced poured concrete construction that is 18 m in length and 6 m in width and 10 m below grade level.
- Diesel Generator Enclosure – The enclosure houses a diesel-generator set which provides emergency power to mitigate power interruptions at the facility.

There are also temporary facilities onsite such as sea containers, office trailers and portable washrooms. A monitored security fence surrounds the NPDWF Main Building, and access into this area is controlled by CNL (Aikens 2017).



The NPDWF main building and ventilation stack

Foundations from the previously removed pump house, emergency vehicle garage, training centre, construction camps, warehouses, dousing tank, transformer and an administration wing remain onsite. There are also two landfills on site which are currently closed. Landfill #1 was used for conventional purposes (e.g., office and cafeteria waste) during the operation of the facility while Landfill #2 was used as a laydown area during construction of the site. Landfill #1 has a certificate of approval (A413107) from the Ontario MOECC acknowledging closure of the landfill. During operation, the domestic sanitary services consisted of two septic tanks which remain onsite but are not in use. There are also buried utilities and drainage systems onsite, some of which are still in use. The NPDNGS also had two underground storage tanks, for diesel

fuel and furnace oil, as well as a tank which contained the radiological liquid waste, all of which were previously removed and soils around them remediated (King 2016).

3.3.2 NPDWF Description

The main building has one story above ground and five levels below ground. The above-ground building consists of the reactor and turbine halls, flanked on the east by the service wing, and on the west by the control wing. Figure 3.3-1 shows a section view of the NPDWF; however, it does not show the two outer wings. As outlined in the decommissioning plans (Aikens 2017), the above-ground structures will be demolished, and the debris will be placed into the lower levels as backfill and covered with grout before the concrete cap and engineered barrier is placed over the grouted facility.



Historical Photograph of the NPD Control Room

Figure 3.3-1. Section View of the NPDWF (Source: Killey 2014)

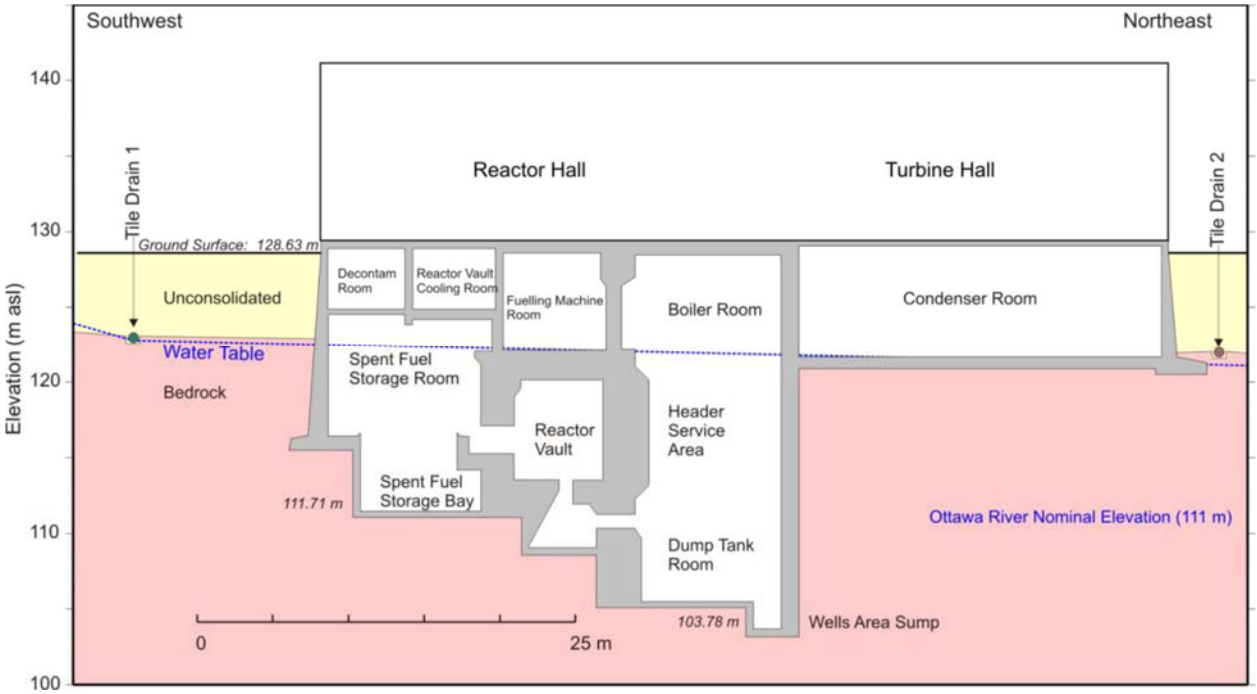
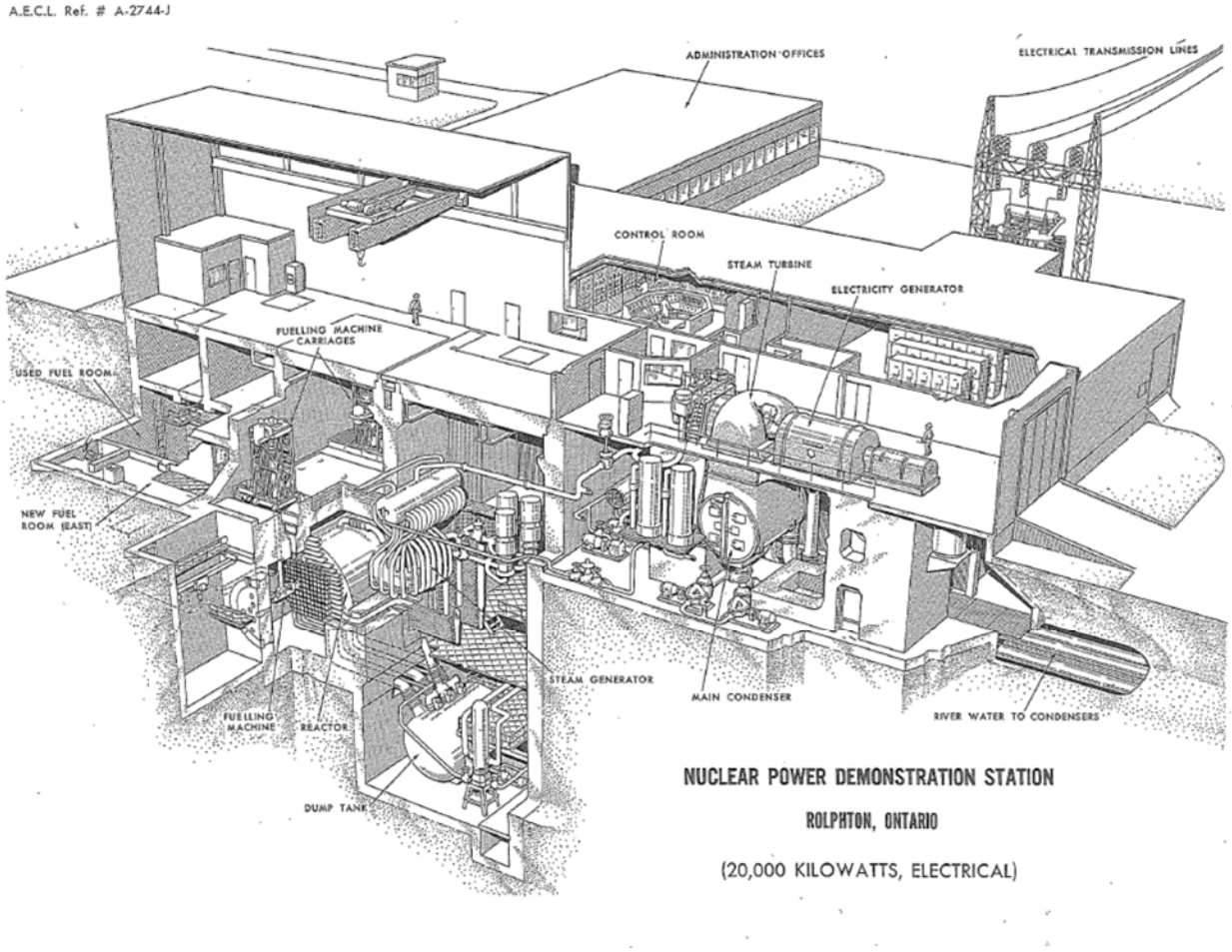


Figure 3.3-2 below provides an cross-section view of the Main Building and these structures during operation. The reactor was heavy water moderated, cooled by pressurized heavy water and fuelled with natural uranium. The reactor core, or calandria, contained 132 horizontal fuel-containing pressure tubes and was surrounded by the heavy water moderator. The heat transport system pumps circulated the hot pressurized heavy water through the reactor coolant tubes to a heat exchanger/boiler unit where the heat was transferred to the boiler steam and water system. The reactor, boiler and auxiliary systems were installed below ground and were surrounded by concrete as shielding to protect the surrounding accessible areas from radiation during operation. Steam generated in the boilers was transferred to the turbine/generator for electrical power generation.

Figure 3.3-2. Cross-Sectional View of the Main Building



As noted above, during shutdown operations the heat transport and moderator systems heavy water was drained and shipped off site. The reactor was de-fuelled and the fuel bundles were transferred to the CRL site. Demineralizer system equipment was removed from the various nuclear process systems and dispositioned (Seto 2015).

3.3.3 Topography

The area surrounding the NPD site, with the exception of the Laurentian Hills directly north and east across the river in Quebec, consists of gently rolling hills, interspaced with many small lakes. The NPD site is situated on the Ottawa River, which runs northwest to southeast, and is at an elevation of approximately 125 m above sea level (asl). The site is situated on a regionally relatively flat area, dipping from a topographic high (approximately 225 m asl) beginning on the north side of Tee Lake (see Figure 8.5-1, below), to Highway 17, which has an approximate elevation of 160 m asl, continuing to the Ottawa River which has an average elevation of 111 m asl (see Figure 3.1-2) (Wills 2013). During the construction of the generating station, numerous man-made terraces and steep interconnecting benches were created for construction and security purposes. This activity has resulted in a highly modified landscape at the NPD site (Wills 2013).



NPD and surrounding landscape

3.4 Applicant Organization

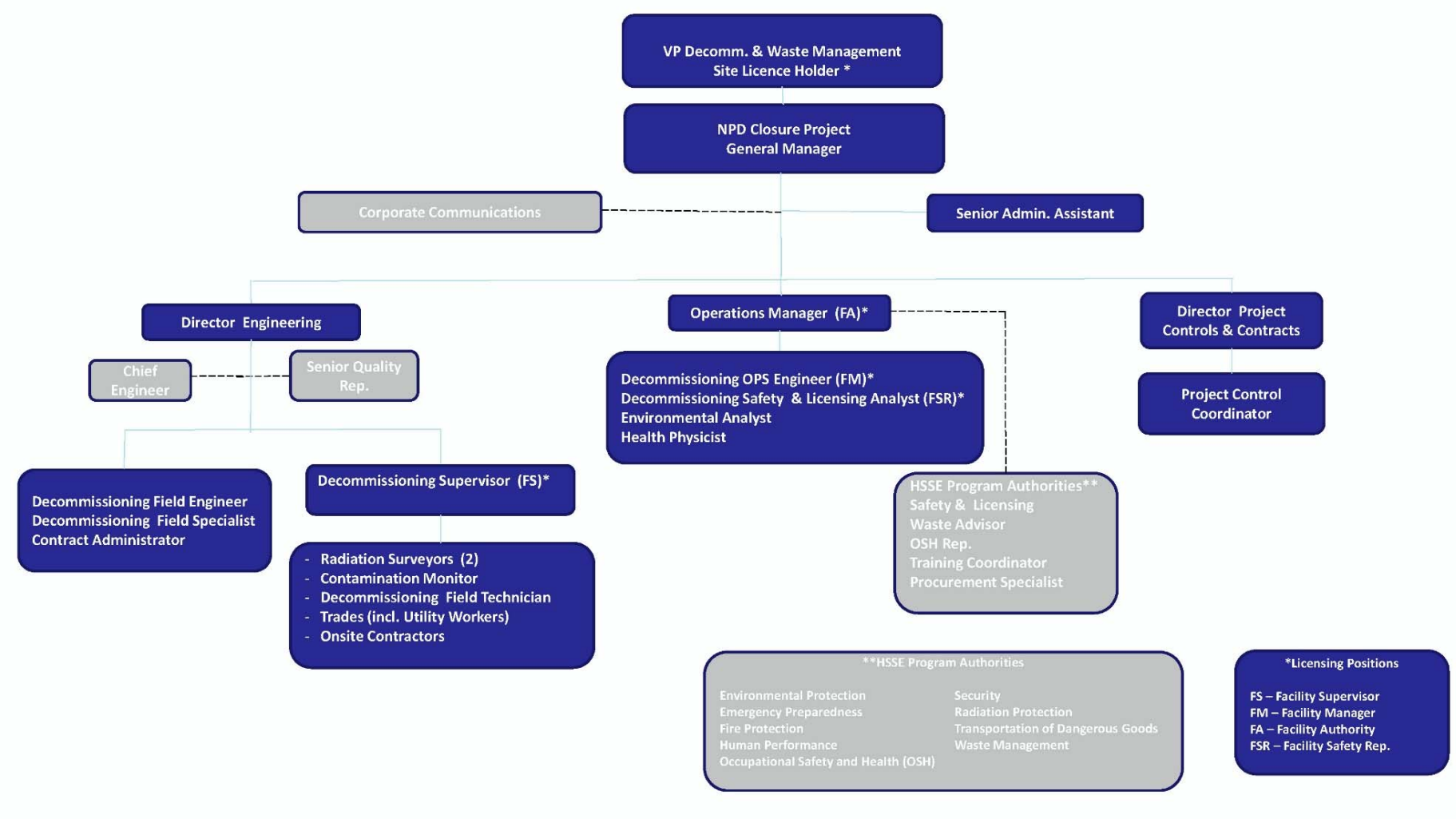
As discussed in Section 3.1 above, CNL is the licensee for the NPDWF, and is the proponent for this project. CNL is a private sector company that is contractually responsible for the management and operation of AECL's nuclear sites, facilities and assets, including the NPD site, and for the performance of AECL's waste and decommissioning responsibilities, under a Government-owned, Contractor-operated (GoCo) model (Schruder 2017).

The primary representatives for the project are:

Mr. Pat Quinn
Director, Corporate Communications
Canadian Nuclear Laboratories
Chalk River Laboratories
286 Plant Road, Building 700
Chalk River, Ontario, K0J 1J0
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Figure 3.4-1 presents the organizational structure for the NPD closure project.

Figure 3.4-1. Project Team Roles and Organization



3.5 Regulatory Framework and the Role of the Government

Environmental Assessment (EA) is a process for reviewing alternative means of carrying out the project, identifying valued components (VCs), project and environment interactions, predicting environmental effects, identifying mitigation measures, assessing accidents, malfunctions, and cumulative effects, evaluating significance, public and stakeholder engagement, Aboriginal engagement, reporting and following-up to verify accuracy and effectiveness. The EA process for this project is being carried out based on the current versions of the *Canadian Environmental Assessment Act* (2012) and the Canadian Nuclear Safety Commission (CNSC) Regulatory Document REGDOC-2.9.1 on *Environmental Protection: Environmental Policy, Assessments and Protection Measures* (CNSC 2016b). This is discussed further in the sub-sections below.

This Environmental Impact Statement (EIS), a required component of the EA process, has been prepared to document the findings of the EA process that meets the requirements of the *Generic Guidelines for the Preparation of an Environmental Impact Statement pursuant to the Canadian Environmental Assessment Act, 2012*. The specific requirements for the EIS are discussed further in Section 5.1.

3.5.1 Regulatory Basis: Canadian Environmental Assessment Act

The Canadian *Environmental Assessment Act* (*CEAA* 2012) is the legal basis for the federal EA process. The CEA Agency sets out the responsibilities and procedures for carrying out EAs that involve federal government decision-making.

Under *CEAA* and its regulations, the proposed project qualifies as a Designated Project, as it results in an end state that includes the disposal of nuclear waste. The *Regulations Designating Physical Activities* (CNSC 2012) identify the CNSC as the Responsible Authority for projects of this type. Therefore, the CNSC is responsible for the conduct of this EA, under *CEAA*; this is further discussed in Section 3.5.2 below.

3.5.2 Regulatory Authority: Canadian Nuclear Safety Commission

The CNSC is the main regulatory authority for this project. The CNSC's Regulatory Document REGDOC-2.9.1 (CNSC 2016b), describes how the CNSC requires EAs to be undertaken for designated projects under *CEAA*. The CNSC requires EAs to be carried out under either *CEAA* or the *Nuclear Safety and Control Act* (*NSCA* 2000). Because this project qualifies as a Designated Project, the EA will be carried out under *CEAA* rather than the *NSCA*. This is an important distinction that affects the process by which the project obtains the necessary licence amendment.

As noted in the previous section, the CNSC is the Responsible Authority for this project, and also regulates the current NPDWF, by way of the existing site licence. CNL currently holds a Class I Nuclear Facility Licence for the NPDWF (*Waste Facility Decommissioning Licence, Prototype Waste Facilities)*, issued by the CNSC under the *NSCA*.

The primary legislation of the CNSC is the *NSCA*, and the regulations made under it. These regulations are identified below; however, as discussed in the Licensing Plan (Walker 2016), these regulations vary in their level of direct applicability to the project, and as drivers of the overall licensing framework:

- General Nuclear Safety and Control Regulations (SOR/2000-202);
- Radiation Protection Regulations (SOR/2000-203);
- Class I Nuclear Facility Regulations (SOR/2000-204);
- Nuclear Substances and Radiation Devices Regulations (SOR/2000-207);
- Packaging and Transport of Nuclear Substances Regulations, 2015 (SOR/2015-145);
- Nuclear Security Regulations (SOR/2000-209);
- Nuclear Non-Proliferation Import and Export Control Regulations (SOR/2000-210);
- Administrative Monetary Penalties Regulations (SOR/2013-139); and
- Canadian Nuclear Safety Commission Cost Recovery Fees Regulations (SOR/2000-212).

In addition to the above regulations, several CNSC technical guidance documents are applicable to the project, including:

- CNSC (2000) *Regulatory Guide – Decommissioning Planning for Licensed Activities* (G-219) *[June 2000 version]*;
- CNSC (2004) *Regulatory Policy – Managing Radioactive Waste* (P-290) *[July2004 version];*
- CNSC (2006) *Regulatory Guide – Financial Guarantees for the Decommissioning of Licensed Activities* (G-206) [June 2000 version];
- CNSC (2006) *Regulatory Guide – Assessing the Long-Term Safety of Radioactive Waste Management* (G-320) *[December 2006 version]*;
- CNSC (2014) *Safety Analysis – Deterministic Safety Analysis* (REGDOC-2.4.1) *[May 2014 version*;
- CNSC (2012) *Public Information and Disclosure* (RD/GD-99.3) *[March 2012 version]*;
- CNSC (2016) *Public and Aboriginal Engagement – Aboriginal Engagement* (REGDOC-3.2.2) *[February 2016 version]; and*
- CNSC (2016) Environmental Protection: *Environmental Policy, Assessments and Protection Measures* (REGDOC-2.9.1).

3.5.3 Additional Regulatory Authorities & Legislation

In addition to the CNSC, the project is subject to other regulatory authorities and legislation, and may require a number of permits and authorizations, including the following:

3.5.3.1 Environment Canada

Canadian Environmental Protection Act, 1999

The *Canadian Environmental Protection Act* of 1999 (*CEPA*) is broadly relevant to the project, in that it defines the nature of toxic substances (including heat), risk assessment, and defines unreasonable risk for certain scheduled substances. Risk is a key concept in both the *CEPA* and the *NSCA* for environmental protection.

Regulations under *CEPA* which may be relevant to the project include:

- the *PCB Regulations:* fluorescent light ballasts in the NPDWF are suspected to contain PCBs. CNL has initiated communications with Environment and Climate Change Canada (ECCC) regarding the entombment of a limited number of PCB-containing light ballasts in the NPDWF that are not safely accessible (Dolinar 2017) and;
- the S*torage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations:* a petroleum storage tank registration may be required, depending on the size of the diesel tanks installed on the NPD site to support decommissioning activities, if required (Aikens 2017).

Migratory Birds Convention Act, 1994

The *Migratory Birds Convention Act* (1994) protects migratory birds, including nests and eggs. According to the decommissioning plans (Aikens 2017), no tree clearing is expected during the decommissioning. Should this change, mitigation measures will be applied (discussed in Section 9.6.3.2).

Species at Risk Act, 2002

The purposes of the *Species at Risk Act* (*SARA* 2002) are to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

A permit under *SARA* (2002) is being sought to undertake decommissioning activities which may disturb chimney swifts (a SAR) which use the ventilation stack as a roost during migration (Dolinar and Vickerd 2017). Potential sources of disturbance to the birds during decommissioning activities are noise, vibration, dust, encroachment and light.

3.5.3.2 Fisheries and Oceans Canada

Fisheries Act, 1985

The purpose of the *Fisheries Act*, under Fisheries and Oceans Canada (DFO), is to protect the productivity of recreational, commercial, and Aboriginal fisheries. It focusses on managing threats to the sustainability and ongoing productivity of these fisheries, providing compliance and protection tools, clarifying regulatory requirements, and, enabling partnerships to allow appropriate agencies and organizations to provide fisheries protection services.

At present, based on the decommissioning plans (Aikens 2017), no in-water works will be completed as part of the decommissioning process. Should this change, the self-assessment tool available on the DFO website will be used to determine if a project review is required.

3.5.3.3 Natural Resources Canada and the CNSC

Nuclear Liability and Compensation Act, 2015

The *Nuclear Liability and Compensation Act* (*NLCA*) strengthens the compensation and civil liability regime for damages that result from a nuclear accident. It substantially increases a nuclear operator's liability for damage, and sets out clear designations for 'nuclear installations' and their respective liability amounts. It also upholds the principle that the operator is held responsible and accountable. The *NLCA*'s designated nuclear installations list includes facilities used to manage radioactive waste, and therefore CNL has a Nuclear Liability Insurance policy for the NPD site. However, the *NLCA* focuses on compensation after-the-fact, and therefore is not a primary regulatory driver for the EA.

3.5.3.4 Canadian Standards Association

In addition, though not necessarily a regulatory authority (i.e. a legislated government agency), the Canadian Standards Association (CSA) produces several standards and guidance documents that are potentially applicable to aspects (or to the overall approach) of the project. The following CSA standards/guidance documents are also specifically identified on the CNSC's website or in guidance documents that are applicable to the project. These include:

- CSA (2000) *Phase II Environmental Site Assessment.* (Z769-00) [Reaffirmed: 2013].
- CSA (2001) *Phase I Environmental Site Assessment.* (Z768-01) [Reaffirmed: 2012].
- CSA (2010) *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.* (N288.4-10) [Reaffirmed: 2015].
- CSA (2011) *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*. (N288.5-11).
- CSA (2011) *Guidance for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances.* (N292.5-11).
- CSA (2012) *Management system requirements for nuclear power plants* (N286-12).

- CSA (2012) *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*. (N288.6-12).
- CSA (2013) *Fire protection for facilities that process, handle, or store nuclear substances.* (N393-13).
- CSA (2014) *Management of low-and intermediate-level radioactive waste.* (N292.3-14).
- CSA (2014) *Decommissioning of facilities containing nuclear substances.* (N294-09) [Reaffirmed: 2014].
- CSA (2015) *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills.* (N288.7-15).
- CSA (2016) Proposed new standard: *Long-term management and disposal of radioactive waste and irradiated fuel.* (N292.6) [In development].

3.5.3.5 Ontario Provincial-Level Permits/Authorizations:

As discussed in the Licensing Plan (Walker 2016), federal authorities and agencies typically are not subject to provincial permitting. However, federal agencies must ensure that their activities (those which would otherwise require provincial permits) are carried out in a manner that meets the intent of the corresponding provincial permitting.

The project is being undertaken on federal lands thus it is not anticipated that any provincial permits will be required.

3.5.3.6 Guidelines and Standards for Effects Assessment

Various federal and provincial guidelines and standards have been used to assess potential environmental effects from the project. These are discussed in detail in Section 9, and include Canadian Council for Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (CEQG) and MOECC Soil, Groundwater and Sediment Standards, Health Canada Drinking Water Quality Guidelines and Provincial Water Quality Objectives (PWQO).

3.6 Report Organization

This EIS report responds to the needs outlined in Section 3.5, as well as the requirements of the EIS Generic Guidelines Document (CNSC 2016a).

3.6.1 Report Organization

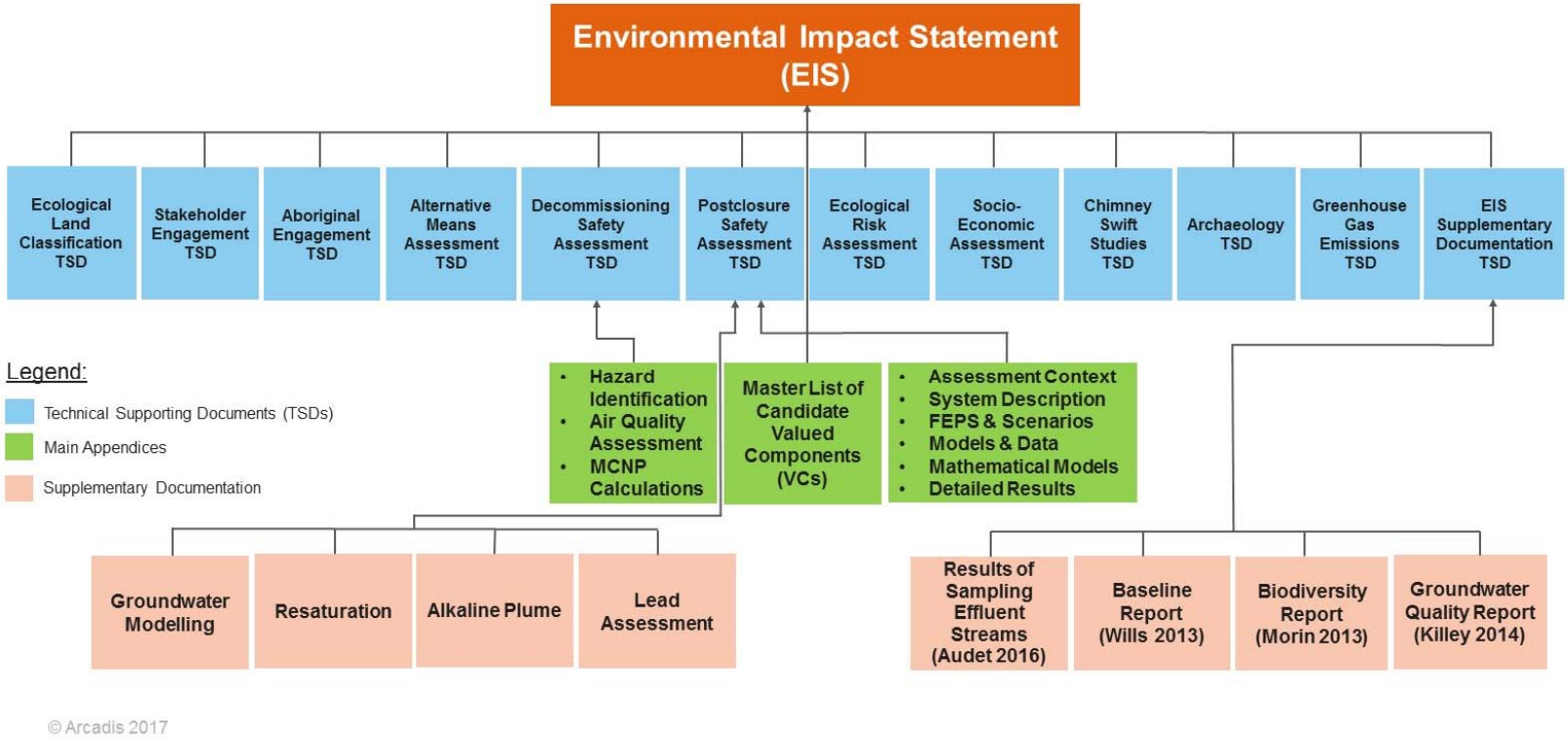
The basic structure of this EIS is as follows:

1. **GLOSSARY:** Above.
2. **EXECUTIVE SUMMARY:** Above.
3. **INTRODUCTION:** This section.

4. **PROJECT DESCRIPTION:** Describes the purpose and alternative means of carrying out the project, the scope of the project, waste and releases, project schedule, and project-related employment.
5. **SCOPE OF THE ENVIRONMENTAL ASSESSMENT:** Describes the factors to be considered, scope of factors including spatial and temporal boundaries, project-environment interactions, constituents of potential concern (COPCs), and VCs.
6. **PUBLIC AND STAKEHOLDER ENGAGEMENT:** Describes the public and stakeholder engagement program and summarizes the findings of the engagement activities. Discusses how public and stakeholder concerns are addressed in the EIS.
7. **ABORIGINAL ENGAGEMENT:** Describes the Aboriginal engagement undertaken, and summarizes the findings of the outreach activities found in the Aboriginal Engagement Report. Discusses how the concerns expressed by Aboriginal groups are addressed in the EIS.
8. **DESCRIPTION OF THE EXISTING ENVIRONMENT:** describes the existing environment (i.e., baseline conditions) and its most important features.
9. **ASSESSMENT & MITIGATION OF ENVIRONMENTAL EFFECTS:** focusses on the potential interactions between the project and the environment, determines any adverse effects, and indicates ways in which such effects would be mitigated. It also includes the identification and assessment of any residual effects, potential accidents and malfunctions, cumulative effects, and effects of the environment on the project.
10. **MITIGATION MEASURES:** summarizes the mitigation measures to be undertaken
11. **CONCLUSION ON SIGNIFICANCE:** summarizes the significance or importance of any adverse residual effects on the environment from the project, potential accidents and malfunctions, cumulative effects, and effects of the environment on the project.
12. **FOLLOW-UP PROGRAM:** summarizes the plan for and preliminary scope of the monitoring and follow-up program, including locations for monitoring and the duration and/or frequency of monitoring activities.
13. **REFERENCES.**

Figure 3.6-1 shows the various documents associated with the EIS, and their relationships. As seen in Figure 3.6-1, much of the information in this EIS has been extracted from TSDs. The TSDs present information on the existing environment, as well as assessments of the potential effects related to the NPD closure project for the various environmental components and phases of the project. The present document has been prepared based on the information available in the TSDs at the time of preparation of this document (i.e., before September 2017).

Figure 3.6-1. EIS Documents and Relationship



3.6.2 Concordance with EIS Guidelines

Table 3.6-1 below presents the project's concordance with the CNSC (2016a) EIS Guidelines.

Table 3.6-1. Table of Concordance

Guideline[1] Section	EIS Guidelines Information Requirement	Corresponding EIS Section (or N/R – shown in bold[2])
1. Presentation and Organization of the EIS	Glossary (including technical words, acronyms and abbreviations)	1 – Glossary
	Table of Concordance	3.6 – Report Organization - Table of Concordance
2. Executive Summary	Executive Summary to be a stand-alone document, which includes: • a concise description of all key components of the project and related activities; • a summary of the consultation conducted with Aboriginal groups, the public, and government agencies, including a summary of the issues raised and the proponent's responses; • an overview of the key environmental effects of the project and proposed technically and economically feasible mitigation measures; and • the proponent's conclusions on the residual environmental effects of the project after taking mitigation measures into account and the significance of those effects.	2 – Executive Summary
3. Introduction and Overview	3.1 Project Overview: a. Description of project, identification of key project components and associated activities. b. Scheduling details, timing of each phase and other key features.	3.2 – Project Overview
	3.2 Project Location: a. Geographical setting (with maps) including project components, project boundaries, existing infrastructure, adjacent land uses and important environmental features. b. Site, local and regional study areas. c. Proximity to federal lands. d. Environmental significance and value of the geographical setting. e. Proximity to environmentally sensitive areas (e.g., parks, wetlands and habitats of SAR). f. Description of local Aboriginal communities, Aboriginal territories, treaty lands and reserve lands.	a. 3.1 – Location of the Project; 3.3 – NPD Site and Facility Description b. 5.2.1 – Spatial & Temporal Boundaries of the Assessment; 8.0 (specific to Environmental Components). c. 3.1 – Location of the Project. d. 8.4 – Aquatic Environment; 8.6 – Terrestrial Environment.

Guideline[1] Section	EIS Guidelines Information Requirement	Corresponding EIS Section (or N/R – shown in bold[2])
		e. 8.4 – Aquatic Environment; 8.6 – Terrestrial Environment. f. 7.0 –Aboriginal Engagement.
	3.3 Regulatory Framework and the Role of Government: a. Relevant approvals and legislation. b. Government policies; resource management or other relevant studies or plans. c. Pertinent treaty or self-government agreements with Aboriginal groups. d. Relevant land use plans, zoning or community plans. e. Regional, provincial and/or national objectives, standards or guidelines that have been used by the proponent to assist in the evaluation of any predicted environmental effects.	a. 3.5 – Regulatory Framework and the Role of Government. b. Section 8.10 – Socio-Economic and Socio-economic Assessment TSD. c. 7 – Aboriginal Engagement. d. Section 8.10 – Socio-Economic. e. 3.5 – Regulatory Framework and the Role of Government; 9.0 – Assessment of Effects.
4. Project Description	4.1 Purpose of the Project: a. Rationale for the project. b. Background. c. The problems or opportunities that the project is intended to satisfy. d. The stated objectives from the perspective of the proponent.	4.1 – Purpose of the Project
	4.2 Alternative Means of Carrying out the Project: a. Identify and describe in sufficient detail the alternative means to carry out the project. b. Identify the effects of each technically and economically feasible alternative means. c. Describe the methodology used for the analysis of alternative means and the conclusion reached (i.e., preferred means).	4.2 – Alternative Means of Carrying out the Project

Guideline[1] Section	EIS Guidelines Information Requirement	Corresponding EIS Section (or N/R – shown in bold[2])
	4.3 Scope of the Project: a. Project components. b. Project activities. c. Changes that have been made to the project since original proposal, including the benefits of these changes to the environment, Aboriginal peoples, and the public. d. Scheduling for all project activities.	4.3 – Scope of the Project: a. 4.3.1 Project Components and Activities. b. 4.3.1 Project Components and Activities. c. 4.3.3 Scope Changes. d. 4.3.2 Project Schedule.
5. Scope of the Environmental Assessment	5.1 Factors to be Considered: a. The environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out. b. The significance of those environmental effects. c. Comments from the public that are received in accordance with the *CEAA* 2012. d. Mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project. e. The requirements of the follow-up program in respect of the designated project. f. The purpose of the designated project. g. Alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means. h. Any changes to the designated project that may be caused by the environment. i. The results of any relevant study conducted by a committee established under section 73[2] or 74 of the *CEAA* 2012. j. Any other matter relevant to the EA that the CNSC requires to be taken into account.	Introduction and discussion in Section 5.1 – Factors to be Considered. Refers to: a. 9 – Effects; 9.11 Accidents and Malfunctions; 9.12 – Cumulative Effects. b. 9.0 – Effects; 11.0 – Conclusion on Significance. c. 6.0 – Public and Stakeholder Engagement. d. 10.0 – Mitigation Measures. e. 12.0 – Follow-up Program. f. 4.1 – Purpose of the Project. g. 4.2 – Alternative Means of Carrying out the Project. h. 9.13 – Effects of the Environment on the Project. i. the CNSC issued their decision on the EA scope, and no additional requirements to the EIS Generic Guidelines were added. j. the CNSC issued their decision on the EA scope, and no additional requirements to the EIS Generic Guidelines were added.

Guideline[1] Section	EIS Guidelines Information Requirement	Corresponding EIS Section (or N/R – shown in bold[2])
	Where there is a reliable and feasible methodology for calculating upstream greenhouse gas emissions that are linked to the project, the proponent will be required to provide sufficient information to estimate these types of emissions. This information should be presented by individual pollutant and should be summarized in CO_2 equivalent units per year. If upstream greenhouse gas emissions are not considered in the assessment, the proponent will provide a rationale in the EIS. The proposed definition of upstream inclu*des "all industrial activities from the point of resource extraction to the project under review."*	9.2 – Effects (Atmospheric); Greenhouse Gas Emissions Technical Supporting Document
	5.2.1 Valued Components: a. Identify VCs that may be affected by changes in the environment, including species at risk and their critical habitat. Describe importance. Provide rationale for excluded VCs. b. Identify those VCs, processes, and interactions that were identified to be of concern during any workshops or meetings held by the proponent, or that the proponent considers likely to be affected by the project. Include discussion of importance. c. Select VCs, taking into account public consultation and Aboriginal engagement. Provide rationale for exclusions.	5.2.4 – Valued Components
	5.2.2 Spatial and Temporal Boundaries: a. The spatial and temporal boundaries used in the EA may vary depending on the VC and will be considered separately for each VC. b. If the temporal boundaries do not span all phases of the project, the EIS will identify the boundaries used and provide a rationale.	5.2.1 – Spatial & Temporal Boundaries of the Assessment, and spatial boundaries individually within Environmental components in Section 9 (e.g. Atmospheric environment).

Guideline[1] Section	EIS Guidelines Information Requirement	Corresponding EIS Section (or N/R – shown in bold[2])
6. Public and Stakeholder Consultation	a. Describe the methods used, where the consultation was held, the persons and organizations consulted, the concerns voiced and the extent to which this information was incorporated in the design of the project as well as in the EIS. b. Summarize key issues raised related to the project and its potential environmental effects, including outstanding issues.	6.0 – Public and Stakeholder Engagement
7. Aboriginal Engagement	Engagement activities with potentially affected Aboriginal groups: a. Summarize the objectives of and the methods used for Aboriginal engagement activities. b. Indicate each Aboriginal group's potential or established rights including geographical extent, nature, frequency, timing and maps and data sets (e.g., fish catch numbers). c. Discuss comments, specific issues and concerns raised by Aboriginal groups and how the key concerns were responded to or addressed. d. Assess the potential adverse impacts of the project on potential or established Aboriginal or treaty rights.	7.0 – Aboriginal Engagement
8. Description of the Environment	8.1 Baseline Environment: a. Describe components of the existing environment and environmental processes, their interrelations and interactions as well as the variability in these components, processes and interactions over time scales appropriate to the EIS. b. Describe the current baseline environment and environmental trends within the project area, including a consideration of past projects and activities carried out by the proponent and/or others within the project area. c. Discuss baseline condition for any new VCs identified mid-project.	8.0 – Description of the Existing Environment

Guideline[1] Section	EIS Guidelines Information Requirement	Corresponding EIS Section (or N/R – shown in bold[2])
9. Effects Assessment	9.1 Predicted Changes to the Physical Environment: a. For each phase, describe the magnitude, geographic extent, timing, frequency, duration and reversibility of predicted changes to the environment. b. Explain and describe the connections and interactions between the changes described.	9.0 – Assessment of Environmental Effects (to the extent possible, given the available information).
	9.2 Predicted Effects on Valued Components: a. Assessment of environmental effects of the project on the identified VCs. b. Selection of additional VCs, if required.	9.0 – Assessment of Environmental Effects (to the extent possible, given the available information).
	9.3 Accidents and Malfunctions (potential health and environmental effects)	9.11 – Accidents and Malfunctions
	9.4 Cumulative Effects	9.12 – Cumulative Effects
	9.5 Socio-economic Environment (the project's indirect socio-economic effects)	9.10 – Socioeconomic Effects
	9.6 Effects of the Environment on the Project	9.13 – Effects of the Environment on the Project
10. Mitigation Measures	Mitigation Measures	10.0 – Mitigation Measures
11. Conclusion on Significance	Conclusion on Significance	11.0 – Conclusion on Significance
12. Follow-up Program	Follow-up Program	12.0 – Follow-up Program

Notes:

1 – Generic Guidelines for the Preparation of an Environmental Impact Statement (CNSC 2016a). Part 2 of the Guidelines document prescribes the EIS Content and Structure.

2 – *CEAA* (2012) 73 (1): The Minister may establish a committee to conduct a study of the effects of existing or future physical activities carried out in a region that is entirely on federal lands.

4 PROJECT DESCRIPTION

4.1 Purpose of Project

The purpose of the project is to safely carry out the decommissioning of the NPDWF. The decommissioning of NPDWF will ensure a prompt reduction of Canadian legacy long-term liabilities and eliminate interim waste storage, while reducing worker risk and transport/waste handling risk.

In Canada, nuclear waste producers and owners are responsible for the funding, organization, management and operation of disposal and other facilities required for their wastes. CNL has developed an Integrated Waste Strategy (IWS) which concisely details “cradle to grave” pathways for all CNL waste streams, from generation to final disposition. The IWS is based on CNL’s waste inventory and forecast data and founded on the fundamental principles of waste avoidance, minimization and re-use. It enables the assessment of the quantities and types of waste across the spectrum of waste that CNL manages, (e.g., from clearable waste to used fuel). In-situ decommissioning of NPDWF meets one of the CNL integrated waste strategy objectives by providing a disposition route for the NPD reactor, components and systems. Previous NPD decommissioning strategies had delayed closure of the NPD site until future disposal facilities had become available. The proposed project ensures CNL focuses their environmental efforts on limiting nuclear legacy obligations for future generations.

As discussed in the decommissioning plans (Aikens 2017), in-situ decommissioning is proposed to carry out these activities (see details in Section 4.2 below). As discussed in Section 3.1 above, this nuclear facility is presently in the safe shutdown state and has a Decommissioning Waste Facility License.

The proposed in-situ decommissioning activities include removing the above ground structure and placing demolition materials into the below grade structure. The below grade structure, reactor and systems and components will be sealed with grout. Grouting is the process of placing, by pumping, a mixture of Portland Cement and water that produces a pourable, concrete-like, mixture to ensure filling of gaps and crevices throughout the facility. The ventilation stack, a current roosting structure for chimney swifts, will be retained. The footprint above the grouted reactor will then be capped with reinforced concrete and the Main Building footprint of NPDWF will be covered with an engineered barrier. In-situ decommissioning will isolate the contaminated systems and components inside the below grade structure. Additional detail on each of these project activities is provided in Section 4.3 below, as well as in Aikens (2017).

The decommissioning activities which constitute the designated project scope are:

- assembly and operation of the grout and concrete batch mixing plant;
- grouting of below grade structures;
- removal of above grade structures to be used as backfill;
- installation of concrete cap and engineered barrier over the grouted area;

- final site restoration; and
- preparation for long-term care and maintenance activities.

4.1.1 Robustness of the System

In-situ decommissioning provides containment and isolation of the NPDWF inventory for a sufficiently long time to ensure that the postclosure environmental concentrations do not cause adverse effects to human health or the environment. The assessment shows that the decommissioned facility will contain the dominant radioactive and non-radioactive contaminants very effectively.

For most of the assessed period, only a small percentage of the initial total radioactivity is released from the NPDWF as soluble contaminants. Even after 50,000 years, the vast majority of the radioactivity (i.e., over 98%) remains in the NPDWF. The remainder gradually decays and disperses so that when it reaches the accessible environment, concentrations are sufficiently low such that the corresponding doses are negligible. These predicted releases are only a small fraction of the current NPD emissions.

The engineered barriers restricting contaminant release from the NPDWF are:

- waste form: the majority of the radioactivity is embedded within the matrix of steels and zircaloy that will corrode very slowly in the chemical environment of the decommissioned NPDWF;
- thick concrete walls of the reactor vault and structure: provide a diffusive barrier; and
- grout backfill: inhibits groundwater movement and creates an alkaline environment that limits the solubility of key contaminants.

The isolation of contaminants is achieved by:

- historic siting of the facility in bedrock;
- institutional controls in the short term (e.g., access controls to site);
- filling much of the NPDWF with grout; and
- placing a concrete slab over the NPDWF: lowers the probability of future inadvertent intrusion.

The containment and isolation described above are considered In-design mitigation measures, i.e., features included in the project design for the purpose of pre-empting possible environmental effects, based on good practice and CNL experience.

4.1.2 Natural Analogues

The EA of the NPDWF in-situ disposal is a challenging undertaking because of the very long time periods involved. Natural analogues can be used to provide understanding and enhance confidence in the behaviour of the NPDWF over time.

Natural analogues are natural or anthropogenic features that are similar to the features being assessed (e.g., isolation and containment). For the NPDWF, some of the examples of natural analogues include:

- Iron-based materials: The PostSA assumes that the inventory embedded in iron-based materials is released gradually. Reports of corrosion of iron-based archaeological artifacts, native metals and meteorites from various locations under a wide range of environmental conditions (Johnson and Francis 1980) were consistent with the assumed range of corrosion in the PostSA.
- Lead: There is a significant quantity of lead associated with shielding at NPDWF. Lead has been used in antiquity for weights, pipes, cladding, etc. and many such artifacts have survived over the years. Recent dating of lead artifacts has shown that such artifacts undergo very slow corrosion when buried in soils with pH greater than 6.5 (Reich *et al*, 2003). This provides credibility to the assumptions of lead solubility in the PostSA.
- Concrete/grout/cement: The PostSA assumes that the grout will gradually degrade as the cement constituents are slowly leached out upon contact with groundwater. The cement being considered for radioactive disposal systems is similar to early cements used in the 3rd century and approximately 1,000 years earlier (Middleton 1888). These cements demonstrate little degradation over approximately 2,000 years (Cramer 1993, Oleson et al. 2004, Vola *et al*. 2011).
- The cap: The PostSA assumes that the cap starts to degrade 100 years after its emplacement and is assumed to have fully degraded (in terms of hydraulic performance) by 1,000 years after decommissioning is complete. Ancient tombs with wooden coffins have stayed dry when covered by such layers for approximately 1300 to 1500 years and are generally well preserved (USGS, 2010; Watanabe 1989).

It should be cautioned that that the use of natural analogues to support long-term safety assessment models has its limitations. In particular, the materials and environmental conditions involved are somewhat different in the analogue compared to the NPDWF and its environment. This is typical of natural analogues. Therefore, we are using the above examples as an additional line of evidence that does not replace the safety assessment. Nonetheless, these examples support the concepts of the long- term containment provided by the NPDWF and illustrate similar long-term behavior of natural and anthropogenic systems.

4.2 Alternative Means of Carrying out the Project

This section provides Step #4 of the *CEAA Operational Policy Statement: Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012 (CEAA* 2015).

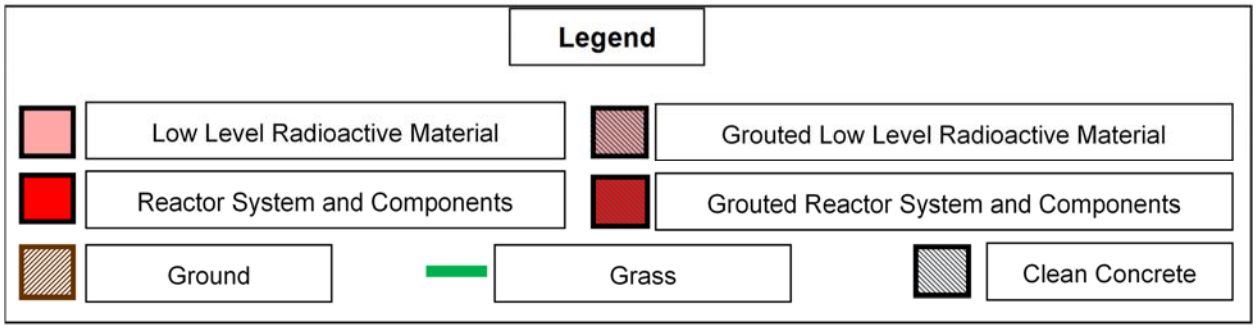
The decommissioning of the NPDWF has been proposed using the In-Situ Decommissioning approach, as discussed in Section 2.2 of the Alternative Means Assessment TSD, triggering an EA. An alternative means assessment is a required input to the EIS as defined in the *CEAA* 2012, the EIS Guidelines (CNSC 2016a), REGDOC 2.9.1 (CNSC 2016b), and the *CEAA Operational Policy Statement: Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012 (CEAA* 2015). The Alternative Means Assessment TSD provides the alternative means assessment for the decommissioning of the NPDWF. The objectives of the Alternative Means Assessment TSD is to provide a qualitative analysis of the environmental risks (including human health) of alternative decommissioning techniques, as specified

in the Project Description (Titterington 2016). The alternative means for decommissioning that are provided in the Project Description and have been considered for this project are (Alternative Means Assessment TSD):

1. Continued Storage with Surveillance
2. Partial Dismantling and Removal
3. Full Dismantling and Removal
4. In-Situ Decommissioning

Each of these four alternative means is described in more detail below, along with a pictographic representation of the approach. The legend for the pictographs can be found directly below.

It is difficult to specify alternative disposition pathways for the radioactive material within NPDWF, primarily for the reactor system and components, given that an alternate waste storage or disposal facility would require waste categorization dependent on the alternate facility's waste acceptance. For example, the low level radioactive material within NPDWF meets the waste acceptance criteria of the CNL proposed Near Surface Disposal Facility (NSDF); however, the reactor system and components inventory does not and thus could not be accepted within the proposed NSDF. Currently, CNL only has interim waste storage for most ILW until a future ILW disposal facility becomes available (CNL 2017b).



1. Continued Storage with Surveillance (SwS)

"Continue with a deferred decommissioning approach which includes maintaining the NPDWF in the Storage with Surveillance phase to allow for further radioactive decay." (Titterington 2016)

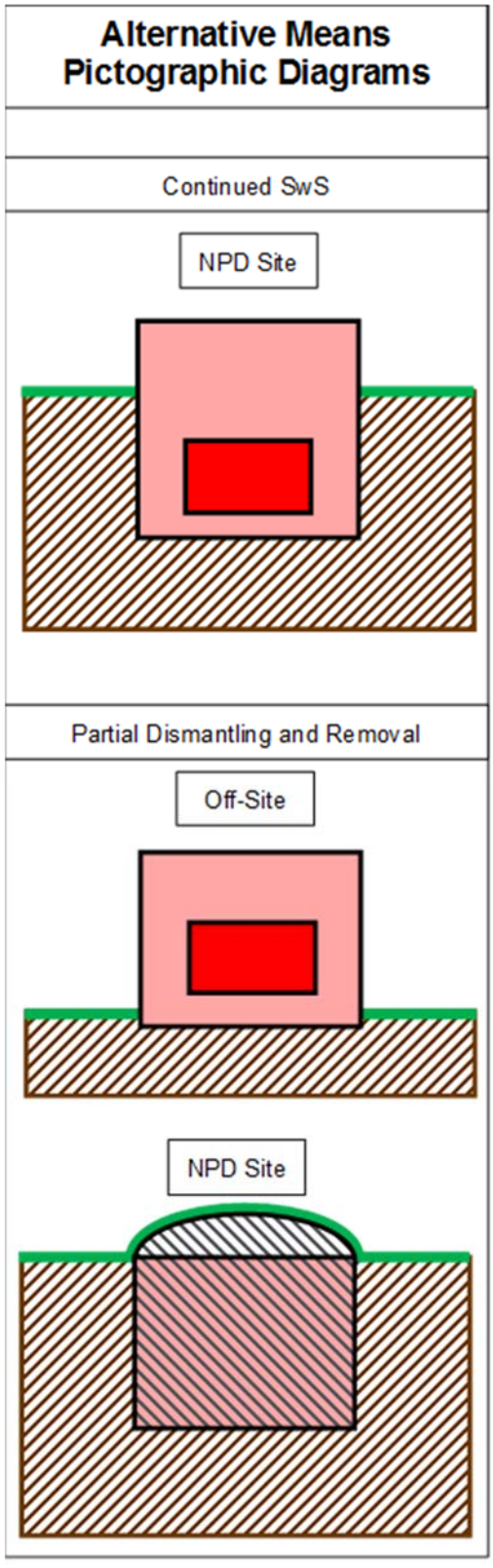
For this analysis, it has been assumed that this approach involves continuing to defer decommissioning by maintaining the NPDWF in the SwS phase, thereby allowing for further radioactive decay. This will involve continued maintenance, monitoring and yearly reporting in the form of annual compliance reports.

Continued SwS has been listed first here and throughout the document because it is used as a baseline case against which the other alternative means are compared.

2. Partial Dismantling and Removal

"Partial removal of the source term (i.e., reactor systems and components) for interim storage at an alternate CNL site until final disposal options are available. The remaining facility systems, structures and components will remain in-situ." (Titterington 2016).

For this analysis, it has been assumed that this alternative means is a combination of the in-situ decommissioning alternative and the full removal alternative. Specifically, this approach involves removal of the reactor system and components. The preliminary assumptions are that the feeders, pressure tubes, calandria tubes, calandria and associated bioshielding will all be removed, and the fuel handling room will be decommissioned. This waste would be packaged in containers for transport and storage. Additionally, a few drums of waste from the spent fuel bay cleanup would likely also be removed. This waste would be stored at an alternate CNL site (most likely CRL) until final disposal options are available. The remaining facility systems, structures and components will remain in-situ, and will be decommissioned in the same manner as described in the in-situ decommissioning alternative means. The above ground structures would be demolished and the rubble would be emplaced in the below grade structures prior to grouting. The ventilation stack would not be demolished, as it will be left as a habitat for the chimney swifts. As with the in-situ decommissioning alternative, a concrete cap and engineered barriers would close the facility and the surrounding area would be remediated.



3. Full Dismantling and Removal

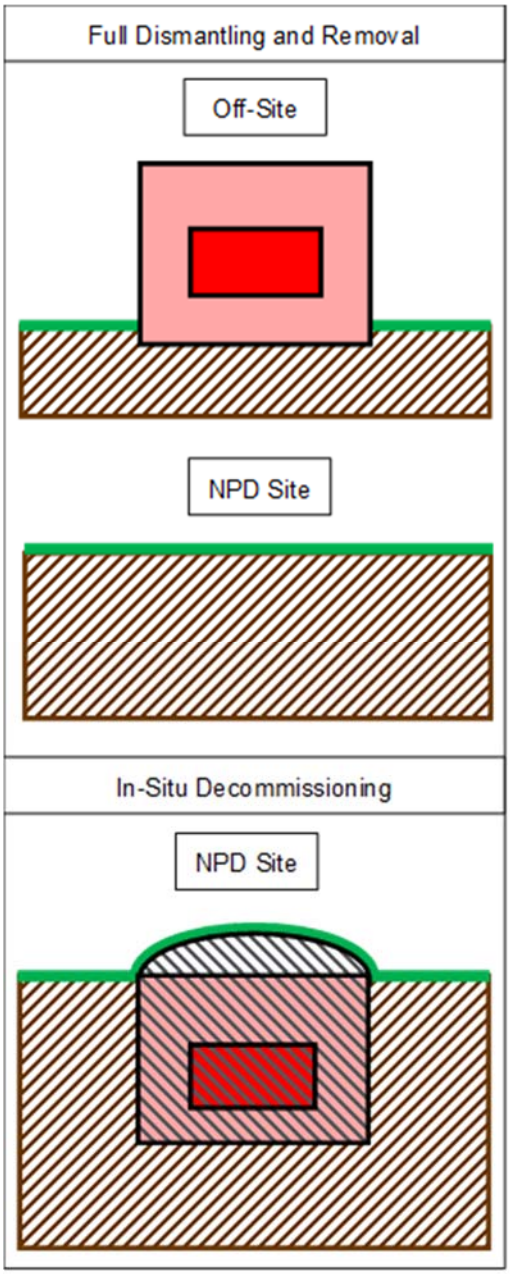
"Full dismantling and removal of all systems, structures and components for interim storage at an alternate CNL site until final disposal options are available." (Titterington 2016)

For this analysis it has been assumed that this alternative means involves removing all radioactive material from the site and storing it temporarily at another CNL facility (most likely CRL), until a final disposal location is available. The structures on site would then be demolished and removed from the site, along with any nuclear or hazardous waste. This would include the removal of the reactor and the associated systems. The site would be remediated following the removal of all structures including the ventilation stack. It has also been assumed that the waste will be stored off-site in containers within a building due to the lack of a disposal facility at the time of waste removal.

4. In-Situ Decommissioning

"In-situ decommissioning where the source term will be isolated inside the below grade structure and systems to allow for continued radioactive decay." (Titterington 2016)

For this analysis it has been assumed that this alternative means involves grouting the reactor and associated systems in place within the building as a means of decommissioning. The above ground structures will be demolished, and the rubble will also be grouted within the below grade structures. The ventilation stack would not be demolished, as it will be left as a habitat for the chimney swifts. Finally, a concrete cap and engineered barrier system would be placed over the facility to close it and the site will be remediated.



All four of these alternative means have been shown to be technically feasible based on the following criteria:

- Reliable Technology, i.e. does the alternative means use a previously demonstrated technology?
- Regulatory Compliance, i.e. does the alternative means meet regulatory requirements?

Additionally, all four of the alternative means have also been shown to be economically feasible, based on the following criterion:

- Cost, i.e., is the alternative within the financial guarantee limit from AECL?

The environmental effects of each alternative means were assessed with respect to the key VCs identified for this study. These VCs are consistent with the comprehensive list of VCs selected for this EIS (see Section 5.2.4). All of the potential interactions between the proposed decommissioning tasks and the VCs were considered during all three timeframes:

- Decommissioning Execution
- Institutional Controls
- Post-Institutional Controls

Relative risk to the VCs for the four alternative means was assessed with respect to "1. continued SwS" as the baseline. The results of this relative risk assessment are shown below in Tables 5-2 through 5-4. The relative risk scale is defined in Table 4.2-1.

In Table 4.2-2 it can clearly be seen that for the Decommissioning Execution phase all of the alternatives carry increased risk relative to the baseline case, "1. continued SwS". This is due to the increase in activities that are associated with each of the options. It can also be seen that while "4. in-situ decommissioning" does have a higher risk than the baseline case, it is lower than "2. partial dismantling and removal" and "3. full dismantling & removal" on almost all of the environmental components.

In the Institutional Controls phase, Table 4.2-3, the differences between the alternative means starts to become more obvious. This is a result of the work put in during the active decommissioning. It can be seen that again, "4. in-situ decommissioning" has many benefits over the others.

Finally, in the Post-Institutional Controls phase, Table 4.2-4, the benefits of permanent disposal can be seen even more. "4. in-situ decommissioning" continues to have much less risk than the baseline case, as the contaminants are all held in the grouted monolith. As with the Institutional Controls phase, it can be seen that "3. full dismantling & removal" is very similar to the baseline case.

Table 4.2-1. Relative Risk Scale

Symbol	Explanation
↑↑ Risk	Alternative is associated with more risk than baseline.
↑ Risk	Alternative is associated with slightly more risk than baseline
≈ Risk	Alternative is associated with approximately same risk as baseline.
↓ Risk	Alternative is associated with slightly less risk than baseline.
↓↓ Risk	Alternative is associated with less risk than baseline.

Table 4.2-2. Summary of Relative Risk for Decommissioning Execution Timeframe

	Environmental Components													
	Environmental Effects						Miscellaneous Physical Effects			Socio-economic Effects	Effects on Aboriginal People	Health Effects (Normal)		
Alternative Means	Atmospheric Environment	Surface Water Environment	Aquatic Environment	Terrestrial Environment	Geological and Hydrogeological Environment	Radiation and Radioactivity Environment	Land Use	Traffic and Transportation	Physical and Cultural Heritage Resources	Socioeconomic Effects	Effects on Aboriginal People's Interests	Public Health	Worker Health	Non-Human Biota
1. Continued SwS	Baseline													
2. Partial Dismantling and Removal	↑↑	↑↑	≈	↑	↑	↑↑	≈	↑↑	≈	↑	↑	↑↑	↑↑	↑↑
3. Full Dismantling and Removal	↑↑	↑↑	≈	↑↑	↑↑	↑↑	≈	↑↑	≈	↑	↑	↑↑	↑↑	↑↑
4. In-Situ Decommissioning	↑	↑	≈	↑	↑	≈	≈	↑	≈	↑	↑	↑	↑	↑

Table 4.2-3. Summary of Relative Risk for Institutional Controls Phase

Alternative Means	Environmental Components													
	Environmental Effects						Miscellaneous Physical Effects			Socio-economic Effects	Effects on Aboriginal People	Health Effects (Normal)		
	Atmospheric Environment	Surface Water Environment	Aquatic Environment	Terrestrial Environment	Geological and Hydrogeological Environment	Radiation and Radioactivity Environment	Land Use	Traffic and Transportation	Physical and Cultural Heritage Resources	Socioeconomic Effects	Effects on Aboriginal People's Interests	Public Health	Worker Health	Non-Human Biota
1. Continued SwS	Baseline													
2. Partial Dismantling and Removal	↓	↓	↓	↓	≈	↑	↓	≈	↓	↓	↓	↓	↑	↓
3. Full Dismantling and Removal	↓	≈	↓	↓↓	↑	↑	↓	≈	↓	↓	↓	↓	↑	↓
4. In-Situ Decommissioning	↓↓	↓↓	↓↓	↓	↓↓	↓↓	↓	≈	↓	↓	↓	↓↓	↓↓	↓↓

Table 4.2-4. Summary of Relative Risk for Post-Institutional Controls Phase

Alternative Means	Environmental Components													
	Environmental Effects						Miscellaneous Physical Effects			Socio-economic Effects	Effects on Aboriginal People	Health Effects (Normal)		
	Atmospheric Environment	Surface Water Environment	Aquatic Environment	Terrestrial Environment	Geological and Hydrogeological Environment	Radiation and Radioactivity Environment	Land Use	Traffic and Transportation	Physical and Cultural Heritage Resources	Socioeconomic Effects	Effects on Aboriginal People's Interests	Public Health	Worker Health	Non-Human Biota
1. Continued SwS	Baseline													
2. Partial Dismantling and Removal	≈	↓	↓	↓↓	↓	↑	↓↓	≈	≈	↓	↓	≈	≈	≈
3. Full Dismantling and Removal	≈	≈	≈	↓↓	≈	↑	↓↓	≈	≈	↓	↓	≈	≈	≈
4. In-Situ Decommissioning	↓	↓↓	↓↓	↓↓	↓↓	↓↓	↓↓	≈	↓	↓↓	↓↓	↓↓	≈	↓↓

In addition to relative risk, absolute risk was also considered in the comparison of alternative means. For example, if alternative means X has negligible risk, but is deemed to be higher than the even smaller risk of alternative means Y, the absolute risk does not give undue credibility to alternative means Y. Similarly, if alternative means X is deemed to have less risk than alternative means Y, but both alternative means carry a significant risk to the environment, alternative means X cannot be considered as a good option, as it will still have significant environmental effects, regardless of how it compares to alternative means Y.

While under institutional control, it is expected that monitoring activities will verify the robustness and integrity of the containment and that releases carry no undue risk under normal operating conditions. This assumption is valid regardless of the alternative means. The main difference between the alternative means during the Decommissioning Execution and Institutional Controls phases is the risk associated with low probability accidents and malfunctions, for example severe weather or large earthquakes. Even under these conditions it is expected that institutional control and monitoring will verify that all releases carry no undue risk.

Beyond the Institutional Controls phase, the differences between the alternative means are more pronounced, especially under disruptive event scenarios and long term processes such as climate change. For “1. continued SwS”, “2. partial dismantling and removal”, and “3. full dismantling and removal”, where waste is being stored, there is an increased risk of effects as a result of the waste being stored above ground, or near surface. “4. in-situ decommissioning” does not have the same risk because all waste is emplaced and grouted below ground in bedrock, thereby limiting the risk.

In addition to the relative and absolute risk assessments discussed above, there is one final consideration in the selection of a preferred means. One of the major concerns of this project is the responsible management of Canada’s Nuclear Legacy Liability. As shown in the Alt Means TSD, it can be seen that “1. continued SwS” does not provide any reduction to the legacy liability. “2. partial dismantling and removal” provides some reduction in the legacy liability, as some of the waste has been packaged and moved to a newer facility, and the remaining waste is grouted securely in place. Similarly, “3. full dismantling and removal” provides some reduction in the legacy liability, as the waste has been packaged and moved to a newer facility. For both of these alternative means, there is continued storage of waste required and as such the final reduction of legacy liability is not done in a timely manner. “4. in-situ decommissioning” succeeds in providing timely reduction of the legacy liability by immediately securing the contamination within the grouted monolith.

Based on the comparison of the relative risk to the environmental VCs, absolute risk to the environmental VCs, and additional consideration, “4. in-situ decommissioning” has been found to be the preferred means for completing this project. A quantitative assessment of environmental effects to the VCs has been completed as part of a Decommissioning Safety Assessment (DecomSA) TSD, Postclosure Safety Assessment (PostSA) TSD and Ecological Risk Assessment (EcoRA) TSD for “4. in-situ decommissioning”. The assessment of effects is summarized in Section 9 of this EIS.

4.3 Scope of the Project

As defined in the Project Description (Titterington 2016), and further reiterated in the decommissioning plans (Aikens 2017), the scope of the project comprises the activities directly associated with the execution phase of the NPDWF decommissioning.

Therefore, for EA purposes, the project will consider:

- assembly and operation of the batch mixing plant;
- grouting of below grade structures;
- removal of above grade structures to be used as backfill;
- installation of concrete cap and engineered barrier over the grouted area;
- final site restoration; and
- preparation for and implementation of long-term care and maintenance.

The major components and activities of the project are discussed in the sub-sections below.

4.3.1 Project Components and Activities

4.3.1.1 Roads

The NPD site has one main access road, as well as a network of gravel roads. These roads are expected to be sufficient for the decommissioning activities and no new roads will need to be made.

4.3.1.2 Grout and Concrete Batch Mixing Plant

Due to the distance between the NPD site and the nearest concrete suppliers, a batch mixing plant will be set up on site to supply the grout and concrete needed for this project (Aikens 2017). The batch mixing plant is one of the major physical components of this project. The activities of the batch mixing plant can be broken down into three main phases: Assembly, Operation, and Disassembly. Each of these phases will be discussed separately, below.

4.3.1.3 Assembly of the Batch Mixing Plant

In addition to bringing in and assembling the batch mixing plant, other materials will need to be trucked in and stockpiled, specifically; aggregate, sand, and cement (see Greenhouse Gas TSD for more details). Furthermore, a water tank, piping, and a power supply will be needed to supply the batch mixing plant. Finally, settling ponds will need to be constructed to allow for equipment wash out. These ponds are engineered catchments that collect water and allow sediments to settle and collect. In accordance with the NPD Effluent Monitoring Plan (DeWaele 2016), water from the settling ponds will be sampled prior to pumping for release or recycling to the batch mixing plant. When complete the settled material will be placed and grouted into the facility. Any remaining aggregate or sand will be used as backfill in the facility before final capping, thereby minimizing or eliminating waste generation (Aikens 2017).

4.3.1.4 Operation of the Batch Mixing Plant

Once the batch mixing plant has been assembled and all of the necessary materials have been gathered, batches of grout/concrete can be mixed.

The batch mixing plant is expected to run on electrical power. In addition, a generator will provide backup power to the batch mixing plant if needed. The backup generator, as well as the heavy machines on-site, will also run on diesel.

4.3.1.5 Disassembly of the Batch Mixing Plant

The disassembly of the batch mixing plant will require the equipment to be washed out, using the settling ponds, before being removed from site. Additionally, the water tanks and piping will need to be removed, and the excess grout and concrete ingredients will be used as backfill on the site as appropriate.

4.3.1.6 Grouting of Below Grade Structure

Grouting is the process of placing, by pumping, a mixture of Portland Cement and water that produces a pourable, concrete-like, mixture to ensure filling of gaps and crevices throughout the facility.

All below-grade areas are to be filled with grout. Using a master fill schedule, lifts of grout pours will be planned to systematically fill the entire structure. The grout pours will be designed to balance forces across walls and between rooms such that failures of the current structures will not occur. Pathways created during preparation of rooms will minimize void space and allow for dissipation of heat during curing of the grout. Quality control measures on grouting operations will be implemented to ensure that the finished product will meet specified parameters. The systems within NPDWF will be grouted with the structure and the outfall discharge pipes will be capped (Aikens 2017).

4.3.1.7 Removal of Above Grade Structures

The main building, the above-ground portion of the pressure relief pit walls, and guard house will all be demolished and placed within voids in the below-ground facility, such as the pressure relief pit and the condenser room (see Section 3.3.1 for a description of structures at NPD). Recyclable material will be separated where practicable and the remaining structures will be crushed and placed as fill prior to final grouting (Aikens 2017).

4.3.1.8 Installation of Concrete Cap and Engineered Barrier

After all below-grade grouting has been completed, a final reinforced concrete cap will be poured over the grouted reactor systems and components. An engineered barrier will be installed over the Main Building footprint of NPDWF to reduce infiltration. The area will be graded and drainage ditching installed to manage precipitation run-off (Aikens 2017).

4.3.1.9 Final Site Restoration

Once the final cap system has been completed, the temporary facilities will be removed. Clean building slabs, foundations and non-essential roadways will be reduced to rubble in place and the area restored with native vegetation. All buried utilities and systems will be capped or disconnected but remain in place, unless there is a risk of subsidence (i.e., the settling or sinking of the surface due to sub-surface movement). This is done to limit the disruption to the environment and habitats. The above grade electrical distribution systems will also be deactivated including removal of the backup power diesel generator from site. Once CNL completes the decommissioning of the NPD reactor and site closure has been achieved, AECL will look at the future of the lands. AECL will take into account consideration for stakeholder engagement, as appropriate, and the duty to consult with Aboriginal peoples.

4.3.1.10 Long Term Care and Maintenance

The capped area will be fenced as part of institutional controls. Routine surveillance of the site may include inspecting the engineered barrier for subsidence, erosion, and animal or other intrusion. Additional groundwater monitoring wells will be installed, as required, to monitor the performance of the in-situ decommissioned facility (Aikens 2017).

4.3.2 Project Schedule

Table 4.3-1 shows the planned schedule for the activities in the Decommissioning Execution, Institutional Controls phases. The Post-Institutional Controls phase is not included in the below table, as there are no activities associated with this project phase.

Table 4.3-1. Proposed Schedule of Project Activities

Decommissioning Phase	Project Description Scope	NPD Closure Project WBS			Corresponding Physical Activity (EIS Interaction Matrix)	Duration	Planned Start
Decommissioning Execution	Assembly and operation of batch mixing plant.	8.1 NPD Enabling Works	8.1.003 Decommissioning Works	8.1.003.24962 Grout Solution Mobilization	1.1 Designate footprint, create access, temporary fencing. 1.2 Assign storage area for raw materials, ship in sand, gravel, fly ash. 1.3 Set up mixing stations, hook up power. 1.4 Truck in necessary water supply. 1.5 Provide slip pipe access to nuclear area. 1.6 Construct wash out pit. 1.7 Level area for concrete pumper. 1.8 Mix grout to required formula. 1.9.a. Truck grout to pumping station 1.9.b Alternatively set up pumping lines from mixing station to various areas around the main building. 1.10 Wash out cement truck sluice and pumper truck and slip pipes.	27 days	2019 March
	Grouting of below grade structures.	8.2 Nuclear System Disposition	8.2.002 Reactor System	8.2.002.24871 Reactor Decommissioning Preps	2.2 Systems Preparation Large Vessels.	29 days	2019 January
			8.2.003 Primary System	8.2.003.24876 Primary Decommissioning Preps	2.2 Systems Preparation Large Vessels.	30 days	2019 January
			8.2.001 Moderator System	8.2.001.24867 Mod. System Decommissioning Preps	2.2 Systems Preparation Large Vessels.	29 days	2019 January
			8.2.004 Other Systems	8.2.004.24880 Other Systems Decommissioning Preps	2.2 Systems Preparation Large Vessels.	34 days	2019 January
		8.3 Building Disposition	8.3.002 Boiler/Moderator Vault	8.3.002.24975 Boiler/Moderator Vault Preps to Grout	2.1 Room Preparation (e.g., sealing of pipes).	25 days	2019 Feb
				8.3.002.24976 Grout from Elevation 347	2.3 Grout Fill Nuclear Area.	21 days	2019 May
			8.3.003 Reactor Vault	8.3.003.24978 Reactor Vault Preps to Grout	2.1 Room Preparation (e.g., sealing of pipes).	27 days	2019 Feb
				8.3.003.24979 Grout from Elevation 358.5	2.3 Grout Fill Nuclear Area.	21 days	2019 June
			8.3.004 Fuel Bay Vault	8.3.004.24981 Fuel Bay Preps to Grout	2.1 Room Preparation (e.g., sealing of pipes).	23 days	2019 Feb
				8.3.004.24982 Grout from Elevation 366	2.3 Grout Fill Nuclear Area.	16 days	2019 June
			8.3.005 Condenser Bay & Control Room	8.3.005.24984 Cond. Bay Preps to Grout	2.1 Room Preparation (e.g., sealing of pipes).	23 days	2019 April
				8.3.005.24985 Grout & Backfill Pipe Chase & Other Areas	3.4 Steel and rubble emplaced in condenser pit according to nesting plan. Fill to 425 level. 3.5 Grout first level of demolition material in condenser pit. 3.6 Steel and rubble emplaced in condenser pit. Fill to 400 level. 3.7 Grout second level of demolition material in condenser pit. 3.8 Steel and rubble in condenser pit. Fill to 425 level. 3.9 Grout third level of demolition material in condenser pit. 3.15 Grout furnace room and adjacent areas to ground level.	32 days	2019 July
	Removal of above grade structures and used as backfill.		8.3.006 Above-Grade Demolition	8.3.006.24988 Demolish Above-Grade Facilities	3.1 Conventional heavy equipment knockdown of reactor hall. 3.2 Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas. 3.3 Set up lay down area and perform clearance surveys on materials for possible recycling.	60 days	2019 June

Decommissioning Phase	Project Description Scope	NPD Closure Project WBS			Corresponding Physical Activity (EIS Interaction Matrix)	Duration	Planned Start
					425'Steel 3.10 Demolition block walls and inside walls around control room and change rooms. 3.11 Collapse ceilings of furnace room and adjacent rooms. 3.12 Emplace block wall rubble in furnace room or condenser.3.13 Remove recyclables from guard house. 3.14 Demolish guard house and emplace in furnace room and adjacent rooms. 3.16 Demolish above grade portion of pressure relief pit. Fill with grout.		
		8.4 Balance of Site Disposition	8.4.003 Stack Disposition	8.4.003.25000 Stack Preparations	5.2 Ventilation stack isolation: (Seal below grade vent line connections, cap at grade level, install drainage and ventilation at base). below grade spaces	16 days	2019 April
			8.4.004 Remaining Features Disposition	8.4.004.25001 Remediate Remaining Features	5.1 Site Restoration (install fencing, install monitoring wells if required, remediate areas impacted by decommissioning, wash out pits and settling ponds, complete closure surveys)	30 days	2020 March
	Install concrete cap and engineered barrier.		8.4.005 Site Restoration	8.4.005.25003 Cap and Barrier Preps to Install	4.1 Concrete cap (construct forms, install rebar, and pour, level and slope concrete). 4.2 Engineered barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	20 days	2019 August
	Final site restoration.			8.4.005.25004 Concrete Cap, Engineered Barrier & Final Site Restoration		50 days	2019 September
			8.4.006 Site Demobilization	8.4.006.25006 Site Demobilization	1.11 Sample and dewater the cleaning pit 1.12 Demobilize batch mixing plant after cap pour 5.3 Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers and install controlled access gate at highway (if required)).	37 days	2019 October
Institutional Controls Phase	Long-term care and maintenance activities.				6.1 Groundwater sampling. 6.2 Vegetation removal. 6.3 Road maintenance. 6.4 Fence maintenance. 6.5 Inspection activities of geotextile cover. 6.6 Life management surveillance of concrete cap.	To be determined	2020 May

4.3.3 Scope Changes

The EIS Guidelines (CNSC 2016a) specify that:

"*The EIS will include a summary of the changes that have been made to the project since originally proposed, including the benefits of these changes to the environment, Aboriginal peoples, and the public.*"

Certain aspects of the project have evolved during the development of decommissioning plans (Aiken, 2017) since the submission of the Project Description (Titterington 2016). The table below summarizes these changes and provides a rationale for the change.

Initial Project Plan (from Project Description (Titterington 2016))	Current Project Plan (Aikens 2017)	Rationale and Benefit for Change
The ventilation stack, the current roosting habitat for chimney swifts, will be demolished and an alternative roosting habitat for chimney swifts constructed. A permit under *SARA* is required in order to remove the ventilation stack.	The ventilation stack, the current roosting habitat for the chimney swift, will be *retained*. A permit under *SARA* is being sought to undertake decommissioning activities which may result in disturbance of the chimney swifts and modify the ventilation stack to incorporate it into the engineered barrier. Best practices, mitigation measures and monitoring requirements have been recommended by a chimney swift subject matter expert to minimize disturbance to the swifts and to detect any impact on the swifts from the project activities (see Chimney Swift TSD).	Uncertainties related to the selection of the new alternative habitat by the chimney swifts are large. In Canada's cold climate, artificial nesting chimneys have not been successful in attracting breeding chimney swifts or roosting groups. A panel of experts from academia, government agencies and Non-governmental organizations (NGO) gathered to discuss the challenges associated with alternative habitat available to chimney swifts in Canada. It was decided that the preferred option for the chimney swifts was to retain the current structure, which is known to attract thousands of individuals every year, removing completely the risk associated with jeopardy of the chimney swift population in Ontario and Canada. The ventilation stack remains structurally sound and capable of continuing to function as a chimney swift habitat for another 50 years. This is expected to complement the timeline for recovery of the species.
After all below grade grouting has been completed, a final reinforced concrete cap will be poured over the foot print of the in-situ	After all below grade grouting has been completed a final reinforced concrete cap will be poured over the *grouted reactor systems and*	The PostSA has demonstrated that the inventory that remains following the Institutional Control phase is primarily in the reactor vault. The

Initial Project Plan (from Project Description (Titterington 2016))	Current Project Plan (Aikens 2017)	Rationale and Benefit for Change
decommissioned reactor facility. An engineered barrier is anticipated to be installed over the concrete cap to reduce infiltration.	*components*. An engineered barrier will be installed over the Main Building footprint *of NPD*WF to reduce infiltration.	inventory elsewhere in NPDWF will be substantially decayed below concentrations which pose a risk if contacted directly. The reactor system and components require the additional safety feature of the concrete cap to protect from inadvertent human intrusion in the Post-Institutional Controls phase. As a result of this decision it requires clarification that the engineered barrier is intended to be installed over the Main Building footprint of the disposal facility and not just over the grouted reactor system and components. The result of these changes means reduced project cost and resources, including less material to site and slightly reduced timeframe for batch plant operation, thus somewhat reduced nuisance effects.
Water will be trucked in from an off-site location. This provides a worst-case assumption for atmospheric emissions.	For operational flexibility, it is also possible to obtain water from the existing dry hydrant on the NPD site.	Discussion with contractors regarding the project led to consideration of the potential drawing of water for the operation of the batch mixing plant. Thus, for operational flexibility, it is necessary to consider the potential of drawing water as part of the project. The hydrant was recently designed and installed according to DFO guidelines. For example, the horizontal strainer includes design features to avoid harm to fish and fish habitat, including placement of wire mesh over the strainer and rip-rap pad under the intake to reduce attractant habitat. Drawing water will eliminate/reduce the need to truck water onto the site, reducing atmospheric emissions associated with the project.

4.4 Waste Strategy

By selecting a strategy of in situ decommissioning, the project end state results in a disposal facility for the waste inventory at the NPD site. In that regard, all of the existing waste inventory at NPDWF, or generated as a result of the decommissioning activities, will remain within the grouted facility. This includes all radiological inventory such as the reactor systems, structures and components, which will be grouted in place. All debris from the above-grade structures demolition will also be re-used as fill for below grade voids (Aikens 2017). This plan for managing waste also includes encapsulation of designated substances materials such as polychlorinated biphenyls (PCBs) contained in light ballasts which are not safely accessible for removal, asbestos, residual mercury contamination and lead paint and shielding.

Only wastes related to NPDWF decommissioning will be disposed of at the NPD site.

4.4.1 Waste Types

During decommissioning of NPDWF, various forms of waste will be encountered. The waste can be divided into two main categories: the existing inventory (such as the systems currently in safe interim storage) and waste generated during the project. Existing inventory includes the radiological and non-radiological inventory that is currently within NPDWF and will be disposed of through in-situ decommissioning. Generated waste is the waste that will be produced as a by-product of the decommissioning activities, and includes items such as gloves and coveralls used by workers as personal protective equipment (PPE).

4.4.1.1 Existing Radiological Inventory

The radiological inventory comprises the radionuclides that would remain in NPDWF as part of the in-situ decommissioning strategy. These will primarily be associated with the reactor system (pressure tubes, calandria, and associated structures), as well as contamination within the heat transfer system, equipment for spent fuel storage and handling, facility structure and historic drummed waste.

Radionuclides will be present in these materials in two forms:

- radionuclides embedded within metals and other materials, present due to the interaction of neutrons from the reactor operation with the structures; and
- as contamination on surfaces, mainly resulting from the handling of fuel elements which had suffered failure of their protective cladding, enabling the release of some radionuclides.

The radionuclide inventory of the reactor was estimated using mathematical models representing the reactor materials and geometry (Smith 1988). CNL has also taken samples of reactor components to verify the estimated inventory (NMNTI 2017). Contamination in other items of plant, and of the building structure, has been estimated based on previous measurements (Gillespie 2017). These data have been combined with estimates of the amount of material that is contaminated in each room to derive an inventory for the main system, components or stored waste in NPDWF.

The majority of the radioactivity, i.e., 75%, is contained in the reactor vault, mainly associated with the disused reactor vessel, the calandria. It is necessary to distinguish between the various materials present, as they differ in both radionuclide inventory and in terms of the mode and rate of release of radionuclides. In particular, radionuclides embedded in metals will only be released at the rate at which the metals themselves corrode, which can be very slow for materials such as zircaloy. The radiological inventory of the reactor system is therefore categorized as being associated with:

- concrete (containing characteristic activation products such as Cl-36, released on contact with groundwater due to the porous nature of the material);
- stainless steel (containing activation products such as Co-60, Ni-59, Ni-63 and C-14, released gradually as corrosion occurs);
- carbon steel (with similar activation products to stainless steel but missing some key isotopes such as Ni-59 and Ni-63, also released by corrosion);
- aluminium (with specific activation products, likely to corrode rapidly depending on water chemistry);
- zircaloy (with specific activation products such as Zr-93, released very slowly by corrosion); and
- surface contamination (fission products and actinides, primarily within the primary circuit) which are released instantaneously on contact with water.

Table 4.4-1 presents the reference radionuclide inventory that is used in the PostSA TSD and is considered conservative. It is based on the highest estimates that have been made of radionuclide concentrations, whether by measurement or by modelling. Typically, the modelled values (from neutron activation calculations) are used in preference to measurement data for the reactor systems. For other facility systems, components and structures, measurement data has been used but includes uncertainty factors to account for measurement uncertainties.

Table 4.4-1. Reference Radiological Inventory for the NPDWF

a) Reference Activity (Bq at 2018) of the Reactor Vault (Source: PostSA TSD Table 3-1)

Radionuclide	Type	Half-life (y)	Aluminium	Concrete	Carbon Steel	Stainless Steel	Zircaloy	Contamination
H-3	a	$1.23x10^{1}$	$9.13x10^{9}$	$1.41x10^{12}$	$2.35x10^{8}$	$1.36x10^{1}$	$2.11x10^{11}$	-
C-14	a	$5.70x10^{3}$	$5.26x10^{11}$	$2.40x10^{10}$	$8.13x10^{7}$	$1.11x10^{10}$	$1.13x10^{12}$	-
Cl-36	a	$3.01x10^{5}$	$1.45x10^{10}$	$2.20x10^{9}$	$1.09x10^{7}$	$1.42x10^{7}$	$2.53x10^{10}$	-
Ca-41	a	$1.02x10^{5}$	-	$7.62x10^{9}$	-	-	-	-
Co-60	a	5.27	$2.98x10^{12}$	$3.18x10^{11}$	$2.61x10^{10}$	$2.90x10^{12}$	$6.70x10^{12}$	-
Ni-59	a	$1.01x10^{5}$	$8.58x10^{9}$	-	-	$4.06x10^{10}$	$1.71x10^{11}$	-
Ni-63	a	$1.00x10^{2}$	$1.35x10^{12}$	$6.83x10^{10}$	$4.39x10^{9}$	$6.38x10^{12}$	$2.63x10^{13}$	-
Se-79	f	$2.95x10^{5}$	-	-	-	-	-	$5.07x10^{5}$
Sr-90	f	$2.88x10^{1}$	-	-	-	-	-	$2.63x10^{10}$
Zr-93	a,f	$1.53x10^{6}$	-	-	-	-	$2.00x10^{11}$	$2.50x10^{6}$
Nb-93m	a,f	$1.61x10^{1}$	-	-	-	-	$1.66x10^{11}$	$2.81x10^{5}$
Nb-94	a,f	$2.03x10^{4}$	-	-	$7.47x10^{6}$	$5.10x10^{8}$	$1.85x10^{8}$	$1.60x10^{2}$
Tc-99	f	$2.11x10^{5}$	-	-	-	-	-	$1.89x10^{7}$
Ag-108m	a	$4.18x10^{2}$	-	-	$2.17x10^{9}$	$2.86x10^{11}$	$3.24x10^{6}$	-
Sn-121m	a,f	$4.39x10^{1}$	-	-	-	-	$3.98x10^{11}$	$8.75x10^{4}$
Sn-126	f	$2.30x10^{5}$	-	-	-	-	-	$6.21x10^{5}$
Sb-125	f	2.76	-	-	-	-	-	$2.69x10^{10}$
I-129	f	$1.57x10^{7}$	-	-	-	-	-	$3.71x10^{4}$
Cs-135	f	$2.30x10^{6}$	-	-	-	-	-	$9.16x10^{5}$
Cs-137	f	$3.02x10^{1}$	-	-	-	-	-	$6.77x10^{10}$
Sm-151	f	$9.00x10^{1}$	-	-	-	-	-	$2.82x10^{8}$
Eu-152	a,f	$1.35x10^{1}$	$2.76x10^{8}$	$1.23x10^{11}$	$5.92x10^{7}$	$9.52x10^{7}$	$3.48x10^{9}$	$3.06x10^{6}$

Radionuclide	Type	Half-life (y)	Aluminium	Concrete	Carbon Steel	Stainless Steel	Zircaloy	Contamination
U-234	act	$2.46x10^{5}$	-	-	-	-	-	$5.14x10^{5}$
U-235	act	$7.04x10^{8}$	-	-	-	-	-	$1.55x10^{3}$
U-236	act	$2.34x10^{7}$	-	-	-	-	-	$3.75x10^{5}$
U-238	act	$4.47x10^{9}$	-	-	-	-	-	$1.98x10^{5}$
Np-237	a, act	$2.14x10^{6}$	-	-	-	-	-	$1.12x10^{5}$
Pu-238	a, act	$8.77x10^{1}$	-	-	-	-	-	$1.55x10^{9}$
Pu-239	a, act	$2.41x10^{4}$	-	-	-	-	-	$5.07x10^{8}$
Pu-240	a, act	$6.56x10^{3}$	-	-	-	-	-	$8.05x10^{8}$
Pu-241	a, act	$1.44x10^{1}$	-	-	-	-	-	$8.05x10^{9}$
Pu-242	a, act	$3.75x10^{5}$	-	-	-	-	-	$9.98x10^{5}$
Am-241	a, act	$4.32x10^{2}$	-	-	-	-	-	$1.28x10^{9}$
Am-242m	a, act	$1.41x10^{2}$	-	-	-	-	-	$8.67x10^{6}$
Am-243	a, act	$7.37x10^{3}$	-	-	-	-	-	$1.79x10^{6}$
Cm-243	a, act	$2.91x10^{1}$	-	-	-	-	-	$1.10x10^{6}$
Cm-244	a, act	$1.81x10^{1}$	-	-	-	-	-	$9.57x10^{6}$

Note: a = indicates activation product, f = fission product, act = actinide

b) Reference Inventory of Fission Products and Actinides in other Rooms (Source: PostSA TSD Table 3-2)

Radionuclide	Type	Half-life (y)	Boiler Room (Bq)	Fuelling Room (Bq)	Turbine Room (Bq)	Generic Contamination* (Bq g^{-1})
H-3	a	$1.23x10^{1}$	$1.42x10^{10}$	$6.75x10^{7}$	$3.49x10^{12}$	$2.52x10^{3}$
C-14	a	$5.70x10^{3}$	$2.88x10^{7}$	$1.36x10^{4}$	$2.91x10^{3}$	$6.88x10^{-6}$
Co-60	a	5.27	$9.42x10^{10}$	$2.25x10^{8}$	$1.87x10^{7}$	$4.42x10^{-2}$
Ni-63	a	$1.00x10^{2}$	$6.79x10^{10}$	$6.04x10^{7}$	$1.29x10^{7}$	$3.04x10^{-2}$
Se-79	f	$2.95x10^{5}$	-	$8.76x10^{4}$	-	-
Sr-90	f	$2.88x10^{1}$	$4.72x10^{9}$	$7.40x10^{9}$	$6.17x10^{7}$	$5.37x10^{-1}$
Zr-93	a,f	$1.53x10^{6}$	-	$4.32x10^{5}$	-	-
Tc-99	f	$2.11x10^{5}$	-	$3.26x10^{6}$	-	-
Sn-121m	a,f	$4.39x10^{1}$		$1.51x10^{4}$		
Sn-126	f	$2.30x10^{5}$	-	$1.07x10^{5}$	-	-
Sb-125	f	2.76	-	$9.46x10^{4}$	-	-
I-129	f	$1.57x10^{7}$	-	$6.42x10^{3}$	-	-
Cs-135	f	$2.30x10^{6}$	-	$1.11x10^{4}$	-	-
Cs-137	f	$3.02x10^{1}$	$7.22x10^{9}$	$1.01x10^{9}$	$9.21x10^{7}$	$2.15x10^{-1}$
Sm-151	f	$9.00x10^{1}$	-	$3.42x10^{6}$	-	-
Eu-152	a,f	$1.35x10^{1}$	-	$3.72x10^{4}$	-	-
U-234	act	$2.46x10^{5}$	-	$6.24x10^{3}$	-	-
U-235	act	$7.04x10^{8}$	-	$5.56x10^{2}$	-	-
U-236	act	$2.34x10^{7}$	-	$4.54x10^{3}$	-	-
U-238	act	$4.47x10^{9}$	-	$1.44x10^{4}$	-	-
Np-237	a, act	$2.14x10^{6}$	-	$1.36x10^{3}$	-	-
Pu-238	a, act	$8.77x10^{1}$	$1.66x10^{9}$	$6.10x10^{6}$	$2.16x10^{7}$	$5.00x10^{-4}$
Pu-239	a, act	$2.41x10^{4}$	$1.70x10^{10}$	$1.25x10^{7}$	$2.22x10^{8}$	$5.14x10^{-3}$
Pu-240	a, act	$6.56x10^{3}$	-	$9.76x10^{6}$	-	-

Radionuclide	Type	Half-life (y)	Boiler Room (Bq)	Fuelling Room (Bq)	Turbine Room (Bq)	Generic Contamination* (Bq g^{-1})
Pu-241	a, act	$1.44x10^{1}$	$1.37x10^{11}$	$2.53x10^{8}$	$1.79x10^{9}$	$4.14x10^{-2}$
Pu-242	a, act	$3.75x10^{5}$	-	$1.21x10^{4}$	-	-
Am-241	a, act	$4.32x10^{2}$	$1.80x10^{10}$	$2.33x10^{7}$	$2.35x10^{8}$	$5.44x10^{-3}$
Am-242m	a, act	$1.41x10^{2}$	-	$1.05x10^{5}$	-	-
Am-243	a, act	$7.37x10^{3}$	-	$2.18x10^{4}$	-	-
Cm-243	a, act	$2.91x10^{1}$	-	$1.33x10^{4}$	-	-
Cm-244	a, act	$1.81x10^{1}$	-	$1.38x10^{5}$	-	-

Notes: * a = indicates activation product, f = fission product, act = actinide

* Generic contamination levels are applied to the whole of the concrete structure of the NPDWF, with the inventories of specific rooms (e.g. the Boiler Room) being additional quantities of radioactivity located within rooms.

The vast majority of the waste inventory, by volume, can be categorized as LLW due to the presence of short-lived radionuclides which will principally decay to below established clearance levels within the Institutional Control phase. Based on the activation products within the reactor system, a small volume (~ 125 m^3) could be classified as ILW and therefore require the degree of containment and isolation afforded by the reactor vault shielding. CSA 292.0-14 (2014b) guidance (*General principles for the management of radioactive waste and irradiated fuel*) suggests limiting the amount of long-lived beta and/or gamma emitting radionuclides (C-14, Cl-36, Ni-63, Zr-93, & Nb-94) in LLW to an average of up to tens of kBq/g. Radionuclides such as C-14, Ni-63 and Zr-93 are present in the reactor system at concentrations exceeding this value. Although the surface contamination within systems includes long-lived alpha emitting radionuclides (e.g., U-235, U-238, Pu-239), these radionuclides are only present in very low residual amounts, thus the significant majority of the long-lived radionuclides are beta emitters.

As mentioned above, all nuclear fuel was previously removed from the NPD site. Therefore, there is no high level waste remaining at NPDWF.

4.4.1.2 Existing Non-Radiological Inventory

The inventory of non-radiological contaminants is dominated by those typically associated with 50-year-old industrial facilities. This includes:

- Lead: from lead paint and lead bricks, previously used as shielding;
- Mercury: from instruments, such as thermometers;
- Asbestos: from pipe insulation, floor tiles and building cladding; and
- PCBs: from light ballasts which will remain due to inaccessibility.

Gillespie (2017) documents the current inventories and locations of hazardous materials in NPDWF, specifically lead, asbestos, PCBs and mercury. Information on these materials is summarized in Table 4.4-2 below. Gillespie (2017) also discusses the expected location of these materials after the NPDWF decommissioning is completed.

Table 4.4-2. Reference Non-Radiological Inventory for NPDWF

Material	Inventory Description
Asbestos	Estimated 230 m^3, of which 165 m^3 is located in sealand containers outside of the NPDWF generated from previous asbestos abatement activities. Also present inside walls in above-grade structure (20 m^3), inside reactor vault (5 m^3), inside boiler room (30 m^3), and exterior transite panels (10 m^3).
Lead	Total quantity of exposed lead: Estimated 26,228 kg (of which 22,680 kg are exposed lead bricks for shielding). Total quantity of encased lead: Estimated 437,900 kg (of which 319,000 kg are shielding walls and roof). Includes lead-based paint (above and below grade); exposed lead bricks and shielding wall; and lead encased in steel, masonite, and concrete (walls, gates, roof, vault, booster rods).
PCBs	Estimated total mass of 2.97 kg PCBs (maximum potential quantity), located in light ballasts which are not safely accessible to remove, located in areas such as the condenser room and boiler room.
Mercury	Estimated less than 0.01 kg residual contamination, located in the boiler room.

4.4.1.3 Generated Waste

In addition to the waste that is already present at NPDWF, further waste will be generated during the project. These decommissioning wastes will be LLW and consist of common industrial items that have become contaminated with low levels of radioactivity during the grouting and demolition activities. This may consist of mops, rags, temporary floor coverings, floor sweepings, protective equipment and clothing as well as possibly hardware items which become expendable such as cameras or temporary lighting. Localized remediation activities may also produce low level contaminated soils which may be emplaced into NPDWF for grouting. As discussed above and in the NPD Waste Management Plan (Gillespie 2017), these wastes will be added to the existing inventory within NPDWF.

The NPDWF currently generates on order of 10 m^3/y of LLW in the form of PPE&C or general consumables. Due to recent work to prepare for decommissioning (i.e. asbestos abatement and system characterization), this volume reflects to the volume of organic waste that may be disposed of during the Decommissioning Execution phase. For context, O.Reg 232/98 (Ontario 1998) includes requirements for gas generation assessment but the regulation applies for (municipal) waste disposal volumes of 40,000 m^3 or more.

Thus, the projected volumes are trivial and the total radiological inventory will be negligible and bounded by the reference radiological inventory.

4.4.2 Waste Characterization

The reference inventories serve as the limit of radiological or non-radiological contaminants which may be grouted within NPDWF, as they have been demonstrated as meeting the appropriate acceptance criteria within the PostSA. The reference radiological inventory is based on well-established and defined previous characterization work (King 2016) or by industry-accepted calculations (i.e., neutron flux modeling, Smith 1988).

A comprehensive characterization plan for the entire NPD site, building and systems was developed to support the decommissioning of NPDWF and which meets the guidelines provided for waste characterization in CSA N292.0-14 (CSA 2014b). The characterization plan provides methodologies and sampling designs intended to provide the data required to support the multiple characterization objectives, which included:

- Confirm the bounding reference inventory of the reactor and associated systems (i.e., primary heat transport and moderator systems). These characterization activities have been completed as part of the planning for decommissioning in order to provide confidence in the reference inventory used within the PostSA TSD (NMNTI 2017, McVeigh 2017); and
- Identify the nature and extent of both radiological and non-radiological contamination within the building structure and other nuclear systems. Sufficient scoping level information was available to support the development of decommissioning plans and a statistical approach has been developed for further verification activities.

As characterization of NPDWF progresses to verify waste inventories, a compilation of the measured inventory will be maintained in a database. The waste inventory database inputs will align with the critical parameters in the PostSA including radionuclide inventory, designated substance inventory, material type for activated systems, and location within NPDWF. Waste inventory entries will be verified and the database will also be in a format that is retrievable. The measured individual radionuclides, as well as the total inventory, will be regularly summed for the entire facility. Total measured inventories will then be compared against the reference inventory utilized in the PostSA. Measured inventories that exceed the reference inventory, or may be generally problematic, would be removed for alternate disposition via other approved CNL routes. However, at this stage in the project, there have been no identified non-compliant inventories within NPDWF. The final measured waste inventory within NPDWF is also expected to be less then the reference inventory due to the conservatisms used during establishing it.

4.5 Potential Project-Related Releases to the Environment

Routine operations, each phase of the project, and every activity within that phase, will have some releases to the environment. These releases may or may not have an effect on the environment; however, before the potential effects can be assessed, all potential releases must be identified. Table 4.5-1 below shows the expected types of releases to air (including noise), groundwater (GW) and surface water (SW), as well as the typical frequencies of these releases.

The release types listed in Table 4.5-1 do not include releases caused from accidents. Accidents and malfunctions, and the predicted effects associated with them, are discussed in the DecomSA TSD and summarized in Section 9.11 below.

Table 4.5-1. Potential Project-Related Releases for each Phase and Activity

Decom. Phase	Associated Activities	Time frame	Pathway	Potential Release	Frequency
Execution	Assembly and operation of batch mixing plant	2019	Air	• Dust from movement of aggregate and machinery • Road dust from trucks • Diesel emissions[1] • Noise from assembly and operation of plant and machinery, and from trucks	Periodic
			GW	• No emissions expected	N/A
			SW	• Releases from settling ponds[2]	Occasional
	Grouting of below-grade structures	2019	Air	• Dust from movement of machinery • Road dust from trucks • Diesel emissions[1] • Noise from machinery, and from trucks • Ventilation for curing the grout • Hydrogen release from a grout-aluminum reaction	Periodic
			GW	• No emissions expected	N/A
			SW	• Releases from settling ponds[2]	Occasional
	Removal of above-grade structures and use as backfill	2019	Air	• Dust from demolition • Road dust from trucks • Potential release of asbestos from Transite cladding • Diesel emissions[1] • Noise from demolition and machinery	Periodic
			GW	• No releases expected	N/A
			SW	• Runoff from rain • Runoff from misting during demolition	Periodic

Decom. Phase	Associated Activities	Time frame	Pathway	Potential Release	Frequency
Closeout	Installation of concrete cap and engineered barrier	2019 – 2020	Air	• Dust from movement of aggregate and machinery • Road dust from trucks • Diesel emissions[1] • Noise from operation of plant and machinery, and from trucks	Periodic
			GW	• No releases expected	N/A
			SW	• Releases from settling ponds[2] • Releases from cleaning of equipment prior to release from site • Runoff	Occasional
	Final site restoration	2020	Air	• Dust from reducing building slabs, foundations and roads to rubble (machinery and deconstruction/ demolition) • Road dust from trucks • Diesel emissions[1] • Noise from machinery and trucks	Periodic
			GW	• No releases expected	N/A
			SW	• No releases expected	N/A
Institutional Controls	Long-term care and maintenance, Facility performance during the Institutional Controls phase	2020-2120	Air	• Negligible releases from maintenance and monitoring activities.	Occasional
			GW	• Eventual release of dissolved contaminants and alkaline plume	Delayed and gradual
			SW	• Dissolved contaminants and alkaline plume in groundwater may reach the Ottawa River	Delayed and gradual

Decom. Phase	Associated Activities	Time frame	Pathway	Potential Release	Frequency
Post-Institutional Controls	Facility performance during the Post-Institutional Controls phase.	>2120	Air	• Eventual releases through cap system	Delayed and gradual
			GW	• Eventual release of dissolved contaminants and alkaline plume.	Delayed and gradual
			SW	• Eventual release of dissolved contaminants leached through groundwater migration	Delayed and gradual

Notes:

N/A – Not applicable, i.e., no release expected.

Periodic – occurring at regular intervals.

Occasional – occurring at infrequent intervals.

1 – Diesel emissions may originate from diesel generators, trucks and machinery.

2 – Settling ponds will be created to collect and settle water used in the grouting and capping cleaning process.

4.6 Project-Related Employment

Based on the project activities discussed above, the employment benefits resulting from the project are likely to be minimal. During the Decommissioning Execution phase, approximately 20 CNL staff and 10 local contractors are expected to be on-site at any given time. During the Institutional Controls phase workers will only be on site during periodic staff visits. CNL has a human resources plan that includes the transitioning of NPD closure project staff to other Decommissioning and Waste Management (DWM) initiatives following completion of the project. Any follow-up monitoring or surveillance activities under institutional controls would require minimal staff that will be supported through periodic surveillance visits from CRL staff.

5 SCOPE OF THE ENVIRONMENTAL ASSESSMENT

5.1 Factors to be Considered

As discussed in Section 3.5, the EA for the project is being conducted under *CEAA* (2012).

This EIS has been prepared in accordance with the methodology provided in the EIS Guidelines (CNSC 2016a). Scoping establishes the EA's parameters and focuses the assessment on relevant issues and concerns. The EA of the designated project must take into account the following factors, as listed in subsection 19(1) of *CEAA*:

- the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project, and any cumulative environmental effects likely to result from the designated project in combination with other physical activities that have been or will be carried out;
- mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;
- the significance of those environmental effects after mitigation (residual effects);
- comments from the public that are received in accordance with the *CEAA*;
- mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;
- the requirements of the follow-up program in respect of the designated project;
- the purpose of the designated project;
- alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means;
- any changes to the designated project that may be caused by the environment;
- the results of any relevant study conducted by a committee established under section 73 or 74 of the *CEAA*; and
- any other matter relevant to the EA that the CNSC requires to be taken into account, in accordance with the *Nuclear Safety and Control Act* Pursuant to subsection 19(2) of the *CEAA*, the scope of the factors to be taken into account under paragraphs 19(1)(a), (b), (d), (e), (g), (h) and (j) is determined by the CNSC, as the responsible authority.

To implement the Government of Canada interim measure with respect to upstream greenhouse gas (GHG) emissions, the CNSC may require consideration of these types of emissions in the scope of the EA. On March 19, 2016, a definition of upstream GHG emissions was published by Environment Canada and Climate Change in the Canada Gazette. The proposed definition of upstream includes "*all industrial activities from the point of resource extraction to the project under review.*" The processes that are to be

considered as upstream activities will vary by the type of resource and the nature of the project under assessment. CNL has prepared a GHG TSD to address this specific requirement.

5.2 Scope of Factors

5.2.1 Spatial & Temporal Boundaries

5.2.1.1 Spatial Boundaries and Scale

Spatial boundaries define the geographical extent(s) within which likely or potential environmental effects will be considered. There are typically three different spatial boundaries (i.e., study areas) that are used to represent the general spatial framework for assessing environmental effects.in EAs:

- Site Study Area: The project footprint (i.e., where project activities would be undertaken including the project's proposed facilities, buildings and infrastructure);
- Local Study Area: The area existing outside the site study area boundary, where measurable changes to the environment resulting from the proposed activities from any phase of the project, either through normal activities, or from possible accidents or malfunctions, may be anticipated; and
- Regional Study Area: the area within which the potential effects of this project may interact with the effects of other projects, resulting in the potential for cumulative effects (CNSC 2016a).

To date, CNL has not received feedback from engagement activities on spatial boundaries.

Also in accordance with the EIS Guidelines (CNSC 2016a), the application of these study areas can vary within each environmental component, to allow the full extent of likely effects to be considered. For example, the study areas for the surface water environment (which focus on the Ottawa River) will vary from the study areas for the Atmospheric Environment (which focus on the air surrounding the project). Therefore, the specific spatial boundaries for each environmental component are described in their respective sections in the Baseline Characterization (Section 8 below). The study areas presented below are general ones that apply to several of the environmental components and will be referred to in Sections 8 and 9 below.

General Site Study Area

The general site study area includes the anticipated footprint of the project, which includes:

- areas within the NPDWF fenceline;
- the main road and transmission line;
- the surrounding paved areas, which may be used for laydown or other project-related activities;
- the building foundations and non-essential roadways that will be reduced to rubble during final site restoration;

- areas that will not necessarily be affected during decommissioning execution activities but will require work during the site restoration (e.g., due to prior contamination); and
- the two landfills on the NPD site.

The Site Study Area extends 50 m into the Ottawa River, in order to capture the releases from the NPD site (for example, sub-surface Drain 1 discharges onto the shore of the Ottawa River, and the wells area sump (WAS) discharges roughly 20 m from the shoreline into the Ottawa River. The site drainage systems are described in detail in Section 8.3). The general Site Study Area is shown in Figure 5.2-1.

General Local Study Area

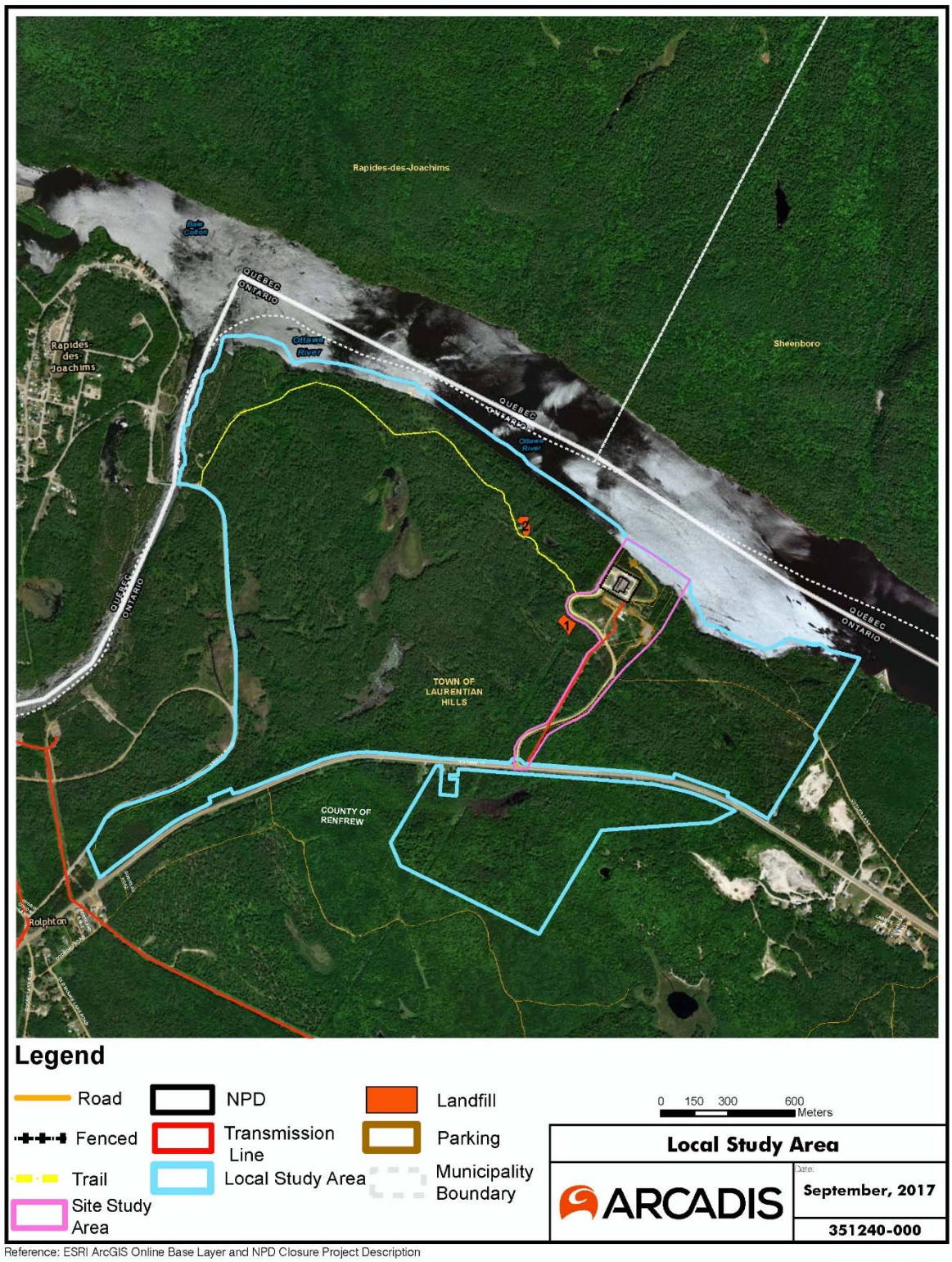
The general Local Study Area comprises the entire NPD property including the shoreline, and extends 50 m into the Ottawa River. The general Local Study Area is presented in Figure 5.2-2.

Figure 5.2-1. Site Study Area



Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Figure 5.2-2. Local Study Area



Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

In this EIS, to avoid repetition and for ease of interpretation, the Site and Local Study Areas are often examined together.

Regional Study Area

Due to the differences between the various environmental components, a general Regional Study Area has not been defined here. The Regional Study Area for each environmental component is presented in Section 8 (Baseline Characterization) below.

5.2.1.2 Temporal Boundaries and Scale

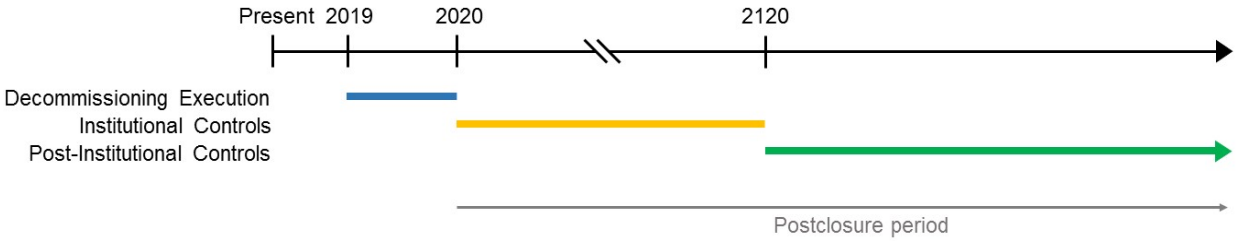
The temporal boundaries for the EA establish the timeframes for which the direct, indirect and cumulative effects are assessed. The following three phases were identified for the NPD Closure Project:

- **Decommissioning Execution**, which includes all activities associated with decommissioning including setup and operation of the batch mixing plant, grouting and demolition activities, installation of the concrete cap and engineered barrier, as well as site restoration and demobilization. The execution-related activities are expected to take one to two years beginning in April 2019;
- **Institutional Controls**, which includes long-term care and maintenance. This is the timeframe where institutional controls (i.e., active oversight) are in effect. A reference period of institutional controls of 100 years is assumed (PostSA TSD). 100 years is a conservative assumption for cessation of institutional controls. Institutional Controls are expected to begin in 2020;
- **Post-Institutional Controls**, which includes abandonment of the site following institutional control. Assessment of the Post-Institutional Controls phase extends far into the future.

To date, CNL has not received feedback from engagement activities on the temporal boundaries outlined for the project.

Figure 5.2-3 illustrates the temporal boundaries of the project. The timelines developed for the three phases are intended to be sufficiently flexible to capture the effects of the project activities. It is important to note that although the planning phase is considered a part of decommissioning, that it is not part of the EA scope.

Figure 5.2-3. Temporal Boundaries of the NPD Closure Project Phases



5.2.2 Project-Environment Interactions

Project-environment interactions were developed by screening potential effects of project-related activities within each relevant component of the environment. Environmental components include media such as the atmospheric environment, resources such as surface water, and cultural aspects such as Aboriginal interests. Environmental components are further sub-divided into environmental sub-components in order to capture all aspects of potential importance. For example, the aquatic environment was divided into sub-components such as aquatic habitat and aquatic biota.

Each project activity was considered individually in order to focus the effort of the assessment, and all for a more detailed screening of potential interactions. The list of project activities outlined in the Detailed Decommissioning Plan (Aikens 2017) was utilized for this purpose. At this stage of the EA process, the identification of the potential project-environment interactions was based on the experience and professional judgement of technical specialists involved in the assessment. Where a plausible mechanism for project-environment interactions was identified, it was noted in the project interactions matrix (Table 5.2-1).

Table 5.2-1. Potential Project Environment Interactions

	Project Works & Activities	Atmospheric Environment		Surface Water Environment	Aquatic Environment		Geological and Hydrogeological Environment			Terrestrial Environment		Ambient Radioactivity	Human Health		Aboriginal Land and Resource Use	Socio-Economic Environment	
		Air Quality	Noise	Site Drainage & Water Quality	Aquatic Habitat	Aquatic Biota (Fish, Benthic Invertebrates etc.)	Soil Quality	Groundwater Quality	Groundwater Flow	Terrestrial Habitat	Terrestrial Biota	External Gamma Radiation	Public Health	Worker Health	Aboriginal Land and Resource Use	Socio-economic Assets	Land Use
1.	**Decommissioning Execution: Batch Mixing Plant**																
1.1	Designate footprint, create access, temporary fencing (west side of main building)	◆	◆	◆						◆				◆	◆	◆	
1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	◆	◆	◆						◆				◆	◆	◆	
1.3	Set up mixing stations, hook up electrical power or diesel power.									◆				◆			
1.4	Truck in necessary water supply	◆	◆							◆				◆	◆	◆	
1.5	Provide slip pipe access to nuclear area.	◆	◆									◆		◆	◆	◆	
1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	◆	◆	◆						◆	◆			◆	◆	◆	
1.7	Level area for concrete pumper.	◆	◆	◆						◆				◆	◆	◆	
1.8	Mix grout to required formula	◆	◆											◆	◆	◆	
1.9.a	Truck grout to pumping station (20 trips per day)	◆	◆							◆				◆	◆	◆	
1.9.b	Alternatively set up pumping lines from mixing station to various areas around the main building.																
1.10	Wash out cement truck sluice and pumper truck and slip pipes. (Daily)			◆		◆											
1.11	Sample and dewater the cleaning pit. Emplace sediments into voids in condenser room	◆	◆	◆										◆	◆	◆	
1.12	Demobilize batch plant after cap pour.	◆	◆											◆	◆	◆	
2.	**Decommissioning Execution: Grouting of Below Grade Structure**																
2.1	Room preparation (sealing of pipes, drilling of holes for grout passage and heat dissipation)											◆		◆		◆	
2.2	Systems Preparation Large Vessels											◆		◆			

	Project Works & Activities	Atmospheric Environment		Surface Water Environment	Aquatic Environment		Geological and Hydrogeological Environment			Terrestrial Environment		Ambient Radioactivity	Human Health		Aboriginal Land and Resource Use	Socio-Economic Environment	
		Air Quality	Noise	Site Drainage & Water Quality	Aquatic Habitat	Aquatic Biota (Fish, Benthic Invertebrates etc.)	Soil Quality	Groundwater Quality	Groundwater Flow	Terrestrial Habitat	Terrestrial Biota	External Gamma Radiation	Public Health	Worker Health	Aboriginal Land and Resource Use	Socio-economic Assets	Land Use
2.3	Grout Fill Nuclear Area	◆	◆							◆	◆	◆	◆	◆	◆	◆	
3.	**Decommissioning Execution: Removal of Above Grade Structure**																
3.1	Conventional heavy equipment knockdown of reactor hall.	◆	◆	◆		◆	◆			◆	◆	◆	◆	◆	◆	◆	
3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	◆	◆	◆		◆	◆			◆	◆	◆	◆	◆	◆	◆	
3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	◆	◆	◆			◆			◆		◆		◆	◆	◆	
3.4	Steel and rubble emplaced in condenser room according to nesting plan. Fill to 380 level.	◆	◆								◆	◆	◆	◆	◆	◆	
3.5	Grout first level of demolition material in condenser room.	◆	◆								◆	◆	◆	◆	◆	◆	
3.6	Steel and rubble emplaced in condenser pit. Fill to 400 level	◆	◆								◆	◆	◆	◆	◆	◆	
3.7	Grout second level of demolition material in condenser room.	◆	◆								◆	◆	◆	◆	◆	◆	
3.8	Steel and rubble in condenser room. Fill to 425 level	◆	◆								◆	◆	◆	◆	◆	◆	
3.9	Grout third level of demolition material in condenser room.	◆	◆								◆	◆	◆	◆	◆	◆	
3.10	Demolition block walls and inside walls around control room and change rooms.	◆	◆	◆		◆	◆			◆	◆	◆	◆	◆	◆	◆	
3.11	Collapse ceilings of furnace room and adjacent rooms.	◆	◆							◆	◆	◆	◆	◆	◆	◆	
3.12	Emplace block wall rubble in furnace room or condenser room.	◆	◆								◆	◆	◆	◆	◆	◆	
3.13	Remove recyclables from guard house.		◆												◆	◆	
3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	◆	◆	◆		◆	◆				◆	◆	◆	◆	◆	◆	
3.15	Grout furnace room and adjacent areas to ground level.	◆	◆								◆	◆	◆	◆	◆	◆	
3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	◆	◆	◆		◆	◆			◆	◆	◆	◆	◆	◆	◆	
4.	**Decommissioning Execution: Install Concrete Cap and Engineered Barrier**																
4.1	Concrete Cap (construct forms, install rebar, and pour, level and slope concrete).	◆	◆	◆					◆					◆	◆	◆	

	Project Works & Activities	Atmospheric Environment		Surface Water Environment	Aquatic Environment		Geological and Hydrogeological Environment			Terrestrial Environment		Ambient Radioactivity	Human Health		Aboriginal Land and Resource Use	Socio-Economic Environment	
		Air Quality	Noise	Site Drainage & Water Quality	Aquatic Habitat	Aquatic Biota (Fish, Benthic Invertebrates etc.)	Soil Quality	Groundwater Quality	Groundwater Flow	Terrestrial Habitat	Terrestrial Biota	External Gamma Radiation	Public Health	Worker Health	Aboriginal Land and Resource Use	Socio-economic Assets	Land Use
4.2	Engineered Barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	◆	◆	◆					◆					◆	◆	◆	
5.	**Decommissioning Execution: Final Site Restoration**																
5.1	Site Restoration (install fencing, install monitoring wells if required, remediate areas impacted by decommissioning, washout pits and settling ponds, complete closure surveys)	◆	◆							◆ □					◆	◆	
5.2	Ventilation Stack Isolation (remove ancillary equipment from stack, stack modification for roost requirements).									□							
5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	◆	◆	◆						◆ □				◆	◆	◆	
6.	**Institutional Controls: Long-Term Care and Maintenance**																
6.1	Groundwater sampling																
6.2	Vegetation removal																
6.3	Road maintenance																
6.4	Fence maintenance																
6.5	Inspection activities of geotextile cover (i.e., moisture sensors)																
6.6	Life management surveillance of concrete cap																
6.7	Renaturalization									□					□	□	□
6.8	Facility performance during the Institutional Controls phase	◆		◆		◆		◆	◆		◆	◆	◆		◆	◆	
7.	**Post-Institutional Controls**																
7.1	Facility performance during the Post-Institutional Controls phase	◆		◆		◆	◆	◆		□	◆	◆	◆		◆□	◆□	□

◆ Potential interaction

□ Positive interaction

5.2.3 Constituents of Potential Concern

Constituents of potential concern (COPCs) are contaminants that may pose a risk to the environment, based on current or predicted future concentrations in the environment. In the studies associated with this EA, all radionuclides for which data is available are considered COPCs. The selection of chemical COPCs was based on comparison of measured levels to existing criteria (i.e., a screening exercise) and by considering the hazardous substances that are known to be in the facility. The radioactive and chemical inventory and generated waste are discussed in Section 4.4.1 above.

5.2.3.1 Radiological COPCs

The PostSA TSD discusses the radiological inventory and highlights dominant radionuclides. The majority of the radiological inventory within NPDWF is associated with reactor systems (calandria and pressure tubes), the biological shield, the primary heat transport system, and the moderator system. The radiological inventory has been developed using a cautious approach as outlined in Section 4.4.1 above. The inventory that has been associated with the reactor core and biological shield is $5.19X10^{13}$ Bq and the inventory associated with the boiler room (i.e., primary heat transport, moderator and other nuclear systems) is $3.62x10^{11}$ Bq. The dominant radionuclides present by total radioactivity are H-3, C-14, Co-60, Ni-59, Ni-63, Zr-93, Nb-93, Ag-108m, Sn-121m, Eu-152, and Pu-241 (see Table 4.4-1). All radionuclides for which data is available are considered COPCs.

5.2.3.2 Chemical COPCs

Typically, a chemical is identified as a COPC if it has a concentration in the environment (at the site) higher than a given criterion, which typically comes from a regulatory source (e.g., from Health Canada, the CCME or MOECC) or background concentrations. Additionally, COPCs are identified by taking into consideration hazardous substances that are known to be in the facility, and therefore are relevant to the project.

First, chemical COPCs were identified based on existing site conditions by screening the available constituent concentrations measured in the baseline environment against available criteria within each of the media (e.g., air, water, sediment, soil). The results of these comparisons, which are presented in detail in the Baseline Characterization (Section 8 below), are summarized in Table 5.2-2.

Table 5.2-2. Chemical COPC Screening, Based on Available Baseline Data (See Section 8 of this EIS)

Environmental Medium	Contaminant(s) Considered	Measurement Location	Applicable Criteria	Exceeds any of the Criteria?
Air	NO_2, SO_2, $PM_{2.5}$	North Bay, Petawawa	MOE 1-hour, 24-hour and annual average criteria. Canadian Ambient Air Quality Standards and National Ambient Air Quality Objectives.	No.
Soil	Several parameters	NPD Site	MOE Guidelines	Aluminum exceeded the MOE Guidelines, but is within Ontario Typical Range (MOEE 1999). (King 2016). At TP-N (near Landfill #1, See Figure 8.5-4) cadmium, copper, lead, molybdenum and zinc exceeded MOE Guidelines. At MT-5 and TP-C (located near the facility, See Figure 8.5-4) aluminum, arsenic, cadmium, copper and 1,2-dichlorobenzene exceeded MOE Guidelines. (MacLarentech 1990). The presence of these contaminants is associated with natural background or past NPD operations, not with NPD closure project activities. Lead is discussed further below.
Surface Water	Several Parameters	NPD Site	Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines (CWQGs and MOE Background and Standard Values	Samples of iron and zinc in MH-3 were found to exceed MOE and CCME guidelines; however, it is noted that MH-3 had no flow during the sampling campaign and there was a sample volume issue (Audet 2016).
		Upstream of NPD	CCME CWQGs.	Copper exceeded, however, these values were attributed to the natural leaching of rocks.

Environmental Medium	Contaminant(s) Considered	Measurement Location	Applicable Criteria	Exceeds any of the Criteria?
Sediment	Several metals	CRL reference and site locations	CCME Canadian Sediment Quality Guidelines (CSQGs) and MOE Guidelines for the Protection and Management of Aquatic Sediments in Ontario (1993).	Some metals exceeded; however, due to the high levels in unaffected sites, these exceedances were considered baseline conditions.
Groundwater	Several parameters	NPD Site	Health Canada Drinking Water Standards and MOE Site Condition Standards for Use Under Part XV.1 of the *Environmental Protection Act* (2011).	Manganese at NPD-10 (which is downgradient from Landfill #2, see Section 8.5) slightly exceeds the aesthetic objective of 50 µg/L; however, it is not associated with NPD closure project activities.

As seen in Table 5.2-2, in all cases measurements were below the criteria, within typical range and/or not associated with the project and are therefore 'screened out', except for lead (discussed below).

In addition to the baseline screening exercise above, this assessment also identified COPCs by considering the hazardous substances that are known to be in the facility. As per the Project Description, this includes industrial chemicals, asbestos materials (such as pipe insulation, floor tiles and transite building cladding), lead-based paint, lead bricks and sheets, PCBs in fluorescent light fixture ballasts, and small quantities of mercury due to residual contamination (Titterington 2016).

The inventory of chemical contaminants (presented in Section 4.4.1) also discusses the possible presence of oils, due to a historical oil leak in the tile drains, which has since been remediated. However, petroleum hydrocarbon levels measured in groundwater at the NPD site were below MOE (2011) groundwater standards as well as Health Canada drinking water standards (see Table 5.2-2 above), and are therefore not retained as COPCs.

Based on the above baseline screening (Table 5.2-2 above) and the hazardous substances identified in the facility, the following list comprises the chemical COPCs that are relevant for the NPD closure project:

- Asbestos;
- Lead;
- Mercury; and
- PCBs.

5.2.4 Valued Components

VCs, sometimes referred to in EAs as valued ecosystem components (VECs), are environmental features that may be affected by a project and that have been identified to be of importance by the proponent, government agencies, Aboriginal peoples, or the public. The value of a component not only relates to its role in the ecosystem, but also to the value people place on it. For example, it may have been identified as having scientific, social, cultural, economic, historical, archaeological, or aesthetic importance (*CEAA* 2012).

VCs are often thought of in terms of the aquatic and terrestrial environments where ecological features, individual species, or important groups of species may be identified. VCs also exist, however, for cultural and socio-economic environmental components such as heritage resources or hunting and trapping activities. In some cases, an environmental component will not have a VC; rather it will be a pathway, or a means for transfer of an effect to a VC in another environmental component. For example, in the atmospheric environment, air quality and noise act as pathways for the transfer of effects to VCs in other environmental components, such as biota in the terrestrial environment.

VC identification is based on the potential project-environment interactions in various environmental components, and the description of the existing environment. As the focal points of the EA study, it is important that the selected VCs represent meaningful receptors of the environmental effects that may be caused by the project. VCs are selected to account for the effect of the project on other species present. A summary of the methodology that was applied for selection of VCs is described below.

5.2.4.1 Valued Component Selection Methodology and Process

Overall, the VC selection process involves:

1. Create master list of candidate VC species, by reviewing relevant reference documents and applying EA process and site knowledge. The main reference documents for VC selection were:

    - Proposed List of Valued Ecosystem Components for Public Consultation (Morin 2013);
    - Biodiversity Report (Morin and Carr 2015);
    - Results of Bat Surveys at NPD (Murrant 2016);
    - NPD Ecological Land Classification Report (ELC TSD);
    - MNRF Ottawa River Review (Haxton and Chubbuck 2002);
    - Atlas of the Breeding Birds of Ontario (BSC *et al.* 2006);
    - Ontario Reptile and Amphibian Atlas Program (ON 2016a); and
    - Ottawa River Background Study (Quebec Labrador Foundation 2005).

    From this, a consolidated master list of candidate VCs was produced. This list is presented in Appendix A. These candidate VCs include biota such as fish or birds, as well as abiotic qualities such as cultural and heritage sites, or socio-economic entities such as fishing.

2. Using the environmental components identified in the project interactions matrix (Table 5.2-1), VCs were selected for and assigned to each environmental component. Some environmental components were identified as pathways, meaning effects in that environmental component would affect VCs in other environmental components. For other environmental components, a VC (from the master list of candidate VCs in Appendix A) was selected and assigned. VC selection was based on the following criteria:

   - Presence and abundance (i.e., representation) in the relevant study areas;
   - Data availability (i.e., sufficient information must be available to allow an appropriate evaluation of effects);
   - Human health importance (i.e., the extent to which human health may be affected);
   - Ecological importance (i.e., the extent to which the growth or sustainability of non-human biota may be affected);
   - Native species (i.e., those that have been well established in the area over a long time period);
   - Degree of exposure (i.e., the extent to which the VC may be exposed to "stressors" associated with the project);
   - Degree of sensitivity (i.e., the extent to which the VC may be sensitive to the "stressors" associated with the project);
   - Conservation status (i.e., the extent to which the VC may be specifically protected by law, designated as rare, threatened, or endangered);
   - Socio-economic importance (i.e., value of the VC as a commercial, recreational or subsistence resource; inherent aesthetic value);
   - Traditional and current importance to Aboriginal Peoples;
   - Cultural and heritage importance to society;
   - Representative of various relevant habitats and other relevant species, including other candidate VCs known to be present at the NPD site; and
   - Can be assessed via surrogate using an existing VC.

   The list of VCs is presented in Table 5.2-3 below. The table includes an explanation of the selection rationale for each VC.

3. Provide opportunity for VC engagement. Once a draft VC list was developed, input was solicited from Aboriginal, agency, and public stakeholders. The feedback received during the VC engagement was documented and is summarized in Section 6.3.3.1, and includes discussion of VCs that were suggested for inclusion during the engagement process.

4. Update Draft VC List to address relevant comments. Provide rationale for any changes and excluded suggestions.

5. Produce Final VC List.

5.2.4.2 Valued Component Identification

Table 5.2-3 below shows the VCs that were selected for each environmental component, based on the master list of candidate VC species (see Appendix A). The table also identifies pathways for the transfer of effects, as discussed above. Only *SARA* (2002) designations are listed for species in the table below. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC. Other SAR (i.e. SARO and COSEWIC) designations are listed in Sections 8.4 and 8.6. Note: Shaded cells represent pathways to VCs in other environmental components.

Table 5.2-3. VCs and Pathways for the NPD Closure Project, by Environmental Component

a) Atmospheric Environment

Environmental Component	Pathway	Rationale
Atmospheric Environment	Pathway to human health	The effects on humans associated with changes in atmospheric conditions (radiological and chemical releases and concentrations) will be considered in the human health component.
	Pathway to non-human biota	The effects on non-human biota associated with changes in atmospheric conditions (radiological and chemical releases and concentrations) will be considered in the aquatic and terrestrial environmental components.
	Pathway to VCs in other environmental components	The effects on VCs in other environmental components associated with changes in atmospheric conditions (e.g. noise) will be considered in the applicable environmental components.

b) Surface Water Environment

Environmental Component	Pathway	Rationale
Surface Water Environment	Pathway to human health	The effects on humans associated with changes in site drainage and surface water quality (radiological and chemical releases and concentrations) will be considered in the human health environmental component.
	Pathway to non-human biota	The effects on non-human biota associated with changes in site drainage and surface water quality (radiological and chemical releases and concentrations) will be considered in the aquatic and terrestrial environmental components.
	Pathway to VCs in other environmental components	The effects on VCs in other environmental components associated with changes in site drainage and surface water quality (e.g., water levels) will be considered in the applicable environmental components.

c) Aquatic Environment

Environmental Component	Sub-Category		VC	Effects Assessed		Rationale
				Habitat	Exposure	
Aquatic Environment	Aquatic Invertebrates		Benthic invertebrates		x	Macroinvertebrates occupy the sediment and are an important food source for benthivorous fish species. They are used to evaluate overall ecosystem health.
	Aquatic Vegetation		Aquatic vegetation		x	Represents a fundamental element of ecosystem health and function.
	Fish	Small	Emerald shiner		x	Numerically important pelagic forage species.
		Large	White sucker		x	Abundant benthivorous, bottom dwelling fish, an important component of that community with available data.
		Large	Lake sturgeon		x	Benthivorous, bottom-dwelling fish. Lake sturgeon has been subject to fishery exploitation in the past, before population declines. It is the largest, longest-living freshwater fish in Ontario. In the stretch of the Ottawa River near NPD, the lake sturgeon is more abundant than elsewhere in the river.

d) Geological and Hydrogeological Environment

Environmental Component	Pathway	Rationale
Geological and Hydrogeological Environment	Pathway to human health	The effects on humans associated with changes in soil and groundwater conditions (radiological and chemical releases and concentrations, and noise) as well as groundwater flow and other physical parameters will be considered in the human health environmental component.
	Pathway to non-human biota	The effects on non-human biota associated with changes in soil and groundwater conditions (radiological and chemical releases and concentrations, and noise) as well as groundwater flow and other physical parameters will be considered in the aquatic and terrestrial environmental components.
	Pathway to VCs in other environmental components	The effects on VCs in other environmental components associated with changes in soil and groundwater conditions (radiological and chemical releases and concentrations, and noise) as well as groundwater flow and other physical parameters will be considered in the applicable environmental components.

e) Terrestrial Environment

Environmental Component	Sub-Category		VC	Effects Assessed		Rationale
				Habitat	Exposure	
Terrestrial Environment	Terrestrial Invertebrates		Soil Invertebrates		x	Soil-dwelling invertebrates (e.g. earthworm). Exposure from soil.
			Monarch butterfly	x	x	SC (*SARA* status) – Monarchs are migrants and are sensitive to habitat fragmentation and disturbance. Found in the Site Study Area.
	Terrestrial Vegetation		Red Maple		x	Upland/wetland deciduous tree common at NPD.
	Birds	Small-Medium, aerial	Chimney swift	x	x	THR (*SARA* status) - migratory insectivorous bird. There is a chimney swift super roost in the ventilation stack at NPD which is in close proximity to site activities and may be impacted.
		Large, aerial	Bald eagle	x	x	Large raptor. Cultural and ecological importance. Known nest in the Local Study Area.
		Medium, ground-dwelling	Ruffed grouse		x	Ground-dwelling non-migratory omnivorous bird. Present at NPD.
		Medium, semi-aquatic	Mallard		x	The Ottawa River is in the heart of the Atlantic Flyway, and is an important stopover for migrating waterfowl such as the mallard. Regional presence.
		Large, semi-aquatic	Great blue heron		x	Large wading piscivorous (fish eating) bird. Great blue herons are sensitive to human disturbance. Regional presence. Great blue herons often return to their nesting colonies for many consecutive years, and are sensitive to habitat destruction or disturbance.
	Mammals	Small, insectivorous	**Little brown myotis** Eastern small-footed myotis Northern myotis Tri-coloured bat	x	x	Bat species known to be present at NPD. All are listed as END under *SARA* except for eastern small-footed myotis which is unlisted. While each listed species is a VC, the little brown myotis (in bold) is used as a surrogate for the others.
		Small, herbivorous	Meadow vole	x	x	Soil-dwelling, small herbivore. Burrowing is an important exposure pathway.

Environmental Component	Sub-Category		VC	Effects Assessed		Rationale
Terrestrial Environment	Mammals	Small, omnivorous	Short-tailed shrew		x	Abundant, mostly-carnivorous small mammal. Burrowing is an important exposure pathway. Sufficient data availability.
		Large, omnivorous	Black bear		x	Large terrestrial omnivore Cultural significance and public interest.
		Large, carnivorous	Eastern wolf		x	SC (*SARA* status) large terrestrial carnivore. Regional presence.
		Small-Medium, semi-aquatic	Muskrat		x	Aquatic piscivore/herbivore. Regional presence.
	Reptiles and Amphibians	Reptile	Blanding's turtle		x	THR (*SARA* status) turtle has been sighted near the Local Study Area, and travels great distances over land.
			Eastern milksnake	x	x	SC (*SARA* status) snake present at NPD.
		Amphibian	Green frog		x	The green frog is abundant and is present in wetlands at NPD.

SARA Status: THR – Threatened, SC – Special Concern, END – Endangered

f) Radiation and Radioactivity Environment

Environmental Component	Pathway	Rationale
Radiation and Radioactivity Environment	Pathway to human health	The effects on humans associated with changes in radioactivity in the environment will be considered in the human health component.
	Pathway to non-human biota health	The effects on non-human biota associated with changes in radioactivity in the environment will be considered in the aquatic and terrestrial environmental component.
	Pathway to VCs in other environmental components	The effects on VCs in other environmental components associated with changes in ambient radioactivity will be considered in the applicable environmental components.

g) Health

Environmental Component	Sub-Category	VC and Rationale
Human Health	Public health	Public: The general public could be exposed to health risk as a result of the project. The effects on humans associated with changes in atmospheric, surface water, geological and hydrogeological conditions (radiological and chemical releases and concentrations), and external gamma radiation are considered.
	Worker health	Worker: Workers could be exposed to health risk as a result of performing their duties relative to the project. The effects on humans associated with changes in atmospheric, surface water, geological and hydrogeological conditions (radiological and chemical releases and concentrations) and external gamma radiation are considered.

h) Aboriginal Land and Resource Use

Environmental Component	VC	Rationale
Traditional Land and Resource Use by Aboriginal Peoples	Trapping	Trapping of fur bearing animals was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. Trapping is a licenced activity in Ontario on provincial land although trapping on private land is allowed. Fur bearing animals may include marten, beaver, otter, fox, mink, etc. Trapping is an activity that provides important links to cultural continuity and traditional way of life. Trapping was specifically identified as a rights-based activity in REGDOC, 3.2.2 (CNSC 2016c).
	Hunting	Hunting was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. The hunting of large game would involve deer and moose but also possibly black bear. Small game includes waterfowl, rabbits, grouse, etc. Hunting is an activity that provides important links to cultural continuity and traditional way of life. Hunting was specifically identified as a rights-based activity in REGDOC, 3.2.2 (CNSC 2016c).
	Fishing	Fishing was a traditional and modern day land and resource activity practiced by Aboriginal peoples in the Ottawa Valley. The Ottawa River was and is still used for sport and subsistence fishing. Fish species targeted on the Ottawa River in the present likely include: walleye, northern pike and smallmouth bass (AECL 2010a). Historically, sturgeon, American Eel and possibly suckers would have also been an important part of the catch. Fishing was specifically identified as a-rights based activity in REGDOC, 3.2.2 (CNSC 2016c).

Environmental Component	VC	Rationale
	Gathering	Gathering was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. The gathering of plants, berries, mushrooms, etc. would have been for subsistence, medicines, crafts and other purposes. Gathering is an activity that provides important links to cultural continuity and traditional way of life. Gathering was specifically identified as a rights based activity in REGDOC, 3.2.2 (CNSC 2016c)
	Cultural Resources & Ceremonies	Aboriginal peoples can place a high degree of value on specific sites of cultural, historical, archaeological, spiritual, social or ecological significance. These sites may have broader cultural significance related to the practice of formal or informal ceremonies at or near these sites. The conducting of cultural ceremonies was specifically identified as an activity in REGDOC, 3.2.2 (CNSC 2016c). This VC will assess whether any known sites of significance and the associated cultural ceremonies will be affected by the proposed undertaking.

i) Socio-Economic Environment

Environmental Component	VC	Rationale
Socio-Economic Environment	Land Use and Planning Regime	The proposed project may allow for redesignation of some or all of the NPD property for another use during the Institutional Controls phase.
	Landscape and Visual Setting	The proposed project may affect the quality of views from the Ottawa River. It is not visible from Highway 17.
	Highway 17	Highway 17 is the main vehicular artery in the area. Project-related increases in traffic may affect capacity and safety of the Highway and represents a risk to human health and safety (e.g., accidents), as well as a risk to the natural environment (e.g., spills, wildlife mortality from increased volume, sensory disturbance from increased noise, increased emissions).
	Walleye	Socio-economic importance as a sportfish.
	White-tailed deer	Socio-economic importance as a game species.
	Residents – Use/ Enjoyment of Property	There may be disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Decommissioning Execution phase for residents living in the Local Study Area. This includes residents potentially hunting/trapping on site.

6 PUBLIC AND STAKEHOLDER ENGAGEMENT

This section describes past, ongoing and proposed public and stakeholder engagement activities and events in accordance with the Generic Guidelines for the Preparation of an Environmental Impact Statement (CNSC 2016a), which state:

"…the EIS will describe the ongoing and proposed participation activities that the proponent will undertake or that it has already conducted on the project. It will describe efforts made to distribute project information, as well information and materials that were distributed during the public consultation process. The EIS will indicate the methods used, where the consultation was held, the persons and organizations consulted, the concerns voiced and the extent to which this information was incorporated in the design of the project as well as in the EIS. The EIS will provide a summary of key issues raised related to the Project and its potential environmental effects, as well as describe any outstanding issues and ways to address them."

In addition, CNSC and CEAA guidance documents require that the following topics are to be included as part of public engagement activities:

- Current project information (CNSC 2016a Section 2.3);
- Alternative Means (CEAA 2015a);
- Valued Components (CNSC 2016a Section 5.2.1);
- Spatial and Temporal Boundaries (CNSC 2016a Section 5.2.2);
- Follow-up monitoring program (CNSC 2016a Section 12).

This chapter summarizes the public engagement activities undertaken for the NPD closure project that fulfill the requirements above.

6.1 Engagement Objectives

CNL is required to ensure that project information is made available to local and host communities and stakeholder groups through a variety of mechanisms to ensure accessibility of fact-based information. Communication activities are conducted in support of this requirement; CNL's specific communication objectives include:

1. Initiating and maintaining two-way communication channels between CNL and host communities and stakeholder groups, determining the best methods for communicating project information and facilitating input at appropriate junctures in the project schedule, so that stakeholder feedback can be integrated into the project planning and design, as appropriate.
2. Developing meaningful, user-friendly information and communication products geared for host communities and stakeholders, ensuring accessible and current information on project activities.
3. Demonstrating CNL's long-term commitment and approach to safely and responsibly managing radioactive waste and decommissioning activities for the benefit of the future generations.

4. Informing and educating host communities and stakeholders about nuclear decommissioning, environmental remediation and radioactive waste management.
5. Meeting all regulatory-based communication and engagement requirements.

CNL has employed a variety of methods and activities to achieve the stated objectives. The following section outlines these methods.

CNL completed a Stakeholder Engagement Report (Stakeholder Engagement TSD), which details the engagement methods and activities through which communication objectives were achieved; each method or activity was applied to inform, educate and discuss the project with specific stakeholders. These methods and activities provided valuable feedback for the project to incorporate, as presented in Section 6.3 below.

6.2 Engagement Methods and Activities

Engagement activities commenced on October 29, 2015, with the introduction of CNL's near and longer term plans, including high-level introduction to the project, to the CNL Environmental Stewardship Council (ESC), discussed below. This section details project specific engagement methods and activities, including the following:

- presentations to various stakeholders (members of the public, industry, elected officials and employees);
- publishing and updating project specific webpage content;
- posting and publishing of project specific fact sheets;
- publishing and distribution of "Project Issue" of CONTACT community newsletter;
- conduct of project site visits;
- conduct of project specific public information sessions
- conduct of project specific employee information sessions;
- participation in public events;
- increased use of social media, including uploading project specific videos to YouTube;
- advertising campaign in support of public information sessions (online, intranet, newspapers, flyer insert, radio public service announcement, social media, paid Facebook advertising); and
- distribution of factsheets and comment cards to local municipal offices in Ontario and Quebec, to function as an information repository and support public input.

Project materials were prepared and distributed in both French and English. The following subsections outline specific engagement methods and activities already undertaken for the project, at the time of preparation of this EIS report (i.e., up to March 31, 2017). Engagement activities will continue as part of

the EA process. The final EIS (or EIS addendum) will include an update on public engagement activities and feedback.

6.2.1 Presentations/Site Tours

CNL uses presentations to help inform and educate stakeholders on the project. These presentations have triggered discussion that helps to inform the project through the regulatory process.

As part of its Public Information Program, CNL periodically hosts stakeholder visits to the NPD site. These visits provide an opportunity for information sharing and open dialogue about the project between CNL and stakeholders. These visits are used as one of several means of engaging with stakeholders.

6.2.1.1 Environmental Stewardship Council – October 2015

Established in 2006, the ESC meets three times annually with the objective of building working relationships and creating opportunities for open dialogue between various stakeholder groups, local communities and CNL. These conversations are integral in providing CNL with a wide range of viewpoints. During meetings, ESC members are presented with information about CNL, CNL's environmental practices, and have the opportunity to ask questions and discuss the information presented. Each meeting is documented and members are asked to take meeting information back to their respective constituents, organizations and communities. Since October 2015 the ESC has received regular project updates at subsequent meetings.

On October 29, 2015, the NPD closure project was first introduced to the members of the ESC as a part of a Decommissioning and Waste Management update.

See Appendix Q1 of the Stakeholder Activities TSD.

Stakeholder(s): Local elected officials, local environmental organizations, and local NGOs.

6.2.1.2 Environmental Stewardship Council – March 2016

At a meeting held on March 24, 2016, a presentation was provided on the NPD closure project by the HSSE Director of the NPD closure project. The presentation encompassed the proposed decommissioning approach, measures to minimize impacts to SARs and the near-term schedule. Following this presentation, ESC members had the opportunity to seek clarification and raise any concerns they had with the project.

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials, local environmental organizations, and local NGOs.

6.2.1.3 Environmental Stewardship Council Meeting – June 2016

ESC members visited the NPD site in the evening, and were given the opportunity to view the evening roosting of the chimney swifts and ask questions related to the project.

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials, local environmental organizations and local NGOs.

6.2.1.4 World Nuclear University Site Visit – July 2016

The World Nuclear University (WNU) is an organization that provides training to young professionals in the nuclear industry. The WNU brings an international industry perspective with participants from more than 20 countries.

Every year during their six-week summer institute, the WNU arranges tours of the local nuclear institutions in the host country. In 2016, the WNU was hosted in Ottawa and on July 15, 2016, 80 nuclear industry representatives/ students toured CNL's CRL and NPD sites. Students were able to tour the NPD site where subject matter experts presented on the proposed in-situ decommissioning technique. Comment cards on the project were provided to this group to receive international nuclear industry feedback.

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): Industry

6.2.1.5 Non-Governmental Organizations Site Visit – July 2016

Northwatch, the Canadian Environmental Law Association (CELA), and the Concerned Citizens of Renfrew County represent three stakeholder groups interested in the EA activities for the project. Northwatch and CELA participated in the CNSC request for comments on the project description and provided their comments.

The site visit included discussion about the project, SAR and groundwater monitoring. Questions from the group focused on groundwater monitoring and how the chimney swift habitat will be managed to ensure the success of the species.

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): NGOs.

6.2.1.6 Organization of Canadian Nuclear Industries Suppliers' Day – September 2016

On September 8, 2016, the Organization of Canadian Nuclear Industries (OCI) Suppliers Day was held at the CRL site. This event was open to OCI and local non-OCI member companies and provided an opportunity for CNL to engage representatives from more than 45 companies in the Canadian nuclear supply chain. A presentation on CNL D&WM initiatives informed the industry participants about the plan for the project.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Industry.

6.2.1.7 Nuclear Waste Management, Decommissioning and Environmental Restoration Conference Presentation – September 2016

At this industry conference, hosted by the Canadian Nuclear Society (CNS) and held in Ottawa, ON between September 11 and 14, 2016, the General Manager of the NPD closure project, gave a presentation on the project. It was an opportunity to inform, educate and receive feedback within the nuclear industry.

See Appendix Q 2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Industry, local elected officials.

6.2.1.8 Canadian Nuclear Society Site Visit – September 2016

A group of 19 individuals from the CNS Conference on Nuclear Waste Management, Decommissioning and Environmental Restoration visited the NPD site on September 15, 2016. The site visit provided an opportunity to elicit feedback on the project from a cross-section of the nuclear industry. The site visit included a tour of the NPD site.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Industry.

6.2.1.9 Ontario Power Generation Tour of NPD Site – September 2016

On September 26, 2016 Ontario Power Generation (OPG) employees, mostly from the Des Joachims Generating Station, located approximately 1.5 km north west of the NPD Site, visited the site to learn about the project. The visit included a presentation and tour. One goal of this meeting was to solicit information from OPG on planned upgrades to dams, for consideration in the cumulative effects assessment (Section 9.12).

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Industry.

6.2.1.10 Canadian Nuclear Society and Women in Nuclear Seminar – September 2016

The CNS and Women in Nuclear (WiN) jointly hosted the Manager of NPD Operations, to give a talk, called “In-Situ Decommissioning of the Nuclear Power Demonstration (NPD) Reactor” at the Chalk River Legion on September 27, 2016. It was open to the public, advertised in a local newspaper and on CNL’s intranet with approximately 40 individuals in attendance. A question and answer period following the presentation provided an opportunity for members of the public to learn more about the project and voice their queries.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): All stakeholders.

6.2.1.11 Environmental Stewardship Council Meeting – October 2016

On October 13, 2016, the ESC was briefed on updates to the NPD closure project. Following these updates, members had the opportunity to seek clarification and raise any concerns they had with the project.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials, local environmental organizations and local nongovernmental organizations.

6.2.1.12 Municipality of Laurentian Hills NPD Site Visit – November 2016

Councillors and municipal staff were invited to the NPD site to learn more about the project. The visit included a presentation and a tour of the site and structures. It was an opportunity for local government stakeholders to learn more about the project, which is considered especially important given that residents of the municipality may have questions about the project. Subject matter experts were available to provide further information in response to questions.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials.

6.2.1.13 Renfrew County Council Meeting and Presentation – December 2016

In December, CNL hosted the Renfrew County Council. The meeting included an overview presentation of CNL, as well as a specific presentation on the project. It provided an opportunity to offer updated information to local elected officials and answer questions.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials.

6.2.1.14 Ottawa Valley Economic Development Meeting – December 2016

The Ottawa Valley Economic Development (OVED) Committee is comprised of economic development officers from the local municipalities, as well key regional employers, for example, Garrison Petawawa, CNL and Algonquin College. OVED holds bi-monthly meetings to discuss economic issues and opportunities throughout Ottawa Valley and Eastern Ontario. On December 15, 2016, CNL hosted a meeting which included a presentation on the project.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Municipality, Industry.

6.2.1.15 Meeting and Project Briefing with Pontiac MP – December 2016

At the request of the Pontiac Member of Parliament (MP), CNL attended a meeting at the MP's constituency office in Campbell's Bay, Quebec. The meeting, held on December 21, 2016, briefed the MP on the project and enabled the MP to discuss the project with CNL.

See Appendix Q2-3 of the Stakeholder Engagement TSD of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials.

6.2.1.16 Technical Discussion Meeting – January 2017

A meeting to discuss technical aspects of the project with former employees and other members of the local scientific community was held on January 19, 2017 in Deep River, Ontario. This meeting was planned in response to a request from a local community member, who assisted in coordinating the discussion.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Public within local community, industry.

6.2.1.17 Presentation and Meeting with Renfrew County Council – January 2017

On January 25, 2017 CNL representatives met with the Renfrew County Council. The meeting included more in-depth updates on the project. It also provided an opportunity to answer questions.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials.

6.2.1.18 Presentation to the Town of Deep River – January 2017

On January 25, 2017 CNL representatives presented to the Deep River Town Council at an open council meeting. The presentation was an overview of CNL activities with specific updates on the project. It also provided an opportunity to answer questions to local government and members of the public.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials, public within the local and host communities.

6.2.1.19 Presentation to the Upper Ottawa Valley Chamber of Commerce – January 2017

On January 27, 2017 CNL representatives presented to the Upper Ottawa Valley Chamber of Commerce at the organization's annual general meeting in Pembroke, Ontario. The presentation was an overview of CNL activities with specific updates on the project. It also provided an opportunity to answer questions to the local business community and share information on CNL's economic impact.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Public within local and host communities.

6.2.1.20 Presentation to the Eastern Ontario Wardens' Caucus – January 2017

On January 31, 2017 CNL representatives attended the Rural Ontario Municipal Association conference and presented to the Eastern Ontario Wardens' Caucus on CNL's activities, with a specific look at the project. It led to another presentation with the United Counties of Prescott Russell.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials.

6.2.1.21 Presentation to the United Counties of Prescott Russell – February 2017

CNL representatives attended the United Counties of Prescott and Russell's council meeting, by invitation, on February 8, 2017. The presentation included an overview of CNL, with a focus on the NSDF project and the NPD closure project.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials, media.

6.2.1.22 Presentation to (MRC) Pontiac Regional County Municipality – February 2017

CNL representatives attended the MRC Pontiac's council meeting on February 14, 2017. The presentation included an overview of CNL, with a focus on the NSDF Project and the NPD closure project.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials.

6.2.1.23 ESC Meeting – March 2017

On March 23, 2017, one of the three annual ESC meetings was held. Members were briefed on updates to the NPD closure project. Following these updates, members had the opportunity to seek clarification and raise any concerns they had with the project.

See Appendix Q4 of the Stakeholder Engagement TSD.

Stakeholder(s): Local elected officials, local environmental organizations and local non-governmental organizations (NGO).

6.2.2 Public Information Sessions

Public information sessions were conducted in June/July 2016 and October 2016 to help CNL inform, educate and solicit feedback from members of the local and host communities surrounding the NPD site.

The topics presented at the June/July Public information sessions included a description of the project and facility (including an area map), the proposed project timeline, Valued Components (soliciting feedback from visitors on which VCs are important to them) and an overview of the CEAA process and regulatory approvals required.



CNL staff member answering questions at a public information session

In addition to the poster boards presented for the June/July sessions, poster boards were displayed at the October 2016 public information sessions reflecting the additional project information that was available. For example, topics such as the PostSA, spatial and temporal boundaries, alternative means, and chimney swifts and the decision to keep the existing ventilation stack were presented.

Subject matter experts were available for answering questions and engaging in one-on-one dialogue with event guests. An effort was made to share updated information that responded to specific areas of interest and to provide a broader context of how the project fits into CNL's overarching goals. In June/July and October 2016, a total of 14 public information sessions were scheduled, advertised and held. The locations were chosen based on proximity to the proposed project site and population size. While advertising was more extensive for the October sessions, the number of individuals who attended was the same as the number who attended the June and July sessions. The October sessions provided CNL the opportunity to

address specific areas of questioning that had arisen through feedback from the initial information sessions in June/July.

See Appendix Q1 of the Stakeholder Engagement TSD for information on the June and July Public Information Sessions. See Appendix Q2-3 of the Stakeholder Engagement TSD for information on the October Public Information Sessions.

Dates and locations are summarized in Table 6.2-1, which shows attendance and feedback for both sets of information sessions.

Stakeholder(s): Local and host communities, local elected officials.

Table 6.2-1. Public Information Session Dates and Locations

Location	June/July Information Sessions		October Information Sessions	
	Attendance	Formal Feedback	Attendance	Formal Feedback
Rapides-des-Joachims	7	6	10	6
Deep River	17	2	22	6
Stonecliffe	2	0	5	0
Sheenboro	29	10	12	2
Pembroke	13	10	20	8
Chalk River	11	10	18	4
Petawawa	17	7	9	2
Total	**96**	**45**	**96**	**28**

6.2.2.1 Poster Boards

Q1 (April-June) Poster Boards (June/July 2016 public information sessions)

The poster boards listed below according to subject were developed with the intent to educate and prompt discussion about the project. The poster boards were used to support tactics such as presentations, public information sessions, employee information sessions, site visits and public events.

Poster board topics included:

- What is an Environmental Assessment? (Overview of the CEAA 2012 Environmental Assessment process);
- Valued Components – NPD Closure Project (VCs identified for so far, and seeking feedback on VCs);
- Preferred Technique (an overview of the alternative means for decommissioning and the benefits of in-situ decommissioning);
- Project Description (the key steps involved in in-situ decommissioning);

- Project Timeline (an overview of the history of the facility and the schedule of the NPD closure project);
- NPD Area Map (map of the NPD property)

See Appendix Q1 of the Stakeholder Engagement TSD.

Q2 (July-September) and Q3 (October-December) Poster Boards (2016 October public information sessions)

CNL created several new informational poster boards with updated information to share with the local communities at the second round of public information sessions in October. The posters were arranged to describe the narrative of why CNL is planning the project and how CNL is proposing to perform the project. The poster boards were a versatile tactic used in conjunction with other tactics such as presentations, employee information sessions, site visits and community events, such as the Petawawa Showcase.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Poster board topics include:

- Legacy Liability (history of NPD and its transfer to AECL and how CNL has the responsibility to decommission the reactor);
- Decommissioning Solution (information on in-situ decommissioning);
- Alternative Means (for the NPD Closure Project);
- Safe by Design (information on the post closure safety assessment – how the project is planning for disruptive scenarios as well as normal evolution of the site);
- Chimney Swifts (updated information on habitat retention decision);
- What Do You Think? (information on the valued components and spatial/temporal boundaries and how to share feedback with CNL);
- Protecting the Environment (information on how CNL's Environmental Protection branch operates, and on how an environmental monitoring program is designed); and
- Regulatory Oversight (information on the CNSC and the requirements of the licensing and the EA processes).

6.2.2.2 Communications Materials at Information Sessions

Communications materials at the Public information sessions were provided in several formats:

- Informational poster boards;
- Project factsheets (See Appendix Q1 of the Stakeholder Engagement TSD);
- Project description (http://www.CNL.ca/site/media/Parent/64-509200-ENA-003.pdf); and,
- Feedback form.

6.2.2.3 Employee Information Sessions

To reach internal stakeholders, employee information sessions were held for the project (Table 6.2-2). These internal events were similar to the public information sessions with the same communications products used and a similar level of access with subject matter experts for the project.

Table 6.2-2. Employee Information Sessions

Location	Date	Attendance	Written Feedback Received
Deep River	June 21, 2016	7	0
CRL Site	June 24, 2016	3	2
Deep River	November 16, 2016	35	0
Chalk River	November 17, 2016	10	0

6.2.2.4 Community Events and Updates

One tactic to support the stated communications objectives of initiating two-way communications and informing and educating was to have CNL representatives attend community events local to the NPD site. Attendance at each event is described in the following sections.

Stakeholder(s): Local and host communities.

6.2.2.5 School House Museum – Strawberry Social – June 2016

The School House Museum is located in Laurentian Hills, Ontario, in close proximity to the site and includes a historical display of the NPD reactor. It is open to the public and owned by a local historical society – the Rolph, Buchanan, Wylie and McKay Historical Society. The museum also hosts an exhibit on NPD.

CNL representatives, including subject matter experts, attended the annual Strawberry Social at the School House Museum on June 26, 2016. Poster boards and factsheets regarding the project were made available for event attendees. CNL's attendance was well-received; the historical society invited CNL to attend a later event, the annual Fun Day in August.

See Appendix Q1 of the Stakeholder Engagement TSD.

6.2.2.6 Rotary Club of North Renfrew – Annual Dinner – July 2016

CNL was invited to present at the Rotary Club of North Renfrew's Annual Dinner. The President and CEO presented on CNL's Vision 2026 with a focus on the project on July 20, 2016.

There were no questions and comments related to the project.

See Appendix Q1 of the Stakeholder Engagement TSD.

6.2.2.7 School House Museum – Fun Day – July 2016

The School House Museum's Annual Fun Day is a community event open to members of the public. CNL was invited to send representatives to discuss the project. CNL's subject matter experts were present to discuss the project on July 26, 2016. Poster boards and factsheets were available to the public.

6.2.2.8 Petawawa Showcase – September 2016

CNL attended Petawawa Showcase September 23 through September 25. It is the Ottawa Valley's largest spring and fall home, consumer and leisure show in September. The event drew approximately 10,000 visitors from across the Ottawa Valley and western Quebec. To ensure visibility, CNL secured a 20x20 foot exhibitor space. Informational posters on the project were displayed and subject matter experts described project activities, facilitated discussion about the project and responded to public inquiries. See Appendix Q2-3 of the Stakeholder Engagement TSD.

6.2.2.9 Letter to NPD Neighbours – October 2016

The NPD closure project sent a letter to households within the vicinity of the NPD site in order to inform the projects' closest "neighbours" of the ongoing work at the site and to invite community members to the October information sessions.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Stakeholder(s): Public within the local community.

6.2.3 Webpage Content

CNL has established a project-specific webpage: www.CNL.ca/NPD. In addition, quick links have been added to the landing page, raising project visibility and easing access to the appropriate pages. Since August 2016, updated information has been added to the project webpage, and webpage activity continues to be tracked and analyzed using Google Analytics. These webpage analytics provide insight into public interaction with the project, as it excludes visitors from within the CNL network.

See Appendix Q1 of the Stakeholder Engagement TSD for website analytics from Q1.

See Appendix Q2-3 of the Stakeholder Engagement TSD for website analytics from August through December of 2016.

On the project webpage, there are mechanisms for the visitor to share feedback on the project through an online submission form and a "mailto" hyperlink.

Stakeholder(s): All stakeholders.

6.2.4 Fact Sheets

Project-specific fact sheets were prepared for use in conjunction with a number of other activities. The fact sheets were available for download on the project website, at each public information sessions, at public events and at employee information sessions.

In addition, copies of the fact sheets have been sent to seven local municipal offices to function as an information repository, as recommended by the CSA (2014a), and to support greater awareness in local host communities.

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): All stakeholders.

6.2.5 Newsletter

CNL's CONTACT newsletter is published and mailed to approximately 55,000 residences in the Renfrew and Pontiac Counties and is available on www.CNL.ca. This publication informs the reader on activities undertaken at CNL's various sites and profiles CNL's community activities.

The June 2016 issue of CONTACT focused on CNL's major projects (including the NPD closure project), and related EA activities.

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): Local and host communities.

6.2.6 Advertising

Q1 Advertising

The goal of advertising the public information sessions was to announce and increase awareness of the events. Advertising began June 10, 2016 on the www.CNL.ca website and on the radio via public service announcements (Star 96.7) on June 14, 2016; newspaper advertisements also ran in appropriate regions in the weeks leading up to the public information sessions. Dates were provided in the most recent June 2016 edition of CNL's CONTACT newsletter (posted online on June 10, 2016 – see Section 6.2.4 above).

See Appendix Q1 of the Stakeholder Engagement TSD.

Stakeholder(s): All.

Q2 and Q3 Advertising

The goal of advertising the October public information sessions was to announce and increase awareness of the events. Advertising began in early October on the www.CNL.ca website and on the radio via public

service announcements (Star 96.7); paid newspaper advertisements ran in three community newspapers in weeks leading up to the information sessions. A flyer insert was published as well, with a reach of approximately 30,000 households across the local region. Facebook advertising via a "Boosted Post" geo-located CNL's online advertising to the locations of each of seven public information sessions that were undertaken for the project.

Stakeholder(s): All.

6.2.6.1 Online Advertising

Public information sessions were advertised online in the following ways:

- Dates were posted on the CNL.ca landing page and the project-specific webpage: http://www.cnl.ca/en/home/environmental-stewardship/npd-closure-project/default.aspx.
- Dates for the June and July public information sessions were also included in the online version of CNL's CONTACT newsletter (Appendix Q1 of the Stakeholder Engagement TSD).
- Paid Facebook advertising via a "Boosted Post" (see Section 6.2.5.6 below).

6.2.6.2 Newspapers Advertising – Print and Online

Public information sessions were advertised in the newspapers listed in Table 6.2-3.

Table 6.2-3. Newspaper Advertisements for Public Information Sessions

Newspaper	Release date	Circulation	Event(s)
North Renfrew Times	June 15, 2016	4,000	Rapides-des-Joachims QC, Deep River ON, Stonecliffe ON, Sheenboro QC, Pembroke ON, Petawawa ON
Pontiac Journal (bi-weekly)	June 15, 2016	9,400	
Shawville Equity	June 22, 2016	4,046	Sheenboro QC, Pembroke ON, Petawawa ON
The Valley Gazette	June 29, 2016	2,300	Pembroke ON, Petawawa ON, Chalk River ON
Eganville Leader	June 29, 2016	6,200	
North Renfrew Times	June 29, 2016	4,000	
Renfrew Mercury	June 30, 2016	13,394	
Arnprior Chronicle	June 30, 2016	8,130	
Petawawa Post	June 30, 2016	13,225	
The News	June 30, 2016	29,000	
Daily Observer	July 2, 2016	3,000	
North Renfrew Times	July 6, 2017	4,000	
North Renfrew Times	Oct 5 and 12, 2016	4,000	All October public information sessions.
Pontiac Journal	Oct 5, 2016	9,400	
Daily Observer	Oct 8 and 15, 2016	3,000	
Flyer Insert	Oct 13, 2016	30,000	

6.2.6.3 Newsletter Advertising

CONTACT, CNL's community newsletter, is published, mailed to residences and is available on www.CNL.ca. The back cover of the spring 2016 edition of CONTACT advertised the June and July public information sessions, inviting people to attend, learn about the project and provide feedback on options.

6.2.6.4 Radio Advertising

Radio advertising was used to promote awareness of, and increase attendance at, public information sessions in June, July and October of 2016. Please note that CNL changed its terminology from 'public open houses' to 'public information sessions' between July and October.

June and July:

CNL ran radio advertisements four times daily from: June 14, 2016 until July 7, 2016 detailing the public information sessions for a total of 92 air times. The advertisement was aired on STAR 96.7, which serves the Renfrew and Pontiac Counties and parts of Ottawa. STAR 96.7 reaches approximately 40, 000 listeners each week.

Radio copy:

"*Canadian Nuclear Laboratories will be holding Public Open Houses to discuss two proposed projects: the Near Surface Disposal Facility, and the Nuclear Power Demonstration Closure Project. For meeting dates, locations and times – go to cnl dot c-a*."

October:

CNL ran radio advertisements from October 2 – 15, 2016. The advertisement was a public service announcement advertising the information sessions and ran 50 times over the two-week period. The advertisement was aired on STAR 96.7, a local country music station, which that serves the Renfrew and Pontiac Counties and parts of Ottawa. STAR 96.7 reaches approximately 40,000 listeners each week.

Radio copy:

"Canadian Nuclear Laboratories will be holding Public Information Sessions to discuss updates on two important projects: the Near Surface Disposal Facility, and the NPD Closure Project. For dates, locations and times – go to c-n-l dot c-a."

6.2.6.5 Intranet – myCNL

The employee and public information sessions were advertised to CNL employees via the corporate intranet – myCNL.

6.2.6.6 Social Media

CNL extensively promoted the public information sessions via Facebook. Social media is also used to inform, educate, promote awareness for events and receive feedback on the project. Three videos have been uploaded to YouTube and promoted via Facebook. Twitter has not been used as broadly as Tweets have been found to receive very little traction, and CNL has a comparatively much larger Facebook following. See Table 6.2-4 below.

Some verbal feedback at the information sessions referenced hearing of the public information sessions through Facebook. This emphasizes what the metrics show, i.e., that social media has proven to be an effective communications tool for engaging with the public.

The CNL social media accounts continue to gain followers. Details on these accounts are in Table 6.2-4 below.

Table 6.2-4. CNL Social Media Account Details

Social	Link	Followers
Facebook	www.facebook.com/CanadianNuclearLaboratories	722
Twitter	www.twitter.com/CNL_LNC	218
YouTube	https://www.youtube.com/channel/UC2GCEfZQgsURh4t_QZ-JwCw	30

Q1 Social media posts:

Total number of posts: 7

Total Reach: 1,636

Total Engagements (Likes, Shares, Retweets, Comments): 56

See Appendix Q1 of the Stakeholder Engagement TSD.

Q2 and Q3 Social Media Posts:

Total number of posts: 19

Total Reach: 37,574

Total Clicks (Engagement): 2,362

Total Shares, Comments and Reactions (Engagement): 508

See Appendix Q2-3 of the Stakeholder Engagement TSD.

6.2.7 Participant Funding

The CNSC offered participant funding through its Participant Funding Program (PFP) to assist members of the public, Aboriginal groups and other stakeholders in participating in the EA, licence application review and Commission hearing processes for the CNL NPD closure project. Recipients provide value-added and relevant information that contributes to a better understanding of the anticipated effects of the project. Recipients also participate in the CNSC's proceedings for this project. The CNSC's decision on who has received funding to participate is available in the CNSC Participant Funding Program Decision: CNL NPD closure project. Information on participant funding for the NPD closure project is available online: http://nuclearsafety.gc.ca/eng/pdfs/participant-funding-program/2017/CNL-NPD-closure-2016-eng.pdf.

6.3 Feedback

This section provides a summary of the feedback from project specific engagement activities (listed in Section 6.2 above):

6.3.1 Public Feedback

The public feedback section incorporates comments from the public, as well as local elected officials.

6.3.1.1 Analysis

Q1 Feedback Analysis

This initial feedback provides valuable insight into what issues are important to stakeholders, enabling CNL to respond to and incorporate the issues of the local community and the broader public into the planning stages. Stakeholders had opportunities to provide formal feedback to CNL on the project via the seven public information sessions, an online submission form, mail (a self-addressed and stamped envelope was made available), telephone and email.

The majority of feedback was received through the public information sessions with a small number of respondents submitting comments through mail and email.

Key issues that emerged from the formal and recorded feedback on the project include:

- effect on the chimney swifts roosting in the NPD stack;
- cost of this option in comparison to alternative methods;
- water quality monitoring – groundwater and the Ottawa River;
- release of non-impacted land after the project is finished;
- post decommissioning NPD site monitoring; and,
- the site's seismic qualifications - consideration for effects of seismic activity.

These key issues and how they are addressed in the EIS are described in Section 6.3.

CNL has received formal feedback (written feedback from the public or CNL staff) through public information sessions, online submission, mail, telephone or email. In Q1, CNL received 30 questions and/or comments focused on the project.

See Appendix Q1 of the Stakeholder Engagement TSD.

The formal comments are categorized by theme in Table 6.3-1, which illustrates the public feedback and issues outlined above.

Table 6.3-1. Distribution of Public Formal Comment Topics in Q1

Topic of Public Formal Question or Comment	Number of Total Comments
In support	12
Satisfied	9
Monitoring	2
Work execution	1
Precedence	1
Cost	1
EA specific	1
Post project	1
Community	1
Continuing storage with surveillance	1

Q2 and Q3 Feedback Analysis

From August 2016 to December 14, 2016, there have been 28 formal comments related to the project. Where individuals requested a response to their comment, Communications and the NPD closure project team dispositioned a written response.

Previously identified areas of interest surrounding the project continue to be prevalent. For instance, the chimney swifts at the site continue to draw interest. Three individuals indicated support for, or interest in, the project's decision to retain the ventilation stack: "I think the in-situ option is the best option and I like the idea of keeping the ventilation stack for the swifts."

Interest in how climate change or natural disaster, in particular, an earthquake, would affect the project also came up, with two individuals mentioning seismic events and/or concern with global warming causing heavy rains and stronger storms. This interest in the seismic qualifications is consistent with feedback from the first round of information sessions.

Another previously identified topic identified was an interest in the cost. Three individuals in the feedback from the October 2016 information sessions mentioned the project's cost and/or funding: "Who funds all this?"

Four questions were concerning what will happen to the site post-closure (in particular, after the release of the unaffected lands at the project site) and one individual indicated concern for protection of the Ottawa River. These are both areas of interest that have arisen before.

A key topic which emerged more concretely in the Q2/Q3 information sessions was an interest in the timeline of the project. Three comments mentioned the timeline of the project.

Other feedback indicated approval or interest in when and how the information was being presented. Three individuals indicated explicit approval with the project plan and eight individuals conveyed that they were satisfied with the information and/or explanations given by CNL staff: “Excellent presentation by presenter, interested to see the future plans for the site.”

Seven comments/questions indicated a desire to access more information, especially the videos of NPD.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

The formal comments are categorized by topic in Table 6.3-2, which illustrates the public feedback and key topics outlined above.

Table 6.3-2. Distribution of Public Formal Comment Topics in Q2/Q3

Topic of Received Question or Comment	Number of Comments
Satisfaction with information	8
Desire for more information	7
Post-closure use of the site	4
Timeline of the project	3
Indicated approval with project plan	3
Cost and/or funding	3
Chimney swifts	3
Risk to Ottawa River/water	2
Climate change and natural disasters	2
Transportation of radioactive material	1
Non-proliferation of nuclear materials	1
Interest in grouting	1
Indicated dissatisfaction with information	1
Health and safety	1
Engineering	1
Containment of calandria	1
Community access to facilities at the NPD site	1

6.3.2 Industry Feedback

Q1 Industry Feedback

The WNU visit (July 15, 2016) provided an opportunity to elicit industry feedback. Individuals completed feedback forms after visiting the project site and learning about the project.

See Appendix Q1.

Topics of feedback are summarized in Table 6.3-3.

Table 6.3-3. Distribution of Concerns from WNU Respondents in Q1

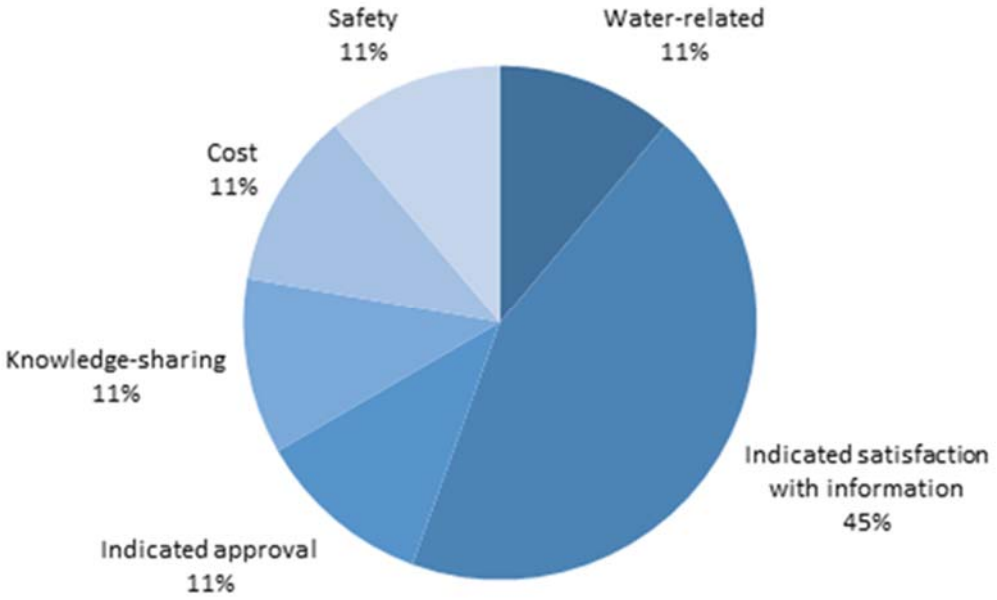
Concern Related to In-situ Decommissioning	% of Total Comments
No concerns	32
N/A – no answer	14
Seepage	14
Monitoring	9
Funding	9
Post project	9
Public acceptance	4
EA specific	4
Safety	5

Q2 and Q3 Industry Feedback

The coon the CNL tour indicated an appreciation and satisfaction with the information provided by CNL's subject matter experts. Consistent with public feedback, comments received on the project from the NWMD&ER Conference guests identified water an area of interest. Industry feedback on the project is summarized in Figure 6.3-1.

See Appendix Q2-3 of the Stakeholder Engagement TSD.

Figure 6.3-1. Summary of Concerns from NWMD&ER Conference Industry Feedback in Q2/Q3



6.3.3 Summary of Feedback

6.3.3.1 Feedback on Valued Components

Section 5.2.4.1 outlines the process that was followed to develop the list of VCs. The list of VCs (Table 5.2-3) was presented on informational poster boards during the June/July 2016 and October 2016 public information sessions (see Section 6.2.5.7), as well as on CNL's external website http://www.CNL.ca/en/home/environmental-stewardship/npd-closure-project/default.aspx. The informational poster boards also included CNL contact information for feedback on VCs. In the October 2016 public information sessions, a questionnaire for visitors to identify the VCs of interest to them was offered, but none of these questionnaires were completed (no visitors chose to complete the questionnaire).

In general, organically generated feedback from public information sessions indicated that there are certain areas of interest from the public that correspond to what the project has determined to be VCs, so far. Specifically, there have been comments and questions, which unambiguously express value in the Ottawa River (water quality) and land use and planning (indicated by concern for future land use at the NPD site) as VCs. Comments and concerns also indicate general public interest and concern about protection of the chimney swift.

The Ottawa River is represented in the EIS through the environmental pathway of surface water which leads to an assessment of human health effects and other representative VCs, including aquatic biota, fishing and residents use and enjoyment of land. Land use and planning and chimney swifts are both included as VCs in the EIS. These topics are also captured in Section 6.3.5.2 as key issues raised during public and stakeholder engagement activities.

6.3.3.2 Key Issues Raised

Feedback on the project helps CNL understand the areas of concern identified by the public. Addressing these concerns will help to further inform stakeholders and improve the project design and EIS. The main concerns voiced from all outreach activities are summarized as key issues, outlined in Table 6.3-4. This table demonstrates how CNL is meeting the regulatory requirements by listing key issues raised related to the project and its potential environmental effects, and describing the extent to which this feedback was incorporated in the design of the project, as well as into the EIS.

Table 6.3-4. Key Issues and How Issue is Addressed in EIS and/or Project Design

Issue	Incorporation into Engagement, Project Design and/or EIS
Species at Risk: How will the decommissioning affect the chimney swifts roosting in the NPD Stack?	• The original decommissioning design included building an alternative habitat and demolition of the existing ventilation stack [Titterington 2016]. In order to minimize the risk to the chimney swifts, CNL decided to retain the existing ventilation stack, instead of demolishing it and replacing it with an alternative habitat. This decision was made with input from a panel of experts composed of academia, government agencies and Non-Governmental Organizations (NGOs). The decision to retain the ventilation stack is described in Section 9.6 of the EIS. • Chapter 9 of the EIS includes an assessment of the potential impact on the chimney swifts as a result of the project decommissioning activities (e.g. noise, dust, vibration and light) which is a summary of the Chimney Swift TSD. Since their current roost will be retained, the project predicts the effects will be minimal given project activities will occur between 7 am and 7 pm (i.e., during daylight hours when the chimney swifts are out foraging) wherever possible. • A subject matter expert on chimney swifts provided advice to CNL on how to protect the chimney swifts during decommissioning activities using best practices, mitigation measures and how to monitor the impacts to the birds. Sections 9, 10 and 12 of this EIS discuss the mitigation measures and follow-up actions related to the chimney swift.
Ottawa River: How will the Ottawa River be protected?	• The Ottawa River is important for many reasons (water quality, flow, recreational use, fishing, ecology). We have captured these aspects through other VCs, including aquatic biota, fishing and residents use and enjoyment of land. Section 9 of this EIS assesses the impact of the project on these VCs. • Consideration was given to the benefit of in-design mitigation measures in preventing or reducing environmental effects. “In-design” mitigation measures are features included in the project design for the purpose of pre-empting possible environmental effects, based on good practice and CNL experience. For example, the use of grout to fill the structure is expected to slow down the release of contaminants to groundwater and subsequently to the Ottawa River, and allow more time for radioactive decay. Other “in-design” mitigation measures can be found in Section 3 (System Description) of the PostSA TSD, and are summarized in Section 4.1 above.
Effects of the environment on the project: Has this project examined the potential effects of an earthquake or climate change or other natural disasters on the NPD?	• The effects of the environment on the project (e.g., earthquakes, tornados, climate change) are assessed in Section 9.13 of this EIS. • Preliminary results have indicated that the potential radiological doses to both human and non-human biota receptors are magnitudes less than the CNSC established dose criteria which protects the public and environment under all plausible conditions.

Issue	Incorporation into Engagement, Project Design and/or EIS
Monitoring: How will monitoring occur around the site and how long will the NPD site be monitored post-decommissioning?	• Proposed follow-up monitoring activities for the Decommissioning Execution and Institutional Controls phases are described in Sections 9 and 12 of this EIS. Note that the EIS presents a conceptual description of the follow-up monitoring activities. The detailed follow-up monitoring program will be developed incorporating federal reviewer and stakeholder feedback from the draft EIS review. • The proposed follow-up monitoring during demolition and grouting activities will include emission and effluent monitoring as well as regular chimney swift counts during their seasonal presence at NPD. • The proposed follow-up monitoring during the Institutional Controls phase will include visual inspections and monitoring the groundwater for parameters that would be indicative a failure of a safety feature.
Financial: What is the cost of this option in comparison to alternative methods, and who is funding this project?	• The Alternative Means TSD presents a high-level cost analysis of the in-situ decommissioning option compared to other alternatives considered. • Funding for the project is provided by AECL, a federal corporation. • In response to earlier public feedback, at the October public information sessions CNL included information on the approximate costs of alternative methods.
Land Use: How will the unaffected land be released after the project is finished?	• As clarified in previous open houses and within the EIS, AECL is the federal corporation that owns the site and CNL is the operator of the NPD site contracted by AECL to perform the closure of the NPD Site. • The final decision on dispositioning of non-impacted land on the NPD site rests with AECL.

6.3.4 Planned Future Engagements

The summary presented within this section of the draft EIS is based on engagement activities up to March 31, 2017. CNL has additional engagements planned for the remainder of 2017 (as well as throughout the EA process) for which the records and feedback will be summarized in future final revisions of the EIS (or EIS addendum). Planned future engagements are described by quarter:

First Quarter (Q1)

In Q1 there are a series of eight public information sessions scheduled to take place in April and May. Updated information on the NPD closure project with respect to safety barriers, waste inventory, proposed follow-up monitoring as well as how public feedback is incorporated into the EIS will be shared at these public information sessions and on the NPD closure project webpage. Internal information sessions for CNL employees are also planned. Letters to households within the vicinity of the NPD site (i.e., Rolphton and Rapides-des-Joachims) will be mailed to increase awareness of the public information sessions in these communities.

CNL will attend Petawawa Showcase, a public event that provides an opportunity for the community members to ask questions to CNL representatives and learn about CNL's activities – including the NPD closure project.

The project will also be inviting specific stakeholder groups to attend chimney swift count nights at the NPD site. These events will provide opportunities for conversation about how the NPD closure project has adjusted the proposed decommissioning plans accordingly including an effects assessment of the impact the proposed decommissioning activities may have on the chimney swifts as they continue to use the existing ventilation stack. As part of our preparation of the environmental impact statement, we have identified mitigation measures to eliminate the potential impact and we have developed a proposed monitoring program for the chimney swifts during, and shortly after, the decommissioning activities.

Information on the project will also be featured in the spring 2017 edition of CNL's community newsletter, CONTACT.

In late June, the CNL Environmental Stewardship Council conducts one of its three annual meetings. This will be another opportunity to update stakeholders, specifically, community groups and non-governmental organizations on developments in the NPD closure project, with particular focus on chimney swift protection.

An industry engagement is also planned with the CANDU® Owners Group Decommissioning and Waste Management Working Group to introduce representatives to the NPD closure project, give a site tour of the facility and information on the planned decommissioning. This will also be an opportunity for industry to ask questions on the project to CNL's subject matter experts.

Second Quarter (Q2)

For Q2, engagement activities will be concentrated on informing stakeholders about the project's submission of the draft EIS, particularly emphasizing how stakeholders can provide feedback to the CNSC.

Activities will include the creation of a new webpage focused on the NPD closure project draft EIS, creation of communications materials specific to the draft EIS, media relations and social media engagement will occur towards the end of Q2.

Letters to households in the vicinity of NPD site and articles for the internal and external newsletter will also help boost awareness of the draft EIS and encourage stakeholder participation.

Over the summer months, more stakeholder outreach is planned with different groups invited to more chimney swift count nights. Again, this engagement activity helps inform and educate on planned mitigation measures to ensure protection of the chimney swift population.

CNL is planning a community open house for August 2017, which will allow members of the local and host communities to visit the CRL site. The NPD site will also be involved in the Open House Day, to highlight the decommissioning plan to members of the local and host communities.

Third Quarter (Q3)

Presentation and meetings with local elected officials, in the regional and municipal governments will be key in this quarter to ensure awareness of the regulatory process and public comment period on the draft EIS for the NPD closure project. The project and other CNL representatives will plan and attend meetings to share an overview of the draft EIS and inform local elected officials on how the public can participate.

An industry engagement is also planned with the National Energy Agency to introduce representatives to the NPD closure project, give a site tour of the facility and information on the planned decommissioning. This will also be an opportunity for industry to ask questions on the project to CNL's subject matter experts.

Internal engagement activities, in the form of employee information sessions and articles on the intranet and in the internal newsletter, are also planned for this quarter. These activities will help to involve internal stakeholder by keeping employees abreast of the project's submission of the draft EIS.

The third CNL Environmental Stewardship Council for 2017 occurs in October. This will be another opportunity to update stakeholders, specifically, community groups and NGOs on developments in the NPD closure project, with particular focus on the submission of the draft EIS and how their respective groups can participate. A fourth round of Public Information Sessions will be planned for early in Q3.

Fourth Quarter (Q4)

Engagement activities in Q4 will continue to update stakeholders on the project and provide information on the next steps in the EA process. Planned activities include the CNL Environmental Stewardship Council

in March, updated webpage content and continued responses to any questions that stakeholders may have about the project and/or the EA process.

6.4 Conclusions

Methods employed to date have helped to inform, educate and discuss the project with stakeholders, and have enabled the public to provide valuable feedback into the project. The project will continue stakeholder engagement efforts to support growth in awareness and understanding of the project. However, it is recognized that there is a preconceived level of public concern with respect to nuclear waste, possibly contributing to differences between perceived and actual risk.

While most of the key issues that stakeholders have brought forth have been resolved or incorporated into the design of the project, one outlier is with regards to land use of the non-impacted land of the NPD site. To address this issue, CNL has clarified through consistent messaging and communications with stakeholders that the NPD property belongs to AECL, a federal corporation. Once CNL completes the decommissioning of the NPD reactor, AECL will look at the future of the lands. AECL will take into account consideration for stakeholder engagement, as appropriate, and the duty to consult with Aboriginal peoples.

Continuing to provide information as it becomes available will encourage transparency, and further feedback, which can assist CNL in understanding and incorporating stakeholder perspectives into project planning, future communications and the EIS.

7 ABORIGINAL ENGAGEMENT

7.1 Introduction

An *Aboriginal Engagement Report* (AER) TSD for the proposed NPD closure project was prepared in 2016 by CNL in accordance with the CNSC's Aboriginal Engagement *Regulatory Document REGDOC-3.2.2* (CNSC 2016c). The first revision of the AER TSD was submitted to CNSC in 2016. A second revision will be submitted to the CNSC to accompany the EIS in September 2017. A final revision reflecting ongoing Aboriginal engagement activities and updated information as a result of this engagement will be submitted to accompany the final EIS. The AER TSD outlines CNL's approach to Aboriginal engagement in order to support the EA process for the planned project. The following text summarizes CNL's Aboriginal communication objectives, the methods adopted to meet these objectives, the First Nation and Métis communities that CNL has identified and included in its Aboriginal engagement for the project, engagement activities that have been undertaken to date, feedback received to date from communities, and further planned engagement activities.

7.2 Objectives

As part of its corporate, environmental and social responsibility, CNL recognizes and encourages the ongoing engagement of Aboriginal communities through the course of its EA process for the project. Through its engagement activities, CNL seeks to inform communities while building awareness and understanding of project activities, to communicate the potential effects of these activities to members of communities, treaty rights (e.g., rights-based activities) and the environment, to seek feedback from communities regarding traditional and current uses of the land surrounding the NPD site and to identify potential impacts of project activities on treaty rights such as the right to trap, hunt, fish, gather or conduct cultural ceremonies.

Regulatory requirements for Aboriginal engagement are set out in Section 2 of the AER TSD. The *Canadian Environmental Assessment Act* (CEAA, 2012) provides a clear description of the environmental effects on Aboriginal peoples that are to be taken into account. The CNSC's REGDOC 3.2.2 (CNSC 2016c) provides more detailed information on Aboriginal engagement and sets out the "requirements and guidance for licencees" with respect to Aboriginal engagement. It also provides procedural direction for licencees. Section 3 "Applicability" of the REGDOC 3.2.2 indicates:

> "*Licencees shall conduct a review to consider whether the activity described in their licence application requesting authorization from the Commission:*
>
> - *Could result in impacts to the environment;*
> - *Could adversely impact an Aboriginal group's potential or established Aboriginal and/or treaty rights, such as the ability to hunt, trap, fish, gather or conduct ceremonies" (section 3 Applicability, page 4).*

As the REGDOC is specific about the above rights and activities (i.e. hunt, trap, fish, gather or conduct ceremonies) those issues are specifically addressed in the AER TSD and this EIS. Chapter 5 of the AER TSD describes traditional land and resource use, based on existing and available information.

Additional CNSC requirements that are to be addressed or considered with respect to Aboriginal Peoples are identified in Table 2-1 of the AER TSD. Additional regulatory requirements for Aboriginal engagement are also noted in Appendix A.3.8 of the CNSC's REGDOC 2.9.1 (CNSC 2016b), as well as the CNSC's *Guidelines for the Preparation of an Environmental Impact Statement*, pursuant to CEAA, 2012 (CNSC 2016a), which are all identified in Table 2-1 of the AER TSD. Key requirements identified in that table associated with the various guiding documents generally relate to identifying Aboriginal community perspectives and/or information associated with: VCs identified for the Project; spatial and temporal boundaries used in this EIS; potential positive or negative effects of the Project on the natural environment, community socio-economic conditions/elements, community health and diet, traditional and current land and resource use (e.g. hunting, trapping, fishing and gathering), and physical and/or cultural heritage features; the mitigation measures suggested in the EIS with respect to potential effects; Aboriginal treaties and litigation associated with the project area; traditional Aboriginal knowledge associated with the project area; and the project Aboriginal engagement process.

Further, on March 8, 2017, the CNSC released it Record of Decision with respect to the scope of the factors to be assessed in the EAs of three designated projects under CEAA 2012, including the NPD closure project. The Record of Decision included statements regarding the CNSC's expectations and directions on Aboriginal engagement as well as total participant funding. Pursuant to section 19 of CEAA 2012, the CNSC determined the scope of factors for the EA for the project to include the factors mandated in paragraphs 19(1)(a) to (h) of CEAA 2012, with no additional factors. As well, the Record of Decision set out that the EA must consider the Guidelines with respect to information and requirements on identifying VCs and spatial and temporal boundaries, and also engage Aboriginal groups and the public on these. See Appendix A of the AER TSD for a copy of the Record of Decision.

CNL's Aboriginal engagement objectives include:

1. Initiating and maintaining two-way communication channels between CNL and First Nation and Métis communities to determine the best methods for communicating project information and to solicit input at appropriate junctures in the project schedule.
2. Developing meaningful, user-friendly information and communication products geared for the public and First Nation and Métis communities, and providing accessible and current information on project activities.
3. Demonstrating CNL's long-term commitment and approach to safe and responsible management of AECL's radioactive waste and decommissioning liabilities.
4. Informing and educating First Nation and Métis communities about nuclear decommissioning, environmental remediation and radioactive waste management.
5. Meeting all regulatory-based communication and engagement requirements.

To meet these objectives, CNL has developed specific strategies to increase the effectiveness of the program so that Aboriginal engagement requirements for the NPD closure project are met. These strategies include:

- presenting information in a format that is easily understood through a variety of communications channels using targeted key messaging;
- engaging technical experts to communicate information in various formats;
- accomplishing all required activities in a timely manner; and,
- providing various means for First Nation and Métis communities to access information.

7.3 Identified First Nation and Métis Communities

A proposed list of First Nation and Métis communities with a potential interest in the project was identified by CNL and included in the AER TSD. Identification of communities was based on consultation with the CNSC and through publicly available sources of information including: First Nation and Métis community and organization websites, the Aboriginal and Treaty Rights Information System (ATRIS) (Government of Canada 2016-17), and Indigenous and Northern Affairs Canada (INAC) First Nation community profiles. The proposed list was based on the identified potential or established Aboriginal or treaty rights of First Nation and Métis communities in the vicinity of the project and is provided in Table 7.3-1 along with a brief rationale for inclusion. The communities included considers the nature of the established and/or claimed rights and potential impacts on those rights caused by the proposed project based on a preliminary assessment of existing and available information. As such, the proposed list is subject to change based on information and dialogue with the identified groups.

Table 7.3-1. Identified Aboriginal Groups

Aboriginal Communities (by representative Organization) and/or Organizations Location	Identification Rationale
Algonquins of Ontario, comprised of ten Algonquin communities: • Antoine Algonquin First Nation; • Algonquins of Pikwàkanagàn First Nation; • Algonquin Nation Kijicho-Manito Madaouskarini; • Bonnechere Algonquin First Nation; • Algonquins of Greater Golden Lake First Nation; • Mattawa-North Bay Algonquin First Nation; • Ottawa Algonquin First Nation; • Shabot Obaadjiwan First Nation (Sharbot Lake); • Snimikobi (Ardoch) (Beaver Creek) Algonquin First Nation; • Whitney Area Algonquins.	• Comprehensive Land Claim. • Accepted for negotiations with Self-Government. • Framework Agreement (Signed). • Established CNL relationship (member of CNL's Environmental Stewardship Council (ESC)*).
Algonquin Anishinabeg Nation (two of its member communities): • Eagle Village First Nation; • Kitigan Zibi Anishinabeg First Nation.	• Comprehensive Land Claim. • Assertion of Rights.
Métis Nation of Ontario (MNO) (community councils representing the project location): • MNO North Bay; • MNO Mattawa Métis;	• Assertion of rights in vicinity of project.

Aboriginal Communities (by representative Organization) and/or Organizations Location	Identification Rationale
• MNO Sudbury via the Mattawa/Lake Nipissing Traditional Territory Consultation Committee.	• Established CNL relationship (member of ESC).
Williams Treaties First Nations, comprised of seven first nations: • Alderville First Nation; • Beausoleil First Nation; • Chippewas of Georgina Island First Nation; • Chippewas of Rama First Nation; • Curve Lake First Nation; • Hiawatha First Nation; • Mississaugas of Scugog Island First Nation.	• Historic treaty, project is located within lands covered by one of the Williams Treaties.
Union of Ontario Indians, which advocates forty member First Nations, seven of which are included and noted above (i.e. Alderville First Nation, Beausoleil First Nation, Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, Curve Lake First Nation, Mississaugas of Scugog Island First Nation and Pikwàkanagàn First Nation).	• Umbrella organization that has members with potential impacted rights. • .
Algonquin Nation Secretariat (ANS), which along with the Algonquin Nation Programs and Services Secretariat (ANPSS) form the Algonquin Nation Tribal Council (ANTC). The ANTC represent three First Nation communities in Quebec: Timiskaming First Nation, the Algonquins of Barriere Lake, and Wolf Lake First Nation.	• Umbrella organization that has members with potential impacted rights.

*CNL has established an Environmental Stewardship Council (ESC) for the Chalk River Laboratories (CRL) site. The function of the council is to provide opportunity for face-to-face meetings and to build an enhanced working relationship through effective two-way dialogue with a representative membership of community opinion. Of the communities the Algonquins of Ontario represents, only the Algonquins of Pikwakanagan hold a seat on the ESC.

The AER TSD provides background information on these communities and/or representative organizations with a potential interest in the project and includes, where possible, reference to individual community's elected council, geographic location, population, and associations or memberships. Section 3 of the AER TSD includes maps of existing or potential claims in relation to the NPD site. The AER TSD will be revised as additional information is provided by these communities and organizations. The information summarized in this EIS reflects the contents of the AER TSD at the time of preparation of the EIS.

As noted in the Record of Decision, funding was offered by the CNSC to assist Aboriginal groups participate in the project, review of the licence application, and the CNSC's hearing processes. Following consideration of applications by Aboriginal communities and groups for funding, participant funding was allocated to the Algonquins of Ontario, Métis Nation of Ontario, and the Algonquin Anishinabeg Nation Tribal Council. Further information on the participant funding process is provided in the CNSC Participant Funding Program Decision (January 25, 2017) which is available on the CNSC's Project webpage (CNSC 2017).

7.4 Engagement Methods

Engagement methods were designed to communicate information to and solicit input from identified Aboriginal communities, while fulfilling CNL's objectives (both corporate and regulatory). Methods CNL has utilized to-date, or plans to undertake, include:

- project notifications and newspaper advertisements;
- letters to First Nation and Métis communities and/or organization representatives (accompanied by follow-up calls);
- email correspondence and/or phone calls with First Nation and Métis communities and/or organization representatives;
- meetings with First Nation and Métis community and/or organization representatives to discuss the project and potential impacts;
- Environment Stewardship Council Meetings (for ESC member communities);
- public information sessions, including display materials and hand-outs; media notifications/releases;
- webpage content;
- presentations to First Nation and Métis communities upon request;
- distributing copies of technical studies or reports upon request;
- technical meetings, upon request, to provide interested communities an opportunity to discuss more detailed technical information concerning the project;
- targeted community initiatives;
- project site visits;
- work plan development to formalize engagement processes with communities; and,
- capacity assistance, as appropriate, such as basic costs to support meetings such as hall rental or production of print materials, in-kind access to the technical expertise of CNL staff, reimbursement for some out-of-pocket expenses to participate in engagement activities such as site visits, tours, etc.

7.5 Engagement Activities Completed

First Nation and Métis community engagement commenced with the launch of the project in October 2015 and with a brief overview of the project at an ESC meeting.

Formal notification of the project in the form of a letter was sent to all identified groups on July 15, 2016. The letter provided information about the project and provided mechanisms for comments and or questions. For groups that indicated interest, CNL invited the groups to engage and initiated a follow up phone call in

order to begin the engagement process and formalize mutually beneficial working relationship through initial steps to understand group interests, capacity and share available information.

Table 7.5-1 provides a summary of engagement activities which have continued to the date of this report's submission. As the project and EA process progresses, the AER and final EIS (or EIS addendum) will be updated with any additional engagement activities undertaken in the future. There is cross over in several instances in engagement activities between this project and the NSDF Project given the proximity and relative timelines of each project. As such engagement that addresses both projects are also noted here as it would be difficult to extract specific discussions regarding the NSDF Project from the summary. Complete copies of correspondence and meeting materials are provided in the appendices of the AER TSD.

Table 7.5-1. Aboriginal Engagement Activities to June 2017

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Environmental Stewardship Council			
October 29, 2015	Environmental Stewardship Council (ESC) meeting A brief overview of the proposed NPD closure project within the context of a larger vision of the company was provided.	Algonquins of Pikwàkanagàn and Métis Nation of Ontario are members of CNL's ESC. Neither representatives nor designates in attendance, meeting materials and notes issued.	2015 October ESC Agenda and Presentation (Appendix B2 of AER TSD).
March 24, 2016	ESC meeting A detailed presentation on the NPD closure project was provided at this meeting.	Algonquins of Pikwàkanagàn and Métis Nation of Ontario are members of CNL's ESC. Neither representatives nor designates in attendance, meeting materials and notes issued.	2016 March Agenda and Presentation (Appendix B3 of AER TSD).
June 16, 2016	ESC meeting Hosted at the CRL site where the group was provided a visit to the NPD closure project site and were able to view roosting of Chimney Swifts.	Algonquins of Pikwàkanagàn and Métis Nation of Ontario are members of CNL's ESC. Neither representatives nor designate in attendance, meeting materials and notes issued.	2016 June ESC Agenda and Presentation (Appendix B4a of AER TSD) Poster Boards (Appendix B4b of AER TSD).
October 13, 2016	ESC meeting An update on the NPD closure project was provided at this meeting.	Algonquins of Pikwàkanagàn and Métis Nation of Ontario are members of CNL's ESC. Neither representatives nor designates in attendance, meeting materials and notes issued.	2016 October Agenda and Presentation (Appendix B5 of AER TSD).
March 23, 2017	ESC meeting An update on the NPD closure project was provided at this meeting.	Algonquins of Pikwàkanagàn and Métis Nation of Ontario are members of CNL's ESC. Neither representatives nor designates in attendance, meeting materials and notes issued.	2017 March Agenda and Presentation (Appendix B6 of AER TSD).

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
June 22, 2017	ESC meeting An update on the NPD closure project was provided at this meeting.	Algonquins of Pikwàkanagàn and Métis Nation of Ontario are members of CNL's ESC. Neither representatives nor designates in attendance, meeting materials and notes issued.	2017 June Agenda and Presentation (Appendix B7 of AER TSD).
Métis Nation of Ontario			
June 2, 2016	NPD closure project - Introductory discussion with Métis Nation of Ontario via Teleconference.	• Region 5 Consultation Committee, Métis Nation of Ontario. • Manager, Natural Resources and Consultation, Métis Nation of Ontario. • Coordinator Lands and Resources, Métis Nation of Ontario. • Director, Corporate Communications, CNL.	n/a
July 15, 2016	Project Introductory Letter and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • President, Métis Nation of Ontario.	Introductory letter (Appendix C of AER TSD).

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
July 20, 2016	Métis Nation of Ontario Mattawa/Lake Nipissing Traditional Territory Consultation Committee meeting with CNL.	Métis Nation of Ontario Mattawa/Lake Nipissing Métis Traditional Territory Consultation Committee: • Councillor, Mattawa Métis Council. • President, North Bay Métis Council. • Chair, Sudbury Métis Council. • President, Sudbury Métis Council, Region 5 Captain of the Hunt. Métis Nation of Ontario Lands, Resources & Consultation Branch Staff: • Coordinator, Lands and Resources. • Consultation Assessment Coordinator. CNL staff: • Environmental Analyst, Environmental Protection. • Project Director, NSDF project. • Director HSSE and Quality, NPD Closure project. • Communications Officer, Corporate Communications. • Director, Corporate Communications.	Meeting Agenda and Presentation (Appendix D1a of AER TSD). Poster Boards (Appendix D1b of AER TSD).
November 01, 2016	Voicemail from CNL to Mattawa Métis Council.	• Corporate Communications, CNL. • Mattawa Métis Council.	Left voicemail that followed up on the Mattawa Métis Council's request for chimney swift video and with offer to provide a SAR expert to come present to the council.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
December 08, 2016	Email from CNL to Mattawa Métis Council.	• Corporate Communications, CNL. • Mattawa Métis Council.	See Appendix D2 of the AER TSD for email following up with Mattawa Métis Council's expressed interest in the chimney swifts and referring where to find the videos of the chimney swifts that CNL had uploaded to YouTube.
December 19, 2016	Email from CNL to Métis Nation of Ontario.	• Director, Corporate Communications, CNL. • Coordinator Lands and Resources, Métis Nation of Ontario.	See Appendix D3 of the AER TSD for email correspondence.
December 22, 2016	Letter from CNL to Métis Nation of Ontario.	• President, North Bay Métis Council. • President, Mattawa Métis Council. • President, Sudbury Métis Council. • Coordinator Lands and Resources, Métis Nation of Ontario. • Manager, Natural Resources and Consultation, Métis Nation of Ontario.	See Appendix D4 of the AER TSD for letter offering an opportunity to meet and an interest in more information from the Métis Nation of Ontario on any potential impacts of the projects.
	Letter from CNL to Métis Nation of Ontario.	CNL staff: • Project Director, NSDF project. • General Manager, NPD Closure Project. • Public Affairs Officer. • Communications Officer, Corporate Communications. • Director, Corporate Communications.	

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Algonquins of Ontario			
July 15, 2016	Project Introductory Letter from CNL to Algonquins of Ontario and request for input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Algonquins of Ontario Consultation Office.	Introductory letter (Appendix C of AER TSD).
August 10, 2016	Algonquins of Ontario Consultation Office and Technical Staff Information Session.	Algonquins of Ontario representatives: • Communications and Policy Strategist. • Senior Resource Technician. • Technical Advisor and Environmental Land Use Planner to the Algonquins of Ontario. • Biologist/Resource Technician. CNL staff: • Director, Corporate Communications. • Public Affairs Officer. • Director, Environmental Protection. • Biologist, Environmental Protection. • Project Director, NSDF project. • General Manager NPD Closure project.	Algonquins of Ontario Agenda (Appendix E1 of AER TSD).
August 10, 2016	Meeting with Algonquins of Ontario and visit to NPD site and the Chalk River Laboratories site.	• Algonquins of Ontario (Consultation staff). • CNL (Corporate Communications, Environmental Protection, NPD Closure Project Team, NSDF Project team).	See Appendix E2 of the AER TSD for agenda, meeting notes and presentation.
November 01, 2016	Telephone call from CNL to Algonquins of Ontario.	• Director, Corporate Communications, CNL. • Technical Advisor and Environmental Land Use Planner to the Algonquins of Ontario.	Telephone call to follow up on project introductory letter and to inquire whether Algonquins of Ontario could visit the NPD site the following week.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
November 01, 2016 (Cont'd)	Email from CNL to Algonquins of Ontario.	• Director, Corporate Communications, CNL. • Algonquins of Ontario.	See Appendix E3 of the AER TSD for email regarding project information and, in particular, archaeological information.
November 03, 2016	Telephone call from Algonquins of Ontario to CNL.	• Algonquins of Ontario Consultation Office. • Director, Corporate Communications, CNL.	Follow up call requesting phone call from CNL to discuss NPD Stage 1 archaeological activity.
	Telephone call from CNL to Algonquins of Ontario.	• Director, Corporate Communications, CNL. • Algonquins of Ontario Consultation Office.	Discussion of current Algonquins of Ontario workload and the inability of Algonquins of Ontario to attend the planned Stage 1 archaeological activities at NPD site, opportunities for Algonquins of Ontario to participate in archaeological activities and/or review of archaeological findings, and opportunities for CNL to provide a project update to the Algonquins of Ontario.
November 01 to 09, 2016	Email correspondence between Algonquins of Ontario and CNL.	• Algonquins of Ontario Consultation Office. • Director, Corporate Communications, CNL.	See Appendix E4 of the AER TSD for email correspondence regarding projects and, in particular archaeological information.
December 05, 2016	Letter from CNL to Algonquins of Ontario including documents sent.	• Director, Corporate Communications, CNL. • Algonquins of Ontario Consultation Office.	See Appendix E5 of the AER TSD for letter, which details information requested and received by the Algonquins of Ontario.

7 Aboriginal Engagement

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
February 13, 2017	Letter from CNL to Algonquins of Ontario enclosing six requested documents.	• Director, Corporate Communications, CNL. • Algonquins of Ontario Consultation Office.	See Appendix E6 of the AER TSD for the letter from CNL to the Algonquins of Ontario which references the six requested documents.
April 12, 2017	Meeting with Algonquins of Ontario staff and Algonquin Negotiation Representatives.	• Algonquins of Ontario Consultation Office. • Algonquins of Ontario. • Algonquin Negotiation Representatives. CNL Staff: • Director, Corporate Communications. • General Manager, NPD Closure Project. • Aboriginal Engagement Consultant, Arcadis. • Chief, Bonnechere Algonquin Community • ANR, Snimikobi Algonquin First Nation. • ANR, Whitney Algonquins. • Algonquins of Greater Golden Lake. • Planning Consultant. • Algonquins of Ontario staff, Lands and Resources. • Algonquins of Ontario office. • ANR Rep, Ottawa Algonquins.	See Appendix E7 of the AER TSD for presentation deck and Memo regarding meeting.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
June 9, 2017	Algonquins of Ontario Site Visit to NPD.	• Algonquins of Pikwàkanagàn, Councillor. • Algonquins of Pikwàkanagàn, Councillor. • Algonquins of Pikwàkanagàn, Councillor. • Algonquins of Pikwàkanagàn, Councillor. CNL Staff: • Director, NSDF Project. • General Manager, NPD Closure Project. • Director, Environmental Protection. • Manager, NSDF Project. • Environmental Analyst, Environmental Protection. • Communications Officer, Corporate Communications.	See Appendix E8 of the AER TSD for Agenda and Presentations.
		CNL Staff: • Biologist, Environmental Protection. • Director, Corporate Communications. • Communications Officer, Corporate Communications. • Cultural Resources Management. • Operations Manager, NPD Closure Project. • Communications Officer, D&WM Communications. • Aboriginal Engagement Consultant, Arcadis.	
June 19, 2017	Algonquins of Ontario Public Information Session.	• 8,000 members of the Algonquins of Ontario were invited. • CNL Project and Communications Staff.	See Appendix E9 of the AER TSD for Presentation and Advertisement.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Algonquins of Pikwàkanagàn			
December 01, 2015	Algonquins of Pikwàkanagàn Site Visit - A detailed presentation of the proposed NPD closure project within the context of a larger vision of the company was provided.	Chief, members of Council, and representatives of the band office attended. Algonquins of Pikwàkanagàn representatives: • Chief. • Councillor. • Councillor. • Councillor. • Councillor. • Executive Director.	Meeting Agenda and Presentation (Appendix F1 of AER TSD).
		• Manager of Algonquins of Pikwàkanagàn First Nation LP. • Employment Development Officer. • Funding Research Coordinator. • Algonquins of Pikwàkanagàn First Nation HVAC LP Resources. CNL staff: • President and CEO. • Vice-President, Human Resources. • General Manager, Health, Safety, Security and Environment (HSSE). • Vice President, Corporate Affairs. • Vice President Decommissioning and Waste Management. • Project Director, NSDF project. • Director, Corporate Communications. • Communications Officer. • Public Affairs Officer. • Talent Acquisition Specialist, Human Resources.	

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
July 15, 2016	Project Introductory Letter and request for community input on any potential adverse impacts from Project activities.	• Director Corporate Communications, CNL. • Chief Algonquins of Pikwàkanagàn First Nation.	Introductory letter (Appendix C of AER TSD).
August 19, 2016	Telephone call from CNL to Algonquins of Pikwàkanagàn.	• Public Affairs Officer, CNL. • Chief Algonquins of Pikwàkanagàn First Nation.	Follow up telephone call to Project Introductory Letter.
Between October 24-26, 2016	Telephone call from CNL to Algonquins of Pikwàkanagàn.	• Public Affairs Officer, CNL. • Algonquins of Pikwàkanagàn First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL.
November 10, 2016	Letter with updated project information from CNL to Algonquins of Pikwàkanagàn and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief Algonquins of Pikwàkanagàn First Nation.	See Appendix F2 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
January 10, 2017	Letter from Algonquins of Pikwàkanagàn to CNL.	• Chief Algonquins of Pikwàkanagàn First Nation. • Director, Corporate Communications, CNL.	See Appendix F3 of the AER TSD for the letter to CNL from Algonquins of Pikwàkanagàn in response to CNL's letter of 2016 November 10, requesting a meeting in April.
June 5, 2017	Email correspondence.	• Public Affairs Officer, CNL • Algonquins of Pikwakanagan	
June 9, 2017	Algonquins of Ontario Site Visit.	• See Algonquins of Ontario Engagement section above for details.	See Algonquins of Ontario Engagement section above for details.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Algonquin Anishinabeg Nation Tribal Council			
July 15, 2016	Project Introductory Letter from CNL to Algonquin Anishinabeg Nation Tribal Council and request for input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Algonquin Anishinabeg Nation Tribal Council.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Algonquin Anishinabeg Nation Tribal Council.	• Public Affairs Officer Corporate Communications, CNL. • Algonquin Anishinabeg Nation Tribal Council.	Call was attempted to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL.
November 10, 2016	Letter with updated project information from CNL to Algonquin Anishinabeg Nation Tribal Council and request for input on potential project impact.	• Director, Corporate Communications, CNL. • Algonquin Anishinabeg Nation Tribal Council.	See Appendix G1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
January 20, 2017	Telephone call from CNL to Algonquin Anishinabeg Nation Tribal Council.	• Public Affairs Officer, CNL. • Algonquin Anishinabeg Nation Tribal Council.	Follow up phone call from CNL to Algonquin Anishinabeg Nation Tribal Council where it was indicated Algonquin Anishinabeg Nation Tribal Council would like a joint meeting with CNSC and CNL in Maniwake.
February 02, 2017	Telephone call from CNL to Algonquin Anishinabeg Nation Tribal Council.	• Public Affairs Officer, CNL. • Algonquin Anishinabeg Nation Tribal Council.	Telephone call to confirm that the Algonquin Anishinabeg Nation Tribal Council would like a separate presentation than CNL's presentation to the Kitigan Zibi Anishinabeg First Nation. However, it was indicated that the Algonquin Anishinabeg Nation Tribal Council would like a site visit to CNL with the Kitigan Zibi Anishinabeg First Nation.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
April 26, 2017	Meeting with AANTC leadership coordinated by the CNSC	• As this was a CNSC coordinated meeting, CNL does not have a full list of participants.	See Appendix G2 of the AER TSD for presentation.
Eagle Village First Nation			
July 15, 2016	Project Introductory Letter from CNL to Eagle Village First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief Eagle Village First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Eagle Village First Nation.	• Corporate Communications, CNL. • Voicemail of Chief, Eagle Village First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Voice message was left.
November 10, 2016	Letter with updated project information from CNL to Eagle Village First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Eagle Village First Nation.	See Appendix H1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
April 26, 2017	Meeting with AANTC leadership, including Eagle Village First Nation Chief.	• As this was a CNSC coordinated meeting, CNL does not have a full list of participants.	See Appendix for presentation
Kitigan Zibi Anishinabeg First Nation			
July 15, 2016	Project Introductory Letter from CNL to Kitigan Zibi Anishinabeg First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Kitigan Zibi Anishinabeg First Nation.	Introductory letter (Appendix C of AER TSD).

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
August 19, 2016	Telephone call from Kitigan Zibi Anishinabeg First Nation to CNL.	• Biologist, Kitigan Zibi Anishinabeg First Nation. • Director, Corporate Communications, CNL.	Telephone call indicated Kitigan Zibi Anishinabeg First Nation had received initial letter and were interested in more project information as it becomes available.
October 24, 2016	Telephone call from CNL to Kitigan Zibi Anishinabeg First Nation.	• Public Affairs Officer, CNL. • Chief/Biologist, Kitigan Zibi Anishinabeg First Nation.	Telephone call offering updated information in response to Kitigan Zibi Anishinabeg First Nation's earlier request.
Between October 24-26, 2016	Telephone call to from CNL to Kitigan Zibi Anishinabeg First Nation.	• Public Affairs Officer, CNL. • Biologist, Kitigan Zibi Anishinabeg First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. CNL offered documentation or presentation on updated information for the NSDF and NPD Closure Projects. The Kitigan Zibi Anishinabeg First Nation representative specified that documentation would be appropriate. CNL offered to send updated poster boards. It was confirmed this could be sent by email.
November 10, 2016	Letter with updated project information from CNL to Kitigan Zibi Anishinabeg First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Kitigan Zibi Anishinabeg First Nation.	See Appendix I1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
November 14, 2016	Email from CNL to Kitigan Zibi Anishinabeg First Nation.	• Public Affairs Officer, CNL. • Biologist, Kitigan Zibi Anishinabeg First Nation. • Kitigan Zibi Anishinabeg First Nation.	See Appendix I2 of the AER TSD for email enclosing electronic copies of updated project information in response to request.
December 22, 2016	Telephone call from CNL to Kitigan Zibi Anishinabeg First Nation.	• Public Affairs Officer, CNL. • Kitigan Zibi Anishinabeg First Nation.	Telephone call to follow up from CNSC meeting of 2016 November 20 with respect to CNL having a meeting and presentation with Kitigan Zibi Anishinabeg First Nation.
January 12, 2017	Telephone call from CNL to Kitigan Zibi Anishinabeg First Nation.	• Public Affairs Officer, CNL. • Kitigan Zibi Anishinabeg First Nation.	Follow up telephone call to inquire about Kitigan Zibi Anishinabeg First Nation's interest (as indicated at the CNSC meeting of 2016 November 20) in having a meeting and presentation from CNL with respect to projects.
	Email from CNL to Kitigan Zibi Anishinabeg First Nation.	• Public Affairs Officer, CNL. • Kitigan Zibi Anishinabeg First Nation. • Biologist, Kitigan Zibi Anishinabeg First Nation.	Follow up email to inquire about Kitigan Zibi Anishinabeg First Nation's interest (as indicated at the CNSC meeting of 2016 November 20) in having a meeting and presentation from CNL with respect to projects; see Appendix I3 of the AER TSD for correspondence.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
January 12, 2017 (Cont'd)	Telephone and email correspondence between Kitigan Zibi Anishinabeg First Nation to CNL.	• Public Affairs Officer, CNL. • Kitigan Zibi Anishinabeg First Nation.	Finalized interest in a 2017 April meeting and presentation from CNL to Kitigan Zibi Anishinabeg First Nation at Kitigan Zibi Anishinabeg First Nation, which would be followed by a site visit to CNL in 2017 May or June; see Appendix I4 of the AER TSD for correspondence.
April 26, 2017	Meeting and presentation with AANTC leadership, including Kitigan Zibi Anishinabeg First Nation Chief.	• As this was a CNSC coordinated meeting, CNL does not have a full list of participants.	See AER TSD Appendix for presentation
May 03, 2017	Meeting with Kitigan Zibi Anishinabeg First Nation.	• Kitigan Zibi Anishinabeg First Nation. • Biologist, Kitigan Zibi Anishinabeg First Nation. CNL Staff: • General Manager, NPD Closure Project. • Director, Corporate Communications. • Project Director, NSDF project. • Director of Engineering, NPD Closure Project. • Biologist, Environmental Protection. • Aboriginal Engagement Consultant, Arcadis.	See AER TSD Appendix for presentation

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Williams Treaties First Nations (Process Coordinator)			
December 15, 2016	Email from CNL to Williams Treaties First Nations Process Coordinator.	• Aboriginal Engagement Consultant, Arcadis. • Williams Treaties First Nations, Process Coordinator.	See Appendix J1 of the AER TSD for email in response to Chippewas of Rama First Nation indicating they had forwarded project information to the Williams Treaties First Nation Process Coordinator.
January 05, 2017	Email from CNL to Williams Treaties First Nations Process Coordinator.	• Aboriginal Engagement Consultant, Arcadis. • Williams Treaties First Nations, Process Coordinator.	See Appendix J2 of the AER TSD for email from CNL to the Williams Treaties First Nations Process Coordinator.
January 20, 2017	Email from CNL to Williams Treaties First Nations Process Coordinator.	• Aboriginal Engagement Consultant, Arcadis. • Williams Treaties First Nations, Process Coordinator.	See Appendix J3 of the AER TSD for email in response to Chippewas of Rama First Nation indicating they had forwarded project information to the Williams Treaties First Nation Process Coordinator.
Alderville First Nation			
July 15, 2016	Project Introductory Letter from CNL to Alderville First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Alderville First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Alderville First Nation.	• Corporate Communications, CNL. • Voicemail of Chief, Alderville First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Voice message was left as a follow-up to the July 15, 2016 CNL letter.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
November 10, 2016	Letter with updated project information from CNL to Alderville First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Alderville First Nation.	See Appendix K1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
Beausoleil First Nation			
July 15, 2016	Project Introductory Letter from CNL to Beausoleil First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Beausoleil First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Beausoleil First Nation.	• Corporate Communications, CNL. • Voicemail of administrative assistant of Chief, Beausoleil First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Voice message and contact information was left.
November 10, 2016	Letter with updated project information from CNL to Beausoleil First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Beausoleil First Nation.	See Appendix L1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Chippewas of Georgina Island First Nation			
July 15, 2016	Project Introductory Letter from CNL to Chippewas of Georgina Island First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Chippewas of Georgina Island First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Chippewas of Georgina Island First Nation.	• Corporate Communications, CNL. • Voicemail of Chief Chippewas of Georgina Island First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Voice message was left.
November 10, 2016	Letter with updated project information from CNL to Chippewas of Georgina Island First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Chippewas of Georgina Island First Nation.	See Appendix M1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Chippewas of Rama First Nation			
July 15, 2016	Project Introductory Letter from CNL to Chippewas of Rama First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Chippewas of Rama First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Chippewas of Rama First Nation.	• Corporate Communications, CNL. • Administrative Assistant to Chief, Chippewas of Rama First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Confirmed receipt of letter. CNL asked how/if they would like project information. The Administrative Assistant noted that a letter would appropriate.
November 10, 2016	Letter with updated project information from CNL to Chippewas of Rama First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Chippewas of Rama First Nation.	See Appendix N1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
November 16, 2016	Email from Chippewas of Rama First Nation to CNL.	• Chief, Chippewas of Rama First Nation. • Director, Corporate Communications, CNL.	See Appendix N2 of the AER TSD for email from Chippewas of Rama First Nation indicating they had forwarded project information to Williams Treaties First Nations Process Coordinator.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Curve Lake First Nation			
July 15, 2016	Project Introductory Letter from CNL to Curve Lake First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Curve Lake First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Curve Lake First Nation.	• Public Affairs Officer, CNL. • Curve Lake First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. The Curve Lake First Nation representative requested a copy of any recent archaeological studies on both projects to view background information and confirm accuracy.
November 10, 2016	Letter with updated project information from CNL to Curve Lake First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Curve Lake First Nation.	See Appendix O1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
December 09, 2016	Email from Curve Lake First Nation to CNL.	• Curve Lake First Nation. • Public Affairs Officer, CNL.	See Appendix O2 of the AER TSD for email acknowledging receipt of archaeological information.
December 15, 2016	Letter from CNL to Curve Lake First Nation enclosing requested information.	• Director, Corporate Communications, CNL. • Curve Lake First Nation.	See Appendix O3 of the AER TSD for letter enclosing requested archaeological information on the NSDF Project site.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
February 09, 2017	Letter from CNL to Curve Lake First Nation enclosing requested information.	• Director, Corporate Communications, CNL. • Curve Lake First Nation.	See Appendix O4 of the AER TSD for the letter from CNL to Curve Lake, which encloses requested archaeological information on the NPD closure project, the Stage 1 Archaeological Assessment.
Hiawatha First Nation			
July 15, 2016	Project Introductory Letter from CNL to Hiawatha First Nation and request for community input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Chief, Hiawatha First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Hiawatha First Nation.	• Corporate Communications, CNL. • Voicemail for Community Consultation Worker with Hiawatha First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Voice message was left offering opportunities to meet and/or share information in other ways and also to inform him that CNL would be sending a letter and note that both the NPD and NSDF projects had updated information.
November 10, 2016	Letter with updated project information from CNL to Hiawatha First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Hiawatha First Nation.	See Appendix P1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Mississaugas of Scugog Island First Nation			
July 15, 2016	Project Introductory Letter and request for community input on any potential adverse impacts from Project activities.	• Director Corporate Communications, CNL. • Chief, Mississaugas of Scugog Island First Nation.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call to from CNL to Mississaugas of Scugog Island First Nation.	• Public Affairs Officer, CNL. • Voicemail of Chief, Mississaugas of Scugog Island First Nation.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL. Voice message was left as a follow-up to the July 15, 2016 CNL letter.
November 10, 2016	Letter with updated project information from CNL to Mississaugas of Scugog Island First Nation and request for community input on potential project impact.	• Director, Corporate Communications, CNL. • Chief, Mississaugas of Scugog Island First Nation.	See Appendix Q1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.
Union of Ontario Indians			
July 15, 2016	Project Introductory Letter and request for input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Grand Council Chief, Union of Ontario Indians.	Introductory letter (Appendix C of AER TSD).
August 02, 2016	Telephone call from CNL to Union of Ontario Indians.	• Director, Corporate Communications, CNL. • Grand Council Chief, Union of Ontario Indians.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL.
November 10, 2016	Letter with updated project information from CNL to Union of Ontario Indians and request for input on potential project impact.	• Director, Corporate Communications, CNL. • Grand Council Chief, Union of Ontario Indians.	See Appendix R1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.

7 Aboriginal Engagement

Date	Event / Activity	Attendance / Correspondence	Notes / Supporting Documentation
Algonquin Nation Secretariat			
July 15, 2016	Project Introductory Letter from CNL to Algonquin Nation Secretariat and request for input on any potential adverse impacts from Project activities.	• Director, Corporate Communications, CNL. • Director General, Algonquin Nation Secretariat.	Introductory letter (Appendix C of AER TSD).
Between October 24-26, 2016	Telephone call from CNL to Algonquin Nation Secretariat.	• Corporate Communications, CNL. • Office of Algonquin Nation Secretariat.	Call was to follow up on the project Introductory Letter and to inquire if there was further interest in project information or meeting with CNL.
November 10, 2016	Letter with updated project information from CNL to Algonquin Nation Secretariat and request for input on potential project impact.	• Director, Corporate Communications, CNL. • Director General, Algonquin Nation Secretariat.	See Appendix S1 of the AER TSD for letter and updated project information in the form of informational posters that were sent.

7.6 Feedback Received to Date

While discussions have been underway with respect to organizing formal meetings between CNL and Aboriginal communities and/or organizations, there has been limited opportunity to do so to date based on the availability of identified communities and organizations. These meetings are an important element in determining how identified First Nations and Métis would like to be engaged with on the project. They are also an important element in facilitating discussion on traditional land use surrounding the NPD site.

Aboriginal interests considered are any Aboriginal interests that: CNL is generally aware of; and/or have been expressed to CNL during engagement with identified First Nations and Métis. Information on traditional land use activities to date has been drawn from: existing studies and reports; formal and informal engagement activities; and general knowledge of the region and local Aboriginal communities and organizations. Engagement on traditional use of land has so far been limited and as such has relied on information from existing studies and reports, as described in the AER TSD. More details on traditional use will be obtained and confirmed through ongoing Aboriginal Engagement processes.

Through its engagement activities, CNL has been able to solicit and respond to some input. To date, biodiversity and cultural heritage studies have been identified by communities as topics of interest. In response, CNL has:

- provided copies to communities, where an interest has been expressed, of project documents related to biodiversity, archaeology and the NPD site in general, as well as images and topographical maps of the site;
- shared informational posters with all identified communities and/or organizations; and,
- shared updated project information with communities and/or organizations at periodic intervals.

CNL has also provided opportunities for participation of First Nations community members in archaeological assessment field studies undertaken as part of the project. As noted above in Table 7.5-1, CNL has since provided the study results to the communities that requested a copy.

7.7 Planned Engagement Activities

Engagement activities with First Nation and Métis communities regarding the project continue, as appropriate and necessary, as EA and project planning activities progress. The nature of additional engagement activities will be consistent with CNL's Aboriginal engagement objectives identified above. CNL will endeavour to evaluate and integrate information provided by these communities in the project planning and design.

CNL has identified additional engagement activities that are planned to take place as the project progresses. In general, these additional activities may include:

- sharing the AER with identified communities;
- notifying identified communities of draft EIS submission;

- ongoing meetings and/or community information sessions to provide project updates, solicit feedback on the project and traditional land use activities, and discuss environmental activities and findings;
- ongoing engagement with identified communities to develop a work plan to formalize a mutually understood working relationship;
- technical meeting facilitation, upon request, to provide interested parties more in-depth information and opportunities to question subject matter experts on the project;
- opportunities for project site visits (for example, a site tour and chimney swift count viewing was planned with participants from the Kitigan Zibi Anishinabeg First Nation for July 2017);
- participation in various targeted community initiatives, when appropriate, such as educational events, fairs, science fairs, and career days;
- ongoing project notifications as described above (e.g. letters, email correspondence, newspaper advertisements, etc.);
- updates to project website content as EA and planning for the project continues, including posting the final EIS and supporting technical studies;
- ongoing tracking and recording of comments, questions, issues and other feedback provided by Aboriginal communities and/or groups, providing responses, and incorporating feedback, as appropriate; and,
- identification of Aboriginal community needs for capacity assistance in order to effectively participate in the project through a collaborative work plan.

Aboriginal community specific engagement activities will be determined following opportunities to discuss individual work plans. The development of a work plan with identified communities is an important element of the engagement process because it assists in clarifying communities and community representatives that CNL will continue to engage with (i.e. Chief and Council, representative bodies, community members etc.). The work plan will schedule identified interest and inputs and expected engagements to facilitate concerns or information requirements. The work plan will schedule with groups time for engagements on areas of interest such as valued components, potential environmental effects of the project and mitigation measures identified. The work plan will also outline and schedule the documentation that will be shared with groups for their review and comment (e.g. draft EIS, licence application, biodiversity and archaeology studies etc.). To-date, such opportunities have not arisen, although CNL continues to reach out to Aboriginal communities in order to enable such discussions and future meetings with communities have been arranged for Summer 2017.

8 DESCRIPTION OF THE EXISTING ENVIRONMENT

8.1 Baseline Characterization Approach

The description of the existing environment focuses on those aspects of the environment that may potentially change as a result of the works and activities of the project. This description of the environmental baseline characterizes the existing environment and processes, and trends within the study areas (defined in Section 5.2.1, and below). It serves as the basis for determining incremental changes and potential environmental effects associated with the project. Information presented in this section comes from a number of sources including, but not limited to, the following documents:

- Nuclear Power Demonstration Site: A Description of the Environmental Baseline for Decommissioning (Wills 2013);
- NPD Biodiversity Report (Morin and Carr 2015);
- Groundwater Quality (Killey 2014); and,
- Effluent Streams Sampling Results (Audet 2016).

The above reports, as well as several other reference documents used in the EIS, have been compiled in a Supplementary Documentation TSD that accompanies this EIS report.

CNL currently conducts routine environmental performance monitoring activities at the NPD site, including compliance surveys and effluent monitoring. The following are aspects of the environmental performance monitoring that are currently reported on an annual basis (i.e., annual compliance reports) and have been used as a source of data for the local study area baseline characterization:

- effluent monitoring program consisting of NPRI estimates, airborne release monitoring through tritium and gross beta/gamma analysis of the ventilation stack airborne emissions and waterborne release monitoring of tritium, gross beta-gamma, and non-radiological parameter monitoring of the sumps, as well as tritium and gross beta/gamma monitoring of groundwater diversion systems; and
- environmental monitoring consisting of tritium and Cs-137 analysis of surface water from the Ottawa River, as well as tritium analysis of water from surface soil and vegetation.

As discussed in DeWaele (2016), the need for an environmental monitoring program (EMP) is based on criteria set out in CSA N288.4 (2010). These criteria are summarized in Table 8.1-1 below. An EMP is needed if one or more of the criteria are met.

Table 8.1-1. Environmental Monitoring Program Requirements (Source: DeWaele 2016)

Monitoring Criteria		Criteria Met at NPD (Yes/No)
An EMP for monitoring of radioactive and non-radioactive contaminants, physical stressors, or environmental effects within the environment on- and surrounding- an AECL site shall be established if:		
(a)	A governing statute, regulation, licence, or permit requires it (or monitoring is required to demonstrate compliance with a statute, regulation, licence, or permit);	No: There is no regulatory requirement for an EMP specifically. The Waste Facility Decommissioning Licence Handbook requires an environmental protection program to be in place – this requirement is met by the Effluent Verification Monitoring Program. Given the very low levels of contaminants in airborne and waterborne effluents, as evidenced by historical and recent effluent monitoring results (see Sections 8.2.2.4 and 8.2.4 of this EIS), and commensurate with the nature and scale of interactions of NPDWF with the environment, the scope of environmental protection measures at the site does not include an EMP.
(b)	The results of an Environmental Risk Assessment (ERA) (or equivalent) indicate a likelihood that the concentration of a contaminant or the intensity of a physical stressor could exceed a Benchmark Value (BV);	No: There is no ERA for the NPDWF.
(c)	The effective dose to members of an off-site critical group from all radioactive releases from the site during normal operations and anticipated transients is estimated to exceed $5x10^{-5}$ Sv (or 0.05 mSv) per year;	No: The effective dose to members of an off-site critical group from all radioactive releases from the site (calculated using past monitoring results) is ~7 $x10^{-5}$ mSv per year, i.e., <0.05 mSv per year.

Monitoring Criteria		Criteria Met at NPD (Yes/No)
(d)	The potential effective dose to members of an off-site critical group from all radioactive releases from the site in the event of an accident is estimated to exceed 1 x10^{-3} Sv (or 1 mSv) per year, which is the public dose limit prescribed by Section 1(3) of the *NSCA Radiation Protection Regulations*;	No: As described in DeWaele (2016), the event conditions described in the Safety Analysis Report (Athauda-Arachchige 2015) that could result in releases to the environment are: • "rain entering the building" was assessed as having a "minor effect" given the low levels of contamination in the Main Building was assessed as acceptable (i.e., meets the dose acceptance criterion of <0.1 mSv to public for a "frequent" event); • "failure of sump pump" was assessed as having "no discernible effect" was assessed as acceptable in the Safety Analysis Report (i.e., meets the dose acceptance criterion of <0.1 mSv to public for a "frequent" event); • "tornadoes" were assessed to meet the dose acceptance criterion of <0.5 mSv to the public for an "occasional" event; and • a failure in the HEPA filtration on the Nuclear Area Ventilation System would result in an insignificant dose to public given the already low particulate contamination levels in the ventilation stack emissions; e.g., an undetected HEPA filter failure during the entire 2014 calendar year, would result in the 2014 radioactive particulate releases leading to a dose to public of 1.65 x 10^{-5} mSv/year. Furthermore, there already exists baseline empirical contaminant data (Wills 2013) for many environmental compartments. Given this, in the event of an accident, aftermath monitoring of various environmental compartments could be quickly implemented, and results compared to the existing baseline data in order to facilitate an impact assessment.
(e)	There are uncertainties in environmental transfer parameters such that releases from the site could potentially cause doses exceeding the levels in c) or d); or	No: Transfer parameters used in the NPDWF DRL model are those referred to in Canadian Standard Association (CSA) N288.1 (2008).
(f)	There are other business reasons, i.e., stakeholder concerns, due diligence, etc.	No.

Note that a few additional criteria were also considered in evaluating the need to establish an EMP:

- *The level of risk from a potential spill or other unintended release of contaminants is unknown or of concern:* No, within the baseline conditions the risk has been extensively assessed in the facility's Safety Analysis Report (Athauda-Arachchige 2015);
- *The release of contaminants is highly variable*: No, the facility baseline condition is a state of 'Storage-with-Surveillance' such that no variability is anticipated and past empirical monitoring data indicates this as well; and
- *The level of risk from unmonitored releases is unknown or of concern*: No.

As Table 8.1-1 indicates, none of the criteria are met at the NPDWF. Therefore, there is no need for an EMP at the NPD site. Although NPD as a stand-alone site does not require an environmental monitoring program, Chalk River's environmental program regionally overlaps with the NPD site, so information from CRL off-site environmental monitoring can be used for the NPD Site.

The description of the existing environment is presented below for each environmental compartment. Baseline data are presented, where available, for the Site, Local and Regional Study Areas defined specifically for that compartment. In general, as described in Section 5.2.1 above, the Local and Regional study areas are outside of the project footprint, and are likely to capture a larger area than where effects are expected.

For many of the environmental components, data from the Regional Study Area can be assumed to be relevant for the baseline characterization of the Site and Local Study Areas. In many instances, due to proximity, relevance and availability, data collected from monitoring near the CRL site can be used to characterize the Regional Study Area for the NPD project. As part of the CRL EMP, CNL collects and analyzes samples in various media, within and outside of the CRL property. CRL's offsite monitoring includes measurements of external gamma, as well as radioactivity in air, surface water, sand, plants and animals. In addition, the CNSC's Independent Environmental Monitoring Program (IEMP) for the CRL site includes offsite locations, as presented in CNSC (2016d). Information from the Environmental Risk Assessment at CRL (Ethier *et al.* 2013) is also used.

It is noted that at the time of preparation of this EIS, CNL was undertaking a site characterization program for the NPD site. As outlined in the Characterization Plan (CNL 2016b), the additional investigations include surface and sub-surface soils, groundwater, river sediments and the NPD building nuclear and non-nuclear area structures and systems. The data collected from the program are intended to provide the information required to support CNL's decision-making, disposition planning, and modelling inputs.

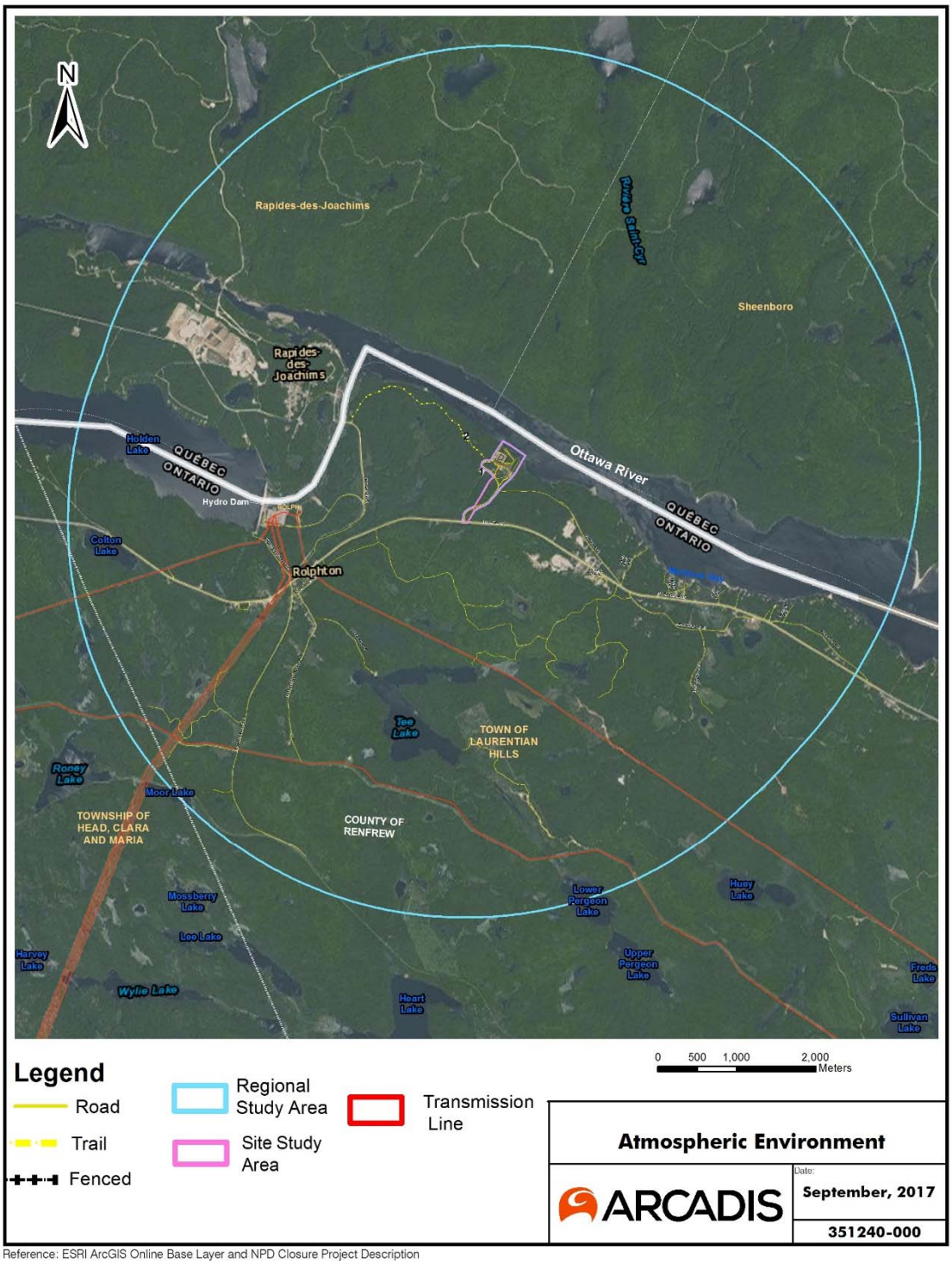
8.2 Atmospheric Environment

8.2.1 Spatial Boundaries

The Site and Local Study Areas for the Atmospheric Environment consist of the atmosphere delineated in the general Site and Local Study areas, shown in Figure 5.2-1 and Figure 5.2-2 respectively.

Although the atmospheric effects of the project are not expected to extend beyond the Local Study Area, a Regional Study Area that extends 5 km beyond the Site Study Area has been defined, as shown in Figure 8.2-1 below. There is limited air quality data available for the Regional Study Area surrounding the NPD site. Some data are available for the CRL facility and areas between the CRL and NPD sites. Even though CRL is beyond the Regional Study Area, these data are used to represent the Regional Study Area in the characterization of baseline atmospheric environment.

Figure 8.2-1. Atmospheric Environment Regional Study Area



Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

8.2.2 Climatic Data

Climate and meteorological conditions are the main forces of contaminant dispersion, transformation and eventual removal from the atmosphere. The near-surface temperature controls the reaction rates of contaminants. Precipitation plays a role in emissions of contaminants from the ground and their removal from the air. Contaminant concentrations decrease with increasing wind speed as a result of dilution. When wind speeds are near zero, local circulations can lead to higher pollutant concentrations near the ground.

Climate is typically defined as the weather patterns over many years. Typically, this is defined by the climate "normal" for the area. Climate normals (or climate averages) are arithmetic calculations based on observed climate values for a given location over a specific time period (typically 30 years), to describe the climatic characteristics of that locations. These 30-year data sets are compiled every 10 years, therefore the 1981-2010 data sets cited here are the most recent sets available.

The meteorological conditions define the wind, temperature and precipitation patterns that can be used to represent the conditions at the site. These are the atmospheric parameters considered most relevant to the NPD closure project (i.e., with respect to contaminant reaction and dispersion) and are therefore presented in detail below. Due to the subterranean nature of the project, parameters such as atmospheric pressure, solar radiation, and fog are not considered relevant. However, climate normal for atmospheric pressure and solar radiation are available and are therefore summarized briefly below. Humidity and fog concerns related to the project are expected to be limited to worker health and safety (e.g., from heat stress caused by humidity), which is discussed in Section 9.8, Human Health Effects. Lightning is discussed in Section 8.11 (Natural Disasters Baseline), along with tornadoes and floods. Topography is important in the NPD area, as the terrain is not flat. In order to take this into account, site elevation data are included in the input data to the air dispersion modelling (presented in the Appendix of the DecomSA TSD).

The meteorological climate stations used in this assessment are located at various locations on the CRL Site. These stations are considered to be the most representative of conditions at NPD, due to proximity and similarity in geographic siting.

Meteorological data collected at CRL over the 5-year period from 2011 to 2015, were used to describe the existing meteorological conditions in the Site, Local and Regional Study Areas. In addition, the 2011 to 2015 data were compared to the 1981 to 2010 climate data from the same station, to ensure that the local data were representative of long-term conditions.

The climate in the region is classified as humid continental, with warm summers, cold winters, and no distinct dry season (Ethier and Hart 2013). Wills (2013) describes the NPD site as having a 'warm microclimate'. The meteorology and climate in the Site, Local and Regional Study Areas are considered to be similar to the conditions prevailing at CRL (Wills 2013).

8.2.2.1 Temperature and Temperature Inversions

The temperature at the Site, Local and Regional Study Areas is considered to be similar to the conditions prevailing at CRL (Wills 2013). Temperature data from the CRL site have been summarized for the 2011 to 2015 period and is presented in Table 8.2-1. The daily temperature ranges from a high of 20.2°C in July

to a low of -12.0°C in January, with the average annual temperature of 5.6°C. The daily maximum temperature ranges from a high of 27.2°C in July to -6.3°C in January, with extreme maximum temperature of 36.0°C in July. The daily minimum temperature is lowest in January (-19.0°C) and highest in July, 13.4°C, with extremes of -36.3°C in January.

The long-term temperature data (i.e., climate normals) at CRL, provided by Environment Canada for the period 1981 to 2010, are summarized in Table 8.2-2. The mean annual temperatures (i.e. mean, mean maximum and mean minimum temperature) from the most recent 5-year period shown in Table 8.2-1 are very similar to the temperature climate normals presented in Table 8.2-2. The mean daily temperatures are below 0°C from December through March. The coldest month is January, with mean daily temperature in the vicinity of -12.0°C. The warmest month is July, with mean daily temperature of 20.3°C. The long term monthly temperature trends from the climate normal data are closely tracked by monthly temperature trends for the period 2011 to 2015, as shown on Figure 8.2-2. As seen in Figure 8.2-2, the similarity in seasonal temperature patterns indicates that the most recent 5-year temperature data is representative of the long term climatic temperatures in the region.

Table 8.2-1. Temperature Normals, Station 'Chalk River AECL', Ontario, 2011 to 2015 (Source: Leeson 2016)

Temperature	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Temperature (°C)	-12.0	-10.3	-3.1	4.5	13.9	17.5	20.0	18.5	14.5	8.0	0.7	-5.5	5.6
Mean Daily Maximum Temperature (°C)	-6.3	-4.6	2.7	10.5	20.8	24.0	27.2	25.1	20.8	13.0	5.2	-1.9	11.5
Mean Daily Minimum Temperature (°C)	-19.0	-17.2	-9.9	-1.4	6.9	11.2	13.4	12.8	9.1	3.3	-3.9	-9.7	-0.3
Extreme Maximum Temperature (°C)	6.9	11.4	26.3	25.3	34.0	35.5	**36.0**	33.9	30.9	29.3	18.3	14.7	36.0
Extreme Minimum Temperature (°C)	**-36.3**	-33.9	-31.7	-13.4	-4.6	2.7	6.0	6.2	-2.2	-7.2	-18.3	-31.9	-36.3

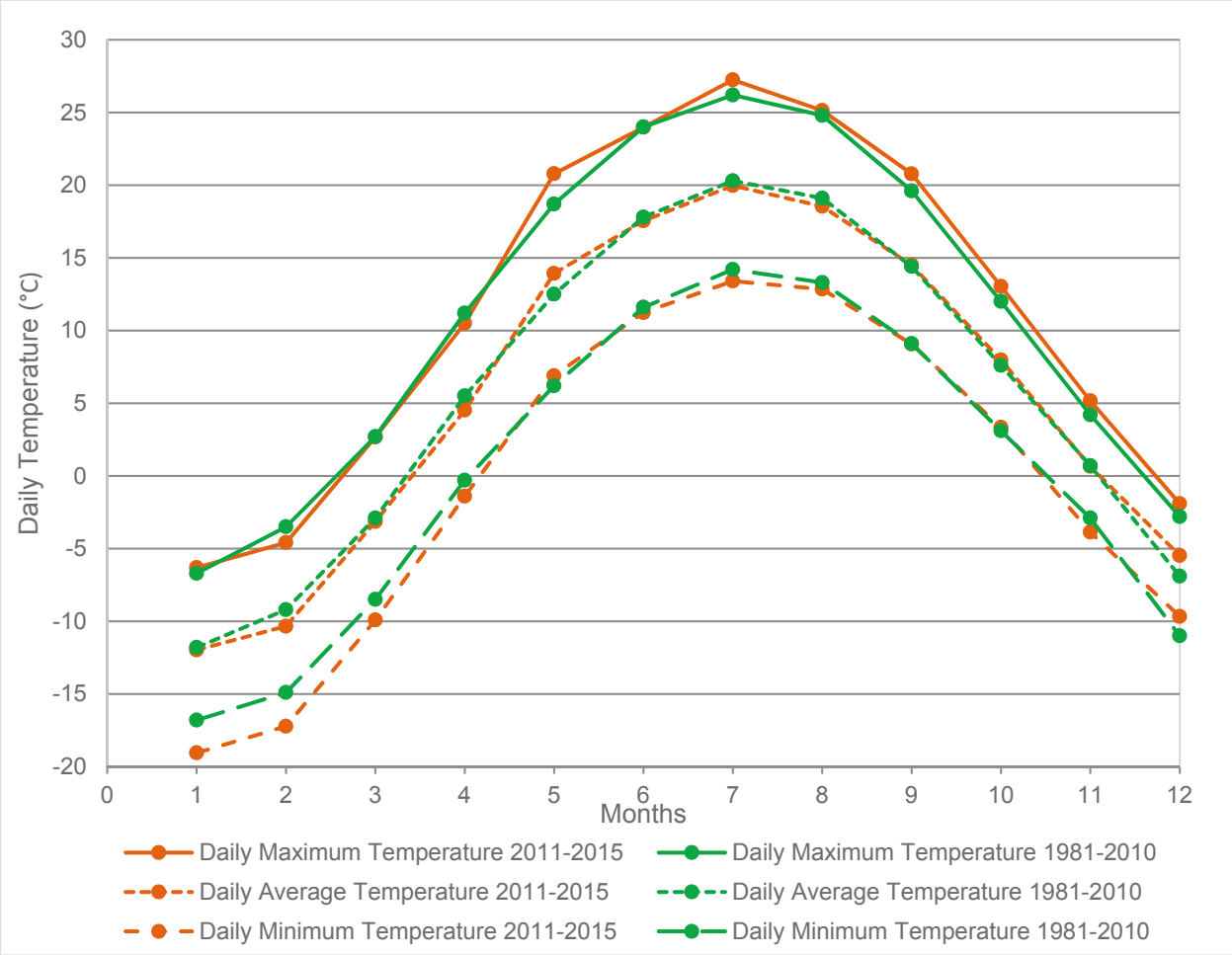
Note: Bolded, grey background values represent the extreme temperature conditions.

Table 8.2-2. Temperature Climate Normals, Station 'Chalk River AECL', Ontario, 1981 to 2010 (Source: Government of Canada 2016a)

Temperature	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Temperature (°C)	-11.8	-9.2	-2.9	5.5	12.5	17.8	20.3	19.1	14.4	7.6	0.7	-6.9	5.6
Mean Daily Maximum Temperature (°C)	-6.7	-3.5	2.7	11.2	18.7	24.0	26.2	24.8	19.6	12.0	4.2	-2.8	10.9
Mean Daily Minimum Temperature (°C)	-16.8	-14.9	-8.5	-0.3	6.2	11.6	14.2	13.3	9.1	3.1	-2.9	-11.0	0.3
Extreme Maximum Temperature (°C)	11.1	15.0	23.9	31.7	34.0	36.0	**39.4**	37.2	34.5	29.5	22.2	14.5	39.4
Extreme Minimum Temperature (°C)	**-39.0**	-35.6	-32.0	-19.4	-8.9	-1.7	3.3	-3.0	-2.0	-9.0	-21.0	-38.0	-39.0

Note: Bolded values represent the extreme temperature conditions.

Figure 8.2-2. Daily Mean, Daily Maximum and Daily Minimum Temperature, Station 'Chalk River AECL', 2011 to 2015 and 1981-2010



Temperature inversions are explained and discussed in the following paragraphs. The air dispersion modelling carried out for this project uses the above atmospheric temperature data as inputs; therefore, temperature inversions, if they have occurred, have been captured in the temperature data set. Details of the air dispersion modelling work are presented in the Appendix C of the DecomSA TSD.

Under normal conditions, the temperature of the air in the atmosphere decreases with height. This is because most of the sun's energy is converted to sensible heat at the ground, which in turn warms the air at the surface. The warm air rises in the atmosphere, where it expands and cools. Sometimes, however, the temperature of air actually increases with height in a layer of the atmosphere; this is temperature inversion. The most common manner in which surface inversions form is through the cooling of the air near the ground at night. In this situation, the ground becomes cooled quickly while the air above it retains the heat the ground was holding during the day. Conditions that favor the development of a strong surface inversion are calm winds, clear skies, and long nights. During daylight hours, surface inversions normally

weaken and disappear as the sun warms the earth's surface. However, under certain meteorological conditions, such as high pressure over the area, these inversions can persist as long as several days. Topography can also play a role in creating a temperature inversion, since it can sometimes cause cold air to flow from mountain peaks down into valleys. This cold air then pushes under the warmer air rising from the valley, creating the inversion. In addition, inversions can also form in areas with significant snow cover, because the snow at ground level is cold and its white color reflects almost all heat coming in. Thus, the air above the snow is often warmer because it holds the reflected energy.

Surface temperature inversions play a major role in air quality, especially during the winter when these inversions are the strongest. The warm air above cooler air acts like a lid, suppressing vertical mixing and trapping the cooler air at the surface. When there is a negative lapse rate (i.e., temperature increasing with height), the atmosphere is strongly statically stable, and so vertical dispersion of pollution is inhibited. Consequently, inversions are usually considered to represent adverse meteorological conditions for pollution dispersion.

The air dispersion modeling in this assessment, presented in an Appendix C of the DecomSA TSD, was carried out using the AERMOD model. AERMET is a meteorological data preprocessor and creates two files: a surface data file and a profile data as input to AERMOD. AERMET requires wind, temperature, cloud cover, an early morning upper air sounding and information on surface roughness, albedo, and Bowen ratio. These data are used in a surface energy balance to estimate the sensible heat flux. The surface shear stress exerted by the wind speed is estimated based on the sensible heat flux. The sensible heat flux as a function of time is then used to compute the mixed layer height during the course of the day. The upper level temperature sounding provides the temperature gradient above the mixed layer, which controls the rate of growth of the mixed layer. The nighttime boundary layer is governed by the computed surface shear stress. The surface parameters, sensible heat flux and surface shear stress, and the boundary layer height are used in boundary layer models to construct the profiles of wind, temperature, and turbulent velocities required by AERMOD.

The meteorological data used as model input consists of five years of hourly data. For each hour, the model computes the state of the atmosphere, partly based on the heat flux calculated at the surface. This defines the stability of the boundary layer and the occasions of temperature inversion. Therefore, the effect of temperature inversions is fully incorporated in the dispersion modeling used for the assessment.

8.2.2.2 Precipitation

Precipitation at the Site, Local and Regional Study Areas is considered to be similar to the conditions prevailing at CRL (Wills 2013). Precipitation data at CRL for the period 2011 to 2015 were available as total precipitation (i.e. including both rain and snowfall). Table 8.2-3 presents a summary of precipitation data from the Chalk River AECL station for the 2011 to 2015 period. Precipitation is fairly consistent throughout the year with slightly more precipitation in the second half of the year. The average annual precipitation measured in this 5-year period was 779 mm. The highest mean monthly precipitation was in October (96.9 mm) and the driest month was February (24.7 mm). Figure 8.2-3 shows the annual total precipitation distribution at CNL in the period 2011 to 2015.

Table 8.2-4 summarizes the 30-year precipitation normals for 1981 to 2010 from the same station provided by Environment Canada. The monthly average is the average amount of precipitation in the identified month over the course of the entire 30-year period. The daily maximum is the single day within that 30-year period for the given month in which the maximum amount of precipitation was measured. The average annual precipitation measured within the 30-year period was 859 mm, with approximately 79% of the total annual precipitation falling as rain. The highest mean monthly rainfall was in September (89.4 mm), while the greatest rainfall in a 24-hour period occurred in August (71.1 mm). The greatest snowfall in a 24-hour period occurred in March (40.1 cm). Snowfall has occurred in every month except from June to September. The total number of days with measurable precipitation was 165. Total precipitation data from the most recent five-year period (2011 to 2015), Table 8.2-3, shows a similar pattern and seasonal distribution as the climate normals for 1981 to 2010, Table 8.2-4.

Table 8.2-3. Precipitation Normals, Station 'Chalk River AECL', Ontario, 2011 to 2015 (Source: Leeson (2016))

Precipitation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Average Monthly Precipitation (mm)	45.1	24.7	40.2	69.2	68.9	91.7	67.2	95.3	75.1	96.9	49.0	56.3	779.4

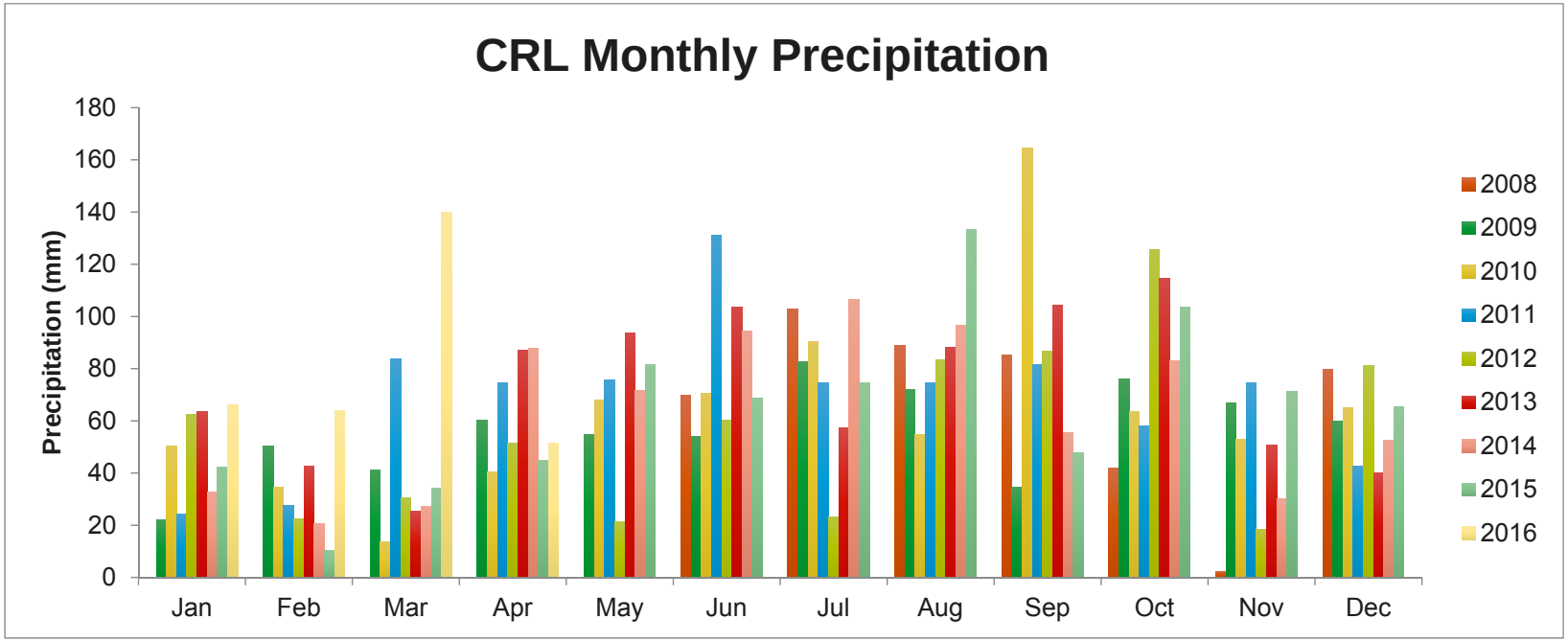
Table 8.2-4. Precipitation Normals, Station 'Chalk River AECL', Ontario, 1981 to 2010 (Source: Government of Canada 2016a)

Precipitation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Average Monthly Rainfall (mm)	14.9	9.8	29.1	50.1	85.0	86.8	84.8	80.7	89.4	79.8	53.0	18.9	682.2
Average Monthly Snowfall (cm)	42.3	34.2	28.1	9.4	1.7	0.0	0.0	0.0	0.0	3.6	22.7	40.1	182.0
Average Monthly Precipitation (mm)	55.2	43.7	56.8	59.3	86.7	86.8	84.8	80.7	89.4	83.4	75.3	57.3	859.3
Extreme Daily Rainfall (mm)	27.8	25.8	36.1	36.5	58.7	70.2	68.6	**71.1**	65.2	43.8	38.6	22.6	71.1
Extreme Daily Snowfall (cm)	28.5	35.9	**40.1**	26.0	13.0	0.0	0.0	0.0	0.3	16.0	31.4	28.0	40.1
Extreme Daily Precipitation (mm)	28.5	35.9	49.0	36.5	58.7	70.2	68.6	**71.1**	65.2	43.8	41.1	29.0	71.1
Extreme Snow Depth (cm)	55.0	64.0	**68.0**	30.0	1.0	0.0	0.0	0.0	0.0	0.0	18.0	43.0	68.0
Number of days with measurable precipitation*	15.5	11.8	11.3	11.7	13.6	13.7	13.9	12.9	14.4	15.0	15.8	15.8	165.3

Note: Bolded, grey background values represent the extreme temperature conditions.

Source: Climatic data files from Environment Canada (http://climate.weatheroffice.ec.gc.ca/climate_normals/).

Figure 8.2-3. Monthly Precipitation for 2008 to 2016 at CRL (Source: Leeson 2016)

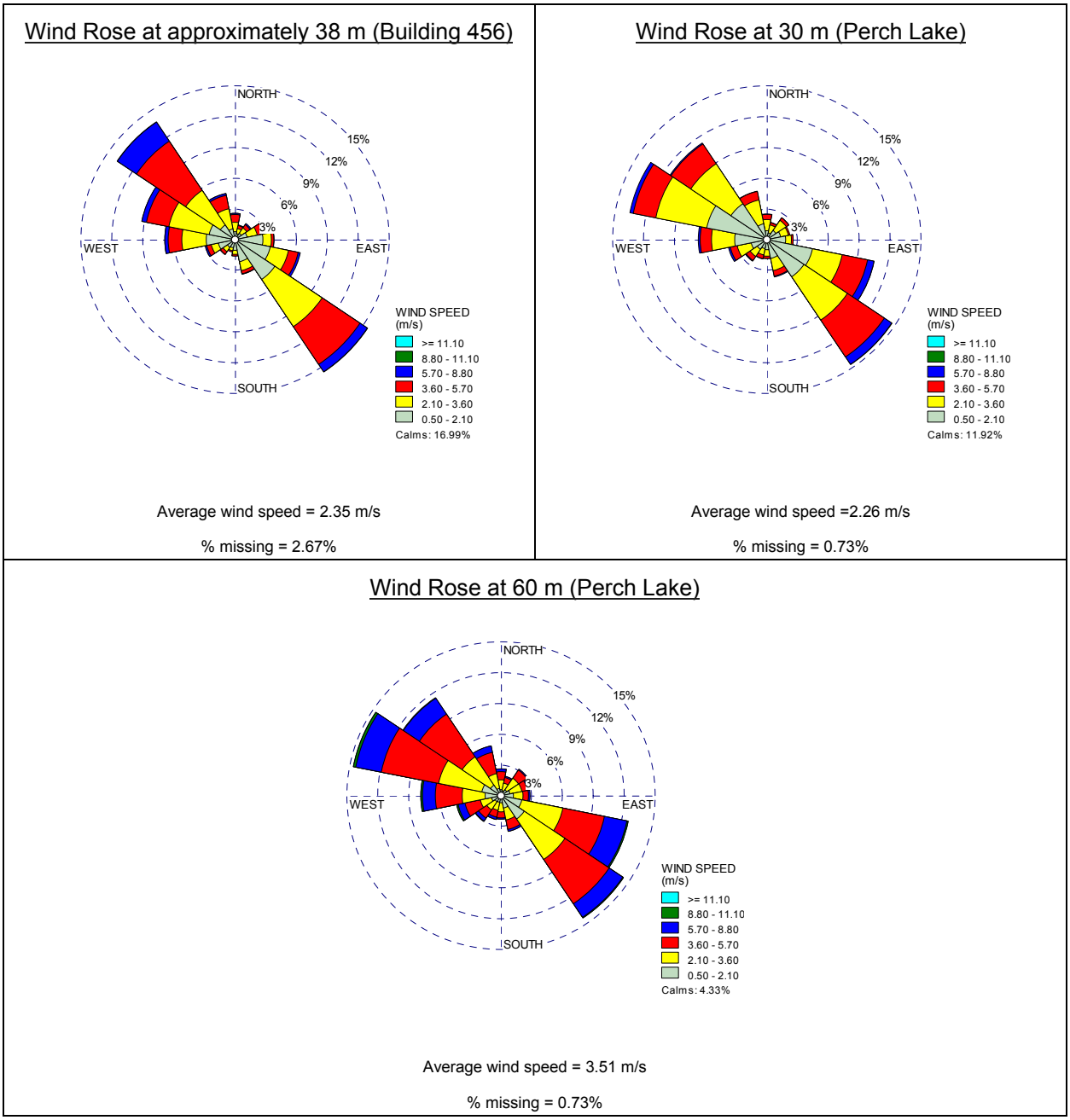


8.2.2.3 Wind

Wind direction is reported as the direction from which the wind blows. The direction and speed of the wind will dictate the direction and distance from the source that a pollutant may travel to. The wind conditions at NPD are considered to be similar to those prevailing at CRL, i.e., moving predominantly along the river valley.

At CRL, wind speed and wind direction are measured at the top of an office building in the CRL main campus (approximately 40 m height), and at 30 m and 60 m height at Perch Lake. Figure 8.2-4 presents the frequency distribution of hourly surface wind speed and direction at three different heights in the period from 2011 to 2015, in the form of a wind rose (a graphical representation of the frequency of winds from each direction). The average wind speed measured at Building 456 was 2.35 m/s, and calms were reported approximately 17% of the time. The prevailing winds were southeasterly (15.5% of the time) and northwesterly (13.8% of the time), parallel to the Ottawa River Valley. The average measured wind speed at the 30 m height was approximately 2.26 m/s, while calms were reported 11% of the time, and the wind direction was primarily from the southeast and the west-northwest, at 14.6% and 13.5% of the time, respectively. The prevailing wind directions at the 60 m level were from the west-northwest and southeast, occurring 15.4% and 14.3% of the time, respectively. The average wind speed was 3.5 m/s. Calm wind conditions were observed to occur 4% of the time.

Figure 8.2-4. Wind Rose Plots, Station 'Chalk River AECL', 2011 to 2015 (Source: Based on data from Leeson 2016)



8.2.2.4 Solar Radiation, Bright Sunshine and Cloud Cover

Solar radiation is the measurement of radiant energy from the sun, on a horizontal surface. Bright sunshine is presented by number of tenths of hours of sunshine that are counted using the Campbell-Stokes sunshine recorder. It should be noted that the amount of "bright sunshine" is less than the amount of "visible sunshine", because the sun's rays are not intense enough to record, especially just after sunrise and towards sunset (Government of Canada 2016b).

Climate normals on bright sunshine and cloud cover are not available at or near the CRL or NPD sites. Tables 8.2-5 and 8.2-6 indicate the average monthly sunshine and cloud cover normals for Ottawa, respectively. Climate normals on bright sunshine at Petawawa are not available. Table 8.2-7 presents the average monthly cloud amount (hours with) climate normals for Petawawa. The hours of bright sunshine increase in July at Ottawa to a maximum of 279 hours due to the increased daylight hours. December has the least amount of bright sunshine because of the increased amount of cloud cover and fewer daylight hours. The average number of total hours with cloud cover (8 to 10 tenths) was 4708 in Ottawa for the period 1981 to 2010, and similarly, 4767 hours in Petawawa in the period 1971 to 2000.

Table 8.2-5. Ottawa Climate Normals 1981 to 2010 - Bright Sunshine (Source: Government of Canada 2016a)

Bright Sunshine	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Total Hours	99.3	131.3	167.1	189.8	229.8	254.2	279.0	249.3	177.6	139.4	84.3	82.6	2083.7
Days with measurable	21.3	22.2	25.1	25.6	27.8	28.3	30.1	29.9	26.8	25.9	20.7	19.8	303.6
% of possible daylight hours	35.0	44.9	45.3	46.9	49.9	54.3	58.9	57.1	47.1	41.0	29.4	30.3	45.0
Extreme Daily	9.1	10.4	11.6	13.5	14.9	15.2	15.1	14.3	12.7	10.6	9.6	8.3	
Date (yyyy/dd)	1959/ 31	1968/ 26	1987/ 24	1952/ 30	1997/ 27	1979/ 25	1999/ 12	2000/ 04	1963/ 04	1976/ 01	1985/ 01	1952/ 18	

Table 8.2-6. Ottawa Climate Normals 1981 to 2010 – Cloud Amount (Source: Government of Canada 2016a)

Cloud Amount (hours with)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0 to 2 tenths	189.0	199.2	235.4	179.7	185.0	178.1	201.5	211.6	223.4	193.9	138.3	156.9	2291.9
3 to 7 tenths	96.8	102.7	119.0	128.0	167.0	195.1	228.1	214.1	168.2	139.1	108.2	99.2	1765.6
8 to 10 tenths	458.3	375.7	389.6	412.3	392.0	346.8	314.5	318.3	328.4	411.0	473.5	488.0	4708.1

Table 8.2-7. Petawawa Climate Normals 1971 to 2000 – Cloud Amount (Source: Government of Canada 2016a)

Cloud Amount (hours with)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0 to 2 tenths	182.7	192.3	214	193.1	185.9	167.8	194.7	198.9	170	161.7	113.6	153.7	2128.3
3 to 7 tenths	115.6	118.8	121.6	140.7	176.9	204.3	240.2	209.3	178	148.4	110.9	105.6	1870.2
8 to 10 tenths	445.8	366.6	408.5	386.3	381.2	347.9	309.1	335.8	372	433.9	495.6	484.8	4767.3

8.2.2.5 Atmospheric Pressure

Atmospheric pressure is the force per unit area exerted by the atmosphere as a consequence of the mass of air in a vertical column from the elevation of the observing station to the top of the atmosphere. Station pressure is the atmospheric pressure in kilopascals (kPa) at the station elevation (Government of Canada 2016b).

Climate normals on atmospheric pressure data are not available at or near the CRL or NPD sites. The monthly pressure normals for Ottawa and Petawawa are presented in the following tables. The data presented in Table 8.2-8 and Table 8.2-9 are considered to be representative of the existing environment on the NPD site and show a very small variation in monthly averages of both station pressure and sea level pressure.

Table 8.2-8. Ottawa Climate Normals 1981 to 2010 – Atmospheric Pressure (Source: Government of Canada 2016a)

Atmospheric Pressure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Station Pressure (kPa)	100.2	100.3	100.2	100.0	100.1	99.9	100.0	100.2	100.3	100.3	100.3	100.3	100.2
Average Sea Level Pressure (kPa)	101.7	101.7	101.7	101.4	101.4	101.3	101.4	101.6	101.7	101.7	101.7	101.7	101.6

Table 8.2-9. Petawawa Climate Normals 1971 to 2000 – Atmospheric Pressure (Source: Government of Canada 2016a)

Atmospheric Pressure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Station Pressure (kPa)	100.0	100.1	100.0	99.8	99.8	99.7	99.8	100.0	100.0	100.1	100.0	100.1	99.9
Average Sea Level Pressure (kPa)	101.7	101.8	101.6	101.5	101.4	101.3	101.4	101.6	101.7	101.8	101.6	101.7	101.6

8.2.3 Air Releases

During the operation of the NPDNGS, there were regular releases to air through the stack, which were released after passing through a filtration system. Following the shutdown and subsequent transition into SwS, releases have been infrequent, generally only for short periods of time such as during entry of personnel into the facility which required purging the nuclear area for inspection and maintenance. Releases to air were and continue to be monitored and compared to Derived Release Limits (DRLs) (Primeau 2016, Wills 2013). The available information on baseline releases to air during the SwS phase is summarized below.

Radiological

Airborne radioactive releases have been monitored by CNL (formerly AECL) since taking ownership of the NPD site. According to the NPD Baseline Report (Wills 2013), the radioactive airborne releases from the NPDWF have been monitored by measuring gross beta, C-14 radioactivity and tritium radioactivity at the source. The data associated with the monitoring of the ventilation stack radioactive releases from 1997 to the present are reported in Table 8.2-10 (Wills 2013).

Table 8.2-10. Specific Values of Total Airborne Releases from the Ventilation Stack

Year	C-14(Bq)	Gross Beta (Bq)	Tritium (Bq)	Total Hours of Ventilation (hours)	Reference
1997	NA	1.2×10^{4}	7.2×10^{10}	NA	(Wills 2013)
1998	NA	4.7×10^{3}	1.30×10^{11}	NA	(Wills 2013)
1999	NA	5.8×10^{3}	1.30×10^{11}	NA	(Wills 2013)
2000	NA	4.4×10^{3}	3×10^{9}	NA	(Wills 2013)
2001	NA	$<2.60 \times 10^{4}$	7.6×10^{10}	NA	(Wills 2013)
2002	NA	$<1.40 \times 10^{4}$	4.8×10^{10}	NA	(Wills 2013)
2003	NA	$<3.00 \times 10^{4}$	1.00×10^{11}	NA	(Wills 2013)
2004	7.3×10^{7}	$<1.49 \times 10^{4}$* / 2.25×10^{5}**	4.1×10^{10}	27.3	(Wills 2013)
2005	1.9×10^{8}	2.40×10^{5}	3.2×10^{10}	44.4	(Wills 2013)
2006	1.32×10^{8}	3.00×10^{5}	3.5×10^{10}	26.1	(Wills 2013)
2007	1.63×10^{7}	2.6×10^{4}	6.9×10^{10}	45	(Wills 2013)
2008	5.00×10^{7}	2.83×10^{4}	1.21×10^{11}	99.5	(Verney 2009)
2009	2.78×10^{7}	4.22×10^{4}	1.70×10^{11}	70.4	(Primeau 2016)
2010	1.56×10^{7}	1.89×10^{5}	1.00×10^{11}	36	(Primeau 2016)
2011	1.10×10^{7}	2.19×10^{4}	6.36×10^{10}	92.5	(Primeau 2016)
2012	1.82×10^{6}	1.56×10^{4}	5.07×10^{10}	95.6	(Primeau 2016)
2013	8.69×10^{7}	6.63×10^{4}	6.68×10^{10}	117	(Primeau 2016)
2014	5.29×10^{8}	5.27×10^{4}	2.63×10^{11}	994	(Primeau 2016)
2015	6.79×10^{8}	4.81×10^{4}	2.15×10^{11}	1191	(Primeau 2016)

Notes:

* Gross beta determined using Microspec--1 using Sr-90/Y-90 as a standard (November 2003 - June 2004).

** Gross beta determined using Canberra Packard Gross Alpha/Beta counter with Co-60 as a standard (June 2004 - November 2004).

Additional information on radiological releases in recent years has been taken from the 2015 Annual Compliance Report (ACR) for the NPD (Primeau 2016). According to the ACR, the HEPA-filtered ventilation system was operated for a total of 1,191 hours in 2015, which is higher than in previous years. The extended run times for the ventilation system in 2015 were due to the increase of work within the Nuclear Area of NPDWF in 2015 (e.g., activities to support asbestos abatement). Table 8.2-11 shows the measured releases to air in 2015, as compared to the DRLs, as well as averaged releases for 2010 – 2014. Following the table is a discussion on the releases of each of the three measured radionuclides, and their amounts relative to the DRL.

Table 8.2-11. NPDWF Annual Airborne Effluent Monitoring Results for 2015

Radionuclide	2015 Release (Bq)	DRL (Bq/a)	% DRL	Average (Bq) 2010-2014
Tritium	2.15×10^{11}	4.52×10^{16}	<0.01	1.09×10^{11}
Gross Beta/Gamma[1]	$<4.81 \times 10^{4}$*	3.83×10^{12}	<0.01	$<6.91 \times 10^{4}$*
C-14	6.79×10^{8}	3.22×10^{15}	<0.01	1.29×10^{8}

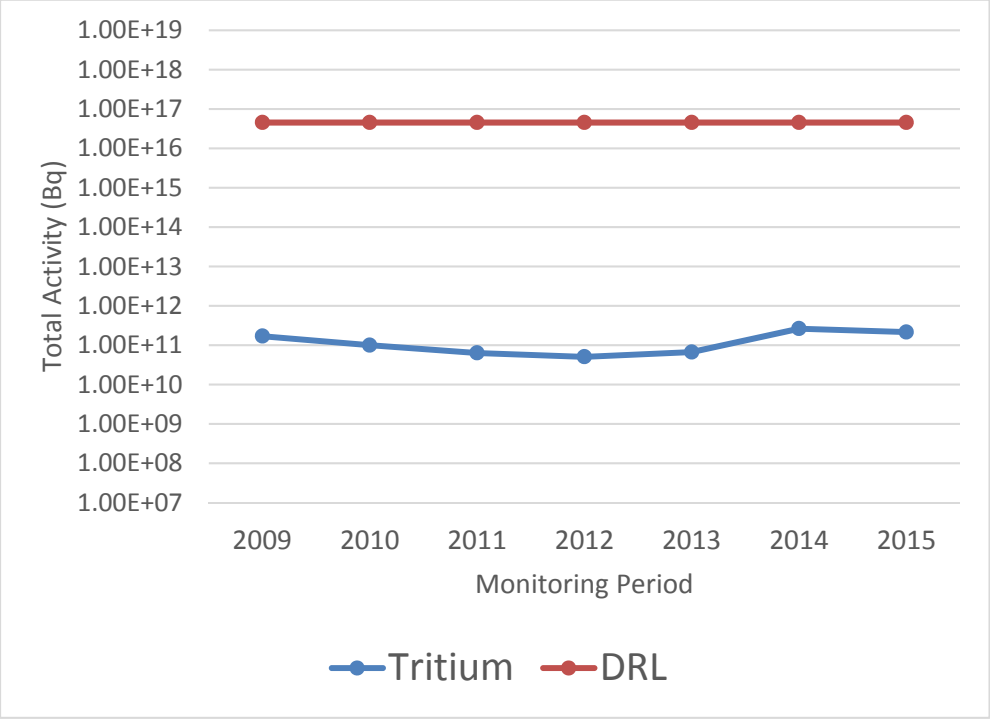
Notes:

[1] Gross Beta-Gamma results were determined using Canberra Packard Gross Alpha-Beta counter and the radioactivity is based on Cs-137.

* The 2012 and 2015 values were at the Minimum Detectable Activity (MDA).

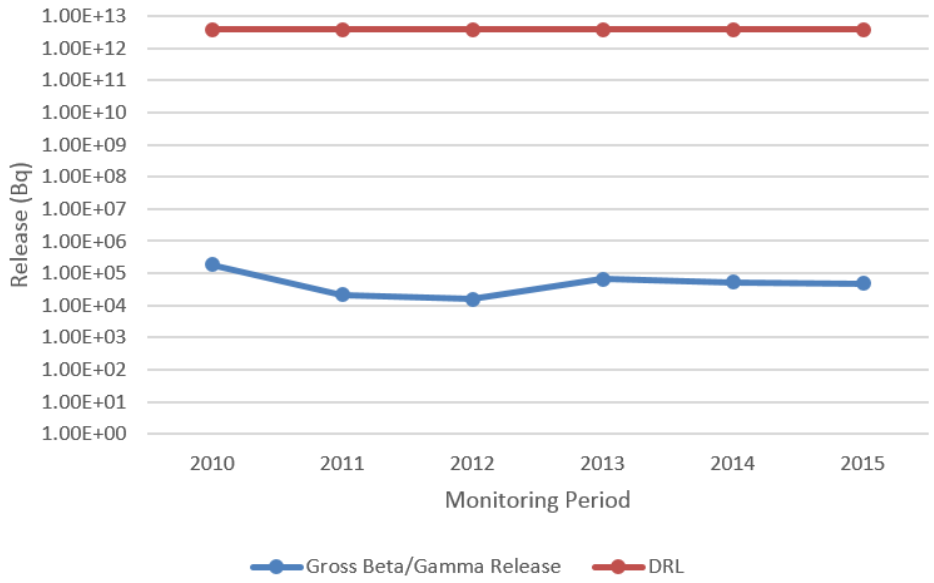
As seen in Table 8.2-11 above, the total airborne tritium release in 2015 was 2.15×10^{11} Bq, which represents less than 0.01% of the DRL (Primeau 2016). As shown in Figure 8.2-5, there is no evident trend in airborne tritium releases over time.

Figure 8.2-5. NPDWF Airborne Release Trend: Tritium (Source: Primeau 2016)



As shown in Table 8.2-11, the total airborne gross beta/gamma release in 2015 was below the minimum detectable activity (MDA, i.e., below detection limits), which corresponds to less than 0.01% of the DRL. This activity is below the average for the period of 2010 to 2014. It is worth noting that the 2012 value, which was included in the 2010 to 2014 average, was also below MDA (Primeau 2016). There is no evident trend in the airborne gross beta/gamma releases, as shown in Figure 8.2-6.

Figure 8.2-6. NPDWF Airborne Release Trend: Gross Beta/Gamma (Source: (Primeau 2016))



Note: 2012 and 2015 results were based on values that were at the MDA.

As shown in Table 8.2-11, the total airborne C-14 release in 2015 was less than 0.01% of the DRL (Primeau 2016). The 2015 C-14 release was higher than the average airborne release for 2010 to 2014, likely due to longer run time of the ventilation system, as discussed above. There is no evident trend in the airborne C-14 releases, as shown in Figure 8.2-7.

Figure 8.2-7. NPDWF Airborne Release Trend: C-14 (Source: Primeau 2016)

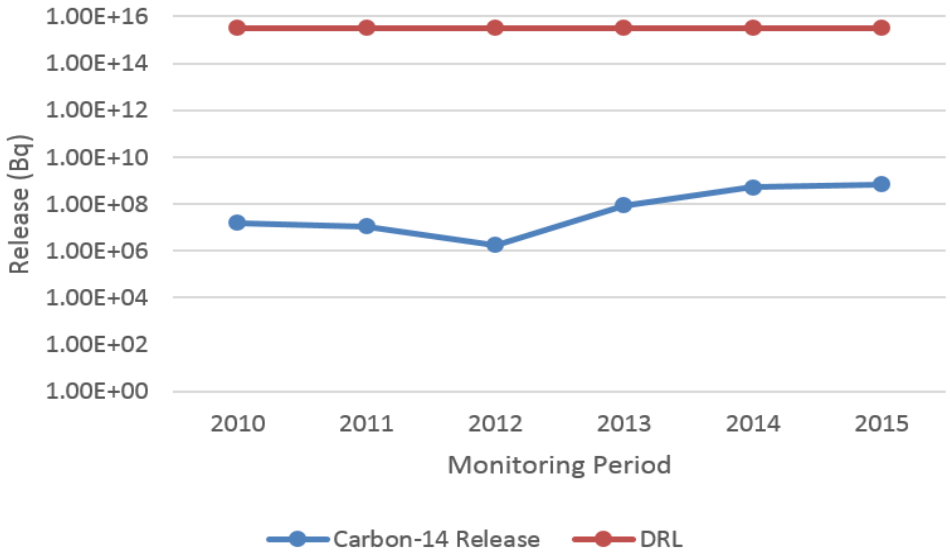
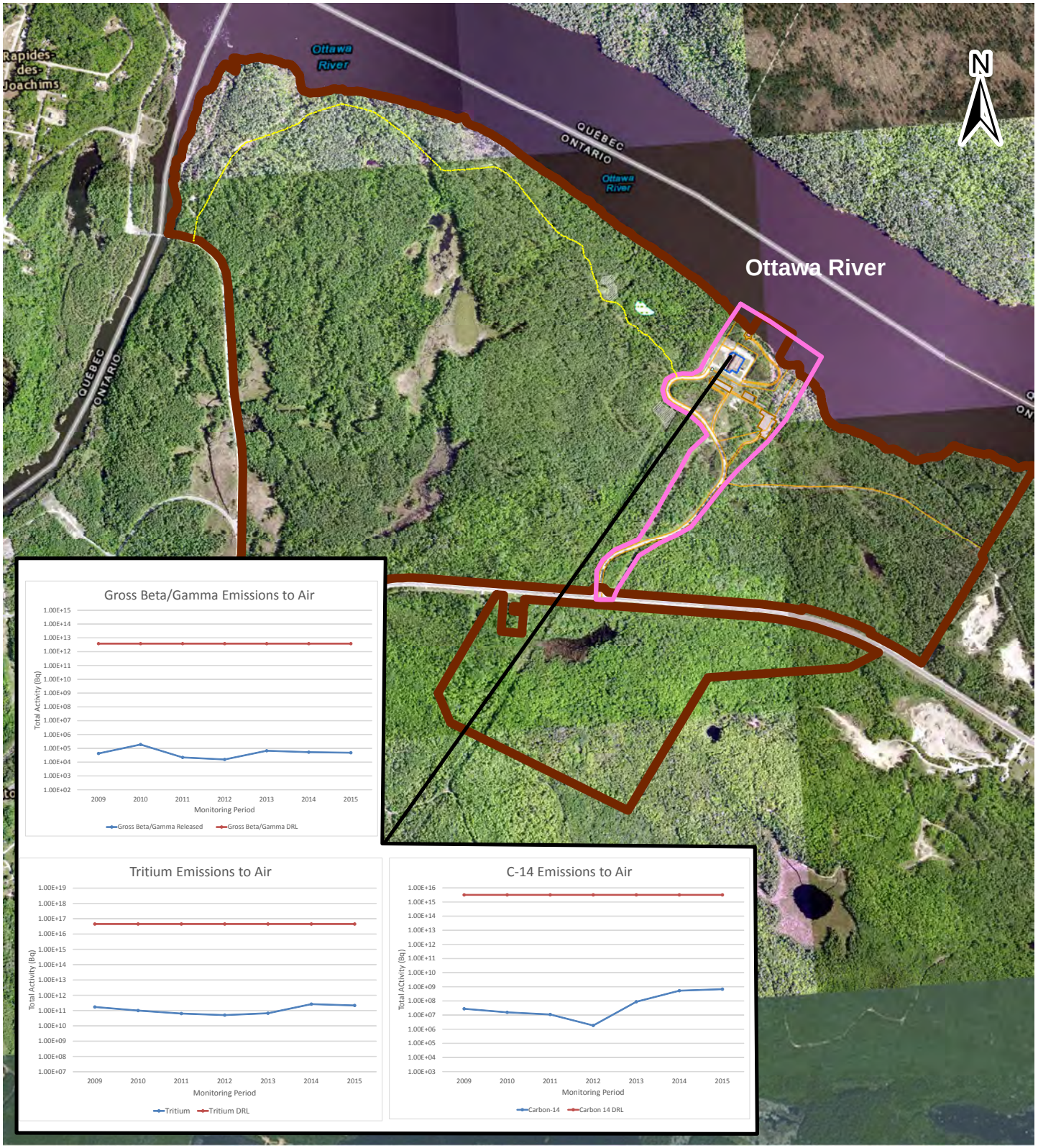


Figure 8.2-8 shows extended historical trends, from 2009 to 2015, and the location on the site where they emanate from.



Legend

- Guardhouse
- Pumphouse
- Parking
- Wetland
- Road
- Trail
- Landfill
- Local Study Area
- Site Study Area
- NPDWF

0 150 300 600 Meters

Baseline Emissions to Air from NPDWF

ARCADIS

Date: **September, 2017**

351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Non-Radiological

As discussed above, the releases to air from the NPDWF are released via a HEPA-filtered ventilation system. Non-radiological releases to air are not monitored and reported, as there are no substantial non-radiological air release sources in the facility (Primeau 2016).

8.2.4 Air Quality

In this section, available information on the air quality at the Site, Local and Regional Study Areas is presented.

The activities that will be undertaken as part of the NPD closure project are of a construction/demolition nature, thus the relevant contaminants include: nitrogen oxides (NO_x – total of nitrogen dioxide, NO_2, and nitrogen oxide, NO), volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter ($PM_{2.5}$, PM_{10} and TSP), as well as greenhouse gases such as methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O) and carbon monoxide. Therefore, baseline air quality has been estimated for these constituents that are likely to be relevant to the project.

8.2.4.1 Site/Local Study Area

Although CNL is not required to monitor air quality at the NPD site (discussed below), it does conduct an annual evaluation of releases to air, in order to assess whether any regulatory air quality reporting is required.

With respect to the federal Greenhouse Gas Emissions Reporting Program (under the *Canadian Environmental Protection Act*), Lambert (2016a) summarizes the estimated releases of greenhouse gases from the NPD site in 2015, i.e., reflecting SwS conditions. The 2015 sources of greenhouse gas emissions include Landfill #1, the emergency diesel generators (which are routinely tested and used during site power outages) and on-site transportation (estimated at less than 100 km per year, by one pickup one truck). Based on the above sources, the estimated 2015 greenhouse gas emissions from the NPD site were 143 tonnes CO_2 equivalent. This is below Canada's the greenhouse gas reporting threshold, and therefore was not reportable for 2015.

With respect to the National Pollutant Release Inventory (NPRI), Lambert (2016b) summarizes the assessment that was carried out to determine that NPD is not required to report to NPRI for the year 2015. The 2015 sources of emissions included the burning of diesel fuel in emergency generators (minimal amount), unpaved road dust (below the reporting limit, as the main road is paved) and solvent use (not routinely being used). These sources were considered to be so minimal that formal calculations were not warranted for the NPD site (Lambert 2016b). Furthermore, the NPD site previously in the SwS state did not meet the annual reporting threshold of 20,000 hours worked.

As shown in Table 8.1-1 above, there is no need for an EMP, as none of the criteria are met at the NPDWF. It is noted that the assessment above, from DeWaele (2016), was made only for baseline conditions. For this reason, air quality in the Site and Local Study areas is assumed to be similar to that in the Regional Study Area, as described below.

8.2.4.2 Regional Study Area

There is limited air quality data available for the Regional Study Area surrounding the NPD site. Some data are available for the CRL facility and areas between the CRL and NPD sites. Even though CRL is beyond the Regional Study Area, these data are used to represent the Regional Study Area in the characterization of baseline atmospheric environment.

Radiological

As part of CRL's EMP, ambient tritium levels in air are measured and reported at and around the CRL facility, including locations along the Ottawa River between the CRL and NPD sites (Boileau and Rahman 2016). The CRL site is conservatively used to represent the Regional Study Area.

From the period of 2010-2015, the 5-year average tritium concentration measured at a number of locations at the CRL site was 8.6 Bq/m^3. For the same time period, the average tritium concentration measured at the CRL site boundary was 0.8 Bq/m^3. At nearby off-site sampling locations, the average 5-year tritium concentration was <0.16 Bq/m^3. Background tritium levels in Ontario and Quebec range from 0.09 to 0.26 Bq/m^3 (Boileau and Rahman 2016).

Non-Radiological

There is limited air quality data available in the vicinity of the NPD site. However, most constituents which define the air quality in the vicinity of the NPD site will not differ substantially from the general air quality in central and eastern Ontario. The substances that combine to produce smog or acid rain, dominate baseline air quality. These include: carbon monoxide (CO), nitrogen oxides (NO_x – total of nitrogen dioxide, NO_2, and nitrogen oxide, NO), volatile organic compounds (VOCs), sulphur dioxide (SO_2), and total suspended particulate matter (TSP).

To determine the background contributions of NO_x, particulate, and SO_2, measured air concentrations from the closest ambient air quality monitoring locations at Petawawa, Napanee, Ottawa, and North Bay were considered. Values for these constituents are reported by ECCC (2016). Note that not all of these stations measure all constituents.

Of the nitrogen oxide compounds (NO_2 and NO, comprising NO_x), NO_2 is the primary constituent of interest. Therefore, most of the discussion related to NO_x focuses on NO_2. All NO_2 measurements were well below the MOE 1-hour and 24-hour average criteria of 400 $\mu g/m^3$ and 200 $\mu g/m^3$, respectively. Annual average NO_2 levels measured in Ottawa and North Bay (2013 through 2014) ranged between 12 and 16 $\mu g/m^3$. It is expected that levels in the vicinity of the NPD Site would approximate the levels measured in North Bay,

as it is less populated and industrialized than Ottawa. For the purposes of this assessment, the following background NO_2 concentrations are assumed to represent background air quality in the vicinity of the NPD Site:

- 1-hour average 90th percentile NO_2 concentration – 26 µg/m^3;
- 24-hour average 90th percentile NO_2 concentration – 24 µg/m^3;
- Annual average NO_2 concentration – 12 µg/m^3.

In general, the measured SO_2 concentrations are very low, and well below the applicable MOE 1-hour, 24-hour and annual average AAQC of 690 µg/m^3, 275 µg/m^3 and 55 µg/m^3 respectively. The measured values are also well below the 24-hour average NAAQO maximum desirable level of 125 µg/m^3. For the purposes of this assessment, the following background SO_2 concentrations are assumed to represent background air quality in the vicinity of the NPD Site:

- 1-hour average 90th percentile SO_2 concentration – 20 µg/m^3;
- 24-hour average 90th percentile SO_2 concentration – 3 µg/m^3;
- Annual average SO_2 concentration – 0 µg/m^3.

The MOE stopped reporting PM_{10} data in 2003, therefore only $PM_{2.5}$ data are provided. The measured $PM_{2.5}$ concentrations in Petawawa are more representative of the conditions at the NPD Site than the other stations, based on proximity. In all cases, the measured concentrations measured at Petawawa meet the MOE AAQC (30 µg/m^3 – 24 hour average) and the Federal NAAQC (28 µg/m^3 – 24 hour average and 10 µg/m^3 annual average). For the purposes of this assessment, the following background $PM_{2.5}$ concentrations are assumed to represent background air quality in the vicinity of the NPD Site:

- 24-hour average 90th percentile $PM_{2.5}$ concentration – 9 µg/m^3;
- Annual average $PM_{2.5}$ concentration – 5 µg/m^3.

In Canada, measured $PM_{2.5}$ concentrations are approximately 50% of the measured PM_{10} concentrations and 25% of the measured TSP concentrations (Environment Canada, Health Canada 2000). Based on this relationship, the following PM_{10} and TSP concentrations are estimated to represent background air quality in the vicinity of the NPD Site:

- 24-hour average 90th percentile PM_{10} concentration – 18 µg/m^3;
- Annual average PM_{10} concentration – 10 µg/m^3;
- 24-hour average 90th percentile TSP concentration – 36 µg/m^3;
- Annual average TSP concentration – 20 µg/m^3.

8.2.5 Ambient Noise

Noise is generally defined as unwanted sound. However, "*noise*" and "*sound*" are often used interchangeably and this is also done in this EIS. Sound is usually described in terms of two characteristics:

volume (measured in decibels, dB) and frequency (conventionally measured in Hertz). To better reflect a human receptor's response to sounds measured by instruments, "*weighting scales*" are used. The *"A weighted scale"* is used to duplicate the human response to sound. Sound levels so adjusted are referred to as *"A weighted decibels"* and assigned the unit abbreviation *dBA*.

The statistical descriptor which has been selected for environmental noise assessments is the energy equivalent level, or L_{eq}. The L_{eq} provides a method of describing time-varying sounds by a single number rather than by the entire cumulative distribution.

8.2.5.1 Site/Local Study Area

The existing sound environment in the Local/Site Study Area is characterized by road traffic from Highway 17; river noise from the Ottawa River; sounds of nature, including singing birds, chirping insects and rustling leaves. The noise on the shores of the Ottawa River would be quite consistent, but would vary in intensity depending on wind conditions. Another occasional source of noise at the NPD site would be the standby generator located on the site. In addition to monthly load testing, this generator supplies power to the site during outages (i.e., interruptions in the Class IV electricity supplied to the site). According to CNL records, there were three extended power outages between July 2015 and January 2017 (i.e., over 1.5 years), which required standby generator operation for several hours.

Currently, ambient daytime and nighttime noise levels are not measured in the site or local study areas. However, noise data from the CRL site are assumed to be an appropriate representation of noise conditions at the NPD site. Ambient noise measurements from the CRL site ranged from 28 to 42 dBA, which are typical for a quiet rural area, with the only major noise sources being on-site traffic. The most significant noise source was traffic along the plant road at CRL (Turner 2008). The minimum separation distance between the closest sensitive receptors and proposed on-site activities is more than 1 km. Health Canada's definition of receptors includes residences, daycares, schools, hospitals, places of worship, nursing homes, and First Nations and Inuit communities. For this project, the closest sensitive receptors are residences located to the southeast and southwest of the NPD Site near Highway 17. Owing to the close proximity of the sensitive receptors to Highway 17, the road traffic noise is expected to be dominant and continuous at these locations for most hours of the day. It is anticipated that sounds of nature would be more audible in the late evenings and overnight hours when the traffic volume on Highway 17 decreases.

Traffic noise was not modelled for this project. As discussed in Section 9, Effects, below, due to the low volume of traffic and short duration of physical activities, a traffic study was not considered necessary for this project, based on discussion with the MTO. The socio-economic effects of increased traffic have been considered. The planned project activities would in reality render the site a stationary noise source.

It is noted that no noise concerns have been raised from the public during current conditions at the NPD site (i.e., from generator operation).

8.2.5.2 Regional Study Area

Background noise levels within the Regional Study Area are expected to vary, depending on factors such as domestic activities, traffic and industry. For most of the Regional Study Area, it is expected that the dominant source of noise would be traffic on Highway 17. Measurements of noise along Highway 17 in the Regional Study Area are not available; however, outdoor noise at receptors close to the highway is likely to range from 50-70 dBA, depending on traffic volume (CHC 2016).

8.3 Surface Water Environment

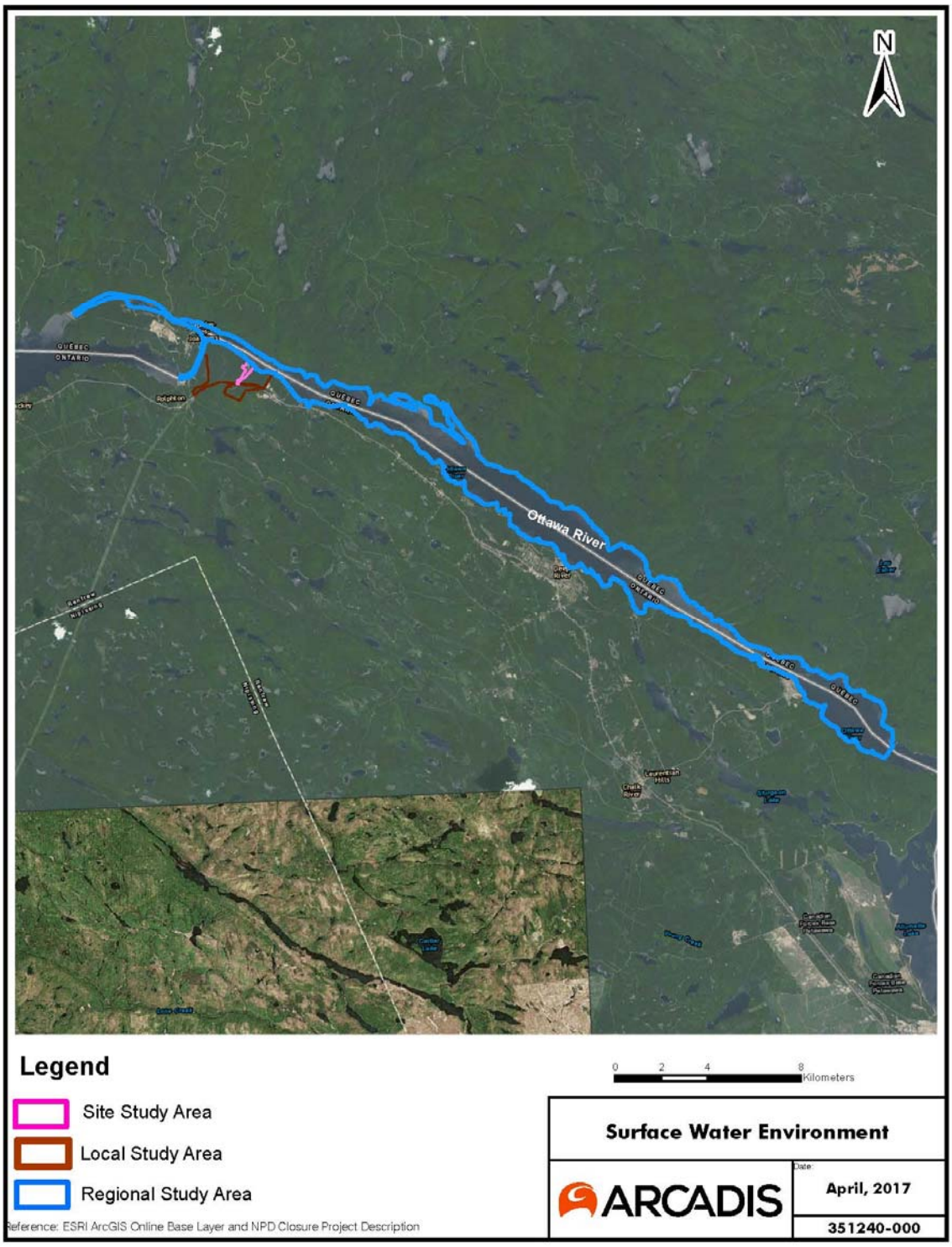
8.3.1 Spatial Boundaries

The Site Study Area for the surface water assessment is the same as the general Site Study Area illustrated in Figure 5.2-1 above. There are no known uses of surface water for drinking water in the Site Study Area.

The Local Study Area for the surface water assessment is the same as the general Local Study Area, illustrated in Figure 5.2-2 above. It contains the shoreline and 50 m into the Ottawa River, as well as the wetlands on the NPD site. On the site, subsurface drains and drainage ditches divert surface water flow away from the facility. There are no known uses of surface water for drinking water in the Local Study Area.

The Regional Study Area for the surface water assessment includes the stretch of the Ottawa River from near the Des Joachims Generating Station, to 30 km downstream of the NPD site (which includes CRL), and extends across the river to include the Quebec shoreline. It is illustrated in Figure 8.3-1 below. In the Regional Study Area, some communities such as Deep River use Ottawa River surface water as intake into the municipal drinking water treatment plant. The Deep River Wastewater Treatment plant also discharges effluent into the Ottawa River. The Chalk River water treatment plant obtains its intake water from Corry Lake, not the Ottawa River.

Figure 8.3-1. Surface Water Environment Regional Study Area



8.3.2 Hydrology

8.3.2.1 Site/Local Study Area

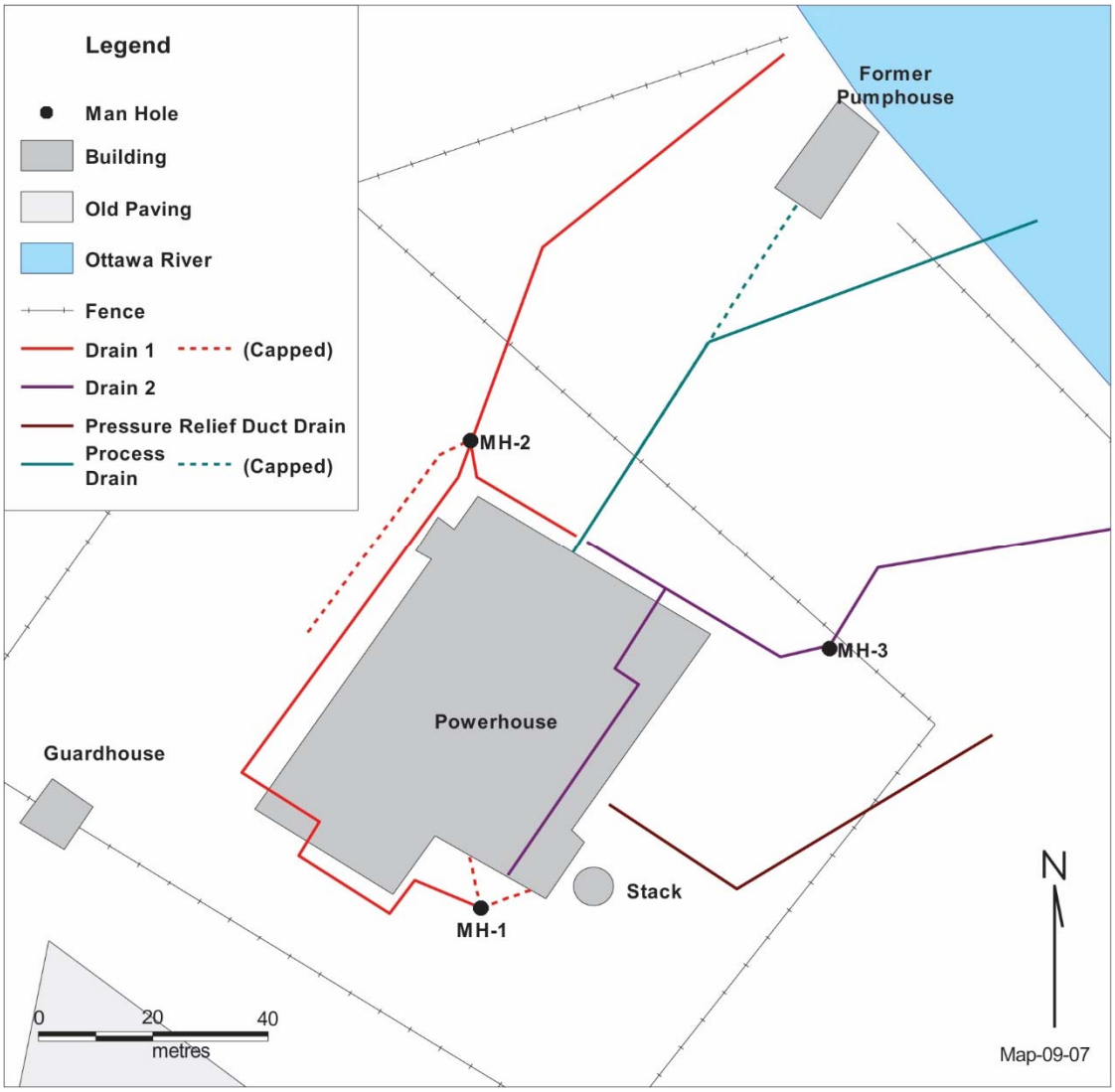
All surface drainage on the NPD site ultimately drains to the Ottawa River. To reduce the risk of water infiltration into the facility, a network of ditches and drains intercepts water flow from adjacent areas and, using gravity, directs it to the Ottawa River (DeWaele 2016).

A tile drain system collects and continuously discharges precipitation, snowmelt and shallow groundwater from around the powerhouse structures to reduce infiltration into the facility. Tile Drain 1 discharges to the river at the shoreline about 60 m upstream of the outfall (Wills 2013). Tile Drain 2 discharges to the river at the shoreline, downstream of the outfall. On Tile Drain No. 1, there are two access ports, Manholes 1 and 2 (MH-1, MH-2). On Tile Drain No. 2, there is one access port, Manhole 3 (MH-3) (Figure 8.3-2). Tile Drain No.2 has been routinely dry in recent years (as shown by sampling of MH-3).



View of the Ottawa River offshore from the NPD site, looking downstream

Figure 8.3-2. Tile Drain and Man Hole (MH) Locations (Source: Wills 2013)



Note: The pressure relief duct drain connects to Drain 2 before exit to the Ottawa River.

Drainage ditches run through the site, collecting precipitation and snow melt and discharging it in the Ottawa River. The drainage ditch system consists of ditches around the building with the land sloping towards the ditches. The access road is also drained by ditches along each side of the road. There are two surface ditch entry points into the Ottawa River: the West Surface Drainage Ditch and the East Surface Drainage Ditch (DeWaele 2016). These ditches are discussed further in Section 8.3.4 below.

A series of sumps, which ultimately collect into the Wells Area Sump (WAS, shown in Figure 3.3-1), accumulates liquids collected from within the facility (e.g., from groundwater seepage, condensation and emergency shower use) is discussed in Section 8.3.3 below.

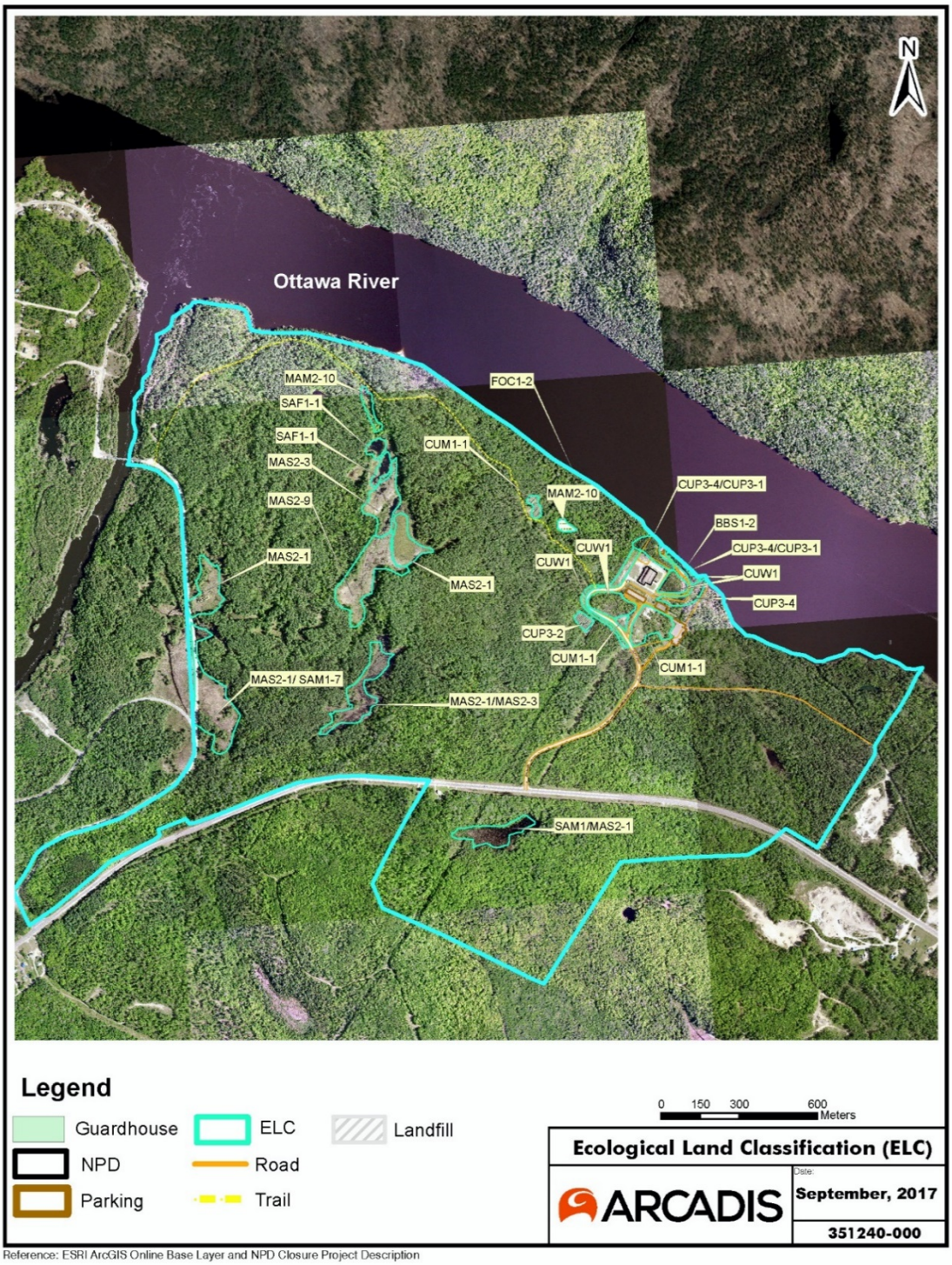


The large wetland complex on the NPD property, located west of the Site Study Area

The primary surface water feature in the Site and Local Study Areas is the Ottawa River, which runs northwest to southeast. According to King (2016), approximately 2,800 m of Ottawa River frontage is associated with the NPD site. The nominal water elevation at the NPD site is 111 m.

In addition to the river shoreline, the Local Study Area also contains some wetlands, including a large wetland complex which spans nearly the entire north-south length of the NPD property to the west of the Site Study Area. As described in the ELC TSD, the types of wetlands include shallow marshes (MAS2-1, MAS2-3, MAS2-9), meadow marshes (MAM2-10), and shallow ponds dominated by a variety of emergent, floating and submergent vegetation (SAF1-1, SAM1-7, SAM1) (Figure 8.3-3). These wetlands are at a higher elevation than NPDWF, and would not be impacted by surface water or groundwater flows from the NPDWF.

Figure 8.3-3. Ecological Land Classification Designations at the NPD Site (see the ELC TSD for descriptions of designations)



Groundwater modelling undertaken at the NPD site (Calder 2017) indicates that groundwater in the vicinity flows towards the facility and discharges to the Ottawa River. The groundwater generally flows towards the river where it is discharged, so the wetlands are not affected by the groundwater in the vicinity of the NPD reactor.

8.3.2.2 Regional Study Area

The entire Regional Study Area lies within the Ottawa River drainage basin. There are no major tributaries near the NPD site.

The Ottawa River adjacent to the NPD site is wide and deep. The river is about 0.5 km wide at NPD. Daily flow measurements of the Ottawa River taken at the Des Joachims Generating Station (just north i.e., upstream, of the NPD site), obtained from the Ottawa River Planning Board (2017) for the time period June 1950 – Dec 2016, were utilized for the following statistical assessment. In order to account for seasonal variations, exclude data outliers and ensure an appropriate level of conservatism, the 5th percentile, and 95th percentile data values were used for the minimum, and maximum values respectively. The resulting flow rates are 336 m^3/s (minimum flow rate), and 1560 m^3/s (maximum flow rate). The mean flow rate was calculated to be 807 m^3/s. The flow past the Des Joachims Dam is regulated according to the demands of the generating station. The coolwater system thermally stratifies in late July through mid-September (Lee 2014), supporting both cool and warm water species (discussed in Section 8.4.3 below).

The banks of the Ottawa River generally have low to moderate slopes, although there are steep granite cliffs in sections of the Québec shoreline. The shorelines are punctuated by points, which create bays. Shoreline substrates include silt, sand, gravel, boulders and occasional rock outcrops (Lee 2014)

It is noted that there are also numerous lakes in the region, ranging in size from small, nameless lakes only 50 – 100 m in diameter, to larger lakes such as Tee Lake and Heart Lake (Figure 8.5-1), as well as many others. These lakes are located both inside and outside of Algonquin Provincial Park. Due to the topography of the region, which will drive water towards the Ottawa River, the Ottawa River is the focus of this assessment.

8.3.3 Surface Water Releases

Releases to surface water from the NPD site are managed in accordance with the Effluent Monitoring Plan (DeWaele 2016), which is aligned with CSA N288.5 (CSA 2016).

Radiological

Liquid radioactive effluents accumulate mainly in the facility WAS. Controlled batch discharges occur from the WAS to the Ottawa River when the sump is near full. Prior to discharge, representative liquid effluent samples are collected by facility operating personnel, analyzed, and verified to be below the DRL. Sampling of the WAS is also conducted semi-annually if batch discharges are not required. The available information on baseline releases to the Ottawa River during the SwS phase is summarized below.

The data associated with the annual monitoring of the WAS radioactive releases are reported in Table 8.3-1. The information reported in the table includes the number of discharges, the total volume discharged and the total amount of various contaminants released. The date and the volume of each release are recorded (Wills 2013).

Table 8.3-1. WAS Annual Radioactive Release

Year	Number of Discharges	Total Volume (m^3)	I-131 (Bq)	Cs-137 (Bq)	Ce-144 (Bq)	C-14 (Bq)	Co-60 (Bq)	Unidentified Beta/Gamma (Bq)[c]	Gross Beta (Bq)[d]	Gross Gamma (Bq)[e]	Tritium (Bq)	Reference
1997	5	49.19	$<2.4x10^4$	$2.04x10^6$	$<9.8x10^5$	NA	$1x10^4$	$9.7x10^5$	NA	NA	$5.02x10^{11}$	(Wills 2013)
1998	5	49.47	$<1.6x10^4$	$2.55x10^6$	$<4.9x10^4$	NA	$7x10^4$	$1.37x10^6$	NA	NA	$5.01x10^{11}$	(Wills 2013)
1999	5	44.44	$<1.4x10^4$	$2.52x10^6$	$<4.5x10^4$	NA	$1.6x10^5$	$9.6x10^5$	NA	NA	$7.75x10^{11}$	(Wills 2013)
2000	5	44.4	$<1.2x10^4$	$3.06x10^6$	$<2.0x10^4$	NA	$9x10^4$	$5.5x10^5$	NA	NA	$1.09x10^{11}$	(Wills 2013)
2001	5	41.05	$<1.2x10^4$	$1.77x10^6$	$<4.1x10^4$	NA	$5x10^4$	$6.2x10^5$	NA	NA	$8.92x10^{11}$	(Wills 2013)
2002	3	22.44	$<8.2x10^3$	$8.5x10^5$	$<3.1x10^4$	NA	$1x10^4$	$2.1x10^5$	NA	NA	$3.67x10^{11}$	(Wills 2013)
2003	3	28.8	$<1.3x10^4$	$1.16x10^6$	$<4.7x10^4$	NA	$<2.3x10^3$	$4.5x10^5$	NA	NA	$2.98x10^{11}$	(Wills 2013)
2004[a]	3	24.8	NA	$8.2x10^5$	NA	$9.54x10^6$	$1x10^4$	$3.1x10^5$	NA	NA	$1.45x10^{11}$	(Wills 2013)
2004[b]			NA	NA	NA	$4.23x10^6$	NA	NA	$2.16x10^6$	$2.53x10^6$	$1.02x10^{11}$	(Wills 2013)
2005	2	21.4	NA	NA	NA	$8.60x10^6$	NA	NA	$4.10x10^6$	$1.90x10^6$	$2.00x10^{11}$	(Wills 2013)
2006	2	32.1	NA	NA	NA	$6.71x10^6$	NA	NA	$2.48x10^6$	$1.24x10^6$	$1.22x10^{11}$	(Wills 2013)
2007	2	21.4	NA	NA	NA	$7.23x10^6$	NA	NA	$2.73x10^6$	$1.44x10^6$	$1.27x10^{11}$	(Wills 2013)
2008	3	32.1	NA	NA	NA	$1.71x10^7$	NA	NA	$4.89x10^6$	$3.00x10^6$	$7.34x10^{11}$	(Verney 2009)
2009	3	32.1	NA	NA	NA	$1.61x10^7$	NA	NA	$6.94x10^6$	$4.01x10^6$	$2.33x10^{11}$	(Primeau 2016)
2010	0	0	NA	NA	NA	N/A	NA	NA	N/A	N/A	N/A	(Primeau 2016)
2011	1	10.7	NA	NA	NA	$9.30x10^6$	NA	NA	$2.1x10^6$	$1.5x10^6$	$1.30x10^{11}$	(Primeau 2016)
2012	1	10.2	NA	NA	NA	$3.75x10^6$	NA	NA	$1.01x10^6$	$1.4x10^6$	$1.27x10^{11}$	(Primeau 2016)
2013	5	6.7	NA	NA	NA	Unavailable	NA	NA	$9.76x10^5$		$1.41x10^{11}$	(Primeau 2016)
2014	4	8.0	NA	NA	NA	$9.84x10^6$	NA	NA	$6.08x10^6$		$9.60x10^{10}$	(Primeau 2016)
2015	2	16	NA	NA	NA	$5.35x10^6$	NA	NA	$4.86x10^6$		$6.61x10^{10}$	(Primeau 2016)

Notes:

[a] Monitoring period 1 January to 29 July.

[b] Monitoring period 30 July to 16 November.

[c] Gross beta determined using Microspec--1 using Sr-90/Y-90 as a standard.

[d] Results determined using a Canberra Packard Gross Alpha/Beta counter and the activity is based on Co-60.

[e] Results determined using a NaI gamma spectrometer and the activity is based on Co-60.

In addition to the information for 1997 – 2007 presented in the above table, Primeau (2016) provides information on releases between 2010 and 2015, as shown below.

In 2015, the contents of the WAS were discharged to the Ottawa River in October and November, following sampling and verification that content was below the DRLs. The total volume of liquid released from NPDWF in 2015 was 16 m^3.

Table 8.3-2. NPDWF Annual Liquid Effluent Monitoring Report for 2015 - Wells Area Sump (Source: Primeau 2016)

Radionuclide	2015 Release (Bq)	DRL (Bq/a)	% DRL	Average (Bq) 2011-2014
Tritium	6.61×10^{10}	4.33×10^{17}	<0.01	1.24×10^{11}
Gross Beta/Gamma	4.86×10^{6}	2.56×10^{13} [1]	<0.01	3.21×10^{6}
C-14	5.35×10^{6} [2]	3.89×10^{14}	<0.01	7.63×10^{6}

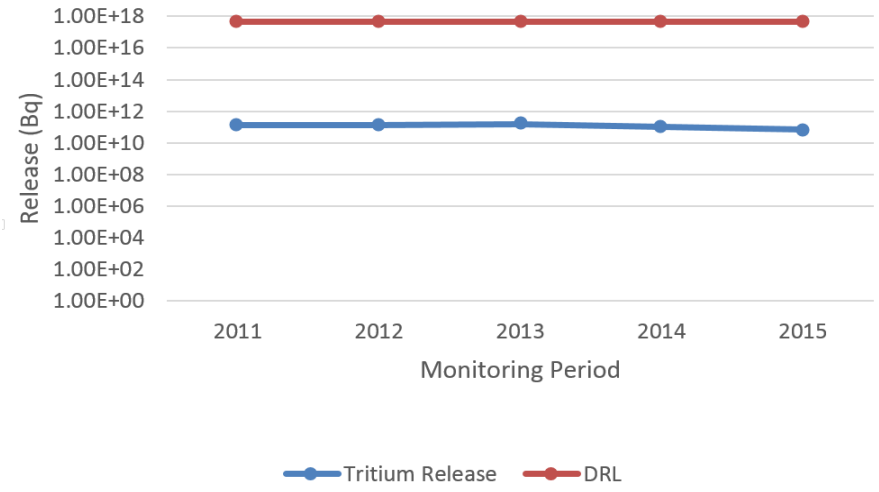
Notes:

[1] Gross Gamma DRL is included as a conservative assumption, as Gross Gamma emitters are included in Gross Beta radioactivity.

[2] C-14 values reported for 2015 are based on one set of analysis.

The total liquid tritium release in 2015 was 6.61×10^{10} Bq, which was less than 0.01% of the DRL (Primeau 2016). As shown in Table 8.3-2 above, the average liquid release for 2011 to 2014 for tritium was 1.24×10^{11} Bq. There is no evident trend in the liquid tritium releases, as shown in Figure 8.3-4.

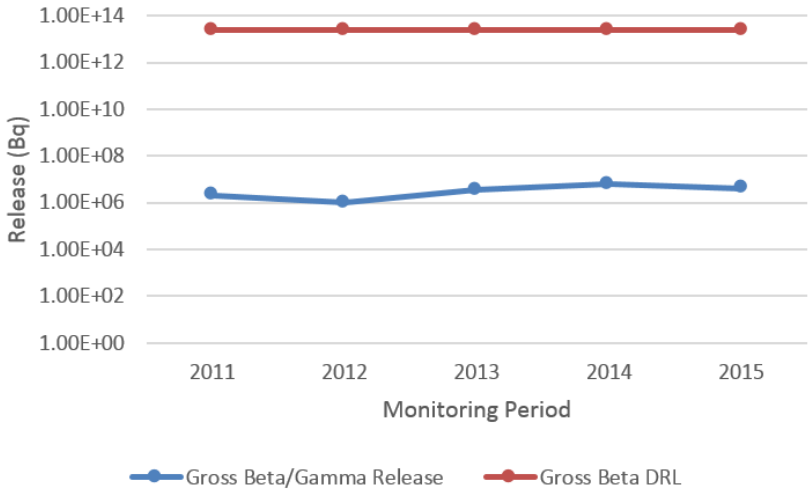
Figure 8.3-4. NPDWF Liquid Release Trend: Tritium (Source: Primeau 2016)



Note: 2010 results are not shown as there were no pump-outs of the WAS at NPDWF during 2010.

In 2015, the total liquid gross beta/gamma release was 4.86×10^{6} Bq, which corresponds to less than 0.01% of the DRL (Primeau 2016). The average liquid release for 2011 to 2014 for gross beta was 3.21×10^{6} Bq. There is no evident trend in the liquid gross beta/gamma releases, as shown in Figure 8.3-5.

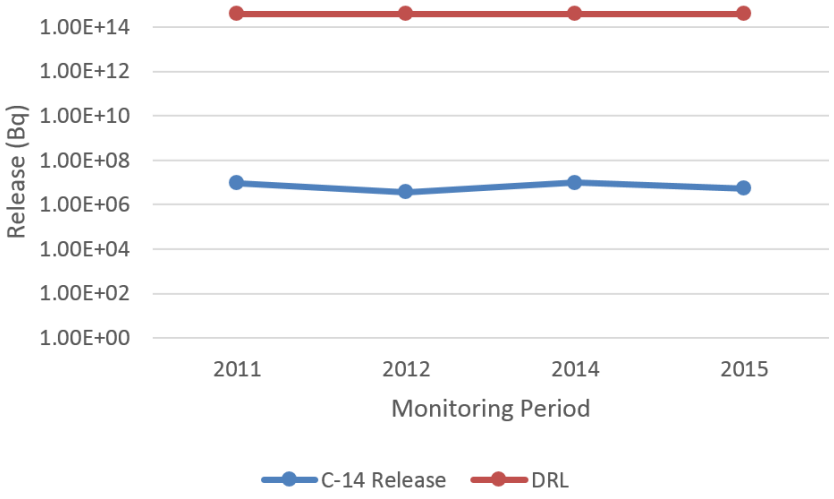
Figure 8.3-5. NPDWF Liquid Release Trend: Gross Beta/Gamma (Source: Primeau 2016)



Note: 2010 results are not shown as there were no pump-outs of the WAS at NPDWF during 2010.

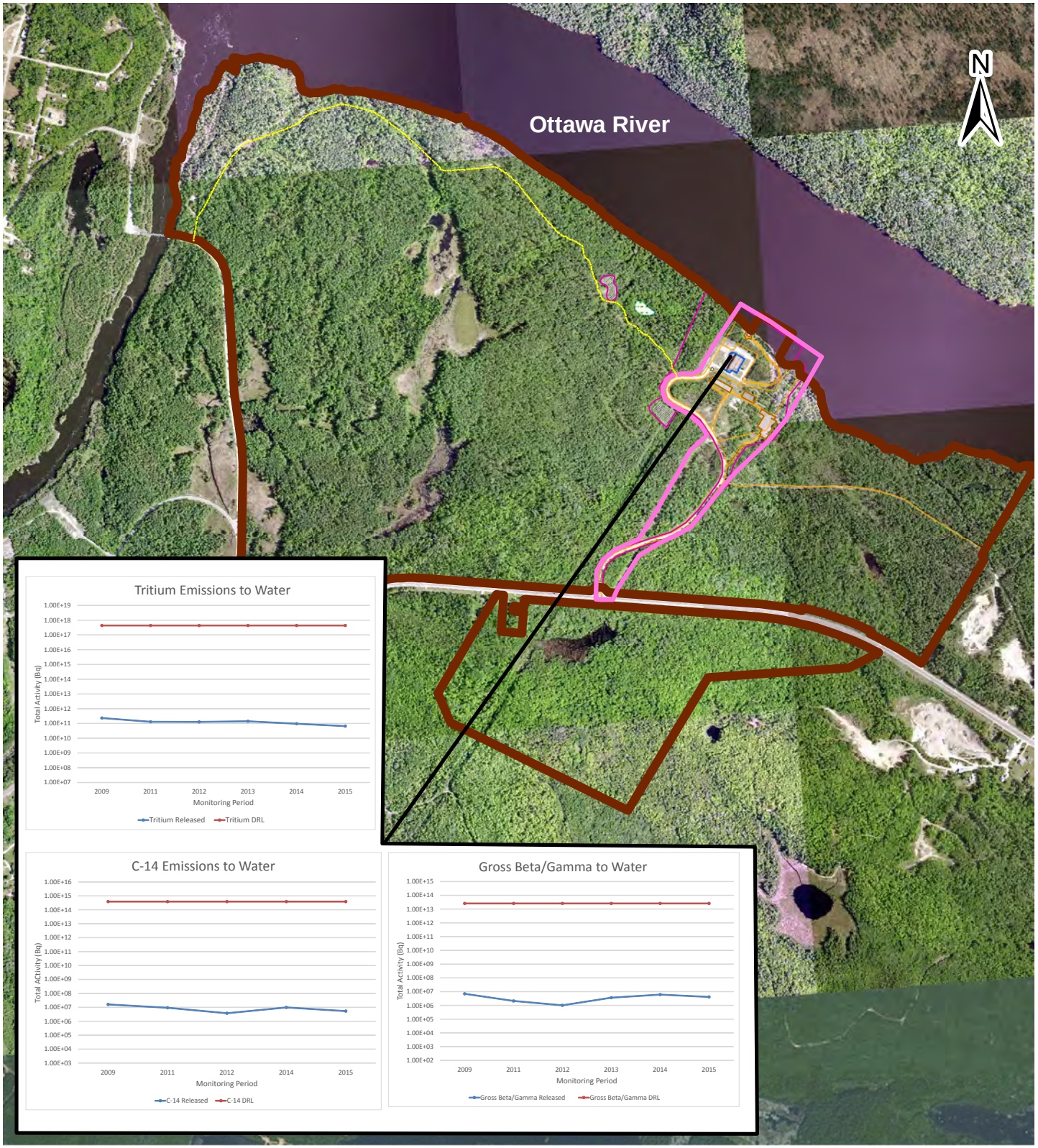
The total liquid C-14 release was 5.35 x10^6 Bq, which is less than 0.01% of the DRL (Primeau 2016). The average liquid release for 2011 to 2014 for C-14 was 7.63 x10^6 Bq; this average does not include 2013 measurement results, as they were not available for that year). There is no evident trend in the liquid C-14 releases, as shown in Figure 8.3-6.

Figure 8.3-6. NPDWF Liquid Release Trend: C-14 (Source: Primeau 2016)



Note: 2010 results are not shown as there were no pump-outs of the WAS at NPDWF during 2010. 2013 results are not shown as they were not available.

Figure 8.3-7 shows extended historical trends for radiological surface water releases from the NPD site, from 2009 to 2015.



Legend

- Guardhouse
- Pumphouse
- Parking
- Wetland
- Road
- Trail
- Landfill
- Local Study Area
- Site Study Area
- NPDWF

0 150 300 600 Meters

Baseline Emissions to Surface Water from NPDWF

ARCADIS

Date: **September, 2017**

351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Non-Radiological

In 2015, the WAS was sampled for non-radiological parameters, including physical and inorganic parameters, volatile organic compounds, and extractable organic compounds, including PCBs and dioxins and furans (Audet 2016). Of the 176 non-radiological parameters analyzed, 11 were measured in exceedance of CCME Environmental Quality Guidelines (EQG). Parameters measured in exceedance of CCME EQG are shown in Table 8.3-3 below. Please note that CCME EQG are used for environmental concentrations, and are not directly applicable to effluent releases which are typically subject to dispersion and dilution processes. The guidelines are shown here for illustrative purposes only. Complete data for all parameters measured is reported by Audet (2016).

CNL is continuing routine monitoring for metals including mercury and lead, as well as dioxins/furans and PCBs in the WAS in order to evaluate the environmental performance further.

Table 8.3-3. Effluent Contaminants Exceeding Canadian Council of Ministers of the Environment Environmental Quality Guidelines (Source: Audet 2016)

Contaminant	Unit	[WAS]	[WAS duplicate]	CCME EQG
Nitrate	mg/L	25.23	25.83	13
Cadmium (Cd)	mg/L	0.051	0.035	0.00009
Copper (Cu)	mg/L	1.37	1.26	0.002
Iron (Fe)	mg/L	7.45	9.02	0.3
Mercury (Hg)	ng/L	647	651	26
Lead (Pb)	mg/L	1.90	1.55	0.001
Zinc (Zn)	mg/L	1.16	0.874	0.03
Pyrene	µg/L	<1.0	1.3	0.025
Bis(2-ethylhexyl)phthalate	µg/L	14	15	2.2[1]
Total dioxins/furans (detected)	pgTEQ/L	204.6	189.1	23
Total PCB	µg/L	4.9	6.0	0.026

Note:

1. CNL guideline limit, as no criterion is listed under CCME.

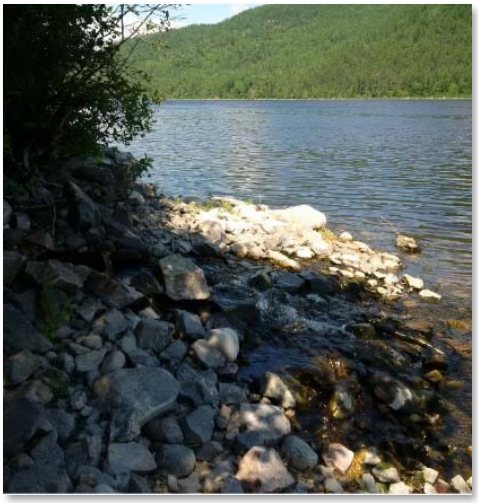
8.3.4 Surface Water Quality

8.3.4.1 Site/Local Study Area

Radiological

Drainage ditches, which are located on both sides of roads on-site, as well as around the facility, collect and divert precipitation during storm events. Due to the nature of the source and its diversion away from the main building, monitoring is not required (Audet 2016).

Water samples from subsurface drains located around the NPDWF are analyzed semi-annually for average gross beta and tritium levels. Figure 8.3-1 shows the tile drain layout and the



Tile Drain 1 discharge at shoreline

sampling locations (MH-1, MH-2 and MH-3). Drain 1 contains two manholes that act as vents, observation stations, cleanouts, and sample points. MH-1 is in collector pipe 1 on the south side and MH-2 is in the same collector pipe on the west side. Drain 1 discharges onto the shore of the Ottawa River. There is one manhole in Drain 2, which is MH-3 on the east side.

The data from these measurements are presented in Table 8.3-4 for Gross Beta and Table 8.3-5 for tritium.

Table 8.3-4. Average Gross Beta Values (in Bq/L) for MH-1, MH-2, MH-3

Year	MH-1	MH-2	MH-3	Reference
1993	<17	<17	<17	(Wills 2013)
1994	83	<17	50	(Wills 2013)
1995	<220	<220	<220	(Wills 2013)
1996	6.4	2.7	4.5	(Wills 2013)
1997	300	<7.7	<2.9	(Wills 2013)
1998	<1.2	<2.7	<2.6	(Wills 2013)
1999	<4	<4.6	<4.1	(Wills 2013)
2000	<2.3	<4	<4.4	(Wills 2013)
2001	<2.2	<1.2	<1.2	(Wills 2013)
2002	<0.8	<0.8	<0.8	(Wills 2013)
2003	<0.8	<0.8	<0.41	(Wills 2013)
2004	<1.9	<1.9	2.3	(Wills 2013)
2005	1.9	<2	2.9	(Wills 2013)
2006	<2.5	4	<3.2	(Wills 2013)
2007	<1.8	<1.8	dry	(Wills 2013)
2008	2.1	1.7	dry	(Verney 2011)
2009	<1.2	<1.2	dry	(Verney 2011)
2010	<1.4	<1.4	dry	(Verney 2011)
2011	<2.6	<2.6	dry	(Primeau 2016)
2012	<MDA	<MDA	dry	(Primeau 2016)
2013	<MDA	<MDA	<MDA	(Primeau 2016)
2014	<1.1	<1.1	<1.1	(Primeau 2016)
2015	1.35	<1.35	<1.52	(Primeau 2016)

Note:

MDA: Minimum Detectable Activity.

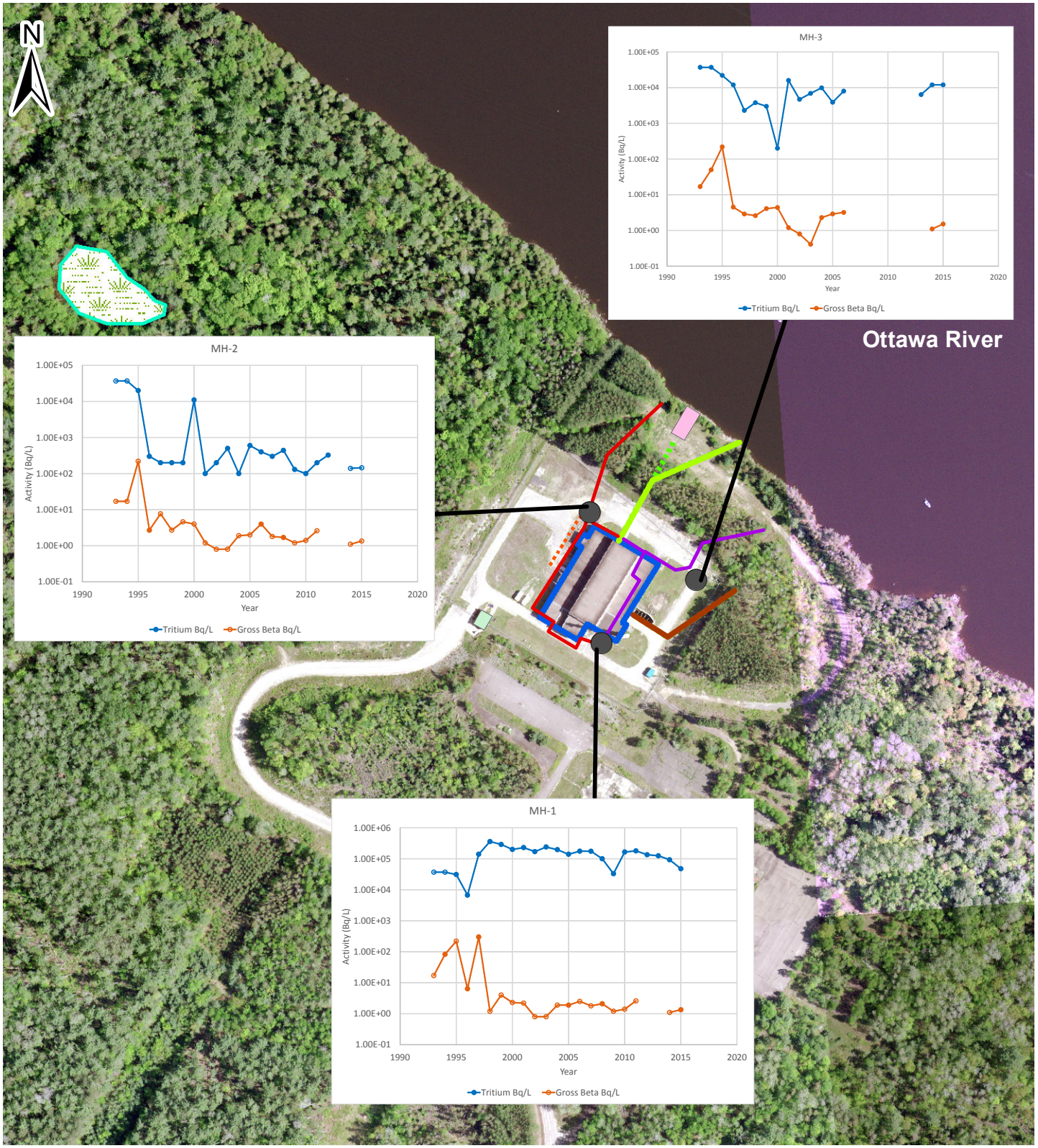
Table 8.3-5. Average Tritium Values (in Bq/L) for MH-1, MH-2, MH-3

Year	MH-1	MH-2	MH-3	Reference
1993	$<3.70x10^4$	$<3.70x10^4$	$<3.70x10^4$	(Wills 2013)
1994	$<3.70x10^4$	$<3.70x10^4$	$<3.70x10^4$	(Wills 2013)
1995	$3.10 x10^4$	$2.00 x10^4$	$2.20 x10^4$	(Wills 2013)
1996	$6.7 x10^3$	$3 x10^2$	$1.20 x10^4$	(Wills 2013)
1997	$1.400 x10^5$	$2 x10^2$	$2.3 x10^3$	(Wills 2013)
1998	$3.600 x10^5$	$2 x10^2$	$3.8 x10^3$	(Wills 2013)
1999	$2.900 x10^5$	$2 x10^2$	$3.0 x10^3$	(Wills 2013)
2000	$2.000 x10^5$	$1.10 x10^4$	$2 x10^2$	(Wills 2013)
2001	$2.300 x10^5$	$1 x10^2$	$1.60 x10^4$	(Wills 2013)
2002	$1.700 x10^5$	$2 x10^2$	$4.7 x10^3$	(Wills 2013)
2003	$2.400 x10^5$	$5 x10^2$	$6.9 x10^3$	(Wills 2013)
2004	$1.970 x10^5$	$1 x10^2$	$9.9 x10^3$	(Wills 2013)
2005	$1.400 x10^5$	$6 x10^2$	$3.9 x10^3$	(Wills 2013)
2006	$1.760 x10^5$	$04 x10^2$	$8.0 x10^3$	(Wills 2013)
2007	$1.750 x10^5$	$3 x10^2$	Dry	(Wills 2013)
2008	$1.00 x10^5$	$4.4 x10^2$	Dry	(Verney 2011)
2009	$3.3 x10^4$	$1.3 x10^2$	Dry	(Verney 2011)
2010	$1.65 x10^5$	$1 x10^2$	Dry	(Verney 2011)
2011	$1.80 x10^5$	$2 x10^2$	Dry	(Primeau 2016)
2012	$1.35 x10^5$	$3 x10^2$	Dry	(Primeau 2016)
2013	$1.25 x10^5$	<MDA	$6.40 x10^3$	(Primeau 2016)
2014	$9.3 x10^4$	$<1.4 x10^2$	$1.2 x10^4$	(Primeau 2016)
2015	$4.77 x10^4$	$<1.45 x10^2$	$1.2 x10^4$	(Primeau 2016)

Note:

MDA: Minimum Detectable Activity.

The historical trend of this data is presented in Figure 8.3-8 below. In this figure, open circles for data points represent the MDA value, however these results were found to be below MDA. From 2007 – 2012 MH-3 was dry at the time of sampling. Other gaps in the plots represent results that were found to be below MDA, but no MDA value was provided (see Table 8.3 4 and Table 8.3 5).



Manhole Water Quality

ARCADIS

Date: September, 2017

351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Note: The pressure relief duct drain connects to Drain 2 before exit to the Ottawa River

Non-Radiological

Drainage ditches, which are located on both sides of roads on-site as well as around the facility, collect and divert precipitation during storm event. Due to the nature of the source and its diversion away from the main building, monitoring is not required (Audet 2016).

Drain 1 was sampled in 2014. All samples were well below the Health Canada screening criteria for drinking water (Killey 2014). In 2015, the tile drain system (i.e., Drains 1 and 2) was sampled for non-radiological parameters, including physical and inorganic parameters, volatile organic compounds, and extractable organic compounds, including PCBs and dioxins and furans (Audet 2016). Exceedances above CCME EQG were reported for iron and zinc in samples from MH-3; however, it is noted in Audet (2016) that there MH-3 had no flow during the sampling campaign, and sample volume issues were experienced.

Chemical levels in surface water in the part of the Ottawa River located in the Site and Local Study Areas are not available.

8.3.4.2 Regional Study Area

Radiological

Surface water sampled by CNL in the Ottawa River is reported in the NPD Baseline Report and ACRs (Verney 2011, Wills 2013, Neville 2015, Primeau 2016). Samples are collected at the former hamlet of Rolphton (near the Des Joachims dam) and at Deep River, which are upstream and downstream respectively of the NPD site. These locations are described in Table 8.3-6.

Table 8.3-6. Ottawa River Upstream and Downstream Sampling Locations (Source: Wills 2013)

Name	Location	Location Code	UTM Easting (m)	UTM Northing (m)
Deep River	Ottawa River, Deep River Water Filtration Plant	ORD	307431	5109106
Des Joachims	Ottawa River, Rolphton (Des Joachims Generating Station)	ORR	291805	5117576

At both sampling stations, river concentrations are less than 0.00004% of the current Maximum Acceptable Concentration (MAC) of 7,000 Bq/L of tritium in drinking water specified by Health Canada (2017). Based on the data collected, there is no sign of any appreciable Cs-137 input to the river from the NPD site since there is no statistically significant difference between the two locations. For the most part, the Sr-90 concentrations at the two locations are not significantly different (Wills 2013). Values for tritium, Cs-137 and Sr-90 from river water samples collected between 1988 and 2015 are presented in Table 8.3-7 and Figure 8.3-9 shows the historical trends for each location.

Table 8.3-7. Ottawa River Radionuclide Concentrations 1988 - 2015

Year	Quarter	Tritium (Bq/L)		Cs-137 (Bq/L)		Sr-90 (Bq/L)		Reference
		Des Joachims	Deep River	Des Joachims	Deep River	Des Joachims	Deep River	
1988	4	21	23	$<2.0 \times 10^{-3}$	$<4.5 \times 10^{-3}$	7×10^{-3}	5.3×10^{-3}	(Wills 2013)
1989	1	19	14	$<3.5 \times 10^{-3}$	$<2.1 \times 10^{-3}$	7.4×10^{-3}	8.5×10^{-3}	
	2	7.1	8.1	$<3.0 \times 10^{-3}$	$<3.8 \times 10^{-3}$	2.8×10^{-3}	7.4×10^{-3}	
	4	6.2	8.9	$<3.5 \times 10^{-3}$	$<0.9 \times 10^{-3}$	7.4×10^{-3}	1.49×10^{-2}	
1990	1	5.6	6.5	$<1.5 \times 10^{-3}$	$<2.1 \times 10^{-3}$	1.04×10^{-2}	1.06×10^{-2}	(Wills 2013)
	2	7.8	6.6	$<2.1 \times 10^{-3}$	2.8×10^{-3}	1.14×10^{-2}	1.22×10^{-2}	
	3	5.5	4.3	$<2.1 \times 10^{-3}$	$<1.5 \times 10^{-3}$	1.55×10^{-2}	1.19×10^{-2}	
	4	4.4	5	$<2.2 \times 10^{-3}$	$<1.2 \times 10^{-3}$	6.9×10^{-3}	4.3×10^{-3}	
1991	1	6.8	6.1	$<1.2 \times 10^{-3}$	$<2.3 \times 10^{-3}$	9×10^{-3}	6.9×10^{-3}	(Wills 2013)
	2	6.3	6.6	5.1×10^{-3}	4×10^{-3}	9.3×10^{-3}	7.3×10^{-3}	
	3	5.5	5.5	2.7×10^{-3}	$<4.1 \times 10^{-3}$	1.04×10^{-2}	8.2×10^{-3}	
	4	0.5	4.9	1.8×10^{-3}	$<2.5 \times 10^{-3}$	6.8×10^{-3}	7.9×10^{-3}	
1992	1	6.6	4.6	$<0.9 \times 10^{-3}$	$<5.7 \times 10^{-3}$	6.7×10^{-3}	9.8×10^{-3}	(Wills 2013)
	2	4.5	5.8	$<4.3 \times 10^{-3}$	$<3.8 \times 10^{-3}$	7.1×10^{-3}	8.1×10^{-3}	
	3	5.2	3.8	3.1×10^{-3}	$<2.8 \times 10^{-3}$	7.7×10^{-3}	1.13×10^{-2}	
	4	3.9	3.4	$<1.3 \times 10^{-3}$	$<2.2 \times 10^{-3}$	3.1×10^{-3}	3.6×10^{-3}	
1993	1	6.6	4.5	$<7.7 \times 10^{-3}$	5.4×10^{-3}	3.9×10^{-3}	5.6×10^{-3}	(Wills 2013)
	2	3.7	4.6	$<2.2 \times 10^{-3}$	$<9.9 \times 10^{-3}$	4.1×10^{-3}	9.4×10^{-3}	
	3	9.6	5.4	4.9×10^{-3}	$<5 \times 10^{-3}$	1.04×10^{-2}	$<2.8 \times 10^{-3}$	
	4	6.5	5.2	4.5×10^{-3}	$<3.4 \times 10^{-3}$	8.7×10^{-3}	6.4×10^{-3}	
1994	1	4.4	4.5	$<2.4 \times 10^{-3}$	2.6×10^{-3}	1.03×10^{-2}	4.8×10^{-3}	(Wills 2013)
	2	4.5	4.7	3.8×10^{-3}	5.2×10^{-3}	4.5×10^{-3}	4.7×10^{-3}	
	3	4.8	3.4	$<2.7 \times 10^{-3}$	$<2 \times 10^{-3}$	7.3×10^{-3}	6.6×10^{-3}	
	4	5.5	3.9	$<3 \times 10^{-3}$	$<2.9 \times 10^{-3}$	7.4×10^{-3}	6.3×10^{-3}	
1995	1	4.1	2.9	$<2.1 \times 10^{-3}$	$<1.4 \times 10^{-3}$	7.4×10^{-3}	7.1×10^{-3}	(Wills 2013)
	2	5.1	4.3	$<2 \times 10^{-3}$	$<2.4 \times 10^{-3}$	8.9×10^{-3}	6.9×10^{-3}	
	3	4	2.5	3.6×10^{-3}	$<1.1 \times 10^{-3}$	6.6×10^{-3}	8×10^{-3}	
	4	4.1	4.5	2.7×10^{-3}	2.7×10^{-3}	3.5×10^{-3}	4.3×10^{-3}	
1996	1	4.3	3.8	1.7×10^{-3}	1.7×10^{-3}	5.5×10^{-3}	6.3×10^{-3}	(Wills 2013)
	2	4.6	3.5	2.2×10^{-3}	3.8×10^{-3}	3.7×10^{-3}	5.7×10^{-3}	
	3	4.2	4.1	1.9×10^{-3}	1.8×10^{-3}	3.3×10^{-3}	3.3×10^{-3}	
	4	6	5.2	1.9×10^{-3}	3.5×10^{-3}	4.8×10^{-3}	5.1×10^{-3}	
1997	1	3.5	3.3	2.2×10^{-3}	1.9×10^{-3}	7.4×10^{-3}	6.4×10^{-3}	(Wills 2013)
	2	3.3	2.2	1.2×10^{-3}	2.8×10^{-3}	6.4×10^{-3}	7.8×10^{-3}	
	3	4.1	3.4	1.3×10^{-3}	0.4×10^{-3}	8.9×10^{-3}	1.07×10^{-2}	

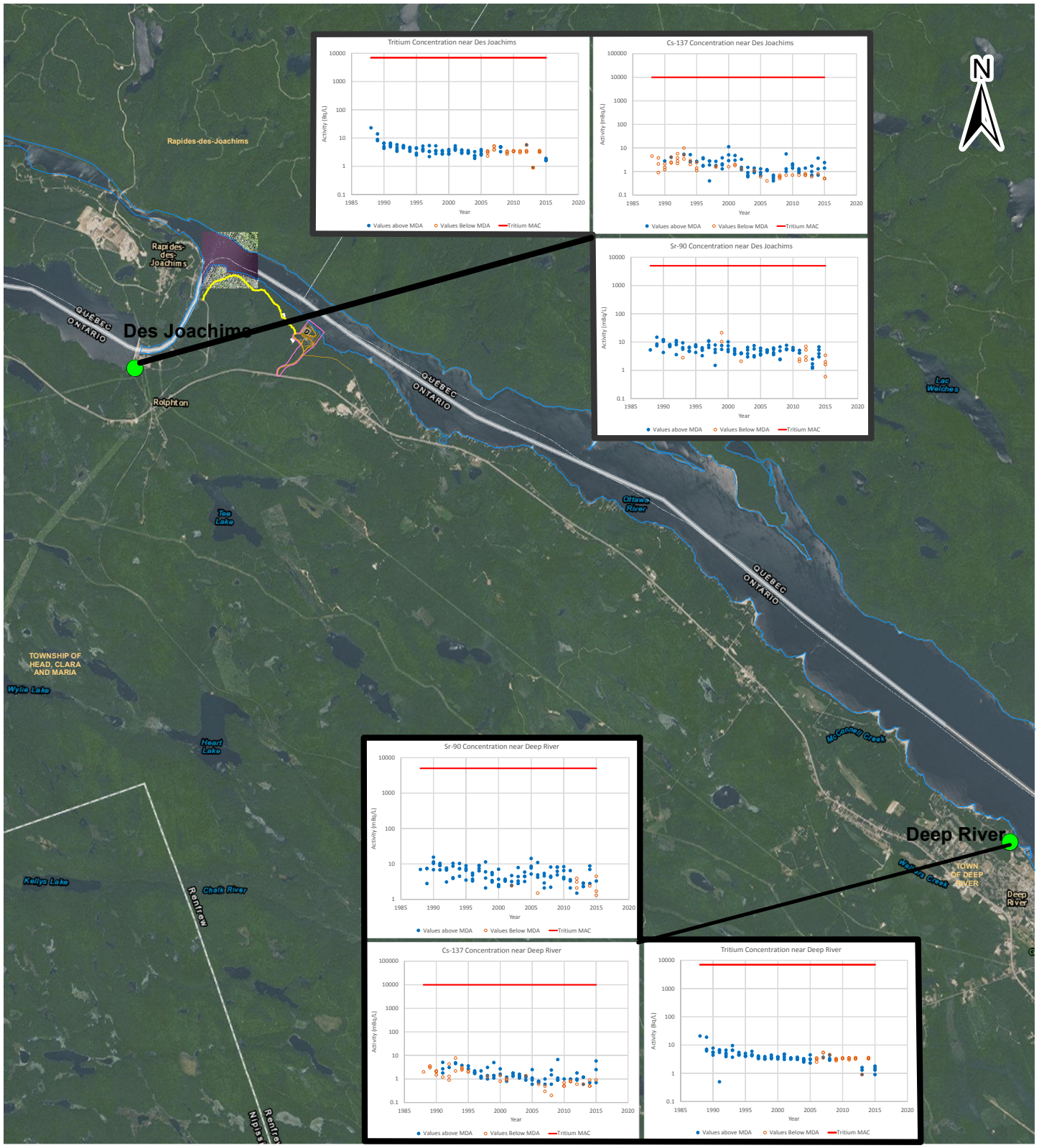
Year	Quarter	Tritium (Bq/L)		Cs-137 (Bq/L)		Sr-90 (Bq/L)		Reference
		Des Joachims	Deep River	Des Joachims	Deep River	Des Joachims	Deep River	
	4	3.8	5.4	1.1×10^{-3}	2.8×10^{-3}	9.1×10^{-3}	1.11×10^{-2}	
1998	1	3.3	2.8	3.1×10^{-3}	$<1.62 \times 10^{-3}$	1.14×10^{-2}	7.9×10^{-3}	(Wills 2013)
	2	3.2	3.6	1.4×10^{-3}	1.8×10^{-3}	6×10^{-3}	5.5×10^{-3}	
	3	3.9	5.3	1×10^{-3}	2.7×10^{-3}	2.1×10^{-3}	4.3×10^{-3}	
	4	3.2	3.5	$<1.26 \times 10^{-3}$	$<1.57 \times 10^{-3}$	4×10^{-3}	1.5×10^{-3}	
1999	1	3.3	3.4	1.1×10^{-3}	3.8×10^{-3}	5.7×10^{-3}	$<2.14 \times 10^{-2}$	(Wills 2013)
	2	3.7	3.6	1.4×10^{-3}	2.1×10^{-3}	5×10^{-3}	$<1.03 \times 10^{-2}$	
	3	4.4	2.8	5×10^{-3}	1.9×10^{-3}	3.1×10^{-3}	5.5×10^{-3}	
	4	3.4	2.7	1.4×10^{-3}	1.3×10^{-3}	3.4×10^{-3}	7.6×10^{-3}	
2000	1	3.8	2.8	$<1.4 \times 10^{-3}$	2.9×10^{-3}	7.1×10^{-3}	10.2	(Wills 2013)
	2	3.8	3.4	1.6×10^{-3}	5.1×10^{-3}	2.3×10^{-3}	7.4×10^{-3}	
	3	3.2	2.7	2.7×10^{-3}	1.13×10^{-2}	3.7×10^{-3}	4.6×10^{-3}	
	4	3.7	3.9	$<0.8 \times 10^{-3}$	$<1.6 \times 10^{-3}$	2.6×10^{-3}	5.5×10^{-3}	
2001	1	3.1	4.4	$<0.9 \times 10^{-3}$	$<1.8 \times 10^{-3}$	3.3×10^{-3}	4.9×10^{-3}	(Wills 2013)
	2	3.8	4	$<1 \times 10^{-3}$	$<2 \times 10^{-3}$	3.6×10^{-3}	4×10^{-3}	
	3	4.8	3.7	1.2×10^{-3}	4.8×10^{-3}	3.7×10^{-3}	5.8×10^{-3}	
	4	4.6	5.3	0.8×10^{-3}	3×10^{-3}	3.3×10^{-3}	3.7×10^{-3}	
2002	1	3.2	3.8	1.3×10^{-3}	1.2×10^{-3}	3.2×10^{-3}	4.1×10^{-3}	(Wills 2013)
	2	3.5	3.6	1.7×10^{-3}	1.5×10^{-3}	4.7×10^{-3}	3.9×10^{-3}	
	3	3.5	2.9	1.4×10^{-3}	$<1.3 \times 10^{-3}$	2.5×10^{-3}	4×10^{-3}	
	4	3.2	3.1	1.8×10^{-3}	3.3×10^{-3}	$<2.4 \times 10^{-3}$	$<2.1 \times 10^{-3}$	
2003	1	3.1	2.9	1.3×10^{-3}	0.9×10^{-3}	2.8×10^{-3}	3×10^{-3}	(Wills 2013)
	2	3.4	3.6	1.6×10^{-3}	1.5×10^{-3}	7.9×10^{-3}	6.5×10^{-3}	
	3	3.1	3	1.3×10^{-3}	0.7×10^{-3}	4.4×10^{-3}	5.3×10^{-3}	
	4	3.7	3.3	1.1×10^{-3}	0.6×10^{-3}	3.3×10^{-3}	3.9×10^{-3}	
2004	1	3	2.3	$<1.4 \times 10^{-3}$	$<1.1 \times 10^{-3}$	4.5×10^{-3}	3×10^{-3}	(Wills 2013)
	2	3.3	3.3	1.3×10^{-3}	1.4×10^{-3}	3.2×10^{-3}	3.3×10^{-3}	
	3	2.8	2.4	0.9×10^{-3}	0.9×10^{-3}	4.4×10^{-3}	5.7×10^{-3}	
	4	2.5	1.9	1.2×10^{-3}	1×10^{-3}	5.9×10^{-3}	7.5×10^{-3}	
2005	1	3.1	2.8	0.9×10^{-3}	0.7×10^{-3}	7.7×10^{-3}	4.9×10^{-3}	(Wills 2013)
	2	4.5	3.9	1.1×10^{-3}	0.9×10^{-3}	8.6×10^{-3}	3.5×10^{-3}	
	3	3.2	2.5	0.6×10^{-3}	1.3×10^{-3}	5.2×10^{-3}	3.8×10^{-3}	
	4	2.3	3.4	2.5×10^{-3}	$<0.6 \times 10^{-3}$	1.43×10^{-2}	6.1×10^{-3}	
2006	1	<2.5	<2.3	0.7×10^{-3}	1.1×10^{-3}	4.9×10^{-3}	4.9×10^{-3}	(Wills 2013)
	2	<3.2	<3.3	$<0.6 \times 10^{-3}$	1.2×10^{-3}	1.1×10^{-2}	5.2×10^{-3}	
	3	<3.1	<3.0	0.8×10^{-3}	1.1×10^{-3}	$<1.5 \times 10^{-3}$	5.3×10^{-3}	

Year	Quarter	Tritium (Bq/L)		Cs-137 (Bq/L)		Sr-90 (Bq/L)		Reference
		Des Joachims	Deep River	Des Joachims	Deep River	Des Joachims	Deep River	
	4	<3.5	<3.5	0.8×10^{-3}	$<0.4 \times 10^{-3}$	4.2×10^{-3}	4.3×10^{-3}	
2007	1	<3.5	<3.8	$<0.5 \times 10^{-3}$	0.7×10^{-3}	2.1×10^{-3}	5.5×10^{-3}	(Wills 2013)
	2	3.7	<3.9	1×10^{-3}	0.5×10^{-3}	4.6×10^{-3}	6.2×10^{-3}	
	3	<5.3	<5.2	0.6×10^{-3}	0.6×10^{-3}	5.4×10^{-3}	3.6×10^{-3}	
	4	<5.5	<5.0	$<0.3 \times 10^{-3}$	0.4×10^{-3}	2.9×10^{-3}	4.2×10^{-3}	
2008	1	<4.6	4.9	$<0.2 \times 10^{-3}$	$<0.6 \times 10^{-3}$	4.5×10^{-3}	2.5×10^{-3}	(Verney 2011)
	2	4.4	4.7	0.6×10^{-3}	$<0.6 \times 10^{-3}$	8.2×10^{-3}	6.8×10^{-3}	
	3	2.9	3.3	2.4×10^{-3}	$<0.5 \times 10^{-3}$	2.2×10^{-3}	2.4×10^{-3}	
	4	3.3	4.9	1.5×10^{-3}	$<0.7 \times 10^{-3}$	4.2×10^{-3}	4.9×10^{-3}	
2009	1	<2.8	<2.7	1.1×10^{-3}	1.3×10^{-3}	4.9×10^{-3}	5.4×10^{-3}	(Verney 2011)
	2	<3.0	<3.0	0.9×10^{-3}	1.0×10^{-3}	8.2×10^{-3}	7.7×10^{-3}	
	3	<3.2	<3.4	6.7×10^{-3}	5.6×10^{-3}	6.2×10^{-3}	5.6×10^{-3}	
	4	<3.3	<3.3	0.9×10^{-3}	$<0.7 \times 10^{-3}$	8.1×10^{-3}	5.7×10^{-3}	
2010	1	<3.4	<3.3	$<0.5 \times 10^{-3}$	1.8×10^{-3}	6.5×10^{-3}	5.2×10^{-3}	(Neville 2015)
	2	<3.4	<3.4	$<0.5 \times 10^{-3}$	2.1×10^{-3}	3.8×10^{-3}	5.3×10^{-3}	
	3	<3.5	<3.5	1.0×10^{-3}	$< 0.7 \times 10^{-3}$	4.2×10^{-3}	6.4×10^{-3}	
	4	<3.3	<3.5	$< 0.7 \times 10^{-3}$	1.4×10^{-3}	8.4×10^{-3}	5.2×10^{-3}	
2011	1	<3.3	<3.4	1.0×10^{-3}	1.1×10^{-3}	3.6×10^{-3}	4.1×10^{-3}	(Primeau 2016)
	2	<3.5	<3.5	$<0.8 \times 10^{-3}$	1.3×10^{-3}	3.3×10^{-3}	5.1×10^{-3}	
	3	<3.5	<3.4	$<0.8 \times 10^{-3}$	0.9×10^{-3}	2.1×10^{-3}	$<2.1 \times 10^{-3}$	
	4	<3.0	<3.0	$<0.8 \times 10^{-3}$	$<0.7 \times 10^{-3}$	6.5×10^{-3}	$<2.5 \times 10^{-3}$	
2012	1	<3.3	<3.3	0.9×10^{-3}	$<0.8 \times 10^{-3}$	1.5×10^{-3}	$<5.3 \times 10^{-3}$	(Primeau 2016)
	2	<3.2	<3.2	1.8×10^{-3}	1.4×10^{-3}	$<3.9 \times 10^{-3}$	$<7.0 \times 10^{-3}$	
	3	<3.6	<3.6	01.0×10^{-3}	$<0.7 \times 10^{-3}$	$<2.1 \times 10^{-3}$	$<2.3 \times 10^{-3}$	
	4	<3.3	5.7	$<0.6 \times 10^{-3}$	$<0.7 \times 10^{-3}$	$<3.1 \times 10^{-3}$	$<3.0 \times 10^{-3}$	

Year	Quarter	Tritium (Bq/L)		Cs-137 (Bq/L)		Sr-90 (Bq/L)		Reference
		Des Joachims	Deep River	Des Joachims	Deep River	Des Joachims	Deep River	
2013	1	0.9	<0.9	1.2×10^{-3}	0.7×10^{-3}	2.8×10^{-3}	2.5×10^{-3}	(Primeau 2016)
	2	<0.9	0.9	1.2×10^{-3}	1.7×10^{-3}	2.9×10^{-3}	1.3×10^{-3}	
	3	1.3	<0.9	$<0.6 \times 10^{-3}$	1.0×10^{-3}	2.3×10^{-3}	1.7×10^{-3}	
	4	1.6	<0.9	0.6×10^{-3}	$<0.6 \times 10^{-3}$	2.3×10^{-3}	1.2×10^{-3}	
2014	1	<3.3	<3.2	$<0.5 \times 10^{-3}$	$<0.8 \times 10^{-3}$	7.0×10^{-3}	3.9×10^{-3}	(Primeau 2016)
	2	<3.3	<3.2	0.7×10^{-3}	0.7×10^{-3}	2.8×10^{-3}	3.0×10^{-3}	
	3	<3.6	<3.6	$<0.5 \times 10^{-3}$	1.3×10^{-3}	8.8×10^{-3}	6.8×10^{-3}	
	4	<3.5	<3.4	$<0.9 \times 10^{-3}$	3.7×10^{-3}	$<2.4 \times 10^{-3}$	5.3×10^{-3}	
2015	1	0.9	1.7	5.8×10^{-3}	$<0.5 \times 10^{-3}$	$<4.5 \times 10^{-3}$	$<0.6 \times 10^{-3}$	(Primeau 2016)
	2	1.5	1.6	2.5×10^{-3}	2.4×10^{-3}	3.3×10^{-3}	$<3.4 \times 10^{-3}$	
	3	1.3	1.6	0.7×10^{-3}	$<0.5 \times 10^{-3}$	$<1.3 \times 10^{-3}$	$<2.0 \times 10^{-3}$	
	4	1.8	1.9	$<0.9 \times 10^{-3}$	1.4×10^{-3}	$<1.7 \times 10^{-3}$	$<1.6 \times 10^{-3}$	

Note:

For the 2008-2015 data, the source documents provide uncertainty (i.e., +/-) values; these are not presented in this table, for clarity.



Legend

- Road
- Trail
- Regional Study Area
- Site Study Area
- Municipality Boundary

0 750 1,500 3,000 Meters

Baseline Surface Water Quality in the Ottawa River

ARCADIS

Date: September, 2017

351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Note: MAC – Maximum Acceptable Concentration (Health Canada)

Non-Radiological

Chemical levels in surface water in the part of the Ottawa River located in the Regional Study Area are not available.

8.3.5 Sediment Quality

8.3.5.1 Site/Local Study Area

Radiological

A study of the river sediment near the NPD outfall pipe was conducted, and the results were reported in Lee (2014).

Figure 8.3-10 and Figure 8.3-11 show the locations where the samples were taken in July/August of 2014. The location IDs refer to the sample number, and the number in the parentheses is the concentration of Cs-137 in Bq/kg. Table 8.3-8 and Table 8.3-9 show the results of this work.

Figure 8.3-10. Ottawa River Sediment Sampling Locations near the NPDWF (Source: Lee 2014)

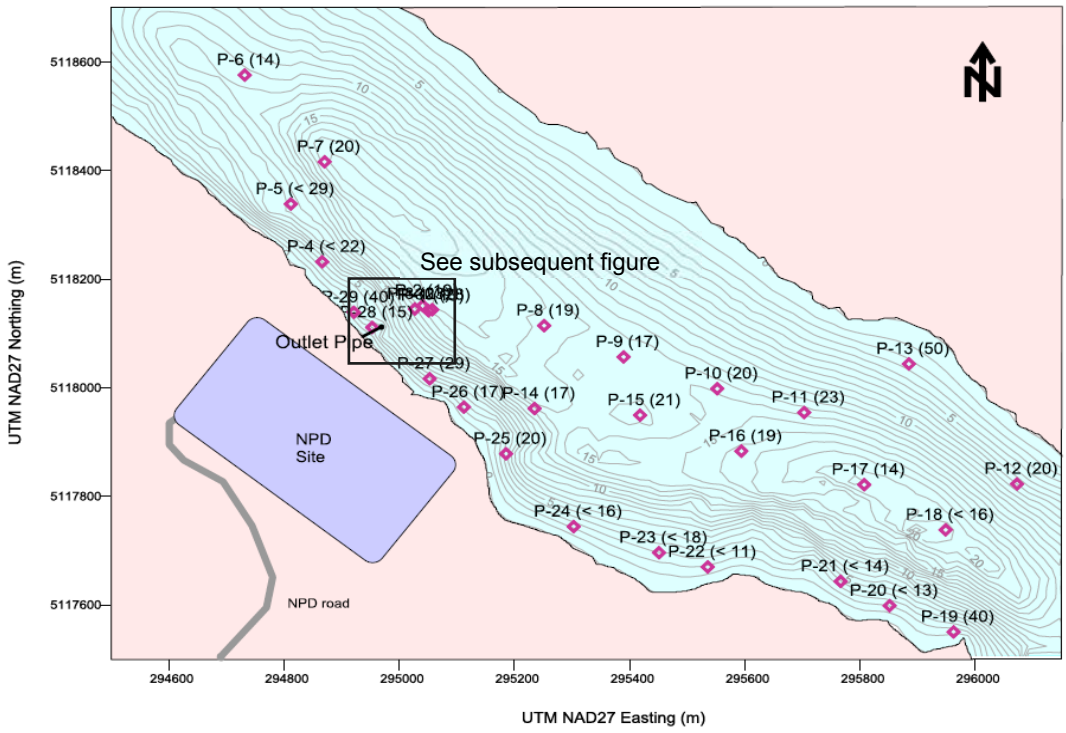


Figure 8.3-11. Ottawa River Sediment Sampling Locations at the NPDWF Outfall

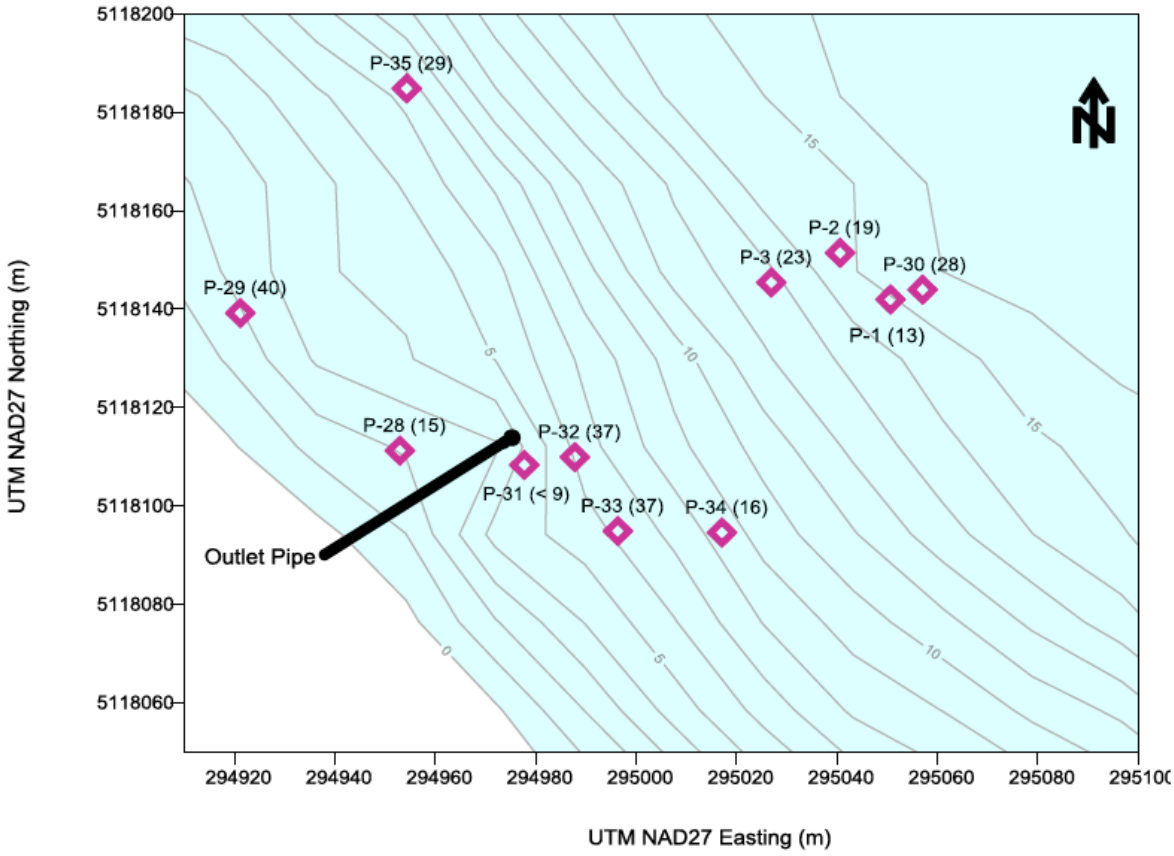


Table 8.3-8. Radiation Concentrations in Dried Sediment Samples Collected near the NPD Outfall (24-Hour Count) (Source: Lee 2014)

Location ID	Radionuclide Concentrations (Bq/kg of dry sediment)								
	K-40	Cs-137	Pb-210	Bi-212	Pb-212	Bi-214	Pb-214	Th-232	Th-234
P-1 (13)	620	13	11	< 75	22	17	27	22	60
P-2 (19)	530	19	6	40	24	< 16	23	24	40
P-3 (23)	510	23	11	< 79	22	< 13	23	22	< 10
P-30 (28)	520	28	13	< 75	14	19	29	14	< 10
P-14 (17)	540	17	9	< 61	14	17	21	14	50
P-15 (21)	540	2	8	< 52	16	< 9.6	19	16	80
P-26 (17)	510	17	12	< 67	10	< 11	21	10	40
P-27 (29)	420	29	9	< 61	15	< 8	17	15	100

Notes:

Uncertainties (found in (Lee 2014)) are based on counting of 50 mL geometry samples with approximately 60 to 95 grams of wet sediment for 24 hours. Concentrations could be converted to dry weight basis by correcting for the moisture content of each sample.

The variation in the concentration of K-40 is due to fluctuations in the background count rates of the samples. The K-40 and U and Th series nuclide concentrations show the contrast between anthropogenic and natural radioactivity.

The acquired spectra of the analyzed samples showed that Am-241 concentrations were below detection limits (5 Bq/kg of wet sediment).

Samples were collected July/August of 2014.

The activity concentrations of the nuclides were decay corrected to 2014 August 8 @ 1200 hrs.

Table 8.3-9. Radiation Concentrations in Dried Sediment Samples Collected near the NPD Outfall (4-Hour Count) (Source: Lee 2014)

Location ID	Radionuclide Concentrations (Bq/kg of dry sediment)								
	K-40	Cs-137	Pb-210	Bi-212	Pb-212	Bi-214	Pb-214	Th-232	Th-234
P-4 (<22)	600	< 22	17	< 200	< 19	< 35	40	< 19	< 180
P-5 (<29)	600	< 29	< 19	< 240	40	60	< 32	44	< 220
P-6 (14)	560	14	12	< 130	15	< 25	24	15	< 130
P-7 (20)	580	20	< 13	< 150	< 15	< 23	< 21	< 15	< 140
P-8 (19)	730	19	12	< 130	19	< 22	< 19	19	< 120
P-9 (17)	620	17	< 11	< 150	16	27	30	< 14	< 120
P-10 (20)	400	20	12	< 160	13	31	20	< 15	< 140
P-11 (23)	600	23	< 9.9	< 150	< 13	< 24	< 17	< 13	< 130
P-12 (20)	700	20	< 17	< 230	< 21	< 36	< 29	< 20	< 210
P-13 (50)	600	50	30	< 430	< 36	< 64	40	< 36	< 390
P-16 (19)	680	19	< 12	< 170	18	17	35	< 16	< 140
P-17 (14)	610	14	14	< 170	12	26	18	12	< 150
P-18 (<16)	700	< 16	< 12	< 180	14	< 26	23	< 15	< 160
P-19 (40)	800	40	16	< 220	15	20	27	< 19	< 180
P-20 (<13)	510	< 13	< 8.8	< 120	< 12	< 21	14	< 11	< 120
P-21 (<14)	630	< 14	< 11	< 150	< 13	41	16	< 13	< 120
P-22 (<11)	590	< 11	< 8.5	< 120	< 11	13	< 15	< 10	< 110
P-23 (<18)	670	< 18	< 13	< 190	< 15	29	14	14	< 160
P-24 (16)	570	< 16	17	< 170	< 14	20	21	< 14	< 150
P-25 (20)	700	20	< 21	< 310	20	< 43	70	< 26	< 270
P-28 (15)	880	15	< 11	< 130	< 14	40	27	< 14	< 150
P-29 (40)	400	40	14	< 210	23	< 35	0	< 21	< 160

Note:
Uncertainties (found in (Lee 2104)) are based on counting of 50 mL geometry samples with approximately 60 to 95 grams of wet sediment for 24 hours.
Concentrations could be converted to dry weight basis by correcting for the moisture content of each sample.
The variation in the concentration of K-40 is due to fluctuations in the background count rates of the samples.
The K-40 and U and Th series nuclide concentrations show the contrast between anthropogenic and natural radioactivity.
The acquired spectra of the analyzed samples showed that Am-241 concentrations were below detection limits (5 Bq/kg of wet sediment).
Samples were collected July/August of 2014.
The activity concentrations of the nuclides were decay corrected to 2014 August 8 @ 1200 hrs.

Non-Radiological

In 2016, CNL collected shallow (0.15 m below ground surface (mbgs)) sediment samples at 16 locations in the Ottawa River, both upstream and downstream of the NPDWF. These samples were submitted for analysis of metals to establish background reference conditions in the sediment. A statistical summary, including the average, maximum, minimum and 90th percentile of the sediment data collected for each metal analysed is presented below in Table 8.3-10.

Except for a few samples, the concentration of analyzed metals met the MOECC Table 1 background site condition standards and CCME Interim Sediment Quality Guidelines (ISQG). The exceedances detected included CCME ISQG for arsenic and cadmium.

Table 8.3-10. Summary of Metal Analysis in Sediment (Golder 2017)

Metals		CCME Sediment ISQG (freshwater)	MOECC Table 1 Site Condition Standards (sediment)	Average	Max	Min	90th percentile
Antimony	µg/g	--	--	0.20	0.21	0.20	0.20
Arsenic	µg/g	5.9	6	5.0	**10**	1.0	9.4
Barium	µg/g	--	--	61	76	11	75
Beryllium	µg/g	--	--	0.32	0.42	0.20	0.37
Boron	µg/g	--	--	5.0	5.0	5.0	5.0
Cadmium	µg/g	0.6	0.6	0.37	**0.61**	0.13	0.55
Chromium	µg/g	37.3	26	21	28	3.4	25
Cobalt	µg/g	--	50	7.4	9.5	1.7	8.9
Copper	µg/g	35.7	16	14	**21**	1.6	20
Hexavalent Chromium	µg/g	--	--	0.21	0.30	0.20	0.23
Lead	µg/g	35	31	7.4	13	1.1	10
Mercury	µg/g	0.17	0.2	0.05	0.05	0.05	0.05
Molybdenum	µg/g	--	--	0.58	0.81	0.50	0.71
Nickel	µg/g	--	16	15	**20**	2.8	19
Selenium	µg/g	--	--	0.50	0.50	0.50	0.50
Silver	µg/g	--	0.5	0.20	0.20	0.20	0.20
Sodium	µg/g	--	--	160	190	72	190
Thallium	µg/g	--	--	0.13	0.16	0.05	0.16
Uranium	µg/g	--	--	0.86	1.5	0.20	1.3
Vanadium	µg/g	--	--	24	31	5.0	30
Zinc	µg/g	123	120	73	88	11	87

Notes:

Exceedance of MOECC Table 1 Full Depth Background Site Condition Standards (sediment).

Exceedance of CCME Interim Sediment Quality Guidelines for the Protection of Aquatic Life (freshwater)

8.3.5.2 Regional Study Area

Radiological

CNL has produced an in-depth model of the sediment contamination and transport at and around the outfall pipe of the CRL facility (Silke *et al.* 2014). The model provides a detailed assessment of the localized environment around the CRL outfall, and as such is not considered representative of the Ottawa River sediment in the Regional Study Area.

Non-Radiological

Chemical levels in sediment in the Ottawa River are summarized and reported as part of the CRL Environmental Risk Assessment (Ethier and Hart 2013). There were reported exceedances of several metals in both reference sites and sites affected by CRL operations. Due to the high levels in unaffected sites, these exceedances were considered to be baseline conditions.

8.4 Aquatic Environment

8.4.1 Spatial Boundaries

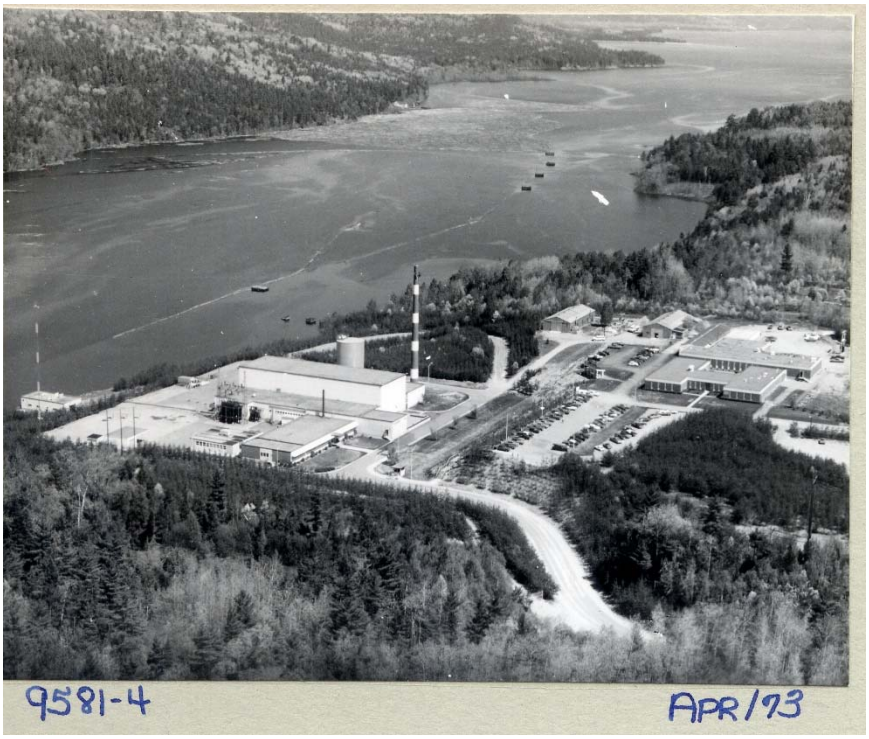
The Site and Local Study Areas for the aquatic environment are consistent with the general Site and Local Study Areas outlined in Section 5.2.1.1. The Regional Study Area for the aquatic environment is consistent with the surface water environment Regional Study Area outlined in Figure 8.3-1 above.

8.4.2 Physical Aquatic Habitat

8.4.2.1 Site/Local Study Area

The Ottawa River near the NPD site is a popular area for fishing, in part due to the turbulent discharge from the Des Joachims Hydro-Electric Generating Station and the submerged, broken cribbing and sunken logs within 2.5 km of the tailrace. The former crib structures can be seen in Figure 8.4-1. The above water cribbing has been removed, but some structures remain underwater. The underwater structures date from the days of transporting logs on the river, an operation that was ongoing during operation of the NPDNGS (Lee 2014).

Figure 8.4-1. Former Cribbing seen in the Ottawa River Offshore of NPD (1973)



The shoreline in the area downgradient of the facility was disturbed during the construction of the NPD reactor. The beach is made of up of river rocks of various sizes. Along the beach and in the river, no aquatic macrophytes or suitable fish nursery habitat were observed. The bank substrate is composed of boulders and gravel with no aquatic vegetation noted (ELC TSD).

There is a dry hydrant in this area, with a water intake pipe extending approximately 10 m into the Ottawa River. The dry hydrant was installed in 2015 to provide an emergency water supply to the local fire department pumper and increase the capability of fighting fires at the facility as well as forest fires. There is a strainer attached to the intake pipe which was designed for the protection of fish, in accordance with DFO guidelines. A rip-rap pad was placed under the intake to reduce attractant habitat.

This stretch of the Ottawa River was selected as an ideal location for the NPDNGS due to its depth and ability to supply cold water for reactor cooling (Quebec-Labrador Foundation 2005).

As discussed in Section 8.3.2, various types of wetland areas are scattered throughout the NPD site, found mainly on the western side of the property.

8.4.2.2 Regional Study Area

The NPD site is located in the reach of the Ottawa River extending approximately 90 km between the Des Joachims Dam upstream and La Passe at the downstream end. Specifically, the NPD site is about 2 km

downstream of the Des Joachims Dam. This reach of the river consists of several lake-like sections separated by short rapids. Upstream of these lakes and rapids, the Ottawa River becomes quite deep, reaching depths of over 60 m. In this section of river, the water can become thermally stratified (Haxton and Chubbuck 2002).

In 2016, the Ottawa River was designated under the Canadian Heritage River System. With this designation, an annual report is prepared describing changes, improvements and threats to the river, and a monitoring report is prepared every 10 years (CHRS 2017).

8.4.3 Aquatic Biota

8.4.3.1 Site/Local Study Area

No information is available specifically for the Site and Local Study Areas. It is expected that the aquatic biota would be similar to those described below for the Regional Study Area.

8.4.3.2 Regional Study Area

The Ottawa River in this area supports diverse warmwater and coolwater fish communities consisting of at least 55 documented species. The provincially-rare fish species in the Ottawa River include the river redhorse. Typical catches from the river include walleye, northern pike, channel catfish, smallmouth bass, and lake sturgeon (Wills 2013).

The Ontario Ministry of Natural Resources and Forestry (MNRF) reviewed the natural environment and resource uses of the Ottawa River, sub-divided by river reach (Haxton and Chubbuck 2002). In the reach of the Ottawa River in the Regional Study Area (i.e., from Des Joachims to La Passe), lake sturgeon are more abundant than other reaches of the river. This could be in part because of the abundance of both lacustrine and rapid riverine habitats for spawning and foraging. Although they were once abundant, American eels have not been recently observed in this reach. There have been very few reports of lake trout despite stocking efforts (Haxton and Chubbuck 2002).

Table 8.4-1 lists the fish species present and potentially present in the Regional Study Area, based on the SARs identified in the NPD Biodiversity Report (Morin and Carr 2015) and the species listed in the MNRF Ottawa River review (Haxton and Chubbuck 2002). SAR designations (i.e., *SARA*, SARO, COSEWIC) are listed for species in the table below. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC.

Table 8.4-1. Fish Species Present and Potentially Present in the Site, Local and Regional Study Areas. *SARA* and SARO Queries Conducted in August 2016

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO – Ontario	
American eel	*Anguilla rostrata*	No Status Yet (THR)	END	Morin and Carr (2015)
Black crappie	*Pomoxis nigromaculatus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Brown bullhead	*Ameiurus nebulosus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Burbot	*Lota lota*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Channel catfish	*Ictalurus punctatus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Common white sucker	*Catostomus commersonii*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Emerald shiner	*Notropis atherinoides*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Fallfish	*Semotilus corporalis*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Lake herring	*Coregonus artedi*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Lake sturgeon	*Acipenser fulvescens*	No Status Yet (THR)	THR	Morin and Carr (2015)
Lake trout	*Salvelinus namaycush*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Lake whitefish	*Coregonus clupeiformis*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Largemouth bass	*Micropterus salmoides*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Longnose gar	*Lepisosteus osseus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Mooneye	*Hiodon tergisus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Muskellunge	*Esox masquinongy*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Northern brook lamprey	*Ichthyomyzon fossor*	SC	SC	Morin and Carr (2015)
Northern pike	*Esox lucius*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Pumpkinseed	*Lepomis gibbosus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO – Ontario	
River redhorse	*Moxostoma carinatum*	SC	SC	Morin and Carr (2015)
Rock bass	*Ambloplites rupestris*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Sauger	*Sander canadensis*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Shorthead redhorse	*Moxostoma macrolepidotum*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Smallmouth bass	*Micropterus dolomieu*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Walleye	*Sander vitreus*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
Yellow perch	*Perca flavescens*	Not Listed	Not Listed	Haxton and Chubbuck (2002)
* Status: **NAR**: Not at Risk; **END**: Endangered; **THR**: Threatened; **SC**: Special Concern.				

In addition to fish species, some characterization of the aquatic invertebrates in the Ottawa River within the Regional Study Area has been carried out. The benthic community at CRL is typical of low-productivity oligotrophic systems (Bond *et al.* 2013). The hickorynut, a type of mollusc, is a species potentially present in the Site Study Area, is listed as Endangered under Ontario SAR (SARO).

The food chain and food web dynamics of the aquatic environment have been described in the conceptual site models of the EcoRA TSD. The EcoRA considers a variety of trophic levels, in order to represent the food chain. The results are summarized in Section 9.4 below.

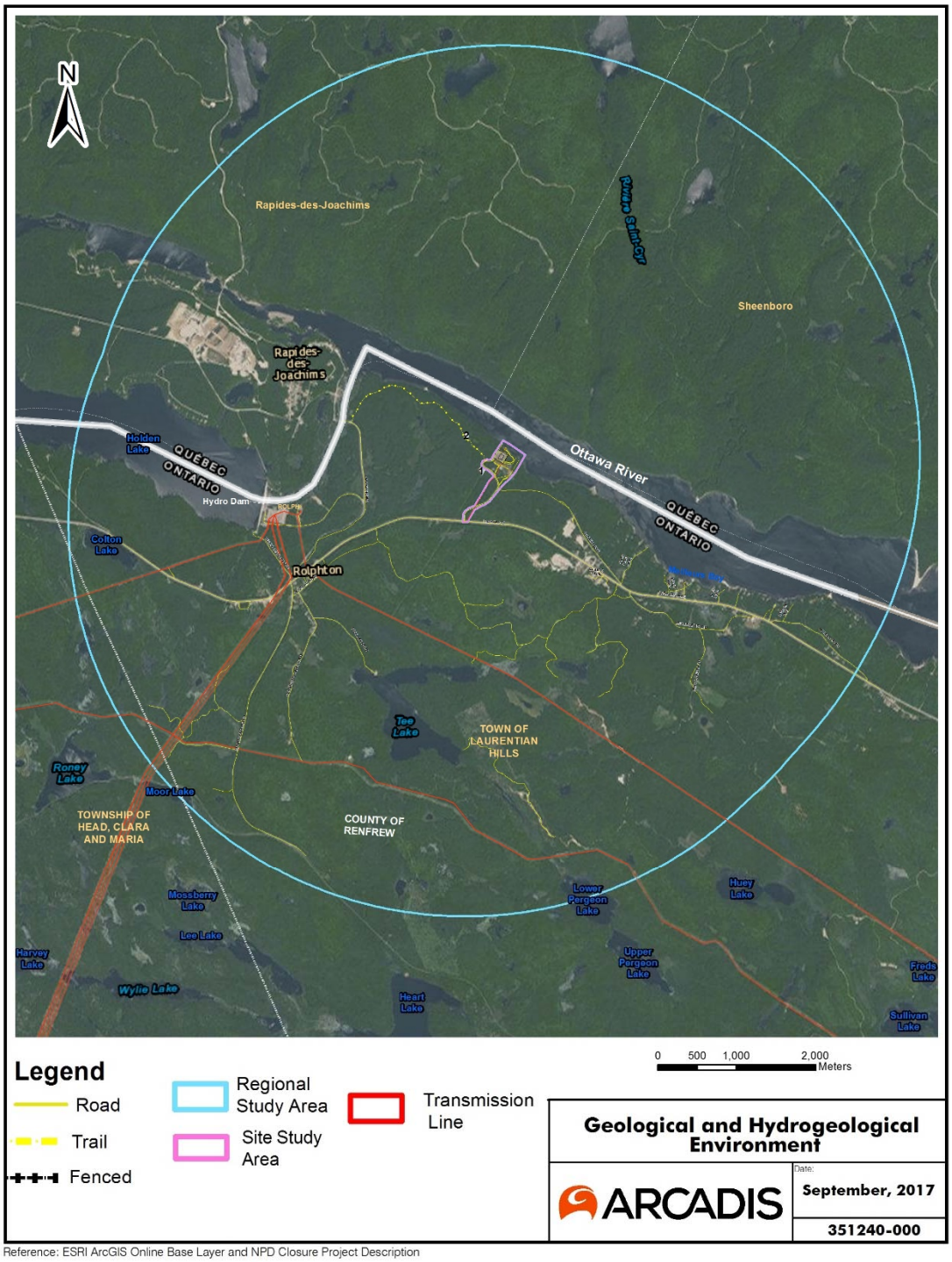
It is noted that while some baseline characteristics of the aquatic environment have been compiled, detailed mapping (e.g., of substrate, fish habitat, and temperature) has not been carried out specifically for the NPD closure project, because no fish habitat impacts are anticipated from the project. Because no in-water work is expected, no physical destruction to the river is expected. Similarly, no temperature or impingement/entrainment effects are expected to occur from the project. Exposure (i.e., chemical and radiological) effects to aquatic species in the Ottawa River are assessed in the EcoRA TSD.

8.5 Geological and Hydrogeological Environment

8.5.1 Spatial Boundaries

The Site and Local Study Areas for the geological and hydrogeological environment consist of the lands delineated in the general Site and Local Study Areas (i.e., Figure 5.2-1 and Figure 5.2-2 respectively). This includes the two closed landfills on the NPD site (shown in Figures 5.2-1 and 5.2-2). The Regional Study Area defined for the geological and hydrogeological environment, illustrated in Figure 8.5-1, extends 5 km beyond the Site Study Area.

Figure 8.5-1. Geological and Hydrogeological Environment Regional Study Area



Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

8.5.2 Geology

8.5.2.1 Site/Local Study Area



Site characterization work at Landfill #1 in 2017. Although results of this characterization work were not available at the time of preparation, this EIS is based on previous characterization (King 2016)

The surface of the NPD site is covered by a boulder pavement (i.e., large boulders) which, in most areas, has been left as a result of water scouring the area and removing the finer fraction of the river-lain sediments. The site is underlain by the Monteagle soil series and the crystalline pink and grey granitic gneisses of the Grenville Province of the Precambrian Shield (Wills 2013).

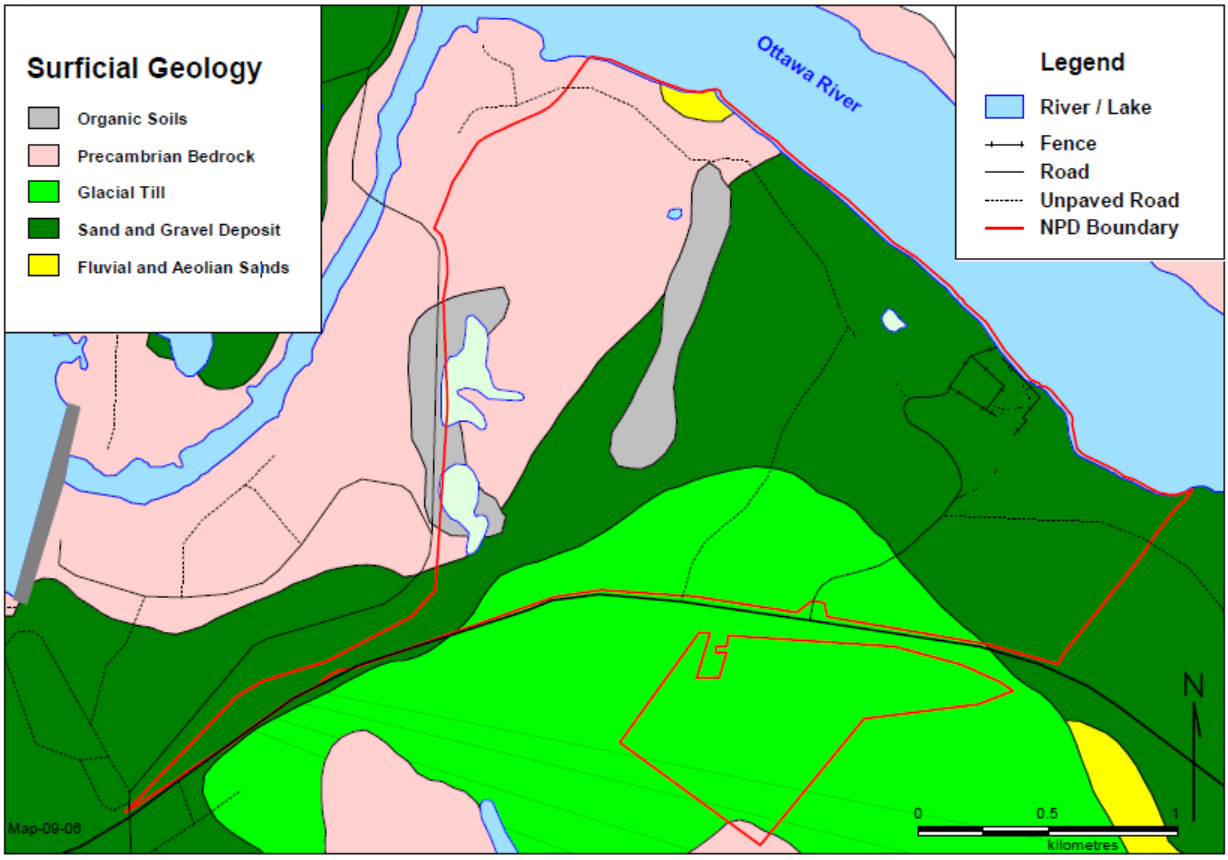
The base rock in the Site Study Area is quartz and granite gneiss with some overburden (1.5 to 7.5 m) of alluvial sand and gravel. The small amount of overburden and relatively steep incline of the base rocks makes ground and subsurface water run off very quickly to the river (Wills 2013).

From the surficial geology map presented in Wills (2013), and shown in Figure 8.5 2, it can be seen that about half of the NPD site is covered by sand and gravel deposits. The western part of the site is shown as Precambrian bedrock, which often includes rock outcrops but has large areas where the bedrock is thinly veneered by glacial till, gravel or other glacially derived material. Two regions of organic soil are noted, the westernmost one corresponding to current wetlands that are visible from the road to Rapides-des-Joachims (Wills 2013).

The potential for liquefaction has not been assessed because the foundation of the NPDWF well within bedrock. Liquefaction of overburden adjacent to NPD foundation would not affect the structural integrity of the NPDWF as the soils do not support the structure.

The NPDWF is situated at an elevation of approximately 125 masl. It is situated in a relatively flat area, gradually sloping towards Highway 17, which has an approximate elevation of 160 masl, and continuing to the Ottawa River, which has an average elevation of 111 masl (King 2016). As discussed in Section 8.2 above, the topography of the NPD site has been taken into consideration in the air dispersion modelling. The effects of the concrete cap on the local site topography are discussed in Section 9.5 below.

Figure 8.5-2. Surficial Geology of the NPD Site (Source: Athauda-Arachchige 2015)



Geology near the Former Landfill 1

The NPD Landfill 1 (L1), shown in Figure 5.2-1 above, was located in a former sand and gravel extraction pit situated along the main access road to the station approximately 250 m southwest of the guardhouse (Athauda-Arachchige 2015). The geology around L1 consists of very bouldery sand and gravel at surface uphill (southwest) of the former landfill, overlying a unit of medium to coarse sand. This sand lies directly below the NPD station access road northwest of the location of the former landfill, and appears to be the host material for L1 itself. A second sand and gravel coarse sand unit, less bouldery and frequently containing some silt, underlies the coarse sand unit and overlies glacially-deposited stony silty sand till. The water table lies just above or below the contact between the coarse sand and the underlying sand and gravel (Athauda-Arachchige 2015).

Geology near the Former Landfill 2

The NPD Landfill 2 (L2), shown in Figure 5.2-1 above, was located northwest of the powerhouse (Athauda-Arachchige 2015). From Highway 17, the land slopes down towards the Ottawa River through the NPD site. This slope is interrupted by a nearly level bench or terrace (at elevation between 135 and 140 masl)

that hosts the former sand and gravel pit which is the location of L2. The surface geology around L2 consists of river-lain sands and gravels, possibly overlaying glacial till, in turn overlying granitic bedrock. Most of the surface in the region is covered by a boulder pavement, a lag concentrate of subrounded rocks up to 2 m in diameter left by water scouring and removal of the finer-grained fraction of the sediments. Extensive areas of bedrock outcrop are found approximately 0.5 km west of L2 at similar elevations, and thin overburden encountered during construction of NPD, suggest that unconsolidated sediments around L2 may be relatively thin (Athauda-Arachchige 2015).

8.5.2.2 Regional Study Area

King (2016) describes the general geology of the region as Precambrian shield consisting of folded and faulted metamorphic rocks (gneiss).

A descriptive geological site model completed for the CRL site is used here to characterize the Regional Study Area, which falls in the Central Gneiss Belt of the Grenville Province (McCrank 2016). The major rock types underlying the region, based on modal mineralogy, are granitoid types; differing in modal quartz content and variations in plagioclase feldspar vs potassic feldspar. Modal analyses falling in the granite-quartz monzonite-monzdiorite fields are dominant. These are mostly felsic rock, which are predominant over the mafic-mineral rich rock (McCrank 2016).

This observation alone indicates that the predominant mineralogy consists of quartz and the feldspars. An approximation of the relevant abundances is plagioclase > potassic feldspar > quartz > biotite > hornblende > garnet > clinopyroxene > orthopyroxene. The ternary plots (Robertson, 1999) illustrated the predominance of the feldspars vs the quartz and the maficminerals. The QAP ternary plots following illustrate the predominance of plagioclase feldspar vs the potassic feldspar (McCrank 2016).

The metamorphic grade due to regional metamorphism in the Precambrian is upper amphiboloite to granulite though there is evidence of retrograde metamorphism in all boreholes (McCrank 2016).

Geotechnical and geophysical hazards such as earthquakes are discussed in Section (8.11 Baseline characterization) and 9.11 (Effects of the environment on the project), below.

8.5.3 Soil Quality

8.5.3.1 Site/Local Study Area

Radiological

Ambient tritium concentrations in soil samples (measured in free tritiated water, HTO) are collected near NPD. Surface soil samples are collected and analyzed annually in September or October. Because the same locations are sampled each year, the same type of soil is therefore sampled; however, the composition can vary between samples. Changes in soil composition do not affect the HTO measurements (as HTO is measured in soil moisture) but could contribute to variations in organically bound tritium (OBT)

measurements. Figure 8.5-3 shows the soil and vegetation sampling locations in the Site and Local Study Areas. Vegetation sampling is discussed in Section 8.5.4 below.

Table 8.5-1 presents the tabulated data for the concentrations of tritium measured in the surface soil in the Site and Local Study Areas. Figure 8.5-3 presents the historical trends of tritium levels for each of the sampling locations (Wills 2013).

Part of the fence that surrounds the NPDWF was moved in 1994, so that the NPD-NE and NPD-NW sampling stations are now outside the fence. However, in order to maintain continuity in the data sets, sampling was repeated at these locations rather than moving the sampling points to the new fence corners. Three new sampling stations were established in 1996 on the west, south, and east sides of the possible new site property perimeter (locations NBW, NBS, and NBE, respectively) (Wills 2013).

Table 8.5-1. Concentrations of Tritium (HTO) in Surface Soil near NPD (in Bq/L)

Year	NB-E	NB-S	NB-W	NPD- NE	NPD- NW	NPD- SE	NPD- SW	O-1B	Reference
1988	NA	NA	NA	NA	NA	NA	NA	36	(Wills 2013)
1990	NA	NA	NA	137	146	104	240	50	(Wills 2013)
1991	NA	NA	NA	110	276	123	76	36	(Wills 2013)
1992	NA	NA	NA	117	43	117	174	30	(Wills 2013)
1993	NA	NA	NA	116	186	188	N/A	34	(Wills 2013)
1994	NA	NA	NA	74	126	53	154	22	(Wills 2013)
1995	NA	NA	NA	156	243	310	186	NA	(Wills 2013)
1996	115	76	127	227	103	260	109	39	(Wills 2013)
1997	98	63	121	250	131	96	114	34	(Wills 2013)
1998	65	23	50	85	66	77	97	31	(Wills 2013)
1999	91	61	74	173	200	136	140	39	(Wills 2013)
2000	45	124	123	45	75	168	39	130	(Wills 2013)
2001	34	25	50	103	87	63	63	25	(Wills 2013)
2002	58	21	39	59	73	157	49	32	(Wills 2013)
2003	47	63	71	74	67	100	44	86	(Wills 2013)
2004	71	63	87	81	99	84	72	37	(Wills 2013)
2005	37	16	20	39	29	42	25	17	(Wills 2013)
2006	33	26	32	25	34	41	26	16	(Wills 2013)
2007	46	25	36	65	54	77	217	23	(Wills 2013)
2008	17	9	32	41	31	37	30	18	(Verney 2011)
2009	35	17	31	42	42	42	62	38	(Verney 2011)
2010	24	14	28	26	30	44	36	10	(Primeau 2016)
2011	13	11	13	32	17	28	13	6	(Primeau 2016)
2012	11	<3	6	68	28	13	15	<3	(Primeau 2016)
2013	31	6	13	34	23	25	26	6	(Primeau 2016)
2014	14	<2	13	11	22	21	12	<3	(Primeau 2016)
2015	9	5	13	24	25	10	15	7	(Primeau 2016)



Legend

- Guardhouse
- Pumphouse
- Parking
- Wetland
- Road
- Trail
- Site Study Area
- Landfill
- NPDWF

0 75 150 300 Meters

Baseline Soil Quality near the NPDWF

ARCADIS

Date: **September, 2017**

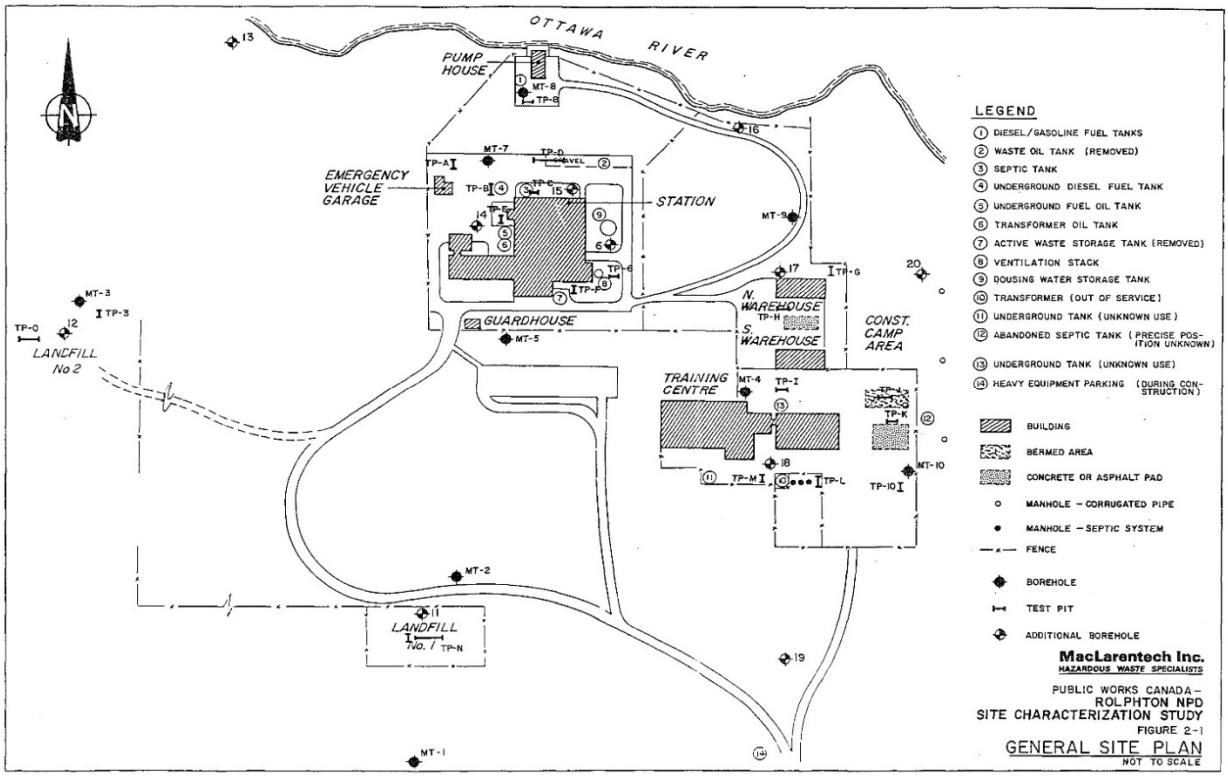
351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Non-Radiological

In 1992, the investigation and removal of an underground diesel fuel tank on the northwest corner of the Main Building indicated fuel oil migration from the legacy tank. The affected area was remediated and regular monitoring continued for several years following the clean-up until 2008. A review of the monitoring results of the soil samples indicates that little or no organic or inorganic contamination remains at levels of concern in the boreholes drilled on-site (King 2016). Borehole locations are shown in Figure 8.5-4. Low pH readings encountered in the surface samples recovered at Boreholes MT-1 and MT-3 are considered to be due to natural leaching and the presence of conifer needles. Neutral conditions (pH 7), within the applicable guidelines were identified in samples taken at greater depths.

Figure 8.5-4. Borehole Locations (from Maclarentech 1990)



Testing for the chlorinated organic compounds in soil samples recovered from selected boreholes indicated that no PCBs were present. Analyses for volatile organics showed the presence of dichloromethane at trace levels in each sample. These results are indicative of a laboratory artifact since this compound is used as a cleaning solvent for instrumentation and containers (MacLarentech 1990).

Selected soil samples recovered from the test pits on-site were also analyzed for heavy metals and organic compounds. Each of these test pits were excavated at locations at which some level of identifiable contamination was anticipated because of the presence of storage tanks, landfill sites and industrial activities. Test pit samples indicated trace levels or organic and inorganic contamination, with three test

pits exhibiting exceedances. At TP-N, which is located near Landfill #1, samples exceeded MOE guidelines for cadmium, copper, lead, molybdenum and zinc. At MT-5 and TP-C, which are located near the facility, exceedances were measured for arsenic, cadmium, copper, and 1,2-dichlorobenzene (MacLarentech 1990).

In 2016 CNL collected shallow (0.15 mbgs) soil samples at 96 locations throughout the NPD exclusion area. These samples were submitted for analysis of analysis of metals in order to establish background reference conditions in the sediment. A statistical summary, including the average, maximum, minimum and 90th percentile of the soil data collected for each metal analysed is presented below in Table 8.5-2. With the exception of in chromium, selenium and vanadium, the background concentrations of analyzed metals met the CCME Soil Quality Guidelines. All these exceedances were seen in a single sample, indicating that this sample may actually be an outlier but was retained for completeness of the data set.

Table 8.5-2. Summary of Metal Analysis in Soil (Golder 2017)

Metals		CCME Residential/ Parkland Soil Quality Guidelines	MOECC Site Condition Standards - Table 1 (soil)	Average	Max	Min	90th percentile
Antimony	ug/g	20	1.3	0.21	0.32	0.20	0.25
Arsenic	ug/g	12	18	1.4	4.2	1.0	1.9
Barium	ug/g	500	220	54	**410**	12	77
Beryllium	ug/g	4	2.5	0.25	1.1	0.20	0.30
Boron	ug/g	--	36	5.0	5.0	5.0	5.0
Cadmium	ug/g	10	1.2	0.15	0.70	0.10	0.23
Chromium	ug/g	64	70	17	**70**	3.1	24
Cobalt	ug/g	50	21	5.0	**31.0**	0.43	8.4
Copper	ug/g	63	92	9.9	50	1.1	27
Hexavalent Chromium	ug/g	0.4	0.66	0.20	0.20	0.20	0.20
Lead	ug/g	140	120	18	42	1.3	30
Mercury	ug/g	6.6	0.27	0.05	0.13	0.05	0.05
Molybdenum	ug/g	10	2	0.78	**6.7**	0.5	0.82
Nickel	ug/g	45	82	8.5	45	1.0	13.2
Selenium	ug/g	1	1.5	0.54	**1.6**	0.50	0.50
Silver	ug/g	20	0.5	0.22	0.47	0.20	0.21
Sodium	ug/g	--	--	98	370	50	150
Thallium	ug/g	1	1	0.08	0.26	0.05	0.12
Uranium	ug/g	23	2.5	0.39	**3.1**	0.09	0.54
Vanadium	ug/g	130	86	41	**210**	7.4	52
Zinc	ug/g	200	290	36	150	5.0	68

Notes:

Exceedance of MOECC Table 1 Full Depth Background Site Condition Standards.

Exceedance of CCME Soil Quality Guidelines for the Protection of Environmental and Human Health.

8.5.3.2 Regional Study Area

Radiological

Soil and vegetation sampling locations off-site of NPD are shown in Figure 8.5-5 and the results of the sampling are shown in Table 8.5-3. As with the Site and Local Study Area locations, the off-site locations are currently sampled once a year in September or October. In 1996, the sampling of the far sites (PQW sites and the O-4 and O-8 sites) was discontinued when a reduced scale of off-site sampling was established (Wills 2013).

Figure 8.5-5. Off-site Soil and Vegetation Sampling Locations (Source: Wills 2013)

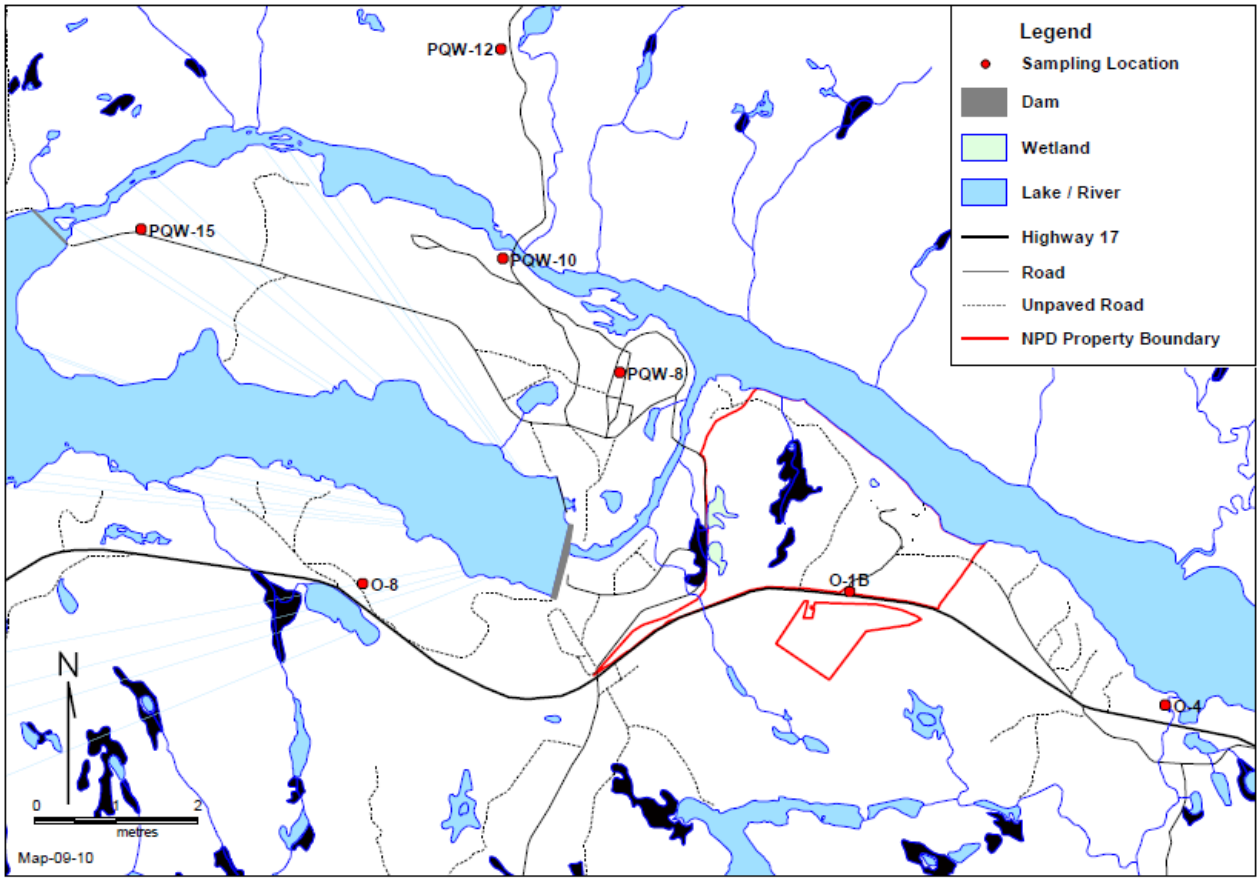


Table 8.5-3. Concentrations of Tritium (HTO) in Surface Soil in the Regional Study Area (in Bq/L) (Source: Wills 2013)

Year	O-4	O-8	PQW-10	PQW-12	PQW-15	PQW- 8
1988	33	19	70	42	30	105
1990	20	13	44	16	25	65
1991	29	12	36	21	32	73
1992	16	15	18	19	30	35
1993	17	20	28	27	18	48
1994	125	17	42	27	25	40
1995	45	20	N/A	21	15	26

Non-Radiological

Information on chemical levels in the soil in the Regional Study Area is not available.

8.5.4 Vegetation Quality

In addition to measuring tritium in the soil (i.e., as HTO), the ambient tritium concentrations in vegetation samples are also measured, in the form of both HTO and OBT. The vegetation samples are collected at the same time and locations as the soil samples. Tritium is measured in the free water in vegetation.

8.5.4.1 Site/Local Study Area

Radiological

The locations of the vegetation samples are identical to those of the soil samples, and can be seen in Figure 8.5-3 above or Figure 8.5-6 below. Tabulated results for HTO in vegetation are presented in Table 8.5-4. Tabulated results for OBT in vegetation are shown in Table 8.5-5. Figure 8.5-6 shows a map with the historical HTO and OBT trends in vegetation for each of the sampling locations.

Table 8.5-4. Concentrations of HTO in Vegetation Samples on NPD Site (in Bq/L)

Year	Sample Location & and Usual Species Collected								Reference
	NB-E	NB-S	NB-W	NPD- NE	NPD- NW	NPD- SE	NPD- SW	O-1B	
	Poplar	White Pine	White Birch	Grasses	Grasses	Grasses	Grasses	White Pine	
1988	NA	NA	NA	NA	NA	NA	NA	215	(Wills 2013)
1989	NA	NA	NA	NA	NA	NA	NA	44	(Wills 2013)
1990	NA	NA	NA	416	110	1380	266	29	(Wills 2013)
1991	NA	NA	NA	784	309	961	577	70	(Wills 2013)

Sample Location & and Usual Species Collected									
Year	NB-E	NB-S	NB-W	NPD- NE	NPD- NW	NPD- SE	NPD- SW	O-1B	Reference
	Poplar	White Pine	White Birch	Grasses	Grasses	Grasses	Grasses	White Pine	
1992	NA	NA	NA	363	321	2288	896	35	(Wills 2013)
1993	NA	NA	NA	436	115	1779	NA	39	(Wills 2013)
1994	NA	NA	NA	328	361	245	1009	49	(Wills 2013)
1995	NA	NA	NA	548	174	796	252	N/A	(Wills 2013)
1996	160	665	423	200	54	1117	656	16	(Wills 2013)
1997	256	381	181	1066	207	779	181	54	(Wills 2013)
1998	237	13	25	69	27	628	70	5	(Wills 2013)
1999	63	73	79	444	167	581	191	36	(Wills 2013)
2000	88	198	161	56	54	215	260	74	(Wills 2013)
2001	52	32	99	456	49	52	188	30	(Wills 2013)
2002	274	14	27	260	194	260	37	25	(Wills 2013)
2003	41	21	30	94	26	183	41	25	(Wills 2013)
2004	78	109	194	119	106	288	380	77	(Wills 2013)
2005	28	63	76	61	86	87	77	38	(Wills 2013)
2006	23	18	25	27	29	155	55	11	(Wills 2013)
2007	47	50	177	64	63	215	397	55	(Wills 2013)
2008	123	9	20	352	89	83	31	11	(Verney 2011)
2009	30	21	41	79	47	141	27	21	(Verney 2011)
2010	41	12	22	36	25	91	36	10	(Primeau 2016)
2011	28	39	61	41	33	88	80	35	(Primeau 2016)
2012	123	73	220	93	107	151	429	129	(Primeau 2016)
2013	20	9	14	103	39	29	20	7	(Primeau 2016)
2014	15	4	8	111	13	132	12	<2	(Primeau 2016)
2015	223	<3	7	39	12	35	22	<2	(Primeau 2016)

Table 8.5-5. Concentrations of OBT in Vegetation Samples on NPD Site (in Bq/L) (Source: Wills 2013)

Year	NB-E	NB-S	NB-W	NPD-NE	NPD-NW	NPD-SE	NPD-SW	O-1B
2000	NA	NA	126	NA	NA	146	NA	NA
2001	73	37	111	78	67	129	98	52
2002	63	39	78	64	95	77	56	48
2003	60	62	155	70	45	75	54	36
2004	60	62	155	83	71	121	139	59
2005	44	39	64	76	70	67	45	39
2006	46	34	79	61	35	68	43	27



Legend

- Guardhouse
- Pumphouse
- Parking
- Wetland
- Road
- Trail
- Site Study Area
- Landfill
- NPDWF

0 75 150 300 Meters

Baseline Vegetation Quality near the NPDWF

ARCADIS

Date: September, 2017

351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

Non-Radiological

Information on chemical levels in vegetation in Site or Local Study Areas is not available.

8.5.4.2 Regional Study Area

Radiological

The locations of the vegetation samples collected in the Regional Study Area are identical to those of the soil samples, and can be seen in Figure 8.5-4 above. Tabulated results for HTO in vegetation are presented in Table 8.5-6.

Table 8.5-6. Concentrations of Tritium (HTO) in Vegetation Samples in the Regional Study Area (in Bq/L) (Source: Wills 2013)

Year	Sample Location & and Usual Species Collected					
	O-4	O-8	PQW-10	PQW-12	PQW-15	PQW- 8
	White Pine	White Pine	White Pine	White Pine	White Pine	White Pine
1988	68	182	253	NA	51	NA
1989	32	13	65	16	21	79
1990	40	9	34	18	16	41
1991	86	26	67	56	44	90
1992	51	20	41	21	23	53
1993	31	14	34	14	21	29
1994	51	22*	60	72	63**	58
1995	28	9	N/A	16	20	21
1996	NA	NA	NA	NA	NA	NA
1997	NA	NA	NA	NA	NA	NA
1998	NA	NA	NA	NA	NA	NA
1999	NA	NA	NA	NA	NA	NA
2000	41	41	41	41	41	41
2001	66	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA
2003	NA	NA	NA	NA	NA	NA
2004	NA	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA
2006	NA	NA	NA	NA	NA	NA
2007	NA	NA	NA	NA	NA	NA

Note:

NA – Not applicable (i.e., no samples collected).

* Poplar

** Maple

Non-Radiological

Information on chemical levels in vegetation in the Regional Study Area is not available.

8.5.5 Hydrogeology

8.5.5.1 Site/Local Study Area

The NPDWF is excavated deep into the surrounding bedrock as is a trench to the river for pipes supplying reactor cooling. The excavated areas surrounding the reactor contain high permeability fill materials (Calder 2017). The predominant hydrogeologic materials at the NPD site are a sandy overburden, bedrock, fill around the facility, and the tile drains. Material properties are summarized in Table 8.5-7. Bedrock at the Rolphton site is expected to be similar to bedrock at the CRL site; bedrock hydraulic conductivity is assumed to be between 10^{-11} and 10^{-4} m/s, with a geometric mean of 6 x10^{-8} m/s, and a porosity of 0.005, based on shallow bedrock investigations at CRL (Davison *et al*. 1995 and RBEL 1994). Specific storage and two-phase flow parameters were estimated based on values used in flow modelling at CRL (Acsion 2014 and Calder and Walsh 2016).

MacLarentech (1990) describes the overburden at the NPD site to be predominantly sand, divided into four classifications of sand with various amounts of gravel, boulders and trace amounts of silt. Sand overburden material properties are based on sand at the CRL site, with a horizontal hydraulic conductivity between 2 x10^{-4} and 2 x10^{-5} m/s, an anisotropic ratio (horizontal/vertical) between 2 to 10 depending on the degree of silt lamination, and a porosity of 0.4 (Raven Beck Environmental Ltd. 1994). Two-phase flow parameters were estimated based on sand samples with similar hydraulic conductivities in the Rosetta model database (USDA 1990).

The fill used at the NPD was described by MacLarentech (1990) as a bouldery sand, similar to the sand overburden found at the site, but with a more consistent size of gravel and boulders and the presence of debris such as rock and construction rubble. Hydraulic conductivity and porosity of the fill was estimated at the upper range for sand, and lower range for gravel (Freeze and Cherry, 1979). Two phase flow properties were assumed similar to the sand overburden, with the alpha parameter scaled by permeability and porosity using the Leverett J-function (Leverett 1941).

Table 8.5-7. NPD Material Property Estimates (Calder 2017)

	Hydraulic Conductivity (m/s)	Anisotropy Ratio (Kh/Kv) (-)	Porosity (-)	Specific Storage (1/m)	Residual Water Saturation (-)	Shape Parameter (-)	Alpha (1/m)
Fill	5x10^{-4}	1	0.3	10^{-5}	0.05	3.17	10.172
Sand	8x10^{-5}	2	0.4	10^{-5}	0.05	3.17	3.524
Till	3x10^{-6}	1	0.3	10^{-5}	0.05	1.68	0.658
Bedrock	6x10^{-8}	1	0.005	3.2x10^{-7}	0.28	2	0.218
Tile Drain	10^{-3}	1	1	10^{-9}	-	-	-

As shown in Figure 3.3-1 above, most of the NPDWF containment area is located below grade, well into the bedrock. The facility's design means that for portions of the facility below the water table, any leakage occurs into the facility, and that there can be no releases to the local groundwater flow system. Groundwater seepage into the facility is directed to the lowest point at the WAS and is less than 10 m^3/a in

the last 5 years. This sump is periodically pumped to the Ottawa River after the water has been sampled and analysed (Primeau 2016).

Site data indicate that the average water table position is near the top of the bedrock, with overlying sands and gravels being largely unsaturated. Natural groundwater flow will be over the surface of the bedrock, and in the upper weathered zone if present. Flow directions are expected to reflect topography, with recharge upgradient of the reactor and discharge perpendicular to the river. Groundwater modelling was done in order to characterize the flow around the facility. Figure 8.5-7 shows that water drains towards the fill surrounding the NPDWF main building, as expected. The overall flow direction is towards the Ottawa River (Calder 2017). Figure 8.5-8 shows the water table elevation contours measured around the NPD site.

As discussed in Section 8.3.4, there is a network of sub-surface drains with the purpose of collecting and removing groundwater from around and under the reactor building structures, to reduce groundwater infiltration into the underground structures. The system consists of three separate collector pipes with feeders, one covering the west and south sides, one on the east side and one draining the pressure relief duct as shown earlier in Figure 8.3-2 (Athauda-Arachchige 2015).

The process effluent drain is in service and is valved out inside the building. The access to the area is controlled to authorized personnel only. This drain is used for batch discharges from the WAS (Athauda-Arachchige 2015).

Figure 8.5-7. Cross Section Through NPDWF (Source: Calder 2017)

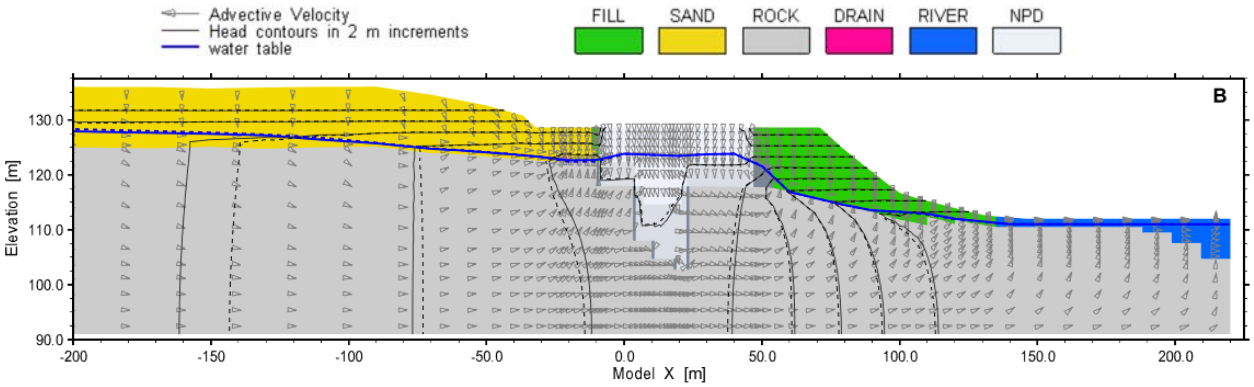
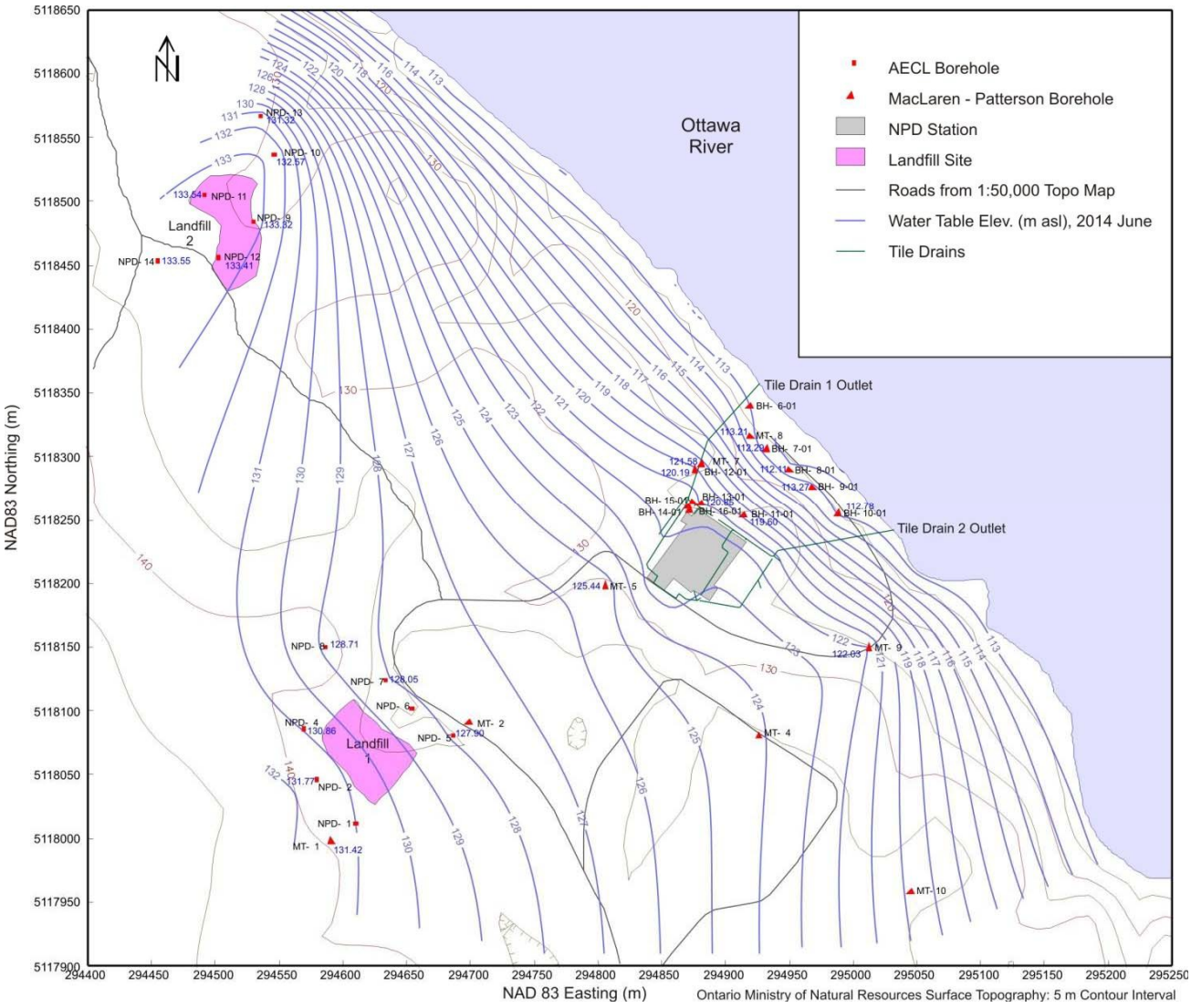


Figure 8.5-8. Water Table Elevation Contours around the NPDWF and Landfills for June 2014 (Source: Athauda-Arachchige 2015)



Hydrogeology near the Former Landfill 1

For the most part, groundwater flow velocities are a few tens of metres per year. Groundwater flow is approximately perpendicular to the water table contours (from the vicinity of Highway 17 towards the Ottawa River). Water passing beneath L1 may discharge to the tile drain system near the facility (Athauda-Arachchige 2015).

Hydrogeology near the Former Landfill 2

No specific drainage features were identified in L2, in keeping with the high- permeability character of clean sands and gravels. However, north of the gravel pit, a small spring stream rises on the final slope to the Ottawa River (probably at the contact between the sand and gravel and underlying till). The most anomalous feature in the region of the former landfill is a small wetland immediately southeast (see Figure 5.2-1). Although surface exposure around the wetland are not visibly different from undisturbed terrain adjacent to the gravel pit, the wetland's presence is a clear indication of substantially lower permeabilities in the subsurface, at least to the northeast (Athauda-Arachchige 2015).

8.5.5.2 Regional Study Area

Due to the amount and variability of hydrogeological data at CRL, this information can be used in order to characterize the Regional Study Area. At CRL, flow systems are recharged on topographic highs created by bedrock ridges, flow laterally within overburden and shallow bedrock and discharge to local wetlands, bogs, streams and lakes. The vast majority of infiltration that recharges the groundwater flows within the permeable sandy overburden. Flow also occurs within shallow bedrock, likely to depths of 50 m, but these flow rates are a small percentage of flow rates in the overlying sands (Ethier and Hart 2013).

Depth to water table on CRL property is controlled primarily by the hydraulic conductivity of the overburden and topography of ground surface. In terrestrial upland areas with permeable sandy overburden, the water table is relatively deep (often greater than 5 m). In flat lying areas underlain by less permeable overburden or bedrock, the water table is typically found within a few metres of the ground surface (Raven Beck Environmental Ltd. 1994).

Linear average flow velocities in sand aquifers range from 10 to 400 m/yr, with the differences controlled by both hydraulic conductivity and hydraulic gradient. Average values of 10 to 100 m/year are likely in shallow bedrock based on average estimates of hydraulic conductivity and porosity (Davison *et al*. 1995). Actual groundwater velocities can differ greatly from these values because of orders of magnitude range in bedrock hydraulic conductivities and porosities.

8.5.6 Groundwater Quality

8.5.6.1 Site/Local Study Area

In the Site and Local Study Areas, groundwater is not currently used as a potable water source.

Radiological

In 2014, a groundwater sampling campaign was conducted at NPD using existing monitoring wells (Killey 2014). These wells are situated around landfills #1 and #2, as well as the facility, as shown in Figure 8.5-8. Analyses was conducted for tritium, alpha and beta activity concentrations. All samples except one were below or within one standard deviation of the detection limit, and all were well below the Health Canada screening criteria for drinking water (Killey 2014). The full Killey (2014) Report is provided in the Supplementary Documentation Report.

Non-Radiological

In June of 2014, a study of the groundwater in the area was conducted and a report on the groundwater quality was prepared (Killey 2014).

Table 8.5-8 shows what parameters were sampled from each well. The analytical results for all samples at all wells are presented in Killey (2014). The locations of the sampling points are shown in Figure 8.5-8. Table 8.5-9 below shows any measurements that exceeded Canadian standards. Canadian Drinking Water Standards, were used in Killey (2014) for this comparison where applicable. Ontario Ministry of the Environment Soil and Groundwater Standards (MOE 2011) were applied for those contaminants that did not have limits in Killey (2014).

Table 8.5-8. NPD Groundwater Contamination Sampling Matrix (Source: Killey 2014)

Location	Sampled?	GPS Location & Elev.	Wellhead Params	Radiological	Anions & DOC	TKN	Alkalinity	Major Cations	Trace Metals	Volatiles (ATGs 16-18)	Phenolics (ATG 20)	PCBs (Total)	PAHs (ATG-19)	Petroleum Components (F1-F4)
NPD-1	NF													
NPD-2	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
NPD-3	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
NPD-4	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
NPD-5	NF													
NPD-6	NF													
NPD-7	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
NPD-8	Yes	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	
NPD-9	Yes	Y	Y	Y	Y		Y	Y	Y			Y		
NPD-10	Yes	Y		Y	Y		Y	Y	Y			Y		
NPD-11	Yes	Y	Y	Y	Y		Y	Y	Y			Y		
NPD-12	Yes	Y	Y	Y	Y		Y	Y	Y			Y		
NPD-13	Yes	Y	Y	Y	Y		Y	Y	Y			Y		
NPD-14	Yes	Y	Y	Y	Y		Y	Y	Y			Y		
MT-1	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
MT-2	NF													
MT-3	NF													
MT-4	NF													
MT-5	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MT-7	Dry													
MT-8	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MT-9	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MT-10	NF													
BH-06-01	Dry													
BH-07-01	Partial	Y	Y	Y	Insufficient Water									
BH-08-01	Dry													
BH-09-01	Yes	Y	Y	Y							Y		Y	Y
BH-10-01	Dry													
BH-11-01	Dry													
BH-12-01	Yes	Y	Y	Y							Y		Y	Y
BH-13-01	Yes	Y	Y	Y							Y		Y	Y
BH-14-01	Dry													
BH-15-01	Dry													
BH-16-01	Dry													
NPD Tile Drain 1	Yes		Y	Y	Y		Y	Y	Y	Y				

Notes: Y – parameter sampled NF – Not found

Table 8.5-9. Groundwater Contaminants Exceeding Health Canada Drinking Water Standards (Source: Killey 2014)

Well ID	Contaminant	Amount Present	Guideline Limit
NPD-9	Aluminum	95 µg/L	100 µg/L
NPD-10	Manganese	52 µg/L	50 µg/L
MT-8	Manganese	280 µg/L	50 µg/L

As seen in Table 8.5-9, aluminum and manganese levels measured in groundwater on the Site Study area are close to or in exceedance of the Health Canada Drinking Water Standards.

The Killey (2014) study also identified detectable levels of extractable petroleum hydrocarbons (EPH) and total petroleum hydrocarbons (TPH), downgradient of a prior diesel fuel leak. However, the levels are lower than detection limits of prior analyses, and the nature of the hydrocarbons indicate that the material is either very old, or had consisted of non-volatile hydrocarbons (Killey 2014).

In August 2012, groundwater was sampled from several boreholes on the NPD site, and two locations in the Ottawa River, and analyzed for petroleum hydrocarbons (PHCs). The test results of that sampling program found that at the available monitoring locations, PHCs could not be detected in most samples. Where PHCs were detected, no exceedances of MOE (2011) standards were identified (Paterson Group 2012).

8.5.6.2 Regional Study Area

In the region, nearby residential communities such as Point Stewart and Rapides-des-Joachims rely on groundwater wells for their domestic water use.

Groundwater monitoring is conducted annually on the CRL site (Ethier and Hart 2013). It is noted that the groundwater quality at the CRL may not be reflective of the entire Regional Study Area.

Volatile organic compounds (chlorinated solvents in particular) were the most frequently encountered anthropogenic organic compounds in groundwaters around some of the waste management areas. Low concentrations of polychlorinated dibenzodioxins and polychlorinated dibenzofurans were detected at the Electrical Storage Yard Landfill. These contaminants are believed to be the result of the past practice of burning landfill wastes (Ethier and Hart 2013).

Among the inorganic parameters included in groundwater monitoring, iron and manganese were frequently elevated (above background) concentrations in groundwaters downgradient of some of the waste management facilities. Both of these metals are naturally present at high concentrations in local soils and both exhibit significant solubilities under reducing conditions when dissolved oxygen is absent. Such reducing conditions are a common natural occurrence in local groundwater flow systems, but the creation of reducing conditions is enhanced when groundwater or infiltration passes through materials with appreciable amounts of readily degradable organic materials. For this reason, elevated iron and

manganese concentrations are observed in groundwater downgradient of the waste management facilities that feature biodegradable waste buried in unlined pits and trenches (Ethier and Hart 2013).

It is noted that this baseline characterization does not consider economic geology, as it is not considered relevant to the project. The project does not involve mining or mineral extraction.

8.6 Terrestrial Environment

8.6.1 Spatial Boundaries

The Site and Local Study Areas for the terrestrial environment consist of the lands delineated in the general Site and Local Study Areas, shown in Figure 5.2-1 and Figure 5.2-2 respectively. The Site Study Area consists primarily of areas previously disturbed by human activity and contains various cultural vegetation communities. This area provides very little suitable habitat to support resident terrestrial species. King (2016) describes the area as “primarily forested with several trails, unpaved roads and paved roads traversing the area”.

The Regional Study Area, illustrated in Figure 8.6-1 below, extends beyond the Local Study Area, even though the effects of the project on the terrestrial environment are not expected to go beyond the NPD site. Much of the information used to characterize the existing terrestrial environment in the Site and Local Study Areas has been obtained at or near the CRL site. These regional data are included in the baseline characterization below.

Figure 8.6-1. Terrestrial Environment Regional Study Area



8.6.2 Forest/Vegetation Communities

8.6.2.1 Site/Local Study Area

According to Wills (2013), the Site/Local Study Area supports diverse mixed upland areas with some wetland areas scattered throughout. It is mainly wooded with the exception of open wetland areas. Wooded uplands generally range from 40-80 years old. Wetland areas on the NPD site are mainly found on the western half of the property. Human disturbance, including logging of white pine in the 1800s and 1900s, and forest fires, has also influenced the current vegetation cover (Wills 2013).



Forest on the NPD Property

An ELC study was undertaken in 2016 (ELC TSD).
Vegetation communities are described qualitatively based on dominant plant species for tree, shrub, and ground cover as well as canopy conditions, relative age, soil wetness and disturbance. The NPD site is mainly wooded with the exception of open wetland areas.

Three common vegetation community classes present in the Site/Local Study Area are as follows:

- Forested Upland Communities: Forests within the Site/Local Study Area are largely coniferous. The canopy is dominated by a mix of white pine, red pine, and jack pine. The sub-canopy is variable dependent on local factors, with predominant species being red maple, black spruce, white birch, balsam fir, white spruce, eastern hemlock, and sugar maple.
- Wetland Communities: Both meadow marshes and shallow marshes are present on the site. Dominant plant species include broadleaf cattail, sedges, and forbs such as goldenrod, meadow rue, and jewelweed. Where trees are present speckled alder, willow, black spruce, and white pine are dominant. Shallow aquatic sites occur on the western half of the Site/Local Study Area and south of Highway 17, and vary between submergent, floating, and emergent plant species.
- Cultural Communities: Cultural meadows are unforested areas that are heavily influenced by human activities. These include roadsides, utility corridors, and abandoned or reclaimed land from decommissioned structures (e.g. foundations and parking lots). Cultural plantations of white pine, red pine, and white spruce are planted along the main road into the built-up area.

With respect to baseline contaminant levels in vegetation, CNL collects measurements of tritium contamination in terrestrial vegetation; these data are presented in Section 8.5.4 above. In addition, the EcoRA uses pathways analysis such as soil-plant transfer factors and air deposition estimates, to model the transport of contaminants in non-human biota and through the food chain.

8.6.2.2 Regional Study Area

The vegetation community classes present at the CRL site are described by Ethier and Hart (2013), and are used here in order to contribute to the understanding of some of the vegetation within the Regional Study Area. Overall the forest is more mixed and deciduous than that of the NPD site. In addition to the vegetation communities found at NPD, CRL also has open sand dunes and sand barrens, as well as rock barrens, and several provincially significant wetlands (Ethier and Hart 2013).



Lady's Slipper (*Cypripedium acaule*)

8.6.3 Vegetation Species

According to Wills (2013), predominant tree species in the Site, Local and Regional Study Areas include:

- Forest Uplands
  - White pine
  - Red maple
  - Poplar
  - Red pine
  - Birch
- Natural coniferous forest (prevalent on downward slopes approaching the river)
  - Pine
  - Cedar
- Cultural Communities (planted along the main road into the built up area)
  - White pine
  - Red pine
  - White spruce

A total of 525 vascular plant species have been recorded on the CRL property. The CRL property is less than 30 km from the NPD site and has been used to represent the plant species within the Regional Study Area. Approximately 87% of these species are native, and 13% are non-native. Native species are indicative of undisturbed ecosystems and are generally valued, and non-native species may be less valued. Non-native species are often associated with disturbed communities (Ethier and Hart 2013).

No nationally or provincially endangered or threatened species of vascular plants have been identified or recorded on the NPD site. No formal survey has been conducted for such species nor would it be a component of a formal EA. Morin and Carr (2015) indicates that American ginseng and butternut trees, both endangered, could be present on the NPD site. The butternut tree has been observed on the CRL site (Ethier and Hart). A list of vegetation species observed at the NPD site during the 2016 ELC study (documented ELC TSD) is presented in Table 8.6-1. A total of 103 vascular plant species were recorded. 21% of these species are non-native. SAR designations (i.e., *SARA*, SARO, COSEWIC) are listed for species in the table below. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC.

Table 8.6-1. Vegetation Species Observed at the NPD site. *SARA* and SARO Queries Conducted in August 2016

Species		Status*	
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario
American Vetch	*Vicia americana*	Not Listed	Not Listed
Balsam Fir	*Abies balsamea*	Not Listed	Not Listed
Bebb's Willow	*Salix bebbiana*	Not Listed	Not Listed
Bird's foot Trefoil	*Lotus corniculatus*	Not Listed	Not Listed
Black Raspberry	*Rubus occidentalis*	Not Listed	Not Listed
Black Spruce	*Picea mariana*	Not Listed	Not Listed
Black-eyed Susan	*Rudbeckia hirta var. pulcherrima*	Not Listed	Not Listed
Bladder Campion	*Silene vulgaris*	Not Listed	Not Listed
Blue Bead-lily	*Clintonia borealis*	Not Listed	Not Listed
Blue Vervein	*Verbena hastata*	Not Listed	Not Listed
Bracken Fern	*Pteridium aquilinum*	Not Listed	Not Listed
Broad-leaved Cattail	*Typha latifolia*	Not Listed	Not Listed
Broad-leaved Meadow Sweet	*Spiraea latifolia*	Not Listed	Not Listed
Bull Thistle	*Cirsium vulgare*	Not Listed	Not Listed
Canada Goldenrod	*Solidago canadensis*	Not Listed	Not Listed
Canada Mayflower	*Maianthemum canadense*	Not Listed	Not Listed
Canada Thistle	*Cirsium canadensis*	Not Listed	Not Listed
Christmas Fern	*Polystichum acrostichoides*	Not Listed	Not Listed
Common Blackberry	*Rubus allegheniensis*	Not Listed	Not Listed
Common Blue-eyed Grass	*Sisyrinchium montanum*	Not Listed	Not Listed
Common Boneset	*Eupatorium perfoliatum*	Not Listed	Not Listed
Common Burreed	*Sparganium emersum*	Not Listed	Not Listed
Common Dandelion	*Taraxacum officinale*	Not Listed	Not Listed
Common Elderberry	*Sambucus canadensis*	Not Listed	Not Listed
Common Evening Primrose	*Oenothera biennis*	Not Listed	Not Listed
Common Milkweed	*Asclepias syriaca*	Not Listed	Not Listed
Common Mullein	*Verbascum thapsus*	Not Listed	Not Listed
Common Plantain	*Plantago major*	Not Listed	Not Listed
Common Viper's Bugloss	*Echium vulgare*	Not Listed	Not Listed
Common Yarrow	*Achillea millefolium*	Not Listed	Not Listed
Cow Vetch	*Vicia gracca*	Not Listed	Not Listed
Curled Dock	*Rumex crispus*	Not Listed	Not Listed
Eastern Hemlock	*Tsuga canadensis*	Not Listed	Not Listed
Eastern Teaberry	*Gaultheria procumbens*	Not Listed	Not Listed
Eastern White Cedar	*Tsuga occidentalis*	Not Listed	Not Listed
Eastern White Pine	*Pinus strobus*	Not Listed	Not Listed

Species		Status*	
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario
English Plantain	*Plantago lanceolata*	Not Listed	Not Listed
False Salomon's Seal	*Maianthemum racemosum*	Not Listed	Not Listed
Fireweed	*Chamerion angustifolium*	Not Listed	Not Listed
Flowering Raspberry	*Rubus odoratus*	Not Listed	Not Listed
Fowl Manna Grass	*Glyceria striata*	Not Listed	Not Listed
Foxtail Barley	*Hordeum jubatum*	Not Listed	Not Listed
Fragrant White Water Lily	*Nymphaea odorata*	Not Listed	Not Listed
Fringed Sedge	*Carex crinite*	Not Listed	Not Listed
Grass spp.	*Poa spp.*	Not Listed	Not Listed
Green Ash	*Fraxinus pennsylvanica*	Not Listed	Not Listed
Hairy Goldenrod	*Solidago hispida*	Not Listed	Not Listed
Hairy Salomon's Seal	*Polygonatum pubescens*	Not Listed	Not Listed
Heal-All	*Prunella vulgaris*	Not Listed	Not Listed
Hemlock Water-parsnip	*Sium suave*	Not Listed	Not Listed
Honeysuckle sp.	*Lonicera sp.*	Not Listed	Not Listed
Indian Pipe	*Monotropa uniflora*	Not Listed	Not Listed
Jack Pine	*Pinus banksiana*	Not Listed	Not Listed
Lady Slipper	*Cypripedium acaule*	Not Listed	Not Listed
Lamb's Quarters	*Chenopodium album*	Not Listed	Not Listed
Largetooth Aspen	*Populus grandidentata*	Not Listed	Not Listed
Low Sweet Blueberry	*Vaccinium angustifolium*	Not Listed	Not Listed
Marsh St. John's-Wort	*Triadenum fraseri*	Not Listed	Not Listed
Meadow Horsetail	*Equisetum pratense*	Not Listed	Not Listed
Meadow Rue	*Thalictrum pubescens*	Not Listed	Not Listed
Nannyberry	*Viburnum lentago*	Not Listed	Not Listed
Orchard grass	*Dactylis glomerata*	Not Listed	Not Listed
Oxeye Daisy	*Leucanthemum vulgare*	Not Listed	Not Listed
Philadelphia Fleabane	*Erigeron philadelphicus*	Not Listed	Not Listed
Pussy Willow	*Salix discolor*	Not Listed	Not Listed
Queen Ann's Lace	*Daucus carota*	Not Listed	Not Listed
Ragweed	*Ambrosia artemisiifolia*	Not Listed	Not Listed
Red Clover	*Trifolium pratense*	Not Listed	Not Listed
Red Maple	*Acer rubrum*	Not Listed	Not Listed
Red Oak	*Quercus rubra*	Not Listed	Not Listed
Red Pine	*Pinus resinosa*	Not Listed	Not Listed
Sedge	*Carex* spp.	Not Listed	Not Listed
Sensitive Fern	*Onoclea sensibilis*	Not Listed	Not Listed
Shining Willow	*Salix lucida*	Not Listed	Not Listed

Species		Status*	
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario
Silver Maple	Acer saccharinum	Not Listed	Not Listed
Slender Willow	*Salix petiolaris*	Not Listed	Not Listed
Smooth Blackberry	*Rubus canadensis*	Not Listed	Not Listed
Speckled Alder	*Alnus incana*	Not Listed	Not Listed
Spotted Jewelweed	*Impatiens capensis*	Not Listed	Not Listed
Spotted Joe-Pye Weed	*Eupatorium maculatum*	Not Listed	Not Listed
Spreading Dogbane	*Apocynum androsaemifolium*	Not Listed	Not Listed
St. John's Wort	*Hypericum perforatum*	Not Listed	Not Listed
Staghorn Sumac	*Rhus typhina*	Not Listed	Not Listed
Sugar Maple	*Acer saccharum ssp. saccharum*	Not Listed	Not Listed
Swamp Milkweed	*Asclepias incarnata*	Not Listed	Not Listed
Sweet Fern	*Comptonia peregrina*	Not Listed	Not Listed
Tamarack	*Larix laricina*	Not Listed	Not Listed
Tartarian Honeysuckle	*Lonicera tatarica*	Not Listed	Not Listed
Timothy	*Phleum pratense*	Not Listed	Not Listed
Trembling Aspen	*Populus tremuloides*	Not Listed	Not Listed
Water Milfoil	*Myriophyllum* spp.	Not Listed	Not Listed
Watershield	*Brasenia schreberi*	Not Listed	Not Listed
White Ash	*Fraxinus americana*	Not Listed	Not Listed
White Birch	*Betula papyrifera*	Not Listed	Not Listed
White Clover	*Trifolium repens*	Not Listed	Not Listed
White Meadow Sweet	*Spiraea alba*	Not Listed	Not Listed
White Spruce	*Picea glauca*	Not Listed	Not Listed
White Sweet-clover	*Melilotus alba*	Not Listed	Not Listed
Wild Sarsaparilla	*Aralia nudicaulis*	Not Listed	Not Listed
Willow	*Salix spp.*	Not Listed	Not Listed
Wool-Grass	*Scirpus cyperinus*	Not Listed	Not Listed
Yellow Pond Lily (Bullhead Lily)	*Nuphar variegata*	Not Listed	Not Listed
Yellow Sweet-clover	*Melilotus officinalis*	Not Listed	Not Listed

8.6.4 Wildlife Species

Wildlife species found in the Site, Local and Regional Study Areas (as described in Section 8.6.1) are typical of a boreal region in Ontario (Wills 2013).

The following sub-sections list the reptile, amphibian, bird and mammal species that are included in the SAR Table for the NPD site (Morin and Carr 2015), as well as species found in the Regional Study Area as reported by Haxton and Chubbuck (2002) and the Quebec-Labrador Foundation (2005). Within this section, discussion of species present is focussed on SARs sighted in the Site and Local Study Areas.

8.6.4.1 Amphibians and Reptiles

Table 8.6-2 lists the amphibian and reptile species present and potentially present in the Site, Local and Regional Study Areas, based on the SARs identified in the NPD Biodiversity Report (Morin and Carr 2015), the Ontario Reptile and Amphibian Atlas (2005), and the species identified in the MNRF Ottawa River review (Haxton and Chubbuck 2002). In total, 25 species of amphibians and reptiles have been reported in this reach of the Ottawa River (Haxton and Chubbuck 2002, Morin and Carr 2015, ON 2005). SAR designations (i.e., *SARA*, SARO, COSEWIC) are listed for species in the table below. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC.



Eastern Milksnake (*Lampropeltis Triangulum*)

In 2015, a juvenile eastern milksnake, a species of concern (*SARA* 2002), was observed within the NPDWF (Morin and Carr 2015). Eastern milksnakes are habitat generalists, and have been recorded in open as well as forested habitats. It is suggested that milksnakes preferentially use open and edge habitats, though their distribution is highly correlated with heavily forested areas (COSEWIC 2014). Individuals are known to enter buildings from August to October.

Table 8.6-2. Amphibian and Reptile Species Present or Potentially Present in the Site, Local and Regional Study Areas. *SARA* and SARO Queries Conducted in August 2016

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
AMPHIBIANS				
American toad	*Anaxyrus americanus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Bullfrog	*Lithobates catesbeianus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Gray treefrog	*Hyla versicolor*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Green frog	*Lithobates clamitans melanota*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Mink frog	*Lithobates septentrionalis*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Northern leopard frog	*Lithobates pipiens*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Eastern red-backed salamander	*Plethodon cinereus*	Not Listed	Not Listed	(ON 2016a)
Spring peeper	*Pseudacris crucifer*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Spotted salamander	*Ambystoma maculatum*	Not Listed	Not Listed	(ON 2016a)
Western chorus frog	*Pseudacris tristeriata*	THR	Not Listed	(Morin and Carr 2015)
Wood frog	*Lithobates sylvaticus*	Not Listed	Not Listed	(ON 2016a)
REPTILES				
Blanding's turtle (GLStL population)	*Emydoidea blandingii*	THR (END)	THR	(Morin and Carr 2015)
Eastern garter snake	*Thamnophis sitalis sirtalis*	Not Listed	Not Listed	(ON 2016a)
Eastern musk turtle (stinkpot)	*Sternotherus odoratus*	THR (SC)	SC	(Morin and Carr 2015)
Eastern hog-nosed snake	*Heterodon platirhinos*	THR	THR	(Morin and Carr 2015)
Eastern milksnake	*Lampropeltis triangulum*	SC	Not Listed	(Morin and Carr 2015)
Eastern ribbonsnake (GLStL population)	*Thamnophis sauritus*	SC	SC	(Morin and Carr 2015)
Eastern spiny softshell	*Apalone spinifera*	THR (END)	THR	(Morin and Carr 2015)
Midland painted turtle	*Chrysemys picta*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Northern map turtle	*Graptemys geographica*	SC	SC	(Morin and Carr 2015)
Northern redbelly snake	*Storeria occipitomaculata*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Northern ringneck snake	*Diadophus punctatus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Northern water snake	*Nerodia sipedon*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Snapping turtle	*Chelydra serpentine*	SC	SC	(Morin and Carr 2015)
Wood turtle	*Glyptemys insculpta*	THR	END	(Morin and Carr 2015)
* Status: **NAR**: Not at Risk; **END**: Endangered; **THR**: Threatened; **SC**: Special Concern.				

8.6.4.2 Birds

Table 8.6-3 provides a list of bird species present or potentially present in the Site, Local and Regional Study Areas, based on reference documents. The list was cross checked against the *SARA* and SARO registries. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC.



Eastern Wood Pewee (*Contopus virens*)

The Ottawa River serves as a major stopover along the Atlantic flyway, particularly for migratory waterfowl (Quebec-Labrador Foundation 2005). There are 34 species of water birds and 11 raptors known to breed in the stretch of the Ottawa River that includes the NPD site.

The following discussion of SARs is focussed on those which have been observed on the NPD site.

In both Ontario and Canada, the chimney swift is a threatened species (*SARA* 2002). From 1968-2005 chimney swifts have experienced a 95% population decline. The NPD ventilation stack currently provides habitat for the largest known chimney swift roost in Ontario (BSC 2012, 2013a and 2013b), (Morin and Carr 2015). Chimney swifts occupy the ventilation stack from May to the end of August, with numbers reaching over 2500 individuals during the spring migration. As part of the decommissioning of the NPD site, initial plans were to remove the ventilation stack. Alternative habitat designs were considered, however due to

the risk of rejection of the alternative habitat, leaving the ventilation stack in place was determined to be the preferred option. The ventilation stack has been deemed structurally sound, and it can be isolated from the facility during decommissioning activities and retained as a roosting location (CNL 2016c).

An active bald eagle's nest has been observed on the site. It is located roughly 875 m northwest of the facility, and 475 m northwest of landfill #2. The MNR guidelines for bald eagle habitat identify a 400 m buffer zone for human activity around nesting sites. Since project activities are limited to the vicinity of the facility, no impact on the bald eagle's nest is expected (Morin and Carr 2015). However, if work within 400 m of the nest is necessary, these activities should be restricted during the courtship and breeding periods.

Common nighthawks and eastern wood-pewees have been observed on the site.

Table 8.6-3. Bird Species Present or Potentially Present in the Site, Local and Regional Study Areas. *SARA* and SARO Queries Conducted in August 2016

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Alder flycatcher	*Empidonax alnorum*	Not Listed	Not Listed	(BSC *et al.* 2006)
American bittern	*Botaurus lentiginosus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
American black duck	*Anas obscura*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
American crow	*Corvus brachyrhynchos*	Not Listed	Not Listed	(BSC *et al.* 2006)
American goldfinch	*Spinus tristis*	Not Listed	Not Listed	(BSC *et al.* 2006)
American kestrel	*Falco sparverius*	Not Listed	Not Listed	(Morin and Carr 2015)
American redstart	*Setophaga ruticilla*	Not Listed	Not Listed	(BSC *et al.* 2006)
American robin	*Turdus migratorius*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
American woodcock	*Scolopax minor*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Bald eagle	*Haliaeetus leucocephalus*	No status (NAR)	SC	(Morin and Carr 2015)
Baltimore Oriole	*Icterus galbula*	Not Listed	Not Listed	(BSC *et al.* 2006)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Bank swallow	*Riparia*	No Status Yet (THR)	THR	(Morin and Carr 2015)
Barn swallow	*Hirundo rustica*	No Status Yet (THR)	THR	(Morin and Carr 2015)
Bay-breasted warbler	*Setophaga castanea*	Not Listed	Not Listed	(Morin 2013)
Belted kingfisher	*Megaceryle alcyon*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Black-and-white warbler	*Mniotilta varia*	Not Listed	Not Listed	(BSC *et al.* 2006)
Black-backed woodpecker	*Picoides arcticus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Black-capped chickadee	*Poecile atricapillus*	Not Listed	Not Listed	(BSC et al. 2006)
Black-billed cuckoo	*Coccyzus erythropthalmus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Blackburnian warbler	*Setophaga fusca*	Not Listed	Not Listed	(Morin 2013)
Black tern	*Chlidonias niger*	No status (NAR)	SC	(Morin and Carr 2015)
Black-throated blue warbler	*Setophaga caerulescens*	Not Listed	Not Listed	(Morin 2013)
Black-throated green warbler	*Setophaga virens*	Not Listed	Not Listed	(Morin 2013)
Blue-headed vireo	*Vireo solitarius*	Not Listed	Not Listed	(BSC *et al.* 2006)
Blue jay	*Cyanocitta cristata*	Not Listed	Not Listed	(BSC *et al.* 2006)
Blue-winged teal	*Anas discors*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Bobolink	*Dolichonyx oryzivorus*	No Status Yet (THR)	THR	(Morin and Carr 2015)
Broad-winged hawk	*Buteo platypterus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Brown Creeper	*Certhia americana*	Not Listed	Not Listed	(BSC *et al.* 2006)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Brown thrasher	*Toxostoma rufum*	Not Listed	Not Listed	(Morin 2013)
Canada goose	*Branta canadensis*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Canada warbler	*Cardellina canadensis*	THR	SC	(Morin and Carr 2015)
Cape May Warbler	*Setophaga tigrina*	Not Listed	Not Listed	(BSC *et al.* 2006)
Cedar waxwing	*Bombycilla cedrorum*	Not Listed	Not Listed	(BSC *et al.* 2006)
Cerulean warbler	*Setophaga cerulea*	SC (END)	THR	(Morin and Carr 2015)
Chestnut-sided warbler	*Setophaga pensylvanica*	Not Listed	Not Listed	(Morin 2013)
Chimney swift	*Chaetura pelagica*	THR	THR	(Morin and Carr 2015)
Chipping sparrow	*Spizella passerina*	Not Listed	Not Listed	(BSC *et al.* 2006)
Clay-colored sparrow	*Spizella pallida*	Not Listed	Not Listed	(Morin 2013)
Cliff swallow	*Petrochelidon pyrrhonota*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Common goldeneye	*Bucephala clangula*	Not Listed	Not Listed	(Morin 2013)
Common grackle	*Quiscalus quiscula*	Not Listed	Not Listed	(BSC *et al.* 2006)
Common loon	*Gavia immer*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Common merganser	*Mergus merganser*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Common nighthawk	*Chordeiles minor*	THR	SC	(Morin and Carr 2015)
Common raven	*Corvus corax*	Not Listed	Not Listed	(BSC *et al.* 2006)
Common tern	*Sterna hirundo*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Common yellowthroat	*Geothlypis trichas*	Not Listed	Not Listed	(Morin 2013)
Cooper’s hawk	*Accipiter cooperii*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Dark-eyed junco	*Junco hyemalis*	Not Listed	Not Listed	(BSC *et al.* 2006)
Downy woodpecker	*Picoides pubescens*	Not Listed	Not Listed	(BSC *et al.* 2006)
Eastern bluebird	*Sialia sialis*	Not Listed	Not Listed	(Morin 2013)
Eastern kingbird	*Tyrannus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Eastern meadowlark	*Sturnella magna*	No Status Yet (THR)	THR	(Morin and Carr 2015)
Eastern phoebe	*Sayornis phoebe*	Not Listed	Not Listed	(BSC *et al.* 2006)
Eastern Towhee	*Pipilo erythrophthalmus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Eastern whip-poor-will	*Antrostomus vociferus*	THR	THR	(Morin and Carr 2015)
Eastern wood pewee	*Contopus virens*	No Status Yet (SC)	SC	(Morin and Carr 2015)
European starling	*Sturmus vulgaris*	Not Listed	Not Listed	(BSC *et al.* 2006)
Evening grosbeak	*Coccothraustes vespertinus*	Not Listed (SC)	Not Listed	(BSC *et al*. 2006)
Field sparrow	*Spizella pusilla*	Not Listed	Not Listed	(Morin 2013)
Golden-crowned kinglet	*Regulus satrapa*	Not Listed	Not Listed	(BSC *et al.* 2006)
Golden-winged warbler	*Vermivora chrysoptera*	THR	SC	(Morin and Carr 2015)
Grasshopper sparrow	*Ammodramus savannarum pratensis*	No Status Yet (SC)	SC	(Morin and Carr 2015)
Gray catbird	*Dumetella carolinensis*	Not Listed	Not Listed	(BSC *et al*. 2006)
Great blue heron	*Ardea herodias*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Great crested flycatcher	*Myiarchus crinitus*	Not Listed	Not Listed	(BSC *et al*. 2006)
Great gray owl	*Strix nebulosa*	Not Listed	Not Listed	(Morin 2013)
Green heron	*Butorides virescens*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Green-winged Teal	*Anas crecca*	Not Listed	Not Listed	(BSC *et al.* 2006)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Hairy woodpecker	*Leuconotopicus villosus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Hermit thrush	*Catharus guttatus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Herring gull	*Larus smithsonianus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Hooded merganser	*Lophodytes cucullatus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
House Wren	*Troglodytes aedon*	Not Listed	Not Listed	(BSC *et al.* 2006)
Indigo bunting	*Passerina cyanea*	Not Listed	Not Listed	(BSC *et al.* 2006)
Killdeer	*Charadrius vociferous*	Not Listed	Not Listed	(BSC *et al.* 2006)
Kirtland's warbler	*Setophaga kirtlandii*	END	END	(Morin and Carr 2015)
Least bittern	*Ixobrychus exilis*	THR	THR	(Morin and Carr 2015)
Least flycatcher	*Empidonax minimus*	Not Listed	Not Listed	(Morin 2013)
Loggerhead shrike Eastern subspecies	Lanius ludovicianus migrans	No Status Yet (END)	END	(Morin and Carr 2015)
Lesser scaup	Aythya affinis	Not Listed	Not Listed	(Morin 2013)
Lincoln's Sparrow	Melospiza lincolnii	Not Listed	Not Listed	(BSC *et al.* 2006)
Magnolia warbler	*Steophaga magnolia*	Not Listed	Not Listed	(Morin 2013)
Mallard	*Anas platyrhynchos*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Marsh wren	*Cistothorus palustris*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Merlin	*Falco columbarius*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Mourning dove	*Zenaida macroura*	Not Listed	Not Listed	(BSC *et al.* 2006)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Mourning warbler	*Geothlypis philadelphia*	Not Listed	Not Listed	(Morin 2013)
Nashville warbler	*Orethlypis ruficapilla*	Not Listed	Not Listed	(Morin 2013)
Northern flicker	*Colaptes auratus*	Not Listed	Not Listed	(Morin 2013)
Northern goshawk	*Accipiter gentilis*	Not Listed	Not Listed	(Morin 2013)
Northern harrier	*Circus cyaneus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Northern mockingbird	*Mimus polyglottos*	Not Listed	Not Listed	(Morin 2013)
Northern Parula	*Setophaga americana*	Not Listed	Not Listed	(BSC *et al.* 2006)
Northern pintail	*Anas acuta*	Not Listed	Not Listed	(Morin 2013)
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Not Listed	Not Listed	(Morin 2013)
Northern saw-whet owl	*Aegolius acadicus*	Not Listed	Not Listed	(Morin 2013)
Northern waterthrush	*Parkesia noveboracensis*	Not Listed	Not Listed	(BSC *et al.* 2006)
Olive-sided flycatcher	*Contopus cooperi*	THR	SC	(Morin and Carr 2015)
Osprey	*Pandion haliaetus*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Ovenbird	*Seiurus aurocapilla*	Not Listed	Not Listed	(BSC *et al.* 2006)
Peregrine falcon	*Falco peregrinus anatum/tundrius*	SC	SC	(Morin and Carr 2015)
Pied-billed grebe	*Podilymbus podiceps*	Not Listed	Not Listed	(Morin 2013)
Pileated woodpecker	*Dryocopus pileatus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Pine Grosbeak	*Pinicola enucleator*	Not Listed	Not Listed	(BSC *et al.* 2006)
Pine Siskin	*Carduelis pinus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Pine warbler	*Setophaga pinus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Purple martin	*Progne subis*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Purple finch	*Haemorhous purpureus*	Not Listed	Not Listed	(Morin 2013)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Red-breasted nuthatch	*Sitta canadensis*	Not Listed	Not Listed	(BSC *et al.* 2006)
Red crossbill	*Loxia curvirostra*	Not Listed	Not Listed	(Morin 2013)
Red-eyed vireo	*Vireo olivaceus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Red-headed woodpecker	*Melanerpes erythrocephalus*	THR	SC	(Morin and Carr 2015)
Red-shouldered hawk	*Buteo lineatus*	SC (Schedule 3) (NAR)	Not Listed	(Morin and Carr 2015)
Red-tailed hawk	*Buteo jamaicensis*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Red-winged blackbird	*Agelaius phoeniceus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Ring-billed gull	*Larus delawarensis*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Ring-necked duck	*Aythya collaris*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Rock pigeon	*Columba livia*	Not Listed	Not Listed	(BSC *et al.* 2006)
Rose-breasted grosbeak	*Pheuticus ludovicianus*	Not Listed	Not Listed	(Morin 2013)
Ruby-crowned kinglet	*Regulus calendula*	Not Listed	Not Listed	(BSC *et al.* 2006)
Ruby-throated hummingbird	*Archilochus colubris*	Not Listed	Not Listed	(BSC *et al.* 2006)
Ruffed grouse	*Bonasa umbellus*	Not Listed	Not Listed	(Morin 2013)
Rusty blackbird	*Euphagus carolinus*	SC	Not Listed	(Morin and Carr 2015)
Savannah sparrow	*Passerculus sandwichensis*	Not Listed	Not Listed	(Morin 2013)
Scarlet Tanager	*Piranga olivacea*	Not Listed	Scarlet Tanager	(BSC *et al.* 2006)
Sedge wren	*Cistothorus platensis*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Short-eared owl	*Asio flammeus*	SC	SC	(Morin and Carr 2015)
Song sparrow	*Melospiza melodia*	Not Listed	Not Listed	(BSC *et al.* 2006)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Sora	*Porzana carolina*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Spotted sandpiper	*Actitus macularius*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Swainson's thrush	*Catharus ustulatus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Swamp sparrow	*Melospiza georgiana*	Not listed	Not Listed	(Morin 2013)
Tennessee Warbler	*Leiothlypis peregrina*	Not Listed	Not Listed	(BSC *et al.* 2006)
Tree swallow	*Tachycineta bicolor*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Turkey vulture	*Cathartes aura*	Not Listed	Not Listed	(BSC *et al.* 2006)
Upland sandpiper	*Bartramia longicauda*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Veery	*Catharus fuscescens*	Not Listed	Not Listed	(Morin 2013)
Vesper Sparrow	*Pooecetes gramineus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Virginia rail	*Rallus limicola*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Warbling Vireo	*Vireo gilvus*	Not Listed	Not Listed	(BSC *et al.* 2006)
White-breasted nuthatch	*Sitta carolinensis*	Not Listed	Not Listed	(BSC *et al.* 2006)
White-throated sparrow	*Zonotrichia albicollis*	Not Listed	Not Listed	(Morin 2013)
Willow flycatcher	*Empidonax traillii*	Not Listed	Not Listed	(Morin 2013)
Wilson's Snipe	*Gallinago delicata*	Not Listed	Not Listed	(BSC *et al.* 2006)
Wilson's Warbler	*Cardellina pusilla*	Not Listed	Not Listed	(BSC *et al.* 2006)
Winter wren	*Troglodytes hiemalis*	Not Listed	Not Listed	(BSC *et al.* 2006)
Wood duck	*Aix sponsa*	Not Listed	Not Listed	(Haxton and Chubbuck 2002)
Wood thrush	*Hylocichla mustelina*	No Status Yet (THR)	SC	(Morin and Carr 2015)

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Yellow-bellied sapsucker	*Sphyrapicus varius*	Not Listed	Not Listed	(Morin 2013)
Yellow-billed Cuckoo	*Coccyzus americanus*	Not Listed	Not Listed	(BSC *et al.* 2006)
Yellow-rumped warbler	*Setophaga coronata*	Not Listed	Not Listed	(BSC *et al.* 2006)
Yellow warbler	*Setophaga petechia*	Not Listed	Not Listed	(BSC *et al.* 2006)
* Status: **NAR**: Not at Risk; **END**: Endangered; **THR**: Threatened; **SC**: Special Concern.				

8.6.4.3 Mammals

Table 8.6-4 provides a list of mammal species present or potentially present in the Site, Local and Regional Study Areas, based on reference documents. The list was cross checked against the *SARA* and SARO registries. Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC.



Eastern Wolf (*Canis lupus lycaon*)

The following list of mammalian species is derived from the SARs listed in the NPD Biodiversity Report (Morin and Carr 2015), as well as a list of mammals that are found in the Ottawa River drainage basin (Quebec-Labrador Foundation 2005). It therefore may include species that are found beyond the Regional Study Area of NPD.

During the summer of 2015, three endangered bat species, the eastern small-footed bat, little brown myotis, and northern myotis were observed on the NPD site in the immediate proximity of the NPDWF (Morin and Carr 2015, Murrant 2016). Murrant (2016) summarizes the 2015 bat survey work, which includes a visual survey of the interior of the main building, in which one bat was found hibernating inside a pipe which led down to the river. Due to the length and inaccessibility of the pipe it could not be determined what type of bat was present or if there were any more bats hibernating further down the pipe. During the thermal imaging survey, no further bats were found in any of the spaces examined. While conducting both searches no other evidence of bat activity (guano etc.) was found (Murrant 2016).

There is currently no evidence of a bat roost located inside the building. With the large amount of forested area around the buildings most bats will likely be roosting in trees, using the open areas around buildings to forage for insects (Murrant 2016).

Table 8.6-4. Mammal Species Present or Potentially Present in the Site, Local and Regional Study Areas. *SARA* and SARO Queries Conducted in August 2016

Species		Status*		References
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Beaver	*Castor canadensis*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Big brown bat	*Eptesicus fuscus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Black bear	*Ursus americanus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Coyote	*Canis latrans*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Deer mouse	*Peromyscus maniculatus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Eastern chipmunk	*Tamias striatus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Eastern cottontail	*Sylvilagus floridanus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Eastern cougar	*Felis concolor couguar*	Not Listed	END	(Morin and Carr 2015)
Eastern small-footed myotis	*Myotis leibii*	Not Listed	END	(Morin and Carr 2015)
Eastern wolf	*Canis lupus lycaon*	SC (THR)	THR	(Morin and Carr 2015)
Eastern gray squirrel	*Sciurus carolinensis*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Ermine	*Mustela erminea*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Hoary bat	*Lasiurus cinereus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Little brown myotis	*Myotis lucifugus*	END	END	(Morin and Carr 2015)
Lynx	*Lynx canadensis*	NAR	Not Listed	(Quebec-Labrador Foundation 2005)
Marten	*Martes americana*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Meadow vole	*Microtus pennsylvanicus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Mink	*Neovison vison*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Moose	*Alces alces*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Muskrat	*Ondatra zibethicus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)

Species		Status*		References
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
Northern flying squirrel	*Glaucomys sabrinus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Northern myotis	*Myotis septentrionalis*	END	END	(Morin and Carr 2015)
Northern water shrew	*Sorex palustris*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Raccoon	*Procyon lotor*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Porcupine	*Erethizon dorsatum*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Red squirrel	*Sciurus vulgaris*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Red fox	*Vulpes vulpes*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Short-tailed shrew	*Blarina brevicauda*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Snowshoe hare	*Lepus americanus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Southern flying squirrel	*Glaucomys volans*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Tri-colored bat	*Perimyotis subflavus*	END	END	(Morin and Carr 2015)
Striped skunk	*Mephitis mephitis*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
White-footed mouse	*Peromyscus leucopus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
White-tailed deer	*Odocoileus virginianus*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)
Woodchuck	*Marmota monax*	Not Listed	Not Listed	(Quebec-Labrador Foundation 2005)

* Status: **NAR**: Not at Risk; **END**: Endangered; **THR**: Threatened; **SC**: Special Concern.

8.6.4.4 Insects

In addition to the wildlife species listed above, some characterization of the insects within the Regional Study Area has been carried out. Table 8.6-5 lists the insect SARs that were identified in the NPD Biodiversity Report (Morin and Carr 2015). Although *SARA* was originally legislated in 2002, the species list is updated frequently based on recommendations from COSEWIC. It is not a comprehensive list of all of the insects that are present or potentially present at the NPD site.



Monarch Butterfly (*Danaus plexippus)*

Monarch butterflies have been observed on the site, primarily in cleared areas such as former parking lots and building foundations. Several varieties of wildflowers are available as nectar sources on the site, including goldenrods (*Solidago* spp.), asters (*Aster* spp.) and milkweeds (*Asclepias* spp.) (Morin and Carr 2015).

Table 8.6-5. Insect Species at Risk Present or Potentially Present in the Site, Local and Regional Study Areas. *SARA* and SARO Queries Conducted in August 2016

Species		Status*		Reference
Common Name	Scientific Name	*SARA*, 2002 (COSEWIC if different)	SARO - Ontario	
INSECTS				
Monarch butterfly	*Danaus plexippus*	SC (END)	SC	(Morin and Carr 2015)
Northern barrens tiger beetle	*Cicidela patruela*	END	END	(Morin and Carr 2015)
Rusty patched bumble bee	*Bombus affinis*	END	END	(Morin and Carr 2015)
* Status: **END**: Endangered; **SC**: Special Concern.				

8.6.5 Regional Provincial Parks and Protected Areas

8.6.5.1 Site/Local Study Area

Within the Site or Local Study Areas, there are no federal or provincially-protected conservation areas, parks, nature reserves, bird sanctuaries or wildlife management areas. There are also no known wildlife corridors within the Site or Local Study Areas. The existing structures and fences on the site are not considered barriers to the overall movement of wildlife across the site, as they are located in already disturbed areas, surrounded by more accessible spaces.

8.6.5.2 Regional Study Area

There are seven provincial parks and protected areas located within the Regional Study Area, which is shown in Figure 8.6-1 above:

- Ottawa River Provincial Park (Waterway Class) – situated discontinuously along the southern shore of the Ottawa River upstream of NPD, the park contains numerous recreational and scenic values (MNRF 2006a).
- Driftwood Provincial Park (Recreation Class) – situated roughly 15 km upstream of NPD, the park contains glacial remnants such as sand, gravel, diabase dike, ice-push ridge, and well-pronounced esker (MNRF 2006b).
- Grant's Creek Provincial Park (Waterway Class) – Grant Creek Provincial Park connects Algonquin Park and the Ottawa River roughly 20 km upstream of NPD. This waterway contains an Algonquin Park canoe route and Grant's Creek Marsh, a provincially significant wetland (MNRF 2009).
- Algonquin Provincial Park (Natural Environment Class) – situated southwest of NPD, it is a large, biologically diverse park which protects a variety of natural, cultural and recreational features and values (MNRF 2006c).
- Algonquin Provincial Park Headwaters – Pembroke Enhanced Management Area (Natural Heritage Class) is located roughly 22 km southeast just outside of Algonquin Provincial Park. This area serves to protect the headwaters of Algonquin Park watercourses by placing conditions on resource development (MNRF 2006d).
- There are a number of fish sanctuaries in Algonquin Provincial Park within the Regional Study Area. These fish sanctuaries prohibit fishing from December 1 until the fourth Saturday of April annually (MNRF 2016b).
- Reilly Bird Nature Reserve – a 27.5-hectare reserve located 3 km downstream of NPD on Meilleurs Bay, an inlet of the Ottawa River. The reserve protects almost half of the shoreline of the bay, which provides habitat for turtles and spawning fish (ON 2016b).

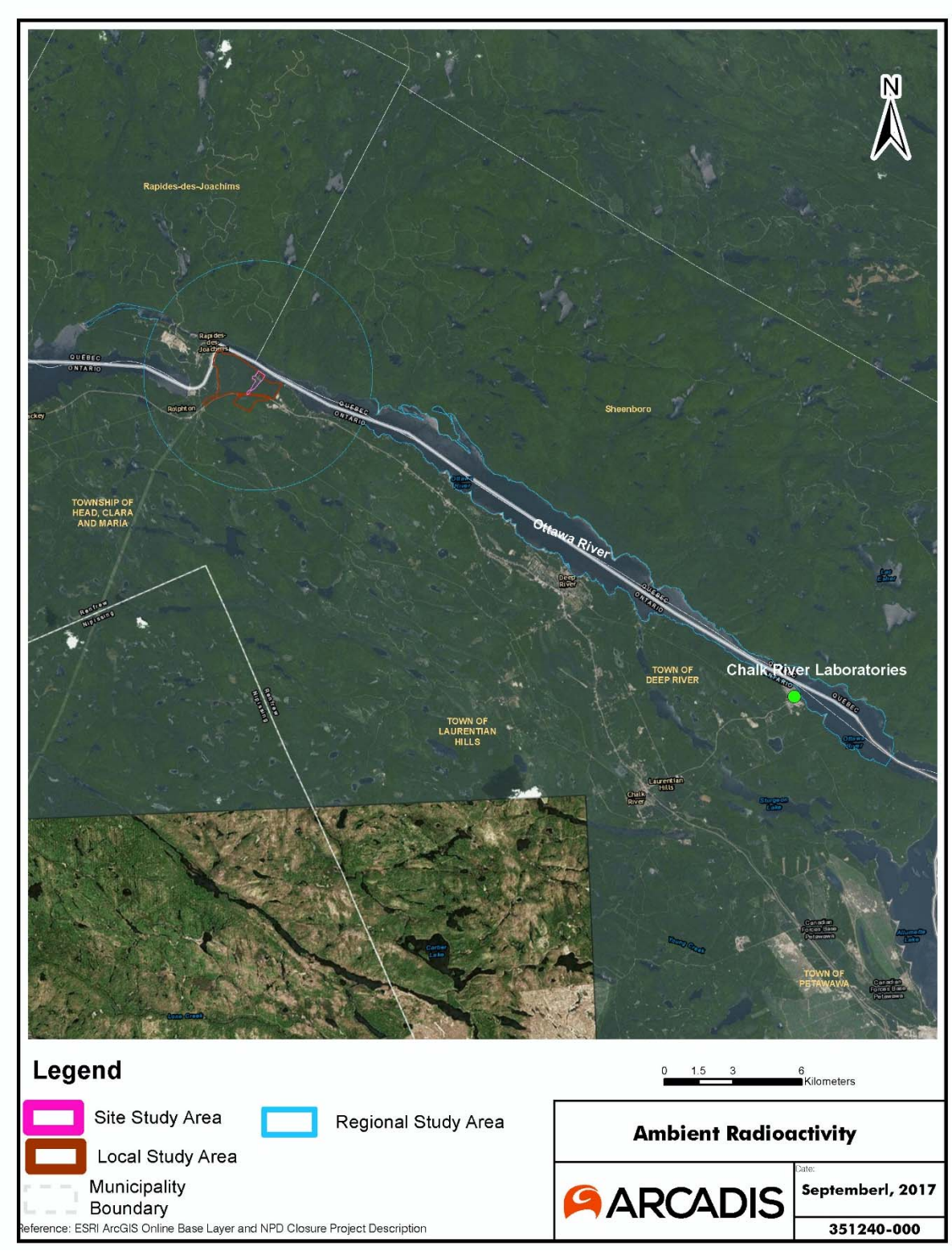
In addition to the above protected areas in the Regional Study Area, there are ZECs (zone d'exploitation controlée, controlled harvesting zone) located across the Ottawa River in Quebec. These are discussed further as part of the socio-economic environment (Section 8.10 below).

8.7 Ambient Radioactivity

8.7.1 Spatial Boundaries

The Site and Local Study Areas for ambient radioactivity consist of the lands delineated in Figure 5.2-1 and Figure 5.2-2 respectively. This includes the two closed landfills on the NPD site. Although ambient radioactivity is not expected to extend beyond the NPD site, a Regional Study Area has been defined, as illustrated in Figure 8.7-1 below; it incorporates both the atmospheric and surface water environment Regional Study Areas. Regional baseline characterization information is also provided where available.

Figure 8.7-1. Ambient Radioactivity Environment Regional Study Area



8.7.2 Site/Local Study Area

CNL monitors ambient gamma radiation dose rates in air at thermoluminescent dosimeter (TLD) stations around the NPD site. Table 8.7-1 gives the locations of the TLDs in the Site and Local Study Areas, and Table 8.7-2 shows the ambient dose rates for these stations.

Figure 8.7-2 shows the locations and historical trends of ambient gamma dose, averaged yearly, for the sampling locations in the Site and Local Study Areas, as well as one sampling location in the Regional Study Area.

Table 8.7-1. Location of the TLD Stations Located Near NPD Site (Source: Wills 2013).

Location	ETB Code	NPD Code	Easting (m)	Northing (m)
NPD at Highway 17	T29	T2	294243	5117291
NPD Main Site (parking lot)	T30	T3	294859	5117896
Point Stewart, NPD, near Ottawa River	T31	T4	295603	5117594

T4 lies along the prevailing wind directions from the NPD site. The ambient radiation fields at T2 (the junction of Highway 17 and the NPD access road) are consistently slightly lower than the other location in the Local Study Area; this is attributed to the wetland conditions around the station, with the water providing some shielding from the soil's natural radiation field (Wills 2013).

Table 8.7-2. Ambient Gamma Radiation in Air at TLD Stations: Site and Local Study Areas (Source: Wills 2013). Locations are Illustrated in Figure 8.7-2

Year	Quarter	NPD at Highway 17 (µR/hr)	NPD Car Park (µR/hr)	Point Stewart (µR/hr)
1972 - 1987	Average over the years 1972-1987	6.9	NA	9.3
1988	4	3.0	5.6	NA
1989	1	4.9	6.9	NA
1989	2	2.4	4.3	7.0
1989	4	5.5	7.7	NA
1990	1	4.3	3.8	NA
1990	2	4.3	7.2	4.6
1990	3	1.6	6.0	NA
1990	4	3.0	6.4	NA
1991	1	6.0	6.0	NA
1991	2	5.0	6.5	NA
1991	3	4.7	6.4	6.0
1991	4	4.3	6.3	NA
1992	1	4.3	5.6	NA
1992	2	4.4	7.3	5.3
1992	3	4.3	6.7	NA
1992	4	4.9	6.8	NA
1993	1	4.5	7.2	NA
1993	2	3.3	5.8	4.9
1993	3	5.0	6.6	NA
1993	4	8.3	10.7	NA
1994	1	3.4	4.3	NA
1994	2	3.9	5.4	5.7
1994	3	5.2	5.7	5.2
1994	4	3.3	5.2	NA
1995	1	3.7	5.9	NA
1995	2	3.1	5.2	5.0
1995	3	5.2	7.1	8.8
1996	1	2.4	2.9	NA
1996	2	2.8	NA	2.9
1996	3	4.4	NA	8.3
1996	4	3.3	NA	NA
1997	1	0.3	2.5	5.2
1997	2	2.8	4.9	5.2
1997	3	2.1	3.7	6.0
1997	4	2.8	4.3	NA

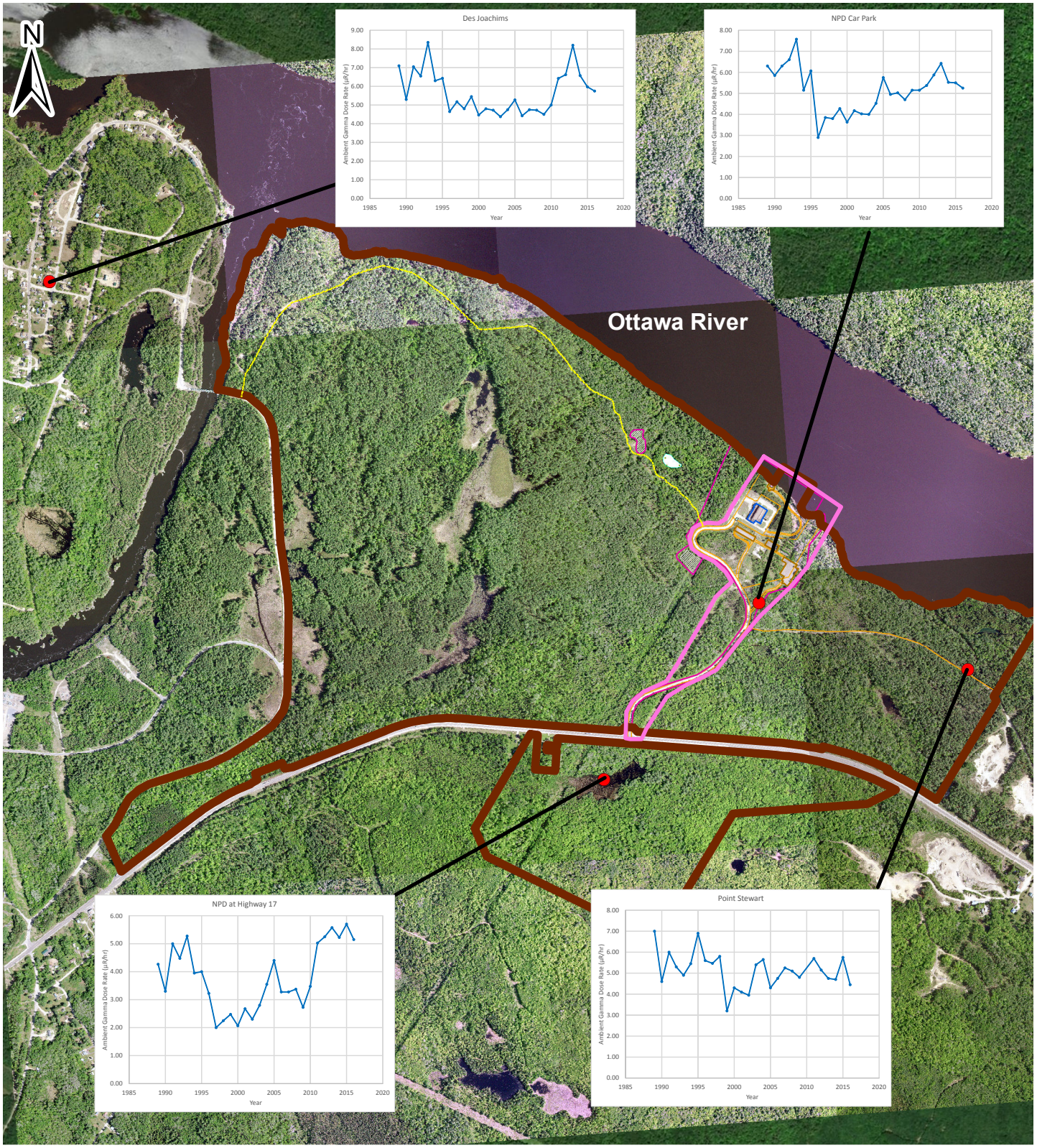
Year	Quarter	NPD at Highway 17 (µR/hr)	NPD Car Park (µR/hr)	Point Stewart (µR/hr)
1998	1	0.4	1.0	NA
1998	2	3.6	5.6	5.9
1998	3	1.9	3.7	5.7
1998	4	3.1	4.9	NA
1999	1	0.0	2.1	NA
1999	2	3.3	5.1	1.8
1999	3	2.6	4.2	4.6
1999	4	4.0	5.7	NA
2000	1	0.1	1.4	NA
2000	2	3.9	5.7	4.9
2000	3	2.2	3.8	3.7
2001	1	1.0	1.6	NA
2001	2	3.6	5.6	1.8
2001	3	2.1	3.7	6.4
2001	4	4.0	5.8	NA
2002	1	-0.7	0.5	NA
2002	2	3.4	5.3	1.2
2002	3	2.9	4.7	6.7
2002	4	3.6	5.6	NA
2003	1	0.2	1.5	NA
2003	2	3.6	5.5	4.4
2003	3	4.4	4.5	6.4
2003	4	3.0	4.5	NA
2004	1	2.1	2.1	NA
2004	2	4.1	6.1	4.6
2004	3	4.5	5.2	6.7
2004	4	3.5	4.7	NA
2005	1	2.7	1.2	NA
2005	2	3.7	6.3	3.2
2005	3	4.6	4.1	5.4
2005	4	6.6	11.4	NA
2006	1	1.5	2.8	NA
2006	2	3.8	5.7	4.5
2006	3	4.1	5.3	5.0
2006	4	3.7	6.0	NA
2007	1	2.9	4.2	NA
2007	2	3.2	5.5	4.4
2007	3	3.6	5.2	6.1
2007	4	3.4	5.2	NA
2008	1	2.3	2.7	NA

Year	Quarter	NPD at Highway 17 (µR/hr)	NPD Car Park (µR/hr)	Point Stewart (µR/hr)
2008	2	3.8	5.6	4.4
2008	3	4.0	5.6	5.8
2008	4	3.4	4.9	NA
2009	1	1.8	3.9	NA
2009	2	3.2	5.3	3.7
2009	3	2.9	5.5	5.9
2009	4	3.0	5.9	NA
2010	1	0.4	4.6	NA
2010	2	1.4	3.6	NA
2010	3	5.7	6.6	NA
2010	4	6.4	5.8	NA
2011	1	1.7	2.6	NA
2011	2	6.7	6.3	5.6
2011	3	5.4	6.3	5.8
2011	4	6.3	6.3	NA
2012	1	3.2	4.4	NA
2012	2	6.1	6.3	4.5
2012	3	5.7	6.9	5.8
2012	4	6.0	5.9	NA
2013	1	4.4	7.3	NA
2013	2	6.6	6.3	3.5
2013	3	5.7	6.6	6.0
2013	4	5.6	5.5	NA
2014	1	3.0	4.3	NA
2014	2	6.0	6.1	4.2
2014	3	5.1	5.7	5.2
2014	4	6.8	6.0	NA
2015	1	3.1	3.9	NA
2015	2	7.2	6.0	6.2
2015	3	5.9	5.6	5.3
2015	4	6.6	6.5	NA
2016	1	3.7	4.5	NA
2016	2	5.7	5.5	4.5
2016	3	5.7	5.9	4.4
2016	4	5.5	5.1	NA

Notes:

NA – Not Applicable (i.e., no data).

In the above table, R is for Roentgens for which the conversion to SI unit is 1 R = 0.0088 Gray.



Legend

- Guardhouse
- Pumphouse
- Parking
- Ambient Gamma Monitoring Locations
- Wetland
- Road
- Trail
- Landfill
- Local Study Area
- Site Study Area
- NPDWF

0 150 300 600 Meters

Ambient Gamma Dose Rate (µR/hr)

ARCADIS

Date: **September, 2017**

351240-000

Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

As seen in the figure above, since the NPDNGS was permanently shut down in 1987, there have been no anomalies in data on ambient radiation fields provided by the TLDs that are located near the NPD site.

Ambient radiation fields were lowest during the first quarters, when snow cover provides partial shielding of radiation from the ground. There was a slight decrease in recorded ambient radiation fields between the start of the post-shutdown monitoring period and 1997. Variations since then have shown no clearly definable trends, and the radiation fields are characteristic of those observed in regions with similar surface soils that are unaffected by nuclear facilities (Wills 2013). The ambient radiation fields are comparable to the radiation field in Ottawa of 5.7 µR/hr arising from natural cosmic and terrestrial sources (CNSC 2013a).

8.7.3 Regional Study Area

As described in Wills (2013), ambient gamma dose rates are also monitored beyond the NPD site. Table 8.7-3 gives the location of the TLD in the Regional Study Area. This TLD, T1, lies along the prevailing wind directions from the NPD site. T1 was moved to its current location at some time between 1994 and 1996, from a location in Des Joachims about half a kilometre away. Table 8.7-4 presents the measured ambient dose rates for this location.

The location and historical trends for the ambient gamma dose rates at this location is shown above in Figure 8.7-2. A maximum average monthly dose rate of 10.9 µR/h was seen in the fourth quarter of 1993.

Table 8.7-3. Location of the TLD Station Located Near NPD (Source: (Wills 2013))

Location	ETB Code	NPD Code	Easting (m)	Northing (m)
Des Joachims (Fraser's)	T28	T1	292354	5119264

Table 8.7-4. Quarterly Ambient Gamma Radiation in Air at the Des Joachims TLD Station (Source: (Wills 2013))

Year	Quarter 1 (µR/hr)	Quarter 2 (µR/hr)	Quarter 3 (µR/hr)	Quarter 4 (µR/hr)	Average (µR/hr)
1972 - 1987	Average over the years 1972-1987				9.3
1988				6.5	6.5
1989	7.8	5.8		7.7	7.1
1990	3.4	6.4	4.6	6.8	5.3
1991	5.5	7.4	7.2	8.1	7.1
1992	6.0	7.4	5.7	7.1	6.6
1993	8.0	7.4	7.1	10.9	8.4
1994	5.8	6.7	6.7	6.0	6.3
1995	5.5	7.0	6.8		6.4
1996	3.1	6.2			4.7
1997	4.2	6.0	4.9	5.6	5.2
1998	3.3	6.3	3.9	5.7	4.8
1999	4.6	6.0	5.1	6.1	5.5
2000	3.3	6.0	4.1		4.5
2001	2.7	5.6	4.1	6.8	4.8
2002	2.8	6.2	4.7	5.2	4.7
2003	3.5	6.3	5.1	2.6	4.4
2004	2.6	5.8	5.9	4.7	4.8
2005	2.1	5.2	5.1	8.7	5.3
2006	3.3	4.6	5.5	4.3	4.4
2007	4.8	5.0	5.1	4.1	4.8
2008	4.1	4.7	5.5	4.6	4.7
2009	3.2	4.7	5.2	4.9	4.5
2010	2.6	3.8	6.2	7.4	5.0
2011	4.2	8.0	6.1	7.4	6.4
2012	4.4	7.5	7.5	7.1	6.6
2013	9.5	8.9	7.1	7.3	8.2
2014	4.7	7.5	6.6	7.5	6.6
2015	4.3	5.0	7.0	7.6	6.0
2016	4.3	6.2	6.0	6.5	5.8

In the above table, R is for Roentgens for which the conversion to SI unit is 1 R = 0.0088 Gray.

8.8 Human Health

8.8.1 Spatial Boundaries

The Site and Local Study Areas for human health are the same as those delineated in Figure 5.2-1 and Figure 5.2-2 respectively. As this area is all owned by the Federal Government, there are no residents present. Workers are, and will continue to be, present in this area for the duration of the decommissioning, and as such the Site/Local Study Areas will describe baseline worker health.

The Regional Study Area for this assessment consists of the Renfrew County and District and Region de l'Outaouais Health Units, illustrated in Figures 8.8-1 and 8.8-2. Renfrew County has a land area of 14,980 km^2 and a population of approximately 103,000. The Region de l' Outaouais has a land area of 30,760 km^2 and a population of approximately 369,000.

Figure 8.8-1. Southern Ontario Health Regions - Renfrew County and District Health Unit is #3557, near the top of the figure (Source: Statistics Canada)

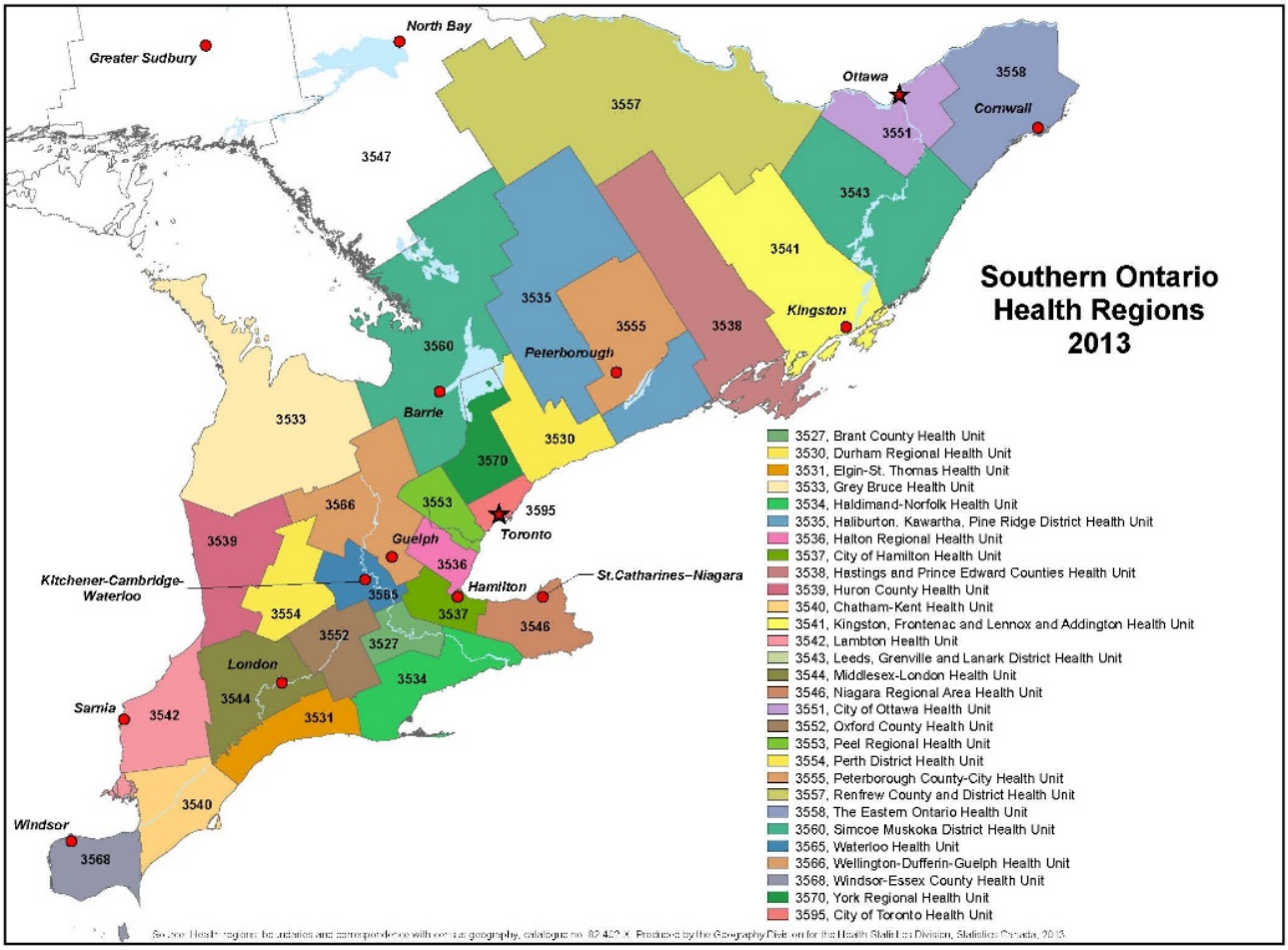
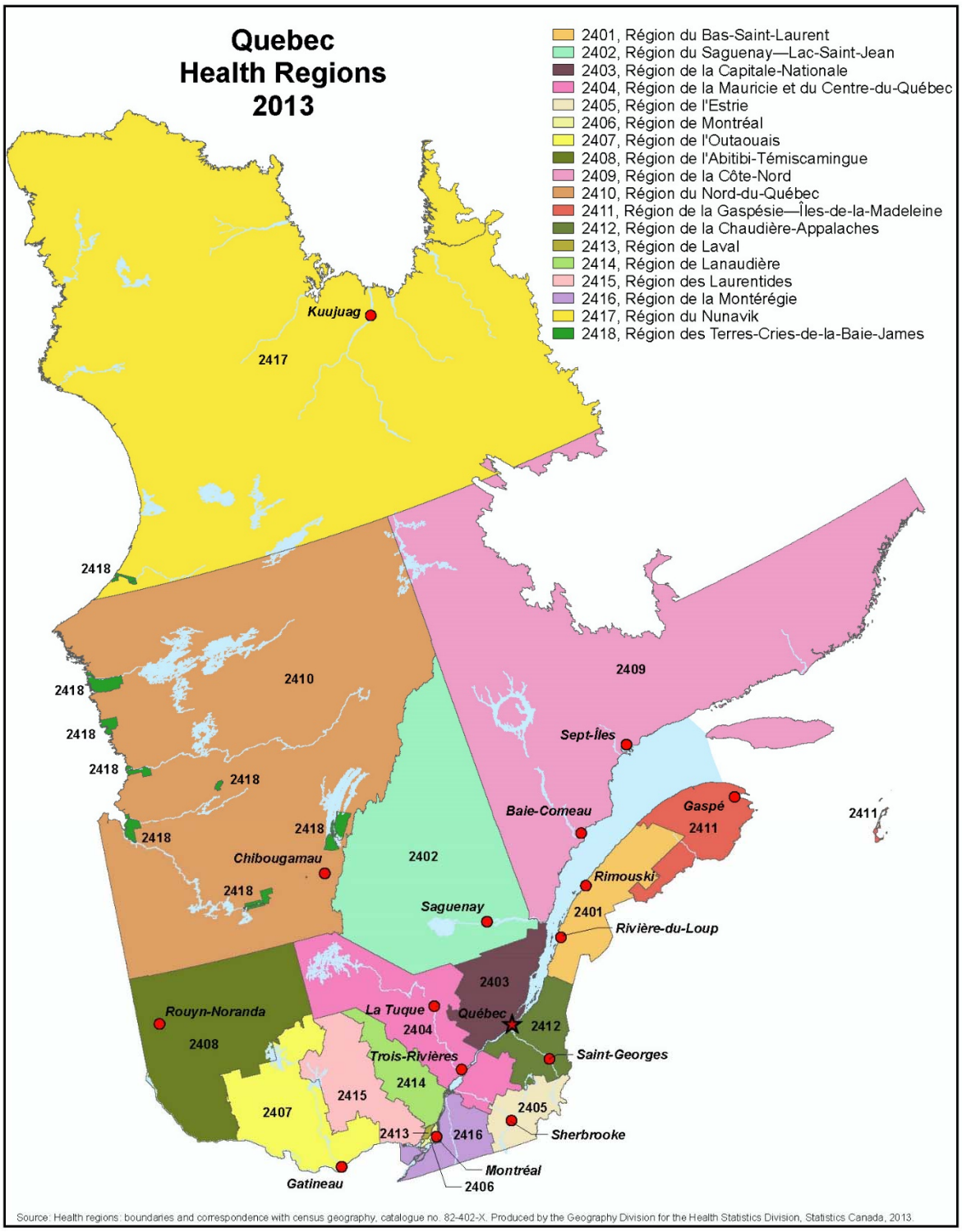


Figure 8.8-2. Quebec Health Regions – Region de l'Outaouais is #2407 (Source: Statistics Canada)



8.8.2 Site/Local Study Area

As discussed above, there are not residents present within the Site/Local Study Area, as it is owned by the Federal Government. The only people present in the Site/Local Study Area are workers and visitors. Workers are assumed to live within the Regional Study Area. As such, the results presented for the Regional Study Area are also applicable to the workers at the site. In addition to the information presented for the Regional Study Area, worker health information is also presented here.

No CNL employees received measurable doses above 100 µSv (10 mrem) at the NPDWF for the year of 2015. The highest dose received by CNL employees was 10 µSv (1 mrem) by a radiation surveyor, utility worker and field specialist. The highest dose received by a contractor was 120 µSv (12 mrem) by a contract radiation surveyor. A licensed asbestos worker also received the same dose over this period. No doses were received by any visitor in 2015. Table 8.8-1 shows the measured whole body and collective doses for workers (both CNL employees and contractors) and visitors (Primeau 2016).

Table 8.8-1. Whole Body and Collective Dose for Workers and Visitors at NPD for 2015 (Primeau 2016)

Work Group	Number of Persons	Whole-Body Dose Including Tritium Plus Committed Effective Dose from Non-Tritium Intakes			Collective (Person mSv)				
		Average (mSv)	Maximum (mSv)	Collective (Person mSv)	Surface Dose including Tritium	Tritium Dose	Non-Tritium Committed Effective Dose	Neutron Dose	Extremity Dose
CNL employees	175	0.0017	0.01	0.03	0.03	0	0	0	0
Contractors	36	0.009	0.12	0.35	0.35	0	0	0	0
Visitors	18	0	0	0	0	0	0	0	0
NPDWF Site	**229**	**0.0017**	**0.12**	**0.38**	**0.38**	**0**	**0**	**0**	**0**

Similarly, in 2014, the highest individual dose of any CNL employee at NPDWF was 0.28 mSv which is representative of a cumulative dose from operational activities over the reporting period. No whole-body radiation doses greater than 0.1 mSv/person was recorded for contractors or visitors to the NPDWF (Neville 2015).

In 2013, no whole-body radiation dose greater than 0.05 mSv was recorded for workers or visitors to NPD during any four-week period in 2013. The radiation fields in the facility remain very low and this, coupled with the short duration of time required to perform routine maintenance and inspections result in the low dose. The dose of 0.05 mSv is the lower level of reporting for CNL's dosimetry services at Chalk River Laboratories (Primeau 2016).

These doses are all very low, well below both regulatory limits and nuclear energy worker (NEW) dose criteria, and are not expected to have any effects on worker health.

8.8.3 Regional Study Area

8.8.3.1 Statistics Canada Health Profiles

The Public Health Agency of Canada (PHAC), a federal agency within the Ministry of Health Portfolio, states that "any analysis of the health of the population must extend beyond an assessment of traditional health status indicators like death, disease and disability. A population health approach establishes indicators related to mental and social well-being, quality of life, life satisfaction, income, employment and working conditions, education and other factors known to influence health" (PHAC 2016). Data related to many of the above factors are collected and compiled by Statistics Canada, based on geographic health region (Statistics Canada Health Profiles 2013). The health profile data collected and compiled by Statistics Canada includes a number of characteristics. The following have been selected as the focus of the baseline health assessment:

- Well-being: includes perceived health, mental health and life stress;
- Health Conditions: including but not limited to overweight/obesity, arthritis, diabetes, mood disorder, pain or discomfort, injuries, strokes and cancer incidences;
- Health Behaviours: includes smoking, drinking, leisure-time physical activity, fruit and vegetable consumption and use of bike helmet;
- Human Function: includes participation and activity limitation, and functional health;
- Mortality and Diseases (classified under Deaths by Statistics Canada): including but not limited to infant mortality, life expectancy, deaths from cancers, circulatory diseases and respiratory diseases, suicide and premature mortality.

Ontario and Renfrew County

Table 8.8-2 presents the statistical data for the above characteristics for Renfrew County and District Health Unit, as well as for the province of Ontario as a whole.

Table 8.8-2. Health Characteristics Data for Renfrew County and District Health Unit and the Province of Ontario. Adapted from Statistics Canada Health Profile (2013)

	Note	Renfrew County and District Health Unit (Health Region)		Ontario (Province)		Statistically Significant Difference?
Characteristic		Population	Rate	Population	Rate	
Well-being						
Perceived health; very good or excellent (%)		89863	56.8%	11129303	60.4%	-
Perceived mental health; very good or excellent (%)		89863	67.6%	11129303	72.4%	-
Perceived life stress (%)		86545	19.9%	10671050	22.8%	-
Health Conditions						
Overweight or obese (%)	*	102620	56.9%	12851820	52.6%	+
Overweight (%)	*	102620	34.3%	12851820	34.3%	~
Obese (%)	*	102620	22.6%	12851820	18.3%	+
Arthritis (%)		86545	19.9%	10671050	17.2%	+
Diabetes (%)		89863	6.9%	11129303	6.6%	+
Asthma (%)		89863	8.1%	11129303	7.9%	+
High blood pressure (%)		89863	21.7%	11129303	17.6%	+
Mood disorder (%)		89863	9.9%	11129303	7.6%	+
Pain or discomfort; moderate or severe (%)		89863	16.7%	11129303	14.2%	+
Pain or discomfort that prevents activities (%)		89863	16.2%	11129303	15.7%	+
Low birth weight (% of live births)	1	985	5.3%	135,930	6.2%	~
Chronic obstructive pulmonary disease (COPD) (%)		61925	3.9%	7339020	3.8%	~
Injuries within the past 12 months causing limitation of normal activities (%)		89863	..	11129303	..	Not Calculated
Injuries in the past 12 months; sought medical attention (%)		89863	..	11129303	..	Not Calculated
Hospitalized stroke event rate (per 100000 population)		80205	139	9807415	119	~
Hospitalized acute myocardial infarction event rate (per 100000 population)		80205	201	9807415	198	~
Injury hospitalization (per 100000 population)	*	102620	532	12851820	409	+

	Note	Renfrew County and District Health Unit (Health Region)		Ontario (Province)		Statistically Significant Difference?
Characteristic		Population	Rate	Population	Rate	
Cancer incidence (per 100000 population)	*	102620	424	12851820	398.8	~
Colon cancer incidence (per 100000 population)	*	102620	50.2	12851820	47.8	~
Lung cancer incidence (per 100000 population)	*	102620	56.7	12851820	49.2	~
Breast cancer incidence (per 100000 population)	2	51405	82.3	6588685	97.8	~
Prostate cancer incidence (per 100000 population)	3	51210	126.5	6263140	135.7	~
Health Behaviours						
Current smoker; daily or occasional (%)		89863	22.2%	11129303	19.2%	+
Current smoker; daily (%)		89863	18.2%	11129303	14.4%	+
Heavy drinking (%)		89863	19.5%	11129303	16.9%	+
Leisure-time physical activity; moderately active or active (%)		89863	54.2%	11129303	53.8%	+
Fruit and vegetable consumption; 5 times or more per day (%)	*	102620	37.3%	12851820	38.9%	-
Bike helmet use (%)		89863	21.8%	11129303	36.1%	-
Participation and activity limitation; sometimes or often (%)		89863	..	11129303	..	Not Calculated
Functional health; good to full (%)		89863	..	11129303	..	Not Calculated
Infant mortality (per 1000 live births)	1	985	5.5	135,930	5.1	~
Life expectancy at birth (years)		N/A	81	N/A	81.5	Not Calculated
Life expectancy at age 65 (years)		N/A	20	N/A	20.3	Not Calculated
Total; all causes of death (per 100000 population)	*	102620	599.2	12851820	521.8	+
All cancers; deaths (per 100000 population)	*	102620	182	12851820	159.1	~
Colorectal cancer; deaths (per 100000 population)	*	102620	22.9	12851820	17	~
Lung cancer; deaths (per 100000 population)	*	102620	50	12851820	40.3	~
Breast cancer; deaths (per 100000 population)	*	102620	12.5	12851820	12	~
Prostate cancer; deaths (per 100000 population)	*	102620	10	12851820	8	~

	Note	Renfrew County and District Health Unit (Health Region)		Ontario (Province)		Statistically Significant Difference?
Characteristic		Population	Rate	Population	Rate	
Circulatory diseases; deaths (per 100000 population)	*	102620	189.6	12851820	155.6	+
Ischaemic heart diseases; deaths (per 100000 population)	*	102620	105.8	12851820	86.9	+
Cerebrovascular diseases; deaths (per 100000 population)	*	102620	35.9	12851820	30.7	~
All other circulatory diseases; deaths (per 100000 population)	*	102620	47.8	12851820	38	~
Respiratory diseases; deaths (per 100000 population)	*	102620	42.6	12851820	41.3	~
Pneumonia and influenza; deaths (per 100000 population)	*	102620	8.8	12851820	11.2	~
Bronchitis; emphysema and asthma; deaths (per 100000 population)	*	102620	2.5	12851820	2.2	~
All other respiratory diseases; deaths (per 100000 population)	*	102620	31.3	12851820	27.8	~
Unintentional injuries; deaths (per 100000 population)	*	102620	32.6	12851820	23.4	~
Suicides and self-inflicted injuries; deaths (per 100000 population)	*	102620	7.3	12851820	7.7	~
Human immunodeficiency virus [HIV] disease; deaths (per 100000 population)	*	102620	x	12851820	0.9	Not Calculated
Premature mortality (per 100000 population)	*	102620	254	12851820	239	~

Notes

.	Not available for any reference period	x	Suppressed to meet the confidentiality requirements of the Statistics Act
..	Not available for a specific reference period	*	assumed whole population
...	Not applicable	1	number of live births
E	Use with caution	2	assumes whole population (Females only)
F	Too unreliable to be published	3	assumes whole population (Males only)

Table 8.8-3. Legend for Statistically Significant Difference Assessment

Symbol	Meaning
-	Renfrew County and District Health Unit shows statistically significant lower responses than Ontario
+	Renfrew County and District Health Unit shows statistically significant higher responses than Ontario
~	No statistically significant difference between the Renfrew County and District Health Unit and Ontario
Not Calculated	Statistical significance not calculated due to lack of information

A two-sided T-test was used to compare the health characteristics between the Renfrew County and District Health Unit and Ontario based on the data obtained from Statistics Canada 2013 Health Profile, as shown in Table 8.8-2. Differences that are statistically significant at α=0.05 level were identified in the last column, with green color denoting a lower percentage in the Renfrew County and District Health Unit area and blue color denoting a higher percentage in the Renfrew County and District Health Unit area when compared to the provincial level in Ontario.

Lower percentages in perceived well-being (both health and mental health) were observed in the Renfrew County and District Health Unit when compared to the provincial percentages. Higher rates of certain health conditions were also observed in the Renfrew County and District Health Unit than in Ontario: obesity, arthritis, diabetes, asthma, high blood pressure, mood disorder, pain or discomfort and injury hospitalization. For health behaviours, percentage of smokers and drinkers are higher in the Renfrew County and District Health Unit than in Ontario. Though more physically active, the residents in the Renfrew County and District Health Unit are less likely to use bike helmet and consume less fruit and vegetable than the average residents in Ontario.

A slightly higher overall death rate was observed in the Renfrew County and District Health Unit for the year where the data was assessed. Specifically, death rates from circulatory diseases and ischaemic heart diseases in the Renfrew County and District Health Unit are slightly higher than the provincial averages.

Quebec and Region de l'Outaouais

Table 8.8-4 presents the statistical data for the above characteristics for Region de l'Outaouais (Health Region), as well as for the province of Quebec as a whole.

Table 8.8-4. Health Characteristics Data for Région de l'Outaouais (Health Region) and the Province of Quebec. Adapted from Statistics Canada Health Profile (2013)

	Note	Région de l'Outaouais (Health Region)		Quebec (Province)		Statistically Significant Difference?
Characteristic		Population	Rate	Population	Rate	
Well-being						
Perceived health; very good or excellent (%)		318605	62.5%	6895303	59.5%	+
Perceived mental health; very good or excellent (%)		318605	72.3%	6895303	74.9%	-
Perceived life stress (%)		306005	30.3%	6644380	27.3%	+
Health Conditions						
Overweight or obese (%)	*	369170	54.2%	7903000	50.5%	+
Overweight (%)	*	369170	35.3%	7903000	33.4%	+
Obese (%)	*	369170	18.9%	7903000	17.1%	+
Arthritis (%)		306005	16.1%	6644380	13.7%	+
Diabetes (%)		318605	5.8%	6895303	6.2%	-
Asthma (%)		318605	13.2%	6895303	8.9%	+
High blood pressure (%)		318605	16.7%	6895303	17.2%	-
Mood disorder (%)		318605	9.9%	6895303	5.0%	+
Pain or discomfort; moderate or severe (%)		318605	15.6%	6895303	14.8%	+
Pain or discomfort that prevents activities (%)		318605	13.2%	6895303	12.7%	+
Low birth weight (% of live births)	1	3879	5.4%	80,890	5.7%	~
Chronic obstructive pulmonary disease (COPD) (%)		210725	7.8%	4641105	4.6%	+
Injuries within the past 12 months causing limitation of normal activities (%)		318605	..	6895303	..	Not Calculated
Injuries in the past 12 months; sought medical attention (%)		318605	..	6895303	..	Not Calculated
Hospitalized stroke event rate (per 100000 population)		281550	.	6152400	.	Not Calculated
Hospitalized acute myocardial infarction event rate (per 100000 population)		281550	237	6152400	219	+
Injury hospitalization (per 100000 population)	*	369170	443	7903000	512	-

	Note	Région de l'Outaouais (Health Region)		Quebec (Province)		Statistically Significant Difference?
Characteristic		Population	Rate	Population	Rate	
Cancer incidence (per 100000 population)	*	369170	408.2	7903000	413.4	~
Colon cancer incidence (per 100000 population)	*	369170	57.5	7903000	52.4	~
Lung cancer incidence (per 100000 population)	*	369170	68.7	7903000	70.1	~
Breast cancer incidence (per 100000 population)	2	187990	98.2	4027140	100.6	~
Prostate cancer incidence (per 100000 population)	3	181180	97.1	3875860	96.5	~
Health Behaviours						
Current smoker; daily or occasional (%)		318605	26.3%	6895303	22.4%	+
Current smoker; daily (%)		318605	22.1%	6895303	17.3%	+
Heavy drinking (%)		318605	16.4%	6895303	18.7%	-
Leisure-time physical activity; moderately active or active (%)		318605	51.4%	6895303	50.1%	+
Fruit and vegetable consumption; 5 times or more per day (%)	*	369170	44.7%	7903000	46.8%	-
Bike helmet use (%)		318605	..	6895303	..	Not Calculated
Human Function						
Participation and activity limitation; sometimes or often (%)		318605	..	6895303	..	Not Calculated
Functional health; good to full (%)		318605	..	6895303	..	Not Calculated
Mortality and Diseases						
Infant mortality (per 1000 live births)	1	3879	3.2	80,890	4.7	~
Life expectancy at birth (years)		N/A	80.1	N/A	81.2	Not Calculated
Life expectancy at age 65 (years)		N/A	19.1	N/A	20.1	Not Calculated
Total; all causes of death (per 100000 population)	*	369170	611.1	7903000	549.9	+
All cancers; deaths (per 100000 population)	*	369170	204	7903000	183.4	+
Colorectal cancer; deaths (per 100000 population)	*	369170	24.1	7903000	21.9	~
Lung cancer; deaths (per 100000 population)	*	369170	67.9	7903000	56.4	+
Breast cancer; deaths (per 100000 population)	*	369170	13	7903000	13	~
Prostate cancer; deaths (per 100000 population)	*	369170	8.8	7903000	7	~

	Note	Région de l'Outaouais (Health Region)		Quebec (Province)		Statistically Significant Difference?
Characteristic		Population	Rate	Population	Rate	
Circulatory diseases; deaths (per 100000 population)	*	369170	161.8	7903000	142.9	+
Ischaemic heart diseases; deaths (per 100000 population)	*	369170	92.6	7903000	77.5	+
Cerebrovascular diseases; deaths (per 100000 population)	*	369170	26.9	7903000	25.8	~
All other circulatory diseases; deaths (per 100000 population)	*	369170	42.4	7903000	39.6	~
Respiratory diseases; deaths (per 100000 population)	*	369170	50.4	7903000	47.2	~
Pneumonia and influenza; deaths (per 100000 population)	*	369170	9	7903000	10.1	~
Bronchitis; emphysema and asthma; deaths (per 100000 population)	*	369170	1.7	7903000	2.5	~
Unintentional injuries; deaths (per 100000 population)	*	369170	23.7	7903000	23.4	~
Suicides and self-inflicted injuries; deaths (per 100000 population)	*	369170	13.2	7903000	14	~
Human immunodeficiency virus [HIV] disease; deaths (per 100000 population)	*	369170	1.1	7903000	1.2	~
Premature mortality (per 100000 population)	*	369170	293.3	7903000	251.1	+

Notes

.	Not available for any reference period	x	Suppressed to meet the confidentiality requirements of the Statistics Act
..	Not available for a specific reference period	*	assumed whole population
...	Not applicable	1	number of live births
E	Use with caution	2	assumes whole population (Females only)
F	Too unreliable to be published	3	assumes whole population (Males only)

Table 8.8-5. Legend for Statistically Significant Difference Assessment

Symbol	Meaning
-	Renfrew County and District Health Unit shows statistically significant lower responses than Ontario
+	Renfrew County and District Health Unit shows statistically significant higher responses than Ontario
~	No statistically significant difference between the Renfrew County and District Health Unit and Ontario
Not Calculated	Statistical significance not calculated due to lack of information

A two-sided T-test was used to compare the health characteristics between the Région de l'Outaouais and Quebec based on the data obtained from Statistics Canada 2013 Health Profile, as shown in Table 8.8-2. Differences that are statistically significant at α=0.05 level were identified in the last column, with green color denoting a lower percentage in the Région de l'Outaouais and blue color denoting a higher percentage in the Région de l'Outaouais when compared to the provincial level in Quebec.

A higher percentage in perceived well-being (health) was observed in the Région de l'Outaouais when compared to the provincial percentages; however, perceived mental health well-being was perceived to be lower in Région de l'Outaouais. Higher rates of certain health conditions were also observed in the Région de l'Outaouais than in Quebec, including: obesity, arthritis, asthma, mood disorder, pain or discomfort, COPD, and hospitalization for acute myocardial infarction events. For health behaviours, percentage of smokers are higher in the Région de l'Outaouais than in Quebec.

A slightly higher overall death rate was observed in the Région de l'Outaouais for the year where the data was assessed. Specifically, death rates from circulatory diseases and cancers are slightly higher in Région de l'Outaouais than the provincial averages.

8.8.3.2 Childhood Leukemia Around Nuclear Facilities

In the late 1980s and early 1990s, the then Atomic Energy Control Board (AECB), now the CNSC, conducted a large, two-phase study to investigate the incidence and mortality of leukemia in children living around nuclear facilities in the province of Ontario, including the NPDWF. The studies looked at data from the Ontario Cancer Registry, for children up to age 14, for areas around the facility as well as the general population of Ontario.

The AECB studies did not find evidence of increased risk of childhood leukemia in the vicinity of the NPDWF. The occurrence of leukemia in the areas surrounding NPDWF was lower than expected, for the area surrounding Rolphton as well as for the entire Renfrew County. These findings were observed based on assessment of residence at birth and assessment of residence at death. The overall conclusion was that the occurrence of childhood leukemia was less than expected and within the bounds of chance variation in the vicinity of the nuclear facilities in Renfrew County (i.e., both, NPDWF and CRL) (Clarke *et al.* 1991).

This is consistent with the findings of the CNSC's study of radiation doses to populations living near Ontario's three nuclear power plants (i.e., Pickering, Darlington and Bruce NGSs). The study, called "Radiation and Incidence of Cancer Around Ontario Nuclear Power Plants from 1990 to 2008", found no evidence of childhood leukemia clusters around the three Ontario NPPs. The rates of cancer incidence for children aged 0–4 and aged 0–14 were similar to the general Ontario population (CNSC 2013b).

8.8.3.3 Local Food Consumption

This section provides information on the local food consumption characteristics for people living in the Regional Study Area, based on the NPD DRL Study (Chouhan and Scheier 2011). The following assumptions were made in developing DRLs:

- Resident groups grow fruits, vegetables and potatoes in a garden that is irrigated by river water (relevant for aquatic releases only);

- The farm groups are also assumed to grow fruits, vegetables and potatoes, at a larger scale;
- Resident groups buy some local meat from a local butcher shop (locally-raised meat);
- Farm groups are assumed to raise other animals for their own consumption (i.e., not for sale);
- Resident and farm groups hunt local deer; and
- Local residents and cottage residents fish in the Ottawa River (relevant for aquatic releases only).

Table 8.8-6 presents the local food consumption percentages that were assumed in the DRL study.

Table 8.8-6. Percentage of Food from Local Sources (Source: Chouhan and Scheier 2011)

Receptor Group	Animal Products							Plant Products			Fish
	Beef	Pork	Poultry	Lamb	Venison	Eggs	Cow Milk*	Fruit	Garden Vegetables	Potatoes	
Airborne Effluents											
Rapides-des-Joachims, Point Stewart and Rolphton residential	10	0	0	0	100	0	0	10	20	20	0
Cottage	0	0	0	0	0	0	0	0	0	0	0
Mackey Beef Farm	100	50	50	100	100	50	20	20	50	50	0
Bass Lake beef farm	100	50	50	0	100	50	20	20	50	50	0
Liquid Effluents											
Cottage	0	0	0	0	0	0	0	0	0	0	100
Point Stewart residential	0	0	0	0	0	0	0	10	20	20	50
Deep River residential	0	0	0	0	0	0	0	10	20	20	50

Note:

* Milk values may be different for breast feeding infants or infants fed on formula.

8.8.3.4 Local Water Use

The majority of people within the Regional Study Area obtain their domestic water (used for ingestion, washing, bathing, and swimming) from groundwater wells. It is noted in the PostSA TSD that these wells draw water from deep aquifers. The farm groups also obtain all of their water from wells, including that used to raise livestock. Most residents of Deep River have access to a municipal water supply, which is pulled from the river. Residents of Deep River and Point Stewart, as well as the cottage group, may also use the Ottawa River for swimming during the summer months (Chouhan and Scheier 2011).

8.9 Aboriginal Land and Resource Use

Information for this section was derived from the Aboriginal Engagement Report (AER) TSD. As noted in the AER TSD, engagement on traditional land and resource use has so far been limited. Information has been drawn largely from: preliminary formal and informal engagement activities; existing studies and reports; and general knowledge of the region and local Aboriginal groups, such as the Algonquins of Ontario. As the Aboriginal engagement process continues, further detail on traditional use will be obtained and confirmed.

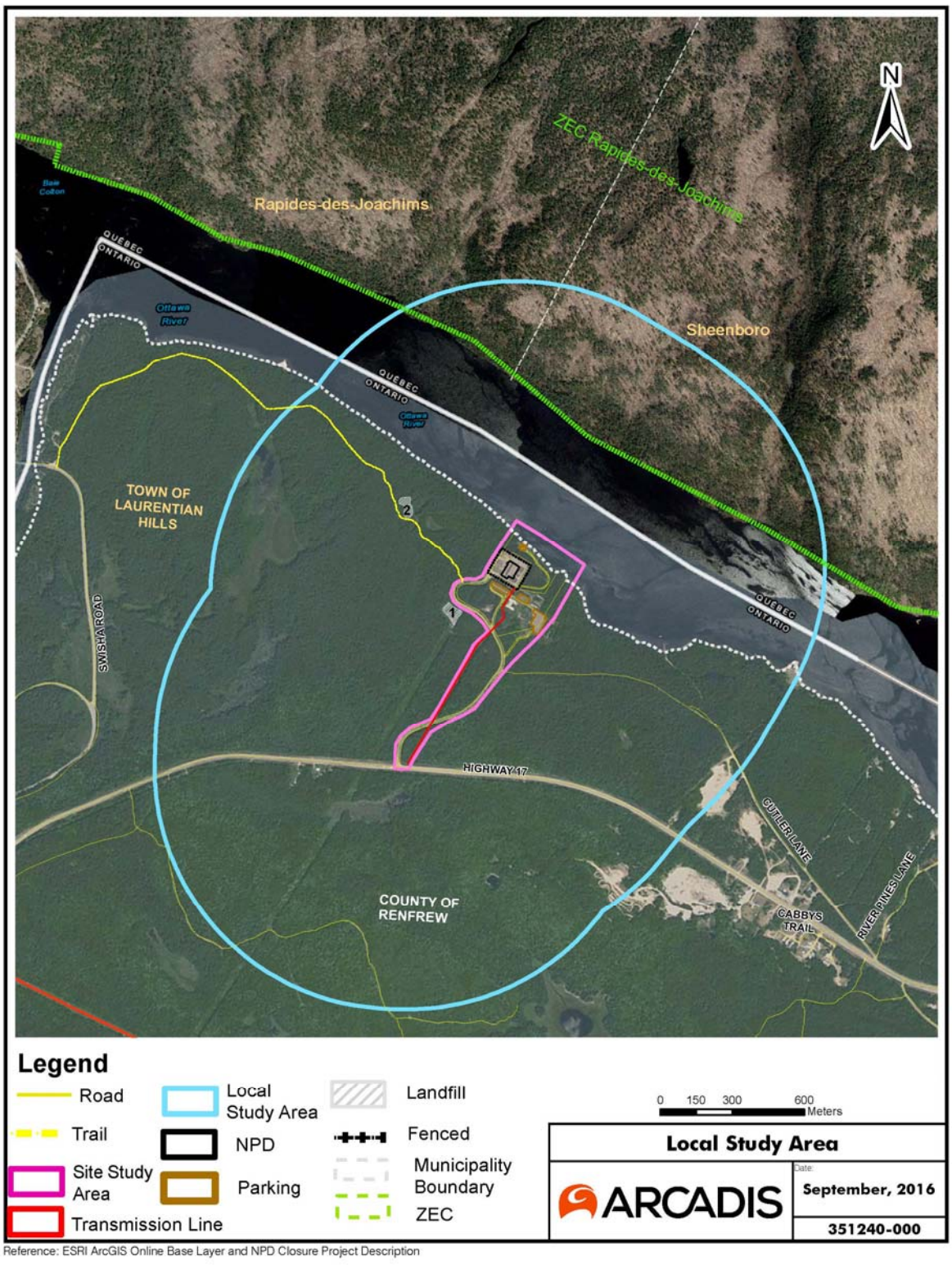
8.9.1 Spatial Boundaries

The spatial boundaries associated with the Aboriginal land and resource use environment were determined based on the potential for the project to affect First Nation and Métis communities and their use of land in proximity to the facility for traditional purposes. These spatial boundaries fall within a much broader area of traditional land use.

The Site Study Area for the Aboriginal land and resource use environment is the same as the general Site Study Area defined in Figure 5.2-1 above.

The Local Study Area has been defined as the Site Study Area plus an area with a 1-km radius beyond the Site Study Area (see Figure 8.9-1 below).

Figure 8.9-1. Local Study Area

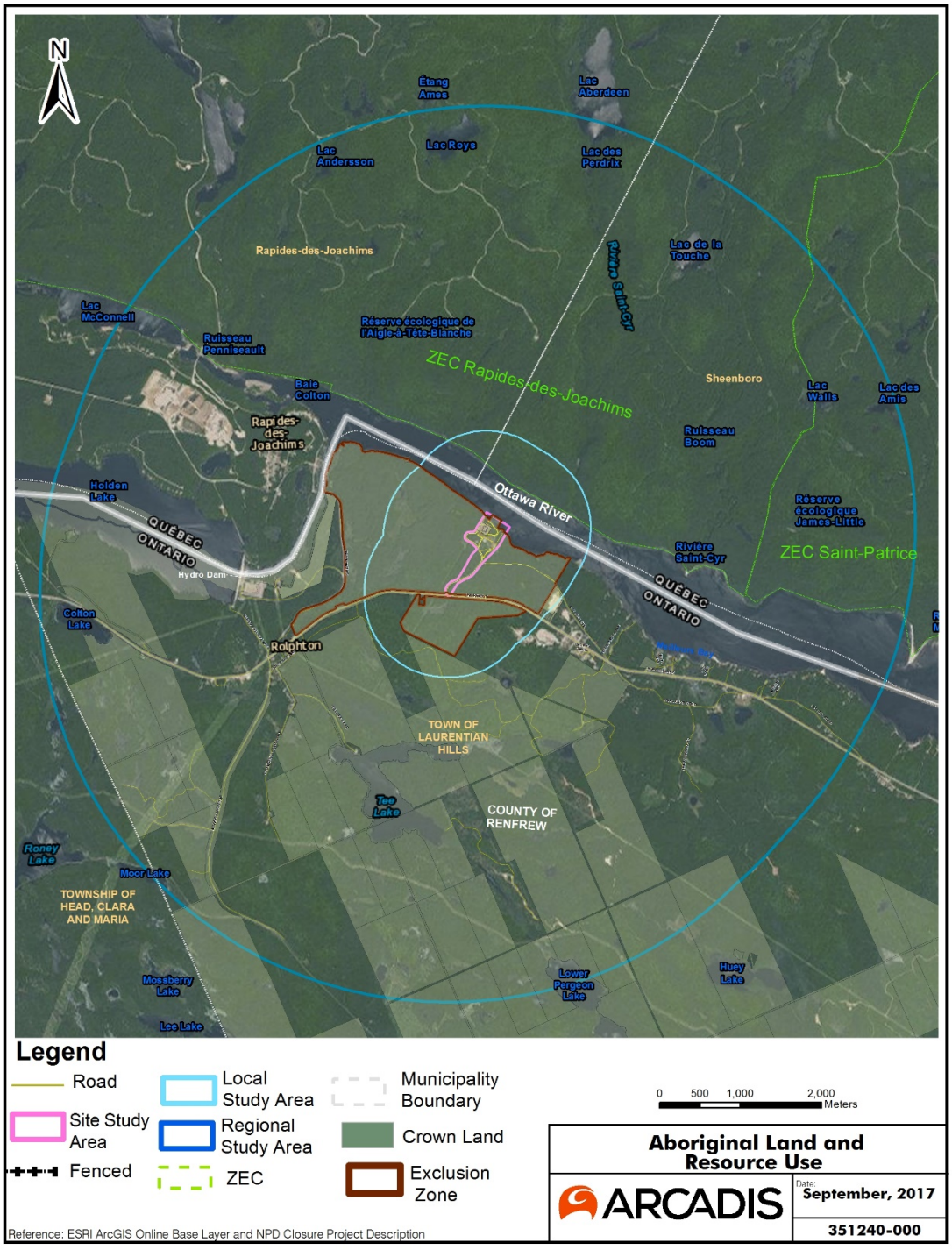


Reference: ESRI ArcGIS Online Base Layer and NPD Closure Project Description

The Regional Study Area has been defined as the Site Study Area and an area with a 5-km radius beyond the Site Study Area, as illustrated in Figure 8.9-2 below.

All of the study areas noted here are illustrated in Figure 8.9-2, along with areas of Crown land (including both federal and provincial lands).

Figure 8.9-2. Aboriginal Land and Resource Use Environment



8.9.2 Traditional Land Use

The project occurs within the general area of the Algonquins of Ontario Settlement Boundary. The area that is the subject of the Algonquin Land Claim in Ontario includes the National Capital Region, all of Renfrew County and most of Algonquin Park. As such, it is assumed that Algonquin of Ontario citizens continue to practice traditional land use activities throughout this region.

While use of the area around the NPD site by other Aboriginal peoples has not been confirmed Algonquin traditional use has occurred for a very long period of time. In the Aboriginal Background Information Report to the Forest Management Plan for the Ottawa Valley Forest (OVF) 2011 to 2021 it was indicated that:

> "*Since the 1700's the Algonquins were known to spend the majority of the year occupying the different parts of the Ottawa Valley hunting, fishing, trapping and gathering among other things. These activities necessitated use of timber and other resources.*" (OVF 2011b)

The Algonquins of Ontario website describes the importance of traditional harvest:

> "*The harvesting of flora and fauna for food and trade has been integral to the Algonquin way of life since time immemorial. These practices embody an inherent respect for the environment and a fundamental commitment to the sustainable management of resources which has been passed from generation to generation.*
>
> *The Algonquins of Ontario (AOO) are comprised of ten Algonquin communities, including the Algonquins of Pikwàkanagàn First Nation, Antoine, Kijicho Manito Madaouskarini (Bancroft), Bonnechere, Greater Golden Lake, Mattawa/North Bay, Ottawa, Shabot Obaadjiwan, Snimikobi and Whitney and Area.*
>
> *The rights of Aboriginal people in Canada to engage in traditional activities, including the harvesting of wildlife, fish, migratory birds and plants, is recognized by the Constitution Act, 1982 and upheld by the Supreme Court of Canada. As stewards of our ancestral lands, the AOO recognize the importance of exercising this right in a responsible manner.*" (AOO 2017a)

The Algonquins of Ontario further re-iterated the importance of traditional harvest in their Agreement-In-Principle with the Governments of Ontario and Canada. In Chapter 8 it is indicated that:

> "*The Final Agreement will provide that Beneficiaries have the right to Harvest Fish, Wildlife, Migratory Birds and Plants for Domestic Purposes throughout the year within the Settlement Area as further described in this Chapter.*" (AOO 2015, p. 51).

As indicated in the quotation above, the intent of such harvest is for domestic purposes and not for commercial purposes (AOO 2015).

It is likely that Aboriginal people and possibly the ancestors of the modern-day Algonquins living in the Ottawa Valley undertook traditional activities such as hunting throughout the Ottawa Valley, which would have likely included lands that are currently under federal government control.

CNL has carried out some preliminary engagement with the Algonquins of Ontario and is aware through the Agreement-in-Principle signed by the Algonquins of Ontario, provincial and federal governments that several land parcels near the NPD site (within the Local and Regional Study Areas) have been identified as “Proposed Settlement Lands” that are to be transferred to some Algonquin institution.

It is unclear what purposes these lands might be for but as they are currently Crown lands upon which Algonquins could practice traditional activities, CNL has assumed that those activities might also occur in the future. Figure 8.9-2 illustrates Crown lands (which include both federal lands) identified within the Site/Local and Regional Study Areas. The Local Study Area within Ontario is largely comprised of federal land. A large portion of the Regional Study Area within Ontario is attributed to provincial land, while much of the study areas that fall within Quebec are attributed to the province’s ZECs.

8.9.2.1 Trapping

Trapping in Ontario occurs on licenced traplines on provincial land that are administered by the MNRF. There are approximately 50 licenced trapline areas in the OVF which is slightly over 800,000 ha (OVF 2011b). Targeted species would include beaver, fisher, marten, etc. (OVF 2011a). Trapping of fur bearing animals was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. The right to trap furbearing animals is outlined in section 8.3.24 of the Algonquins of Ontario Agreement-In-Principle. The inclusion of such a chapter indicates the importance of trapping as a cultural activity to the Algonquins of Ontario.

CNL has assumed that trapping is occurring on provincial land in the OVF (and the nearby Algonquin Park Forest) by registered Algonquins who are members of one of the ten Algonquins of Ontario communities. CNL is unsure if Aboriginal individuals from other First Nations and communities are trapping in the OVF.

Site/Local Study Area

The vast majority of lands within the Ontario portion of the Local Study Area are federal lands owned by AECL with remaining lands in private tenure. A small portion of the Local Study intersects one designated Trapline Area (PE026) (MNRF 2010b).

Regional Study Area

The Regional Study Area intersects two designated Trapline Areas (PE026 and PE027) (MNRF 2010b). It is possible but not yet determined whether there are Aboriginal people holding these traplines.

As noted in the Socio-economic TSD, trapping may also be occurring by landowners on private land adjacent to the Federal lands owned by AECL as trapping on private lands is permitted. This trapping on private land may or may not be undertaken by Aboriginal people.

8.9.2.2 Hunting

Hunting is a popular activity in the OVF (OVF 2011c). Hunting was and is practiced by Aboriginal people in the Ottawa Valley. Hunting today would include moose, elk, deer (and possibly also black bear), small game (including partridge) and waterfowl.

The Algonquins of Ontario continue to hunt in the present day. The Algonquins of Ontario prepare an annual Algonquin Harvest Management Plan specifically to address the hunting of larger game including moose, elk and deer (AOO 2016). The harvesting of wildlife is outlined in section 8.3 of the Algonquins of Ontario Agreement-In-Principle. The inclusion of such a chapter indicates the importance of hunting as a cultural activity to the Algonquins of Ontario.

Site/Local Study Area

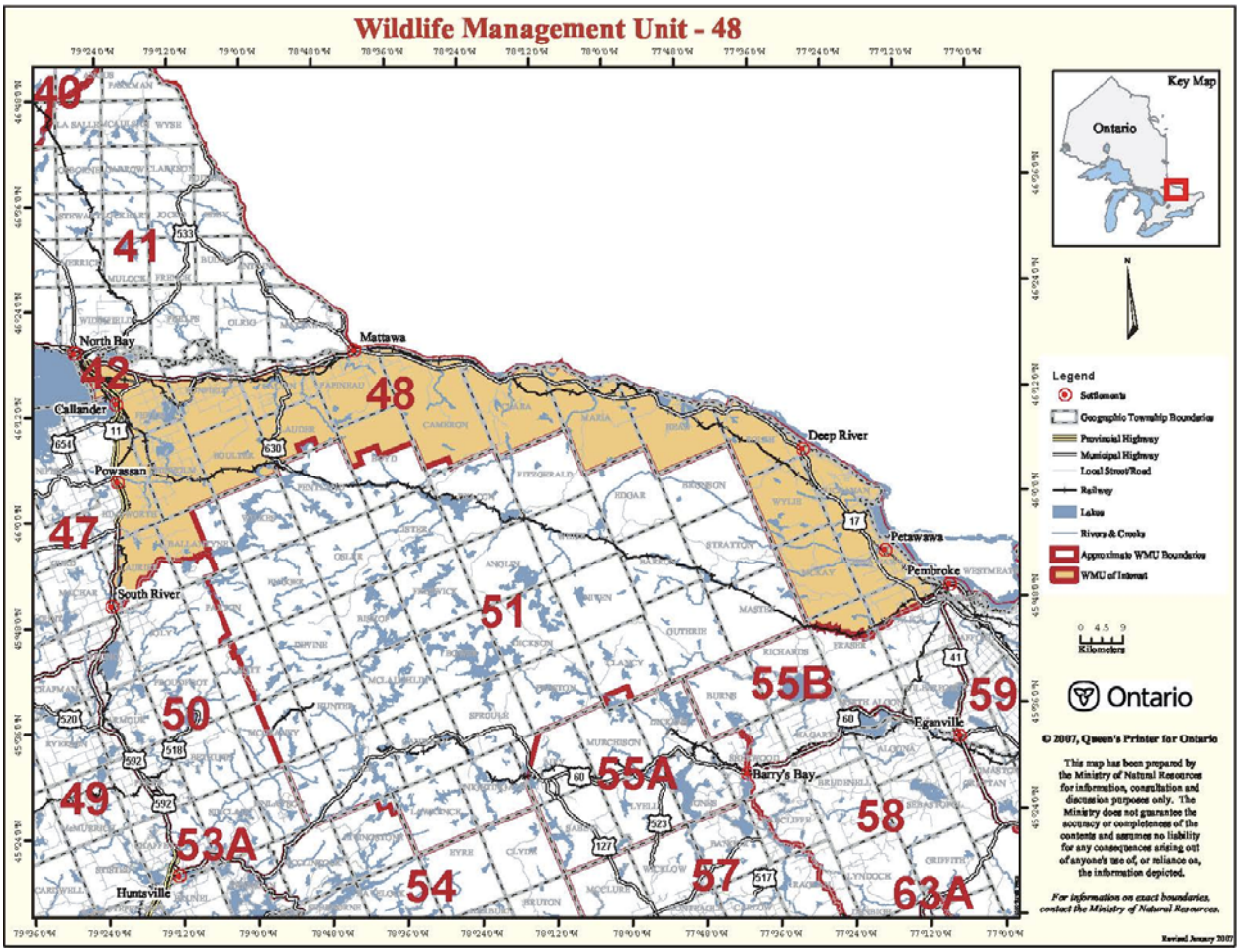
Due to restricted access (e.g., there are “no trespassing” signs and gates at roadways) to the site there is no hunting permitted on the NPD site or within the boundaries of the AECL property surrounding the NPD site. As noted above, the Local Study Area is largely comprised of Federal lands owned by AECL with some lands in private tenure. As described in the Socio-economic TSD, the Federal lands include an approximate 380 ha Exclusion Zone. It is likely that there is hunting occurring on adjacent private property.

Regional Study Area

The Regional Study Area includes provincial, federal and private lands where hunting may also be occurring. It is unknown whether hunting on these private lands is being undertaken by Aboriginal peoples.

The provincial Wildlife Management Unit that envelops the NPD site is Wildlife Management Unit #48 (Figure 8.9-3) (MNRF 2007).

Figure 8.9-3. Wildlife Management Unit #48



Source: MNRF, 2007

Algonquin harvest in this management unit is known, as targets for moose have been identified for it (AOO 2017b). While there is no elk harvest in this management unit it would be expected that there is likely harvest of deer, small game and waterfowl in this management unit. While it is not confirmed, it is very likely that there are some Algonquins and possibly some other Aboriginal people hunting within 5 km of the perimeter of the AECL owned lands.

It would be expected that some Aboriginal people in Quebec also hunt on the Quebec side of the Ottawa River. Likely the hunting of animals is similar to Ontario and targets moose, deer, small game and waterfowl.

8.9.2.3 Fishing

Fishing was a traditional and modern day land and resource activity practiced by Aboriginal peoples in the Ottawa Valley. The Ottawa River was and is still used for sport and subsistence fishing. Fish species

targeted would have likely included the same type of sport and subsistence fish that occur today such as walleye, smallmouth bass and northern pike (AECL 2010).

Historically, sturgeon, suckers and American eels would have also been likely taken. A review of interview surveys with members of the Mattawa-Algonquin community also indicated that goldeneye were also harvested (Settlement Surveys 1998). The harvesting of fish is outlined in section 8.2 of the Algonquins of Ontario Agreement-In-Principle. The inclusion of such a chapter indicates the importance of fishing as a cultural activity to the Algonquins of Ontario.

Site/Local Study Area

Due to the restricted access (e.g., there are "no trespassing" signs and gates at roadways) to the site there is no fishing on the NPD site or within the boundaries of the AECL property surrounding the NPD site.

Regional Study Area

It is likely that there is fishing by Aboriginal people on the Ottawa River in the vicinity of the NPD site. This fishing is likely a combination of both sport and subsistence fishing. Fishing is likely to also occur in lakes that are in proximity to the site such as Tee Lake (see Figure 8.5-1).

8.9.2.4 Gathering

Gathering is a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. The gathering of plants, berries, mushrooms, etc. would have been for subsistence, medicines, crafts and other purposes. The Algonquin Park Forest Management Plan Background Information Report (AFA 2010) noted that Algonquin people used plant resources such as spruce roots and gum and mushrooms). The harvesting of plants is outlined in section 8.5 of the Algonquins of Ontario Agreement-In-Principle. The inclusion of such a chapter indicates the importance of gathering as a cultural activity to the Algonquins of Ontario.

In previous resource management exercises, members of Algonquin communities have also identified the importance of White Birch and Cedar. This culminated in a protocol being developed within the OVF Forest Management Plan for a gathering protocol related to these two species which were important for craft and medicinal purpose. This was described as:

> "*Algonquin people have identified birch bark, and materials from white cedar as significant cultural value derived from area forests. They have conveyed their desire to ensure identification and access to suitable trees for construction of traditional canoes and crafts is recognized in forest management planning. The existence of suitable trees for canoe building is scarce, hence everyone's desire to increase awareness of field personnel and industry to facilitate and improve the potential for birch bark gathering, and extracting cedar for use in the canoe building and native crafts trades. The use of a relatively small number of trees for these uses should not conflict with harvesting or forest management objectives. Concerns for timing, access, and safety can be administered by open communication between the company, the harvest licensee/operator, and the person wishing to utilize the tree for canoe building or native crafts.*" (OVF 2011b. p.7)

The Algonquin Park Forest Management Plan Aboriginal Background Information Report (AFA 2010) also noted timber resources were used for fuelwood, shelter, canoe and tool making. As well, the Algonquins are widely known for their skill in making birch bark canoes, a skill which remains within the community to this day.

While the above information on gathering is focused on the Ontario side of Algonquin territories, it would be assumed similar plant and tree resources would be utilized by Algonquin people on the Quebec side.

Gathering is an activity that provides important links to cultural continuity and traditional way of life.

Site/Local Study Area

Due to restricted access (e.g., there are "no trespassing" signs and gates at roadways) to the site, there is no gathering on the NPD site or within the boundaries of the AECL property surrounding the NPD site. It is possible that there may be some gathering activities in the Local Study Area within private lands adjacent to the Federal lands. Through engagement, the Métis have indicated an interest in learning of the possible presence of blueberry. Section 8.6 of the EIS includes low sweet blueberry (*Vaccinium angustifolium*) as a species that has been identified at the NPD site. Providing this ecosite remains following post-construction, this area may become available for future gathering if access is granted.

Regional Study Area

Aboriginal people also likely gather plant materials and other resources on provincial land in the Regional Study Area.

8.9.3 Cultural Resources and Ceremonies

Aboriginal peoples place a high degree of value on specific sites of cultural, historical, archaeological, spiritual, social or ecological significance. These sites may have broader cultural significance related to the practice of formal or informal ceremonies at or near these sites.

Site Study Area

CNL notes that to date there has been no indication that Aboriginal cultural ceremonies occur at the NPD site. However, this issue is discussed in further detail below.

A Stage 1 Archaeological Assessment of the NPD site (Archaeology TSD) was undertaken by Kinickiniick Heritage Consulting and is titled: "Stage 1 Archaeological Assessment of the Nuclear Power Demonstration (NPD) Property Part of Lots 41-45, 48 & Town Plot, Range A & B Rolph Twp. (Geo), Township of Laurentian Hills, Renfrew County". The Stage 1 Assessment determined that there is no archaeological potential within the decommissioning footprint due to extensive disturbance during facility construction, however CNL contracted Kinickinick to undertake a Stage 1 assessment in order to provide stakeholders with background information about the history and archaeological potential of the NPD property.

As indicated in the Archaeology TSD, historical photographs of NPD under construction clearly show that disturbance throughout the nuclear power plant grounds was deep and extensive, including the shoreline of the Ottawa River. The archaeologist noted that there is no archaeological potential within the proposed disturbance footprint for the NPD decommissioning. Beyond the footprint of the project and within the NPD site the archaeologist has noted that there is high archaeological potential both for historical homesteads and the pre-European contact period. These areas will not be impacted by the project, and therefore an assessment of this area of the property is not warranted at this time. The archaeologist also noted that there are some registered archaeological sites outside of the NPD site (see section 3.2.2 of the Archaeology TSD)). CNL is not aware of any other specific cultural resources and ceremonies near the NPD site.

The Archaeology TSD provides an overview of the archaeological and historical context around the NPD site spanning many periods. Readers who are interested in this historical context are encouraged to read this TSD. It is noted on page 12 of the Archaeology TSD that: “Except for scattered trading posts, the Algonquin and Nipissing were the sole occupants of the Ottawa Valley in this period and, of course, they chose to live, as much as possible, at the most attractive locations in their territory. These included: the islands in the Ottawa River, the mouths of principal tributaries, the junctions of principal tributary streams, the foot of rapids and falls, at the ends of portage routes, and around wild rice lakes and reliable fisheries.” This suggests that these Aboriginal peoples would have travelled along the Ottawa River and likely camped in the vicinity of the NPD site.

In summary, there are no known cultural ceremonies that occur at the NPD site.

Regional Study Area

CNL acknowledges that there are proposed Algonquin land claim settlement lands located near the NPD site (near Tee Lake) that likely are of significance to certain members of the Algonquins of Ontario. There may be cultural ceremonies associated with this area, which is situated south of the NPD property.

8.10 Socio-Economic Environment

Information for this section was derived from the Socio-Economic Assessment TSD (Socio-Economic TSD).

Socio-economic baseline data was collected through a variety of sources. These included Statistics Canada, Municipal corporations, planning documents, tourism boards, and provincial agencies. Data was predominantly derived through desktop review of existing data. Sources of data included:

- planning and land use documents (e.g., Official Plans, municipal zoning documents, forest management plans, provincial agency reports and ZEC profiles);
- government databases (e.g., census profiles; MNRF Crown Land Use Policy Atlas);
- interactive maps (e.g., ZEC and Ministry of Natural Resources and Forestry (MNRF) maps);
- acts and regulations (e.g., regulations overseeing ZEC); and,
- municipal and local websites (e.g. tourism association websites, campground and recreational websites).

8.10.1 Spatial Boundaries

The spatial boundaries with respect to the socio-economic environment were determined based on the potential for the project to affect adjacent communities and their proximity to the facility.

The Site Study Area for the socio-economic environment is the same as the general Site Study Area defined in Figure 5.2-1 above.

The Local Study Area has been defined as the Site Study Area plus a 1 km area beyond the Site Study Area, and is the same as that used for Aboriginal land and resource use (see Figure 8.9-1 above). Within Ontario, this area is limited to the Town of Laurentian Hills. Within Quebec borders, this includes a small portion of the ZEC Rapides-des-Joachims where it abuts the opposite side of the Ottawa River from the Site Study Area.

The Regional Study Area has been defined as the Site Study Area and a 5 km radius beyond the Site Study Area, and is the same as the Regional Study Area outlined for Aboriginal land and resource use (Figure 8.9.2). Within Ontario, this area includes a portion of both the Town of Laurentian Hills and the United Townships of Head, Clara and Maria. The Regional Study Area also covers lands within Quebec. This includes the eastern portion of the island of Rapides-des-Joachims and two ZECs (controlled harvesting zones or zones d'exploitation controlee) across the Ottawa River: ZEC Rapides-des-Joachims (the study area parts of which are situated within the municipalities of Rapides-des-Joachims and Sheenboro) and ZEC Saint-Patrice (the study area portion of which is situated within the municipality of Sheenboro).

8.10.2 Socio-Economic Conditions

8.10.2.1 Site/Local Study Area

Municipalities

Renfrew County

The Site Study Area falls entirely within Renfrew County in eastern Ontario at the northern end of County boundaries. Spanning an area of approximately 7,440 km^2 (Statistics Canada 2011), Renfrew County comprises twelve townships (Admaston/Bromley; Bobbechere Valley; Brudenell, Lyndoch and Raglan; Greater Madawaska; Head, Clara and Maria; Horton; Killaloe-Hagarty-Richards; Laurentian Valley; McNab/Braeside; Madawaska Valley; North Algona Wilberforce; Whitewater Region) and five towns (Arnprior; Deep River; Laurentian Hills; Petawawa; Renfrew). Renfrew County has an estimated population of 86,966 in 2011, a 4 percent increase from the 2006 population of 83,615. The majority of growth in the County is anticipated to occur within urban areas, with the five towns accounting for nearly half the County total population in 2011 (Baird 2016; Renfrew County 2013). Approximately 150 km northwest of Ottawa, the independent City of Pembroke is located within Renfrew County borders along the Ottawa River and has an estimated population of 14,360 in 2011, a 3.1 per cent increase from the 2006 population of 13,930 (Statistics Canada 2011). The City is the largest commercial and service centre between North Bay and Ottawa, and development activities are closely linked to those occurring within the neighbouring County

(City of Pembroke 2014). The County and City have a combined median age of 43.9 (Statistics Canada 2011).

Key employers within the County include Garrison Petawawa, CNL, Renfrew County District School Board and the County itself. Economic activities generally include forestry, resource mining, agriculture, retail, service, manufacturing and government activities, with some high-tech industry expanding in to the area more recently also (Renfrew County 2016a and 2016b).

Town of Laurentian Hills

The Town of Laurentian Hills is a lower tier municipality. The Site Study Area is located within the Town boundaries. The Town spans an amalgamated area of the Townships of Rolph, Buchana, Wylie and McKay and the Village of Chalk River, covering an area of approximately 640 km^2. The Site Study Area is limited to its most northerly border. The Town has an estimated population of 2,811 in 2011.This has increased 8 percent from 2,789 in 2006 (Statistics Canada 2011). The median age is 41.1. Chalk River (approximately 1,500 (Batten 2016a)), Rolphton and Point Alexander comprise the settlement areas for the majority of residents, with some settlement also occurring along the periphery of the Town of Deep River and along the Highway 17 corridor (Town of Laurentian Hills 2010).

Approximately 25 km downstream of the Site Study Area, CRL serves as the primary source of employment in the area (Batten 2016a; Town of Laurentian Hills 2016). Garrison Petawawa provides another key source of employment to the Town. Within the municipality, Chalk River comprises the primary source of public services to the community. The Town shares a landfill on the border of Chalk River with Town of Deep River. Highway 17 serves as the primary transportation route through the Town (Batten 2016a; Town of Laurentian Hills 2016).

Assets

Hunting, Trapping and Fishing

The vast majority of lands within the Ontario portion of the Local Study Area are Federal lands owned by AECL. The remaining lands are in private tenure. Therefore, there is no provincial land upon which to undertake hunting. It is possible that one of the private landowners may hunt on their property. The entire Local Study Area is identified as Deer Wintering Area and Bear Management Area (MNRF 2010a, 2010c and 2016). The small portion of ZEC Rapides-des-Joachims situated within the Local Study Area may have some seasonal hunting activity.



White-tailed Deer (*Odocoileus virginianus*)

Provincial trap lines are based on provincial land. One of the designated Trap Line Areas intersects a small portion of the Local Study Area (MRNF 2010b), beyond the Exclusion Zone, where trapping may occur. It is possible that a landowner may trap on the private land adjacent to the Federal lands owned by AECL. Some trapping may occur in the small portion of ZEC Rapides-des-Joachims that falls within the Local Study Area.

Sport and subsistence fishing is feasible within the Ottawa River, particularly along the near and far shorelines. The Ottawa River provides a major draw for boaters and anglers (OVF 2011b). There is no commercial fishing in the Local Study Area.

Recreation

Within Ontario, there are no formal tourism operations in the Local Study Area. Tourists visiting the ZEC territories come from across Ontario and beyond. ZEC Rapides-Des-Joachims estimates thousands of visitors annually (Rivet 2016).

There are no designated hiking or snowmobile trails present on the Ontario side of the Local Study Area. Hiking is feasible within ZEC Rapides-des-Joachims, although this portion of the ZEC is steep and could be difficult to access despite numerous trails throughout.

No official boat launches are situated within the Local Study Area. An unofficial boat launch exists off Cutler Lane which was previously used by local residents. However, access to the launch has been restricted by CNL. Boating can occur within the portion of the Ottawa River that falls within this area between Ontario and Quebec. The presence of watercourses for recreational canoeing within the small area of ZEC Rapides-des-Joachims is extremely limited with one small portion of a watercourse included in the area (ZEC Rapides-des-Joachims 2016).

Resources

Gravel and sand are used commercially and also for the construction and maintenance of forest access roads within the County (OVF 2016a). A portion of a Ministry of Transportation (MTO) aggregate pit is situated within the Local Study Area. The pit occupies a MTO permitted area of 4.6 ha and is located north of Highway 17 near Cutler Lane, along the edge of the 1 km boundary. Access to the pit is available from Highway 17. The site has unlimited annual extraction (MNRF 2016).

The Local Study Area also intersects a privately operated Class A licence pit and quarry occupying a 25 ha area. The majority of the site is situated south of the MTO pit and on the south side of Highway 17. A portion of this site is adjacent to the MTO pit although the majority is situated to the south of Highway 17, with access from the highway. Extraction at this site is permitted to a maximum of approximately 54,500 tonnes annually (MNRF 2016).

There are no active mine claims within the Local Study Area (MNDM 2016).

Residential

Fewer than ten residential properties fall within the Local Study Area. Given the size of the exclusion zone, these are located along the extremities of the area but generally situated along Highway 17 and Cutler Lane.

Other

Two inactive landfills are located within the Exclusion Zone. According to CNL, both are located in two former gravel pits. Landfill 1 situated along the main access road to the station southwest of the guardhouse was used for conventional purposes such as office waste and has a certificate of approval (A413107) from the Ontario MOECC acknowledging its closure. Landfill 2 was located northwest of the facility as a lay down area during construction of the original facility.

8.10.2.2 Regional Study Area

Municipalities

Head, Clara and Maria

To the west of the Site Study Area is the United Townships of Head, Clara and Maria which intersect the Regional Study Area. The Townships span approximately 730 km^2 and are situated at the northernmost boundary of Renfrew County and include four small hamlets along the Ottawa River: Mackey, Stonecliffe, Bissett Creek, Deux-Rivières (Townships of Head, Clara and Maria 2016). Approximately 85 to 90 per cent of the Townships are government (mainly provincial) land. The estimated population of the Townships is 235 in 2011, a 3.1 per cent increase from 228 in 2006. The median age in is 55.8 (Statistics Canada 2011). The Townships include five key campgrounds (including Driftwood Provincial Park) that provide a source of tourism and recreation in the area. Logging has typically been the primary industry in the Townships with activities managed by the Algonquin Forestry Authority and two key family-owned operations operating with seasonal hires. The Townships rely heavily on public and commercial services provided through other communities such as the Town of Deep River (Gibson, Jim 2016; Townships of Head, Clara and Maria 2016).

Rapides-des-Joachims

The nearest population centre to the Site Study Area is Rapides-des-Joachims, in Aberdeen Township, Pontiac County, Quebec. The village of Rapides-des-Joachims (also known as “Swisha”) occupies an island in the Ottawa River, just beyond the Quebec border to the west of the Site Study Area. The approximate 2.5 km by 5.5 km island comprises a portion of the municipality of Rapides-des-Joachims, shared with the ZEC Rapides-des-Joachims which is located immediately to the north of the island abutting the Ottawa River (discussed further below). The island is connected to Ontario via an interprovincial bridge and County Road 635 which intersects at Highway 17 near the hamlet of Rolphton. Another bridge on the north side of the island crosses to mainland Quebec and also serves as an entrance to the remainder of the municipality (e.g. within ZEC Rapides-des-Joachims). Two dams are located at either end of the island: a Hydroelectric Dam (Des Joachims Generating Station, operated by Ontario Power Generation (OPG)) at

the southeastern end which connects between the island and Ontario, and McConnell Lake Control Dam at the western end connecting between the island and mainland Quebec (Gibson, James 2016; Rapides-des-Joachims 2016).

The population across the municipality of Rapides-des-Joachims was 131 in 2011, a 23.8 per cent decrease from 2006. The decrease in population may be attributed to a limited influx of permanent residents and an aging community (the median age of the community is 47.8 in 2011 (Statistics Canada 2011)). The municipality relies heavily upon surrounding communities (particularly Deep River) for public services (e.g. schools, shopping, banking, police, etc.) as it is geographically isolated from Quebec communities beyond its ZEC. Approximately ten residents are employed by CNL. Other sources of employment are found in Deep River and Pembroke. Several residents were employed by the Commonwealth Plywood at the local mill which has been closed for several years now with the downturn in the logging industry (Gibson, James 2016).

Deep River

The Town of Deep River is situated approximately 17 km southwest of the Site Study Area, along the Ottawa River, spanning an area of about 51 km^2. The Town does not directly intersect the Site Study Area, Local Study Area or Regional Study Area. Deep River was included due to the heavy reliance of the surrounding communities on its economic, social and health related services and provides a more comprehensive understanding of the community interactions across municipal boundaries.

The estimated population in Deep River was 4,193 in 2011. This has decreased by 5 percent from 4,216 in 2006. The median age was 47.5 (Statistics Canada 2011). While it is not situated within the Regional Study Area, the Town provides for the majority of public health, service and commercial resources of the communities surrounding the Site Study Area and as such is included here. Deep River is the hub of the surrounding communities providing: medical services (hospital, doctors, dental), schools (k-12), shopping, sports activities (arena, hockey, and swimming pool), recreation (marina, boating, beaches, boating, snowmobiling, and cross-country skiing), community services (seniors, adults, and youth programs), weekly newspaper, library, and the arts (symphony, live theatre, art exhibits, potters guild etc.) (Lougheed 2016; Town of Deep River 2012 and 2016).

The Town was originally established as a residential community for employees and their families of what was to become the Chalk River Nuclear Laboratories (now the CRL of CNL) and houses many CNL and Garrison Petawawa employees. Deep River is almost entirely dependent on Garrison Petawawa, CNL, and local commercial business for employment. Over 2,700 people were employed with CNL in 2011 and Garrison Petawawa personnel have become an increasingly important source of new residents for the community. Many former CNL employees have chosen to stay and 33 percent of the population are seniors (Lougheed 2016; Town of Deep River 2016). According to the municipality, the Town has been static for some time with little growth occurring and economic activities such as logging surrounding the area have been on the decline. The original closure of the NPDNGS in the 1980's had a large impact on the economy and community in Deep River (Town of Deep River 2016) and CNL activities continue to have a strong influence on the community (Lougheed 2016).

Assets

Hunting, Trapping and Fishing

The majority of hunting within the Regional Study Area within Ontario occurs on provincial land and species generally include deer and moose (Batten 2016a). A large portion of the Regional Study Area is identified as Deer Wintering Area (MNRF 2010c). While deer move across both public and private lands, typically more deer hunting in the OVF occurs on provincial land. Within Renfrew County in 2005, approximately 12,348 of the deer hunters were residents and approximately 100 came from beyond the municipality.

Moose Aquatic Feeding Area is also present. Tagging and an increase in the number of moose in the OVF has resulted in an increase in moose hunting since 2005. One of three identified moose hunting areas in the Ottawa Valley forest (OVF) occurs within the northern portion of Renfrew County (part of Wildlife Management Unit 48) and intersects the Regional Study Area (MNRF 2007; OVF 2011b). In 2009, moose hunters in the OVF comprised approximately 1,206 residents of Renfrew County and 11 tag holders from tourist outfitter camps which are established on private lands but that hunt on provincial land (OVF 2011b).

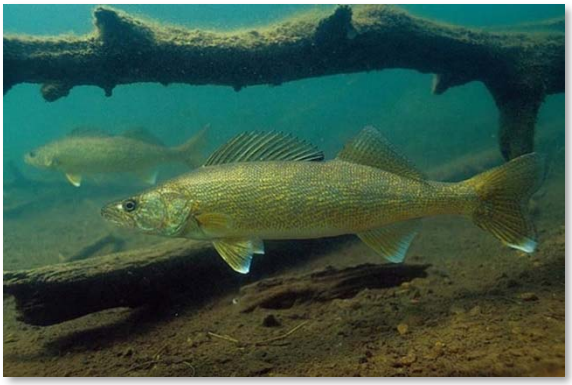
One of the 18 Bear Hunting Areas within the OVF intersects much of the Regional Study Area. Such areas include an area of provincial land which is licensed to a tourist operator for bear hunting services, with an average of two people working up to two months annually. Local residents comprised 1,201 bear hunters in 2009 and are generally increasing in number over the last five years. Dropping in number over the past five years, 157 tourists hunted through tourist outfitters. Similar to moose hunting establishments, bear hunting outfitters conduct activities on provincial land despite being established on private land (OVF 2011b).

Raptor and Heron Nesting sites are also present within the Regional Study Area (MNRF 2010c).

Seasonal hunting within the two ZEC territories that intersect the Regional Study Area is permitted. Modes of hunting generally include: firearm, bow, or crossbow. The primary species hunted are moose, bear and deer, although other species include moose, Virginia deer, black bear, ruffed grouse, and hare (Rivet 2016; Réseau ZEC 2016). In ZEC Saint-Patrice, species generally include moose, Virginia deer, black bear, ruffed grouse, hare, and wild turkey (Réseau ZEC 2016). Information on hunting, transport of carcasses through the region and regulations are provided on the ZEC websites for visitors. Wildlife protection officers are present on site within the ZECs to monitor and regulate hunting activities (Réseau ZEC 2016).

Approximately fifty registered trap lines are present on provincial land within the OVF area. For about six months of the year, an average of two people work each trap line area (OVF 2011b). Two designated Trap Line Areas intersect the Regional Study Area (MRNF 2010b) although trapping is limited and generally includes beaver (Batten 2016a). A downturn in the demand for fur has had a negative impact on the trapping industry in this area and beaver populations have been on the rise. In the 2009 trapping season, approximately 2,122 beavers were harvested. Further, trappers in the OVF have noted some of the implication of forest management on trapping, based on changes to furbearing habitat and the lack of harvest to the shore adjacent to beaver ponds, and the loss of martin and martin habitat. (OVF 2011b).

Within the ZEC territories trapping is common and generally includes species such as beaver, lynx, wolf, and raccoon (Rivet 2016; Réseau ZEC 2016).



Walleye (*Sander vitreus*)

Commercial fishing is also absent within the Regional Study Area. Most recreational fishing occurs along the Ottawa River (Township of Laurentian Hills 2016). A larger expanse of the Ottawa River accommodates greater opportunities for sport and subsistence fishing, particularly with proximity to the Island of Rapides-des-Joachims. A spawning ground is present along the length of the island's north side from its eastern tip to the McConnel Control Dam. Popular fish include: walleye, catfish, pike and sturgeon. Recreational fishing includes locals, cottagers and tourists (Rapides-des-Joachims 2016). Several waterbodies are present within the Regional Study Area that provide potential for sport fishing as many of the coldwater lakes in Renfrew County are annually stocked with brook trout, lake trout, rainbow trout, brown trout and splake (OVF 2011b).

Numerous lakes and rivers provide fishing opportunities within the ZEC territories although fishing is closely monitored and regulated. The ZEC websites provide information on species stocking of lakes, historical catches, and information on planning, rules and regulations (Réseau ZEC 2016). Typical fish species within ZEC Rapides-des-Joachims include bass, pike, whitefish, walleye, muskellunge, brook trout, perch, lake trout, and splake. In ZEC Saint-Patrice fish species generally include bass, pike, whitefish, walleye, brook trout, Atlantic salmon, perch, lake trout, and splake (Réseau ZEC 2016).

Recreation

Tourism in the Regional Study Area is largely resource based (e.g. hunting, fishing and recreation) and comprised largely of drive-in resource use with tourism activities occurring predominantly on private land (OVF 2011a). Rapides-des-Joachims is working toward boosting its economic profile and attracting more residents and tourists within its borders. Initiatives include (Gibson, James 2016):

- developing the municipally operated McConnell campground through expansion of sites and increasing amperage to accommodate a trend of larger trailers. Only a few of the sites at this camp still use tents.
- by adding new docks that can accommodate overnight parking, boat traffic should increase, particularly with the draw of the nearby Dumoine River in ZEC Dumoine to the west of ZEC. Rapides-des-Joachims. The Dumoine River is popularly known for its multi-day canoeing trips.
- working toward increased control over the land use on the island to better facilitate redevelopment of the area, and increasing boutiques and local crafts operations, thus drawing in more permanent and seasonal residents, driving development further. Redevelopment of the area would assist in marketing the island as the 'gateway' to the Dumoine River.

The Town of Laurentian Hills contains trails used for hiking and several ATV and snowmobile trails maintained by local associations, some of which intersect the Regional Study Area such as the Pembroke/North Bay TOP snowmobile trail that forms a portion of the Round Algonquin Park snowmobile trail loop (SCSA 2016; NRSA 2016). There is also the possibility of future use of a discontinued stretch of Canadian Pacific (CP) Railway system that crosses the Town and several other municipalities (comprising about 218 km across Renfrew County) traveling from Smiths Falls to Mattawa. The County of Renfrew has acquired the corridor which could provide an attractive source of hiking, snowmobiling and cross-country skiing (Renfrew County 2016b; Batten 2016b). This abandoned railway corridor, named the Ottawa Valley Recreational Trail, intersects the Regional Study Area and could serve as a tourist draw to the area.

There are no official boat launches in the Town of Laurentian Hills (Batten 2016a). There are two launches on the Island of Rapides-des-Joachims: one on the south side near the Hydro Dam, and the other across from the municipal office on the north-east end of the island. Free daily docking is provided by the municipality of Rapides-des-Joachims. A private operation also offers boat transport across the island as a means of navigating the Hydro Dam and McConnell Control Dam (Gibson, James 2016; Rivet 2016). There are three boat launches in the Townships of Head, Clara and Maria, although none are located within the Regional Study Area. Boating generally occurs around the campground sites although an approximate 69 km stretch of the Ottawa River is available for boating between the Hydro Dam at Rapides-des-Joachims and at Mattawa. Canoe traffic also occurs down the Dumoine River in Quebec which reaches the Ottawa River across from the Townships of Head, Clara and Maria (Gibson, Jim 2016). While it is located outside the Regional Study Area, a boat launch in Deep River also serves as a resource for boating along the Ottawa River.

Resources

In addition to the two aggregate sites identified in the Local Study Area, the Regional Study Area includes a third site southeast of Rolphton. This privately operated pit with a Class B licenced area of 16.5 ha is located west of Tee Lake and along the east side of Old Moore Lake Road. Extraction at this site is permitted to a maximum of 20,000 tons annually (MNRF 2016).

There are active mine claims within the Regional Study Area, however they represent a very small portion of the Study Area and are located on the western edge of the area boundary within Township of Head, Clara and Maria (MNDM 2016).

Residences

Numerous properties are identified within the Regional Study Area. Residential properties generally cluster in areas following the Highway 17 corridor, and in the village of Rapides-des-Joachims whose residential area is concentrated on the eastern side of the island. Some cottages appear on the waterfront of the island, while others are scattered along the south side of the Ottawa River.

Other

Within the Regional Study Area is the OPG's Des Joachims Generating Station. The hydro dam is situated at the southeast end of the Rapides-des-Joachims and has a generating capacity of 429 megawatts. It is the largest of OPG's developments along the Ottawa River (OPG 2016).

8.10.3 Land Use

Information for this section was derived from the Socio-Economic TSD. For the purpose of this EIS, the discussion of land use is limited to formal considerations i.e., planning regimes and designations.

The presence of large areas of provincial land within the area present numerous opportunities for activities such as forestry, hunting, fishing recreation and tourism. Nearly half of the land area of Renfrew County is provincial and federal land. The provincial land is dominated by resource uses such as forestry, mineral exploration, fishing and hunting, etc. and is open to the public. The federal land is reserved for the specific uses such as Garrison Petawawa and CNL which are Restricted Access areas. Numerous lakes, river systems and other natural features provide opportunities for recreational and tourist activities. As well, a large stretch of the County's border abuts Algonquin Provincial Park in the west and northwest and the Ottawa River along its full northeast extent providing further access to extensive tracts of recreational opportunity beyond County limits (Renfrew County 2016a).

The Town of Laurentian Hills is comprised predominantly of federal and federal lands with a smaller area allocated to privately owned property (Renfrew County 2016b). Provincial lands are distributed across the north and south of the Town of Laurentian Hills and are generally used for recreational uses including: fishing, hunting, cross-country skiing, swimming, boating, and snowmobiling (Batten 2016a; Town of Laurentian Hills 2016). Key features that traverse the area are the Temiskawawa Waterway and Pembroke/North Bay Trans Ontario Provincial (TOP) snowmobile Trails (Town of Laurentian Hills 2016). The Trans Canada Energy East pipeline also traverses the Regional Study Area. Within the town, federal lands are designated for use by the Petawawa Military Reserve, given its proximity to the Canadian Forces Garrison Petawawa in Petawawa. Predominant resources in the Town include managed forest and agricultural land (livestock) (Batten 2016a).

ZEC Rapides-des-Joachims includes the remainder of the municipality of Rapides-des-Joachims. ZECs are controlled zones set aside by the Quebec government for the purposes of developing, harvesting and conserving wildlife and wildlife species. They are also used for recreational purposes by local municipal residents. The vast majority of the ZEC are Quebec public land similar to provincial and federal public use land in Ontario.

The study area portion of ZEC Saint-Patrice is immediately to the east of ZEC Rapides-des-Joachims within the municipality of Sheenboro, Pontiac County and accounts only for a small area of the ZEC at the ZEC's most southwesterly corner. The ZEC is managed similarly to Rapides-des-Joachims.

8.10.3.1 Site/Local Study Area

A limited number of land uses occur within the Local Study Area. The majority of the area is comprised predominantly of federal land. The Site Study Area and Exclusion Zone are situated entirely on federal land within property attributed to AECL, a federal corporation (Figure 3.1-3). As well, a few privately owned properties intersect the Local Study Area, and are attributed largely to residential properties, with a few areas of aggregate extraction, occurring along the Highway 17 corridor.

Municipal planning documents permit the following land uses within the Ontario portion of the Local Study Area: Crown Land, Rural Land, Lakes and Rivers, Permanent Wetland, Mineral Aggregate Resources, Hydro Line, Provincial Highway (i.e. Highway 17), Municipal Maintained Road (i.e. Cutler Lane).

According to the Town of Laurentian Hills Zoning By-Law (2012), the land use intent of this area includes three types:

- Rural (RU) comprises a mixture of land uses appropriate to rural areas including low density residence, farms and forestry. This designation regulates the use of land or the use, erection or alteration of any building/structure. Permitted uses include: Agriculture; Camp; Cemetery; Commercial Greenhouse; Dwellings (duplex, seasonal, semi- and single-detached); Equestrian Establishment (minimum 2 ha lot area); Farm Produce Outlet; Forestry uses; Group Homes (with restriction); Log Hauling Operation; Marine Facility; Park; Parking Area; Portable Asphalt/Concrete Plant; Private Club; Public Service use (with restriction); Public Utility (with restriction); Wayside Quarry; Wayside Pit; Accessory Dwellings; Bed and Breakfasts; Home Industry (with restriction); Home Occupation (with restriction); and, Sleep Cabin (with restriction).
- Mineral Aggregate Resources Pit recognizes/regulates the extraction of sand and gravel and associated extractive industrial manufacturing and processing uses. It generally restricts the use, erecting or alteration of any building/structure in the zone. Permitted uses include: Accessory uses, Buildings or Structures (with restriction) (e.g. crushing and screening facilities, stock piles, asphalt and concrete plants, administration facilities, weigh stations, security kiosk etc.); Agriculture use (not including buildings and structures); Camp in Mineral Aggregate Resources Reserve (EMR) Zones, Conservation use; Existing Residential Building and Accessory uses; Farm Produce Outlet; Forestry use (not including buildings and structures); Outdoor Recreation uses (not including buildings and structures); Pit within Mineral Aggregate Resources Pit Zone; Portable Asphalt/Concrete Plant in Mineral Aggregate Resources Pit and Mineral Aggregate Resources Quarry (EMQ) Zones; any activities associated with the progressive rehabilitation of the lands in Mineral Aggregate Resources Pit and EMQ Zones; Public Utility (with restriction); Quarry in EMQ Zones; Wayside Pit; and, Wayside Quarry.
- Environmental Protection (EP) Zone regulates development in areas subject to natural hazards and/or have environments sensitive to development (i.e. floodplain, steep or slippery slopes, and wetlands). It generally restricts the use or erection of any building or structure in the EP. Permitted Uses include: Accessory uses, Buildings or Structures; Conservation use; Forestry use; Existing Dwelling; Existing Agricultural Use; Outdoor Recreational uses (active and passive); and Structures for flood or erosion control or slope stabilization.

The By-Law also stipulates that Crown lands are not subject to the provisions of the By-Law or the Town's Zoning Schedules. As such, the land use intent identified above for the Local Study Area only apply to non-Crown land areas.

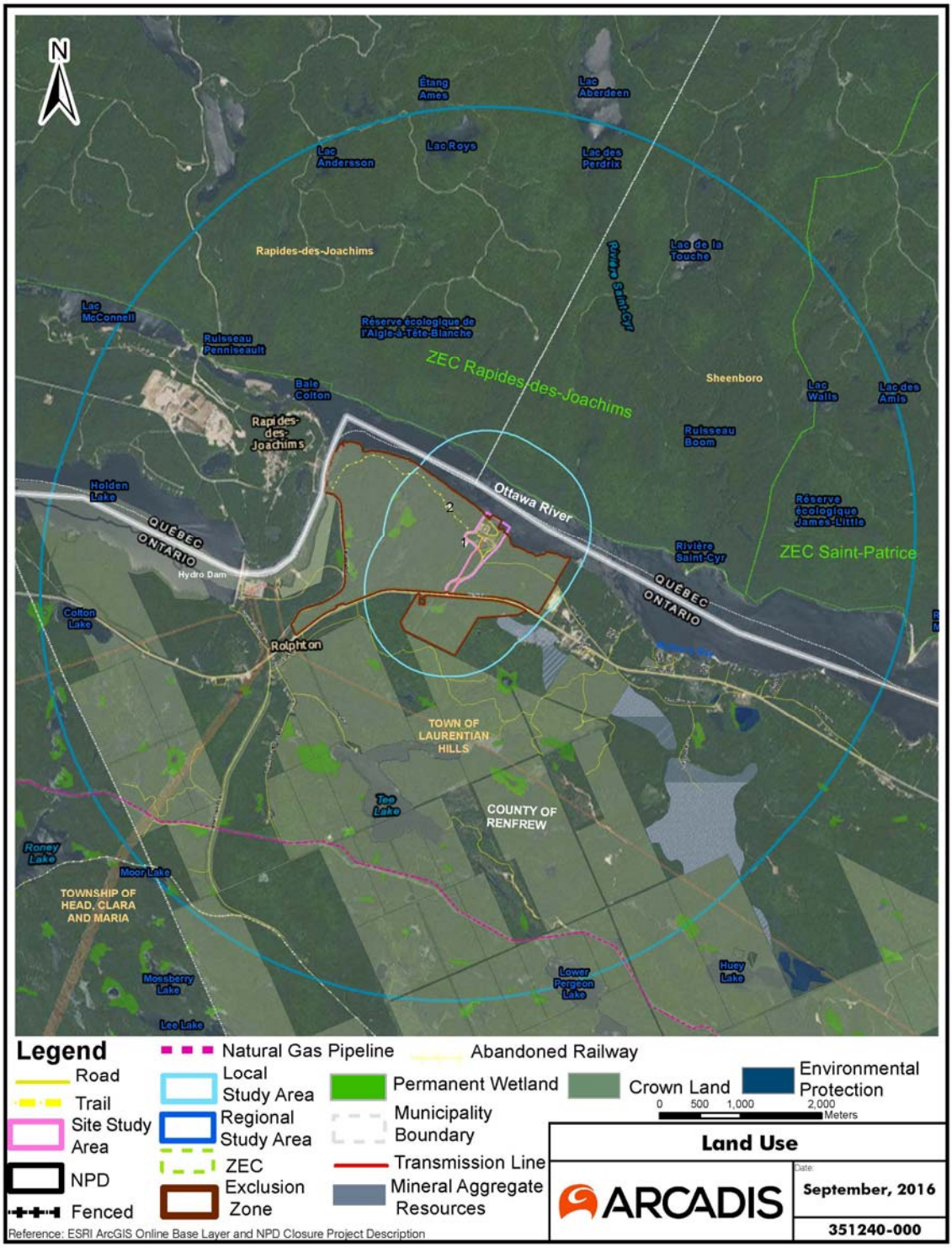
The Ottawa River intersects the Local Study Area and across the river within Quebec the area includes forested public lands situated within the ZEC Rapides-des-Joachims. The ZEC is a controlled exploitation area intended to manage and preserve wildlife located within its borders. It is used predominantly as a hunting and fishing location. Access to the ZEC is limited to seasonal time periods (generally May through October) and registration and access fees are compulsory. Specific guidelines and quotas are applied to hunting and fishing of species within the territory and are enforced upon entry and exit from the territory. Additional permitted uses include trapping, camping, hiking, boating and snowmobiling (Rivet 2016; Réseau ZEC 2016).

8.10.3.2 Regional Study Area

The majority of the Regional Study Area intersects an area of provincial land-use designation known as "Multiple Natural Resource Use" (Figure 8.10-1). According to the Ministry of Natural Resources and Forestry (MNRF 1983) Pembroke District Land Use Guidelines for this designation, the Land Use Intent of this area is:

> "*Within this area, resource management will be directed to multiple use management. Standard management practices combined with the concept of sequential use will enable MNR to take full advantage of the potential of the natural resource.*
>
> *Management of this area is also governed by the general policies contained in the Pembroke District Land Use Guidelines (1983).*"

Figure 8.10-1. Land Use



Permitted activities in this provincial land use designation vary widely. Permitted activities include: Aggregate Extraction; Bait Fishing; Commercial Fishing; Commercial Fur Harvesting; Commercial Hydro Development; Commercial Power Generation Development; Commercial Timber Harvest; Existing Commercial Tourism (Services and/or Facilities); Mineral Exploration and Development; Peat Extraction; Wild Rice Harvesting; Existing and New Road Development and Maintenance; Crown Land Recreation; Hunting; Existing and New Road Use (public); and, Sport Fishing. Non-permitted activities include: Cottaging Crown Land Disposition (as no new cottage lots on provincial land are permitted); and, Existing Crown Land Disposition, Seasonal Recreation Camp. As well, no new hunt camps are permitted with respect to Hunting activities. Crown Land Disposition is a potentially permitted activity, although this is subject to MNRF planning and approval policies and procedures and significant restrictions on land disposition on designated trout lakes exist.

Also within the Regional Study Area and situated on the Ottawa River shoreline, immediately across from the island of Rapides-des-Joachims southern shore, a 'Recommended Provincial Park' (Ottawa River Provincial Park) would span an area of 10,359 ha westward from the OPG hydro dam at Rolphton. This area is recognized for several scenic and recreational values, including stands of white pine reflecting the areas logging history and a proposed Ottawa to New Liskard recreational boating route. Lakes designated for lake trout management are situated within this area (MNRF 2016). The Regional Study Area intersects the southeasterly portion or this recommended park.

Several additional land use designations are identified within the Regional Study Area, including those outlined above in Section 8.10.3.1. A large portion of the Ontario land use is attributed to provincial land. Other municipal land use designations include Environmental Protection, Inactive Waste Disposal (i.e. southwest of Rolphton), Contaminated Site (i.e. southwest of Rolphton), and Hamlet Settlement Area (i.e. Rolphton). Additional features include Crown Road, Private Lane and Natural Gas Pipeline (i.e. TransCanada high pressure pipeline).

The Town of Laurentian Hills Zoning By-Law, identifies land use intent for the Regional Study Area to include the following zones:

- Residential
    - Residential One (R1)
    - Limited Service Residential (LSR)
    - Mobile Home Park Residential (MHP)
- Commercial
    - General Commercial (GC)
    - Recreational Commercial (RC)
- Industrial
    - Mineral Aggregate Resources Reserve (EMR)
    - Mineral Aggregate Resources Pit
    - Waste Disposal (DMW)
- Institutional and Open Space
    - Open Space (OS)
    - Community Facility (CF)

- Other
    - Rural (RU)
    - Environmental Protection (EP)

Within Ontario, Rural (RU) accounts for the dominant land use within the area. Other permitted activities are distributed sparsely across the land base. As noted in Section 8.10.3.1, the land use intent identified within the By-Law only apply to non-federal or provincial land areas.

Within Quebec, in addition to ZEC Rapides-des-Joachims, the Regional Study Area also intersects ZEC Saint-Patrice (at its most south westerly border) across the Ottawa River and the eastern portion of the island of Rapides-Des-Joachims.

8.10.4 Archaeology

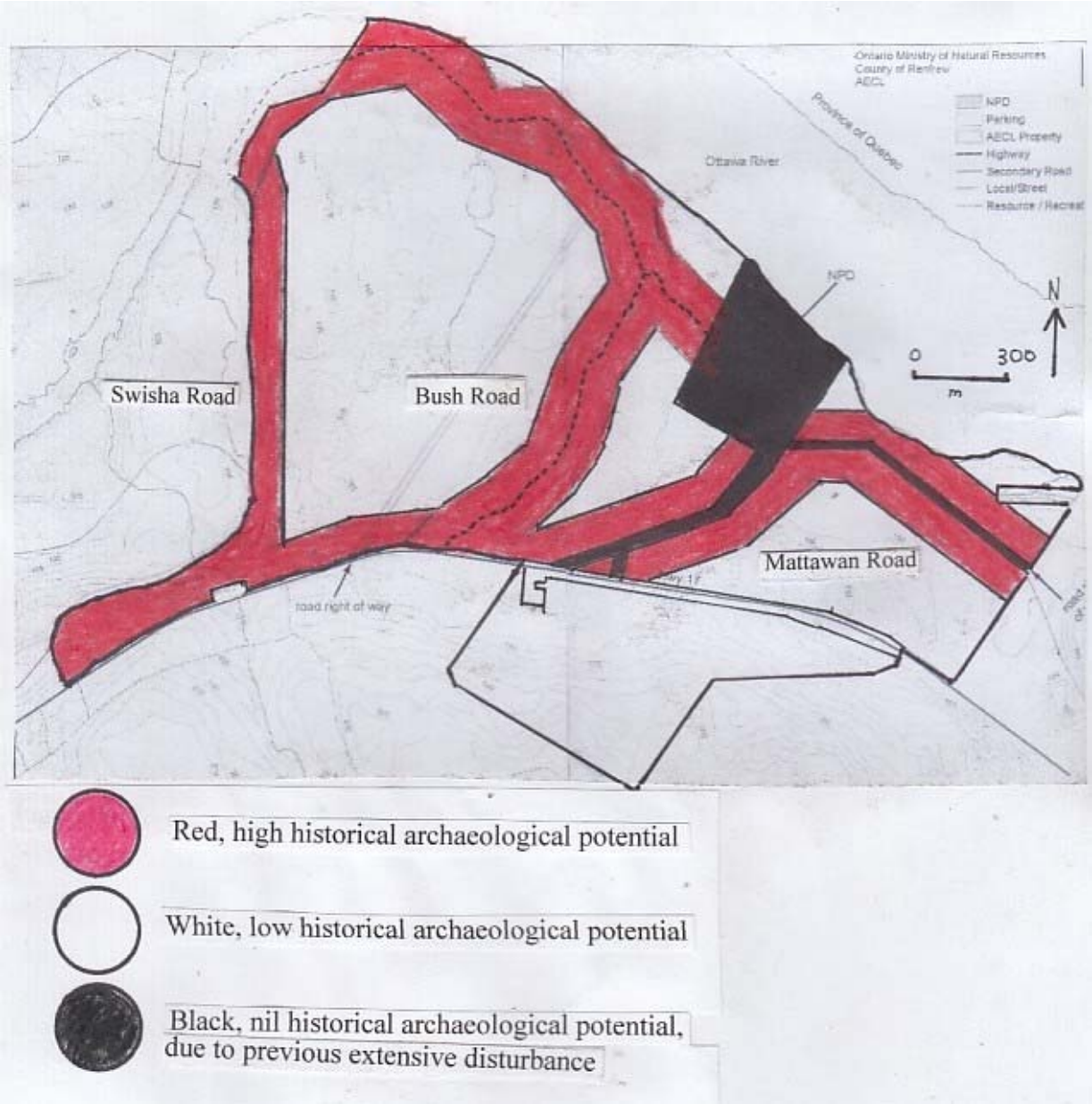
This environmental component includes the archaeology and built heritage resources of the Ottawa River and the NPD site vicinity.

In October 2016, a Stage 1 archaeological assessment was conducted for the NPD property. The objective of a Stage 1 archaeological assessment is to provide background information about the geography, history, land use, previous archaeological fieldwork and existing archaeological sites in the vicinity; and current condition of the property and setting. These data are used to evaluate pre-contact and historical archaeological potential on the site.

8.10.4.1 Site/Local Study Area

As described in the Archaeology TSD, there are no known existing archaeological sites in the Site Study Area (i.e., area that decommissioning activities are proposed to occur). Historical photographs of NPD under construction clearly show that disturbance throughout the nuclear power plant grounds was deep and extensive, including the river shore. The Site Study Area has nil archaeological potential (Figure 8.10-2). However, areas of high historical archaeological potential exist in the Local Study Area. These areas of high potential are based on the proximity to historical roads. Historical research detailed in the Archaeology TSD clearly shows there were generations of settlers on the NPD property, raising families and constructing buildings and docks.

Figure 8.10-2. Map of Historical Archaeological Potential in the Local Study Area

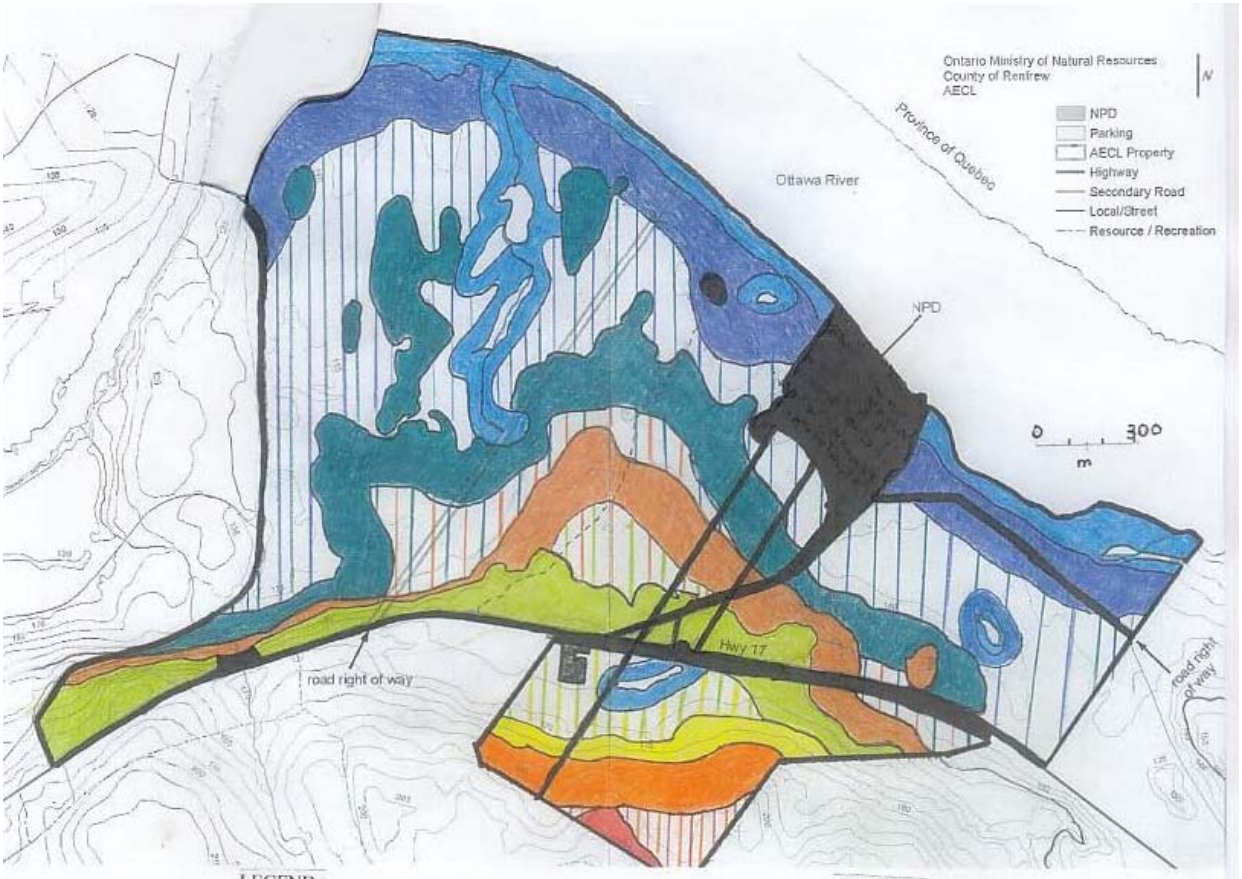


The NPD property has 95 m relief and the slopes are steep, although there is an area of lower rock knobs and muskeg in the former Town Plot that drains into the Ottawa River near a small sandy point called “Hydro Beach”. The Town Plot wetland terrain would have been a complex kaleidoscope of islands and channels during the Middle Archaic period. The land on both sides of the entrance road, between the plant and the highway, were active shorelines during the Early Archaic and Late Palaeo-Indian periods. The high terrain south of the highway were shorelines during the Champlain Sea maximum, during the Palaeo-Indian period.

Given that pre-contact archaeological potential is predicted primarily by proximity to water, and given that every elevation of the NPD property was once an active river shoreline, the whole property between 200 m and the modern waterline is one big relic shoreline and therefore, it all has archaeological potential. Nevertheless, there were times of shoreline stasis—sometimes for millennia, sometimes a few centuries or generations—where human activity would have been concentrated and artifacts more likely to be deposited.

The pre-contact archaeological predictive model for the NPD property takes these longer-lived shorelines into account and maps them in distinctive colours. Furthermore, in the NPD model, the full 150 m width is considered to have high archaeological potential and the areas in between have been given moderate archaeological potential, instead of low potential as the standards allow. In these respects, the NPD model of pre-contact archaeological potential is more rigorous than the Ministry of Culture standards and guidelines require. The map of historical archaeological potential presented in (Figure 8.10-3).

Figure 8.10-3. Map of Pre-Contact Archaeological Potential



LEGEND

- Red, 200 m+, high archaeological potential; Champlain Sea Maximum, Palaeo-Indian; 10,800 B.P., First Fire,
- Red & Orange Stripes, moderate archaeological potential, Champlain Sea maximum, Palaeo-Indian, First Fire
- Orange, 180 m+ high archaeological potential, Champlain Sea maximum, Palae-Indian, 10, 10,500 B.P., First Fire
- Orange & Yellow Stripes, moderate archaeological potential. Palaeo-Indian, 10,000 B.P., Champlain Sea Maximum
- Yellow, 170 m+ high archaeological potential, Early Mattawa Flood, 9,600 B.P Early Archaic, Second Fire
- Yellow & Light Green Strines, moderate archaeological potential , Early Mattawa Flood, Second Fire
- Light Green, 159 m+, high archaeological potential, Early, Mattawa Base Flow, Early Archaic, 9,500 B.P.,Third Fire
- Light Green & Brown Stripes, moderate archaeological potential, Mattawa Base Flow, Early Archaic, Third Fire

LEGEND

- Brown, 150 m+, Ottawa-Marquette Low Stand, high archaeological potential, Palaeo-Indian, 10,100 B.P., Second Fire
- Brown & Dark Green Stripes, moderate archaeological potential, Mattawa Base Flow, Early Archaic
- Dark Green 140 m+, high archaeological potential, Middle Archaic, 8,500 B.P., Third Fire
- Dark Green & Dark Blue Stripes, moderate archaeological potential, Mattawa Base Flow, Third Fire
- Dark Blue, 130 m+, high archaeological potential, Middle Archaic, 8,000-4,700 B.P., Third Fire
- Dark Blue & Light Blue Stripes, moderate archaeological potential, Middle Archaic, Mattawa Base Flow, Third Fire
- Light Blue, high archaeological potential, Late Archaic, Woodland, Historical, 4,700 B.P to 1960, Fourth, Fifth & Sixth Fires
- Black, nil archaeological potential due to previous, extensive, disturbance.

8.10.4.2 Regional Study Area

NPD is in the CbGj and CbGk Borden Blocks. The Borden system is a standardized co-ordinate system that uses upper and lower case letters; each block is ten degrees latitude by ten degrees longitude. The CbGj and CbGk Borden Blocks extend beyond the Regional Study Area defined for the socio-economic environment.

As previously stated, there are no archaeological sites on the NPD property; however, there are several beyond the NPD property boundary, namely: the Meilleur Bay (CbGj-3) site excavated by Clyde Kennedy in 1957; Boom Creek (CbGj-1) and Fraser Bay (CbGj-2) recorded by Barry Mitchell in 1984; and Postes des Rapides-des-Joachims (CbGk-1), which has archaeological material spanning the 19th century that relates to the local Aboriginal community.

8.11 Natural Disasters

8.11.1 Spatial Boundaries

The Site and Local Study Areas for natural disasters consist of the general Site and Local Study Areas delineated in Figure 5.2-1 and Figure 5.2-2 respectively. Due to the differences in the nature of different natural disasters, a general Regional Study area has not been defined here. Natural disasters are discussed on the appropriate spatial scales below.

8.11.2 Seismicity

8.11.2.1 Site/Local Study Area

The baseline seismicity for the Site/Local Study areas will be the same as that described for the Regional Study Area (discussed below), as seismicity does not vary greatly across such a small distance (the size of the Local Study Area).

8.11.2.2 Regional Study Area

The NPD site lies on the western edge of the Ottawa-Bonnechere Graben, an ancient rift valley in the Canadian Shield of Northeastern Ontario and Quebec. This Graben was formed from the movement of two major fault zones known as the Mattawa and Petawawa faults. These faults are still active and are the source of earthquakes, such as the 1935 Timiskaming earthquake and the 2000 Kipawa earthquake. The length of the Ottawa-Bonnechere Graben is about 700 km, and runs from the Montreal area on the east to near Sudbury and Lake Nipissing on the west (Athauda-Arachchige 2015).

Seismicity in Ontario is characterized by diffuse patterns of activity, ranging from low to moderate level of seismicity. The NPD site lies within a broad belt of seismicity in the eastern part of the province. Most seismic events in this region have been small to moderate in magnitude, but there have been a few significant larger earthquakes. Based on a probabilistic estimate of seismic disturbances for the next 100

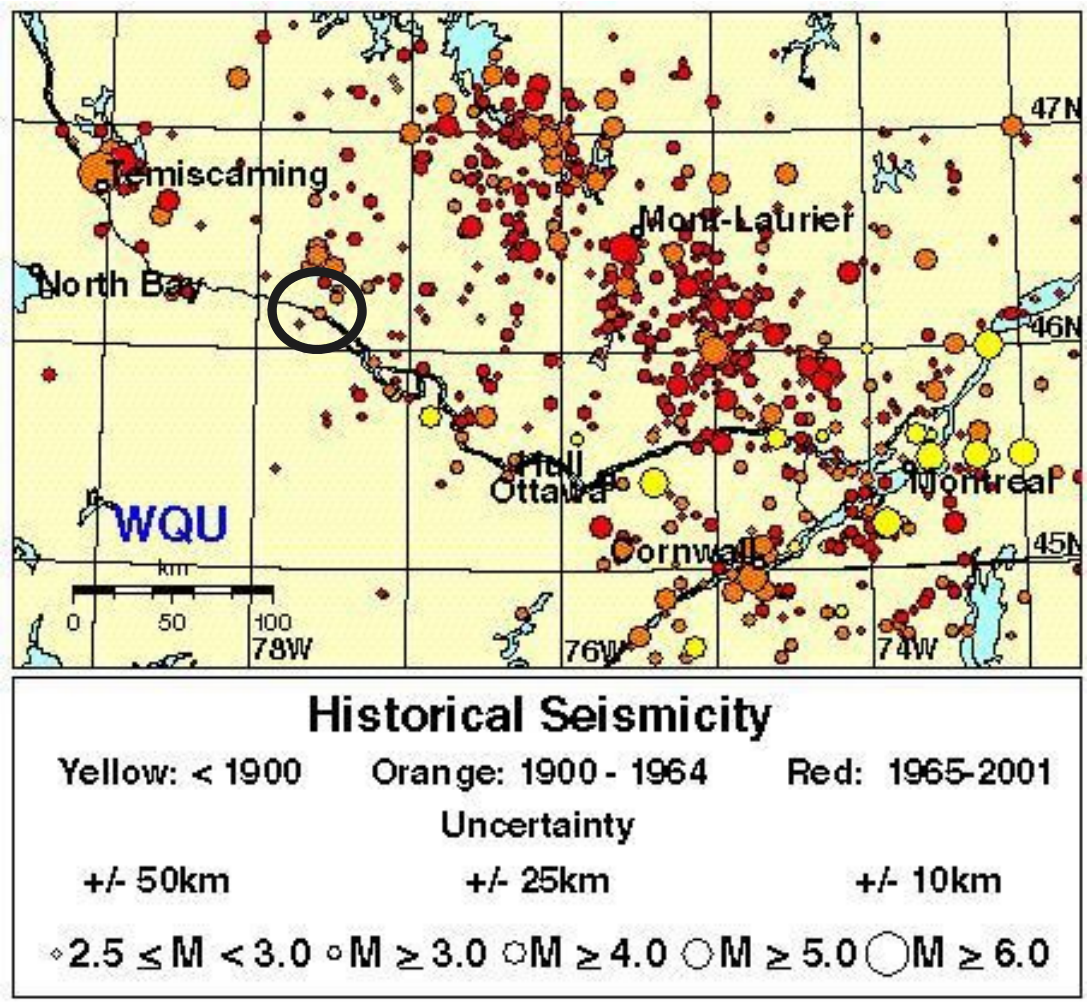
years, the magnitude of peak horizontal velocity and peak horizontal acceleration have been shown to be quite low (Athauda-Arachchige 2015).

A number of earthquakes have occurred in the vicinity of the NPD site. Of most relevance to NPDWF is the magnitude 5.0 Val-des-Bois, Quebec earthquake of 2010 June 23. This earthquake occurred in a region of moderate earthquake activity known as the West Quebec seismic zone. The largest historically damaging earthquakes in the region include a magnitude 6.0 near Montreal (Quebec) in 1732, a magnitude 6.2 near Timiskaming (Quebec) in 1935 November and a magnitude 5.8 near Cornwall (New York) in 1944 September. Two moderate earthquakes have occurred near Timiskaming (Quebec) in 2000 January of magnitude 5.2, and Plattsburgh (New York) in 2002 of magnitude 5.1. Like the Val-des-Bois event, both of these moderate sized earthquakes were widely felt in Ontario, Quebec and the northern United States. Two moderate earthquakes occurred near the Ontario-Quebec border of magnitude 5.2 and magnitude 4.1 aftershock (near Shawville, Quebec) on 2013 May 17 were felt in both provinces (Athauda-Arachchige 2015).

A magnitude 4.0 earthquake, occurring about 30 km from Chalk River in 1963, would also have been strongly felt. The strongest shaking of the site in the last 100 years was caused by the Timiskaming earthquake in 1935 (Athauda-Arachchige 2015).

Examination of the seismic data since 1661 indicates some significant earthquakes have occurred in the region at greater distances from the NPD: in 1732 near Montreal (estimated magnitude of 6.0), 1816 near Montreal (estimated magnitude of 5.5 to 6), in 1929 at Attica, New York State (magnitude of 5.2), in 1983 in the Adirondacks of northern New York State (magnitude of 5.6), and in 1988 south of Chicoutimi, Quebec (magnitude of 6.0). Figure 8.11-1 shows the seismic events and relative size in the Western Quebec seismic zone (WQU) (Athauda-Arachchige 2015); the circle identifies the area around the NPD site.

Figure 8.11-1. Historical Seismicity (Modified from: (Athauda-Arachchige 2015))



8.11.3 Tornadoes

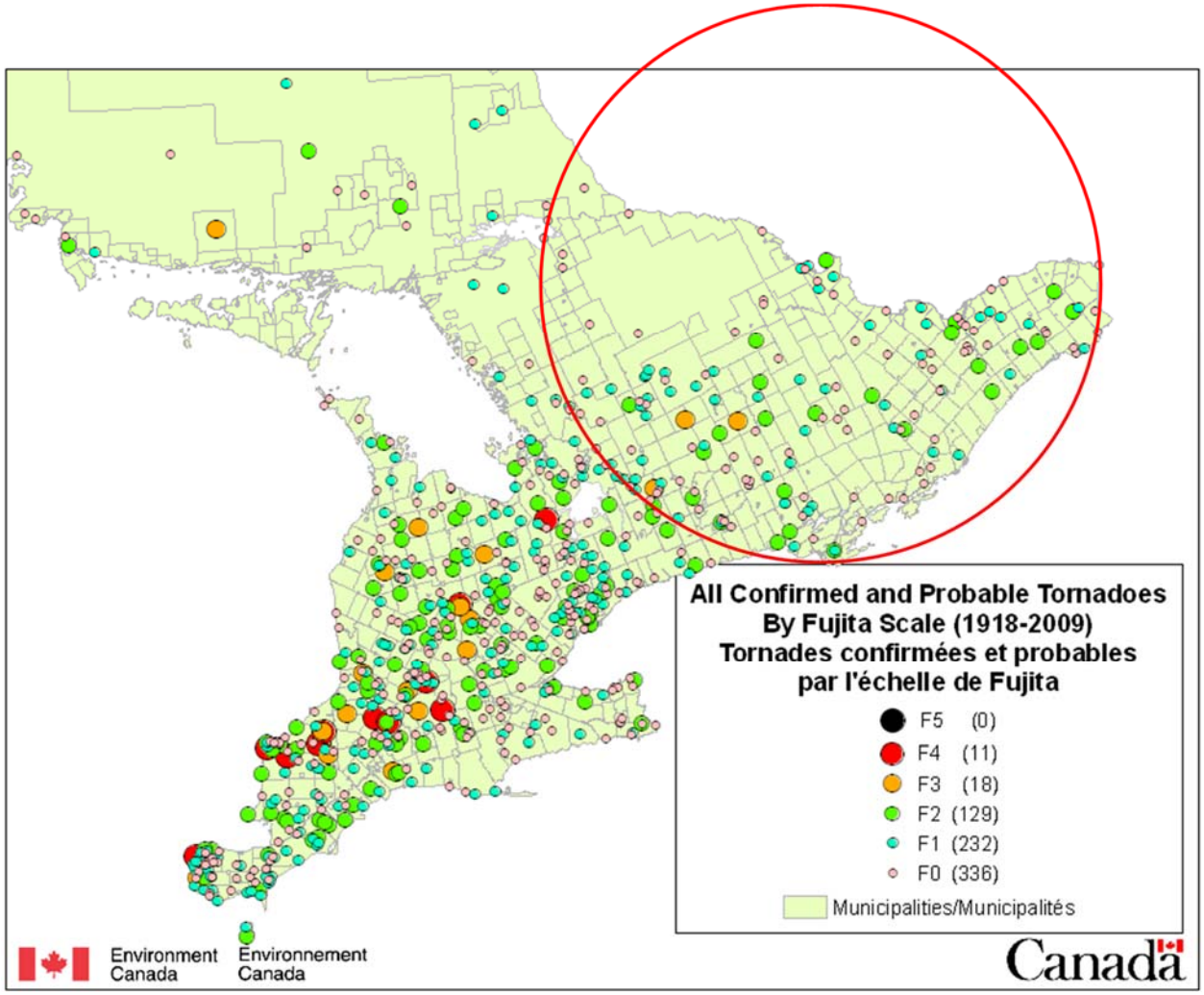
8.11.3.1 Site/Local Study Area

The baseline frequency and severity of tornadoes for the Site/Local Study areas will be the same as that described for the Regional Study Area (below), as this does not vary greatly across such a small distance (the size of the Local Study Area).

8.11.3.2 Regional Study Area

The occurrence of tornadoes within a distance of 200 km of the NPD site was assessed using data obtained from the Emergency Management Ontario (EMO 2016). The area within 200 km of the NPD site is shown with a red circle on Figure 8.11-2. Information from prior to 1918 may not be complete, and may cause an underestimation of the annual frequency of the occurrence of tornadoes.

Figure 8.11-2. Confirmed and Probable Tornadoes between 1918 and 2009 in Ontario (EMO 2016)



The number of confirmed and probable tornadoes from 1976 to 2015 in Southern Ontario is shown in Table 8.11-1 below. The Southern Ontario tornado inventory over the 40 years from 1976 to 2015 yields approximately 4.8 tornadoes per 100,000 km^2 per year or 0.6 EF2 and higher tornadoes per 100,000 km^2 per year (EMO 2016).

Table 8.11-1. Number of Confirmed and Probable Tornadoes from 1974 to 2015 in Southern Ontario (EMO 2016)

F / EF Number	Number of Tornadoes
0	157
1	73
2	25
3	5
4	2
5	0
Total	**262**

The wind speed associated with Fujita and enhanced Fujita scales are shown in Table 8.11-2. The enhanced F-scale is still an estimate of wind speed (not measurements) based on damage.

Table 8.11-2. Wind Speed for Fujita and Enhanced Fujita Scales

Fujita Scale			Derived Enhanced Fujita Scale		Operational Enhanced Fujita Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

According to an article in the North Renfrew Times on 1984 July 15, a tornado touched down in the area between Deep River and Rolphton causing one death, many injuries and extensive damage along the Upper Ottawa Valley and Quebec (Athauda-Arachchige 2015).

This tornado lasted about 10 minutes, and the trees were flattened in the path of the tornado along the Ottawa River to just north of the Ontario Highway 17. The damage seemed to be limited to an area about 2 km wide. The estimate of property damage was low, and the damage was confirmed mainly to outbuildings and a personal vehicle (Athauda-Arachchige 2015).

8.11.4 Floods

8.11.4.1 Site/Local Study Area

The baseline frequency and severity of flooding for the Site and Local Study Areas are expected to be the same as those described for the Regional Study Area (described below).

8.11.4.2 Regional Study Area

Flooding of the NPD site could occur due to:

- Flooding from the Ottawa River (i.e. river level rise);
- Heavy precipitation; or,
- Failure of the dams on the Ottawa Rover upstream of the site.

Flooding from the Ottawa River (High-Water Flooding)

The probability of flooding by river water is not considered likely because control of the river water is exercised by Ontario Power Generation's (OPG's) Des Joachims Generating Station, located approximately 3 km upstream from NPD (Athauda-Arachige 2015). The highest recorded level of the Ottawa River at NPD is 114 masl. Seasonal fluctuations in the level of the river, between 110 m and 114 masl, do not affect NPD. The only possibility for the river water to enter the nuclear portion of the facility would be for the river level to rise above 118 m and enter the process drainage pipe; this would mean a rise of 4 m above its maximum level.

Flooding from Heavy Precipitation

The Canadian Disaster Database, maintained by Public Safety Canada, recorded 24 major floods in Ontario within the past 25 years. The major floods in Ontario from 1990 to 2015 are shown in Table 8.11-3. The majority of these floods occurred in Southern Ontario. Assuming that each major flood affects 1000 km^2 (conservative estimate), the annual probability (frequency) the NPD site falls within a flood affected area is $7.3x10^{-3}$ (based on the Southern Ontario Area of 137,000 km^2).

Table 8.11-3. Ontario Major Floods from 1990 to 2015 (Public Safety Canada 2013)

Location	Event Start Date
Toronto, Ontario	8-Jul-13
Kasabonika Lake First Nation, Ontario	27-May-13
Thunder Bay	28-May-12
Kashechewan and Fort Albany, Ontario	24-Mar-12
Fort Albany and Kashechewan First Nations, Ontario	24-Mar-12
James Bay ON	9-May-08
Albany River ON	25-Apr-08
Trent Hills ON	17-Apr-08
Belleville ON	14-Apr-08
Port Bruce ON	18-Feb-08
Kashechewan ON	23-Apr-06
Kashechewan ON	23-Apr-05
Attawapiskat ON	19-May-04

Location	Event Start Date
Municipalities of Ignace, Fort Frances, Rainy River, Alberton, Atikokan, Chapple, Dawson, Emo, La Valle, Lake of the Woods, Morley, Machin; Township of Sioux-Narrows - Nestor Falls, ON	9-Jun-02
Attawapiskat First Nation ON	1-May-02
Eastern Ontario and Quebec	28-Mar-98
Durham ON	9-Jan-97
Ottawa ON	8-Aug-96
Atikokan ON	5-Jul-96
Timmins and Dufferin County ON	17-May-96
Southern ON	16-Jan-94
Elmira ON	28-Aug-92
Toronto ON	31-Jul-92
Attawapiskat ON	18-May-92

The facility SAR (Athauda-Arachchige 2015) mentions that heavy precipitation could occur mostly in the summertime. The highest rainfall recorded at CRL (about 25 km from NPDWMF) in a 24-hour period (since 1963), was 70.2 mm in the 24 hours of 2002 June 11. Other significant events occurred on 1999 July 05 when 60.8 mm was recorded in six hours and on 1999 September 29 when 25.5 mm was recorded in three hours. The National Building Code Design Rainfall data for Deep River area are: 15 minutes rainfall of 23 mm, one-day rainfall of 92 mm, and annual total precipitation of 850 mm (Athauda-Arachige 2015).

The likelihood of external flooding due to a precipitation event is also assessed in the facility Safety Analysis Report (Athauda-Arachchige 2015; Section 10.5.3.2), where localized flooding due to surface run-off of meteorological extremes and or spring thaw conditions was identified as extremely unlikely because of the good drainage provided by the site topography. The landscape diverts heavy precipitation from the NPDWF to the Ottawa River, and the NPDWF is accessed by site staff to inspect for any damage after a flooding event.

Overall the frequency is rare (i.e. between $3x10^{-2}$ and 10^{-4} per year) (Athauda-Arachige 2015).

Flooding from dam failure

Based on the findings of the 1999 *Ottawa River Dam Break and Inundation Mapping Study* performed by OPG, Athauda-Arachchige (2015) reports that a probable maximum precipitation event combined with a 100-year snow-pack condition gives rise to the highest estimated flood level (i.e. the river study's worse-case flood scenario). The results show that the Des Joachims dam would be capable of generating dam-break flood waves. Probable maximum flood flows would be several times greater than the normal river flows and, the flood volumes would exceed the storage capacity of the reservoir, causing significant flooding.

In the event the failure of the Timiskaming dam (about 193 km northwest of the NPD site) were to occur, the flood wave resulting from this dam failure would fill the Otto Holden dam (about 145 km northwest of the NPD site) and Des Joachims dam (about 3 km northwest of the NPD site) reservoirs causing overtopping and potential failure of the Otto Holden and Des Joachims dams. In the event of the failure of these main three dams, the river basin has to drain the flows from its tributaries as well as additional large and abrupt flows due to failure of dams. If sufficient time elapses between the dam failure event and the time when outflows from the basin begins to exceed the inflows, the water in the basin may back up all the way to the NPD site causing severe flooding at the facility.

As reported in the DecomSA TSD, the frequency of flooding by dam failure is considered to be negligible compared with the frequency of a flood from heavy precipitation on site.

8.11.5 Potential for Natural Fires or Explosions

8.11.5.1 Site/Local Study Area

The Site Study Area is unlikely to have a forest fire (specifically in the boundary of the Site Study Area), as it is mostly previously disturbed land, and much of the space has been cleared for roads, buildings, and fire breaks. Firebreaks have been cut through forests in the Local Study Area to minimize the risk of the spread of fire and to facilitate the fighting of a forest fire. Additionally, no spontaneous combustion sources remain on the Site Study Area. Electrically energized systems consist of physical security and fire detection equipment, lighting circuits, power supply to sump pumps, nuclear-area ventilation fans, unit heaters in the static state control area and the emergency diesel generator. All accessible redundant electrical circuits have been removed from the facility. De-energized wiring and cable remains in the former nuclear-area of the building (Dunfield and Glennie 2012). The bulk of the cable trays have been stripped of cables. There is a low probability of cable insulation fires in the reactor building. In addition, combustible materials have been removed from the building and stored outside in sea containers (Athauda-Arachchige 2015).

The Local Study Area consists of a large wooded area, and as such it is susceptible to natural forest fires. It is expected that the Local Study Area will behave similarly to the Regional Study Area, which is described below.

8.11.5.2 Regional Study Area

The Regional Study Area contains large areas of forest interspersed with some cleared towns and roads. Forest fires may result from extremely dry conditions, lightning or human activities (e.g., campfires). Some pests, such as pine beetle, damage and kill trees, which increase the amount of dry, dead organic matter that can provide fuel for a fire. According to Environment Canada (2016), within Canada, lightning is most frequent in southern Ontario. The lightning flashes per year are calculated as the average number per 100 km^2 (i.e. the area covered by a square of 10 km by 10 km). Lightning flashes per year per 100 km^2 for Ottawa is 90 and for Thunder Bay is 36 (CNL 2013). (Athauda-Arachchige 2015).

The forest of Barron Township in Algonquin Park, 30 km southwest of NPD, has a natural fire rotation of 70 years, i.e., it takes 70 years to burn an area equivalent of the area studied without fire suppression (Cwynar 1977). While anthropogenic sources account for roughly half of all forest fires in Barron Township, the area of forest fires decreases with fire suppression. Since effective fire suppression has been in practice, there have been no major (>50% of township) fires in the township, the most recent having occurred in 1875 (Cwynar 1977).

Based on data in the National Forestry Database, over 8,000 fires occur in Canada each year, and burn an average of over 3 million hectares (CNFDB 2016). This means, on average, each fire burns 375 ha or 3.75 km^2 of forest (Morin and Carr 2015). The data extracted from NFD also shows that there were 597 forests fire in Ontario in 2015 with 10-year average of 803 forest fires (MNRF 2016c). Given the Ontario area of 1.076 million km^2, this represents a frequency of 7.46×10^{-4} forest fire per year per km^2. Considering 3.75 km^2 of area surrounding the facility, the frequency of a forest fire that may affect the site would be 2.8×10^{-3} per year.

9 ASSESSMENT & MITIGATION OF ENV. EFFECTS

9.1 Effects Assessment Approach

9.1.1 Background

CEAA (2012) defines environmental effects as:

5 (1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are:

(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:

(i) fish and fish habitat as defined in subsection 2(1) of the Fisheries Act,

(ii) aquatic species as defined in subsection 2(1) of the Species at Risk Act,

(iii) migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994, and

(iv) any other component of the environment that is set out in Schedule 2;

(b) a change that may be caused to the environment that would occur:

(i) on federal lands,

(ii) in a province other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or

(iii) outside Canada; and

(c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on:

(i) health and socio-economic conditions,

(ii) physical and cultural heritage,

(iii) the current use of lands and resources for traditional purposes, or

(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Exercise of power or performance of duty or function by federal authority

(2) However, if the carrying out of the physical activity, the designated project or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under any Act of Parliament other than this Act, the following environmental effects are also to be taken into account:

> *(a) a change, other than those referred to in paragraphs (1)(a) and (b), that may be caused to the environment and that is directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the physical activity, the designated project or the project; and*
>
> *(b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on:*
>
> > *(i) health and socio-economic conditions,*
> >
> > *(ii) physical and cultural heritage, or*
> >
> > *(iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.*

The EIS Guidelines (CNSC 2016a) state that predicted changes to the environment are to be considered in relation to each phase of the project (i.e., Decommissioning Execution, Institutional Controls and Post-Institutional Controls) and are to be described in terms of magnitude, geographic extent, timing, frequency, duration and reversibility. The CNSC provides similar criteria for assessment of effects, in its REGDOC-2.9.1 (CNSC 2016b), which are used in this EIS for the assessment of effects:

- Magnitude of the effect – The size or degree of the effect compared against baseline conditions or thresholds.
- Spatial extent of the effect – The geographic area over or throughout which the effects will be measurable.
- Duration and frequency of the effect – The time period over which the effect will last, and the rate of recurrence of the effect (or conditions causing the effect).
- Degree to which the effect can be reversed or mitigated – The degree to which the effect can be prevented, reduced or reversed (typically measured by the time it will take to restore the environmental attribute or resource).
- Ecological importance – The importance of the environmental attribute or resource to ecosystem health and function.

In addition to the above criteria, another one was also considered in the assessment of effects on human health:

- Human Health – The degree to which the physical aspects of human health may be affected.

9.1.1.1 Supporting Documents

The assessment of environmental effects in this EIS often relies upon TSDs and other documents for the prediction of potential environmental effects in a number of environmental components for each project phase. The information provided by these TSDs is presented graphically in Figure 9.1-1.

Figure 9.1-1. Illustration of Information Presented in TSDs

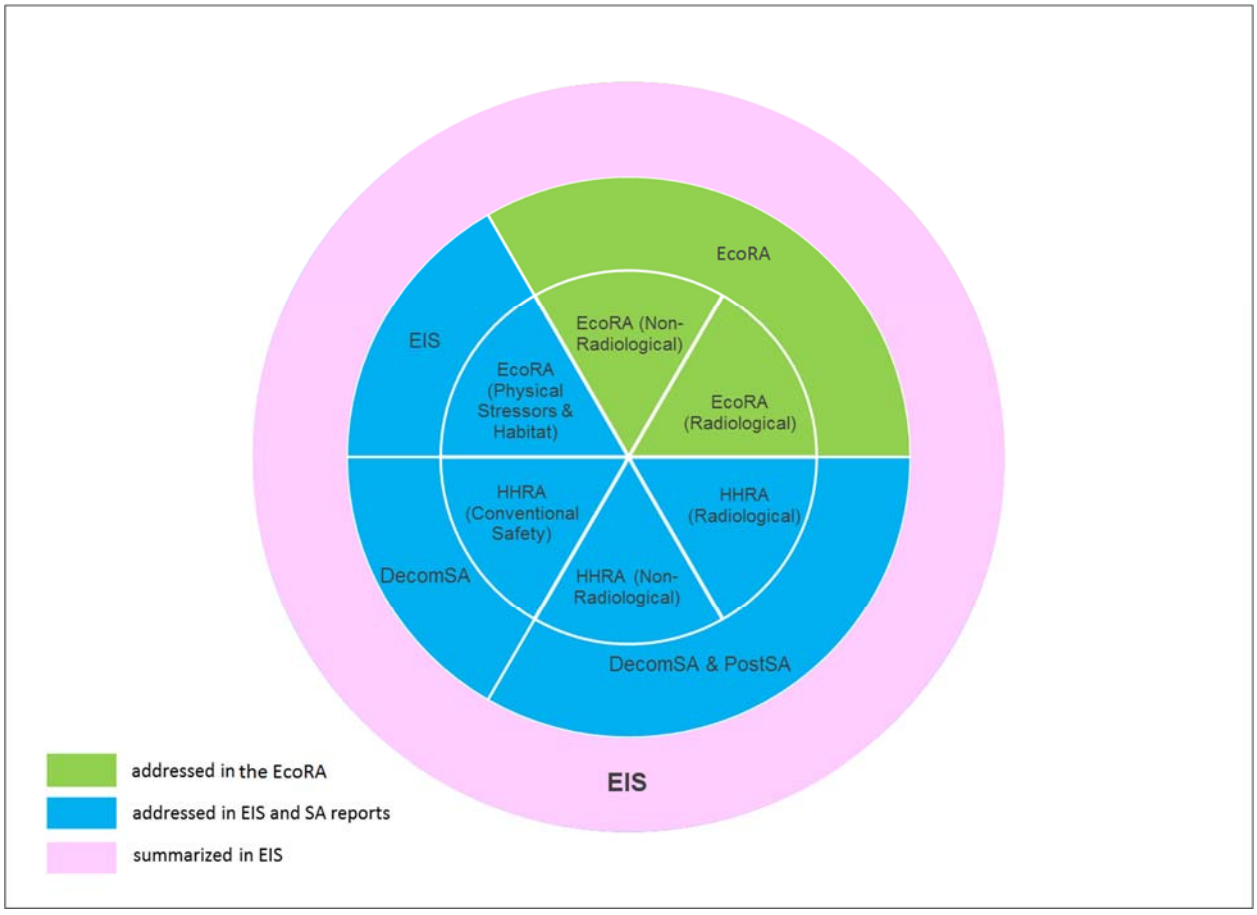
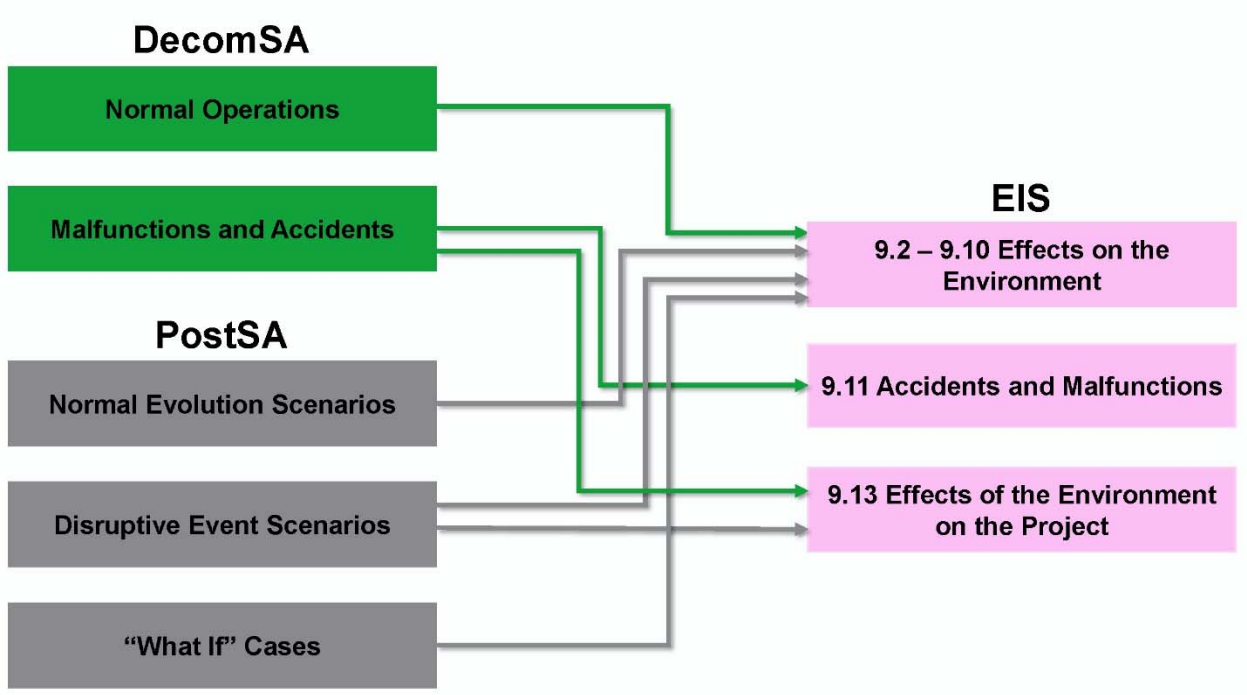


Figure 9.1-2 illustrates how the results from the DecomSA and PostSA TSDs have been incorporated into the effects assessment in this EIS.

Figure 9.1-2. DecomSA and PostSA Effects Integration into EIS



The DecomSA, EcoRA and PostSA TSDs cover the following time frames:

- Decommissioning Execution phase – Decommissioning Safety Assessment (DecomSA) TSD and Ecological Risk Assessment (EcoRA) TSD.
- Institutional Controls and Post-Institutional Controls phases – Postclosure Safety Assessment (PostSA) TSD and EcoRA TSD.

In this EIS, the reader is often referred directly to these documents for details. In other cases, relevant sections of the TSDs are copied into this section. To provide context, a general background of the relevant TSDs is provided as follows.

Decommissioning Safety Assessment (DecomSA TSD)

The DecomSA TSD assesses the safety of human receptors (i.e., workers and members of the public) from normal operations and accidents as part of the Decommissioning Execution phase. Exposure for workers during the Institutional Controls phase is not expected to be any greater than the current ambient dose (< 0.0005 mSv/hr). The DecomSA TSD focuses on assessing safety to members of the public and workers from exposure to radiological and chemical contaminants, as well as conventional accidents (e.g., direct injuries) resulting specifically from the NPD closure project. The DecomSA TSD also provides information on project-related releases to the environment under normal activities and other credible scenarios (i.e., accidents and malfunctions, effects of the environment on the project). The normal activities are discussed

within each relevant environmental component (Sections 9.2-9.10 below). The DecomSA TSD also considers the following bounding scenarios, which are discussed in Section 9.11 Accidents and Malfunctions and Section 9.13 Effects of the Environment on the Project:

1) **Forest Fire and Release of Radioactivity** – release of radioactivity due to fire spreading to the building and subsequently mobilizing and releasing radionuclides;
2) **Forest Fire and Release of Chemical Contaminants** – release of chemicals (e.g., mercury, combustion by-products) due to fire spreading to the building and subsequently mobilizing and releasing chemicals;
3) **Tornado and Release of Radioactivity** – release of radioactivity due to damage to the building and subsequently mobilizing and releasing radionuclides;
4) **Tornado and Release of Chemical Contaminants** – release of chemicals due to damage to the building and subsequently mobilizing and releasing chemicals;
5) **Major Flood and Release of Radioactivity** – release of radioactivity due to water ingress and subsequently mobilizing and releasing radioactivity;
6) **Accidental Exposure to Radioactivity** – unanticipated radiological dose during demolition of walls, and cutting holes, vessels and pipes;
7) **Accidental Exposure to Chemicals** – unanticipated exposure to chemicals during demolition of walls, and cutting holes, vessels and pipes;
8) **Underground (Indoor) Fire and Release of Radioactivity** – airborne release of radionuclides and subsequent exposure;
9) **Underground (Indoor) Fire and Release of Chemicals** – airborne release of fire by-products (smoke and chemicals), as well as chemicals involved in the fire and subsequent exposure;
10) **Stack Collapse and Release of Radioactivity** – release of radioactivity and exposure.

Postclosure Safety Analysis (PostSA TSD)

The PostSA TSD is used to analyze long-term implications (i.e., during the Post-Institutional Controls phase) of the project. The purpose of the PostSA TSD is:

- To undertake a quantitative assessment of the postclosure radiological and non-radiological safety of the in-situ decommissioning of the NPD according to CNL's reference strategy;
- To identify those uncertainties that have the greatest potential effect on the long-term performance of the decommissioned facility; and
- To provide necessary information to support an EA which will address the requirements of *CEAA* (2012) and G-320 (CNSC 2006).

Evaluating postclosure safety requires projections of the future condition of the NPDWF and its environment and how people might interact with it. Approaches have been developed to undertake such evaluations, centred on a "system analysis" method. This involves representing the NPDWF, the facility inventory present, and all potentially relevant media, with mathematical models to represent the key processes that may occur (e.g. corrosion of wastes, dissolution into groundwater, uptake by plants). It is essential that the model is relevant, well-grounded and auditable. This is achieved through a systematic approach to safety assessment. The international community has developed best practice guidance on the process, which is

documented in a report of the International Atomic Energy Agency's (IAEA) Improving Safety Assessment Methodologies (ISAM) programme (IAEA 2004) and incorporated into a more recent safety guide (IAEA 2012). This process has been applied internationally since its publication, is consistent with Regulatory Guide G-320 (CSNC 2006), and underpins the PostSA analysis.

The PostSA TSD uses the best available information on the NPDWF and its environment to form the basis of the mathematical models developed specifically to represent the system. These have been used to calculate results that can be compared with relevant Canadian criteria and standards, as well as inform on uncertainties and identify the most important aspects of the system. These uncertainties and important aspects are captured using a number of scenarios, which are summarized in Section 4.1 of the PostSA TSD, and within the groupings below.

- Normal Evolution Scenario;
- Disruptive Event Scenarios;
- "What If" Cases;
- Defence-in-Depth Cases;
- Alternative Strategy Cases; and
- Sensitivity Calculations.

The normal evolution scenario starts immediately following the Decommissioning Execution phase to capture the entire postclosure period (i.e., Institutional Controls and Post-Institutional Controls phase). Other scenarios (discussed below) are assessed immediately following the Institutional Controls phase, since if such a scenario were to take place during the IC phase, CNL would take corrective mitigation measures to prevent any residual effects.

Normal Evolution Scenario

In this scenario, the facility is assumed to be closed as planned, with no unforeseen events. Parts of the NPDWF that lie below the water table will gradually resaturate. It is expected that resaturation may take several decades to complete. Once saturated, the soluble contaminants in the facility will begin to be released into the groundwater. When the cap begins to degrade, rainfall and snowmelt will percolate down through the facility towards the water table.

Groundwater contact with the facility structure and grout will gradually degrade it as the cement constituents are slowly leached. As it degrades, the pH of the cement will fall and its porosity will increase. Over thousands of years, the cement and concrete will gradually lose strength and may begin to crack and fracture, e.g. as a result of corrosion of rebar. Close to the surface, freeze-thaw effects will degrade the cap and concrete cover.

Groundwater flows in the vicinity of the NPDWF are assumed to be dominantly through the base of the overburden. This is consistent with the presence of a relatively permeable overburden material underlain by bedrock that has substantially lower permeability.

The primary point of potential contaminant release into the biosphere is taken to be the riverbed close to the shore of the Ottawa River. In the aquatic environment, the contaminants may sorb to sediments or be taken up by aquatic flora and fauna. The dominant process will, however, be advection, dispersion and subsequent dilution in the water. River water is also used by people in many cases; for example, Deep River obtains its water from the Ottawa River.

Disruptive Event Scenarios

Disruptive event scenarios are designed to address uncertainties that have arisen during the definition of scenarios and conceptual models. Each is a variant on the normal evolution scenario and is described with scenario-specific assumptions. The following four disruptive event scenarios were assessed in the PostSA:

- Site investigation (human intrusion): this scenario assesses the potential of humans drilling, extracting and examining a core sample from the facility, potentially leading to internal or external exposures.
- Engineering degradation: It is possible that an earthquake, or other unforeseen events, might result in the engineered structures not performing as anticipated. This scenario captures such situations.
- Surface erosion: Flooding of sufficient magnitude has the potential to remove material (e.g., vegetation, overburden) from the surface. This would potentially dilute contaminants in groundwater and expose contaminated rock to the surface environment.
- Early glaciation: Glaciation is not expected to occur for more than 100,000 y from present. However, glaciation could happen earlier, scouring the surface, removing and redistributing all of the overburden and potentially some of the bedrock – resulting in a transfer of contaminants to the biosphere. This scenario assumes that glaciation occurs after 60,000 years.

"What If" Cases

"What if" cases represent a deliberately extreme set of assumptions that can be used to understand the absolute limits of safety performance. These have been identified as potentially of interest in the same way as other scenarios, but discounted from the main set of assessment calculations on the basis that they are of very low or negligible likelihood. Nevertheless, they inform on the underlying bounds to postclosure safety and, as such, provide valuable perspective. However, due to their very low likelihood they are not included in consideration for the identification and assessment of residual effects.

- Mass excavation: This case examines the complete disruption and excavation of the NPDWF, providing a basic perspective on the intrinsic hazard of the radioactive material in the facility. It is assumed that the entire inventory is dispersed in surface soils that are subsequently used e.g., for cultivating foods by the site resident.
- River level fall: This case examines the consequences of a fall in the river level of several metres, sufficient to permit groundwater to be released directly to the surface (i.e., to shoreline sediment).
- Well in contaminated plume: This case examines the potential for a well located between the facility and the river. The resulting pathways could lead to exposures with substantially less dilution than the normal evolution scenario.

As listed above, the PostSA TSD also considers other types of cases, including Defence-in-Depth Cases, Alternative Strategy Cases and Sensitivity Calculations. These cases serve to: illustrate the importance of grout in the facility and address uncertainty in model parameters (sorption, hydraulic gradient, resaturation and inventory) and assess feasibility of an alternate strategy. Thus, these scenarios are not relevant for the EIS effects assessment.

The PostSA TSD considers two potential exposed groups:

- Site resident family: A highly conservative group that maximizes potential exposures. This is reflected by a small household (comprising two adults, a child and an infant) residing directly over the decommissioned facility and pursuing a self-sufficient lifestyle. This includes use of potentially contaminated river water for domestic and agricultural purposes.
- A hunting/recreational group, represented by a small number of adults and children making hunting and/or recreational use of the river and the area surrounding the NPD. Their exposure pathways, including obtaining wild foods, is also representative of the types of habits that might be exhibited by Aboriginal groups.

In the site investigation disruptive event scenario, an additional potentially exposed group is considered:

- Intruder: a person involved in drilling into the NPDWF is assumed to be directly exposed to 5 kg of contaminated material, retrieved from the reactor vault.

Ecological Risk Assessment (EcoRA TSD)

The EcoRA TSD assesses the effects of radiological and chemical contaminants on non-human biota during the Decommissioning Execution and Post-Institutional Controls phase. Other stressors associated with the project (e.g., noise, dust, changes in habitat) are assessed within the EIS. The EcoRA TSD incorporates contaminant concentration data in various environmental media, from the DecomSA (for the Decommissioning Execution phase) and PostSA (for the Post-Institutional Controls phase) TSDs to assess ecological risk.

In the EcoRA, the ecological receptors for the site were selected based on the list of VCs identified for the site in this EIS (Section 5.2.4), as well as selection criteria outlined in CSA N288.6-12 (CSA 2012). Ecological receptors are used as assessment endpoints, which are expressions of the actual environmental values to be protected. In general, the assessment endpoints selected in this study were healthy populations of the identified indicator species within the study area. SARs were considered on an individual level. The results of the EcoRA are summarized in Sections 9.4 (Aquatic Environment) and 9.6 (Terrestrial Environment) below.

In the EcoRA screening process for radiological contaminants, if the radionuclide concentration was below the no effects concentration (NEC) value, then that radionuclide was “screened out” or excluded from the assessment for the particular scenario being screened. If the radionuclide concentration was greater than the NEC value and a dose coefficient was available, then the radionuclide was “screened in” or included for assessment in the EcoRA; if a dose coefficient was not available, then the radionuclide was “screened out”. If an NEC value was not available but a dose coefficient was available, then the radionuclide was

"screened in". In the screening exercise conducted for the EcoRA, no radionuclide exceeding an NEC was excluded from assessment due to a lack of available dose coefficient. It is noted that excluding a radionuclide from assessment because a dose coefficient is not available would result in an underestimation of the total dose and perhaps any potential effects; however, the radiation dose cannot be estimated without a dose coefficient.

In the EcoRA screening process for chemical contaminants, the maximum contaminant concentrations predicted over time in each affected environmental medium (i.e., soil, groundwater, river sediments, river water) for each scenario were screened against applicable criteria. Contaminants were "screened in" for the scenario and assessed in the EcoRA if an exceedance of the most conservative criterion was noted in at least one environmental medium for that scenario and a toxicity reference value (TRV) was available. This screening approach is consistent with N288.6-12 (CSA 2012).

The following supporting documents are also used for the assessment and mitigation of potential environmental effects:

- Greenhouse Gas Emissions Associated with the NPD Closure Project TSD (Greenhouse Gas TSD);
- Chimney Swift TSD;
- Archaeology TSD; and,
- Socio-Economic TSD.

9.1.2 Approach

The effects section of the EIS is divided into project-related effects by environmental compartment (Sections 9.2 to 9.10), accidents and malfunctions (Section 9.11), cumulative effects (Section 9.12) and effects of the environment on the project (Section 9.13). The approaches for assessing accidents and malfunctions, cumulative effects and effects of the environment on the project are discussed in Sections 9.11, 9.12 and 9.13 respectively.

The approach for assessment of project-related effects (i.e., Sections 9.2 to 9.10) is presented below. It has been carried out using the general approach, as prescribed in CNSC (2016b) REGDOC-2.9.1 and the EIS Guidelines (CNSC 2016a). These steps have been carried out for each environmental compartment, based on the VCs and spatial and temporal assessment boundaries selected earlier in this EIS.

9.1.2.1 Identification of Residual Effects

Each project-environment interaction that was identified in the Interactions Matrix (see Section 5.2.2), was evaluated further to identify the likely effect of the change on a VC in the relevant environmental component or on a pathway to VCs in other environmental components. To determine whether an interaction has the potential to result in a residual effect, the findings of various TSDs, input from technical experts, mitigation measures, and the CNSC criteria for the assessment of effects (in Section 9.1.1 above) were considered. As shown in the Interactions Matrix (Table 5.2-1), potential effects can be beneficial or adverse. Only potential adverse effects are carried forward for assessment.

Effects that are likely to occur after the use of mitigation measures are identified as residual effects. By assessing residual effects, consideration was given to the benefit of in-design mitigation measures in preventing or reducing environmental effects. In-design mitigation measures are features included in the project design for the purpose of pre-empting possible environmental effects, based on good practice and CNL experience. For example, the use of grout to fill the structure is expected to slow down the release of contaminants to groundwater and subsequently to the Ottawa River, and allow more time for radioactive decay. In-design mitigation measures are described in Section 3 (System Description) of the PostSA TSD, and are summarized in Section 4.1 above.

When adverse residual effects are identified, additional mitigation measures will be developed and outlined within each environmental component (i.e., under the Monitoring and Follow-up sub-section). Monitoring and follow-up measures may also be identified for effects that were not identified as adverse residual effects, in order to confirm the predictions of the effects assessment and that the planned mitigation measures are being carried out and that they are effective.

9.1.2.2 Assessment of Residual Effects

Each of the adverse residual effects identified in the above steps were subjected to an analysis of significance, and classified into one of the following significance levels:

- Minor Adverse Effect: The adverse residual effect is minor or insignificant; or
- Significant Adverse Effect: The adverse residual effect is significant. Additional or more effective mitigation to reduce the effect of the effect is not considered possible.

The methodology used to classify residual adverse effects as minor or significant was developed from a similar approach used by the CNSC in its Environmental Assessment Screening Report for the Pickering B Refurbishment and Continued Operation project (CNSC 2007c, Section 11.1). This methodology was also utilized for the New Nuclear – Darlington Environmental Assessment.

Each adverse residual effect was evaluated based on the criteria from CNSC REGDOC-2.9.1 (CNSC 2016b), as outlined in Table 9.1-1 below. For each of the criteria below, a rating of Low, Moderate or High was assigned.

Table 9.1-1. Criteria for Classification of Residual Effects

Effects Criteria	Effects Level Definition		
Level of Effect	**Low**	**Moderate**	**High**
Magnitude	Effect exceeds baseline conditions; however, is less than reference criteria or guideline values.	Effect will likely exceed reference criteria or guideline values but has little or no effect on VC or pathways to VC.	Effect will likely exceed reference criteria or guideline values and may cause an effect on VC or pathway to VC.
Spatial (Geographic) Extent of Effect	Effect limited to Site Study Area or immediate surroundings.	Effect limited to Local Study Area.	Effect extends into or beyond Regional Study Area.
Duration/ Timing of Effect	Effects is limited to short-term events.	Effect is limited to Decommissioning Execution and Institutional Controls period.	Effect extends into the Post-Institutional Controls phase.
Frequency/ probability of conditions causing effect	Conditions or phenomena causing the effect are unlikely and/or infrequent.	Conditions or phenomena causing the effect likely an infrequent occurrence.	Conditions or phenomena causing the effect to occur at regular and/or frequent intervals.
Reversibility Risk	Effect ceases once source/stressor is removed.	Effect persists for some time after source/stressor is removed.	Effect is not readily reversible.
Effect on Human Health	Effect exceeds baseline conditions; however, is less than reference criteria or guideline values.	Effect will likely exceed reference criteria or guideline values but has little or no effect on human health or pathway to human health.	Effect will likely exceed reference criteria or guideline values and may cause an effect on human health or pathway to human health.
Ecological Importance (of VC)	The VC being affected is common and abundant within the Local Study Area.	The VC being affected is less common and of limited abundance within the Local Study Area.	The VC being affected is recognized as being at risk either provincially or nationally.

Once the rating was complete, a two-step process was applied by the respective EA specialists to determine significance of the adverse residual effects, based on their criteria ratings. The potential for a re-assessment of an adverse residual effect was also incorporated into the process.

Step 1: If a Moderate or High rating is assigned to all of the criteria dealing with the nature or extent of the effect (as follows):

- magnitude;
- spatial (geographic) extent;
- duration/timing;
- frequency/probability; and
- reversibility.

then proceed to Step 2. If a Low rating is assigned to any of the Step 1 criteria, the effect is deemed a minor residual adverse effect (i.e., not significant), and no further assessment is required.

Step 2: If a Moderate or High rating is assigned to at least one of the criteria dealing with the environmental and/or social implications of the effect (as follows):

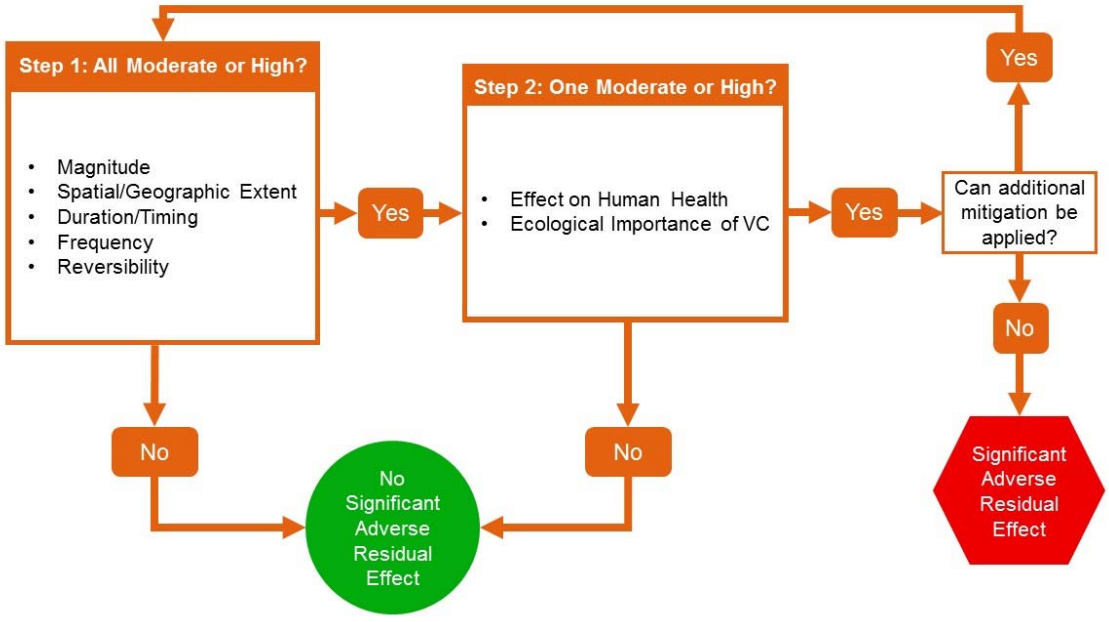
- effect on human health; or,
- ecological importance of VC,

then the effect is forwarded for an assessment of the possibility of applying additional mitigation measures.

If additional mitigation measures cannot be applied to the residual adverse effect, then the effect is deemed a significant residual adverse effect. If additional mitigation can be applied, then the residual adverse effect is sent back to Step 1 for re-assessment. If all Step 2 criteria are assigned a Low rating, the effect is deemed a minor residual adverse effect (i.e., not significant).

This methodology is shown graphically in Figure 9.1–3.

Figure 9.1-3. Methodology for Determination of Significance



For Step 1, the criteria ratings were established such that any residual adverse effect rated as “low” in any of the criteria would necessarily be a residual adverse effect that was so minimal that it could not be significant, regardless of the ratings of the other criteria used in Step 1 or Step 2. In Step 2, the criteria ratings were established such that any adverse residual effect that achieves at least one “medium” or “high” rating would be considered significant.

9.1.2.3 Monitoring and Follow-up Activities

CEAA (2012) requires that the EIS include a framework or preliminary program upon which EA follow-up actions will be managed throughout the life of the project (which in this case, applies until the end of the Institutional Controls phase). The EA follow-up program is documented in Section 12 of this EIS and in Sections 9.2.5 to 9.10.5 for each environmental component. The preliminary scope of the EA follow-up monitoring program covers the Decommissioning Execution and Institutional Controls phases of the project. Recommendations are also provided on how to use this monitoring data during the initiation of the Post-Institutional Controls Phase. It is expected that the proposed follow-up monitoring program will be reviewed and adjusted on regular basis in order to account for evolving site conditions, stakeholder perceptions, and any feedback from the monitoring program. Regulatory license conditions may also stipulate additional monitoring not related to the EA follow-up program, but if this occurs, data will be shared to meet the collective requirements. As discussed in CNSC (2016b) REGDOC-2.9.1, the main objectives of the follow-up program are to verify the accuracy of the EA predictions, and determine the effectiveness of the mitigation measures implemented.

It is noted that the CNSC verifies and monitors all EA follow-up activities through the CNSC licensing and compliance process.

9.2 Atmospheric Environment

9.2.1 Selection of Valued Components

As outlined in Section 5.2.4, the atmospheric environment (i.e. air quality and noise) represents features that can be affected by the project and as such would be pathways or mechanisms for transfer of an effect to another environmental component (e.g. terrestrial environment, human health). As such, no VCs have been selected in the atmospheric environment. The effects of changes in atmospheric conditions will be considered in the applicable environmental components.

Table 9.2-1. Valued Component Selection for the Atmospheric Environment

Environmental Component	Pathway	Rationale
Atmospheric Environment	Pathway to human health	The effects on humans associated with changes in atmospheric conditions (radiological and chemical releases and concentrations) will be considered in the Human Health component.
	Pathway to non-human biota health	The effects on non-human biota associated with changes in atmospheric conditions (radiological and chemical releases and concentrations) will be considered on Terrestrial Environment VCs.
	Pathway to VCs in other environmental components	The effects on VCs in other environmental components associated with changes in atmospheric conditions (noise) will be considered in the applicable environmental components. These will include effects in the Socio-Economic Environment and Aboriginal Land and Resource Use.

9.2.2 Assessment Boundaries

9.2.2.1 Spatial Boundaries

Similar to the atmospheric environment baseline characterization in Section 8.2 above, the Site and Local Study Areas for this assessment are consistent with the general spatial boundaries outlined in Section 5.2.1.1. The Regional Study Area for the atmospheric environment is outlined in Figure 8.2-1 above.

9.2.2.2 Temporal Boundaries

The temporal boundaries for this assessment are the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.2.3 Identification of Residual Effects

9.2.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the atmospheric environment may occur as a result of interactions associated with operations and activities in the Decommissioning Execution, Institutional Controls and Post-Institutional Controls phases, in particular:

- Batch mixing plant;
- Grouting of below grade structures;
- Removal of above grade structures;
- Installation of concrete cap and engineered barriers;
- Final site restoration;
- Facility performance during the Institutional Controls phase; and
- Facility performance during the Post-Institutional Controls phase.

Table 9.2-2. Project-Environment Interactions in the Atmospheric Environment

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**1**	**Batch Mixing Plant**	
	1.1	Designate footprint, create access, temporary fencing (west side of main building).	Creating access will generate dust and noise.
	1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	Trucking and storage of materials will result in typical greenhouse gas (GHG) emissions, combustion and dust releases and noise.
	1.4	Truck in necessary water supply.	Operation of trucks will result in GHG emissions, combustion and dust releases and noise.
	1.5	Provide slip pipe access to reactor side.	Providing slip pipe access will involve creating openings in walls – GHG emissions, combustion and dust releases and noise.
	1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	Construction of the wash out pit will involve earth-moving machinery, resulting in GHG emissions, combustion and dust releases and noise.

		Project Works and Activities	Potential Interaction
Decommissioning Execution	1.7	Level area for concrete pumper.	Levelling area for the concrete pumper may involve earth-moving machinery, resulting in GHG emissions, combustion and dust releases and noise.
	1.8	Mix grout to required formula.	Mixing grout is expected to result in GHG emissions, combustion and dust releases and noise.
	1.9a	Truck grout to pumping station (20 trips per day).	Operation of trucks will GHG emissions, combustion and dust releases and noise.
	1.11	Sample and dewater the cleaning pit. Emplace sediments into voids in condenser room.	Pumping out water and removing sediment will likely involve heavy machinery – resulting in GHG emissions, combustion and dust releases and noise.
	1.12	Demobilize batch plant after cap pour.	Removing equipment from site will involve the operation of trucks – resulting in GHG emissions, combustion and dust releases and noise.
	2	**Grouting of Below Grade Structure**	
	2.3	Grout Fill Nuclear Area.	Mixing and pumping grout is expected to result in GHG emissions, combustion and dust releases. Grouting will displace air containing tritium, lead and asbestos from the facility.
	3	**Removal of Above Grade Structure**	
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition will result in GHG emissions, combustion, surface contamination and dust releases and noise.
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Cutting steel and crushing masonry will result in GHG emissions, combustion, surface contamination and dust releases and noise.
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	Transportation of materials will involve trucking/machinery, resulting in GHG emissions, combustion and dust releases and noise.
	3.4	Steel and rubble emplaced in condenser room according to nesting plan. Fill to 380 level.	Transportation of materials will involve trucking/machinery, resulting in GHG emissions, combustion and dust releases and noise. Emplacement will displace air containing tritium, lead and asbestos from the facility.
	3.5	Grout first level of demolition material in condenser room.	Mixing and pumping grout is expected to result in GHG emissions, combustion and dust releases and noise. Grouting will displace air containing tritium, lead and asbestos from the facility.

		Project Works and Activities	Potential Interaction
Decommissioning Execution	3.6	Steel and rubble emplaced in condenser pit. Fill to 400 level.	Transportation of materials will involve trucking/machinery, resulting in GHG emissions, combustion and dust releases and noise. Emplacement will displace air containing tritium, lead and asbestos from the facility.
	3.7	Grout second level of demolition material in condenser pit.	Mixing and pumping grout is expected to result in GHG, combustion and dust emissions and noise. Grouting will displace air containing tritium, lead and asbestos from the facility.
	3.8	Steel and rubble in condenser pit. Fill to 425 level.	Transportation of materials will involve trucking/machinery, resulting in GHG emissions, combustion and dust releases and noise. Emplacement will displace air containing tritium, lead and asbestos from the facility.
	3.9	Grout third level of demolition material in condenser pit.	Mixing and pumping grout is expected to result in GHG emissions, combustion and dust releases and noise. Grouting will displace air containing tritium, lead and asbestos from the facility.
	3.10	Demolition block walls and inside walls around control room and change rooms.	Demolition will result in GHG, combustion, surface contamination and dust emissions and noise.
	3.11	Collapse ceilings of furnace room and adjacent rooms.	Demolition will result in GHG emissions, combustion, surface contamination and dust releases and noise.
	3.12	Emplace block wall rubble in furnace room or condenser room.	Transportation of materials will involve trucking/machinery, resulting in GHG emissions, combustion and dust releases and noise. Emplacement will displace air containing tritium, lead and asbestos from the facility.
	3.13	Remove recyclables from guard house.	Removal of recyclables (i.e. metal and wiring) will result in noise.
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Demolition will result in GHG emissions, combustion, surface contamination and dust releases and noise.
	3.15	Grout furnace room and adjacent areas to ground level.	Mixing and pumping grout is expected to result in GHG emissions, combustion and dust releases and noise. Grouting will displace air containing tritium, lead and asbestos from the facility.
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition will result in GHG emissions, combustion, surface contamination and dust releases and noise.

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**4**	**Install Concrete Cap and Engineered Barrier**	
	4.1	Concrete Cap (construct forms, install rebar, and pour, level and slope concrete).	Mixing and pumping concrete is expected to result in GHG emissions, combustion and dust releases and noise.
	4.2	Engineered Barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	Operation of trucks and earth-moving equipment will result in GHG emissions, combustion and dust releases and noise.
	5	**Final Site Restoration**	
	5.1	Site Restoration (install fencing, install monitoring wells if required, remediate areas affected by previous operations or decommissioning activities, wash out pits and settling ponds, complete closure surveys).	Will involve earth-moving equipment and other equipment which will result in GHG emissions, combustion and dust releases and noise.
	5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	Will involve trucking and heavy machinery, GHG emissions, combustion and dust releases and noise.
IC*	**6**	**Long Term Care and Maintenance**	
	6.8	Facility performance during the Institutional Controls phase.	Potential releases of volatilized radioactivity to air through the cap system.
PIC**	**7**	**Postclosure**	
	7.1	Facility performance during the Post-Institutional Controls phase.	Potential releases of volatilized radioactivity to air through the cap system.

* - IC: Institutional Controls phase.

** - PIC: Post-Institutional Controls phase.

9.2.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

Air

Where applicable and possible, industry best management practices, such as those identified in CNL's Land and Habitat Procedure (Morin 2015) and Cheminfo Services Inc. (2005) Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities, will be employed, including the following:

- regular maintenance of machinery to efficiently reduce emissions;
- haulage trucks covered to minimize dust emissions;
- minimization of dust generation through planning and site layout;
- dust suppression during demolition and material sizing activities;
- cover storage piles (stockpiles) during heavy rainstorms;

- compaction of disturbed soil after completion of activities;
- minimization of drop heights of materials;
- barriers to prevent dispersion of materials;
- safe work practices for loading debris;
- avoidance of prolonged storage of debris;
- proper techniques for the use and handling of chemicals;
- limit idling of vehicles/equipment on-site to minimize emissions (DeWaele 2013a); and,
- post speed limits on-site (see Section 9.6.3.2) to minimize dust emissions.

Noise

Noise-specific mitigation measures include:

- operation of batch mixing plant restricted to between 7 am and 7 pm only to be allowed outside this period in exceptional circumstances;
- activities to take place during the daytime, with the exception of emergency situations such as power outages which would require standby generator operation;
- sequencing of work such that the simultaneous operation of noisy equipment is minimized, where possible;
- location of the batch mixing plant at least 1 km from all nearby residences, if possible;
- direct piping of grout into the facility rather than delivery by truck, where reasonable. This would reduce the on-site truck movement noise;
- trucks operating at the project site are well maintained and are equipped with appropriate mufflers;
- placement of the generator in an acoustically treated enclosure to reduce noise (if required);
- maintenance of noise levels in compliance with CNL's Occupational Health & Safety Program requirements;
- post speed limits on-site (see Section 9.6.3.2); and,
- maintenance of on-site truck route in good condition in order to prevent truck tray noise caused by driving over uneven roadway.

9.2.3.3 Effects After Mitigation

Decommissioning Execution

Activities in the Decommissioning Execution phase will produce GHG emissions such as methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O) and carbon monoxide, combustion emissions (primarily NO_x, with minor SO_2), particulate matter (TSP, PM_{10} and $PM_{2.5}$), VOC, lead and asbestos emissions, radiological emissions (C-14, Gross Beta and HTO) and noise. These contaminants are assessed in the DecomSA TSD, and the results are discussed below.

The effects of noise in the Site and Local Study Area are assessed qualitatively. Due to the nature of the work, quantity and nature of equipment on site, and proximity to Highway 17, no noise effects are expected. However, since the atmospheric environment is a pathway to VCs in other environmental components (e.g., terrestrial environment, aboriginal land and resource use, and the socio-economic environment), the

project's potential effects on noise are assessed with respect to the VCs in those environmental components (see Sections 9.6.4, 9.9.4 and 9.10.4 respectively).

Site/Local Study Area

It is noted that installation of the concrete cap and engineered barrier is expected to alter the topography in the immediate vicinity of the project. However, this localized change is not expected to affect overall regional topography or weather conditions.

Non-Radiological

In the Site and Local Study Areas, project-related generation of NO_2, SO_2, VOCs (represented by acrolein), CO, TSP, PM_{10} and $PM_{2.5}$ were assessed in the DecomSA. It was conservatively assumed that all Decommissioning Execution activities will occur simultaneously with respect to these contaminants. The predicted incremental concentrations of NO_2, SO_2, TSP, PM_{10} and $PM_{2.5}$ at nearby residences and at Point Stewart are well within normal measured variability and the difference in air quality is not considered measurable. Further consideration of these emissions is not required.

It is noted that CO, NOx, SPM, PM_{10}, $PM_{2.5}$ and VOCs (Total) are considered Criteria Air Contaminants in ECCC's NPRI program. If emissions of these contaminants exceed the reporting threshold, then they must be reported under NPRI. The air quality assessment (summarized in the DecomSA TSD) estimated that the annual emissions of all of the above contaminants will be well below the NPRI reporting thresholds (all are below 1 kg per year, compared to the thresholds ranging from 0.3 to 20 tonnes per year). Reporting to NPRI will not be required. The VOC emission estimates are also well below the reporting thresholds under the Canada-U.S. Air Quality Agreement, which requires reporting of annual emissions greater than 1 tonne.

GHG emissions associated with the project were also assessed in the GHG TSD. The GHG TSD follows the general methodology described in the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment (FPTCCCEA 2003) General Guide for Practitioners on incorporating GHG emissions in an EA. The emissions assessed include direct and indirect (i.e., upstream) emissions. Upstream emissions consist of raw material extraction and transport, cement production (including pyroprocessing), and transport of cement, fine and coarse aggregates to the batch mixing plant. The direct emissions for the Decommissioning Execution phase of the project are estimated to be 0.35 tons of CO_2-eq. The indirect emissions from the project are estimated at 8,202 tonnes CO_2-eq. The project's GHG emissions (direct and indirect combined) are negligible in comparison to Ontario's total GHG emissions (i.e., less than 0.005%) and are approximately 0.3% of the Ontario total for cement production.

Grouting of the below grade facility will displace contaminants found in the air within the facility, and demolition will also release surface contamination in air. This air is expected to contain lead and asbestos. The project may meet the criteria for reporting lead and asbestos releases under NPRI due to the amount of lead and asbestos being disposed of in the facility as disposal is captured under the NPRI definition of "otherwise use". If disposal quantities meet the NPRI reporting threshold, all releases of lead and asbestos will need to be reported. In this case, lead and asbestos releases will be monitored by CNL (see Section 9.2.5). The release of lead and asbestos through air displacement was assessed in the DecomSA TSD.

The potential effects of these COPC releases on workers, the public and non-human biota are considered in Sections 9.6.3, 9.8.3 and 9.10.3 of this EIS.

Radiological

Releases to air of volatile radionuclides from the facility may occur. The potential effects of these releases on workers, the public and non-human biota are discussed in Sections 9.6.3, 9.8.3 and 9.10.3 of this EIS.

Grouting of the below grade facility will displace air that is currently in the facility, and demolition will also release surface contamination in air. This air contains low levels of tritium. The potential effects of tritium releases on workers, the public and non-human biota are discussed in Sections 9.6.3, 9.8.3 and 9.10.3 of this EIS.

Regional Study Area

Non-Radiological

The potential effects of transportation on the atmospheric environment in the Regional Study Area is considered in the DecomSA in a bounding scenario with all other activities (i.e., in the Site and Local Study Area) that produce NO_2, SO_2, TSP, PM_{10} and $PM_{2.5}$. Similarly, GHGs are considered for the project as a whole. Since no effects are expected with respect to these in the Site and Local Study Areas, no effects are expected in the Regional Study Area during the Decommissioning Execution phase. Further consideration of these emissions is not required.

Grouting of the below grade facility will displace contaminants found in the air within the facility, and demolition will also release surface contamination in air. This air is expected to contain lead and asbestos. The release of lead and asbestos through air displacement was assessed in the DecomSA TSD. The potential effects of these COPC releases on the public and non-human biota are discussed in Sections 9.6.3, 9.8.3 and 9.10.3 of this EIS.

Radiological

The potential effects of tritium releases from air displacement on the public and non-human biota in the Regional Study Area are discussed in Sections 9.6.3, 9.8.3 and 9.10.3 of this EIS.

Institutional Controls and Post-Institutional Controls

As shown in Table 9.2-2, no noise interactions are expected during the Institutional Controls or Post-Institutional Controls phases. Some vehicle-related emissions to air may occur during the Institutional Controls phase (e.g., combustible gases for vehicles used for groundwater sampling or vegetation removal activities); however, these emissions would be bounded by emissions during the Decommissioning Execution phase, and therefore do not require further consideration.

The PostSA TSD examines several potential scenarios for the postclosure period (i.e., Institutional Controls and Post-Institutional Controls phases) as a way to capture and quantify uncertainties in the future conditions at the site and assess the potential for radiological and non-radiological contamination of the

atmospheric environment (among other environments) for these scenarios. For detail on these scenarios, the reader is directed to the PostSA TSD. For example, airborne contaminants can spread to and potentially affect the terrestrial environment. Since the atmospheric environment is a pathway to VCs in other environmental components (e.g. terrestrial environment, human health), the project's effects on the atmospheric environment are assessed with respect to the VCs in those other environmental components (see Sections 9.6.4, 9.8.4 and 9.10.3 respectively).

9.2.3.4 Prediction Confidence and Uncertainty

Although the project has been described in Titterington (2016), Aikens (2017) and various other studies, there are some uncertainties with respect to some aspects of the project details. These uncertainties, and their implications on the assessment of effects, are outlined below.

It is unknown whether grout will be pumped or trucked from the batch mixing plant to various areas. It was assumed that the grout would be transported from the batch plant to the facility by truck; as this is anticipated to have greater potential for environmental effects. The method of moving the grout from the batch plant to the facility has been left operationally flexible for the grout contractor.

It was conservatively assumed that no airborne contaminants from the facility are captured by the HEPA filter system although they will be used as required.

The GHG TSD acknowledges that there are no GHG models available for grout. Consequently, the GHG emission estimates use cement/concrete production as a surrogate for grout. The GHG TSD used conservative assumptions wherever possible; for example, it was assumed that the standby diesel generator at the batch mixing plant will operate for 12 hours per day. Material volumes were selected to be conservative. The use of US default values for the calculation of indirect CO_2 emissions may result in uncertainty, as concrete and grout manufacturing, as well as raw material extraction and transportation may differ between the United States and Canada. As discussed earlier, the project's GHG emissions (direct and indirect combined) are negligible in comparison to Ontario's total GHG emissions (i.e., less than 0.005%) and are approximately 0.3% of the Ontario total for cement production. Therefore, there is enough margin in the results to accommodate the above uncertainties.

Variability in airborne contaminant concentrations in the facility is accounted for by the assumption that concentrations are equal to the most contaminated room for each contaminant.

Variability in tritium concentration in air is accounted for in the assumption that all air has a tritium concentration equal to the highest contaminated room. Additionally, tritium is treated as tritiated water (HTO) to be conservative wherever HTO dose calculations are available.

During the demolition of the above grade structures there is the possibility for lead (from lead-based paint) to be released into the atmosphere, and potentially affect the atmospheric environment. The following assumptions have been made for the analysis of this case:

- The total inventory of lead paint in the above-grade structure was assumed to be released as particulate (see Section 5.2 of the DecomSA TSD).
- Given that much of the paint will remain adhered to the demolition debris, and will not be released as airborne particulate, an airborne release fraction of 0.01 has been applied.
- Of the particulate created, only a portion will be of a respirable size. Therefore, it has been assumed that 10% of the airborne particulate will be respirable (i.e., a factor of 0.1).
- Given that water spray misting will be used as a dust control measure, it is assumed that only a small portion (i.e., 10%) of the released respirable particles would not be captured.
- The rate that the buildings are being demolished, and therefore the rate that the lead is being released, is estimated based on the number of days spent demolishing the above grade buildings:
    - 30 total days are spent actively demolishing the above grade structures (excluding the ventilation stack);
    - It was assumed that 8 hours per day were spent demolishing buildings. This allowed for the total inventory to be divided by the total demolition time (s) producing a resulting release rate in g/s.
- The release occurs at approximately 1 m (corresponding to the height of release for the CALPUFF calculations (Appendix C of the DecomSA TSD).

REGDOC 2.9.1 provides guidance on characterizing the effects on the project on the atmospheric environment. As per REGDOC 2.9.1 (Appendix C.1), radiological and non-radiological emissions (including greenhouse gases) during the different phases of the project have been characterized, including postulated accidents and malfunctions. The modelling includes site-specific atmospheric characteristics and receptors. REGDOC 2.9.1 also states that the predictions should include average and maximum emissions from planned discharges, point sources and fugitive releases. However, due to the large amount of unknown information, many assumptions were made in order to estimate future emissions. Wherever possible, very conservative assumptions were made (such as those described above). Therefore, the emission estimates are likely representative of a maximum, based on the available information. There is not enough information to produce average emission estimates, and they are likely not required, as no issues are expected even from the very conservative emission estimates. With respect to noise estimates, REGDOC 2.91 suggests that daytime and night time noise levels and tonal noise be predicted and compared to baseline levels and published guidelines. In this EIS, the assessment of noise effects was conducted qualitatively, based on knowledge of planned project activities and nearby receptor locations. It is noted that ambient daytime and night time noise levels are not currently measured at the site, and no noise concerns have been raised during current conditions (i.e., during generator operation).

9.2.3.5 Residual Effects

Table 9.2-3 summarizes the air quality and noise effects assessment carried out above and presents the residual effects that were identified for the atmospheric environment. The residual effects in Table 9.2-3 are grouped by effect rather than by individual interaction as listed in Table 9.2-2.

Table 9.2-3. Summary of Residual Effects in the Atmospheric Environment

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution					
Atmospheric Environment: Air Quality (non-radiological).	All Decommissioning Execution activities.	Decommissioning Execution activities (including Batch mixing plant setup and operation, material transport, generator operation, demolition, sizing) will result in emissions of NO_x, SO_2, TSP, PM_{10}, $PM_{2.5}$.	Standard Construction Practices (e.g., dust suppression, machinery maintenance).	NO_x, SO_2, TSP, PM_{10}, and $PM_{2.5}$ emissions will be minor, temporary and localized.	Effects of non-radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.6 and 9.8.
Atmospheric Environment: Noise.	Batch mixing plant set-up and operation.	Transportation of material, equipment and grout and operation of the batch mixing plant is expected to generate noise.	Activities will be restricted to between 7 a.m. and 7 p.m where possible.	It is unlikely that noise from the operation of the batch mixing plant would cause an adverse noise effect on humans or wildlife.	No adverse residual effect.
Atmospheric Environment: Air Quality (radiological).	Volatile radionuclides in air displaced from grouting the below grade structure and demolition of above grade structure.	Contaminated air from the facility will be released to the atmospheric environment.	Dust suppression.	Volatile radionuclides in air may result in exposure effects on non-human biota and human health.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.6 and 9.8.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Atmospheric Environment: Air Quality (non-radiological).	Lead and asbestos in air displaced from grouting the below grade structure and removal of above grade structures.	Contaminated air from the facility will be released to the atmospheric environment.	Dust suppression	Lead and asbestos in air may result in exposure effects on non-human biota and human health.	Effects of non-radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.6 and 9.8.
Atmospheric Environment: Noise.	Grouting involves trucking between the batch mixing plant and the facility.	Vehicle and equipment operation will generate noise.	Standard Construction Practices (e.g., timing of activities).	It is unlikely that noise from the operation of the batch mixing plant would cause an adverse noise effect on humans or wildlife.	No adverse residual effect.
Atmospheric Environment: Noise.	Demolition and sizing of material.	Demolition of above grade structures, cutting metal and crushing masonry is expected to generate noise.	Standard Construction Practices (e.g., timing of activities).	Noise generated may affect nearby residents and wildlife, however the noise is expected to be of short duration, limited to daytime hours and intermittent.	No adverse residual effect.
Atmospheric Environment: Noise.	Earth moving, concrete mixing, transportation, pouring.	Batch mixing plant operation, vehicle transportation, operation of heavy mobile equipment such as front end loaders and backhoes.	Standard Construction Practices (e.g., timing of activities).	It is unlikely that noise from the operation of the batch mixing plant would cause an adverse noise effect on humans or wildlife.	No adverse residual effect.
Atmospheric Environment: Noise.	Removal of temporary structures and rubblizing of non-essential roadways.	These activities will involve the use of mobile powered equipment such as pavement breakers, backhoes, excavators, bull	Standard Construction Practices (e.g., timing and sequencing of activities).	These noise sources would not be continuous and unlikely to be simultaneous.	No adverse residual effect.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
		dozers, compactors, etc. and are thus potential sources of noises.			
Institutional Controls and Post-Institutional Controls					
Atmospheric Environment: Air Quality (radiological).	Radionuclides volatilizing from surface media.	Contamination of air may affect VCs in other environmental components.	In-design mitigations to isolate and contain the inventory in order to reduce the potential for contamination in the atmospheric environment.	Contamination of air may affect VCs in other environmental components.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.6 and 9.8.

9.2.4 Assessment of Residual Effects

Since the atmospheric environment is a pathway to other environmental components (e.g., terrestrial environment and human health), potential adverse residual effects are considered within those environmental components (see Sections 9.6.4, 9.8.4 and 9.10.4).

9.2.5 Monitoring and Follow-up

The atmospheric environment (i.e., air quality, noise) represents a pathway for transfer of an effect to VCs in other environmental components. Investigative further action is triggered if parameters of concern (radiological and non-radiological) measured are found to be above applicable guidelines or limits, or if any notable changes are observed. Monitoring and follow-up activities in the atmospheric environment are discussed below and presented in Table 9.2-4.

Decommissioning Execution

During the Decommissioning Execution phase, CNL will conduct non-periodic event-based (e.g., during grouting displacement of air from the facility) monitoring (through measurement or estimation) for parameters of concern (radiological and non-radiological) in air. CNL will also continue to conduct emissions estimates and reporting of combustible gases (e.g., associated with NPRI). Investigative further action (e.g., sampling rainwater for tritium, soil sampling) will be triggered if parameters measured are found to be above applicable guidelines or limits, or if any notable changes are observed.

During periods of high activity, CNL will monitor noise levels.

Institutional Controls

During the Institutional Controls phase, soil vapour analysis may be triggered if groundwater monitoring indicates potential volatilization of radioactivity from surface media.

Table 9.2-4. Monitoring and Follow-up Activities in the Atmospheric Environment

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Atmospheric Environment	Air Quality (non-radiological)	Potential Source(s) of Effects: - Batch mixing plant set-up and operation - Grouting of below grade structure - Removal of above grade structure - Install concrete cap and engineered barrier - Final site restoration Proposed Monitoring: - For each new activity or modification of an existing activity (see footnote): measure parameters of concern (e.g., lead, asbestos) in air displaced from grouting the below grade structure and demolition activities. - Estimate combustible gases (e.g., based on project-related traffic and equipment). - Visual inspection for dust. Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits, or if actual number of vehicles/kilometers travelled exceeds the prediction on which emission estimates were based. - If high levels of dust are identified (qualitative), adjust dust suppression measures accordingly	Verify EA prediction (i.e., no adverse residual effect on non-radiological air quality or related VCs)	For each new activity or modification of an existing activity (see footnote): monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting). Visual inspection for dust is ongoing	NPDWF currently conducts annual industrial hygiene assessment of lead, asbestos and mould in air within the facility. Emissions associated with NPRI and GHG reporting are estimated. Facility to ensure that NPRI and GHG reporting includes updated estimates.
	Air Quality (radiological)	Potential Source(s) of Effects: - Grouting of below grade structure - Removal of above grade structure Proposed Monitoring: - For each new activity or modification of an existing activity (see footnote): measure parameters of concern (e.g., tritium) in air displaced from grouting the below grade structure and demolition activities. Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits. - If any parameters are above applicable guidelines, collect rain water and measure contaminant levels (e.g., tritium) in precipitation.	Verify EA prediction (i.e., no adverse residual effect on radiological air quality or related VCs)	For each new activity or modification of an existing activity (see footnote): monitor for minimum one week.	NPDWF currently conducts monitoring of airborne radiological releases (i.e., tritium and gross beta).
	Noise	Potential Source(s) of Effects: - Batch mixing plant set-up and operation - Trucking of grout between the batch mixing plant and the facility - Demolition and sizing of material - Earth moving, concrete mixing, transportation, pouring - Removal of temporary structures and rubblizing of non-essential roadways Proposed Monitoring: - Noise monitoring during periods of high activity Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits, or if complaints received.	Verify EA prediction (i.e., no adverse residual noise effects)	At periods of high activity: monitor for minimum one week.	Currently, NPDWF does not routinely monitor noise levels.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Institutional Controls Phase					
Atmospheric Environment	Air Quality (radiological)	Potential Source(s) of Effects: - Volatilization of radionuclides from surface media Proposed monitoring: - If elevated levels in groundwater, consider soil vapour analysis. Trigger for further action: - Investigation if soil vapour analysis identifies parameters are above applicable guidelines.	Verify EA prediction (i.e., no adverse residual effect on atmospheric environment or related VCs)	Soil vapour analysis: only if triggered by groundwater monitoring	NPDWF does not currently conduct soil vapour monitoring.

Note: Modification of an existing activity could include, for example: during grouting activities, a change in grouting location to a different part of the NPDWF where the potential for emissions may substantially increase, monitoring should start again.

9.2.6 Conclusion

The potential for residual effects in the atmospheric environment was discussed in Section 9.2.3 based on predicted effects after applied mitigation measures. However, since the atmospheric environment is a pathway to VCs in other environmental components (specifically the terrestrial environment and human health), any potential residual effects are considered in the applicable environmental components. Monitoring for parameters of concern on a per-event basis (e.g., monitoring noise during demolition), and estimating project-related emissions will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects.

9.3 Surface Water Environment

9.3.1 Selection of Valued Components

As outlined in Section 5.2.4, the surface water environment (i.e., site drainage and water quality) represents features that can be affected by the project and as such would be pathways or mechanisms for transfer of an effect to another environmental component (e.g., aquatic environment, terrestrial environment, human health). As such, no VCs have been selected in the surface water environment. The potential effects of changes in the surface water conditions will be considered in the applicable environmental components.

Table 9.3-1. Valued Component Selection for the Surface Water Environment

Environmental Component	Pathway	Rationale
Surface Water Environment	Pathway to human health	The potential effects on humans associated with changes in site drainage and surface water quality (radiological and chemical releases and concentrations) will be considered in the Human Health component.
	Pathway to non-human biota health	The potential effects on non-human biota associated with changes in site drainage and surface water quality (radiological and chemical releases and concentrations) will be considered for Aquatic Environment and Terrestrial Environment VCs.
	Pathway to VCs in other environmental components	The potential effects on VCs in other environmental components associated with changes in site drainage and surface water quality (e.g., water levels) will be considered in the applicable environmental components.

9.3.2 Assessment Boundaries

9.3.2.1 Spatial Boundaries

Similar to the surface water environment baseline characterization in Section 8.3 above, the Site and Local Study Areas are consistent with the general spatial boundaries outlined in Section 5.2.1.1. The Regional Study Area for this assessment is outlined in Figure 8.3-1.

9.3.2.2 Temporal Boundaries

The temporal boundaries for this assessment are the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.3.3 Identification of Residual Effects

9.3.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the surface water environment may occur as a result of interactions associated with operations and activities in the Decommissioning Execution, Institutional Controls, and Post-Institutional Controls phases, in particular:

- Installation and operation of the batch mixing plant;
- Removal of above grade structures;
- Install concrete cap and engineered barrier;
- Final site restoration;
- Facility performance during the Institutional Controls phase;
- Facility performance during the Post-Institutional Controls phase.

Table 9.3-2. Project-Environment Interactions in the Surface Water Environment

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**1**	**Batch Mixing Plant**	
	1.1	Designate footprint, create access, temporary fencing (west side of main building).	Activities associated with designating footprint may affect site drainage.
	1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	Storage of raw materials may affect site drainage properties on the site. Runoff from the stockpiles may affect water quality.
	1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	Construction of the wash out pit will affect site drainage as land will be graded and the pit will be lined with a watertight material. Wash out pit operation has the potential to affect water quality.
	1.7	Level area for concrete pumper.	Levelling may affect site drainage.
	1.10	Wash out cement truck sluice and pumper truck and slip pipes. (Daily)	Equipment wash out may affect water quality on site.
	1.11	Sample and dewater the cleaning pit. Emplace sediments into voids in condenser pit.	Dewatering the pit may affect surface water quality on the site.

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**3**	**Removal of Above Grade Structure**	
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition affects water quality due to potential runoff.
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Outdoor cutting steel and crushing masonry may affect water quality due to potential run-off.
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	Runoff from material stored outdoors may affect water quality.
	3.10	Demolition block walls and inside walls around control room and change rooms.	Demolition may affect water quality due to potential runoff.
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Demolition may affect water quality due to potential runoff.
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition may affect water quality due to potential runoff.
	4	**Install Concrete Cap and Engineered Barrier**	
	4.1	Concrete Cap (construct forms, install rebar, and pour, level and slope concrete).	Concrete cap installation will impede water infiltration, thus affecting site drainage.
	4.2	Engineered Barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	Grading and installing layers of earth will affect site drainage. Installation of the engineered barrier may increase soil runoff, affecting water quality.
	5	**Final Site Restoration**	
	5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	Decontamination of equipment via wash out will affect water quality on site. Rubblizing asphalt, parking areas and non-essential roads will alter site drainage.
IC*	**6**	**Long Term Care and Maintenance**	
	6.8	Facility performance during the Institutional Controls phase	Groundwater will start to enter the grouted structure and come into contact with contamination. Dissolved contaminants and alkaline groundwater will flow out and may reach the Ottawa River.
PIC**	**7**	**Post-Institutional Controls**	
	7.1	Facility performance during the Post-Institutional Controls phase	Groundwater will enter the eventually degraded grouted structure. Dissolved contaminants and alkaline groundwater will flow out and may reach the Ottawa River.

*IC: Institutional Controls phase

**PIC: Post-Institutional Controls phase

9.3.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

In addition to the in-design mitigation measures identified in Section 4.1 above, the following mitigation measures have been identified to ensure the protection of the surface water environment. These mitigation measures are consistent with CNL's Land and Habitat procedure (Morin 2015):

- impedance of rainwater inflow into the facility with construction of the concrete cap and monolith;
- sediment and erosion controls consistent with CNL's Environmental Protection Procedure on Management of Land and Habitat (Morin 2015), that provides the specific details on the management of potential erosion and sedimentation prior to commencement of construction. This will provide details on how and where surficial materials will be stockpiled, construction work will be scheduled to minimize the duration of time that bare soils are exposed before stabilization (i.e., revegetation) occurs. Typical sediment and erosion control measures may include silt fences/barriers, straw bale flow checks, proper stockpile and wash out pit design and placement;
- dust suppression measures outlined in Section 9.2.3.2;
- road maintenance activities should follow the guidelines included in the Synthesis of Best Practices Road Salt Management (TAC 2003) and CNL's Management of Land and Habitat procedure (Morin 2015);
- utilization of spill kits and secondary containment of storage tanks (e.g., for fuel oil) to contain any releases from spillage or tank rupture (Morin 2015); and,
- reuse of water from the wash out pit for the batch mixing plant (if possible); retention and emplacement of settled sediment in the facility.

For perspective on industry practices related to waterborne emissions, the Ontario Ministry of the Environment (MOE) Guidelines for Evaluating Construction Activities Impacting on Water Resources (MOE 1984) suggest mitigation measures that include the following:

- retention of existing vegetation where feasible;
- maintenance of low runoff velocities (control runoff);
- restriction of the use of heavy construction equipment to within the approved work areas to minimize soil disturbance and vegetation destruction;
- diversion of runoff away from exposed areas and stockpiles, and strategic placement away from concentrated stormwater flows;
- retention of sediment on site;
- revegetation of disturbed areas by seeding and/or planting following construction as soon as seasonal conditions permit;
- proper design, inspection and management of wash out pits (settling ponds) and material storage site(s); and,
- use of paved (impermeable) areas for stockpile and material laydown to reduce infiltration, and cover prior to heavy precipitation.

These mitigation measures will ensure minimal runoff, sediment transport and contamination outside of the Site Study Area.

9.3.3.3 Effects After Mitigation

Decommissioning Execution

Site and Local Study Area

Some decommissioning activities have the potential to result in water/soil contamination and contaminated flows into the river from water runoff (e.g., from rain water, misting, water used in metal cutting, etc.). This water could become contaminated during activities in the Decommissioning Execution phase, including aggregate storage, wash out pit dewatering, demolition, and material sizing. Mitigation measures (e.g., silt fencing and dust suppression) will reduce the likelihood and/or magnitude of any unplanned releases. As discussed in the DecomSA TSD, mitigation measures are expected to trap and prevent any releases to the surface water environment. Wash out water will be sampled prior to dewatering, ensuring negligible effects to surface water quality. Installation of the concrete cap and engineered barrier may have temporary localized effects on site drainage. Any affected areas will be remediated following Decommissioning Execution activities, thus no residual effects after mitigation are expected on the surface water environment in the Site and Local Study Areas during the Decommissioning Execution phase.

Regional Study Area

Potential effects in the Regional Study Area will only occur if effects spread from the Site and Local Study Areas. Since no effects are expected in the Site and Local Study Areas, no effects are expected in the Regional Study Area during the Decommissioning Execution phase.

Institutional Controls and Post-Institutional Controls

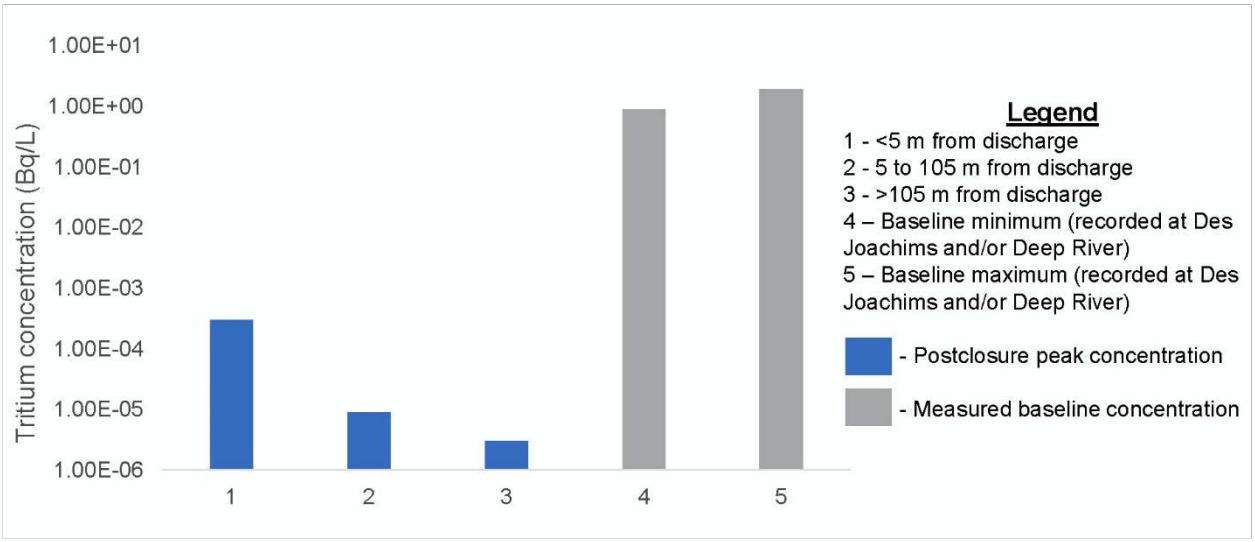
The PostSA TSD examines several potential scenarios for the postclosure period as a way to capture and quantify uncertainties in the future conditions at the site and assess the potential for radiological and non-radiological contamination of the surface water environment (among other environments) for these scenarios. For detail on these scenarios, the reader is directed to the PostSA TSD. For example, contaminated groundwater from degraded grouted structure is expected to flow into the Ottawa River. Since the surface water environment is a pathway to VCs in other environmental components (e.g., aquatic environment, terrestrial environment and human health), the project's effects on the surface water environment are assessed with respect to the VCs in those environmental components (see Sections 9.4.3, 9.6.3, 9.8.3, 9.9.3 and 9.10.3).

As shown in Table 9.3-2 above, there is the potential for contaminated groundwater flowing from the facility to reach the Ottawa River in the postclosure period (Institutional Controls and Post-Institutional Controls phases. The resulting concentrations of select contaminants in the Ottawa River (surface water and sediment) are shown below, and compared with measured baseline concentrations for comparison. The EcoRA and PostSA TSDs consider these releases combined with baseline concentrations (i.e., total) in their assessments.

Radiological

Figure 9.3-1 shows maximum predicted tritium concentrations and measured baseline tritium concentrations in Ottawa River surface water. Concentrations within 5 m of where the groundwater plume releases to the surface water are three orders of magnitude below measured baseline tritium concentrations.

Figure 9.3-1. Tritium Concentrations in Ottawa River Surface Water

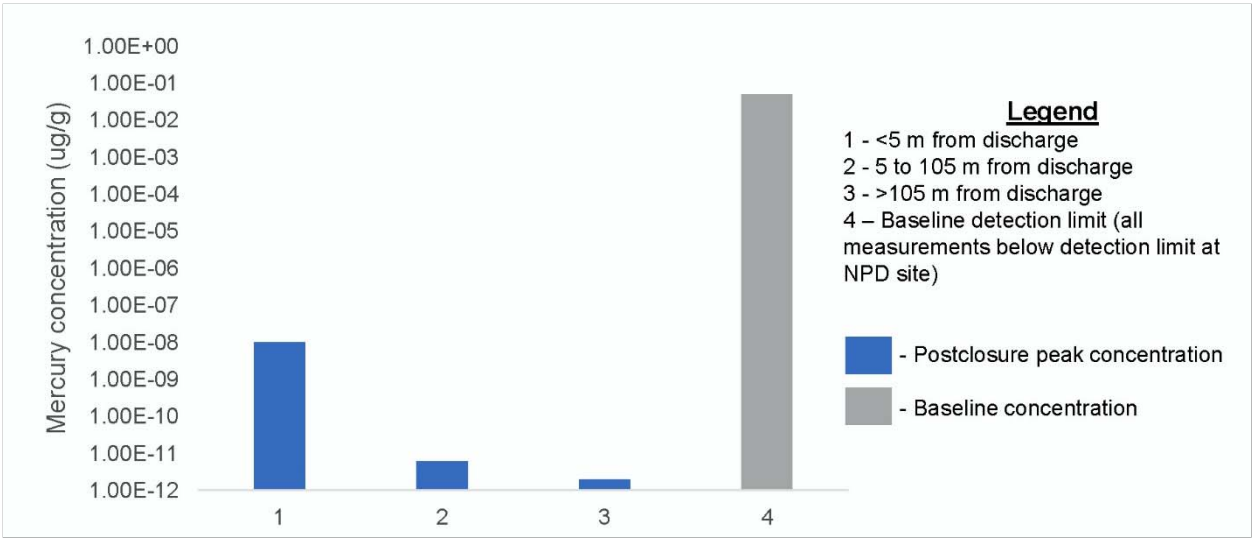


Note:
Baseline tritium concentrations are the maximum and minimum quarterly measurements taken at Des Joachims and Deep River in 2015 (Primeau 2016).

Non-radiological

As shown in Figure 9.3-2, predicted mercury concentrations in sediment within 5 m of the groundwater plume discharge point are six orders of magnitude below the mercury detection limit listed in the Report on Conventional Contaminants of Concern of the NPD Site (Golder 2017).

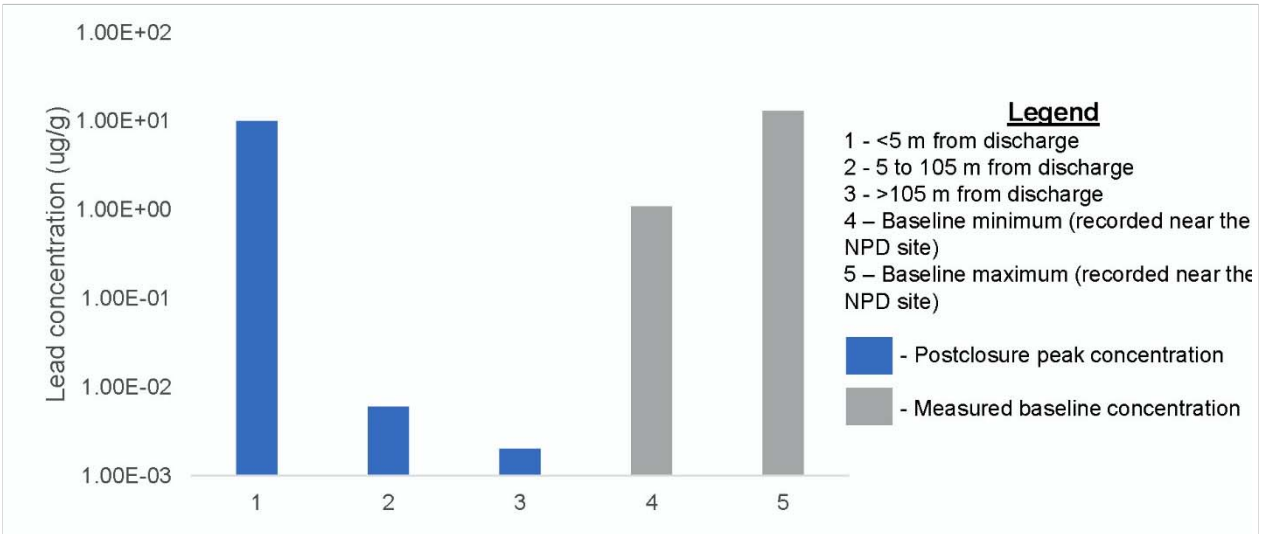
Figure 9.3-2. Mercury Concentrations in Ottawa River Sediment



Note:
Baseline data is from Report on Conventional Contaminants of Concern of the NPD Site (Golder 2017). Mercury baseline measured concentrations were all below the detection limit, thus the detection limit is shown on the figure.

As shown in Figure 9.3-3, predicted incremental lead concentrations in sediment within 5 m of the groundwater plume discharge point are within the range of baseline lead concentrations measured in sediment near the NPDWF.

Figure 9.3-3. Lead Concentrations in Ottawa River Sediment



Note:
Baseline data is from Report on Conventional Contaminants of Concern of the NPD Site (Golder 2017).

9.3.3.4 Prediction Confidence and Uncertainty

Although the project has been described in Titterington (2016), Aikens (2017) and various other studies, there are some minor uncertainties with respect to some aspects of the project details. These uncertainties, and their implications on the assessment of effects, are outlined below.

The volume and frequency of wash out pit dewatering releases have not been determined; however, proper sampling of water prior to dewatering will address this uncertainty by controlling releases. Potential runoff has not been characterized, however dust suppression and runoff diversion and management are expected to limit runoff to a localized area. Runoff monitoring (see Section 12) will ensure that there will be no effects to the surface water environment.

Since the location of certain aspects of the project (e.g., the laydown area) have not been finalized, there is some uncertainty with the potential for these activities to affect surface water quality. The exact locations of the batch mixing plant, staging areas, raw material storage areas, on-site trucking routes could influence the potential for surface water quality contamination. The sediment and erosion controls, consistent with Morin (2015), discussed under mitigation measures above, would reduce this uncertainty.

In the PostSA TSD, uncertainties in postclosure conditions (e.g. floods), key parameters (e.g. inventory of contamination) are addressed inherently by assessing several disruptive scenarios.

9.3.3.5 Residual Effects

Table 9.3-3 summarizes the effects assessment above and presents the residual effects that were identified for the surface water environment and are carried forward for assessment in the appropriate environmental components. The residual effects in Table 9.3-3 are grouped by effect rather than by individual interaction as listed in Table 9.3-2.

Table 9.3-3. Summary of Residual Effects in the Surface Water Environment

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution					
Surface Water: Site Drainage.	Upgrading road surface and existing surfaces.	Establishing the project footprint may affect site drainage.	Sediment and erosion controls.	Effects on site drainage are temporary, minor and localized, and not expected to affect overall site drainage.	No adverse residual effects.
Surface Water: Site Drainage and Water Quality.	Raw material storage.	Storage of raw materials may affect site drainage properties on the site. Runoff from the stockpiles may affect water quality.	Runoff diversion away from stockpiles, and strategic placement away from concentrated flows of stormwater. Stockpiles will be placed on impermeable material, and covered prior to heavy precipitation.	Temporary, minor and localized effect on site drainage and water quality. No effects on the overall surface water environment are expected.	No adverse residual effects.
Surface Water: Site Drainage.	Level area for concrete pumper.	Regrading will affect site drainage.	Standard dust suppression practices.	Effects on site drainage are temporary and localized, and not expected to affect overall site drainage.	No adverse residual effects.
Surface Water: Site Drainage and Water Quality.	Wash out pit (preparation and operation).	Construction of the wash out pit will affect site drainage as it will be lined with a watertight material. Equipment wash out and dewatering may affect water quality on site.	Proper design, inspection and management procedures of wash out pit.	Effects on site drainage are temporary and localized, and not expected to affect overall site drainage.	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Surface Water: Water Quality.	Demobilization of batch mixing plant (after cap pour).	Possible equipment decontamination (wash out) may affect water quality on site.	Proper design, inspection and management procedures of wash out pit.	Sampling prior to dewatering will ensure negligible effects to water quality.	No adverse residual effects.
Surface Water: Water Quality.	Demolition of above grade structures.	Demolition affects water quality due to potential runoff.	Dust suppression, runoff diversion and standard construction procedures will reduce effect on water quality.	Effects on surface water quality are temporary, minor and localized, and not expected to affect overall surface water quality.	No adverse residual effects.
Surface Water: Water Quality.	Sizing of material.	Outdoor cutting steel and crushing masonry may affect water quality due to potential run-off.	Dust suppression, runoff diversion and standard construction procedures will reduce effect on water quality.	Effects on surface water quality are temporary, minor and localized, and not expected to affect overall surface water quality.	No adverse residual effects.
Surface Water: Water Quality.	Set up laydown area and perform clearance surveys.	Run-off from material stored outdoors may affect water quality.	Utilizing paved areas for laydown will reduce infiltration, as well as runoff diversion will reduce the effect on surface water quality.	Effects on surface water quality are temporary, minor and localized, and not expected to affect overall surface water quality.	No adverse residual effects.
Surface Water: Site Drainage.	Concrete cap installation.	Concrete cap installation will impede water infiltration, thus affecting site drainage.	Sediment and erosion controls.	The concrete cap covers the footprint of the current building; thus, the concrete cap may have a minor, but unmeasurable effect on site drainage.	No adverse residual effects.
Surface Water: Site Drainage.	Engineered barrier.	Grading and installing layers of earth will affect site drainage and alter soil run off, affecting site drainage	Sediment and erosion controls.	The engineered barrier may have a minor effect on site drainage.	No adverse residual effects.
Surface Water: Site Drainage and Water Quality.	Site demobilization.	Possible equipment decontamination via wash out, if required, may affect water quality on site.	Proper design, inspection and management procedures of wash out pit.	No measurable effect is expected from equipment decontamination. Creating rubble out of asphalt, parking areas and non-essential	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
		Creating rubble out of asphalt, parking areas and non-essential roads will alter site drainage.		roads will increase local soil infiltration, having a positive effect on site drainage.	
Institutional Controls and Post-Institutional Controls					
Surface Water: Water Quality (radiological).	Facility performance during the postclosure period.	Groundwater will flow into the eventually degraded grouted structure. Contaminated groundwater will flow out and eventually into the Ottawa River.	In-design mitigations to isolate and contain the inventory in order to reduce the potential of groundwater contamination.	Groundwater will flow into the eventually degraded grouted structure. Contaminants will reach surface water, river sediment and shoreline sediment.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.4, 9.6 and 9.8.
Surface Water: Water Quality (non-radiological).	Facility performance during the postclosure period.	Groundwater will flow into the eventually degraded grouted structure. Contaminated groundwater will flow out and eventually into the Ottawa River.	In-design mitigations to isolate and contain the inventory in order to reduce the potential of groundwater contamination.	Groundwater will flow into the eventually degraded grouted structure. Contaminants will reach surface water, river sediment and shoreline sediment.	Effects of non-radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.4, 9.6 and 9.8.

9.3.4 Assessment of Residual Effects

Since the surface water environment is a pathway to other environmental components (e.g., aquatic, terrestrial environments and human health), any potential adverse residual effects identified are further assessed within those environmental components (see Sections 9.4.4, 9.6.4, 9.8.4, 9.9.4 and 9.10.4).

9.3.5 Monitoring and Follow-up



Environmental monitoring of the Ottawa River

The surface water (i.e., site drainage, water quality) environment represents a pathway for transfer of an effect to VCs in other environmental components. Monitoring and follow-up activities within the surface water environment are discussed below and presented in Table 9.3-4. Further action will be triggered if parameters are above applicable guidelines or other notable changes (e.g., significant changes to surface drainage or water quality, or poor maintenance leading to repeated spills to ground) are observed during monitoring activities in other environmental components (e.g., geological and hydrogeological environment). Triggered actions may involve sediment monitoring, or monitoring in other environmental components (e.g., aquatic environment and terrestrial environment).

Decommissioning Execution

In the Decommissioning Execution phase, CNL will conduct routine visual inspection of surface drainage patterns in the Site Study Area. Further investigation will be required if significant changes are observed.

CNL will conduct routine inspections to ensure proper vehicle and equipment maintenance in order to reduce the potential for spills. Surface water runoff and discharge water from the batch mixing plant will be collected and analyzed for parameters of concern (radiological and non-radiological), as is currently done on a batch discharge basis for the WAS. Event-based monitoring may be triggered if unique events such as spills occur. Further investigation will be required if changes in pH are noted, or parameters of concern (radiological and non-radiological) are above guidelines.

Institutional Controls

In the Institutional Controls phase, CNL will continue visual inspections of surface drainage, as well as looking for changes to topography, and indicators of subsidence in the Site Study Area. CNL will maintain vegetative cover to prevent the growth of deep-rooted trees near the concrete monolith. If changes are

observed, geophysical methods may be employed to confirm the integrity of the engineered barrier and concrete monolith.

As in the Decommissioning Execution phase, event-based monitoring may be triggered if unique events such as spills occur. CNL will conduct routine sampling and analysis of water quality in the Ottawa River for radiological and non-radiological parameters of concern. Further investigation will be required if changes in pH are noted, or parameters of concern (radiological and non-radiological) are above guidelines.

Table 9.3-4. Monitoring and Follow-up Activities in the Surface Water Environment

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Surface Water Environment	Site Drainage	Potential Source(s) of Effects: - Upgrading road surface and existing surfaces - Leveling area for concrete pumper - Raw material storage - Wash out pit (preparation and operation) - Removal of above grade structures - Concrete cap installation - Engineered barrier - Site demobilization Proposed Monitoring: - Visual inspection of surface drainage patterns near the decommissioning activities. Trigger for further action: Investigation if significant changes to surface drainage.	Determine effectiveness of mitigation measures (e.g., runoff diversion and control; washout pit design; paving and covering of laydown areas).	Inspections: periodic.	Currently, NPDWF conducts monthly surveillance inspections.
	Water Quality	Potential Source(s) of Effects: - Set up laydown area - Raw material storage - Wash out pit (preparation and operation) - Demolition of above grade structures - Sizing of material - Demobilization of batch mixing plant (after cap pour) - Site demobilization Proposed Monitoring: - Conduct routine inspections to maintain vehicles (reduce spills to ground). - Analyze water from batch discharges for parameters of concern (e.g., lead). - Measure surface runoff for parameters of concern. - In the event of incidents such as spills, unique environmental monitoring would be triggered. Trigger for further action: - Investigation (e.g., sediment sampling) if parameters above applicable guidelines, or indication of poor maintenance. - Monitoring required for any unique events such as spills.	Verify EA prediction (i.e., no adverse residual effect on water quality or related VCs). and Determine effectiveness of mitigation measures (e.g., runoff diversion and control; washout pit design).	Inspections: periodic. Sampling and analysis of batch discharges: as required (event-based). Sampling and analysis of runoff: periodic. Incident-specific water quality monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts semi-annual sampling and analysis of liquid effluent in the tile drain systems. CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and Cs-137) CNL currently conducts routine radiological surveys which include ambient radiation dose measurements and contamination surveys.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Institutional Controls phase					
Surface Water Environment	Site Drainage	Potential Source(s) of Effects: - Changes to topography on and/or near the surface above the concrete monolith. Proposed Monitoring: - Visual inspection of surface drainage patterns, changes to topography, and indicators of subsidence near the decommissioning activities. - Management of vegetative cover at surface to prevent growth of deep-rooted trees near the concrete monolith Trigger for further action: If changes observed, confirm integrity of concrete monolith with geophysical methods.	Determine effectiveness of mitigation measures (e.g., runoff diversion and control; washout pit design; paving and covering of laydown areas).	Inspections: periodic.	Currently, the NPDWF conducts monthly surveillance inspections.
	Water Quality (radiological and non-radiological)	Proposed Source(s) of Effects: - Potential for post-closure groundwater flow into eventually-degraded structure, and into Ottawa River Proposed Monitoring: - Routine sampling analysis of the Ottawa River for parameters of concern (chemical and/or radiological). Trigger for further action: Investigation (e.g., sediment sampling) if parameters above applicable guidelines, or notable changes are observed.	Verify EA prediction (i.e., no adverse residual effect on surface water environment or related VCs) and Determine effectiveness of mitigation measures (e.g., concrete cap design, grout fill)	Surface water monitoring: periodic	CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and Cs-137). non-periodic (i.e., occasional event-based) groundwater monitoring.

9.3.6 Conclusion

The potential for residual effects in the surface water environment was discussed in Section 9.3.3 based on predicted effects after applied mitigation measures. However, since the surface water environment is a pathway to VCs in other environmental components (i.e., the aquatic and terrestrial environments and human health), any potential residual effects are considered in the applicable environmental components. Monitoring activities, such as inspection of site drainage properties and analyzing discharges for parameters of concern, will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects.

9.4 Aquatic Environment

9.4.1 Selection of Valued Components

As outlined in Section 5.2.4, VCs for the aquatic environment were selected to encompass the potential effects of the project on the aquatic environment as well as other environmental components such as surface water that act as a pathway to transfer effects to the aquatic environment. VCs were selected to represent a variety of ecological roles within the aquatic environment. VCs for the aquatic environment and the rationale for their selection are listed in Table 9.4-1.

Table 9.4-1. Valued Component Selection for the Aquatic Environment

Environmental Component	Sub-Category		VC	Effects Assessed		Rationale
				Habitat	Exposure	
Aquatic Environment	Aquatic Invertebrates		Benthic invertebrates		x	Macroinvertebrates occupy the sediment and are an important food source for benthivorous fish species. They are used to evaluate overall ecosystem health.
	Aquatic Vegetation		Aquatic vegetation		x	Represents a fundamental element of ecosystem health and function.
	Fish	Small	Emerald shiner		x	Numerically important pelagic forage species.
		Large	White sucker		x	Abundant benthivorous, bottom dwelling fish, an important component of that community with available data.
		Large	Lake sturgeon		x	Benthivorous, bottom-dwelling fish. Lake sturgeon has been subject to fishery exploitation in the past, before population declines. It is the largest, longest-living freshwater fish in Ontario. In the stretch of the Ottawa River that includes NPD, the lake sturgeon is more abundant than elsewhere in the river.

9.4.2 Assessment Boundaries

9.4.2.1 Spatial Boundaries

Similar to the aquatic environment baseline characterization in Section 8.4 above, the Site and Local Study Areas for this assessment are consistent with the general spatial boundaries outlined in Section 5.2.1.1. The Regional Study Area for the aquatic environment is consistent with the surface water environment Regional Study Area outlined in Figure 8.3-1 above.

9.4.2.2 Temporal Boundaries

The temporal boundaries for this assessment are the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.4.3 Identification of Residual Effects

9.4.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the aquatic environment may occur as a result of interactions during the Decommissioning Execution, Institutional Controls and Post-Institutional Controls phases, in particular:

- Installation and operation of the batch mixing plant;
- Removal of above grade structures;
- Facility performance during the Institutional Controls phase; and
- Facility performance during the Post-Institutional Controls phase.

Interactions in other environmental components (e.g., surface water and geological and hydrogeological environments) have the potential to affect aquatic biota and habitats. This is illustrated in Table 9.4-2 below.

None of the activities of the project are expected to affect fish habitat; there will be no infilling, construction or blasting in the river, and no activities near the wetlands. Releases are considered in the assessment of effects on biota in this section and in the EcoRA TSD.

Table 9.4-2. Project-Environment Interactions in the Aquatic Environment

Phase		Project Works and Activities	Potential Interaction	Habitat	Exposure
Decommissioning Execution	**1**	Batch Mixing Plant			
	1.10	Sample and dewater the cleaning pit. Emplace sediments into voids in the condenser pit.	Contamination may affect aquatic biota that could enter the wash out pit prior to sampling and dewatering.		x
	3	Removal of Above Grade Structure			
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition may contaminate the Ottawa River via runoff and affect aquatic biota.		x
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Material sizing may contaminate the Ottawa River via runoff and affect aquatic biota.		x
	3.10	Demolition block walls and inside walls around control room and change rooms.	Demolition may contaminate the Ottawa River via runoff and affect aquatic biota.		x
Decommissioning	**3.14**	Demolish guard house and emplace in furnace room and adjacent rooms.	Demolition may contaminate the Ottawa River via runoff and affect aquatic biota.		x
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition may contaminate the Ottawa River via runoff and affect aquatic biota.		x
IC*	**6**	**Long Term Care and Maintenance**			
	6.8	Facility performance during the Institutional Controls phase	Groundwater will start to enter the grouted structure and come into contact with contamination. Dissolved contaminants may reach the Ottawa River.		x
PIC**	**7**	**Post-Institutional Controls**			
	7.1	Facility performance during the Post-Institutional Controls phase	Groundwater will flow into the eventually degraded structure. Contaminated and alkaline groundwater will flow out and eventually into the Ottawa River.		x

*IC: Institutional Controls

**PIC: Post-Institutional Controls

9.4.3.2 Proposed Mitigation Measures

Since other environmental components (i.e., surface water environment, atmospheric environment, geological and hydrogeological environment) act as pathways to affect the aquatic environment, mitigations within these components (e.g. in-design mitigation measures, dust suppression, runoff diversion, wash out pit design and management etc.) will also reduce potential effects to the aquatic environment. Because there are no in-water activities expected, no additional mitigation measures specific to the aquatic environment have been identified.

9.4.3.3 Effects After Mitigation

Decommissioning Execution

Habitat-Related Effects

None of the activities of the project are expected to affect fish habitat; there will be no infilling or construction in the river, and no activities near the wetlands. Therefore, no effects to aquatic habitat are expected in the Site, Local or Regional Study Areas during the Decommissioning Execution phase.

Exposure-Related Effects

In the EcoRA TSD, all radiological and chemical COPCs were screened out of the assessment for the Decommissioning Execution phase. Therefore, no potential exposure-related effects to aquatic biota are expected in the Site, Local or Regional Study Areas during the Decommissioning Execution phase.

For details on the screening process, see the EcoRA TSD or Section 9.1.1.1 above.

Institutional Controls and Post-Institutional Controls

Habitat-Related Effects

No potential habitat-related effects are expected in the aquatic environment in the Site, Local or Regional Study Areas during the postclosure period (Institutional Controls and Post-Institutional Controls phases).

Exposure-Related Effects

During the postclosure period, the grouted structure will degrade and groundwater will flow into the facility. Contaminants will dissolve into the groundwater, which will continue to flow and release contaminants to the Ottawa River. As shown in the Alkaline Plume Supplementary Document to the PostSA TSD, the alkaline plume flowing from the grouted structure is expected to be sufficiently diluted and of relatively small volume, and are not expected to result in contamination to the aquatic environment.

The EcoRA TSD assesses radiological and non-radiological exposure of aquatic biota to this contamination. The results of the EcoRA are conservatively assumed to apply to the Site, Local and Regional Study Areas, and are briefly summarized as follows:

Radiological

In the EcoRA TSD, no radiological contaminants were screened in for the normal evolution scenario.

However, in one disruptive event scenario (surface erosion), Ag-108m was screened in, and therefore considered further for that scenario in the EcoRA. No other radiological contaminants were screened in for the assessment. The EcoRA found no exceedances of the Ag-108m dose rate guideline for any of the aquatic biota assessed in the surface erosion scenario.

In the river level fall "what if" case, Ag-108m was screened in, and therefore considered further for that scenario in the EcoRA TSD. As stated in Section 9.1, "what if" cases are deliberately extreme, and thus do not warrant comparison to dose guidelines or toxicity reference values. However, no exceedances of the Ag-108m dose rate guideline for any of the aquatic biota assessed in river level fall scenario.

Therefore, no undue effects to aquatic biota are anticipated from exposure to radiation during the postclosure period (Institutional Controls and Post-Institutional Controls phases).

Non-radiological

In the EcoRA TSD, no non-radiological contaminants were screened in for the normal evolution scenario for the postclosure period. For details on the screening process, see the EcoRA TSD or Section 9.1.1 of this EIS.

However, in one disruptive event scenario (engineering degradation), lead was screened in, and therefore considered further for that scenario. No other chemical contaminants were screened in for the assessment. As stated in the EcoRA TSD, all screening indices (SI) for lead were below 1 for all aquatic biota assessed. An SI is the ratio (i.e., unitless) of an estimated exposure level (or estimated environmental concentrations) divided by a corresponding toxicity reference value or benchmark value. An SI value below one indicates that no effects are expected.

Therefore, no potential undue effects from non-radiological exposure were predicted for aquatic biota in the postclosure period (Institutional Controls and Post-Institutional Controls phases).

9.4.3.4 Prediction Confidence and Uncertainty

Section 6 of the EcoRA TSD outlines the uncertainties associated with the assessment of risk to aquatic biota. Most of these uncertainties are addressed through the use of conservative assumptions (e.g., 100% absorption of intake of a COPC from diet).

REGDOC 2.9.1 provides guidance on characterizing the effects of the project on aquatic flora and fauna, including a full accounting of effects on species of natural conservation status and their habitat. As per REGDOC 2.9.1 (Appendix C.3), the aquatic environment effects assessment was based on predictions from the EcoRA TSD, and covered effects such as the following (from REGDOC 2.9.1):

- effects on habitat;

- effects on aquatic species, including rare or sensitive species; and
- contaminant exposures through environmental and food chain transport.

None of the physical activities of the project are expected to affect fish habitat: there will be no blasting, infilling or construction in the river, and no activities near the wetlands. Neither thermal effects nor impingement and entrainment effects are assessed, as this is not relevant to the project.

REGDOC 2.9.1 (Appendix C.3) requires a clear description of how any predicted effects compare to the expected reference condition for unexposed biota on a biological population basis, taking natural variation into account. Predictions of effects should include sufficient detail to allow follow-up verification.

Uncertainty in animal behaviour is addressed in the EcoRA through the assumption that biota are present in the Site Study Area year-round, which is likely to overestimate the magnitude of exposure for mobile biota (i.e., lake sturgeon, white sucker, emerald shiner).

Any potential for undue effects is based on maximum concentrations in the EcoRA. However, the duration of any effects is unknown. It has been assumed that any effects are long-term.

9.4.3.5 Residual Effects

Table 9.4-3 summarizes the effects assessment above and presents the residual effects that were identified for the aquatic environment. The residual effects in Table 9.4-3 are grouped by effect rather than by individual interaction as listed in Table 9.4-2.

Table 9.4-3. Summary of Residual Effects in the Aquatic Environment

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution						
Aquatic Environment	Dewatering the wash out pit.	Benthic invertebrates Aquatic vegetation Emerald shiner White sucker Lake sturgeon	Equipment wash out and dewatering may affect aquatic biota.	Proper design, inspection and management procedures of wash out pit.	No effects are predicted.	No adverse residual effects.
Aquatic Environment	Demolition of above grade structures.	Benthic invertebrates Aquatic vegetation Emerald shiner White sucker Lake sturgeon	Demolition may affect aquatic biota via potential runoff.	Dust suppression, runoff diversion and standard construction procedures will reduce effects.	No effects are predicted.	No adverse residual effects.
Aquatic Environment	Sizing of material.	Benthic invertebrates Aquatic vegetation Emerald shiner White sucker Lake sturgeon	Outdoor cutting steel and crushing masonry may affect aquatic biota via potential run-off.	Dust suppression, runoff diversion and standard construction procedures will reduce effects.	No effects are predicted.	No adverse residual effect.
Institutional Controls and Post-Institutional Controls						
Aquatic Biota (radiological)	Facility performance during the postclosure period.	All aquatic VCs	Groundwater will flow into the eventually degraded structure. Contaminated groundwater may flow out and eventually into the Ottawa River. This may be transferred to biota	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects in the terrestrial environment.	Radionuclides are expected to be within acceptance criteria.	No adverse residual effects.

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Aquatic Biota (non-radiological)	Facility performance during the postclosure period.	All aquatic VCs	Groundwater will flow into the eventually degraded structure. Contaminated groundwater may flow out and eventually into the Ottawa River. This may be transferred to biota.	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects in the terrestrial environment.	Chemical contaminants are expected to be below benchmarks.	No adverse residual effects
Aquatic Environment: Engineering Degradation (non-radiological)	Instantaneous degradation of the concrete and grout, altering the hydraulic properties and decreasing contaminant transport times.	Benthic invertebrates Aquatic vegetation Emerald shiner White sucker Lake sturgeon	Lead in groundwater reaching the Ottawa River is predicted to contaminate surface water and sediment and may affect aquatic biota.	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects in the aquatic environment.	No undue effects are predicted	No adverse residual effect.
Aquatic Environment: Surface Erosion (radiological)	Flooding of sufficient magnitude has the potential to expose contaminated rock to the surface environment.	Benthic invertebrates Aquatic vegetation Emerald shiner White sucker Lake sturgeon	Exposure to contaminated rock may affect aquatic biota.	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects in the aquatic environment.	No undue effects are predicted	No adverse residual effect.

9.4.4 Assessment of Residual Effects

Based on the assessment described above, no adverse residual effects on the aquatic environment have been predicted.

9.4.5 Monitoring and Follow-up

The VCs in the aquatic environment are benthic invertebrates, aquatic vegetation, emerald shiner, white sucker and lake sturgeon. The follow-up and monitoring work undertaken by CNL in other environmental components (i.e., the surface water and geological and hydrogeological environments) is directly related to confirming the EIS findings related to aquatic environment VCs. Monitoring and follow-up activities within the aquatic environment are discussed below and presented in Table 9.4-4. Further action will be triggered if parameters are above applicable guidelines or other notable changes are observed during monitoring activities in other environmental components. If further action is triggered, CNL may undertake sediment sampling and analysis, decommissioning activities will be reviewed, and/or options will be discussed with CNL biologist(s) (e.g., benthic community characterization).

Table 9.4-4. Monitoring and Follow-up Activities in the Aquatic Environment

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Aquatic Environment	Aquatic Biota	Potential Source(s) of Effects: - Wash out pit (preparation and operation) - Demolition of above grade structures - Sizing of material Proposed Monitoring: - Water quality monitoring, as per the surface water environment Trigger for further action: - Investigation if parameters above applicable guidelines, or indication of poor maintenance. Monitoring required for any unique events such as spills.	Verify EA prediction (i.e., no adverse residual effect on water quality or related VCs).	Inspections: periodic Sampling and analysis of batch discharges: as required (event-based, e.g., transition between activities). Sampling and analysis of runoff: periodic. Incident-specific water quality monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts semi-annual sampling and analysis of liquid effluent in the tile drain systems. NPDWF currently conducts routine radiological surveys which include ambient radiation dose measurements and contamination surveys. CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and Cs-137).
Institutional Controls phase					
Aquatic Environment	Aquatic Biota	Proposed Source(s) of Effects: - Potential for post-closure groundwater flow into eventually-degraded structure, and into Ottawa River Proposed Monitoring: - Monitoring of parameters of concern, as per the surface water environment Trigger for further action: Investigation if parameters above applicable guidelines, or indication of poor maintenance.	Verify EA prediction (i.e., no adverse residual effect on surface water environment or related VCs). and Determine effectiveness of mitigation measures (e.g., concrete cap design, grout fill)	Surface water monitoring: periodic	CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and Cs-137).

9.4.6 Conclusion

The assessment in Section 9.4.3 found that based on the predicted impacts after applied mitigation measures, no adverse residual effects on the aquatic environment are expected to result from the project. Monitoring activities in other environmental components (i.e., surface water, and geological and hydrological environments) will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects related to the aquatic environment. If monitoring identifies concerns in the other environmental components, CNL will assess the implications to the aquatic environment (e.g., through discussion with CNL biologists).

9.5 Geological and Hydrogeological Environment

9.5.1 Selection of Valued Components

As outlined in Section 5.2.4, the geological and hydrogeological environment (i.e. soil quality, groundwater flow and quality) represents features that can be affected by the project and as such would be pathways or mechanisms for transfer of an effect to another environmental component (e.g. surface water environment, aquatic environment). As such, no VCs have been selected in the geological and hydrogeological environment (Table 9.5-1). The potential effects will be considered with respect to VCs in other applicable environmental components.

Table 9.5-1. Valued Component Selection for the Geological and Hydrogeological Environment

Environmental Component	Pathway	Rationale
Geological and Hydrogeological Environment	Pathway to human health	The potential effects on humans associated with changes in soil and groundwater conditions (radiological and chemical releases and concentrations,) as well as groundwater flow and other physical parameters will be considered in the Human Health component.
	Pathway to non-human biota health	The potential effects on non-human biota associated with changes in soil and groundwater conditions (radiological and chemical releases and concentrations) as well as groundwater flow and other physical parameters will be considered for the Aquatic and Terrestrial Environment VCs.
	Pathway to VCs in other environmental components	The potential effects on VCs in other environmental components associated with changes in soil and groundwater conditions (radiological and chemical releases and concentrations, and noise) as well as groundwater flow and other physical parameters will be considered in the applicable environmental components. These will include effects on Surface Water Environment, Aquatic Environment and Terrestrial Environment VCs.

9.5.2 Assessment Boundaries

9.5.2.1 Spatial Boundaries

Similar to the geological and hydrogeological baseline characterization in Section 8.5 above, the Site and Local Study Areas for this assessment are consistent with the general spatial boundaries outlined in Section 5.2.1.1. The Regional Study Area for the geological and hydrogeological environment is outlined in Figure 8.5-1, and extends five km beyond the Site Study Area.

9.5.2.2 Temporal Boundaries

The temporal boundaries for this assessment are the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.5.3 Identification of Residual Effects

9.5.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the geological and hydrogeological environment may occur as a result of interaction with activities in the Decommissioning Execution, Institutional Controls and Post-Institutional Controls phases:

- Removal of above grade structures;
- Facility performance during the Institutional Controls phase;
- Facility performance during the Post-Institutional Controls phase.

The rationale for these interactions is included in Table 9.5-2 below.

Table 9.5-2. Project-Environment Interactions in the Geological and Hydrogeological Environment

		Project Works and Activities	Rationale
Decommissioning Execution	**3**	**Removal of Above Grade Structure**	
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition will release contaminated particulate matter which may affect soil quality.
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Sizing of material will release contaminated particulate matter which may affect soil quality.
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	Material laydown may release contaminated particulate matter which may affect soil quality.
	3.10	Demolition block walls and inside walls around control room and change rooms.	Demolition will release contaminated particulate matter which may affect soil quality.
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Demolition will release contaminated particulate matter which may affect soil quality.
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition will release contaminated particulate matter which may affect soil quality.
IC*	**6.**	**Long Term Care and Maintenance**	
	6.8	Facility performance during the Institutional Controls phase.	Groundwater will start to enter the grouted structure, which will affect groundwater flow in a localized area. Soil contamination may also occur (e.g., via the surface water environment). Groundwater will come into contact with contamination, affecting groundwater quality.
PIC[10]	**7**	**Post-Institutional Controls**	
	7.1	Facility performance during the Post-Institutional Controls phase.	Groundwater will flow into the eventually degraded grouted structure and become contaminated. Soil contamination may also occur (e.g., via irrigation). An alkaline plume from the grouted structure may contaminate the groundwater.

*IC: Institutional Controls

**PIC: Post-Institutional Controls

As seen in the above table, soil quality and topography were identified as having potential project-environment interactions as part of the geological environment. No other project-environment interactions have been identified relating to geology and geomorphology. Interrelationships with the groundwater regime are discussed as a part of the hydrogeological environment.

9.5.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

In addition to the in-design mitigation measures identified in Section 4.1 above, the following mitigation measures have been identified to limit and/or eliminate contamination of groundwater and soil:

- survey and remediation of localized areas of contamination in affected areas (e.g. laydown areas, staging areas) as required throughout the project;
- dust suppression and sedimentation, runoff and erosion control mitigation measures identified for the atmospheric and surface water environments in Sections 9.2.3.2 and 9.3.3.2 to minimize and localize effects to soil and groundwater quality;
- proper design, inspection and management of wash out pits and material storage site(s);
- specific spill prevention and clean-up procedures will be prepared by CNL prior to commencement of construction, in accordance with CNL's Management and Monitoring of Emissions procedure (DeWaele 2013a) to minimize the risk of accidental spills. CNL's Waste Management procedures (Gillespie 2017) will be followed for any removal and disposition of contaminated material;
- Storage of only material expected to be clean in laydown areas; and
- reduction in the probability of accidental spills that will affect surface water quality through adherence to spill management practices including: health and safety procedures, proper chemical storage in approved containers, secondary spill containment for harmful substances, spill containment measures and training of personnel in spill containment procedures.

9.5.3.3 Effects After Mitigation

Decommissioning Execution

Site and Local Study Area

In the Decommissioning Execution phase, there are potential effects to soil quality from the release of contaminated particulate during demolition and material sizing. As discussed in Section 8 of the DecomSA TSD, mitigation measures (identified above) will trap and remediate effects to soil quality, and as such, only localized and negligible effects on soil quality are expected. Effects to groundwater flow may occur from the engineered barrier; however, these effects are expected to be localized to the area surrounding the concrete cap and barrier. No effects are expected on groundwater quality during the Decommissioning Execution phase.

Regional Study Area

Any potential effects within the Site and Local Study Areas are localized. Therefore, no effects are expected to extend into the Regional Study Area during the Decommissioning Execution phase.

Institutional Controls and Post-Institutional Controls

Since the geological and hydrogeological environment is a pathway to VCs in other environmental components (e.g., aquatic and terrestrial environments and human health), the project's potential effects

on the geological and hydrogeological environment (in particular groundwater flow and quality) are assessed with respect to the VCs in those environmental components (see Sections 9.4.3, 9.6.3, 9.8.3, 9.9.3 and 9.10.3).

Any potential changes to groundwater flow are expected to occur during resaturation. Any effects on groundwater flow will be temporary and localized to the area surrounding the NPDWF. The PostSA TSD also considers impacts on soil quality in the Institutional Controls and Post-Institutional Controls phases (e.g., via irrigation of soil used for growing crops).

As discussed in the PostSA TSD, during the Institutional Controls phase, the facility will gradually resaturate, and dissolved contaminants will start leaching out into the surrounding groundwater. Contaminant concentrations in the groundwater surrounding the NPDWF are expected to be much lower than within it.

Radiological

As discussed in the PostSA TSD, during the Institutional Controls phase, the concentrations in the surrounding groundwater are dominated by tritium, peaking at around 1,000 Bq/L. By 130 y, concentrations are less than 1 Bq/L. For perspective, the current drinking water guideline for tritium is 7,000 Bq/L (Health Canada 2017). During the Post-Institutional Controls phase, groundwater continues to flow out of the NPDWF. However, total radioactivity concentrations in groundwater are lower than during the Institutional Controls phase. The PostSA TSD provides more details on radionuclide concentrations in the groundwater.

Non-radiological

As discussed in the PostSA TSD, during the Institutional Controls and Post-Institutional Controls phase, the concentrations of lead in groundwater peak at 0.0046 mg/L after 70,000 y. For perspective, the current drinking water guideline for lead is 0.01 mg/L (Health Canada 2017). No other non-radioactive contaminants reach the environment in any considerable concentration. The PostSA TSD provides more details on non-radiological concentrations in the groundwater which are considered in the assessment of effects on VCs (Sections 9.4, 9.6, 9.8, 9.9, 9.10).

9.5.3.4 Prediction Confidence and Uncertainty

Although the project has been described in Titterington (2016), Aikens (2017) and various other studies, there are some minor uncertainties with respect to some aspects of the project details. These uncertainties, and their implications on the assessment of effects, are outlined below.

Since the location of certain aspects of the project (e.g., the laydown area) have not been finalized, there is some uncertainty with the potential for these activities to affect soil and groundwater quality and groundwater flow. The exact locations of the batch mixing plant, staging areas, raw material storage areas, on-site trucking routes have could influence the potential for soil and groundwater contamination. The sediment and erosion controls, consistent with Morin (2015), discussed under mitigation measures above, would reduce this uncertainty.

It is assumed that runoff and sediment will be properly contained/managed to localize any potential effects, and remediation will ensure that effects do not extend past the Decommissioning Execution phase.

REGDOC 2.9.1 (CNSC 2016b, Appendix C.4) states the requirement for a description of any predicted changes to the environment due to: modifications to the geology and geomorphology of the site; removal of bedrock and/or consolidated deposits; or disturbance of soils or sediments. Since the project does not involve the removal of bedrock or deposits, and does not involve any new disturbance of soil, this is not considered relevant. Changes to the shoreline are discussed in this EIS in Section 9.11 (Accidents and Malfunctions), and sediment transport is addressed in Section 9.4 of this EIS (Aquatic Environment).

In the PostSA TSD, uncertainties in postclosure conditions (e.g. floods), key parameters (e.g. source term inventory) were addressed inherently by assessing several disruptive scenarios. The well in contaminated plume “what if” case is used to address other uncertainties, such as where future generations take their water.

9.5.3.5 Residual Effects

Table 9.5-3 summarizes the effects assessment above and presents the residual effects that were identified for the geological and hydrogeological environment and are carried forward for assessment in the appropriate environmental components. The residual effects in Table 9.5-3 are grouped by effect rather than by individual interaction as listed in Table 9.5-2.

Table 9.5-3. Summary of Residual Effects in the Geological and Hydrogeological Environment

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution					
Geological and Hydrogeological Environment: Groundwater Flow	Washout pit construction and operation.	Washout pit will create an impermeable area on the site, affecting groundwater flow and direction.	Proper design, inspection and management of wash out pits	Effects are expected to be localized.	No adverse residual effects.
Geological and Hydrogeological Environment: Soil Quality.	Demolition.	Demolition will release contaminated particulate matter which may affect soil quality.	Dust suppression methods (e.g. misting) and runoff control will trap dust and other potential contaminants produced from demolition, thereby limiting contamination of the surrounding soil. Soil remediation during final site restoration, if necessary.	Effects on soil quality are negligible, localized and temporary.	No adverse residual effects.
Geological and Hydrogeological Environment: Soil Quality.	Sizing of material.	Sizing of material will release contaminated particulate matter which may affect soil quality.	Dust suppression methods (e.g. misting) will trap dust and other potential contaminants produced from crushing of masonry and cutting beams, thereby limiting contamination of the surrounding soil. Cutting will also be done in a controlled manner.	Effects on soil quality are negligible, localized and temporary.	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
			Soil remediation during final site restoration, if necessary.		
Geological and Hydrogeological Environment: Soil Quality.	Material laydown and clearance surveys.	Material laydown may release contaminated particulate matter which may affect soil quality.	Dust suppression methods (e.g. misting) and runoff control will trap dust and other potential contaminants. Only material that is expected to be clean will be brought to the clearance survey lay down area, therefore further minimizing the potential for contamination. Soil remediation during final site restoration, if necessary.	Effects on soil quality are negligible, localized and temporary.	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Institutional Controls and Post-Institutional Controls					
Geological and Hydrogeological Environment: Groundwater Quality (radiological).	Facility performance during the postclosure period.	Groundwater will flow into the eventually degraded structure and become contaminated.	In-design mitigation measures to isolate and contain the inventory in order to reduce the potential of groundwater contamination.	Contaminated groundwater has the potential to transfer effects to humans and biota in other environmental compartments.	Effects of radiological exposure are assessed in terms of their dose in non-human biota and humans in Sections 9.4, 9.6 and 9.8.
Geological and Hydrogeological Environment: Groundwater Quality (non-radiological).	Facility performance during the postclosure period.	Groundwater will flow into the eventually degraded structure and become contaminated.	In-design mitigation measures to isolate and contain the inventory in order to reduce the potential of groundwater contamination.	Contaminated groundwater has the potential to transfer effects to humans and biota in other environmental compartments.	Effects of non-radiological exposure are assessed in terms of their dose in non-human biota and humans in Sections 9.4, 9.6 and 9.8.

9.5.4 Assessment of Residual Effects

Since the geological and hydrogeological environment is a pathway to other environmental components (e.g., surface water, aquatic and terrestrial environments, human health), the potential adverse residual effects are further assessed within those environmental components (see Sections 9.3.4, 9.4.4, 9.6.4, 9.8.4, 9.9.4 and 9.10.3).

9.5.5 Monitoring and Follow-up

The geological and hydrogeological environment (i.e., soil quality, groundwater flow and quality) represents a pathway for transfer of an effect to VCs in other environmental components (i.e., surface water, aquatic, and terrestrial environments). Monitoring and follow-up activities within the geological and hydrogeological environment are discussed below and presented in Table 9.5-4. Further action will be triggered if parameters measured are above guidelines and/or upgradient groundwater levels, or if there are notable changes to groundwater quality, flow regime or slope stability. Further action may also be triggered if parameters are above applicable guidelines are observed in other environmental components (i.e., surface water environment and ambient radioactivity). Triggered actions are designed to confirm integrity of the concrete monolith during the Institutional Controls phase. Failure of the concrete monolith would lead to potential effects to biota and humans.

Decommissioning Execution

In the Decommissioning Execution phase, CNL will conduct routine groundwater analyses for parameters of concern (radiological and non-radiological) to verify that potential effluent emissions are below applicable guidelines. Groundwater flow and direction will also be measured at the end of the Decommissioning Execution phase, and if significant changes are noted, geophysical methods will be employed to confirm the integrity of the engineered barrier and concrete monolith.

Institutional Controls

In the Institutional Controls phase, CNL will conduct routine groundwater analyses for parameters of concern (radiological and non-radiological), at a lower frequency than in the Decommissioning Execution phase, to verify that potential effluent emissions are below the applicable guidelines. Groundwater flow and direction will also be measured, and if significant changes are noted, geophysical methods will be employed to confirm the integrity of the engineered barrier and concrete monolith.

CNL will also conduct slope stability measurements, which may trigger slope stabilization if changes are observed, since slope failure could result in surface exposure of the concrete monolith.

Further investigation will be required if changes in pH are noted, or parameters are above guidelines.

Table 9.5-4. Monitoring and Follow-up Activities in the Geological and Hydrogeological Environment

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Geological and Hydrogeological Environment	Soil and Groundwater Quality	Potential Source(s) of Effects: - Demolition - Sizing of material - Material laydown and clearance surveys Proposed monitoring: - Measure groundwater flow and direction at end of decommissioning. - Routine groundwater analyses for parameters of concern (chemical and/or radiological). - Routine radiological surface surveys, per ambient radioactivity Trigger for further action: - Investigation if significant unexpected changes to groundwater flow. - If groundwater parameters above applicable guidelines or upgradient groundwater, conduct soil sampling and analysis for parameters of concern. - If routine radiological surveys identify elevated areas, conduct soil sampling for parameters of concern. Monitoring required for any unique events such as spills.	Verify EA prediction (i.e., no adverse residual effect on soil quality or groundwater flow, or related VCs)	Groundwater flow and direction: at end of decommissioning Sampling and analysis of groundwater: periodic. Routine radiological surface surveys: periodic, as well as a final survey following completion of decommissioning activities. Incident-specific soil or groundwater monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.
Institutional Controls phase					
Geological and Hydrogeological Environment	Groundwater Quality (radiological and non-radiological)	Potential Source(s) of Effects: - Potential leaching of soluble contaminants from degradation of grouted structure. Proposed Monitoring: - Routine groundwater analyses for parameters of concern (chemical and/or radiological). - Measure groundwater flow and direction. Trigger for further action: - If groundwater parameters above applicable guidelines or upgradient groundwater, conduct soil sampling and analysis for parameters of concern. If significant unexpected changes to groundwater flow, employ geophysical methods to confirm integrity of engineered barrier.	Verify EA prediction (i.e., no adverse residual effect on groundwater quality or related VCs)	Sampling and analysis of groundwater: periodic. Groundwater flow and direction: periodic, low frequency. Incident-specific soil or groundwater monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.
	Topography	Potential Source(s) of Effects: - Potential loss of soil cover and exposure of concrete monolith Proposed Monitoring: - Slope stability measurements Trigger for further action: If significant changes, consider slope stabilization.	Determine effectiveness of mitigation measures (e.g., design of engineered barrier)	Soil stability monitoring: periodic, low frequency.	NPDWF currently conducts monthly surveillance inspections.

9.5.6 Conclusion

The potential for residual effects in the geological and hydrogeological environment was discussed in Section 9.5.3, based on predicted effects after applied mitigation measures. However, since the geological and hydrogeological environment is a pathway to VCs in other environmental components (specifically the surface water, aquatic and terrestrial environment and human health), any potential residual effects are considered in the applicable environmental components. Monitoring activities such as the measurement of groundwater quality, flow and direction will verify the accuracy of the EA predictions.

9.6 Terrestrial Environment

9.6.1 Selection of Valued Components

As outlined in Section 5.2.4, VCs for the terrestrial environment were selected to encompass the potential effects of the project to the terrestrial component as well as other environmental components (e.g., atmospheric environment, geological environment) that act as a pathway to transfer potential effects to the terrestrial environment. VCs were selected to represent a variety of ecological roles within the terrestrial environment. All species are assessed for exposure-related effects. Species that are likely to be found in the Site Study Area are selected for assessment of habitat-related effects. The VCs for the terrestrial environment, with rationale for their selection, are listed in Table 9.6-1.

Table 9.6-1. Valued Components for the Terrestrial Environment

Environmental Component	Sub-Category	VC	Effects Assessed		Rationale
			Habitat	Exposure	
Terrestrial Environment	Terrestrial Invertebrates	Soil invertebrates		x	Soil-dwelling invertebrates (e.g. earthworm). Exposure from soil.
		Monarch butterfly	x	x	SC (*SARA* status) – Monarchs are migrants and are sensitive to habitat fragmentation and disturbance. Found in the Site Study Area.
	Terrestrial Vegetation	Red maple		x	Upland/wetland deciduous tree common in the Local Study Area.

Environmental Component	Sub-Category		VC	Effects Assessed		Rationale
				Habitat	Exposure	
Terrestrial Environment	Birds	Small-medium, aerial	Chimney swift	x	x	THR (*SARA* status) - migratory insectivorous bird. There is a chimney swift super roost in the ventilation stack in the Site Study Area which is in close proximity to site activities and may be affected.
		Large, aerial	Bald eagle	x	x	Large raptor. Cultural and ecological significance. Known nest in the Local Study Area.
		Medium, ground-dwelling	Ruffed grouse		x	Ground-dwelling non-migratory omnivorous bird. Present in the Local Study Area.
		Medium, semi-aquatic	Mallard		x	The Ottawa River is in the heart of the Atlantic Flyway, and is an important stopover for migrating waterfowl such as the mallard. Likely present in the Regional Study Area.
		Large, semi-aquatic	Great blue heron		x	Large wading piscivorous bird. Great blue herons are sensitive to human disturbance. Present in the Regional Study Area. Great blue herons often return to their nesting colonies for many consecutive years, and are sensitive to habitat destruction or disturbance.

Environmental Component	Sub-Category		VC	Effects Assessed		Rationale
				Habitat	Exposure	
Terrestrial Environment	Mammals	Small, insectivorous	**Little brown myotis** Eastern small-footed myotis Northern myotis Tri-coloured bat	x	x	Bat species known to be present in the Site Study Area. All are listed as END under *SARA* except for eastern small-footed myotis. While each listed species is a VC, the little brown myotis (in bold) is used as a surrogate for the others.
		Small, herbivorous	Meadow vole	x	x	Soil-dwelling, small herbivore. Burrowing is an important exposure pathway.
		Small, omnivorous	Short-tailed shrew		x	Abundant, mostly-carnivorous small mammal. Burrowing is an important exposure pathway.
		Large, omnivorous	Black bear		x	Large terrestrial omnivore Cultural importance and public interest.
		Large, carnivorous	Eastern wolf		x	SC (*SARA* status) large terrestrial carnivore. Likely present in the Regional Study Area.
		Small-Medium, semi-aquatic	Muskrat		x	Aquatic piscivore/herbivore. Likely present in the Regional Study Area.
	Reptiles and Amphibians	Reptile	Blanding's turtle		x	Sighting near the Local Study Area. THR (*SARA* status) Travels great distances over land.
			Eastern milksnake	x	x	SC (*SARA* status) snake present in the Site Study Area.
		Amphibian	Green frog		x	The green frog is abundant and is present in wetlands in the Local Study Area.

9.6.2 Assessment Boundaries

9.6.2.1 Spatial Boundaries

Similar to the terrestrial environment baseline characterization in Section 8.6 above, the Site and Local Study Areas for this assessment are consistent with the general spatial boundaries outlined in Section 5.2.1.1. The Regional Study Area for the terrestrial environment is outlined in Figure 8.6-1.

9.6.2.2 Temporal Boundaries

The temporal boundaries for this assessment are consistent with the standard temporal boundaries outlined in Section 5.2.1.2.

9.6.3 Identification of Residual Effects

9.6.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the terrestrial environment may occur as a result of interaction with activities in the Decommissioning Execution phase and the Post-Institutional Controls phase, in particular:

- Installation and operation of the batch mixing plant;
- Grouting the below grade structure;
- Removal the above grade structure;
- Final site restoration;
- Facility performance during the Institutional Controls phase; and
- Facility performance during the Post-Institutional Controls phase.

The rationale for these interactions is included in Table 9.6-2 below.

Table 9.6-2. Project-Environment Interactions in the Terrestrial Environment

Phase		Project Works and Activities	Potential Interaction	Habitat	Exposure
Decommissioning Execution	**1**	Batch Mixing Plant			
		Generation of garbage, particularly food wastes.	Generation of food or other wastes by workers on site may attract wildlife (i.e. bears to the site).		
	1.1	Designate footprint, create access, temporary fencing (west side of main building).	Despite being in a previously disturbed area, all activities related to establishing the project footprint (fencing) are expected to result in dust and emissions, and affect and displace wildlife.	x	x
	1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	Despite being in a previously disturbed area, storage of raw materials will create dust, physical effects (noise, vibration, encroachment) and emissions, affecting vegetation and wildlife.	x	x
Decommissioning Execution	**1.3**	Set up mixing stations, hook up electrical power or diesel power.	Despite being in a previously disturbed area, all activities related to establishing the project footprint (i.e. setting up mixing stations, power supply) are expected to affect wildlife habitat.	x	
	1.4	Truck in necessary water supply.	Transportation of water is expected to create dust, physical effects (noise, vibration, encroachment) and emissions.	x	x
	1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	Despite being in a previously disturbed area, excavation of the wash out pit is expected to create dust, physical effects (noise, vibration, encroachment) and emissions, affecting vegetation and wildlife. The wash out pit may attract wildlife.	x	x
	1.7	Level area for concrete pumper.	Despite being in a previously disturbed area, levelling the ground is expected to create dust, physical effects (noise, vibration, encroachment) and emissions, affecting vegetation and wildlife.	x	x
	1.9a	Truck grout to pumping station (20 trips per day).	On-site transportation is expected to create dust, physical effects (noise, vibration, encroachment) and emissions	x	x

Phase		Project Works and Activities	Potential Interaction	Habitat	Exposure
Decommissioning Execution	**2**	Grouting of Below Grade Structure			
	2.3	Grout Fill Nuclear Area.	Displacement of air containing tritium, lead and asbestos may result in exposure effects to non-human biota. Transportation of grout is expected to create dust, physical effects (noise, vibration, encroachment) and emissions.	x	x
	3	Removal of Above Grade Structure			
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition will release noise, dust, radioactivity and other potential contaminants.	x	x
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Material sizing will result in physical effects (noise, vibration, encroachment), dust, radioactivity and other potential contaminants.	x	X
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	Off-site material transport may affect off-site traffic. On-site material transportation will create dust, physical effects (noise, vibration, encroachment).	x	x
	3.4	Steel and rubble emplaced in condenser room according to nesting plan. Fill to 380 level.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.5	Grout first level of demolition material in condenser room.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.6	Steel and rubble emplaced in condenser room. Fill to 400 level	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.7	Grout second level of demolition material in condenser room.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.8	Steel and rubble in condenser room. Fill to 425 level.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.9	Grout third level of demolition material in condenser room.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x

Phase		Project Works and Activities	Potential Interaction	Habitat	Exposure
Decommissioning Execution	**3.10**	Demolition block walls and inside walls around control room and change rooms.	Demolition will create physical effects (noise, vibration, encroachment), dust, radioactivity and other potential contaminants.	x	x
	3.11	Collapse ceilings of furnace room and adjacent rooms.	Demolition will release create physical effects (noise, vibration, encroachment), dust, radioactivity and other potential contaminants.	x	x
	3.12	Emplace block wall rubble in furnace room or condenser room.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Air displacement from below grade structure will release radioactivity and other potential contaminants.		x
	3.15	Grout furnace room and adjacent areas to ground level.	Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.		x
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition will create physical effects (noise, vibration, encroachment), dust, radioactivity and other potential contaminants. Air displacement from below grade structure will release dust, radioactivity and other potential contaminants.	x	x

Phase		Project Works and Activities	Potential Interaction	Habitat	Exposure
Decommissioning Execution	**5**	Final Site Restoration			
	5.1	Site Restoration (install fencing, install monitoring wells if required, remediate areas affected by previous operations or decommissioning, wash out pits and settling ponds, complete closure surveys, create rubble from non-essential asphalt).	These activities will create physical effects (noise, vibration, encroachment), dust and emissions. Remediating areas affected by previous operations or decommissioning is expected to reverse some of the habitat-related effects of the decommissioning.	x	x
	5.2	Ventilation Stack Isolation – Remove ancillary equipment from ventilation stack (e.g. ladder, lights), modification to ventilation stack for roosting requirements (e.g. venting).	Creating an air passage in the ventilation stack (e.g. via drilling) may release radioactivity. Improvements made to the ventilation stack will improve conditions for the chimney swifts.	x	x
	5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	Demobilizing the site will result in dust and reverse some of the habitat-related effects of the decommissioning.	x	x
IC*	**6**	Long-term Care and Maintenance			
	6.7	Renaturalization of the Site Study Area.	Renaturalization of a portion of the Site Study Area may increase habitat.	X	
	6.8	Facility performance during the Institutional Controls phase	Groundwater will start to flow into the eventually degraded structure. Contaminated and alkaline groundwater will flow out and eventually into the Ottawa River. This will be transferred to soil through irrigation, and biota through drinking water.		x
PIC**	**7**	Postclosure			
	7.1	Facility performance during the Post-Institutional Controls phase	Groundwater will flow into the eventually degraded structure. Contaminated and alkaline groundwater will flow out and eventually into the Ottawa River. This will be transferred to soil through irrigation, and biota through drinking water.		x
		Renaturalization	Renaturalization in the Site Study Area may increase habitat.	x	

Notes:

* - IC: Institutional Controls phase

** - PIC: Post-Institutional Controls phase.

9.6.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

In addition to the in-design mitigation measures identified in Section 4.1 above, the following mitigation measures have been identified to ensure the protection of the terrestrial environment:

- dust and noise suppression measures as described in Section 9.2.3.2;
- delineation of work areas, limiting project activities to within previously disturbed areas to reduce direct loss of wildlife on-site resulting from the project;
- posted speed limits in the Site Study Area, as well as the access road to reduce roadkill on-site;
- localized surface scarifying with a track machine to break up soil-compacted areas during final site restoration where necessary; these areas will then be top-dressed as required and replanted with native vegetation. Subsoil will be tilled and cultivated as necessary during clean up to remove compacted material;
- disposal of garbage on-site, particularly food waste, in proper containers to deter wildlife;
- completion of visual inspection to ensure that no bat roosts are present in the facility prior to commencement of below-grade grouting. If a roost is found, then through consultation with CNL biologist mitigation measures such as the installation of artificial bat houses and planning work outside of the maternity roosting period will be implemented;
- sweep work areas for the presence of SARs (e.g., eastern milksnakes, nests, bats, roosts, barn swallows, monarch butterflies) prior to work being undertaken, particularly from August to October when juveniles milksnakes are known to enter buildings (Morin and Carr 2015). Employee training will ensure that if a milksnake is encountered, the situation will be properly handled to ensure compliance with *SARA* requirements;
- no clearing of milkweed during the early life stages of monarch butterflies, and no removal of milkweed outside of the Site Study Area; and
- if work within 400 m of the bald eagle's nest becomes necessary, these activities should be restricted during the courtship and breeding periods (MNRF 2010d).

In addition, CNL has identified mitigation measures specifically for the protection of migratory bird in the Site Study Area (chimney swift specific mitigation is discussed below). The project activities are expected to remain within previously disturbed areas, and no tree clearing is planned. In order to protect nesting migratory birds, in accordance with the Migratory Birds Convention Act, the site preparation activities will avoid tree clearing during the breeding bird season (April 15 – August 20), wherever possible. If such activities cannot be scheduled outside the prime nesting season, a nest survey should be conducted beforehand (i.e., within 2 days) to ensure there are no active nests in the areas of activity. It is also possible that migratory birds (e.g., ground nesting birds) could be present in the Site Study Area during site preparation activities. Therefore, nest surveys should also be conducted prior to establishing the project footprint if set up of various components (e.g., batch mixing plant) commences during the breeding bird season (Morin and Carr 2015).

As discussed in Section 8.5, CNL undertook investigation of the viability of ventilation stack removal. It was decided that ventilation stack retention will mitigate the risk of abandonment of the ventilation stack by the chimney swifts. In addition to ventilation stack retention, proposed mitigation measures with regard to the chimney swift roost are identified in the Chimney Swift TSD, and are listed below:

- limitation of decommissioning activities to between 7 am and 7 pm (i.e., daylight hours when the swifts are not in the ventilation stack) where possible; and,
- restriction of Decommissioning Execution activities near the roost (within 5 m) as much as possible. Placement of infrastructure (e.g., batch plant) should be avoided within 5 m. Further, as a precaution, any reduction in Decommissioning Execution activities between 5-90 m of the roost would be beneficial.

The following mitigation measures (identified in the Chimney Swift TSD) are to be undertaken when chimney swifts are suspected in the ventilation stack (e.g., at night, during inclement weather etc.):

- noise performance should be considered in the selection of mechanical equipment and vehicles;
- bearing in mind a minimum placement of 5m from the ventilation stack, mobile plants (e.g., compressors, generators) and other noisy apparatuses such as concrete batching should be located as far as possible from the ventilation stack. These devices should be oriented to direct noise emissions away from the ventilation stack as far as possible, and onsite structures and terrain will be used to screen the ventilation stack and provide noise suppression wherever practicable;
- dramatic and sudden disturbances should only ever be undertaken between 7 am and 7 pm;
- the noise level of audible warning devices should be kept to the minimum necessary for employee health and safety;
- major demolition activities should be undertaken following a planned schedule;
- major demolition procedures should be developed to keep noise and vibration to a minimum without compromising demolition requirements;
- if significant vibration impacts cannot be avoided, consider relocating sources so that there is no direct line of sight between the source and ventilation stack;
- orient all external lighting fixtures so that the top of the ventilation stack is not illuminated;
- insofar as is practical, keep dust from demolition to a minimum (see dust suppression methods in Section 9.2.3.2); and,
- activities that will create substantial vibration and noise should only be undertaken between 7 am and 7 pm, and it is also recommended that a ‘soft-start’ approach be undertaken. This requires that each time the activity is initiated after a period of inactivity (>24 hours), the disturbance (noise and vibration) levels will be gradually increased over a 30-minute period to allow swifts at least an opportunity to acclimate. Noise and vibration should be minimized without compromising demolition requirements.

9.6.3.3 Effects After Mitigation

In this section, habitat-related and exposure-related effects are discussed for each phase of the project.

The EcoRA TSD assessed exposure effects for all radiological and chemical COPCs identified in the EIS. The results of the EcoRA TSD have a large safety margin, given the conservative assumptions that were used, such as:

- It was assumed that terrestrial biota would spend all of their time on-site, consuming all of their food and water from the site, regardless of migratory patterns or home ranges; and
- Maximum contaminant concentrations at the most sensitive receptor locations were used.

Decommissioning Execution

Site Study Area

Habitat-Related Effects

Despite its previously disturbed nature, there is limited potential for loss of habitat for animals potentially found in the Site Study Area associated with Decommissioning Execution activities. The loss of habitat is temporary and minor, displacing wildlife to cultural communities unaffected by project activities, or the surrounding forests. The project is not expected to introduce any physical barriers to wildlife. The following terrestrial VCs in the Site Study Area may have the potential to be affected by loss of habitat: monarch butterfly, eastern milksnake, meadow vole, little brown myotis.

As discussed in Section 8.6, the ventilation stack in the Site Study Area is used as a roost by chimney swifts. The potential effects of Decommissioning Execution activities on chimney swifts are assessed in the Chimney Swift TSD. Activities are not expected to physically alter the roost's habitat quality. However, due to the proximity of the ventilation stack to Decommissioning Execution activities, there is potential for disturbance of the roost through loud noise (acute and/or chronic), vibration (from demolition or machinery) and encroachment (i.e., activities being carried out too close to the ventilation stack, regardless of noise or vibration produced). These effects are most likely to occur when Decommissioning Execution activities overlap with the chimney swifts being present in the roost. Chimney swifts spend the day foraging, and they usually only roost at night or during inclement weather (i.e., rain and/or low temperature). Chimney swifts are often roosting in the ventilation stack during the day in May due to cold temperatures. Therefore, the only Decommissioning Execution activities that pose a greater risk of directly disturbing roosting chimney swifts are those that occur at night (which would only be during an abnormal situation) or on poor weather days (when Decommissioning Execution activities are ongoing). Although no effects on the chimney swift are expected, the chimney swift roost will be monitored regularly throughout decommissioning to ensure they are not disturbed. Details of this monitoring is discussed in Section 9.6.5.

The noise generated by the proposed project would likely be audible to wildlife in the immediate vicinity of the project activities. Although the proposed project is located in a largely rural area that is habitat for both large and small mammals including common rodents, deer, bears, foxes, etc. as well as avian species, its proximity to Highway 17 means that wildlife in the project area may be accustomed to elevated noise levels. In addition, even in cases where the noise is elevated above background noise conditions, it should be noted that such noise will be localized and temporary in nature.

Ground-dwelling VCs such as the eastern milksnake and meadow vole are likely to be temporarily displaced by Decommissioning Execution activities and operations. Eastern milksnakes are habitat generalists and have been recorded in both open and forested habitats (COSEWIC 2014). Therefore, the Site Study Area is not considered to comprise important habitat for milksnakes. It is possible that incidental mortality will arise as a result of project operations and activities. Proper delineation of the work area will deter wildlife from entering the Site Study Area. Training employees to identify and properly handle milksnakes, and conducting regular site sweeps in work areas will help to ensure that milksnakes will be recognized and removed from the Site Study Area to prevent incidental mortality. No residual habitat effects are expected on the eastern milksnake.

The monarch butterfly is known to be present in the Site Study Area. No habitat-related effects are expected, as CNL will conduct site sweeps, and no clearing of milkweed will take place during the early life stages. Milkweed will not be removed outside of the Site Study Area.

Meadow voles are likely present in the Site Study Area, and throughout suitable habitat in the surrounding area. Any potential population decline as a result of habitat loss in the Site Study Area is temporary and not expected to affect the local population. No residual habitat effects are expected on the meadow vole.

With respect to little brown myotis and the other bat VCs, no effect on habitat is expected, as no tree clearing is planned and a visual inspection will be done to confirm that no roosts are in the facility. Decommissioning activities are not expected to cause measurable noise disturbances for any nearby roosts.

No effects are expected on migratory bird habitat in the Site Study Area.

There is potential for direct loss of wildlife from project activities, particularly as roadkill from vehicle operation on-site. Posted speed limits and the small amount of on-site vehicle use will limit the potential for roadkill. Furthermore, during the Decommissioning Execution phase, animals are likely to avoid these areas due to their frequent disturbance and availability of surrounding vegetation communities. Proper delineation of the work area will reduce wildlife entering the site.

Following final site restoration and demobilization, land outside the licensed area will begin to renaturalize, which is expected to have a positive effect on the biodiversity of terrestrial biota.

Overall no reduction in wildlife productivity is expected.

Exposure-Related Effects

In the Site Study Area, all radiological and chemical COPCs were screened out of the assessment for the Decommissioning Execution phase in the EcoRA TSD, and therefore were not assessed further (i.e., for effects on terrestrial biota). Thus, it is predicted that no undue exposure-related effects will be observed for terrestrial biota during the Decommissioning Execution phase.

For details on the screening process, see the EcoRA TSD or Section 9.1.1.1 above.

Local Study Area

Habitat-Related Effects

No effects are expected on the bald eagle's nest in the Local Study Area, as it is sufficiently distanced from Decommissioning Execution activities. No habitat effects on other terrestrial VCs in the Local Study Area are expected.

Decommissioning Execution activities will also result in an increase in noise and dust for surrounding undisturbed communities in the Local Study Area. These effects are expected to be temporary, minor and localized as discussed in Section 9.2.3.3.

There is potential for direct loss of wildlife as roadkill from vehicle operation to and from the site in the Local Study Area. This is expected to be a temporary, occasional and minor effect.

Exposure-Related Effects

In the Local Study Area, all COPCs were screened out of the assessment for the Decommissioning Execution phase in the EcoRA TSD, and therefore were not assessed further (i.e., for effects on terrestrial biota). Thus, it is predicted that Decommissioning Execution activities have a low potential to affect terrestrial vegetation and wildlife.

Regional Study Area

Habitat-Related Effects

No habitat-related effects are expected in the Regional Study Area during the Decommissioning Execution phase.

There is potential for direct loss of wildlife as roadkill from vehicle operation to and from the site in the Regional Study Area. This is expected to be a temporary, occasional and minor effect.

Exposure-Related Effects

In the Regional Study Area, all COPCs were screened out of the assessment in the EcoRA TSD, and therefore were not assessed further (i.e., for effects on terrestrial biota). Thus, it is predicted that Decommissioning Execution activities have a low potential to affect terrestrial vegetation and wildlife.

Institutional Controls and Post-Institutional Controls

Habitat-Related Effects

No adverse habitat-related effects are expected during the Institutional Controls and Post-Institutional Controls phases in the Site, Local or Regional Study Areas.

Renaturalization of the Site Study Area over time may increase habitat for wildlife and would be beneficial for both vegetation and wildlife communities.

Exposure-Related Effects

During the postclosure period (i.e., Institutional Controls and Post-Institutional Controls phases), the grouted structure will degrade and groundwater will flow into the facility. Soluble contaminants will dissolve into the groundwater, which will continue to flow and release contaminants to the Ottawa River. This will affect terrestrial wildlife and biota through drinking the water, irrigation, consumption of aquatic biota and plants and swimming. The alkaline plume flowing from the grouted structure is expected to be sufficiently diluted and of relatively small volume, and are not expected to result in contamination to the terrestrial environment.

The PostSA TSD examines several potential scenarios for the postclosure period as a way to capture and quantify uncertainties in the future conditions at the site (for detail on these scenarios, the reader is directed to the PostSA TSD). The PostSA TSD details the results of the assessment of radiological and non-radiological contamination of the terrestrial environment (among other environments) for these scenarios. The PostSA scenarios were assessed for potential effects on terrestrial biota in the EcoRA TSD. These results of this assessment are summarized below.

Radiological

In the EcoRA TSD, no radiological contaminants were screened in for the normal evolution scenario.

However, in one disruptive event scenario (surface erosion), Ag-108m was screened in, and therefore considered further for that scenario in the EcoRA TSD. No other radiological contaminants were screened in for the assessment. The EcoRA found no exceedances of the Ag-108m dose rate guideline for any of the terrestrial biota assessed.

Therefore, no undue effects to terrestrial biota are anticipated from exposure to radiation during the Institutional Controls and Post-Institutional Controls phases of the project.

In the river level fall “what if” case, Ag-108m was screened in, and therefore considered further for that scenario in the EcoRA TSD. As stated in Section 9.1, “what if” cases are deliberately extreme, and thus do not warrant comparison to dose guidelines or toxicity reference values. However, it is noted that the EcoRA TSD found no exceedances of the Ag-108m dose rate guideline for any of the terrestrial biota assessed in river level fall scenario.

Non-radiological

In the EcoRA TSD, no non-radiological contaminants were screened in for the normal evolution scenario.

However, in one disruptive event scenario (engineering degradation), lead was screened in, and therefore considered further for that scenario. For the Institutional Controls and Post-Institutional Controls phases, no other chemical contaminants were screened in for the assessment.

In the EcoRA TSD, predicted lead concentrations in all environmental media resulted in no undue effects to terrestrial biota. It is noted however, that the SI value for the chimney swift was just below 1. An SI is the ratio (i.e., unitless) of an estimated exposure level (or estimated environmental concentrations) divided

by a corresponding toxicity reference value or benchmark value. An SI value below one indicates that no effects are expected. This potential exposure was driven by the background concentration of lead in soil through the consumption of terrestrial insects.

9.6.3.4 Prediction Confidence and Uncertainty

Although the project has been described in Titterington (2016), Aikens (2017) and various other studies, there are some minor uncertainties with respect to some aspects of the project details. These uncertainties, and their implications on the assessment of effects, are outlined below.

The exact locations of the batch mixing plant, staging areas, raw material storage areas, on-site trucking routes have not yet been finalized. Since the location of certain aspects of the project (e.g., the laydown area) have not been finalized, there is some uncertainty in the assessment effects on the terrestrial environment. The entire Site Study Area has been identified as the project footprint, which is conservative as the delineated work area is expected to be smaller. As discussed above, CNL does not intend to extend the project footprint outside of already disturbed areas.

In addition, the schedule has not been finalized. The uncertainty of timing certain activities may change the potential effects of noise, dust and other disturbances. This uncertainty is mitigated by restricting the timing of certain activities, as well as dust and noise mitigation outlines in Section 9.2.3.2.

The locations of pits for raw material acquisition are unknown and will depend on the contractor selected for the batch plant and grouting activities. The uncertainty with respect to distance travelled off-site may affect the potential roadkill in the Regional Study Area.

The chimney swifts' diet consists entirely of terrestrial insects, which are represented by soil invertebrates (earthworm) in the model due to a lack of available TFs for insects. This is a conservative assumption, as it provides a direct pathway to soil contamination.

Uncertainty in animal behaviour is addressed in the EcoRA through the assumption that biota are present in the Site Study Area year-round, which is likely to overestimate the magnitude of exposure for mobile biota (e.g., migrating birds, such as chimney swift, and hibernating animals, such as little brown myotis and black bear).

The monarch butterfly was not fully assessed due to a lack of available data on the effects of the lead. However, the exposure to lead through its diet of vegetation is considered to be negligible, as terrestrial vegetation does not exceed benchmarks in any scenarios.

REGDOC 2.9.1 provides guidance on characterizing the effects on the project on terrestrial flora and fauna, including a full accounting of effects on species of elevated conservation status and their habitat. As per REGDOC 2.9.1 (CNSC 2016b, Appendix C.5), the terrestrial environment effects assessment was based on predictions from the EcoRA TSD, and covered effects such as the following (from REGDOC 2.9.1):

- effects on terrestrial habitat and loss of habitat for relevant species;

- disturbance of feeding, nesting or breeding habitats;
- direct and indirect wildlife mortality (e.g., roadkill);
- disruption of daily or seasonal wildlife movements such as migration or home ranges;
- contaminant exposures through environmental and food chain transport.

Some effects were assessed quantitatively in Section 9.6.3.3 above, such as physical barriers to wildlife; noise and vibration; reduction in wildlife productivity and effects on biodiversity.

REGDOC 2.9.1 (CNSC 2016b, Appendix C.3) requires a clear description of how any predicted effects compare to the expected reference condition for unexposed biota on a biological population basis, taking natural variation into account. Predictions of effects should include sufficient detail to allow follow-up verification.

In the PostSA TSD, uncertainties in postclosure conditions (e.g. floods), key parameters (e.g. inventory of contamination) are addressed inherently by assessing several disruptive scenarios. Conservative assumptions are also used to address other uncertainties, such as sediment characteristics.

9.6.3.5 Residual Effects

Table 9.6-3 summarizes the effects assessment discussed above. As seen in Table 9.6-3, no adverse residual effects on the terrestrial environment have been identified. The residual effects in Table 9.6-3 are grouped by effect rather than by individual interaction as listed in Table 9.6-2.

Table 9.6-3. Summary of Residual Effects in the Terrestrial Environment

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution						
Terrestrial: Vegetation Communities/ Wildlife	Establishing the footprint of batch mixing plant and related activities (wash out pit, pumper, raw material storage, earth grading).	Meadow vole Eastern milksnake	Loss of vegetation and wildlife habitat.	All project works to take place in previously disturbed areas. Site to be restored at the end of the Decommissioning Execution phase. Site sweeps for ground nests to be conducted prior to establishing project footprint if during breeding season.	Temporary loss of vegetation and wildlife habitat.	No adverse residual effects.
Terrestrial: Wildlife	Operation of vehicles on-site.	Meadow vole Eastern milksnake	Wildlife mortality via roadkill.	Wildlife exclusion fencing to be put in place around construction areas if required. Posted speed limits. Employee training and site sweeps for eastern milksnake will increase awareness and proper procedures are followed.	Small number of vehicles, occurrence of roadkill likely infrequent.	No adverse residual effects.
Terrestrial: Vegetation	Dust releases (material transport/storag e, vehicle operation etc.).	Red maple Chimney swift	Dust generation may result in reduced plant growth or senescence.	Dust suppression measures outlined in Section 9.2.3.2 will be also be effective in minimizing the effects on vegetation.	Minor, localized and temporary effect on vegetation communities.	No adverse residual effect.
Terrestrial: Vegetation Communities/ Wildlife	Establishing the footprint of batch mixing plant and related activities (wash out pit, pumper, raw	Chimney swift Bald eagle Little brown myotis Meadow vole Eastern milksnake	Increased levels of physical effects (noise, vibration, encroachment), dust and emissions affecting surrounding	Standard construction best practices to be applied are discussed in Section 9.2.3.2 will also be effective at minimizing effects of noise, dust and emissions on vegetation and wildlife.	Temporary and localized effect. Species would generally be expected to return to the area following the	No adverse residual effects.

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
	material storage, earth grading).		undisturbed vegetation communities.		Decommissioning Execution phase.	
Terrestrial: Wildlife	Generation of garbage.	Black bear	Open access to food waste may attract wildlife to the Site Study Area and may result in nuisance bear problems.	Proper garbage disposal containers (i.e. sealed containers and frequent removal) and waste management practices will be utilized.	No effects are expected.	No adverse residual effect.
Terrestrial: Vegetation Communities/ Wildlife	Displacement of tritiated air from the facility during grouting and emplacement.	All terrestrial VCs	Release of radioactivity to terrestrial environment and potential exposure effects to vegetation and wildlife.	No mitigation measures identified.	No effects are expected.	No adverse residual effects.
Terrestrial: Vegetation Communities/ Wildlife	Transportation of grout and materials around the site.	All terrestrial VCs	Transportation of grout and materials around the site will create physical effects (noise, vibration, encroachment), dust, and emissions.	Standard construction best practices to be applied discussing in Section 9.2.3.2 will also be effective at minimizing effects of noise, dust and emissions on vegetation and wildlife.	Temporary and localized effect. Species would generally be expected to return to the area following the Decommissioning Execution phase.	No adverse residual effects.
Terrestrial: Vegetation Communities/ Wildlife	Displacement of tritiated air from the facility during grouting and emplacement.	All terrestrial VCs	Release of radioactivity to terrestrial environment and exposure effects to vegetation and wildlife.	No mitigation measures have been identified.	No effects are expected.	No adverse residual effect.
Terrestrial: Vegetation	Demolition and related material	All terrestrial VCs	Increased physical effects (noise, vibration, encroachment), dust,	Mitigation measures identified in Section 9.2.3.2 with respect to noise and dust effects will be also	Temporary and localized effect from noise and	No adverse residual effects.

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Communities/ Wildlife	sizing and storage.		radioactivity and other potential contaminants from material to terrestrial environment.	be effective in minimizing the effects on wildlife and vegetation.	dust. Species would generally be expected to return to the area following the Decommissioning Execution phase. No exposure effects are expected.	
Terrestrial: Vegetation Communities/ Wildlife	Restoring and demobilizing the site (earth moving, material and equipment transport, remediation).	All terrestrial VCs	Physical effects (noise, vibration, encroachment), dust and emissions will be released. These activities will allow eventual renaturalization of the area.	Standard construction best practices to be applied are discussed in Section 9.2.3.2 will also be effective at minimizing effects of noise, dust and emissions on vegetation and wildlife.	Temporary, localized and minor disturbance.	No adverse residual effects.
Terrestrial: Vegetation Communities/ Wildlife	Demobilization (equipment and material removal from site).	All terrestrial VCs	Demobilization of the site will reverse some of the habitat-related effects of the decommissioning.	No mitigation measures have been identified.	Eventual renaturalization and reclamation.	No adverse residual effects.

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Institutional Controls and Post-Institutional Controls						
Terrestrial: Vegetation Communities/ Wildlife (radiological)	Facility performance during the postclosure period.	All terrestrial VCs	Groundwater will flow into the eventually degraded structure. Contaminated groundwater may flow out and eventually into the Ottawa River. This may be transferred to soil through irrigation, and biota through drinking water.	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects in the terrestrial environment.	Radionuclides are expected to be within acceptance criteria.	No adverse residual effects.
Terrestrial: Wildlife (non-radiological)	Facility performance during the postclosure period.	All terrestrial VCs	Groundwater will flow into the eventually degraded structure. Contaminated groundwater may flow out and eventually into the Ottawa River. This may be transferred to soil through irrigation, and biota through drinking water	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects in the terrestrial environment.	Chemical contaminants are expected be below benchmarks.	No adverse residual effects

9.6.4 Assessment of Residual Effects

Based on the assessment described above, no adverse residual effects on the terrestrial environment have been predicted.

9.6.5 Monitoring and Follow-up



Local youth group participating in chimney swift roost count.

The VCs in the terrestrial environment are soil invertebrates, monarch butterfly, red maple, chimney swift, bald eagle, ruffled grouse, mallard, great blue heron, little brown myotis (bats), short-tailed shrew, black bear, eastern wolf, muskrat, Blanding's turtle, eastern milksnake and green frog. Monitoring and follow-up activities within the terrestrial environment are discussed below and presented in Table 9.6-4. In addition to monitoring in the terrestrial environment, follow-up and monitoring work undertaken by CNL in other environmental components (i.e., atmospheric, surface water, and geological and hydrogeological environments and ambient radioactivity) are directly related to confirming the EIS findings related to VCs in the terrestrial environment. Further action will be triggered if parameters are above applicable guidelines or other notable changes are observed during monitoring activities in other environmental components. If further action is triggered, decommissioning activities will be reviewed, and/or options will be discussed with Environmental Protection and/or CNL biologist(s).

Decommissioning Execution

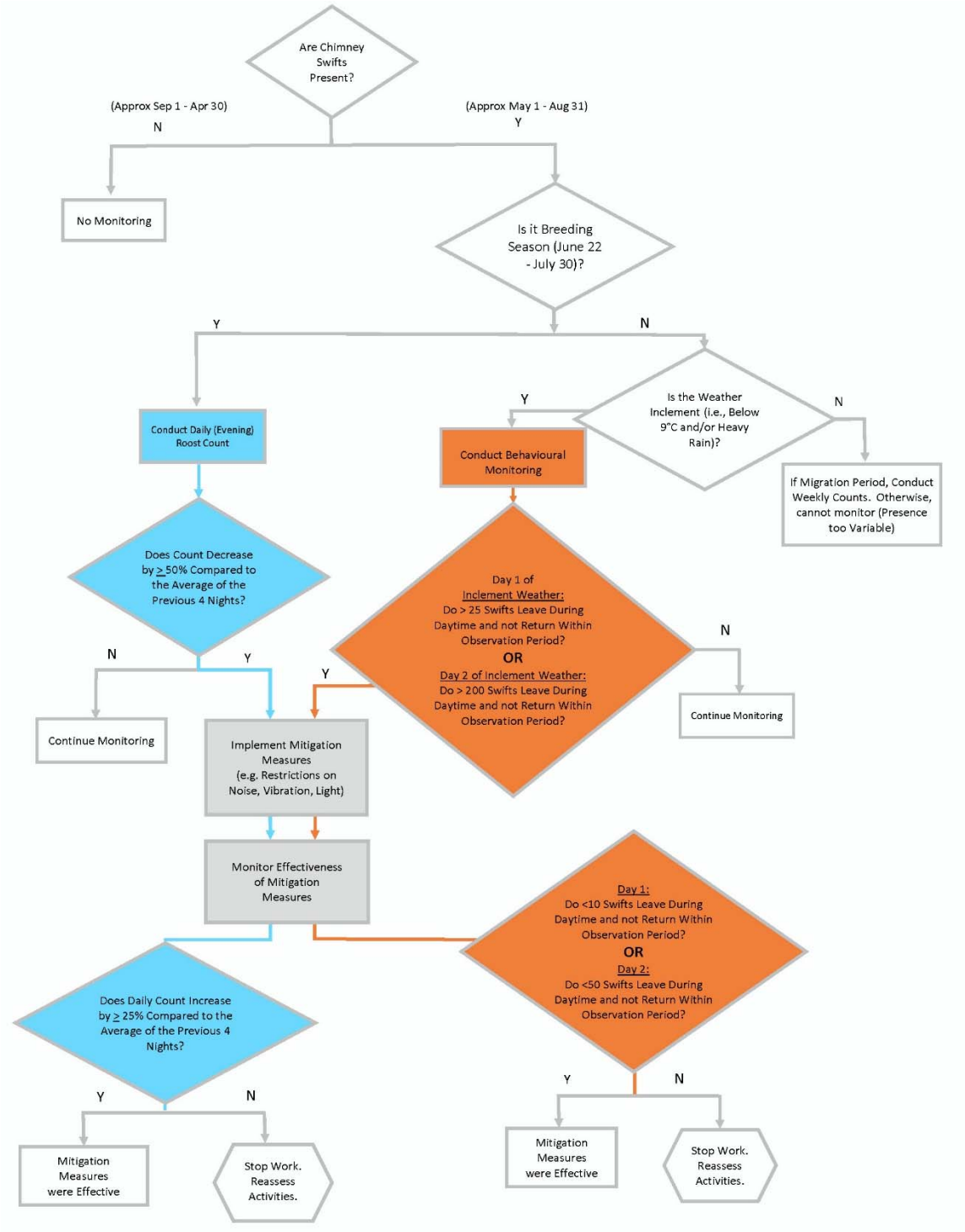
Barn swallows, bats and milksnakes are SARs that have the potential to frequent the building. During the Decommissioning Execution phase, routine checks will be conducted to locate any SARs prior to work. If any SARs are identified, Environmental Protection will be contacted.

CNL will conduct chimney swift monitoring according to recommendations in the Chimney Swift TSD, which include behavioural monitoring during inclement weather in the non-breeding season and daily evening roost counts during the breeding season.

During the non-breeding season (May 1 to June 21 and July 31 to September 1), if inclement weather is occurring during the day, if >25 swifts leave the roost during the 1-hour observation period on the first day of inclement weather, or >200 swifts leave the roost during the observation period on second day of inclement weather and do not return during the observation period. During the breeding period (June 22 to July 30), if a ≥50% decrease in average daily counts from previous four nights is observed while decommissioning activities are occurring, it is indicative of disturbance.

Upon the occurrence of any circumstances listed above, decommissioning activities taking place should be reviewed and additional mitigation measures should be applied (additional details provided in Section 9.6.3 of this EIS and in the Chimney Swift TSD). In order to assess the effectiveness of the mitigation measures, monitoring should be conducted to confirm their effectiveness prior to the resumption of work. Monitoring of mitigation effectiveness will use the same protocols listed above, but with a differing threshold of response. During the non-breeding period, If <10 swifts leave the roost on the first day of inclement weather during the observation period, or <50 swifts leave the roost on the second day of inclement weather during the observation period, then a positive response to mitigation measures is indicated. During the breeding period, if there is a ≥25% increase in the average daily counts from the previous four nights, then a positive response to mitigation measures is indicated. Figure 9.6-1 presents a flow chart outlining chimney swift monitoring, mitigation and monitoring of mitigation effectiveness.

Figure 9.6-1. Chimney Swift Monitoring Program Flow Chart



Monitoring and follow-up activities conducted in other environmental components (i.e., atmospheric, surface water and geological and hydrogeological environments and ambient radioactivity) will also confirm EIS predictions for effects to VCs in the terrestrial environment during the Decommissioning Execution phase.

Institutional Controls

During the Institutional Controls phase, CNL will conduct periodic (i.e., once every five years) visual inspections of the ventilation stack. If the integrity of the ventilation stack has been compromised (i.e., deterioration of concrete), the situation will be assessed and appropriate repairs will be considered. Inspections will continue for the lifespan of the ventilation stack, or until the chimney swift is no longer listed as a SAR. Unique inspection will be triggered if circumstances occur that could change the integrity of the ventilation stack (i.e., a seismic event).

For three years following completion of decommissioning activities, CNL will conduct weekly evening roost counts when chimney swifts are present at the NPD site (i.e., migratory period). After the three-year period, volunteers may be used to participate in National Roost Count Days (typically five per year).

Monitoring and follow-up activities conducted in other environmental components (i.e., atmospheric, surface water and geological and hydrogeological environments and ambient radioactivity) will also confirm EIS predictions for effects to VCs in the terrestrial environment during the Institutional Controls phase. If parameters are above applicable guidelines or notable changes are observed, CNL biologist(s) will be consulted.

Table 9.6-4. Monitoring and Follow-up Activities in the Terrestrial Environment

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Terrestrial Environment	Species at Risk	Potential Source(s) of Effects: - Potential presence of SARs during decommissioning activities Proposed monitoring: - Routine checks for barn swallows, monarch butterflies, bats and milksnakes. Trigger for further action: - If presence of a SARs, contact Environmental Protection. - If presence of a SARs habitat is found (e.g., bat roost or barn swallow nest), contact Environmental Protection. If work within 400m of the bald eagle's nest becomes necessary, mitigation measures (such as restriction of activities during the courtship and breeding periods) will be applied.	Verify EA prediction (i.e., no adverse residual effect on terrestrial VCs). and Determine effectiveness of mitigation measures (e.g., inspections for bat roosts, work area sweeps prior to any work, employee training).	Visual inspection for bat roosts: event-based (i.e., prior to commencement of below grade grouting and above grade demolition). Sweep work areas for the presence of SARs: event based (i.e., prior to undertaking specific activities).	Facility conducted a fauna and foliage biodiversity survey in support of planning for decommissioning.
	Chimney Swifts	Potential Source(s) of Effects: - Ventilation stack isolation and modification - Establishing footprint of batch mixing plant and related activities - Demolition - Restoring and demobilization. Proposed monitoring for roost disturbance: - **Behavioural monitoring during inclement weather in non-breeding season**. Monitor for >25 swifts leaving the roost in the daytime during the first day of inclement weather, and do not return within the observation period. Option to use >200 threshold on second day of inclement weather (more reliable). - **Daily evening roost counts during breeding season.** For daily counts, monitor for a >50% decrease in average counts from the previous 4 nights. As per recommendations in the Chimney Swift TSD, to minimize disruption to swifts, decommissioning activities should be minimized near roost and limited to between 7 am and 7 pm as much as possible. Trigger for further action: - If above monitoring detects a disturbance of the roost, review associated decommissioning activities and apply additional mitigation measures, which include additional monitoring (see details in Section 12.5.5.1 below). Evaluate mitigation measures: If mitigation is not effective, stop work and re-assess activities.	Verify EA prediction (i.e., no adverse residual effect on chimney swifts). and Determine effectiveness of mitigation measures (e.g., noise consideration, distance from ventilation stack, work between 7 am and 7 pm, noise limits, etc.). Note that these mitigation measures would only be applied if triggered by the results of the monitoring (See details in Section 12.5.5.1 below).	Behavioural monitoring: first and second day of inclement weather occurrence. (1-hr periods during poor weather while activities are taking place, in the daytime). Roost counts: daily during breeding season (June 22 – July 30)	Facility currently conducts chimney swift roost counts on a weekly basis when chimney swifts are present at NPD.
	Terrestrial Wildlife and Vegetation	Potential Source(s) of Effects: - Establishing footprint of batch mixing plant and related activities - Operation of vehicles on site - Grouting of below grade structure - Demolition and related material sizing and storage - Demobilization - Final site restoration Proposed monitoring: - Estimate combustible gases (e.g., based on project-related traffic and equipment), as per atmospheric environment above (Table 9.2-4). - Measure parameters of concern (e.g., lead, asbestos, tritium) in air displaced from grouting the below grade structure and removal of above grade structures as per the atmospheric environment above (Table 9.2-4).	Verify EA prediction (i.e., no adverse residual effect on terrestrial wildlife or vegetation)	Air quality parameters: For each new activity, monitor for minimum one week. Noise: During periods of high activity, monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting)	Facility currently conducts annual industrial hygiene assessment of lead, asbestos and mould in air within the facility. Emissions associated with NPRI reporting are estimated Facility to ensure that NPRI reporting includes updated estimate of combustible gases based on vehicle kilometres travelled.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
		- Wildlife: Noise monitoring, as per atmospheric environment above. Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits, or if actual number of vehicles/kilometres travelled exceeds the prediction on which emission estimates were based. - Investigation if any noise complaints received. If any parameters are above applicable guidelines, collect rain water and measure contaminant levels (e.g., tritium) in precipitation.			Facility currently performs sampling of surface soil and vegetation for tritium analysis.
Institutional Controls phase					
Terrestrial Environment	Terrestrial Wildlife and Vegetation	Potential Source(s) of Effects: - Potential leaching of soluble contaminants from degradation of grouted structure. Proposed Monitoring: - Routine groundwater analyses for parameters of concern (chemical and/or radiological). Trigger for further action: Investigation if groundwater parameters above applicable guidelines, e.g., soil sampling and analysis for parameters of concern, CNL biologist(s) may be consulted.	Verify EA prediction (i.e., no adverse residual effect on groundwater quality or related VCs).	Sampling and analysis of groundwater: periodic.	Facility currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.
	Chimney Swifts	Potential Source(s) of Effects: - Potential loss of habitat due to ventilation stack deterioration. Proposed Monitoring: - Visual inspection of ventilation stack for signs of deterioration. - Weekly evening roost counts for a period of three years after decommissioning. Trigger for further action: If changes observed, assess and conduct repairs to ventilation stack if needed.	Verify EA prediction (i.e., no adverse residual effect on chimney swift habitat).	Visual inspection: periodic, infrequent (e.g., every five years) for the lifespan of the ventilation stack or until species is no longer listed (CNL 2016c). and Inspection if unique incident occurs (e.g., seismic event) For three years following completion of decommissioning activities, CNL will conduct weekly evening roost counts when chimney swifts are present at the NPD site (i.e., migratory season)	Facility currently conducts life management program inspections every five years for integrity of concrete structures including the ventilation stack.

9.6.6 Conclusion

The assessment in Section 9.6.3 found that based on the predicted impacts after applied mitigation measures, no adverse residual effects on the terrestrial environment are expected to result from the project. Monitoring activities have been identified for the terrestrial environment, such as checks for SARs on a per-event basis, and chimney swift monitoring. In addition, monitoring activities in other environmental components (i.e., atmospheric, surface water, and geological and hydrogeological environments and ambient radioactivity) will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects related to the terrestrial environment. If monitoring identifies concerns in the other environmental components, CNL will assess the implications to the terrestrial environment (e.g., through discussion with CNL biologists).

9.7 Ambient Radioactivity

9.7.1 Selection of Valued Components

As shown in Section 5.2.4, ambient radioactivity represents features that can be affected by the project and as such would be pathways or mechanisms for transfer of an effect to another environmental component (e.g. aquatic environment, terrestrial environment, human health). As such, no VCs have been selected in the ambient radioactivity environment (Table 9.7-1). The potential effects of changes in ambient radioactivity are considered in the applicable environmental components.

Table 9.7-1. Valued Component Selection for Ambient Radioactivity

Environmental Component	Pathway	Rationale
Ambient Radioactivity	Pathway to human health	The potential effects on humans associated with changes in ambient radioactivity will be considered in the human health.
	Pathway to aquatic environment	The potential effects on aquatic biota associated with changes in ambient radioactivity will be considered in the aquatic environment.
	Pathway to terrestrial environment	The potential effects on terrestrial biota associated with changes in ambient radioactivity will be considered in the terrestrial environment.

9.7.2 Assessment Boundaries

9.7.2.1 Spatial Boundaries

Similar to the ambient radioactivity baseline characterization in Section 8.7 above, the Site and Local Study Areas for this assessment are consistent with the general spatial boundaries outlined in Section 5.2.1.1. The Regional Study Area incorporates both the atmospheric and surface water environment Regional Study Areas (see Figure 8.7-1).

9.7.2.2 Temporal Boundaries

The temporal boundaries for this assessment are the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.7.3 Identification of Residual Effects

9.7.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the ambient radioactivity may occur as a result of interaction with activities in the Decommissioning Execution, Institutional Controls and Post-Institutional Controls phases, in particular:

- Grouting of below grade structures;
- Removal of above grade structures;
- Facility performance during the Institutional Controls phase; and
- Facility performance during the Post-Institutional Controls phase.

Table 9.7-2. Project-Environment Interactions in Ambient Radioactivity

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**1**	**Batch Mixing Plant**	
	1.5	Provide slip pipe access to nuclear area.	Drilling of slip pipe access holes could affect the external radiation field.
	2	**Grouting of Below Grade Structure**	
	2.1	Room preparation (e.g., sealing of pipes).	Some associated activities will take place in areas with higher ambient radioactivity, however the *overall* radiation levels remain unchanged.
	2.2	System preparation large vessels.	Some associated activities will take place in areas with higher ambient radioactivity, however the *overall* radiation levels remain unchanged.
	2.3	Grout fill nuclear area.	Grout filling will displace (i.e. release to the environment) air containing tritium from within the facility.
	3	**Removal of Above Grade Structure**	
	3.1	Conventional heavy equipment knockdown of reactor hall.	During demolition, there is potential for surface contamination from the structures to be released into the environment.
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Sizing of material from the facility may release radionuclides to the environment.
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	Storage of potentially contaminated materials may affect the radiation and radioactivity environment.
Decommissioning Execution	**3.4**	Steel and rubble emplaced in condenser room according to nesting plan. Fill to 380 level.	Emplacing material in the facility will displace air containing tritium which will affect the radiation and radioactivity environment.
	3.5	Grout first level of demolition material in condenser room.	Grout filling will displace (i.e. release to the environment) air containing tritium from within the facility.
	3.6	Steel and rubble emplaced in condenser room. Fill to 400 level.	Emplacing material in the facility will displace air containing tritium which will affect the radiation and radioactivity environment.
	3.7	Grout second level of demolition material in condenser room.	Grout filling will displace (i.e. release to the environment) air containing tritium from within the facility.
	3.8	Steel and rubble emplaced in condenser room. Fill to 425 level.	Emplacing material in the facility will displace air containing tritium which will affect the radiation and radioactivity environment.
	3.9	Grout third level of demolition material in condenser room.	Grout filling will displace (i.e. release to the environment) air containing tritium from within the facility.
	3.10	Demolition block walls and inside walls around control room and change rooms.	During demolition, there is potential for surface contamination to be released into the environment.

		Project Works and Activities	Potential Interaction
	3.11	Collapse ceilings of furnace room and adjacent rooms.	During demolition, there is potential for surface contamination to be released into the environment.
	3.12	Emplace block wall rubble in furnace room or condenser room.	Emplacing material in the facility will displace air containing tritium which will affect the radiation and radioactivity environment.
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Emplacing material in the facility will displace air containing tritium which will affect the radiation and radioactivity environment.
	3.15	Grout furnace room and adjacent areas to ground level.	Grout filling will displace (i.e. release to the environment) air containing tritium from within the facility.
	3.16	Demolish above grade portion of pressure relief pit.	During demolition, there is potential for surface contamination to be released into the environment.
IC*	**6**	**Long Term Care and Maintenance**	
	6.8	Facility performance during the Institutional Controls phase.	Potential releases of volatilized radioactivity to air through the cap system.
PIC**	**7**	**Post-Institutional Controls**	
	7.1	Facility performance during the Post-Institutional Controls phase.	Potential releases of volatilized radioactivity to air through the cap system.

* - IC: Institutional Controls phase.

** - PIC: Post-Institutional Controls phase.

9.7.3.2 Proposed Mitigation Measures

Mitigation measures with respect to radiation doses to humans are discussed in Section 9.8.3.2.

9.7.3.3 Effects After Mitigation

Decommissioning Execution

The DecomSA TSD examines the potential effects of Decommissioning Execution activities on ambient radioactivity. Activities such as drilling holes in below grade structures, displacement of air from the facility during grouting and emplacement, and demolition have the potential to affect ambient radioactivity. Since ambient radioactivity is a pathway to VCs in other environmental components (e.g., aquatic environment, terrestrial environment, human health), potential effects on ambient radioactivity are considered for VCs (humans and non-human biota) in those other environmental components (see Sections 9.4.3, 9.6.3, 9.8.3, 9.9.3 and 9.10.3). The DecomSA TSD uses dose calculations consistent with the DRL, which accounts for all relevant routes of exposure, including consideration of consumers of country food whose exposure pathways may differ due to cultural norms, as per REGDOC 2.9.1 (CNSC 2016b, Appendix C.6) requirements (see Table 8.8-4).

Institutional Controls and Post-Institutional Controls

The PostSA TSD examines several potential scenarios for the postclosure period (i.e., Institutional Controls and Post-Institutional Controls phases) as a way to capture and quantify uncertainties in the future conditions at the site (for detail on these scenarios, the reader is directed to the PostSA TSD) and assess the potential for radiological and non-radiological contamination of the atmospheric environment (among other environments) for these scenarios. Since ambient radioactivity is a pathway to VCs in other environmental components (e.g., aquatic environment, terrestrial environment, human health), potential effects on ambient radioactivity are considered for VCs (humans and non-human biota) in those other environmental components (see Sections 9.4.3, 9.6.3, 9.8.3, 9.9.3 and 9.10.3). The PostSA TSD uses dose calculations which account for all relevant routes of exposure, including consideration of consumers of country food, as well as a site resident who fishes, grows crops and raises livestock.

9.7.3.4 Prediction Confidence and Uncertainty

Air displaced from the facility is likely to have variable tritium concentrations. To determine the amount of tritium released when the air is displaced, this variability is accounted for by the assumption that the air has a tritium concentration equal to the highest contaminated room. Additionally, tritium is treated as HTO to be conservative wherever HTO dose calculations are available.

In the PostSA TSD, uncertainties in postclosure conditions (e.g. floods), key parameters (e.g. inventory of contamination) are addressed inherently by assessing several disruptive scenarios. Conservative assumptions are also used to address other uncertainties, such as sediment characteristics.

9.7.3.5 Residual Effects

Table 9.7-3 summarizes the effects assessment above and presents the residual effects that were identified in ambient radioactivity. The residual effects in Table 9.7-3 are grouped by effect rather than by individual interaction as listed in Table 9.7-2.

Table 9.7-3. Summary of Residual Effects in the Radiation and Radioactivity Environment

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution					
Ambient Radioactivity	Grouting will displace contaminated air from within the facility. This activity includes all air displacement (e.g. from emplacement).	Tritium in air will be released to the environment.	No mitigation measures identified.	Air containing low levels of tritium will be displaced due to the pouring of grout into the facility.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.4, 9.6 and 9.8.
Ambient Radioactivity	Demolition may release surface contamination to the environment.	Surface contamination release may affect the environment.	Standard Construction Practices related to dust suppression from demolition.	Contamination in the atmosphere may affect the environment and non-human biota and human health.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.4, 9.6 and 9.8.
Ambient Radioactivity	Metal cutting and crushing of masonry may release surface contamination.	Sizing of material may release radionuclides to the environment.	Standard Construction Practices related to dust suppression.	The components to be sized will primarily be portions of the aboveground facility, and are unlikely to have high concentrations of radionuclides.	Effects of radiological exposure are assessed in terms of their dose in humans and

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
					non-human biota in Sections 9.4, 9.6 and 9.8.
Ambient Radioactivity	Material laydown and perform clearance surveys.	Storage of potentially contaminated materials may affect ambient radioactivity.	Standard Construction Practices related to dust and runoff suppression.	Effects are expected to be temporary, while potentially contaminated material is in the lay down area.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.4, 9.6 and 9.8.
Institutional Controls and Post-Institutional Controls					
Ambient Radioactivity	Radioactivity volatilized from surface media.	Radioactivity may volatilize to the environment.	In-design mitigations to isolate and contain the inventory in order to reduce the potential effects on ambient radioactivity.	Radioactivity may be volatilized and inhaled by humans and non-human biota.	Effects of radiological exposure are assessed in terms of their dose in humans and non-human biota in Sections 9.4, 9.6 and 9.8.

9.7.4 Assessment of Residual Effects

Since ambient radioactivity is a pathway to other environmental components (e.g., aquatic and terrestrial environments, human health), the adverse residual effects are further assessed within those environmental components (see Sections 9.4.4, 9.6.4, 9.8.4, 9.9.4 and 9.10.4).

9.7.5 Monitoring and Follow-up

Ambient radioactivity represents a pathway for transfer of an effect to VCs in other environmental components. Monitoring and follow-up activities related to ambient radioactivity are discussed below and presented in Table 9.7-4. Monitoring activities (e.g., radiation protection surveys, gamma monitoring, and passive air sampling) will verify that no parameters are above applicable guidelines are identified. Further action will be triggered if parameters are above applicable guidelines or other notable changes are observed.

Decommissioning Execution

CNL will conduct routine radiation protection surveys (indoor and outdoor), passive tritium air sampling and ambient radioactivity monitoring at TLD monitoring locations around the NPD site during the Decommissioning Execution phase. Investigative further action will be triggered if parameters are above applicable guidelines are identified.

Institutional Controls

CNL will continue to conduct routine radiation protection surveys (outdoor) and ambient radioactivity monitoring at TLD monitoring locations around the NPD site during the first five years of the Institutional Controls phase. Investigative further action will be triggered if parameters are above applicable guidelines are identified.

Table 9.7-4. Monitoring and Follow-up Activities in Ambient Radioactivity

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Ambient Radioactivity	Ambient radioactivity	Potential Source(s) of Effects: - Establishing footprint of batch mixing plant and related activities (e.g., drilling of slip pipe access holes) - Grouting of below grade structure - Removal of above grade structure Proposed monitoring: - Area TLDs (i.e., constant ambient radioactivity monitoring around the NPD site) - Routine radiation protection surveys (indoors and outdoors) - Passive tritium air sampling Trigger for further action: Investigation if parameters are above applicable guidelines identified.	Verify EA prediction (i.e., no adverse residual effect on ambient radioactivity environment or related VCs).	Routine radiation protection surveys: periodic. TLD monitoring locations around NPD site: for each new activity	NPDWF currently performs ambient gamma radiation field surveys and monitors tritium levels with passive air samples within the facility.
Institutional Controls Phase					
Ambient Radioactivity	Ambient radioactivity	Potential Source(s) of Effects: - Volatilization of radionuclides from surface media Proposed monitoring: - Area TLDs (i.e., constant perimeter gamma monitoring) - Routine radiation protection surveys (outdoors) Trigger for further action: Investigation if parameters are above applicable guidelines identified	Verify EA prediction (i.e., no adverse residual effect on ambient radioactivity environment or related VCs).	Routine radiation protection surveys: periodic. TLD monitoring locations around NPD site: on-going	NPDWF currently conducts ambient gamma radiation field surveys and monitors tritium levels with passive air samples within the facility.

9.7.6 Conclusion

The potential for residual effects in the ambient radioactivity environment was discussed in Section 9.7.3 based on predicted effects after applied mitigation measures. However, since ambient radioactivity is a pathway to VCs in other environmental components (specifically the aquatic environment, terrestrial environment and human health), any potential residual effects are considered in the applicable environmental components. Monitoring activities such as the use of TLDs will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects related to ambient radioactivity.

9.8 Human Health

9.8.1 Selection of Valued Components

As outlined in Section 5.2.4, VCs for human health were selected to encompass the potential effects of the project on human health as well as exposure via pathways from environmental components (e.g., atmospheric, surface water environment, geological and hydrogeological environment, ambient radioactivity). The VCs for human health, along with rationale for their selection, are listed in Table 9.8-1.

Table 9.8-1. Valued Component Selection for Human Health

Environmental Component	Sub-Category	VC and Rationale
Human Health	Public	The general public may be exposed to health risk as a result of the project. The potential effects on humans associated with changes in atmospheric, surface water, geological and hydrogeological conditions (radiological and chemical releases and concentrations), and external gamma radiation are considered.
	Worker	Workers may be exposed to health risk as a result of performing their duties relative to the project. The potential effects on humans associated with changes in atmospheric, surface water, geological and hydrogeological conditions (radiological and chemical releases and concentrations) and external gamma radiation are considered.

Note: Effects on human health from possible accidents and malfunctions are discussed in Section 9.11 below.

9.8.2 Assessment Boundaries

9.8.2.1 Spatial Boundaries

Similar to the human health baseline characterization in Section 8.2 above, the Site and Local Study Areas for this assessment are consistent with the general spatial boundaries outlined in Section 5.2.1.1. As this area is all owned by the Federal Government, there are no residents present. Workers are, and will continue to be, present in this area for the duration of the decommissioning, and as such the Site/Local Study Areas will describe baseline worker health.

The Regional Study Area for this assessment consists of the Renfrew County and District Health Unit, and Region de l'Outaouis Health Unit, illustrated in Figure 8.8-1 and 8.8-2.

9.8.2.2 Temporal Boundaries

The temporal boundaries for this assessment are the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.8.3 Identification of Residual Effects

9.8.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to human health may occur as a result of interaction with Decommissioning Execution operations and activities associated with:

- Batch mixing plant;
- Grouting of below grade structures;
- Removal of above grade structures;
- Installation of concrete cap and engineered barriers;
- Final site restoration;
- Facility performance during the Institutional Controls phase; and
- Facility performance during the Institutional Controls phase.

Table 9.8-2. Project-Environment Interactions in Human Health

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**1**	**Batch Mixing Plant**	
	1.1	Designate footprint, create access, temporary fencing (west side of main building).	Work conducted near the facility has the potential to release dust, increase radiation doses to workers.
	1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker health.
	1.3	Set up mixing stations, hook up electrical power or diesel power.	Work conducted near the facility has the potential to increase radiation doses to workers.
	1.4	Truck in necessary water supply.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker health.
	1.5	Provide slip pipe access to nuclear area.	This activity has the potential to release dust and increase radiation doses to workers. Specifically, to the workers drilling holes for slip pipe access and workers nearby.
	1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker health.

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**1.7**	Level area for concrete pumper.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker health.
	1.8	Mix grout to required formula.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and equipment emissions may affect worker health.
	1.9a	Truck grout to pumping station (20 trips per day).	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker and public health.
	1.11	Sample and dewater the cleaning pit. Emplace sediments into voids in condenser room.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker health.
	1.12	Demobilize batch plant after cap pour.	Work conducted near the facility has the potential to increase radiation doses to workers. Dust and vehicle emissions may affect worker health.
	2	**Grouting of Below Grade Structure**	
	2.1	Room preparation (e.g., sealing of pipes).	Work conducted within the facility has the potential to increase radiation doses to workers.
	2.2	Systems Preparation Large Vessels.	The activities associated with this task are routine construction activities. Potential effects on workers as part of this task are grouped with activity **1.5** (Provide slip pipe access to nuclear area).
	2.3	Grout Fill Nuclear Area.	Displacement of air containing dust, tritium, lead and asbestos may result in effects to the public and workers.
	3	**Removal of Above Grade Structure**	
	3.1	Conventional heavy equipment knockdown of reactor hall.	Release of surface contamination may increase exposure to dust, radioactivity and other potential contaminants to the public and workers.
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Release of surface contamination may increase exposure to dust, radioactivity and other potential contaminants to the public and workers.
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	Conducting clearance surveys has the potential to increase radiation doses to workers.
	3.4	Steel and rubble emplaced in condenser room according to nesting plan. Fill to 380 level.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.5	Grout first level of demolition material in condenser room.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.6	Steel and rubble emplaced in condenser room. Fill to 400 level.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**3.7**	Grout second level of demolition material in condenser room.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.8	Steel and rubble in condenser room. Fill to 425 level.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.9	Grout third level of demolition material in condenser room.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.10	Demolition block walls and inside walls around control room and change rooms.	Release of dust and surface contamination may increase exposure to the public and workers.
	3.11	Collapse ceilings of furnace room and adjacent rooms.	Release of dust and surface contamination may increase exposure to the public and workers.
	3.12	Emplace block wall rubble in furnace room or condenser room.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Release of surface contamination may increase radiation doses to the public and workers.
	3.15	Grout furnace room and adjacent areas to ground level.	Displacement of dust, lead, asbestos and tritium in air from the facility has the potential to increase exposure to the public and workers.
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Release of dust and surface contamination may increase exposure to the public and workers.
	4	**Install Concrete Cap and Engineered Barrier**	
	4.1	Concrete Cap (construct forms, install rebar, and pour, level and slope concrete).	Work conducted near the facility has the potential to release dust and increase radiation doses to workers.
	4.2	Engineered Barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	Work conducted near the facility has the potential to release dust and increase radiation doses to workers.
	5	**Final Site Restoration**	
	5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	Work conducted near the facility has the potential to release dust and increase radiation doses to workers.

		Project Works and Activities	Potential Interaction
IC*	**6**	**Long Term Care and Maintenance**	
	6.8	Facility performance during the Institutional Controls phase	Groundwater will start to enter the eventually degraded grouted structure. Contaminated groundwater will flow out and has the potential to affect the public.
PIC**	**7**	**Post-Institutional Controls**	
	7.1	Facility performance during the Post-Institutional Controls phase	Groundwater will enter the eventually degraded grouted structure. Contaminated groundwater will flow out and has the potential to affect the public.

Note
*Institutional Controls
**PIC: Post-Institutional Controls

9.8.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

In addition to the in-design mitigation measures identified in Section 4.1 above, mitigation measures identified in other environmental components, such as dust suppression and vehicle maintenance may also reduce the potential for effects on public and worker health. The following mitigation measures are outlined in the DecomSA TSD.

- *General:*
  - Staff and contractors will receive orientation to ensure they are aware of decommissioning activities, hazards, and emergency procedures.
  - Signs will be posted to indicate where decommissioning work is taking place and to alert people to detours where applicable.
  - Work control documents will be developed to guide safe execution of the decommissioning activities.
  - Hazards to personnel will be identified through work control documents and eliminated or controlled using engineered controls, administrative controls, and PPE.
  - Regular updates will be given to site personnel on updates in the proposed decommissioning work plans.
  - CNL health and safety programs are in place to prevent and mitigate injury to personnel.
  - An NPD Emergency Procedure (Ingram 2017) is in place, and is consistent with CNL's Emergency Preparedness Program.
  - Emergency response is available through local municipal Fire Department.
  - Stop work procedures will be followed for power outages.
  - Overall site 'good housekeeping' will be upheld.
  - Contractor Health & Safety Management Program, reviewed by supply chain management and meeting CNL requirements.

- Periodic communication updates to local residents on the project construction activities, including: construction schedule, activities, dedicated contact person for inquiries and emergencies etc.

o *Radiation Dose:*

Radiological work assessments will be performed as detailed work packages are developed. They will include specific measures to reduce collective and individual worker dose to ensure that the dose is below relevant dose threshold standards. As per current practice at the NPD site, all internal and external doses received by NPD workers will be monitored and reported as part of the operational dose management program. This system will be in effect during the Decommissioning Execution phase of the project:

- As mentioned above, work control documents will be prepared for all activities. Where there is the potential for workers to encounter radiological hazards, the preparation of work control
- documents include a radiological assessment completed by CNL health physics personnel. Work control documents are then developed to include radiological aspects as appropriate.
- Hazards to personnel will be identified through work control documents and eliminated or controlled using engineered controls, administrative controls, and PPE.
- Utilization of air monitors, dosimeters, and bioassay will be used as required to detect the spread and uptake of contamination before it exceeds limits.
- Emergency response capability is available from local municipalities.
- An NPD Emergency Procedure is in place, and is consistent with CNL's Emergency Preparedness Program.

o *Asbestos:*

- Signage will be installed to indicate asbestos laydown/interim-storage areas.
- Procedures will be in place for handling and storage of abated asbestos (bagged).
- Work control documents will be developed for all activities, including those involving handling of abated (bagged) asbestos and transite.

o *PCBs:*

- Work control documents will be developed for all activities, including those involving handling PCB-containing light ballasts.
- Sources of PCBs will be confirmed through characterization and will be clearly identified prior to executing activities involving handling of PCB-containing materials (e.g., caulking, paint, cables, light ballasts, etc.).
- Appropriate personal protection equipment will be available and used, given that PCB-containing material is limited to light ballasts.

o *Lead:*

- Work control documents will be developed for all activities, including those involving lead-containing materials.
- Sources of lead are known and will be clearly identified prior to executing decommissioning activities.
- Appropriate personal protection equipment will be used, based on the nature of the activities (e.g. gloves, respirators, etc.).

o *Mercury:*

- Work control documents will be developed for all activities, including those involving mercury-containing equipment/instrumentation.

- Sources of mercury are known and will be clearly identified prior to executing decommissioning activities.

o *Hydrogen generation:*

- Ensuring proper ventilation during grouting.
- Pouring grout in batches to allow a set up time between pours or lowering grout temperature (< 20°C) reduces hydrogen production rate.

9.8.3.3 Effects After Mitigation

Decommissioning Execution

Site and Local Study Area

Non-radiological

During the Decommissioning Execution phase, the site and local study areas will be occupied primarily by workers. Vehicle and equipment operation and on-site transportation will release NO_x, SO_2, VOCs, TSP, PM_{10}, and $PM_{2.5}$. These activities are discussed in Section 9.2 above. In the DecomSA TSD, it is conservatively assumed that these activities will occur simultaneously (i.e., the maximum potential emissions and releases are considered). Worker exposure to NO_x, SO_2, VOCs, TSP, PM_{10}, and $PM_{2.5}$ for all activities is considered here. The release of these contaminants will be mitigated by standard dust suppression measures listed for the atmospheric environment in Section 9.2.3.2, as well as proper vehicle maintenance to reduce emissions. No adverse health effects to workers are anticipated in the Site and Local Study Areas.

Grouting and removal of the above grade structure will result in the displacement of air from inside the facility, which contains suspended lead and asbestos. This was assessed in Section 8.5 of the DecomSA TSD. Exposure to workers will be limited by following the appropriate work control documents described in 9.8.3.2 above. Worker exposures were compared to benchmark values (8-hr limits in this case) to produce (unitless) SI values. An SI of 1 means that the worker exposure is equal to the benchmark value. SIs for lead and asbestos for near-field workers were 4.75 $x10^{-8}$ and 2.14 $x10^{-9}$ respectively. These exposures are well below benchmark values by 8 and 9 orders of magnitude respectively; and as such no adverse health effects to workers are expected.

Radiological

Activities that may result in radiation exposure for workers are assessed in the DecomSA TSD. These activities include drilling holes in below grade structures, displacement of air from the facility during grouting and emplacement, and demolition. Radiation protection protocols, work control documents, safeguards and mitigation will reduce the extent of exposure for the workers and are described in Section 9.8.3.2 above.

The maximum total dose for workers received during grouting and emplacement was predicted to be 1.79 x 10^{-5} mSv/y in the DecomSA TSD. The maximum total dose received by a driller while creating slip pipe access was 0.436 mSv. Contaminant release during demolition calculated to result in a maximum total

dose of $1.37x10^{-3}$ mSv. These doses are well below the regulatory limit of 50 mSv/y for NEW (CNSC 2015) by at least 2 orders of magnitude; therefore, no adverse health effects to workers are anticipated.

Regional Study Area

Non-Radiological

The DecomSA TSD assesses chemical exposure of members of the public in the Regional Study Area during the Decommissioning Execution phase. Exposure to lead and asbestos for members of the public was compared to more conservative benchmark values resulting in maximum SI of $1.14x10^{-6}$ and $5.13x10^{-9}$ respectively, and are at least 6 orders of magnitude lower than the public benchmark values. Therefore, no adverse health effects are anticipated for the public (e.g., from releases to air or surface water).

Radiological

As determined in the DecomSA, the maximum total dose rate to the public during grouting and emplacement was calculated to be $3.37x10^{-6}$ mSv/y. The maximum total dose to the public during demolition was calculated to be $1.64 x10^{-4}$ mSv/y, well below the public dose limit of 1 mSv/y by 4 orders of magnitude. Thus, no adverse health effects are expected for members of the public in the Regional Study Area.

Institutional Controls and Post-Institutional Controls

Site and Local Study Area

The PostSA TSD examines several potential scenarios for the postclosure period (Institutional Controls and Post-Institutional Controls phases) as a way to capture and quantify uncertainties in the future conditions at the site (for detail on these scenarios, the reader is directed to the PostSA TSD) and assess the potential for radiological and non-radiological contamination to affect human health for these scenarios. The reader is directed to the PostSA TSD, which details the results of the assessment of radiological and non-radiological contamination on human health (among other environmental components) for these scenarios. Human health results are briefly summarized here.

Two potential exposed groups are considered in this assessment:

- Site resident family: A highly conservative group that maximizes potential exposures. This is reflected by a small household (comprising two adults, a child and an infant) residing directly over the decommissioned facility and pursuing a self-sufficient lifestyle. This includes use of potentially contaminated river water for domestic and agricultural purposes.
- A hunting/recreational group, represented by a small number of adults and children making hunting and/or recreational use of the river and the area surrounding the NPD. Their exposure pathways, including obtaining wild foods, is also representative of the types of habits that might be exhibited by Aboriginal groups.

In the site investigation disruptive event scenario, an additional potentially exposed group is considered:

- Intruder: a person involved in drilling into the NPDWF is assumed to be directly exposed to 5 kg of contaminated material, retrieved from the reactor vault.

Radiological

In the normal evolution scenario dose estimates, the highest dose was received by an adult hunter (0.0001 mSv/y). This is more than 3,000 times lower than the dose criterion of 0.25 mSv/y. The peak dose was estimated to occur 1,200 y after closure of the facility. The peak dose to a member of the site resident group is also estimated to occur after 1,200 y, and peaks at 0.00004 mSv/y. This is 6,250 times lower than the dose criterion of 0.25 mSv/y. According to the PostSA TSD, these levels of exposure reflect the very low environmental concentrations expected. This is because the main pathway for the release of contaminants is expected to be gradual leakage from the facility, followed by transport in groundwater in the overburden before release into a large water body.

The PostSA also assessed four disruptive event scenarios, as described in Section 9.1 above for the same receptors.

- In the human intrusion scenario, a person is assumed to drill into the NPDWF and retrieve a 5 kg sample of material, which is then inspected. The highest dose is received if the intrusion were to occur immediately following the Institutional Controls phase, and the material with the highest dose rate is retrieved. The highest dose is to the intruder, and is 0.6 mSv. All doses are below the dose criterion for disruptive events of 1 mSv/y.
- In the engineering degradation scenario (such as a major seismic event), rather than a gradual degradation of the engineered barriers in the system, it is assumed that they go directly into a degraded state at the end of the Institutional Controls phase. The highest dose is 0.0003 mSv/y, received by the hunter. The dominant exposure pathway for both groups was external exposure from sediment while in the water and on the shore. All doses are far below the dose criterion for disruptive events of 1 mSv/y.
- In the surface erosion scenario, a flood or erosion event is assumed to scour the surface and lead to persons being directly exposed to the contaminated overburden. The highest peak dose was estimated for the site resident receptor and is 0.0005 mSv/y. All doses are far below the dose criterion for disruptive events of 1 mSv/y.
- In the early glaciation scenario, glacial scouring after 60,000 y disperses the remaining radioactivity in surface soils and sediment. The highest peak dose increases substantially relative to the normal evolution scenario (0.003 mSv/y estimated for the hunter). The dominant pathway is ingestion of animal products. All doses are far below the dose criterion for disruptive events of 1 mSv/y.

Therefore, all doses estimated for the normal evolution and disruptive event scenarios were below the relevant dose criteria in the PostSA TSD.

As described in Section 9.1, “what if” cases represent a deliberately extreme set of assumptions that can be used to understand the absolute limits of safety performance. Due to the extreme conservatism, the

doses are not compared with any criteria, and these cases are not included in the identification and assessment of residual effects; however, the results are presented here to provide perspective.

- In the mass excavation scenario, the highest predicted dose is 3 mSv/y, and is dominated by the consumption of crops grown in contaminated soil.
- In the river level fall scenario, the contaminated groundwater is released to shoreline sediment rather than the river bed sediment. A maximum peak dose of 0.004 mSv/y is estimated to occur at 1,200 y for the hunter receptor.
- In the well in contaminated plume scenario, water used by the site resident for irrigation and drinking, is obtained from a well in the contaminant groundwater plume from the facility. A maximum dose of 0.004 mSv/y is predicted after 100 y.

Non-radiological

The PostSA TSD determined that lead is the only non-radioactive contaminant that may reach the environment in any considerable concentration.

In the normal evolution scenario, the peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration (0.0046 mg/L after 70,000 y) is below all of the relevant MOE generic Site Condition Standards (2011 – Table 6, 7, 8, 9) for groundwater and the Health Canada (2017) drinking water guideline for lead.

The PostSA also assessed four disruptive event scenarios, as described in Section 9.1 above for the same receptors.

- In the site investigation scenario, the peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration is the same as in the normal evolution scenario (discussed above).
- In the engineering degradation scenario, the peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration (0.015 mg/L after 70,000 y) exceeds applicable guidelines; however, the PostSA TSD determined that there is no likely exposure pathway from groundwater to humans in this scenario.
- In the surface erosion scenario, the peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration is the same as in the normal evolution scenario (discussed above).
- In the early glaciation scenario, the peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration is the same as in the normal evolution scenario (discussed above).

As described in Section 9.1, “what if” cases represent a deliberately extreme set of assumptions that can be used to understand the absolute limits of safety performance. Due to the extreme conservatism, the lead concentrations predicted in the PostSA TSD are not compared with any criteria, and these cases are not included in the identification and assessment of residual effects.

Regional Study Area

Since no effects on human health have been identified in the Site and Local Study Areas, no effects are expected in the Regional Study Area for the Post-Institutional Controls phase.

9.8.3.4 Prediction Confidence and Uncertainty

Uncertainty in the DecomSA TSD is addressed through conservative assumptions (i.e., variability in airborne contaminant concentrations in the facility is accounted for by the assumption that concentrations are equal to the most contaminated room for each contaminant).

There is some uncertainty in the characterization of potential effects to Aboriginal groups, due to lack of site-specific information on diet and lifestyle. However, this has been accounted for this using conservative assumptions. For example, the DRL, which is used in the DecomSA calculations, is scaled to the most conservative receptor (taking into consideration country foods), and the PostSA TSD includes hunter/gatherer and site resident profiles. Other Aboriginal concerns such as effects on land use and socio-economic conditions are assessed separately in subsequent sections of this EIS.

In the PostSA TSD, uncertainties in postclosure conditions and events (e.g. floods, human intrusion) and key parameters (e.g. inventory of contamination) are addressed inherently by assessing several disruptive scenarios. Conservative assumptions are also used to address other uncertainties, such as sediment characteristics.

9.8.3.5 Residual Effects

Table 9.8-3 summarizes the effects assessment above and presents the residual effects that were identified in human health. The residual effects in Table 9.8-3 are grouped by effect rather than by individual interaction as listed in Table 9.8-2.

Table 9.8-3. Summary of Residual Effects in Human Health

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution					
Human Health: Public (non-radiological)	All vehicle and equipment production of NO_x, SO_2, TSP, PM_{10}, and $PM_{2.5}$.	Localized changes in the atmospheric environment may affect nearby residents.	Mitigation measures (e.g. dust suppression, equipment maintenance) for the atmospheric environment are described in Section 9.2.3.2.	For all activities, no measurable changes in air quality are predicted, therefore no effects are expected.	No adverse residual effects.
Human Health: Worker (non-radiological)	All vehicle and equipment production of NO_x, SO_2, TSP, PM_{10}, and $PM_{2.5}$.	Localized effects are expected in the atmospheric environment which may affect workers.	Mitigation measures (e.g. dust suppression, equipment maintenance) for the atmospheric and surface water environments are described in Section 9.2.3.2.	No effects are expected on worker health from changes in air quality.	No adverse residual effects.
Human Health: Worker (radiological)	Establishing footprint.	Workers are expected to be exposed to small amounts of radiation during this activity.	Following work control documents and radiation protection protocol.	All doses are expected to be well below relevant dose criteria.	No adverse residual effects.
Human Health: Public (non-radiological)	Stockpile grout ingredients.	Runoff from stockpiles may affect surface water quality which may affect nearby residents.	Mitigation measures (e.g., runoff diversion, dust suppression) for the surface water environment are described in Section 9.4.3.2.	No measurable changes in water quality in the Ottawa River, therefore no effects to the public are predicted.	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Human Health: Worker (non-radiological)	Stockpile grout ingredients.	Runoff from stockpiles may affect surface water quality which may affect workers.	Mitigation measures (e.g., runoff diversion, dust suppression) for the surface water environment are described in Section 9.4.3.2.	No measurable changes in water quality in the Ottawa River, therefore no effects to workers are predicted.	No adverse residual effects.
Human Health: Worker (radiological)	Provide slip pipe access to nuclear area.	Drilling holes for slip pipe access has the potential to increase radiation doses to workers.	Follow work control documents and radiation protection protocol.	All doses are expected to be well below relevant dose criteria.	No adverse residual effects.
Human Health: Public (non-radiological)	Construction and operation of washout pits.	Surface water quality may be affected by wash out pit construction and operation which may affect nearby residents.	Mitigation measures (e.g., proper washout pit design and management) for the surface water environment are described in Section 9.4.3.2.	Localized site drainage effects are expected, but will not affect the surface water environment as a whole. No measurable changes on water quality in the Ottawa River, therefore, no effects on the public are predicted.	No adverse residual effects.
Human Health: Worker (non-radiological)	Construction and operation of washout pits.	Surface water quality may be affected by wash out pit construction and operation which may affect workers.	Mitigation measures (e.g., proper washout pit design and management) for the surface water environment are described in Section 9.4.3.2.	No measurable changes in water quality in the Ottawa River, therefore no effects to workers are predicted.	No adverse residual effects.
Human Health: Public (radiological and non-radiological)	Grout fill nuclear area.	Displacement of air from the facility containing lead, asbestos and tritium which may affect nearby residents.	No mitigation measures have been identified.	Lead and asbestos are well below benchmark values for nearby residents. Tritium exposure calculations for the public are well below the minimum regulatory requirement.	No adverse residual effects.
Human Health: Worker	Grout fill nuclear area.	Displacement of air from the facility containing lead,	Follow work control documents and radiation protection protocol.	Lead and asbestos are well below benchmark values for workers.	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
(radiological and non-radiological)		asbestos and tritium which may affect workers.		Tritium exposure calculations for workers are below worker dose criterion.	
Human Health: Public (radiological)	Demolition of above grade structures.	Surface contamination of the structure may be released into the atmospheric environment which may affect the public.	Mitigation measures (e.g., runoff diversion, dust suppression) for the atmospheric environment are described in 9.3.3.2.	All doses are expected to be well below relevant dose criteria.	No adverse residual effects.
Human Health: Worker (radiological)	Demolition of above grade structures.	Surface contamination of the structure may be released into the atmospheric environment which may affect worker health.	Follow work control documents and radiation protection protocol.	All doses are expected to be well below relevant dose criteria.	No adverse residual effects.
Human Health: Public (radiological and non-radiological)	Demolition of above grade structures.	Runoff may affect surface water quality and the public.	Mitigation measures (e.g., runoff diversion, dust suppression) for the surface water environment are described in Section 9.3.3.2.	No measurable changes in water quality in the Ottawa River, therefore no effects to the public are predicted.	No adverse residual effects.
Human Health: Public (radiological and non-radiological)	Sizing of material.	Runoff and release of surface contamination may affect public health.	Relevant mitigation measures (e.g., runoff diversion, dust suppression) for the surface water environment are described in Section 9.4.3.2.	No measurable changes in water quality in the Ottawa River, therefore no effects to the public are predicted.	No adverse residual effects.

Environmental Component	Source of Effect	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Human Health: Worker (radiological and non-radiological)	Sizing of material.	Runoff and release of surface contamination may affect worker health.	Relevant mitigation measures (e.g., runoff diversion, dust suppression) for the surface water environment are described in Section 9.4.3.2.	No measurable changes in water quality in the Ottawa River, therefore no effects to workers are predicted.	No adverse residual effects.
Human Health: Worker (radiological)	Clearance surveys on potentially recyclable material.	Conducting clearance surveys has the potential to increase radiation doses to workers.	Following work control documents and radiation protection protocol.	All doses are expected to be well below relevant dose criteria.	No adverse residual effects.
Institutional Controls and Post-Institutional Controls					
Human Health: Public (radiological)	Facility performance during the postclosure period.	Exposure to radionuclides in groundwater, surface water, sediment, food, as well as external radiation could affect human health.	In-design mitigations to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects on human health.	All doses are expected to be well below relevant dose criteria.	No adverse residual effects.
Human Health: Public Engineering Degradation (non-radiological)	Instantaneous degradation of the concrete and grout, altering the hydraulic properties and decreasing contaminant transport times.	Exposure to lead in groundwater, surface water, sediment, soil and food could affect human health.	In-design mitigations to isolate and contain the inventory in order to reduce the potential of groundwater contamination and effects on human health.	The PostSA TSD determined that there is no likely exposure pathway from groundwater to humans.	No adverse residual effects.

9.8.4 Assessment of Residual Effects

Based on the assessment described above, no adverse residual effects on human health have been predicted.

9.8.5 Monitoring and Follow-up

The VCs for human health are worker and public health. Monitoring and follow-up activities related to human health are discussed below and in Table 9.8-4. Further action will be triggered if parameters are above applicable guidelines or other notable changes are observed.

Decommissioning Execution

CNL will continue to conduct radiation dose monitoring and indoor air quality monitoring during the Decommissioning Execution phase to confirm that there are no effects on worker health.

Monitoring conducted in other environmental components (i.e., atmospheric environment and ambient radioactivity) will also confirm EIS predictions for effects on worker and public health during the Decommissioning Execution phase.

Institutional Controls

CNL will conduct radiation dose monitoring during the Institutional Controls phase to confirm that there are no effects on worker health.

Monitoring conducted in other environmental components (i.e., atmospheric environment, geological and hydrogeological environment and ambient radioactivity), such as radiation protection surveys and groundwater monitoring, will also confirm EIS predictions for effects on worker and public health during the Institutional Controls phase.

Table 9.8-4. Monitoring and Follow-up Activities in Human Health

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution Phase					
Human Health	Worker health	Potential Source(s) of Effects: - Batch mixing plant - Grouting of below grade structures - Removal of above grade structures - Installation of concrete cap and engineered barriers - Final site restoration Proposed monitoring: - Perform routine bioassays as well as TLDs to monitor whole-body dose. Routine radiation protection surveys, as per ambient radioactivity above - Monitor indoor air quality - Estimate combustible gases (e.g., based on project-related traffic and equipment), as per atmospheric environment above. - Monitor parameters of concern (e.g., lead, asbestos, tritium) in air displaced from grouting the below grade structure and removal of the above grade structure, as per atmospheric environment above. - Wildlife: noise monitoring, as per atmospheric environment above. - Conduct monitoring for each new activity for a short time period to confirm no effect, as per atmospheric environment above. Trigger for further action: Investigation if parameters are above applicable guidelines identified.	Verify EA prediction (i.e., no adverse residual effect on worker health).	Air quality parameters and industrial hygiene: For each new activity, monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting). Routine radiation protection surveys: periodic.	Workers within the NPDWF are currently monitored by CNL Dosimetry Services, which includes routine bioassay as well as assignment of TLDs to monitor whole-body dose. NPDWF currently conducts annual industrial hygiene assessment of lead, asbestos and mould in air within the facility.
Institutional Controls phase					
Human Health	Worker health	Potential Source(s) of Effects: - Radiological exposure during worker presence on-site (e.g., for monitoring and long-term care and maintenance of the site) Proposed monitoring: - Perform routine bioassays as well as TLDs to monitor whole-body dose. - Routine radiation protection surveys, as per ambient radioactivity above. - Monitor parameters of concern in air, as per the atmospheric environment above. Trigger for further action: Investigation if parameters are above applicable guidelines identified.	Verify EA prediction (i.e., no adverse residual effect on worker health).	Air quality parameters: For each new activity, monitor for minimum one week. Routine radiation protection surveys: periodic.	Workers within the NPDWF are currently monitored by CNL Dosimetry Services, which includes routine bioassay as well as assignment of TLDs to monitor whole-body dose.
Human Health	Public health	Potential Source(s) of Effects: - Potential leaching of soluble contaminants from degradation of grouted structure. Proposed Monitoring: - Routine groundwater analyses for parameters of concern (chemical and/or radiological) as per the geological and hydrogeological environment,	Verify EA prediction (i.e., no adverse residual effect on groundwater quality or related VCs)	Sampling and analysis of groundwater: periodic.	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.

9.8.6 Conclusion

The assessment in Section 9.8.3 found that based on the predicted impacts after applied mitigation measures, no adverse residual effects on human health are expected to result from the project. Monitoring activities in other environmental components (i.e., atmospheric, surface water, and geological, and hydrogeological environments and ambient radioactivity) will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects related to human health. If monitoring identifies concerns in the other environmental components, CNL will assess the implications to human health (e.g., using human health risk assessment as required).

9.9 Aboriginal Land and Resource Use

9.9.1 Selection of Valued Components

As outlined in Section 5.2.4, VCs for Aboriginal traditional land and resource use were selected based on consideration of a number of factors, including the:

- Knowledge of Aboriginal traditional land and resource use practices that interact with the environment;
- Aboriginal and/or treaty rights;
- Engagement (as documented in the Aboriginal Engagement TSD); and,
- Consideration of other EAs.

The VCs for Aboriginal land and resource use, with rationale for their selection, are listed in Table 9.9-1.

Table 9.9-1. Valued Component Selection for Aboriginal Land and Resource Use

Environmental Component	VC	Rationale
Traditional Land and Resource Use by Aboriginal Peoples	Trapping	Trapping of fur bearing animals was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. Trapping is a licenced activity in Ontario on provincial land although trapping on private land is allowed. Fur bearing animals may include marten, beaver, otter, fox, mink, etc. Trapping is an activity that provides important links to cultural continuity and traditional way of life. Trapping was specifically identified as a rights-based activity in REGDOC, 3.2.2 (CNSC 2016c).

Environmental Component	VC	Rationale
	Hunting	Hunting was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. The hunting of large game would involve deer and moose but also possibly black bear. Small game includes waterfowl, rabbits, grouse, etc. Hunting is an activity that provides important links to cultural continuity and traditional way of life. Hunting was specifically identified as a rights-based activity in REGDOC, 3.2.2 (CNSC 2016c).
	Fishing	Fishing was a traditional and modern day land and resource activity practiced by Aboriginal peoples in the Ottawa Valley. The Ottawa River was and is still used for sport and subsistence fishing. Fish species targeted on the Ottawa River in the present likely include: walleye, northern pike and smallmouth bass (AECL 2010a). Historically, sturgeon, American Eel and possibly suckers would have also been an important part of the catch. Fishing was specifically identified as a rights-based activity in REGDOC, 3.2.2 (CNSC 2016c).
	Gathering	Gathering was a traditional and modern day land and resource use activity practiced by Aboriginal peoples in the Ottawa Valley. The gathering of plants, berries, mushrooms, etc. would have been for subsistence, medicines, crafts and other purposes. Gathering is an activity that provides important links to cultural continuity and traditional way of life. Gathering was specifically identified as a rights-based activity in REGDOC, 3.2.2 (CNSC 2016c).
	Cultural Resources & Ceremonies	Aboriginal peoples can place a high degree of value on specific sites of cultural, historical, archaeological, spiritual, social or ecological significance. These sites may have broader cultural significance related to the practice of formal or informal ceremonies at or near these sites. The conducting of cultural ceremonies was specifically identified as an activity in REGDOC, 3.2.2 (CNSC 2016c). This VC will assess whether any known sites of significance and the associated cultural ceremonies will be affected by the proposed undertaking.

9.9.2 Assessment Boundaries

9.9.2.1 Spatial Boundaries

Similar to the Aboriginal land and resource use baseline characterization in Section 8.9 above, the Site Study Area for this assessment is consistent with the general Site Study Area defined in Figure 5.2-1 above.

The Local Study Area has been defined as the Site Study Area plus an area with a 1-km radius beyond the Site Study Area (Figure 8.9-1).

The Regional Study Area has been defined as the Site Study Area plus an area with a 5-km radius beyond the Site Study Area (Figure 8.9-2).

9.9.2.2 Temporal Boundaries

The temporal boundaries are the same as the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.9.3 Identification of Residual Effects

9.9.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to Aboriginal Land and Resource Use may occur as a result of operations and activities in the Decommissioning Execution, Institutional Controls and Post-Institutional Controls phases, in particular:

- Installation and operation of the batch mixing plant;
- Grouting of below grade structures;
- Removal of above grade structures;
- Install concrete cap and engineered barrier;
- Final site restoration;
- Renaturalization;
- Facility performance during the Institutional Controls phase; and
- Facility performance during the Post-Institutional Controls phase.

Table 9.9-2. Project-Environment Interactions with Aboriginal Land and Resource Use

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**1**	**Batch Mixing Plant**	
	1.1	Designate footprint, create access, temporary fencing (west side of main building).	On-site activities may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	Raw material transport may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.4	Truck in necessary water supply.	Trucking may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.5	Provide slip pipe access to reactor side.	On-site activities may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	Earth-moving may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.7	Level area for concrete pumper.	Earth-moving may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.8	Mix grout to required formula.	On-site activities may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.9a	Truck grout to pumping station (20 trips per day).	Trucking may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.11	Sample and dewater the cleaning pit. Emplace sediments into voids in condenser room.	On-site activities may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	1.12	Demobilize batch plant after cap pour.	Demobilization activities may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	2	**Grouting of Below Grade Structure**	
	2.1	Room preparation (e.g., sealing of pipes).	Equipment and material transportation may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	2.3	Grout Fill Nuclear Area.	On-site activities may release air containing tritium, lead and asbestos, and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).

		Project Works and Activities	Potential Interaction
Decommissioning Execution	**3**	**Removal of Above Grade Structure**	
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition may release surface contamination and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Material sizing may release surface contamination and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.4	Steel and rubble emplaced in condenser pit according to nesting plan. Fill to 380 level.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.5	Grout first level of demolition material in condenser room.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.6	Steel and rubble emplaced in condenser room. Fill to 400 level.	On-site material transportation may result in roadkill and may produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.7	Grout second level of demolition material in condenser room.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.8	Steel and rubble in condenser room. Fill to 425 level.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.9	Grout third level of demolition material in condenser room.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.10	Demolition block walls and inside walls around control room and change rooms.	Demolition may release surface contamination and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).

		Project Works and Activities	Potential Interaction
Decommissioning Execution	3.11	Collapse ceilings of furnace room and adjacent rooms.	Demolition may release surface contamination and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.12	Emplace block wall rubble in furnace room or condenser room.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.13	Remove recyclables from guard house.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Demolition may release surface contamination and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.15	Grout furnace room and adjacent areas to ground level.	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition may release surface contamination and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	4	**Install Concrete Cap and Engineered Barrier**	
	4.1	Concrete Cap (construct forms, install rebar, and pour, level and slope concrete).	On-site material transportation may result in roadkill and produce nuisance effects for trapping, hunting, fishing and gathering activities (noise and dust).
	4.2	Engineered Barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	5	**Final Site Restoration**	
	5.1	Site Restoration (install fencing, install monitoring wells if required, remediate areas affected by previous operations or decommissioning activities, wash out pits and settling ponds, complete closure surveys, rubblize non-essential asphalt).	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).
	5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	On-site material transportation may result in roadkill and produce nuisance effects for nearby trapping, hunting, fishing and gathering activities (noise and dust).

		Project Works and Activities	Potential Interaction
IC*	**6**	**Long-Term Care and Maintenance**	
	6.7	Renaturalization.	Land Use may change during and/or after the Institutional Controls phase. Renaturalization of site may lead to an increase of wildlife and may benefit trapping, hunting, and gathering activities.
	6.8	Facility performance during the Institutional Controls phase	Groundwater will start to enter the eventually degraded grouted structure. Contaminant release from the grouted structure may affect non-human biota (e.g., game and fish species) health and/or populations.
PIC**	**7**	**Post-Institutional Controls**	
	7.1	Facility performance during the Post-Institutional Controls phase.	Groundwater will enter the eventually degraded grouted structure. Contaminant release from the grouted structure may affect non-human biota (e.g., game and fish species) health and/or populations.
		Renaturalization	Land Use may change during and/or after the Institutional Controls phase. Renaturalization of site may lead to an increase of wildlife and may benefit trapping, hunting, and gathering activities.

Notes:

* - IC: Institutional Controls phase

** - PIC: Post-Institutional Controls phase.

9.9.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

In addition to the in-design mitigation measures identified in Section 4.1 above, the following mitigation measures have been identified to ensure the protection of the Aboriginal land and resource use environment:

- dust suppression measures as described in Section 9.2.3.2;
- construction activities will generally occur between 7 am and 7 pm with the overall objective of minimizing nuisance effects (i.e. noise and traffic) on traditional resource users in the Local and Regional Study Areas. This should be subject to further discussion with potentially impacted Aboriginal groups. It is noted that special or emergency circumstances may require deviation from this restriction; and,
- periodic communication updates on project construction activities to Aboriginal groups is required, including: construction schedule, activities, dedicated contact person for inquiries and emergencies, etc.

9.9.3.3 Effects After Mitigation

In this section, indirect effects to Aboriginal land and resource use are discussed for each phase of the project.

Decommissioning Execution Phase

Site/Local Study Area

As discussed above in Section 9.9.4.2, CNL will minimize potential nuisance effects (i.e. noise) on nearby land users (e.g. hunters, trappers, and gatherers) by instituting restrictions on construction hours and days of the week. Other nuisance-related mitigation measures (i.e. dust suppression) are discussed in Section 9.2.3.2.

Construction activities will not impede traditional resource harvesting activities on adjacent federal, provincial and private lands. Construction activities at the NPD site will be very localized, controlled and temporary in duration. Therefore, any disturbance effects will be minor, localized and temporary in duration.

Any effects on the terrestrial and aquatic environments (i.e., fish and wildlife displacement, contamination) would also affect the ability to hunt and fish in the Local Study Area.

Regional Study Area

As noted in the Socio-Economic TSD, the traffic and transportation effects associated with the project are expected to be greatest by far during the Decommissioning Execution phase. Within the Regional Study Area, the transportation/haul route will be limited to Highway 17 and the NPD Site access road from the highway. As discussed below in Section 9.10.3.2, CNL will minimize traffic nuisance effects on nearby traditional land users in the Regional Study Area by instituting restrictions on construction hours and days of the week. No measurable noise or dust nuisance effects are expected for traditional land users in the Regional Study Area.

There will be nuisance effects (noise and dust) in the Regional Study Area for nearby traditional land users (e.g., trappers, hunters, anglers, gatherers) that should largely be mitigated by a variety of general and specific construction mitigation measures identified in Section 9.9.4.2 above.

Institutional Controls and Post-Institutional Controls

Site/Local Study Area

As determined in the EcoRA TSD, no potential undue effects have been predicted for terrestrial or aquatic biota. Therefore, no potential effects are expected on Aboriginal land and resource use in the Site and Local Study Areas in the postclosure period (Institutional Controls and Post-Institutional Controls phases).

Renaturalization may increase vegetation and habitat for wildlife, providing a potential benefit to traditional hunters, trappers and gathers in the NPD Site and Local Study Areas in the postclosure period.

During the Institutional Controls phase, land in the Local Study Area surrounding the licensed area may be released for other uses by AECL. As lands will only be released as applicable under the soil and groundwater quality guidelines, no residual effects are expected.

Regional Study Area

No effects to Aboriginal land and resource use have been identified in the Regional Study Area for the postclosure period (Institutional Controls and Post-Institutional Controls phases).

9.9.3.4 Prediction Confidence and Uncertainty

There are private lands immediately adjacent to the NPD Site and Federal lands, and it is possible but unknown whether traditional land uses occur on these lands. It is conservatively assumed that adjacent lands and waters will be used by hunters, trappers, anglers and gatherers.

REGDOC 2.9.1 (CNSC 2016b, Appendix C.8) requires identification of any concerns raised by Aboriginal people about the facility or activity in relation to any Aboriginal or treaty rights. This information is provided in the AER TSD.

9.9.3.5 Residual Effects

Table 9.9-3 summarizes the effects assessment above and presents the residual effects that were identified on Aboriginal land and resource use. The residual effects in Table 9.9-3 are grouped by effect rather than by individual interaction as listed in Table 9.9-2.

Table 9.9-3. Summary of Residual Effects on Aboriginal Land and Resource Use

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution						
Aboriginal Land and Resource Use	On-site transportation, demolition, material sizing.	Trapping Hunting Fishing Gathering	Nuisance effects (dust, and noise).	Dust suppression, restricting hours of activity, communication with Aboriginal groups.	Minor, temporary and localized nuisance effect on nearby Aboriginal land users.	No adverse residual effects.
Aboriginal Land and Resource Use	All interactions with the terrestrial environment (see Section 9.6.3.1.	Trapping Hunting	Wildlife displacement, contamination, or mortality affecting hunting activities.	See mitigation measures identified for the terrestrial environment in Section 9.6.3.2.	No measurable habitat or exposure effects, and therefore hunting, are expected.	No adverse residual effects.
Aboriginal Land and Resource Use	All interactions with the aquatic environment (see Section 9.3.3.1.	Fishing	Fish displacement, contamination, or mortality affecting traditional angling activities.	See mitigation measures identified for the aquatic environment in Section 9.4.3.2.	No measurable habitat or exposure effects, and therefore fishing, are expected.	No adverse residual effect.
Institutional Controls and Post-Institutional Controls phase						
Aboriginal Land and Resource Use	Renaturalization	Trapping Hunting Gathering	During the Institutional Controls and Post-Institutional Controls phases, renaturalization of site may lead to an increase of wildlife and may benefit trapping, hunting, and gathering activities.	No proposed mitigation.	Potential benefit for traditional hunting, trapping and gathering activities. Access to the licensed area will be restricted, which will limit the total additional area of use, thus no measurable effects are expected.	No adverse residual effects.

9.9.4 Assessment of Residual Effects

Based on the assessment described above, no adverse residual effects on Aboriginal land and resource use have been predicted.

9.9.5 Monitoring and Follow-up

No specific environmental monitoring has been identified for Aboriginal land and resource use. Monitoring in other environmental components will confirm the EIS predictions (i.e., that no effects are expected on Aboriginal land and resource use). Ongoing Aboriginal engagement activities will take place throughout the Decommissioning Execution and Institutional Controls phases to identify any changing concerns or perceptions related to the project.

9.9.6 Conclusion

The assessment in Section 9.9.3 found that based on the predicted impacts after applied mitigation measures, no adverse residual effects on Aboriginal land and resource use are expected to result from the project. Monitoring activities in other environmental components (i.e., atmospheric, surface water, geological and hydrogeological and terrestrial environments, ambient radioactivity and human health) will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects related to Aboriginal land and resource use. If monitoring identifies concerns in the other environmental components, CNL will assess the implications to Aboriginal land and resource use (e.g., through ongoing Aboriginal engagement activities).

9.10 Socio-economic Environment

Section 9.5 of the Generic Guidelines for the Preparation of the Environmental Impact Statement states the following:

“The proponent will use the information in appendix A, section A.3.7, Socio-economic environment, of the CNSC (2016b) REGDOC-2.9.1, Environmental Protection: Environmental Policy, Assessments and Protection Measures, to assess the project’s indirect socio-economic effects.” In Section A.3.7 of CNSC (2016b), it is stated that:

“The applicant should characterize the socio-economic environment and identify all indirect socio-economic effects. An indirect effect is a secondary environmental effect that occurs as a result of a change that a project may cause in the environment. Paragraph 5(2)(b) of CEAA 2012 refers to any change to the environment caused by the project on health and socio-economic conditions, physical and cultural heritage, or any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. For additional guidance, refer to Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance under the Canadian Environment Assessment Act, 2012 [22].”

In this EIS and in the Socio-Economic TSD, the socio-economic factors examined include those that are potentially affected by the effects of the project to the natural environment. Requirements specific to socio-economic conditions under CNSC REGDOC-2.9.1 are addressed in the EIS and TSD.

9.10.1 Selection of Valued Components

As outlined in Section 5.2.4, VCs in the socio-economic environment were selected to encompass potential effects on human uses and enjoyment of the land (e.g., hunting, tourism, forestry, etc.), land use designations, and traffic and transportation. The VCs for the socio-economic environment, with rationale for their selection, are listed in Table 9.10-1.

Table 9.10-1. Socio-Economic Valued Component Selection

Environmental Component	VC	Rationale
Socio-Economic Environment	Walleye	Socio-economic importance as a sportfish.
	White-tailed deer	Socio-economic importance as a game species.
	Residents – Use/ Enjoyment of Property	Potential disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Decommissioning Execution phase for residents living in the Regional Study Area. This includes residents potentially hunting/trapping in the Local Study Area.
	Land Use and Planning Regime	The proposed project may allow for redesignation of some or all of the NPD property for other uses following the Decommissioning Execution and Institutional Controls phases.
	Landscape and Visual Setting	Due to the proximity of the site to the Ottawa River, the project may affect the quality of views from the river. It is not visible from Highway 17.
	Highway 17	Highway 17 is the main vehicular artery in the area. Project-related increases in traffic may affect capacity and safety of the Highway and represents a risk to human health and safety (e.g., accidents), as well as a risk to the natural environment (e.g., spills, wildlife mortality from increased volume, sensory disturbance from increased noise, increased emissions).

9.10.2 Assessment Boundaries

9.10.2.1 Spatial Boundaries

Similar to the socio-economic environment baseline characterization in Section 8.10 above, the Site Study Area for this assessment are consistent with the general Site Study Area outlined in Section 5.2.1.1. The Local and Regional Study Areas for the socio-economic environment are the same as those outlined for Aboriginal land and resource use (Section 8.9.1).

9.10.2.2 Temporal Boundaries

The temporal boundaries are the same as the standard temporal boundaries outlined in Section 5.2.1.2 of this EIS.

9.10.3 Identification of Residual Effects

9.10.3.1 Project-Environment Interactions

As shown in Table 5.2-1, potential effects to the socio-economic environment may occur as a result of operations and activities in the Decommissioning Execution, Institutional Controls and Post-Institutional Controls phases, in particular:

- Installation and operation of the batch mixing plant;
- Grouting of below grade structures;
- Removal of above grade structures;
- Install concrete cap and engineered barrier;
- Final site restoration;
- Renaturalization;
- Facility performance during the Institutional Controls; and
- Facility performance during the Post-Institutional Controls phase.

Table 9.10-2. Project-Environment Interactions in the Socio-Economic Environment

		Project Works and Activities	Potential Interaction
Decommissioning Execution	1	**Batch Mixing Plant**	
	1.1	Designate footprint, create access, temporary fencing (west side of main building).	Establishing the project footprint and installing fencing may affect the landscape and visual setting from the Ottawa River. On-site activities may produce nuisance effects for nearby residents/land users (noise, dust and traffic).
	1.2	Assign storage area for raw materials, ship in sand, gravel, fly ash. Likely west side of licensed area.	Trucking in raw materials will affect traffic and transportation. Raw material transport may produce nuisance effects for nearby residents/land users (noise, dust, traffic). A minor depletion of local aggregate reserves may occur.
	1.4	Truck in necessary water supply.	Trucking in water supply will affect traffic and transportation, and produce exhaust and dust. Trucking may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	1.5	Provide slip pipe access to reactor side.	On-site activities may produce nuisance effects for nearby residents/land users (noise, dust).
	1.6	Construct wash out pit. Lined excavation with water transfer. Likely near batch mixing station.	Earth-moving may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	1.7	Level area for concrete pumper.	Earth-moving may produce nuisance effects for nearby residents/land users (noise, dust).
	1.8	Mix grout to required formula.	On-site activities may produce nuisance effects for nearby residents/land users (noise, dust).
	1.9a	Truck grout to pumping station (20 trips per day).	Trucking will affect traffic and transportation, and produce exhaust and dust. Trucking may produce nuisance effects for nearby residents/land users (noise and dust).
	1.11	Sample and dewater the cleaning pit. Emplace sediments into voids in condenser room.	On-site activities may produce nuisance effects for nearby residents/land users (noise).

		Project Works and Activities	Potential Interaction
Decommissioning Execution	1.12	Demobilize batch plant after cap pour.	Demobilization will require removal of equipment and materials from the site via truck, thereby affecting traffic and transportation. Demobilization activities may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	2	Grouting of Below Grade Structure	
	2.1	Room preparation (e.g., sealing of pipes).	Equipment and material transportation may produce nuisance effects for nearby residents/land users (traffic).
	2.3	Grout Fill Nuclear Area.	On-site activities may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3	Removal of Above Grade Structure	
	3.1	Conventional heavy equipment knockdown of reactor hall.	Demolition equipment transportation to the site, and on-site material transportation will affect traffic. Demolition may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.2	Sizing of material such as cutting steel beams or crushing masonry for fitting into void areas.	Material sizing may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.3	Set up laydown area and perform clearance surveys on materials for possible recycle.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.4	Steel and rubble emplaced in condenser room according to nesting plan. Fill to 380 level.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.5	Grout first level of demolition material in condenser room.	On-site material transportation y and may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.6	Steel and rubble emplaced in condenser room. Fill to 400 level.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.7	Grout second level of demolition material in condenser room.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.8	Steel and rubble in condenser room. Fill to 425 level.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.9	Grout third level of demolition material in condenser room.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.10	Demolition block walls and inside walls around control room and change rooms.	Demolition equipment transportation to the site, and on-site material transportation will affect traffic and transportation. Demolition may produce nuisance effects for nearby residents/land users (noise, dust, traffic).

		Project Works and Activities	Potential Interaction
Decommissioning Execution	3.11	Collapse ceilings of furnace room and adjacent rooms.	Demolition equipment transportation to the site, and on-site material transportation will affect traffic and transportation. Demolition may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.12	Emplace block wall rubble in furnace room or condenser room.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.13	Remove recyclables from guard house.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.14	Demolish guard house and emplace in furnace room and adjacent rooms.	Demolition equipment transportation to the site, and on-site material transportation will affect traffic and transportation. Demolition may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.15	Grout furnace room and adjacent areas to ground level.	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	3.16	Demolish above grade portion of pressure relief pit. Fill with grout.	Demolition equipment transportation to the site, and on-site material transportation will affect traffic and transportation. Demolition may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	4	Install Concrete Cap and Engineered Barrier	
	4.1	Concrete Cap (construct forms, install rebar, and pour, level and slope concrete).	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	4.2	Engineered Barrier (ship in materials, layer and shape mound, install geotextile layer, grade property, install remaining earth layers and seed).	Shipping in materials will affect traffic and on-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).

		Project Works and Activities	Potential Interaction
Decommissioning Execution	5	Final Site Restoration	
	5.1	Site Restoration (install fencing, install monitoring wells if required, remediate areas affected by previous operations or decommissioning activities, wash out pits and settling ponds, complete closure surveys, create rubble from non-essential asphalt).	On-site material transportation may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
	5.3	Demobilize Site (Remove temporary facilities, decontaminate equipment, remove power upgrades, poles and lines, return transformers).	Removal of temporary facilities, equipment and utilities will improve the landscape and visual setting. On-site material transportation will affect transportation safety and may produce nuisance effects for nearby residents/land users (noise, dust, traffic).
IC*	6	Long-Term Care and Maintenance	
	6.7	Renaturalization.	Renaturalization may attract bird watchers to the site. Land Use designation may change during the Institutional Controls phase.
	6.8	Facility performance during the Institutional Controls phase.	Groundwater will start to enter the eventually degraded grouted structure. Contaminant release from the grouted structure may affect non-human biota (e.g., game and fish species) health and/or populations.
PIC**	7	Post-Institutional Controls phase	
	7.1	Facility performance and renaturalization during the Post-Institutional Controls phase.	Groundwater will enter the eventually degraded grouted structure. Contaminant release from the grouted structure may affect non-human biota (e.g., game and fish species) health and/or populations.
		Renaturalization	Land Use may change during and/or after the Institutional Controls phase. Renaturalization of site may lead to an increase of wildlife and may benefit land users and tourism (e.g. hunters, trappers, bird watchers, etc.).

Notes:

* - IC: Institutional Controls phase

** - PIC: Post-Institutional Controls phase

9.10.3.2 Proposed Mitigation Measures

The mitigation measures presented below are preliminary and have been developed based on the current understanding of the project. As the project approaches detailed work planning, details will be refined, and additional mitigation measures may be developed as required.

In addition to the in-design mitigation measures identified in Section 4.1 above, the following mitigation measures have been identified to ensure the protection of the socio-economic environment:

- dust suppression measures as described in Section 9.2.3.2;
- post speed limits on-site as described in Section 9.6.3.2;
- the greatest effect of traffic and transportation associated with the project will occur during the Decommissioning Execution phase. Within the Local and Regional Study Areas, the transportation/haul route is limited to Highway 17 and the NPD site access road from the highway;
- review of a company's safety records which includes any traffic accidents or driver's records, as per CNL's contracting and hiring practices;
- construction activities will generally occur between 7 am and 7 pm wherever possible, with the overall objective of minimizing nuisance effects (i.e. noise and traffic) on residents in the Local and Regional Study Areas. This should be subject to further discussion with the local municipality. It is noted that special or emergency circumstances may require deviation from this restriction;
- when a significant amount of off-site transportation is required (e.g., during raw material delivery), the timing of equipment and material shipping to the site should be staggered to minimize the contribution of the project to peak traffic volumes;
- during the Decommissioning Execution and Institutional Controls phases, restrict access to the licensed area via a fence with a locked gate to deter trespassing; and,
- periodic communication updates on project construction activities to local residents are recommended, including: construction schedule, activities, dedicated contact person for inquiries and emergencies etc.

No mitigation measures have been identified for land use in the study area, as formal changes in land use designation are not expected to occur during the Decommissioning Execution. Land use redesignation will only be applied as appropriate during the Institutional Controls phase. During the Institutional Controls phase, land in the Local Study Area surrounding the licensed area may be released for other uses.

No mitigation measures have been identified with respect to aggregate depletion, as the effect is expected to be minor, and accompanied by positive economic benefits.

9.10.3.3 Effects After Mitigation

In this section, potential indirect socio-economic effects are discussed for each phase of the project. The Socio-Economic assesses potential effects of the project relating to land use, forestry, trapping, hunting, fishing, tourism and recreation, aggregates, minerals and residences.

Decommissioning Execution Phase

Site Study Area

No effects after mitigation are expected in the Site Study Area during the Decommissioning Execution phase. As discussed in the Socio-Economic TSD, the project may affect transportation operations and safety through the transportation of materials and equipment on-site. This will largely be mitigated by posting and adhering to speed limits on-site. The remaining effect is minor and inherent in vehicle operation.

There are no residents within the Site Study Area, and no nuisance effects are expected on land users (i.e. anglers, hunters, trappers, tourists) in the Site Study Area.

A Stage 1 archaeological assessment was conducted for the NPD property, and it was determined that there are no expected impacts to the NPD property. Details are provided in the Archaeological TSD.

Local Study Area

As discussed on the Socio-Economic TSD, the traffic and transportation effects associated with the project are expected to be greatest during the Decommissioning Execution phase. Within the Local Study Area, the transportation/haul route will be limited to Highway 17 and the NPD site access road from the highway.

There are approximately ten residents within the Local Study Area, and there may be nuisance effects (i.e. noise, traffic) associated with the Decommissioning Execution phase. Similarly, tourists in the Local Study Area may also experience nuisance effects. No nuisance effects are expected on land users (i.e. anglers, hunters, trappers) in the Local Study Area.

The project is expected to result in increased traffic volumes, which may be reflected in a potential increase in incidents and delays, even after mitigation measures. The increase traffic volume is expected to be temporary and minor, thus the effects on transportation safety and Highway 17 traffic not significant. The Ministry of Transportation (MTO) has reviewed the project, and concluded that it has no traffic or transportation-related concerns with respect to the project (MTO 2016).

There may be a minor depletion of aggregate in the Local Study Area should aggregate be sourced locally. Aggregate will be sourced on the open market, and no residual effects are expected.

Within the Local Study Area, the landscape and visual setting may be affected by the general activities and footprint of the project. The visual character of the shoreline, as viewed from the Ottawa River, may decrease. In order to mitigate this potential effect, CNL will ensure that the existing natural buffer (made up of the treed slope) remains in place during the Decommissioning Execution phase. The site is not visible from Highway 17; therefore, the visual setting from Highway 17 is not likely to be affected.

No effects are expected on walleye and white-tailed deer populations. Therefore, no effects are expected on the ability to hunt and fish in the Local Study Area.

As discussed earlier, the Stage 1 archaeological assessment (documented in the Archaeology TSD) states that no effects on archaeology are expected to the NPD property.

Regional Study Area

As discussed in the Socio-Economic TSD, the traffic and transportation effects associated with the project are expected to be greatest during the Decommissioning Execution phase. Within the Regional Study Area, the transportation/haul route will be limited to Highway 17 and the NPD site access road from the highway. As discussed above in Section 9.10.3.2, CNL will minimize potential traffic nuisance effects on residents and nearby land users in the Regional Study Area by instituting restrictions on construction hours and days of the week. No measurable noise or dust nuisance effects are expected for residents and land users in the Regional Study Area.

The project is expected to result in increased traffic volumes and an increased likelihood of incidents and delays, even after mitigation measures. The Ministry of Transportation (MTO) has reviewed the project, and concluded that it has no traffic or transportation-related concerns with respect to the project (MTO 2016).

In the Regional Study Area, there may be aggregate depletion associated with the grouting and concreting activities during the Decommissioning Execution phase if aggregate is sourced locally. However, these effects are expected to be minor and also to provide positive economic benefit. Aggregate will be sourced on the open market.

There will be nuisance effects (noise, dust, traffic) in the Regional Study Area for residences and nearby land users (e.g. tourists, hunters, trappers, anglers) that should largely be mitigated by a variety of general and specific construction mitigation measures identified in Section 9.10.3.2 above.

Institutional Controls Phase and Post-Institutional Controls Phase

Site and Local Study Areas

Renaturalization may also increase vegetation and habitat for wildlife, providing a potential benefit to hunters and trappers in the Site and Local Study Areas. Renaturalization on the site, and protection of chimney swift habitat may attract bird watchers to the site. This may be a potential minor economic benefit to nearby businesses.

Forest resources may become available for forestry activities in the Site and Local Study Areas during the Institutional Controls and Post-Institutional Controls phases. Renaturalization may also increase forest resources.

During the Institutional Controls and Post-Institutional Controls phases, it is assumed that the licensed area will be abandoned, making the land available for other uses. It is unknown how the licensed area might be redesignated. Changes in land use planning designation are not expected to result in residual effects.

As determined in the EcoRA TSD, no potential undue effects have been predicted for the white-tailed deer or walleye.

Therefore, no potential effects are expected on the socio-economic environment in the Site and Local Study Areas in the Institutional Control and Post-Institutional Controls phases.

Regional Study Area

No potential socio-economic effects have been identified in the Regional Study Area for the Institutional Controls and Post-Institutional Controls phases.

9.10.3.4 Prediction Confidence and Uncertainty

There are private lands immediately adjacent to the NPD property, and it is possible but unknown whether private landowners hunt or trap on their property. It is conservatively assumed that adjacent lands and waters will be used by hunters, trappers and anglers.

There is uncertainty about locations where aggregate materials will be obtained. This may change the potential effects on local aggregate resource levels as well as traffic and transportation along Highway 17.

It is unknown whether or how land use may be redesignated during the Institutional Controls phase. During the Post-Institutional Controls period, it is unknown how the licensed area might be redesignated. This uncertainty in the Post-Institutional Controls phase is accounted for through the use of conservative assumptions, sensitive receptors and various scenarios.

The location of various elements of the Decommissioning Execution phase is undetermined, which could affect the project footprint, and the extent of the effect of the project on landscape and visual setting.

9.10.3.5 Residual Effects

Table 9.10-3 summarizes the effects assessment above and presents the residual effects that were identified for the socio-economic environment. The residual effects in Table 9.10-3 are grouped by effect rather than by individual interaction as listed in Table 9.10-2.

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Table 9.10-3. Summary of Residual Effects in the Socio-Economic Environment

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Decommissioning Execution						
Socio-Economic Environment	General activities and project footprint.	Landscape and visual setting	A decrease in the visual character of the shoreline from the Ottawa River.	Maintaining current natural buffer for the duration of the Decommissioning Execution phase.	The project may be temporarily slightly more visible than the current facility.	No adverse residual effects.
Socio-Economic Environment	Employee, material and equipment transportation to and from site.	Traffic and transportation	Increased traffic volume could affect the safety of road users.	Timing of shipments will be staggered when possible.	Traffic delays and the probability of traffic incidents may increase temporarily during the Decommissioning Execution phase as a result of increased volume.	No adverse residual effects.
Socio-Economic Environment	On-site transportation, demolition, material sizing.	Residents – use/enjoyment of property	Nuisance effects (dust, noise and traffic).	Dust suppression, restricting hours of activity, communication with public.	Minor, temporary and localized nuisance effect on residents and nearby land users use and enjoyment of land.	No adverse residual effects.
Socio-Economic Environment	All interactions with the terrestrial environment (see Section 9.6.3.1.	White-tailed deer	Wildlife displacement, contamination, or mortality affecting hunting activities.	See mitigation measures identified in Section 9.6.3.2.	No effects on hunting are expected, as there are no predicted habitat or exposure effects on white-tailed deer.	No adverse residual effects.

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Socio-Economic Environment	All interactions with the surface water environment (see Section 9.3.3.1.	Walleye	Fish displacement, contamination, or mortality affecting angling activities.	See mitigation measures identified in Section 9.3.3.2.	No effects on fishing are expected, as there are no predicted habitat or exposure effects on walleye.	No adverse residual effect.
Socio-Economic Environment	Aggregate use	N/A	Minor depletion of existing reserves of aggregate material.	No proposed mitigation.	A potential minor depletion of existing reserves of aggregate material, however there is a positive economic benefit.	No adverse residual effects.
Institutional Controls						
Socio-Economic Environment	Land Use Redesignation	Land Use and Planning Regime	During the Institutional Controls phase, the project may allow for redesignation of the NPD property.	No proposed mitigation.	Land outside of the licensed area may become available for other uses.	No adverse residual effects.
Socio-Economic Environment	Renaturalization	N/A	During the Institutional Controls phase, wildlife, bird watchers and tourists may be attracted to the site.	No proposed mitigation.	Potential benefit for tourism and recreation. Access to the licensed area will be restricted, which will limit exposure of bird watchers. Bird watchers will be present infrequently and irregularly for short periods of time, thus no measurable effects are expected.	No adverse residual effects.

Environmental Component	Source of Effect	Potentially Affected VCs	Potential Effect	Proposed Mitigation	Potential Effect After Mitigation	Residual Effect
Post-Institutional Controls						
Socio-Economic: Land Use	Land Use Redesignation.	Land Use and Planning Regime.	During the Post-Institutional Controls phase, the project may allow for redesignation of the NPD property.	No proposed mitigation.	Land will be available for other uses.	No adverse residual effects.
Socio-Economic Environment	Renaturalization	N/A	During the Post-Institutional Controls phase, wildlife, bird watchers and tourists may be attracted to the site.	No proposed mitigation.	Potential benefit for tourism and recreation, hunting and trapping.	No adverse residual effects.
Socio-Economic Environment	Contaminant releases affecting the aquatic environment.	Walleye	Groundwater will flow into the eventually degraded structure. Contaminated groundwater will flow out and eventually into the Ottawa River.	In-design mitigations to isolate and contain the inventory in order to reduce the potential effects on the socio-economic environment.	No effect expected on walleye.	No adverse residual effects.
Socio-Economic Environment	Contaminant releases affecting the terrestrial environment.	White-tailed deer	Eventual releases to the atmospheric environment through the cap system. Groundwater will flow into the eventually degraded structure. Contaminated groundwater will flow out and eventually into the Ottawa River, which could transfer to biota through drinking water.	In-design mitigations to isolate and contain the inventory in order to reduce the potential effects on the socio-economic environment.	No effect expected on white-tailed deer.	No adverse residual effects.

9.10.4 Assessment of Residual Effects

Based on the assessment described above, no adverse residual effects on the socio-economic environment have been predicted.

9.10.5 Monitoring and Follow-up

No specific environmental monitoring has been identified for the socio-economic environment. Monitoring in other environmental components will confirm the EIS predictions (i.e., that no effects are expected in the socio-economic environment). Ongoing public and stakeholder engagement activities will take place throughout the Decommissioning Execution and Institutional Controls phases to identify any changing concerns or perceptions related to the project.

9.10.6 Conclusion

The assessment in Section 9.10.3 found that based on the predicted impacts after applied mitigation measures, no adverse residual effects on the socio-economic environment are expected to result from the project. Monitoring activities in other environmental components (i.e., atmospheric, surface water, geological and hydrogeological and terrestrial environments, ambient radioactivity and human health) will verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects related to the socio-economic environment. If monitoring identifies concerns in the other environmental components, CNL will assess the implications to the socio-economic environment (e.g., through ongoing public and stakeholder engagement activities).

9.11 Accidents and Malfunctions

In accordance with the EIS Guidelines (CNSC 2016a) and associated regulatory documents (such as REGDOC 2.9.1, CNSC 2016b), the EIS includes an assessment of the potential environmental effects of accidents or malfunctions that may occur in connection with the designated project.

The assessment of potential accidents and malfunctions considered both radiological and chemical events:

- radiological accidents and malfunctions: events that involve radioactive substances and components and therefore could result in the acute release of radioactivity as well as non-radiological substances; and
- conventional accidents and malfunctions: events that involve only non-radiological substances, and therefore have no potential for release of radioactivity.

Accidents and malfunctions that may occur during the project were identified, characterized and evaluated in the DecomSA TSD for both the Decommissioning Execution and Institutional Controls phases. This is because the Decommissioning Execution phase is when work will actively be taking place, and when the facility will be most susceptible to initiating events. Following the Decommissioning Execution phase, monitoring and long-term care and maintenance will take place during the Institutional Controls phase. In

addition, the PostSA TSD considered disruptive event scenarios and “what-if” cases which examine the potential effects of unlikely disruptive events that lead to possible penetration of barriers and abnormal degradation and loss of containment. These disruptive scenarios are designed to test the robustness of the project plan. These disruptive scenarios are not considered accidents and malfunctions, and as such have been assessed throughout Section 9, above. In the Post-Institutional Controls phase, there will be no workers or activities on site, and as such there is no possibility for accidents or malfunctions to occur.

9.11.1 Regulatory Guidelines and CNL Procedures

The EIS Guidelines (CNSC 2016a) dictate that the information in Appendix A.3.4 of REGDOC 2.9.1 (CNSC 2016b) be used to assess the potential health and environmental effects from postulated accident and malfunction scenarios.

As per REGDOC 2.9.1 (CNSC 2016b), the applicant must provide an assessment of the potential health and environmental effects that occur from radiological and conventional accidents and malfunctions. The EIS should also include any mitigation measures such as monitoring, contingency, clean-up or restoration work in the surrounding environment that would be required during or immediately following the postulated malfunction and accident scenarios.

The assessments of accidents and malfunctions must provide a description of postulated accidents and malfunctions sequences, considering:

- initiating events: internal, external and human-induced;
- the frequency of these events; and
- either a bounding approach or facility-specific information.

Furthermore, the EIS should include details of the source, quantity, mechanism, pathway, rate, form and characteristics of any potential releases resulting during the hypothetical malfunction or accident.

The assessments of accidents and malfunctions focused on those events that are considered credible in the context of the project, i.e., those that have a reasonable probability of occurrence based on professional judgement in a context of project-specific conditions. The threshold identified by the CNSC for credibility of a nuclear accident scenario is that it has a one in one million (i.e., 1×10^{-6}) or greater chance of occurring in any year (CNSC 2010).

If an accident or malfunction situation occurs, CNL has procedures in place which address requirements for immediate response and post-event clean-up or restoration. Of note, CNL's Emergency Preparedness Program (described in Section 10.2 below) has been designed for immediate response to emergency situations. The program ensures emergency readiness and emergency management to support programs such as reactor safety/accident management, decommissioning, radiation and environmental protection, fire and occupational health and safety. In terms of post-event clean-up or restoration CNL's Environmental Protection Program (see Section 10.2) includes procedures that address the identification, management and remediation of lands that are contaminated.

9.11.2 Postulated Accidents and Malfunctions

A bounding scenario approach has been selected for the assessment of accidents and malfunctions in the Decommissioning Execution and Institutional Controls phases.

Section 7 of the DecomSA TSD details the approach used to identify bounding scenarios. The identification of potential accident and malfunction scenarios began with a systematic review of activities during the Decommissioning Execution and Institutional Controls phases to identify hazards. Hazards were identified and characterized by assigning conservative (i.e., erring on the side of greater consequence and greater frequency) preliminary frequency, severity and risk ratings. Frequency ratings were estimated based on initiating event probabilities, and any other relevant probabilities. Initiating events considered in the hazard identification process included:

- Operational initiating events (such as power and equipment failure);
- Human Error initiating events (such as improper handling and spills); and,
- Natural, external, or environmental initiating events (such as earthquakes and forest fires).

Detailed information on these preliminary initiating event estimates is presented in Section 7 of the DecomSA TSD.

Credible scenarios (i.e. those with $>10^{-6}$ probability and non-negligible potential consequences) were grouped based on similar consequence types. Within these groups, the scenario with the greatest potential consequence was identified. These scenarios are called bounding scenarios, and are the focus of the accidents and malfunctions assessment in the DecomSA TSD. Each hazard identified is encompassed within the selected bounding scenarios (i.e., if a hazard is not selected as a bounding scenario, it is bounded by another scenario that is expected to have greater consequence). For each bounding scenario, the potential source term release was estimated. The resulting concentrations at receptor locations - and the resulting exposure to these concentrations - were calculated and compared to appropriate criteria.

A total of 10 bounding scenarios were selected based on the expected risk identified through the hazard identification process. All selected bounding scenarios occur in the Decommissioning Execution phase. Of the bounding scenarios identified below, only scenarios 1, 2, 6, 7, 8, 9 and 10 are considered in the assessment of accidents and malfunctions in this section of the EIS. Bounding scenarios 1, 2, 3, 4, 5 are discussed as part of effects of the environment on the project (in Section 9.13 of this EIS).

Conventional accident and malfunction events identified are addressed collectively, and will be discussed further in Section 9.11.5. The resulting bounding scenarios are presented in Table 9.11-1 below.

Table 9.11-1. Resulting Bounding Scenarios

Number	Bounding Scenario	Consequence
1	Forest fire	Release of **radioactivity** due to fire spreading to the building and subsequently mobilizing and releasing radionuclides.
2	Forest fire	Release of **chemicals** (e.g. mercury, combustion by-products) due to fire spreading to the building and subsequently mobilizing and releasing chemicals.
3	Tornado	Release of **radioactivity** due to damage to the building and subsequently mobilizing and releasing radionuclides
4	Tornado	Release of **chemicals** due to damage to the building and subsequently mobilizing and releasing chemicals.
5	Flood	Release of **radioactivity** due to water ingress and subsequently mobilization of radionuclides.
6	Accidental exposure to **radioactivity.**	Radiological dose during demolition of walls, cutting holes, cutting vessels and pipes. *Note: though radiological doses are anticipated as part of normal operations, this accident scenario represents exposure* beyond *the levels anticipated as part of normal planned demolition activities. See Section 8 of the DecomSA TSD for assessment of normal operations.*
7	Accidental exposure to **chemicals.**	Exposure to chemicals during demolition of walls, cutting holes, cutting vessels and pipes. *Note: limited to exposure* beyond *the levels anticipated as part of normal planned demolition activities. See Section 8 of the DecomSA TSD for assessment of normal operations.*
8	Underground fire (including equipment fire).	Airborne release of **radionuclides** and subsequent exposure.
9	Underground fire (including equipment fire)	Airborne release of fire by-products (smoke and chemicals), as well as chemicals involved in the fire and subsequent exposure.
10	Collapse of ventilation stack.	Release of **radioactivity** and exposure.

In addition to the bounding scenarios listed above, the DecomSA TSD also considers hydrogen production and concentration during grouting. The primary measure that will be used to maintain the hydrogen levels at a safe concentration will be to control the environment in the vault with active ventilation that can sufficiently sweep out the produced hydrogen. Given the maximum hydrogen generation rate of 3.18 x 10^{-4} m^3/s, an air flow rate of 3.18 x 10^{-1} m^3/s (674 cubic feet per minute) would ensure the hydrogen concentration does not rise above 1%. Ventilation can be sized accordingly. A standard 2000 cubic feet per minute ventilator should be adequate. Additional measures to reduce hydrogen generation include pouring grout in batches to allow a set up time between pours or lowering grout temperature (< 20°C) which also reduces the hydrogen production rate. With the implementation of these hydrogen safety measures, adverse effects on workers are not anticipated.

9.11.3 Dose and Exposure Limits

9.11.3.1 Radiological Dose Criteria

Dose/acceptance criteria for assessing accidents and malfunctions were obtained from CNL's existing Safety Analysis Report (Athauda-Arachchige 2015); these are outlined in Table 9.11-2 below. These dose criteria depend on the frequency with which a receptor is exposed. Four event frequency ranges (with an associated dose band) are used to define the accidents and malfunctions. The upper bound of the dose band is considered as the safety goal, while the lower bound is considered as the safety target. Predicted doses below the safety target are acceptable, while doses above the safety target must be justified. Doses in excess of the safety goal are unacceptable.

Table 9.11-2. Dose Acceptance Criteria – Accidents and Malfunctions (based on Athauda-Arachchige 2015)

Frequency Range (Events/year)	Description of Event Occurrence	Dose Range per Event (mSv)	
		On-Site Personnel (Workers)	Off-Site Personnel (Public)
$>3\times10^{-1}$	**Frequent**; Events that are expected to occur several times during the lifetime of the facility. *(e.g. frequency of approx. 1 every 3 years)*	<1	<0.1
3×10^{-1} to 3×10^{-2}	**Occasional**; Events may occur a few times during the lifetime of the facility. *(e.g. frequency of approx. 1 every 3 years to 1 every 30 years)*	1 to 5	0.1 to 0.5
$<3\times10^{-2}$ to 10^{-4}	**Rare**; Events have slight chance of occurring during the lifetime of the facility. *(e.g. frequency of approx. 1 every 30 years to 1 every 10,000 years)*	>5 to 50	>0.5 to 5.0
$<10^{-4}$ to 10^{-6}	**Extremely Rare**; Events are not expected to occur during the lifetime of the facility. *(e.g. frequency of approx. 1 every 10,000 years to 1 every 1,000,000 years)*	>50 to 100	>5 to 100

Note:
Frequency ranges for rare and extremely rare events have been adjusted to avoid overlapping of these frequency ranges.

Furthermore, in addition to the dose criteria explained above, the NEW dose criteria (50 mSv/y) has been used to ensure that doses are sufficiently low.

9.11.3.2 Non-Radiological Benchmarks

The following non-radiological contaminants were identified in the COPC screening in Section 5.2.3 of this EIS for assessment of potential health effects to human receptors, based on the chemical inventory of the facility and on the nature of bounding scenario events (e.g. combustion products from fires):

- Lead;
- Mercury;
- Asbestos; and,
- PCBs (assumed >54%Cl).

The DecomSA also assessed dioxins and furans (byproducts of PCBs combustion) for fire-related accident scenarios only.

Worker Receptors

For worker receptors, the chosen benchmarks are the Immediately Dangerous to Life or Health (IDLH) values. Where IDLH values were unavailable, the public Protective Action Criteria (PAC) -1 values were used. The chosen benchmarks are presented in Table 9.11-3.

Table 9.11-3. Non-Radiological Criteria – Worker Receptors – Accidents and Malfunctions

Chemical	Benchmark Value	Reference
Mercury Vapor	10 mg/m^3	IDLH (NIOSH 2016a)
PCB	13 mg/m^3	IDLH value not available. Public PAC-1 value used to fill gap.
Dioxins & Furans ***(as 2,3,7,8-Tetrachlorodibenzo-p-dioxin)***	0.00013 mg/m^3	IDLH value not available. Public PAC-1 value used to fill gap.
Asbestos	0.05 mg/m^3	IDLH value not available. Public PAC-1 value used to fill gap.
Lead	100 mg/m^3	IDLH (NIOSH 2016b)

Public Receptors

The benchmarks selected for assessing public exposure to non-radiological species under one-hour accidents and malfunctions scenarios (exposure time) are the U.S. DOE PACs (U.S. DOE 2016). PACs are developed and maintained by the U.S. Department of Energy (DOE) / National Nuclear Security Administration (NNSA). PACs are a comprehensive set of short-term public exposure guidelines based on hierarchical selection of criteria from among U.S. Environmental Protection Agency AEGLs (Acute Exposure Guideline Levels), American Industrial Hygiene Association one-hour EPRGs (Emergency Response Planning Guidelines), or internal TEELs (Temporary Emergency Exposure Limits) where AEGLs or ERPGs are not available.

PAC values are divided into four different categories based on the associated type of health effects:

- PAC 0 – no adverse health effects;
- PAC 1 – mild, transient health effects;
- PAC 2 – irreversible or other serious health effects that could impair ability to take protective action;
- PAC 3 – life threatening health effects.

PAC-1 values are chosen for this assessment, as they represent the maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour. Table 9.11-4 presents the benchmark values identified for public receptors.

Table 9.11-4. Non-Radiological Criteria – Public Receptors – Accidents and Malfunctions

Chemical	PAC-1 Criteria (US DOE 2016) [in mg/m^3]
Mercury [a]	0.15
PCBs [b]	13
Dioxins & Furans [c]	0.00013
Asbestos	0.05
Lead	0.15

Notes:

[a] As mercury vapour; Hg_2O is not stable.

[b] DOE 2016 generic value for PCBs/Aroclor.

[c] As 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

Dioxins & Furans

Public (and worker) benchmark criteria for dioxins and furans are based on TCDD. Table 9.11-5 presents the toxic equivalence factors (TEQs) for other dioxin and furan congeners. TCDD has the highest toxic equivalent ratio (i.e. 1.0) among congeners. Therefore, it is conservative to use TCDD as the representative dioxin and furan compound.

Table 9.11-5. TEQs for Dioxin & Furan Congeners

Dioxins		Furans	
Congeners	**Toxic Equivalence Factor**	**Congeners**	**Toxic Equivalence Factor**
2,3,7,8-TCDD	1	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	0.5	1,2,3,7,8-PeCDF	0.05
-	-	2,3,4,7,8-PeCDF	0.5
1,2,3,4,5,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,7,8,9-HxCDF	0.1
-	-	2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,4,6,7,8-HpCDF	0.01
-	-	1,2,3,4,7,8,9-HpCDF	0.01
OCDD	0.001	OCDF	0.001

Notes:
A dioxin counterpart does not exist for every furan congener because the dioxin structure is more symmetric than the furan structure. For example, the furans 1,2,3,7,8-PeCDF and 2,3,4,7,8-PeCDF are different isomers, whereas the dioxins 1,2,3,7,8-PeCDD and 2,3,4,5,8-PeCDD are identical, and therefore the name 2,3,4,7,8-PeCDD is not used. For non-2,3,7,8 congeners, the TEQs are assumed to be zero.

9.11.4 Radiological Accidents and Malfunctions Effects

This section presents the expected effects of the radiological accidents and malfunctions. As discussed above, radiological accidents and malfunctions are events that involve radioactive substances and components and therefore could result in the acute release of radioactivity as well as non-radiological substances.

For detailed information and analysis of these scenarios, please see Section 9 and Appendix F of the DecomSA TSD. Mitigation measures for the bounding scenarios, including safeguards and CNL's planned responses, are discussed in Appendix B of the DecomSA TSD.

All scenarios were assessed for worker and public receptors, however only bounding scenarios 1 through 5, 8 and 9 (from Table 9.11-1) were determined to have the potential to affect non-human biota (EcoRA TSD).

The results below are presented as maximum SIs. An SI is the ratio (i.e., unitless) of an estimated exposure level (or an estimated environmental concentration) divided by a corresponding toxicity reference value or benchmark value. An SI of <1 means that no effects are expected. An SI of >1 means that effects may occur.

9.11.4.1 Forest Fire

Radiological

The forest fire bounding scenario (Scenario #1) results in doses to non-human biota, public and workers that are below their respective acceptance criteria. The maximum calculated total dose received was 2.84 x 10^{-4} mSv for a worker. This dose is below the regulatory limit of 50 mSv/y for NEW by 5 orders of magnitude.

Non-Radiological

The forest fire bounding scenario (Scenario #2) results in exposure concentrations for non-human biota, public and workers that are below the appropriate exposure limit for each contaminant. The maximum calculated SIs are shown below in Table 9.11-6.

Table 9.11-6. Forest Fire - Inhalation Screening Indices

Non-Rad Chemicals	Maximum Screening Index *[unitless; comparison of estimated concentration to benchmark value]*
Asbestos	6.00 x 10^{-1}
Lead	1.69 x 10^{-3}

The above SI values are below 1, indicating that calculated potential public and worker exposures are below the relevant benchmark values.

9.11.4.2 Accidental Exposure

Radiological

The accidental exposure to radiation bounding scenario (Scenario #6) results in doses to both public and workers that are below their respective acceptance criteria. Two scenarios are considered:

i) A worker spends additional time drilling, thereby increasing exposure time. The maximum calculated total dose is 8.69 x 10^{-1} mSv.

ii) The source is stronger than originally estimated, resulting in additional exposure. The maximum calculated total dose is 5.30 x 10^{-1} mSv.

These doses are below the regulatory limit of 50 mSv/y for NEW by 2 orders of magnitude.

Non-Radiological

As discussed in Section 9.3.7 of the DecomSA TSD, there is no exposure route to hazardous chemicals from the assessed activities. Therefore, no exposure to hazardous chemicals is expected in this bounding scenario.

9.11.4.3 Indoor Fire

Radiological

The indoor fire bounding scenario (Scenario #8) results in doses to non-human biota, public and workers that are below their respective acceptance criteria. The maximum calculated total dose is 1.12 $x10^{-3}$ mSv. This dose is below the regulatory limit of 50 mSv/y for NEW by 4 orders of magnitude.

Non-Radiological

The indoor fire bounding scenario (Scenario #9) results in exposure concentrations for non-human biota, public and workers that are below the appropriate exposure limit for each contaminant. Two scenarios are considered:

i) A fire in the fuelling machine room results in the release of lead. The maximum SI is shown in Table 9.11-7.

Table 9.11-7. Indoor Fire in Fuelling Machine Room - Screening Index (Inhalation only)

Non-Rad Chemicals	Maximum Screening Index *[unitless; comparison of estimated concentration to benchmark value]*
Lead	7.89 x 10^{-1}

ii) The inhalation SI for a fire in the boiler room (resulting in mercury release) are shown in Table 9.11-8.

Table 9.11-8. Indoor Fire in Boiler Room - Screening Index (Inhalation only)

Non-Rad Chemicals	Maximum Screening Index *[unitless; comparison of estimated concentration to benchmark value]*
Mercury	2.39 x 10^{-1}

9.11.4.4 Stack Collapse

Radiological

The ventilation stack collapse bounding scenario (Scenario #10) results in doses to both public and workers that are below their respective acceptance criteria. The maximum calculated total dose is 1.15 x 10^{-2} mSv. This dose is below the regulatory limit of 50 mSv/y for NEW by 3 orders of magnitude.

9.11.4.5 Risk Evaluation Conclusions

Each of the 10 bounding scenarios underwent a consequence assessment to determine the source term (radiological and chemical) involved, estimated dispersion/transport to receptor locations, and corresponding dose estimates at each receptor location. These dose estimates were assigned severity ratings. Each of the 10 bounding scenarios then underwent a likelihood assessment to determine their probability of occurrence and the probability mechanisms involved, i.e. the initiating events and conditional probabilities, as applicable. These probability estimates were assigned frequency ratings. Lastly, the severity ratings and frequency ratings for each bounding scenario were used, in conjunction with a risk matrix, to calculate a risk rating for each bounding scenario. Table 9.11-8 presents the risk matrix overlaid with all 10 bounding scenarios (abbreviated as B.Scn), according to their severity, frequency, and risk ratings.

Table 9.11-8. Risk Matrix Showing all Bounding Scenarios

Frequency Ratings	Severity Ratings				
	S0	S1	S2	S3	S4
F0	R0	R0 B.Scn.#3 B.Scn.#4	R0	R0	R1
F1	R0 B.Scn.#5	R0 B.Scn.#1 B.Scn.#2 B.Scn.#10	R0	R1	R2
F2	R0 B.Scn.#7	R0 B.Scn.#6 B.Scn.#8 B.Scn.#9	R1	R2	R3
F3	R0	R1	R2	R3	R3

Notes:
R0 - The risk is negligible; no further action is necessary.
R1 - The risk is tolerable, further protective measures are not essential but should be considered.
R2 - The risk for internal events is unacceptable, additional engineered solutions must be put in place to protect against the risk. For external events that cause damage and injury, but not due to failure of the process, the risk is tolerable.
R3 - The risk is unacceptable, the proposed process is inherently unsafe, major modifications to the proposed design are required.
See Table 4-4 in the DecomSA TSD for descriptions of Frequency Ratings.
See Table 4-5 in the DecomSA TSD for descriptions of Severity Ratings.

As shown in Table 9.11-8, all bounding scenarios were assessed to have negligible risk scores. The potential risks to non-human biota are addressed in the EcoRA TSD.

9.11.5 Non-Radiological Accidents and Malfunctions Effects

This section presents the predicted effects of the non-radiological accidents and malfunctions as reported in the DecomSA. As discussed above, conventional accidents and malfunctions are events that involve only non-radiological substances, and therefore have no potential for release of radioactivity.

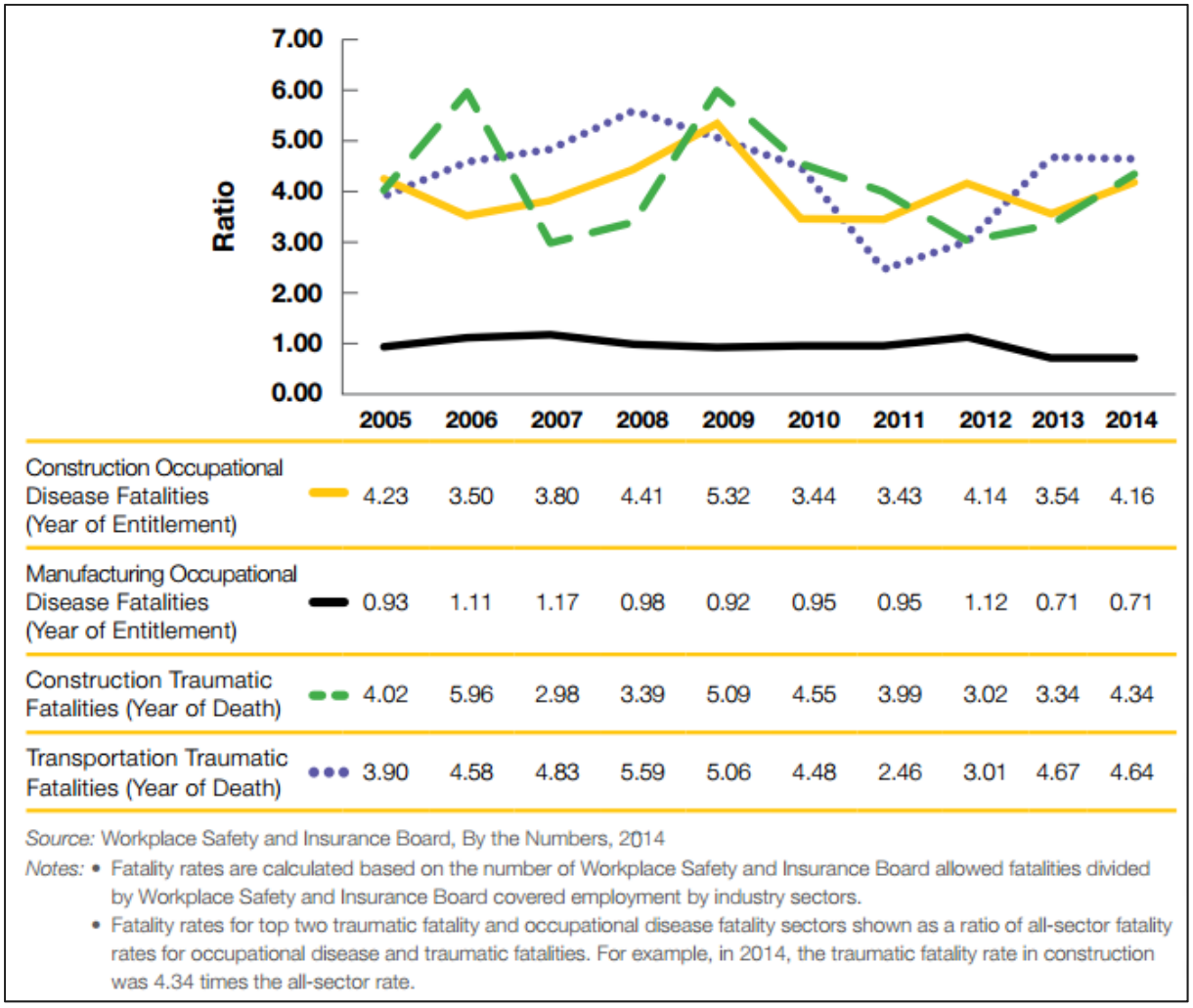
9.11.5.1 Conventional Accidents, Malfunctions & Safeguards

Conventional Accidents and Malfunctions Statistics for Construction Projects

Major construction projects (which includes decommissioning activities) involve the interaction of personnel with hazards such as moving and stationary heavy equipment/machinery, electricity and temporary power lines, working at heights, working in confined spaces, working with potentially unstable structures, etc. In contrast to specific industrial facilities where each activity/position is routine, with little variability, well characterized, and the occupational settings are well defined, construction projects can involve several ad-hoc tasks performed by workers as part of the execution of a larger overall activity. Such projects may also use equipment that are generally rotated from one site to another (e.g., cranes). In these situations, conventional occupational accidents and malfunctions are governed by the limits of human performance as well as the reliability of the equipment (related to its maintenance).

According to the Ontario Ministry of Labour (MOL) 2014-2015 report entitled *Occupational Health & Safety in Ontario* (MOL 2015), from 2005 to 2014, 28.3% of traumatic fatalities and 28.0% of occupational disease fatalities occurred in the construction sector, while this sector accounted for 7.0 percent of total employment under provincial jurisdiction (2014). These statistics indicate that higher fatality rates occur in the construction industry compared with other industrial sectors. The MOL (2015) report also noted that for the last 10 years, construction and transportation sectors has been the top two sectors in terms of the fatality rates (depicted in Figure 9.11-1 below).

Figure 9.11-1. Comparison of Conventional Accident Statistics by Sector (MOL 2015)



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Construction Occupational Disease Fatalities (Year of Entitlement)	4.23	3.50	3.80	4.41	5.32	3.44	3.43	4.14	3.54	4.16
Manufacturing Occupational Disease Fatalities (Year of Entitlement)	0.93	1.11	1.17	0.98	0.92	0.95	0.95	1.12	0.71	0.71
Construction Traumatic Fatalities (Year of Death)	4.02	5.96	2.98	3.39	5.09	4.55	3.99	3.02	3.34	4.34
Transportation Traumatic Fatalities (Year of Death)	3.90	4.58	4.83	5.59	5.06	4.48	2.46	3.01	4.67	4.64

Source: Workplace Safety and Insurance Board, By the Numbers, 2014

Notes:
- Fatality rates are calculated based on the number of Workplace Safety and Insurance Board allowed fatalities divided by Workplace Safety and Insurance Board covered employment by industry sectors.
- Fatality rates for top two traumatic fatality and occupational disease fatality sectors shown as a ratio of all-sector fatality rates for occupational disease and traumatic fatalities. For example, in 2014, the traumatic fatality rate in construction was 4.34 times the all-sector rate.

The fatality rate in the construction sector has not appeared to change over this time period. This consistency over time suggests that the rates of these accidents and malfunctions in these sectors are being controlled by human performance in typical industry practices, and as such, rates have reached an as-low-as-reasonably-possible state under the existing health and safety regulatory framework. Given the awareness of the roles of human factors in these accidents and malfunctions, provisions including training, procedures, and safeguards have been put in place by CNL to achieve as-low-as-reasonably-possible accidents and malfunctions rates.

It should also be noted that the work-place accident statistics mentioned above are aggregated data collected from a large number of industrial sectors, some of which may not have robust occupational health and safety programs. In contrast, the work carried out for the NPD closure project will be subject to additional oversight, as a result of the safety culture developed in the nuclear industry.

Fundamental Safety

Principles

The Fundamental Safety Principles outlined in the Safety Analysis Report (Athauda-Arachchige 2015) are expected to be followed for decommissioning activities. Information on these principles is presented below, based on Athauda-Arachchige (2015) but with revisions to apply to conventional safety of the planned decommissioning activities.

A safety culture governs the actions of all individuals and organizations engaged in activities related to radioactive waste management. The principles relating to safety culture include operating organization responsibility, quality and management system, human factors, and safety analysis and verification.

- Operating Organization Responsibility

The primary responsibility for assuring safety rests with CNL as the licensee. This responsibility includes, but is not limited to, the provision of trained, qualified staff and the provision of competent engineering and technical support staff.

The organization, responsibilities and processes are in place to: satisfy the CNL's policies on Health and Safety, and Environment; to ensure conformance with the Radiation Protection (RP) Program; to manage radiological hazards; and, to establish a safe working environment that ensures the protection of environment and personnel. See Section 10.2 for a description of relevant CNL management programs.

- Quality Assurance

A Management System meeting the requirements of the Canadian Standards Association Standard N286 is applied to the decommissioning phases of the project. All CNL employees must comply with the requirements of CNL's Quality Policy and those of the Management Manual (see Athauda-Arachchige 2015 for specific references).

- Feedback of Experience

CNL maintains an Operational Experience Database containing information obtained internally at CNL. In addition to this, CNL also has access to external operating experience. CNL has examined both of these sources of data to identify the lessons learned (LLD) from previous operating experience that may be relevant for planning decommissioning activities.

- In-design Mitigation

Features are included in the project design for the purpose of pre-empting possible environmental effects (e.g., isolation and containment of inventory) (See Section 4.1.1 of this EIS).

Relevance to Project Decommissioning Activities

The activities identified for the NPD closure project share similarities to those of conventional construction and demolition projects. The hazard identification process presented in Section 7 and Appendix B of the DecomSA TSD identified 29 conventional accident and malfunction scenarios, 13 of which have the *potential* for severe consequences (e.g. fatalities). Five (5) of these 13 represent the potentially severe consequences of natural phenomena (i.e., from forest fires, tornados, flooding, and earthquakes), which are considered in Section 9.13 (Effects of the project on the Environment) this EIS. The remaining 16 scenarios represent the potentially severe consequences of: conventional construction accidents and malfunctions (e.g. severe fall or equipment-related injury); electrocution; crane failure and load drop (and resulting crushing injuries); and structural collapse (and resulting crushing injuries) outlined in Appendix B of the DecomSA TSD.

In contrast to typical construction projects (and typical safeguards), the project's planned decommissioning activities will be performed with an *additional* degree of training, procedures, and safeguards in place since this project involves decommissioning of an historic nuclear reactor and radiation protection principles are involved. Staff and contractors will receive orientation to ensure they are aware of decommissioning activities, hazards, and emergency procedures. Additionally, hazards to personnel will be identified through work control documents, and eliminated or controlled using engineered controls, administrative controls, and PPE. This includes provisions for common construction hazards such as working at heights, working with electricity, confined spaces, etc.

To further emphasize the role of safety, a non-exhaustive list outlining many examples of safeguards that will be applied to the project is presented in Section 7.4 of the DecomSA TSD covering conventional accidents and malfunctions safeguards, routing/transportation safeguards, fuelling safeguards, weather and natural event safeguards, security safeguards, grouting safeguards, and many other topics.

Therefore, given the fundamental safety principles that govern project planning and execution, and the many safeguards involved, conventional accidents are considered to be managed to as low as reasonably possible.

9.12 Cumulative Effects

9.12.1 Background

Section 19(1) of *CEAA* (2012) requires the assessment of cumulative environmental effects, defined in CEAA (2012) as effects that are "*likely to result from the designated project in combination with other physical activities that have been or will be carried out.*" Similarly, REGDOC 2.9.1 prescribes that:

- the applicant shall assess any residual adverse environmental effects of the project in combination with other past, present or reasonably foreseeable projects and/or activities within the study area, as per *CEAA* (2012), Paragraph 19(1)(a); and
- the approach and methods should be consistent with the CEAA's Operational Policy Statement on Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012 (CEAA 2015).

According to the CEAA (2015) Operational Policy Statement:

"The approach and level of effort applied to assessing cumulative environmental effects in a project EA is established on a case-by-case basis taking into consideration:

- *the characteristics of the project;*
- *the risks associated with the potential cumulative environmental effects;*
- *the state (health, status or condition) of VCs that may be impacted by the cumulative environmental effects;*
- *the potential for mitigation and the extent to which mitigation measures may address potential environmental effects; and,*
- *the level of concern expressed by Aboriginal groups or the public.*

All cumulative environmental effects assessments should include the five steps described below – scoping, analysis, mitigation, significance, and follow-up. EA documentation must clearly explain and justify the methodologies that have been used to assess cumulative environmental effects.

1. ***Scoping** – identifying VCs for which residual environmental effects are predicted, determining spatial and temporal boundaries to capture potential cumulative environmental effects on these VCs, and examining the relationship of the residual environmental effects of the designated project with those of other physical activities.*
2. ***Analysis** – describing the methodologies (including assumptions and conclusions made using professional judgement) and including data and community and traditional Aboriginal knowledge.*
3. ***Mitigation** – Mitigation measures must be identified for any significant adverse cumulative environmental effects.*
4. ***Significance** – considering the significance of likely cumulative environmental effects, taking mitigation measures into account.*
5. ***Follow-up** – developing follow-up programs that address the cumulative environmental effects."*

CEAA (2015) also states:

"Accordingly, the environmental effects of accidents and malfunctions must be considered in the assessment of cumulative environmental effects if they are likely to result from the designated project in combination with other physical activities that have been or will be carried out."

9.12.2 Assessment of Cumulative Effects

Since the project has no residual effects, cumulative effects assessment is therefore not required. The following discussion is provided in recognition of the identification of the Ottawa River as a key stakeholder concern.

Two dams upstream of the NPD site (Des Joachims dam and McConnell dam) are scheduled to undergo improvements from 2017 to 2021. These OPG projects involve in-water works, and additional spilling of water from the dam may be required to lower reservoir levels (Bradley 2017). The resulting increased flows may cause erosion and effects on downstream fish habitat. Since the NPD closure project does not involve any in-water work, and no habitat effects are expected, no cumulative effects on fish habitat are expected. The potentially elevated levels of mercury in the upstream reservoirs (a common characteristic of dam reservoirs) may also result in a change in the mercury levels in the Ottawa River downstream. The maximum predicted concentration of mercury in the Ottawa River is $2x10^{-14}$ mg/L occurring during the Post-Institutional Controls phase. The peak mercury concentration in the Ottawa River resulting from the NPD closure project is negligible, and over ten orders of magnitude below applicable guidelines.

A number of projects may take place at the CRL site (e.g., Near Surface Disposal Facility, infrastructure decommissioning, environmental remediation, National Research Universal shutdown, etc.). Based on the assessment in this EIS, the maximum radioactivity in the Ottawa River surface water predicted from the NPD closure project is <1 Bq/L. Current measured concentrations of tritium upstream and downstream of the NPDWF are <2 Bq/L. For perspective, the current drinking water guideline for tritium is 7,000 Bq/L (Health Canada 2017). Therefore, the predicted total levels correspond to a dose that is orders of magnitude below regulatory criteria. Thus, radioactivity in the Ottawa River resulting from the NPD closure project is negligible; therefore, there are no potential cumulative effects driven by the NPD closure project.

If subsequent monitoring identifies a residual effect not predicted or anticipated by the EIS, the cumulative effects of the project would be re-evaluated.

9.13 Effects of the Environment on the Project

In accordance with the EIS Guidelines (CNSC 2016a) and associated regulatory documents (such as REGDOC 2.9.1, CNSC 2016b), this EIS includes an assessment of the potential effects of the environment on the project. This assessment was carried out as an evaluation of how climate change, severe weather conditions and other environmental events may interact with and potentially alter the condition and function of the project, such that there would be resultant effects on the environment or human health and safety. The approach to the assessment of the effects of the environment on the project, detailed below, involved:

- Identifying and describing those environmental conditions (i.e., events) with a reasonable probability of occurring and that have potential to affect the project, including associated hazards to workers or the public;
- Describing the significance of any likely effects on the project, including hazards to workers and the public (if any).

The effects of the environment on the project are assessed in the:

- DecomSA TSD (for humans in the Decommissioning Execution phase);
- PostSA TSD (for humans in the Post-Institutional Controls phase); and
- EcoRA TSD (for non-human biota in both the Decommissioning Execution and Post-Institutional Controls phase).

Each TSD assesses a number of scenarios, including scenarios where the environment affects the facility. This section provides an overview of the results of these assessments for a number of environmental effects on the project, including climate change, forest fires, floods, earthquakes, severe weather such as tornados, lightning strikes, ice storms, and changes to the Ottawa River.

Additional discussion of potential effects of the environment on the project with respect to accidents and malfunctions is provided in Section 9.11.

9.13.1 Regulatory Guidelines and CNL Documents

The EIS Guidelines (CNSC 2016a) dictate that the information in Appendix A.3.9 of REGDOC 2.9.1 (CNSC 2016b) be used to assess the potential effects of the environment on the project. As per REGDOC 2.9.1 (CNSC 2016b):

> *the EIS shall take into account how the environment could adversely affect the project. The applicant shall also take into account any potential effects of climate change on the project, including an assessment of whether the project might be sensitive to changes in climate conditions during its lifecycle.*
>
> *Some adverse environmental conditions are flooding, severe weather, biophysical hazards (such as algae), geotechnical hazards and seismic events.*

9.13.2 Climate change

There are many factors that can affect the rate of release of contaminated material from the facility. The climate of the region plays a large role in determining how contamination moves and dilutes once it leaves the facility. The models that have been used to predict long term releases, as discussed in the PostSA TSD, include considerations for the potential changes in the climatic setting. During the warm period, the climate is assumed to remain broadly similar to the present day. However, climate change may also result in an increased occurrence and/or severity of extreme weather phenomena, such as flooding, drought, and forest fires. In addition, several features, events or processes that will occur as a result of climate changes have been acknowledged in Appendix C of the PostSA TSD and thus incorporated into the scenarios

evaluated in the PostSA TSD (e.g. flooding and surface erosion, changes to the Ottawa River). The potential effects of these phenomena are discussed in subsequent sections. In addition to the normal evolution scenario, disruptive event scenarios are also considered, including early glaciation.

9.13.3 Glaciation

Current understanding of the long-term effects of global warming indicates that the next ice age will not occur for 100,000 y as a result of anthropogenic climate change (Ganopolski et al. 2016). However, the PostSA TSD assesses an early glaciation scenario, which assumes that the entire facility would be removed and distributed by the glacier after 60,000 y. Associated events include flooding and surface erosion, and changes to the Ottawa River.

Concentrations of contaminants near the current site would actually decrease due to the dispersion, but concentrations further from the facility would increase. Overall, concentrations are expected to be very low. The resulting dose (0.003 mSv/y) to human receptors is elevated relative to the normal evolution scenario, however it is still well below the dose criterion for disruptive events (1 mSv/y). The peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration (0.0046 mg/L) is unchanged from the normal evolution scenario. As shown in the EcoRA TSD, all contaminant concentrations were below screening levels for non-human biota.

9.13.4 Forest fire

Given that the NPD is surrounded by nearby forests, the occurrence of a forest fire has the potential to affect the project. In the DecomSA TSD, it was determined that the annual probability of forest fire on the NPD property is 2.8×10^{-3}. Forest fires could be caused by natural (e.g., dry conditions and lightning) or anthropogenic sources. As such, forest fires are also considered in Section 9.11 above. A large forest fire could potentially engulf the entire above grade structure, causing damage and potentially releasing both radiological and chemical contamination.

The EcoRA TSD found that all contaminants (radiological and non-radiological) were below screening levels, and as such did not warrant further investigation. The DecomSA TSD found that all worker and public exposures were also below acceptable limits for both radiation and chemicals. The maximum calculated total dose received for workers and public was 2.84×10^{-4} mSv. Maximum SIs for asbestos and lead were 6.0×10^{-1} and 1.69×10^{-3} respectively. An SI value below one indicates that no effects are expected. Forest fires are unlikely to affect the project following the Decommissioning Execution phase when the facility is below grade.

9.13.5 Tornado

The distribution of tornadoes, particularly in Ontario, appears to be random and extremely localized. A tornado usually affects a limited area and only for a short period of time; however, serious property damage and injury, including fatalities, may occur along its path. The annual probabilities of the NPD site falling within the affected area of an EF-2 tornado has been calculated as 6.2×10^{-5} as shown in the DecomSA

TSD. An EF-2 tornado is not anticipated to cause serious damage to the facility, but may cause damage to the ventilation system or release surface contamination.

As calculated in Section 9 of the DecomSA, the maximum predicted dose calculated for the tornado scenario is 7.97×10^{-8} mSv. The maximum SIs (environmental concentrations compared to relevant worker and public benchmarks) for asbestos and lead were 6.60×10^{-1} and 2.93×10^{-3} respectively. An SI value below one indicates that no effects are expected.

During the life of the ventilation stack, a tornado could potentially result in the collapse of the ventilation stack, which is discussed in Section 9.11.4.4 (For further information, please see the EcoRA and DecomSA TSDs).

9.13.6 Flood

A flood at the NPD site could occur due to high water in the Ottawa River, heavy precipitation and/or failure of the dams on the Ottawa River upstream of the site. A flood at the NPD site would have the potential to remove surface contamination from the above ground facility and carry it downstream.

The facility Safety Analysis Report (Athauda-Arachige 2015) reports that flooding from high water levels in the Ottawa River is unlikely due to control of the water level by the Des Joachims Generating Station. Based on conservative estimates of annual flooding the probability that a given area falls within a localized flood affected area is 7.3×10^{-3}, as calculated in the DecomSA TSD. The facility Safety Analysis Report (Athauda-Arachige 2015) notes this localized flooding from heavy precipitation is extremely unlikely due to the drainage provided by the site topography. The facility is also currently assessed for damage following any flooding event. Flooding also has the potential to occur as a result of dam failure. The facility Safety Analysis Report determined that the probability of dam failure is negligible (Athauda-Arachige 2015) (For further information, please see the EcoRA/DecomSA TSDs).

Flooding was assessed as part of the surface erosion disruptive event scenario in the PostSA TSD. The highest resulting dose (0.0005 mSv/y) to human receptors is elevated relative to the normal evolution scenario, however it is still well below the dose criterion for disruptive events (1 mSv/y). The peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration (0.0046 mg/L) is the same as in the normal evolution scenario. As shown in the EcoRA TSD, all contaminant concentrations were below screening levels for non-human biota.

9.13.7 Earthquake

The NPD site lies within a zone categorized as a region with moderate seismic risk. As such, the likelihood of an earthquake of sufficient strength to damage the buildings is estimated to be less than 4×10^{-4}, as shown in the DecomSA TSD. This scenario is considered as a part of hazard identification in the DecomSA, however it is bounded by other scenarios considered during the Decommissioning Execution phase (including forest fire, tornado, and conventional health and safety). In the Decommissioning Execution phase, an earthquake could result in the collapse of some structures, including the ventilation stack. The potential effects of the ventilation stack collapsing are discussed in Section 9.11.4.4.

During the Post-Institutional Controls phase, the facility will be filled with grout, and will be entirely below ground, therefore eliminating the risk of collapse. However, if an earthquake of sufficient strength was to occur, ground acceleration could result in degradation of the barrier properties of the grouted facility which would result in faster release of contamination in groundwater. This is assessed as part of the engineering degradation disruptive event scenario in the PostSA TSD. The maximum resulting dose received by humans is 0.0003 mSv/y, and is well below the dose criterion for disruptive events (1mSv/y). The peak groundwater lead concentration (0.015 mg/L) exceeds applicable guidelines for lead, however the PostSA TSD determined that there was no likely exposure pathway from groundwater to human health. As discussed in the EcoRA TSD, no effects were predicted for non-human biota.

9.13.8 Lightning Strike

A lightning strike hitting the facility is a realistic possibility. Lightning strikes generally happen during thunderstorms, which are more common during the warmer months of the year (May to September). The potential effect of a lightning strike would depend on what phase of the decommissioning process the strike occurred in. In the current SwS phase, and early in the Decommissioning Execution phase, a lightning strike that hits the facility could result in a fire or other damage. The potential effects of a forest fire, from any source, including lightning, are discussed in Section 9.13.4, and in the DecomSA and EcoRA TSDs. No potential effects from a lightning strike are expected after the Decommissioning Execution phase.

9.13.9 Ice Storm

Ice storms are caused when the atmosphere is layered - a layer of warm air above the denser cold air near surface. As precipitation falls in the warm layer, rain forms. The rain then falls into the shallow cold layer and freezes. Ice storms can damage structures because of the weight of accumulated ice. Ice storms are known to occur in the region of NPD. On average, Ottawa and Montreal receive freezing precipitation 12 to 17 days a year. However, this type of precipitation generally lasts only a few hours. Though it did not occur at the NPD site, a severe ice storm occurred in Eastern Ontario and Quebec; over 90 millimetres of freezing drizzle fell during the 5-day storm. This magnitude has an annual probability of occurrence of about 1 in 100 (Ontario Hydro 1998). The potential effects of such an ice storm may include the buildup of ice on buildings, power lines and other structures. This could result in a loss of power, and potentially the loss of ventilation. It is not expected that an ice storm would result in any significant damage to structures. It is possible, in the future, that a severe ice storm could result in the collapse of the ventilation stack, if the concrete has degraded sufficiently to weaken the structural integrity. The potential effects of ventilation stack collapse are discussed above in Section 9.11.4.4.

9.13.10 Changes to the Ottawa River

The Ottawa River is a dominant surface water feature of the area. All surface drainage on the NPD site is to the Ottawa River. Changes to the flow, level or location of the Ottawa River could affect the releases from the project and the resultant effects to people and the environment. If the water level of the Ottawa River were to drop significantly, the groundwater could begin to discharge to the shoreline, as opposed to in the river. This would result in the contaminants from the facility being released onto the shore, and this has been assessed in the PostSA TSD. This is expected to result in higher shoreline sediment

concentrations in a small patch near the discharge site and a peak dose of 0.004 mSv/y, however since this scenario is considered to be extremely conservative, it is not compared to dose criteria. The peak lead concentrations in all media except groundwater are below all applicable guidelines. The peak groundwater lead concentration (0.0046 mg/L) is the same as in the normal evolution scenario. As discussed in the EcoRA TSD, no effects were predicted for non-human biota.

The collapse of the ventilation stack, which is being retained to provide habitat for chimney swifts, could be caused by changes in the Ottawa River, and is considered in the DecomSA TSD. This scenario is considered in Section 9.11 Accidents and Malfunctions.

Flooding and surface erosion was assessed as a disruptive event scenario in the PostSA TSD. All doses received were estimated to be well below the relevant dose criterion. These results are summarized in Section 9.8.3 and in the PostSA TSD.

10 MITIGATION MEASURES

This section provides a summary of the mitigation measures identified in Section 9 to satisfy regulatory requirements outlined in the CNSC (2016a) EIS Guidelines. CNL, as project proponent, will be responsible for implementation of the proposed mitigation measures.

10.1 Regulatory Requirements

The CNSC Reg Doc 2.9.1 and Section 2 of CEAA define mitigation as "*…the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or other means" (*CEAA 2012 and CNSC 2016b*).*

The EIS Guidelines (CNSC 2016a) state that:

> *Every EA conducted under the CEAA 2012 will consider measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project. Measures that are technically and economically feasible include application of best industry practices, pollution prevention principles such as best available technology and techniques economically achievable (BATEA), and radiation protection principles such as keeping radiation exposure and doses as low as reasonably achievable (ALARA).*
>
> *Each measure will be specific, achievable, measurable and verifiable, and described in a manner that avoids ambiguity in intent, interpretation and implementation. Mitigation measures may be considered for inclusion as conditions in the EA decision statement and/or in other compliance and enforcement mechanisms provided by other authorities' permitting or licensing processes.*
>
> *As a first step, the proponent is encouraged to use an approach based on the avoidance and reduction of the effect(s) at the source. Such an approach may include the modification of the design of the project or relocation of project components.*
>
> *The EIS will describe the standard mitigation practices, policies and commitments that constitute technically and economically feasible mitigation measures and that will be applied as part of standard practice regardless of location (including the measures directed at mitigating adverse socio-economic effects). The EIS will then describe the project's environmental protection plan and its environmental management system, through which the proponent will deliver this plan. The plan will provide an overall perspective on how potentially adverse effects would be minimized and managed over time. The EIS will further discuss the mechanisms the proponent would use to require its contractors and sub-contractors to comply with these commitments and policies and with auditing and enforcement programs.*

The EIS will then describe mitigation measures that are specific to each environmental effect identified. Measures will be written as specific commitments that clearly describe how the proponent intends to implement them and the environmental outcome the mitigation is designed to address. The EIS will describe mitigation measures in relation to species and/or critical habitat listed under the Species at Risk Act (SARA). These mitigation measures will be consistent with any SARA permit, applicable recovery strategy and/or action plan.

The EIS will specify the actions, works, minimal disturbance footprint techniques, best available technology, corrective measures or additions planned during the project's various phases to eliminate or reduce the significance of potential adverse effects. The impact statement will also present an assessment of the effectiveness of the proposed technically and economically feasible mitigation measures. The reason(s) for determining if the mitigation measure reduces the significance of a potential adverse effect will be made explicit. The proponent is also encouraged to identify mitigation measures for effects that are adverse although not significant.

The EIS will indicate what other technically and economically feasible mitigation measures were considered, and explain why they were rejected. Trade-offs between cost savings and effectiveness of the various forms of mitigation will be justified. The EIS will identify who is responsible for the implementation of these measures and the system of accountability.

For proposed mitigation measures for which there is little experience or that have questionable effectiveness, the potential environmental risks and effects – should those measures not be effective –will be clearly and concisely described. In addition, the EIS will identify the extent to which technological innovations will help mitigate environmental effects. Where possible, it will provide detailed information on the nature of these measures, their implementation and management and how these are integrated in the follow-up program.

The IAEA SSG-29 specific safety guide for Near Surface Disposal Facilities for Radioactive Waste contains best practice guidance, though it does not comprise regulatory requirements. It states *"that potential adverse impacts can be mitigated to an acceptable degree, technical, economic, social and environmental factors being taken into account" (*IAEA 2014a*).*

For SARs defined by the federal *Species at Risk Act* (*SARA* 2002), pursuant to subsection 79(1) of that Act, Responsible Authorities under the *Canadian Environmental Assessment Act* must notify the appropriate federal Minister if any listed wildlife species, its critical habitat or the residences of individuals of that species may be adversely affected by the project. Pursuant to subsection 79(2) of the *Species at Risk Act*, if the project is carried out, Responsible Authorities must also ensure that measures are taken to avoid or lessen those effects and to monitor them; these measures must be taken in a way that is consistent with any applicable recovery strategy and action plans (*SARA* 2002).

10.2 CNL Management Programs

The following presents an overview of CNL's existing programs related to environment, safety and security. CNL is responsible for and committed to providing to the health and safety of its employees and the public and the protection of the environment. Mitigation measures developed for the NPD closure project will be developed in alignment with these programs. The relevant management programs include, but are not limited to:

Radiation Protection Program

CNL's Radiation Protection Program is designed and implemented so that CNL complies with, or exceeds, the level of radiation safety that is required by the relevant regulations pursuant to the NSCA and CNL's Health and Safety Policy.

The fundamental objectives of the CNL Radiation Protection Program are to:

- limit the doses to less than the regulatory limits;
- limit doses to employees and members of the public to levels as low as reasonably achievable, social and economic factors being taken into account (ALARA principle); and,
- prevent detrimental non-stochastic (deterministic) health effects caused in employees and members of the public by CNLs use of radiation.

These objectives are achieved through facility design, staff training, administrative exposure control procedures, contamination control requirements, and work planning and supervision. A combination of Action Levels and dose management tools are used to keep radiation doses to employees below regulatory limits.

Environmental Protection Program

CNL's Environmental Protection Program provides compliance with applicable environmental regulatory requirements and requirements that CNL has adopted as a matter of policy. The program is registered under ISO 14001 and is designed to provide for the protection of the environment and the public in relation to CNL's activities. The Environmental Protection Program incorporates the following key elements of the ISO-14001 Environmental Management System (EMS) Standard:

Environmental Policy

- Commitment to pollution prevention.
- Setting environmental objectives and targets to support continual improvement of environmental performance.
- Complying with applicable laws, recognized standards and guidelines applicable to CNL activities.
- Reviewing the impacts of CNL facilities, projects, services and products on the environment.

Planning

- Identification and determination of significance of those environmental aspects associated with CNL's activities.
- Establishment of environmental objectives and targets.
- Development of appropriate plans and/or programs to achieve the objectives and targets.

Implementation and Operation

- Defining and documenting appropriate roles and responsibilities.
- Establishment and maintenance of operational controls over environmental aspects.

Checking and Corrective Action

- Monitoring to verify environmental performance and compliance.
- Maintaining non-conformance and corrective and preventative action procedures.

Management Review

- Periodic review by CNL's management to ensure the ongoing suitability, adequacy and effectiveness of the EMS.

Occupational Health and Safety Program

CNL's Occupational Safety and Health Program is designed to provide for the protection of workers and public health and safety in relation to CNL activities. CNL and its contactors will meet all applicable health and safety legislative requirements. Canadian Nuclear Laboratories requires that contractors and their subcontractors maintain a level of safety equivalent to that of CNL employees while on-site.

All activities related to the NPD closure project will be covered by either CNL's work permits with completed Radiological Safety Assessments, as required, or by approved work procedures. A Work Permit System for all non-routine work involving potential health and safety hazards provides that hazards are evaluated and appropriate protective measures taken.

Emergency Preparedness Program

CNL's Emergency Preparedness Program comprises planning and response elements to provide that processes are in place to control and mitigate the consequences of an emergency (whether related to a nuclear/radiological or conventional incident) both on- and off-site. In accordance with the Ontario Nuclear Emergency Plan, the program includes infrastructure, assigned response staff and other resources, and periodic exercises to test and demonstrate emergency preparedness. The Emergency Preparedness Program takes into consideration guidance provided in the CNSC's Nuclear Emergency Preparedness and Response document (CNSC 2016d).

Fire Protection Program

CNL is dedicated to the delivery of a compliant Fire Protection Program that will provide the highest level of fire and life safety to all CNL employees and facilities. The objectives of the Fire Protection Program include preventing fire losses, providing responsible fire protection management, demonstrating compliance to applicable fire protection codes and standards, and providing reliable facilities from a fire protection perspective.

The Fire Protection Program provides services including developing fire prevention processes and conducting fire safety inspections. Fire hazard analyses, code compliance reviews and fire protection screenings are also conducted as part of the program.

10.3 Scope

Mitigation is the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means. The proponent must describe general and specific measures intended to mitigate the potentially adverse environmental effects of the project. The proponent must indicate which measures respond directly to statutory or regulatory requirements.

The proposed mitigation measures for the project are summarized by project phase in Table 10.3-1. In the Post-Institutional Controls phase, no mitigation measures have been identified beyond in-design mitigation measures (such as the delay of contaminant transport through grouting). In-design mitigation measures are discussed in Section 3 of the PostSA TSD and Section 4.1 above. The mitigation measures below have been developed based on the current understanding of the project. As the project approaches detailed work planning, additional mitigation measures may be developed as required. Specific plans outlining environmental protection measures will be developed by contractors engaged to undertake the decommissioning activities, ensuring that CNL programs are adhered to and mitigation measures defined as part of this EIS are incorporated.

Information on methods, procedures and policies associated with the proposed mitigation measures are also discussed and/or referenced below. The mitigation measures are described in further detail within each environmental component in Section 9 of this EIS.

In the table below, the asterisk denotes mitigation measures to be undertaken when working at night, or during inclement weather, or if triggered by chimney swift monitoring activities (i.e., disturbance or roost abandonment is detected).

Table 10.3-1. Summary of Mitigation Measures

Environmental Component	Environmental Sub-Component	Proposed Mitigation Measures
Decommissioning Execution Phase		
Atmospheric Environment (Section 9.2.3.2; Table 9.2-3)	Air Quality	Regular maintenance of machinery to efficiently reduce emissions
		Haulage trucks covered to minimize dust emissions
		Minimization of dust generation through planning and site layout
		Cover storage piles during heavy rainstorms
		Compaction of disturbed soil after completion of activities
		Minimization of drop heights for materials
		Barriers to prevent dispersion of materials
		Safe work practices for loading debris
		Avoidance of prolonged storage of debris
		Proper techniques for the use and handling of chemicals
		Roads and areas will be wetted/misted as needed in dry conditions to minimize dust generation
		Post speed limits on-site (see Terrestrial Environment) to minimize dust emissions
		Limit idling of vehicles and equipment on-site to minimize emissions (DeWaele 2013a)
		Dust suppression during demolition and material sizing activities
	Noise	Operation of batch mixing plant between 7 am and 7 pm only to be allowed outside this period in exceptional circumstances
		Limit decommissioning activities to between 7 am and 7 pm as much as possible
		Sequencing work to minimize the simultaneous operation of noisy equipment
		Location of the batch mixing plant at least 1 km from nearby residences (if possible)
		Direct piping of grout into facility, where reasonable
		Trucks operating at the site are well maintained with appropriate mufflers
		Placement of generator in enclosure to reduce noise (if required)
		Maintenance of noise levels in compliance with CNL's OSH requirements
		Post speed limits on-site (as described in Terrestrial Environment)
		Maintenance of roads in good condition to prevent uneven roadway
Surface Water Environment (Section 9.3.3.2; Table 9.3-3)	Site Drainage and Water Quality	Retention of existing vegetation (where feasible)
		Maintenance of low runoff velocities (control run-off)
		Impedance of rainwater inflow into facility with construction of concrete monolith
		Restriction on heavy construction equipment to within approved work areas
		Diversion of runoff away from exposed areas and stockpiles, and strategic placement away from concentrated stormwater flows
		Revegetation of disturbed areas after construction (seasonal)

Environmental Component	Environmental Sub-Component	Proposed Mitigation Measures
		Proper design, inspection and management of wash out pits and material storage site(s)
		Use of paved (impermeable) areas for stockpile laydown to reduce infiltration and cover prior to heavy precipitation
		Dust suppression measures (as described in Atmospheric Environment)
		Road maintenance activities, as per guidelines (TAC 2003; Morin 2015)
		Utilization of spill kits and secondary containment of storage tanks to contain releases from spillage or tank rupture (Morin 2015)
		Reuse wash out pit water for batch mixing plant (if possible); retention and emplacement of settled sediment in the facility
		Sediment and erosion controls consistent with Morin (2015)
Aquatic Environment (Table 9.4-3)	All	No additional mitigation measures identified. Mitigation measures taken in other environmental compartments which serve as pathways will reduce potential effects
Geological and Hydrogeological Environment (Section 9.5.3.2; Table 9.5-3)	Soil Quality	Survey and remediation of localized areas of contamination on a regular basis throughout the project
		Dust suppression and sedimentation, runoff and erosion control (see Atmospheric and Surface Water Environment)
		Proper design, inspection and management of wash out pits and material storage site(s)
		Spill prevention, management, practices and clean-up procedures (consistent with the Environmental Monitoring Program (DeWaele 2013b) and CNL's Management of Land and Habitat Procedure (Morin 2015) to minimize risk of accidental spills.
		Storage of only material expected to be clean in lay down areas
Terrestrial Environment (Section 9.6.3.2; Table 9.6-3)	Vegetation communities and wildlife	Dust and noise suppression measures (see Atmospheric Environment)
		Delineation of work areas, limiting project activities to disturbed areas, including wildlife exclusion fencing (if required)
		Posted speed limits in the Site Study Area and access road
		Site restoration: localized surface scarifying with a track machine to break up soil-compacted areas, top-dressed (as required), replanted with native vegetation, subsoil tilled and cultivated (as needed)
		Disposal of garbage on-site, particularly food waste, in proper containers to deter wildlife
	SAR	Employee training and site sweeps for SARs (milksnakes, nests, bats, barn swallows, monarchs) prior to work
		Completion of visual inspection for barn swallow nests and bat roosts in facility prior to decommissioning
		If work <400 m of bald eagle's nest, activities restricted during courtship and breeding periods (MNRF 2010d)
		No tree clearing planned, but if it is necessary, will avoid during bird breeding season (if possible) (Morin and Carr 2015)
		Limitation of decommissioning activities to between 7 am and 7 pm as much as possible (i.e., daylight hours, when chimney swifts are not roosting in ventilation stack)

Environmental Component	Environmental Sub-Component	Proposed Mitigation Measures
		Noisy equipment and activities minimum 5m and directed away from ventilation stack (MNRF 2013), but should preferably be located as far as possible to suppress noise
		Orientation all external lighting fixtures so that top of the ventilation stack is not illuminated*
Terrestrial Environment (Section 9.6.3.2; Table 9.6-3)	SAR	Keep demolition dust to a minimum, insofar as possible (see Atmospheric Environment dust mitigation measures) *
		Activities with substantial vibration and noise done between 7 am and 7 pm wherever possible, with 'soft-start' approach. Each time the activity is initiated after a period of inactivity (>24 hours), the disturbance levels will be gradually increased over a 30-minute period to allow chimney swifts an opportunity to acclimate. Noise and vibration should be minimized without compromising demolition requirements (MNRF 2013).*
		Major demolition activities should follow a planned schedule*
		Consideration of noise performance in selection of mechanical equipment and vehicles*
		Dramatic and sudden disturbances only between 7 am and 7 pm if possible*
		Noise level of audible warning devices should be kept to the OSH minimum*
		If significant vibration impacts cannot be avoided, consider relocation of sources away from ventilation stack (i.e., no direct line of sight) *
Ambient Radioactivity (Table 9.7-3)	All	Mitigation measures with respect to radiation doses to humans are considered in Human Health
Human Health (Section 9.8.3.2; Table 9.8-3)	All	Staff and contractor orientation to ensure awareness of decommissioning activities, hazards, and emergency procedures
		Signage to indicate where decommissioning work is taking place
		Development of work control documents to guide safe execution of the decommissioning activities
		Hazards will be identified through work control documents and eliminated or controlled using engineered controls, administrative controls, and PPE
		Regular updates to site personnel on changes in the proposed decommissioning work plans
		CNL health and safety programs in place to prevent and mitigate injury to personnel
		An NPD Emergency Procedure (Ingram 2017) is in place, and is consistent with CNL's Emergency Preparedness Program
	All	Emergency response is available through local municipal Fire Department
		Adherence to stop work procedures for power outages
		Overall site 'good housekeeping' will be upheld
		CNL Contractor Health & Safety Management Program
		Periodic communication update to local residents on the project construction activities, including: construction schedule, activities, dedicated contact person for inquiries and emergencies etc.

Environmental Component	Environmental Sub-Component	Proposed Mitigation Measures
		Radiological work assessments will be performed as detailed work packages are developed. They will include specific measures to reduce collective worker dose to the extent possible.
	All	Monitoring and reporting all internal and external doses received by NPD workers
		Utilization of air monitors, dosimeters, and bioassay as required to detect the spread and uptake of contamination
		Signage to indicate asbestos laydown/interim-storage areas.
		Procedures for handling and storage of abated asbestos (bagged). (MOE 1994)
		Sources of asbestos, PCBs, lead and mercury will be confirmed through characterization and will be clearly identified prior to executing activities.
Aboriginal Land and Resource Use (Section 9.9.3.2; Table 9.9-3)	All	Dust suppression measures (as described in Atmospheric Environment)
		Construction activities will generally occur between 7 am and 7 pm, with the overall objective of minimizing nuisance effects (i.e. Noise and traffic) on traditional resource users in the Local and Regional Study Areas. This should be subject to further discussion with Aboriginal groups. It is noted that special or emergency circumstances may require deviation from this restriction
		Periodic communication updates on project construction activities to Aboriginal groups is required, including: construction schedule, activities, dedicated contact person for inquiries and emergencies, etc.
Socio-Economic Environment (Section 9.10.3.2; Table 9.10-3)	All	Dust suppression measures (as described in Atmospheric Environment)
		Post speed limits on-site (as described in Terrestrial Environment)
		The transportation/haul route is limited to Highway 17 and the NPD site access road from the highway
		Review of a company's safety records which includes any traffic accidents or driver's records, as per CNL's contracting and hiring practices
		Construction activities will generally occur between 7 am and 7 pm with the overall objective of minimizing nuisance effects (i.e. noise and traffic) on residents in the Local and Regional Study Areas. This should be subject to further discussion with the local municipality. It is noted that special or emergency circumstances may require deviation from this restriction
		When a significant amount of off-site transportation is required (e.g., during raw material delivery), the timing of equipment and material shipping to the site should be staggered to minimize the contribution of the project to peak traffic volumes
		Restrict access to the licensed area via a fence with a locked gate to deter trespassing
		Periodic communication updates on project construction activities to local residents are recommended, including: construction schedule, activities, dedicated contact person for inquiries and emergencies etc.

Environmental Component	Environmental Sub-Component	Proposed Mitigation Measures
Institutional Controls Phase		
Surface Water Environment (Section 9.3.3.2; Table 9.3-3)	Site Drainage and Water Quality	Retention of existing vegetation (where feasible)
		Maintenance of low runoff velocities (control run-off)
		Impedance of rainwater inflow into facility with concrete monolith
Geological and Hydrogeological Environment	Groundwater Quality	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination
Post-Institutional Controls Phase		
Surface Water Environment	All	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination
Aquatic Environment	All	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination
Geological and Hydrogeological Environment	All	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination
Terrestrial Environment	All	In-design mitigation to isolate and contain the inventory in order to reduce the potential of groundwater contamination

Note:

* Denotes mitigation measures to be undertaken when working at night, or during inclement weather, or if triggered by chimney swift monitoring activities (i.e., disturbance or roost abandonment is detected).

10.4 Relation to EA Follow-up Program

The purpose of a EA follow-up program (see Section 12 of this EIS), in part, is to verify whether the required mitigation measures identified in the EIS were implemented effectively. This compliance monitoring on its own does not satisfy the requirements for a follow-up program, but serves to track conditions or issues during the project lifespan or at certain times (CNSC 2016b).

10.5 Consideration of Alternate Mitigation Measures

Alternate Chimney Swift Habitat

CNL has considered several alternate mitigation measures related to the chimney swifts, including building a replacement habitat that would mimic the current conditions and physical characteristics of the ventilation stack. There is uncertainty related to the success of the new alternative habitat due to an incomplete understanding what makes a roosting structure attractive to chimney swifts. In Canada's cold climate, artificial nesting chimneys have not been successful in attracting breeding chimney swifts or roosting groups. A panel of experts from academia, government agencies and NGOs was assembled by the project to discuss the challenges associated with alternative habitat available to chimney swifts in Canada. It was decided that the current preferred alternate is to retain the existing ventilation stack, ensuring minimal disruption to the thousands of chimney swifts that migrate to the NPD stack each year.

Dust Suppression Alternatives

CNL considered different dust suppression techniques during demolition, including wetting agents and fogging. It was determined that using these substances could introduce potential chemical contaminants into the system. Therefore, CNL chose to use water misting with added sand to absorb any standing water to reduce potential impacts to biota. The sand could then be used as backfill.

Dismantlement

CNL considered dismantlement to reduce noise effects. However, CNL instead chose mechanical demolition due to its advantages such as lower economic cost and less dose and conventional risk to workers. Considering these benefits, along with noise mitigation measures (e.g., restricting demolition activities to between 7am and 7pm where possible), mechanical demolition is the preferred option.

Alternate Strategies

Alternate strategies (e.g., the use of bentonite as fill, the use of a groundwater diversion system) were assessed in an early iteration of the PostSA to optimize the design of the current preferred strategy.

Other Alternatives

CNL decided to keep all decommissioning wastes on-site at NPD rather than shipment to CRL, thereby reducing traffic and reusing material as fill. Location of the batch mixing plant at the NPD site results in less traffic effects than if concrete batching was done elsewhere and batches were shipped to the NPD site.

11 CONCLUSION ON SIGNIFICANCE

11.1 Assessment Findings

This EIS discusses project-environment interactions, proposed mitigation measures, potential adverse residual effects after mitigation, determination of significance of adverse residual effects, and recommended monitoring and follow-up activities. Based on the assessment in Section 9, the NPD closure project will not result in any adverse residual environmental effects, including effects from accidents and malfunctions, cumulative effects, and effects of the environment on the project.

The absence of adverse residual effects during the Decommissioning Execution phase reflects the comprehensive management systems in place (e.g., CNL's Environmental Protection Procedures). The absence of adverse residual effects during the Institutional Controls and Post-Institutional Controls phases demonstrates the effectiveness of in-design mitigation measures and viability of the project.

During any phase of the project, including the years following closure, doses to members of the public are lower than the regulatory limit. The assessment shows that doses are lower than regulatory limits by a factor of at least 1,000.

Aboriginal, and public and stakeholder engagement identified interest in a number of VCs, including: water quality in the Ottawa River, chimney swift, and land use and planning. No residual effects were identified for these VCs.

11.2 Confidence in Assessment Findings

The facility has been in storage with surveillance for over 30 years with the same inventory that is proposed to be retained in the grouted facility, with no impact on the environment.

All proposed Decommissioning Execution activities will be carried out in accordance with CNL policies and procedures, provincial and federal regulations, and measures designed to mitigate effects on human health and the environment. The proposed technologies are known and proven. In-situ decommissioning has been in use for at least 50 years.

In the long term, following the defence-in-depth principle, the PostSA has demonstrated that the failure of any of the physical engineered barriers will not compromise the performance of the system. It should be noted that while time is elapsing and eventually leading to the degradation of the engineered barriers (which is taken into account in the assessment), the radioactivity is progressively decaying. The assessment has shown that the effectiveness of the engineered barriers over time and as they progressively degrade is adequate to protect the ever-decreasing radiological hazard at any given point in time.

The EIS highlights areas of uncertainty (e.g., contaminant concentrations, contaminant transport characteristics, land use near NPD, etc.) that could affect the EIS findings. Therefore, consistent with regulatory and international best practices, these uncertainties are addressed as follows:

- Process: it uses a systematic, transparent and auditable process for developing and analysing safety in all phases of the project;
- Comparison with regulatory safety criteria: The safety assessment results are orders of magnitude below these criteria; and
- Range of performance indicators: a wide range of indicators (e.g., releases, environmental concentrations, doses, etc.) has been used.

In addition, a range of scenarios has been assessed, to encompass possible conditions during all project phases. The range of results for the various scenarios is a very valuable confidence-building measure, as it demonstrates that even under a range of different assumptions and conditions, the safety criteria are met illustrating the intrinsic robustness of the system. This is further supported by observations of these engineered barriers' durability under natural conditions.

It is CNL's conclusion that with the identified mitigation measures, the NPD closure project is not likely to result in any adverse residual effects. Follow-up and monitoring activities (summarized in Section 12 below) will verify EA predictions and determine the effectiveness of mitigation measures.

12 FOLLOW-UP PROGRAM

This section provides a preliminary plan for a follow-up monitoring program to satisfy regulatory requirements outlined in the EIS Guidelines (CNSC 2016a). As the proponent of the project, CNL will be responsible for implementing and managing the proposed follow-up monitoring program. The responsible owner of the site, AECL (Government of Canada), will be responsible for the provision of funds to maintain the follow-up monitoring program.

CNL currently conducts environmental performance monitoring activities at the NPD site, including compliance and effluent monitoring programs as well as inspections and surveillance activities. The following are aspects of the current environmental performance monitoring that are currently reported on an annual basis:

- ambient radiation field surveys including gamma radiation measurements and passive air samples within the facility, to determine ambient tritium levels from discrete survey points from within the NPDWF;
- effluent monitoring program consisting of NPRI monitoring, airborne release monitoring through tritium and gross beta/gamma analysis of the ventilation stack emissions and waterborne release monitoring through tritium, gross beta-gamma, and non-radiological parameter monitoring of the sumps, as well as tritium and gross beta/gamma monitoring of groundwater diversion systems; and
- environmental monitoring consisting of tritium and Cs-137 analysis of the Ottawa River, as well as tritium analysis of water from surface soil and vegetation.

These monitoring activities will be updated to ensure the new objectives of the EA follow-up monitoring are met. CNL also performs routine monitoring, surveillance and testing activities of the NPDWF to detect any deficiencies in structures or safety features. Appropriate maintenance and repair activities are initiated based on inspection findings.

12.1 Preliminary Scope

The preliminary scope of the EA follow-up monitoring program covers the Decommissioning Execution and Institutional Controls phases of the Project. No monitoring or reporting will occur in the Post-Institutional Controls phase. Monitoring during the Institutional Controls phase will verify the anticipated performance of the concrete monolith. Recommendations are also provided on how to use this monitoring data during the initiation of the Post-Institutional Controls phase. The proposed follow-up monitoring program will be reviewed and adjusted on a regular basis in order to account for evolving site conditions, stakeholder perceptions, and any feedback from the monitoring program. Regulatory licence conditions may also stipulate additional monitoring not related to the EA follow-up program, but if this occurs, data will be shared to meet the collective requirements.

The final scope and framework of the EA follow-up monitoring program will incorporate feedback from stakeholders and regulatory authorities.

12.2 Regulatory Requirements

The CNSC (2016b) REGDOC-2.9.1 and *CEAA* (2012) both specify the need for a follow-up monitoring program to meet the following "generic program objectives": to verify the **accuracy of the EA predictions** (Objective 1); and to determine the **effectiveness of any measures implemented to mitigate potential adverse environmental effects** (Objective 2). The detailed follow-up monitoring program will be developed to ensure compliance with requirements specified in CSA standards N288.4, N288.5, N288.6 and N288.7 (CSA 2015a, 2016, 2012 and 2015b).

In addition, the IAEA-SSG-331 Pub1640 on the Monitoring and Surveillance of Radioactive Waste Disposal Facilities (IAEA 2014b) specifies that "*The monitoring programme for a disposal facility should include source and environmental monitoring programmes to assess public exposure and impact on the environment as well as to assess potential release pathways*" and "*The monitoring programme should include assessment of the performance of the disposal system for the operational and post-closure periods*" (IAEA 2014b).

12.3 Relationship of Follow-up Monitoring Program to Other Programs

CNL's Environmental Protection Program (CNL 2017a) is designed to ensure protection of the environment and the public from CNL's activities. Adherence to this program ensures that potential environmental adverse effects resulting from CNL activities are prevented or mitigated. The program includes requirements for:

- Identification and assessment of significant environmental aspects related to CNL's operations;
- Management of radioactive emissions;
- Management of radioactive waste;
- Management of non-radioactive waste;
- Radiological and non-radiological effluent and environmental monitoring; and
- Environmental incident report and investigation.

CNL is committed to achieving continual improvement in environmental performance through its management systems. CNL manages environmental related matters through an existing Environmental Management System (EMS). The EMS is registered within the requirements of the International Organization for Standardization 14001:2004 standard (ISO 2004). It includes compliance and improvement systems to evaluate areas for improvement or trending. It will continue to be implemented for the NPD Closure Project and will be updated, as needed, as part of an annual management review process. As site conditions and monitoring dictate, or as new technology emerges, CNL will adaptively manage site practices and the monitoring program to meet the defined objectives. This may include regular evaluation of predictive models; which will be defined in the detailed follow-up monitoring program.

If the follow-up monitoring program identifies that adverse environmental effects are greater than predicted, then CNL will evaluate whether they result in changes to the conclusions in this EIS. If changes are confirmed, then CNL will evaluate the need for revised mitigation actions and management practices to

manage effects. Where the need for revised mitigations is identified, they will be developed and implemented.

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.

12.5 Preliminary EA Follow-up Monitoring Program

The proposed monitoring and follow-up activities may be modified and activities may be added pending the actions needed to satisfy regulatory and/or stakeholder concerns identified during engagement activities or review of the draft EIS prior to finalizing the follow-up monitoring program.

During the Decommissioning Execution and Institutional Controls phases, the detailed follow-up monitoring program will be developed to include the following components:

- Ensure the Decommissioning Execution activities are completed in a manner that protects human health and the environment, including required mitigation measures.
- Monitor effectiveness and maintenance of environmental protection measures.
- Confirm that monitoring is conducted by competent professionals and technicians, who are using accepted methodology in the relevant fields.
- Manage detailed and complete records of the follow-up monitoring program, including results, equipment used, location, dates, photographs, observations, etc.
- Provide effective reporting and communications to appropriate individuals on issues of non-compliance.
- Complete reporting requirements.

Table 12.5-1 provides a preliminary list of activities that would be specifically developed for the NPD closure project EA follow-up monitoring program. These activities were identified primarily to confirm the effects predictions, assumptions and mitigation actions outlined in Section 9 above. Monitoring elements have been defined for all activities and/or conditions where a potential effect to a VC has been identified, regardless of whether a residual effect was predicted, since this prediction requires confirmation as per CNSC (2016b) REGDOC-2.9.1 and CEAA (2012) requirements. CNL does have the option of reducing monitoring effort for activities and/or conditions where no residual effect was predicted, and to remove monitoring once this prediction is confirmed.

Table 12.5-1. Table of Proposed Follow-up and Monitoring Activities for the NPD Closure Project

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Decommissioning Execution (DE) Phase					
Atmospheric Environment	Air Quality (non-radiological)	Potential Source(s) of Effects: - Batch mixing plant set-up and operation - Grouting of below grade structure - Removal of above grade structure - Install concrete cap and engineered barrier - Final site restoration Proposed Monitoring: - For each new activity or modification of an existing activity (see Note 2): measure parameters of concern (e.g., lead, asbestos) in air displaced from grouting the below grade structure and demolition activities. - Estimate combustible gases (e.g., based on project-related traffic and equipment). - Visual inspection for dust. Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits, or if actual number of vehicles/kilometres travelled exceeds the prediction on which emission estimates were based. - If high levels of dust are identified (qualitative), adjust dust suppression measures accordingly	Verify EA prediction (i.e., no adverse residual effect on non-radiological air quality or related VCs)	For each new activity or modification of an existing activity (see Note 2): monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting) Visual inspection for dust is ongoing/	NPDWF currently conducts annual industrial hygiene assessment of lead, asbestos and mould in air within the facility. Emissions associated with NPRI and GHG reporting are estimated. Facility to ensure that NPRI and GHG reporting includes updated estimates.
	Air Quality (radiological)	Potential Source(s) of Effects: - Grouting of below grade structure - Removal of above grade structure Proposed Monitoring: - For each new activity or modification of an existing activity (see Note 2): measure parameters of concern (e.g., tritium) in air displaced from grouting the below grade structure and demolition activities. Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits. - If any parameters are above applicable guidelines, collect rain water and measure contaminant levels (e.g., tritium) in precipitation.	Verify EA prediction (i.e., no adverse residual effect on radiological air quality or related VCs)	For each new activity or modification of an existing activity (see Note 2): monitor for minimum one week.	NPDWF currently conducts monitoring of airborne radiological releases (i.e., tritium and gross beta).
	Noise	Potential Source(s) of Effects: - Batch mixing plant set-up and operation - Trucking of grout between the batch mixing plant and the facility - Demolition and sizing of material - Earth moving, concrete mixing, transportation, pouring - Removal of temporary structures and rubblizing of non-essential roadways Proposed Monitoring: - Noise monitoring during periods of high activity Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits, or if complaints received.	Verify EA prediction (i.e., no adverse residual noise effects)	At periods of high activity: monitor for minimum one week.	Currently, NPDWF does not routinely monitor noise levels.
Surface Water Environment	Site Drainage	Potential Source(s) of Effects: - Upgrading road surface and existing surfaces - Leveling area for concrete pumper - Raw material storage - Wash out pit (preparation and operation) - Concrete cap installation - Engineered barrier - Site demobilization Proposed Monitoring: - Visual inspection of surface drainage patterns near the decommissioning activities. Trigger for further action: Investigation if significant changes to surface drainage.	Determine effectiveness of mitigation measures (e.g., runoff diversion and control; washout pit design; paving and covering of laydown areas).	Inspections: periodic.	Currently, NPDWF conducts monthly surveillance inspections.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
	Water Quality	Potential Source(s) of Effects: - Set up laydown area - Raw material storage - Wash out pit (preparation and operation) - Demolition of above grade structures - Sizing of material - Demobilization of batch mixing plant (after cap pour) - Site demobilization Proposed Monitoring: - Conduct routine inspections to maintain vehicles (reduce spills to ground). - Analyze water from batch discharges for parameters of concern (e.g., lead). - Measure surface runoff for parameters of concern. - In the event of incidents such as spills, incident-specific environmental monitoring would be triggered. Trigger for further action: - Investigation (e.g., sediment analyses) if parameters above applicable guidelines, or indication of poor maintenance. - Monitoring required for any unique events such as spills.	Verify EA prediction (i.e., no adverse residual effect on water quality or related VCs). and Determine effectiveness of mitigation measures (e.g., runoff diversion and control; washout pit design).	Inspections: periodic. Sampling and analysis of batch discharges: as required (event-based, e.g., transition between activities). Sampling and analysis of runoff: periodic. Incident-specific water quality monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts semi-annual sampling and analysis of liquid effluent in the tile drain systems. CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and cesium) NPDWF currently conducts routine radiological surveys which include ambient radiation dose measurements and contamination surveys.
Aquatic Environment	Aquatic Biota	Potential Source(s) of Effects: - Set up laydown area - Raw material storage - Wash out pit (preparation and operation) - Demolition of above grade structures - Sizing of material - Demobilization of batch mixing plant (after cap pour) - Site demobilization Proposed Monitoring: - Water quality monitoring, as per the surface water environment Trigger for further action: - Investigation if parameters above applicable guidelines, or indication of poor maintenance. - Monitoring required for any unique events such as spills.	Verify EA prediction (i.e., no adverse residual effect on water quality or related VCs).	Inspections: periodic Sampling and analysis of batch discharges: as required (event-based, e.g., transition between activities). Sampling and analysis of runoff: periodic. Incident-specific water quality monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts semi-annual sampling and analysis of liquid effluent in the tile drain systems. NPDWF currently conducts routine radiological surveys which include ambient radiation dose measurements and contamination surveys.
Geological and Hydrogeological Environment	Soil and Groundwater Quality	Potential Source(s) of Effects: - Demolition - Sizing of material - Material laydown and clearance surveys Proposed monitoring: - Measure groundwater flow and direction at end of decommissioning. - Routine groundwater analyses for parameters of concern (chemical and/or radiological). - Routine radiological surface surveys, per ambient radioactivity Trigger for further action: - Investigation if significant unexpected changes to groundwater flow. - If groundwater parameters above applicable guidelines or upgradient groundwater, conduct soil and/or sediment sampling and analysis for parameters of concern. - If routine radiological surveys identify elevated areas, conduct soil sampling for parameters of concern. - Monitoring required for any unique events such as spills.	Verify EA prediction (i.e., no adverse residual effect on soil quality or groundwater flow, or related VCs)	Groundwater flow and direction: at end of decommissioning Sampling and analysis of groundwater: periodic. Routine radiological surface surveys: periodic, as well as a final survey following completion of decommissioning activities. Incident-specific soil or groundwater monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring. NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Terrestrial Environment	Species at Risk	Potential Source(s) of Effects: - Potential presence of SARs during decommissioning activities Proposed monitoring: - Routine checks for barn swallows, monarch butterflies, bats and milksnakes. Trigger for further action: - If presence of SARs, contact CNL biologist. - If presence of SAR habitat is found (e.g., bat roost or barn swallow nest), contact CNL biologist. - If work within 400m of the bald eagle's nest becomes necessary, mitigation measures (such as restriction of activities during the courtship and breeding periods) will be applied.	Verify EA prediction (i.e., no adverse residual effect on terrestrial VCs). and Determine effectiveness of mitigation measures (e.g., inspections for bat roosts, work area sweeps prior to any work, employee training).	Visual inspection for bat roosts: event-based (i.e., prior to commencement of below grade grouting and above grade demolition). Sweep work areas for the presence of SARs: event based (i.e., prior to undertaking specific activities).	NPDWF conducted a fauna and foliage biodiversity survey in support of planning for decommissioning.
	Chimney Swifts	Potential Source(s) of Effects: - Ventilation stack isolation and modification - Establishing footprint of batch mixing plant and related activities - Demolition - Restoring and demobilization. Proposed monitoring for roost disturbance: - **Behavioural monitoring during inclement weather in non-breeding season**. Monitor for >25 swifts leaving the roost in the daytime during the first day of inclement weather, and do not return within the observation period. Option to use >200 threshold on second day of inclement weather (more reliable). - **Daily evening roost counts during breeding season.** For daily counts, monitor for a >50% decrease in average counts from the previous 4 nights. As per recommendations in the Chimney Swift TSD, to minimize disruption to swifts, decommissioning activities should be minimized near roost and limited to between 7 am and 7 pm as much as possible. Trigger for further action: - If above monitoring detects a disturbance of the roost, review associated decommissioning activities and apply additional mitigation measures, which include additional monitoring (see details in Section 12.5.5.1 below). - Evaluate mitigation measures: If mitigation is not effective, stop work and re-assess activities.	Verify EA prediction (i.e., no adverse residual effect on chimney swifts). and Determine effectiveness of mitigation measures (e.g., noise consideration, distance from stack, work between 7 am and 7 pm, noise limits, etc.). Note that these mitigation measures would only be applied if triggered by the results of the monitoring (See details in Section 12.5.5.1 below).	Behavioural monitoring: first and second day of inclement weather occurrence. (1-hr periods during poor weather while activities are taking place, in the daytime). Roost counts: daily during breeding season (June 22 – July 30)	NPDWF currently conducts chimney swift roost counts on a weekly basis when chimney swifts are present at the NPD site.
	Terrestrial Wildlife and Vegetation	Potential Source(s) of Effects: - Establishing footprint of batch mixing plant and related activities - Operation of vehicles on site - Grouting of below grade structure - Demolition and related material sizing and storage - Install concrete cap and engineered barrier - Demobilization - Final site restoration Proposed monitoring: - Estimate combustible gases (e.g., based on project-related traffic and equipment), as per atmospheric environment above. - Monitor parameters of concern (e.g., lead, asbestos, tritium) in air displaced from grouting the below grade structure. - Wildlife: Noise monitoring, as per atmospheric environment above. Trigger for further action: - Investigation if parameters above applicable guidelines, thresholds or limits, or if actual number of vehicles/kilometres travelled exceeds the prediction on which emission estimates were based. - Investigation if any noise complaints received. - If any airborne parameters are above applicable guidelines, collect rain water and measure contaminant levels (e.g., tritium) in precipitation.	Verify EA prediction (i.e., no adverse residual effect on terrestrial wildlife or vegetation)	Air quality parameters: For each new activity, monitor for minimum one week. Noise: During periods of high activity, monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting)	NPDWF currently conducts annual industrial hygiene assessment of lead, asbestos and mould in air within the facility. Emissions associated with NPRI reporting are estimated NPDWF to ensure that NPRI reporting includes updated estimate of combustible gases based on vehicle kilometres travelled. NPDWF currently performs sampling of surface soil and vegetation for tritium analysis.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Ambient Radioactivity	Ambient radioactivity	Potential Source(s) of Effects: - Establishing footprint of batch mixing plant and related activities (e.g., drilling of slip pipe access holes) - Grouting of below grade structure - Removal of above grade structure Proposed monitoring: - Area TLDs (i.e., constant perimeter gamma monitoring) - Routine radiation protection surveys (indoors and outdoors) Trigger for further action: - Investigation if parameters are above applicable guidelines identified.	Verify EA prediction (i.e., no adverse residual effect on ambient radioactivity environment or related VCs).	Routine radiation protection surveys: periodic. TLD monitoring locations around the NPD site: on-going	NPDWF currently performs ambient gamma radiation field surveys and monitors tritium levels with passive air samples within the facility.
Human Health	Worker health	Potential Source(s) of Effects: - Batch mixing plant - Grouting of below grade structures - Removal of above grade structures - Installation of concrete cap and engineered barriers - Final site restoration Proposed monitoring: - Perform routine bioassays as well as TLDs to monitor whole-body dose. Routine radiation protection surveys, as per ambient radioactivity above. - Routine bioassay as well as assignment of TLDs to monitor whole-body dose - Monitor indoor air quality - Estimate combustible gases (e.g., based on project-related traffic and equipment), as per atmospheric environment above. - Monitor parameters of concern (e.g., lead, asbestos, tritium) in air displaced from grouting the below grade structure, as per atmospheric environment above. - Wildlife: noise monitoring, as per atmospheric environment above. - Conduct monitoring for each new activity for a short time period to confirm no effect, as per atmospheric environment above. Trigger for further action: - Investigation if parameters are above applicable guidelines identified.	Verify EA prediction (i.e., no adverse residual effect on worker health).	Air quality parameters and industrial hygiene: For each new activity, monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting). Routine radiation protection surveys: periodic.	Workers within the NPDWF are currently monitored by CNL Dosimetry Services, which includes routine bioassay as well as assignment of TLDs to monitor whole-body dose. NPDWF currently conducts annual industrial hygiene assessment of lead, asbestos and mould in air within the facility.
Other	Concrete monolith	Potential Source(s) of Effects: - Degradation of concrete monolith once installed Proposed monitoring: - Routine groundwater analyses for parameters of concern related to degradation (e.g., pH), as per geological and hydrogeological environment above. Trigger for further action: - If groundwater monitoring results indicate potential for accelerated degradation or other performance issues (after accounting for changes to baseline), assess need to confirm integrity of concrete monolith.	Verify EA prediction (i.e., no contamination is being transported from the facility during the Institutional Controls phase).	Sampling and analysis of groundwater: periodic.	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
	Stakeholders	Potential concerns: - Potential stakeholder concerns may arise during execution of decommissioning activities Proposed monitoring: - Regular stakeholder engagement under CNL's Public Information Program (e.g., ESC, webpage and social media updates, newsletters) Trigger for further action: - If concerns raised, discuss options with CNL Communications Team.	Not applicable	Periodic	Through the Public Information Program, CNL routinely engages with stakeholders through the Environmental Stewardship Committee (quarterly) as well as social media and the CONTACT community newsletter. CNL also makes available the annual environmental performance reporting for the facility to sustain open and transparent communication with stakeholders and to assure that the impacts are acceptably low. NPDWF is currently conducting stakeholder engagement activities related to the NPD closure project.
Institutional Controls (IC) phase					
Atmospheric Environment	Air Quality (radiological)	Potential Source(s) of Effects: - Volatilization of radionuclides from surface media Proposed monitoring: - If elevated levels in groundwater, consider soil vapour analysis. Trigger for further action: - Investigation if soil vapour analysis identifies parameters are above applicable guidelines.	Verify EA prediction (i.e., no adverse residual effect on atmospheric environment or related VCs)	Soil vapour analysis: only if triggered by groundwater monitoring	NPDWF does not currently conduct soil vapour monitoring.
Surface Water Environment	Site Drainage	Potential Source(s) of Effects: - Changes to topography on and/or near the surface above the concrete monolith. Proposed Monitoring: - Visual inspection of surface drainage patterns, changes to topography, and indicators of subsidence near the decommissioning activities. - Management of vegetative cover at surface to prevent growth of deep-rooted trees near the concrete monolith Trigger for further action: - If changes observed, confirm integrity of concrete monolith with geophysical methods.	Determine effectiveness of mitigation measures (e.g., runoff diversion and control; washout pit design; paving and covering of laydown areas).	Inspections: periodic.	NPDWF currently conducts monthly surveillance inspections.
	Water Quality (radiological and non-radiological)	Proposed Source(s) of Effects: - Potential for post-closure groundwater flow into eventually-degraded structure, and release of dissolved contaminants into Ottawa River Proposed Monitoring: - Routine sampling and analysis of the Ottawa River for parameters of concern (chemical and/or radiological). Trigger for further action: - Investigation (e.g., sediment analyses) if parameters above applicable guidelines, or notable changes are observed.	Verify EA prediction (i.e., no adverse residual effect on surface water environment or related VCs) and Determine effectiveness of mitigation measures (e.g., concrete cap design, grout fill)	Surface water monitoring: periodic	CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and cesium).
Aquatic Environment	Aquatic Biota	Proposed Source(s) of Effects: - Potential for post-closure groundwater flow into eventually-degraded structure, and release of dissolved contaminants into Ottawa River Proposed Monitoring: - Monitoring of parameters of concern, as per the surface water environment Trigger for further action: - Investigation if parameters above applicable guidelines, or indication of poor maintenance.	Verify EA prediction (i.e., no adverse residual effect on surface water environment or related VCs) and Determine effectiveness of mitigation measures (e.g., concrete cap design, grout fill)	Surface water monitoring: periodic	CNL currently conducts quarterly monitoring of the Ottawa River above and below stream of the NPD site (i.e., tritium and cesium).

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Geological and Hydrogeological Environment	Groundwater Quality (radiological and non-radiological)	Potential Source(s) of Effects: - Potential leaching of soluble contaminants from degradation of grouted structure. Proposed Monitoring: - Routine groundwater analyses for parameters of concern (chemical and/or radiological). - Measure groundwater flow and direction. Trigger for further action: - If groundwater parameters above applicable guidelines or upgradient groundwater, conduct soil and/or sediment sampling and analysis for parameters of concern. - If significant unexpected changes to groundwater flow, employ geophysical methods to confirm integrity of engineered barrier.	Verify EA prediction (i.e., no adverse residual effect on groundwater quality or related VCs)	Sampling and analysis of groundwater: periodic. Groundwater flow and direction: periodic, low frequency. Incident-specific soil or groundwater monitoring: event-based (e.g., in case of a spill or other unique incident).	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.
	Topography	Potential Source(s) of Effects: - Potential loss of soil cover and exposure of concrete monolith Proposed Monitoring: - Slope stability measurements Trigger for further action: - If significant changes, consider slope stabilization.	Determine effectiveness of mitigation measures (e.g., design of engineered barrier)	Soil stability monitoring: periodic, low frequency.	NPDWF currently conducts monthly surveillance inspections.
Terrestrial Environment	Terrestrial Wildlife and Vegetation	Potential Source(s) of Effects: - Potential leaching of soluble contaminants from degradation of grouted structure. Proposed Monitoring: - Routine groundwater analyses for parameters of concern (chemical and/or radiological). Trigger for further action: - Investigation if groundwater parameters above applicable guidelines, e.g., soil sampling and analysis for parameters of concern, CNL biologist(s) may be consulted.	Verify EA prediction (i.e., no adverse residual effect on groundwater quality or related VCs)	Sampling and analysis of groundwater: periodic.	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.
	Chimney Swifts	Potential Source(s) of Effects: - Potential loss of habitat due to ventilation stack deterioration. Proposed Monitoring: - Visual inspection of ventilation stack for signs of deterioration. - Weekly evening roost counts for a period of 3 years after decommissioning. Trigger for further action: - If changes observed, assess and conduct repairs to stack if needed.	Verify EA prediction (i.e., no adverse residual effect on chimney swift habitat)	Visual inspection: periodic, infrequent (e.g., every 5 years) for the lifespan of the ventilation stack or until species is no longer listed (CNL 2016c). and Inspection if unique incident occurs (e.g., seismic event) For three years following completion of decommissioning activities, CNL will conduct weekly evening roost counts when chimney swifts are present at the NPD site (i.e., migratory season).	NPDWF currently conducts life management program inspections every 5 years for integrity of concrete structures including the ventilation stack.

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Ambient Radioactivity	Ambient radioactivity	Potential Source(s) of Effects: - Volatilization of radionuclides from surface media Proposed monitoring: - Area TLDs (i.e., constant perimeter gamma monitoring) - Routine radiation protection surveys (outdoors) Trigger for further action: - Investigation if parameters are above applicable guidelines identified	Verify EA prediction (i.e., no adverse residual effect on ambient radioactivity environment or related VCs).	Routine radiation protection surveys: periodic. TLD monitoring locations around NPD site: on-going	NPDWF currently conducts ambient gamma radiation field surveys and monitors tritium levels with passive air samples within the facility.
Human Health	Worker health	Potential Source(s) of Effects: - Radiological exposure during worker presence on-site (e.g., for monitoring and long-term care and maintenance of the site) Proposed monitoring: - Perform routine bioassays as well as TLDs to monitor whole-body dose. - Routine radiation protection surveys, as per ambient radioactivity above. - Estimate combustible gases (e.g., based on project-related traffic and equipment), as per atmospheric environment above. - Monitor parameters of concern (e.g., lead, asbestos, tritium) in air displaced from grouting the below grade structure, as per the atmospheric environment above. Trigger for further action: - Investigation if parameters are above applicable guidelines identified.	Verify EA prediction (i.e., no adverse residual effect on worker health).	Air quality parameters: For each new activity, monitor for minimum one week. Estimation of combustible gases: event-based (e.g., as required for reporting). Routine radiation protection surveys: periodic.	Workers within the NPDWF are currently monitored by CNL Dosimetry Services, which includes routine bioassay as well as assignment of TLDs to monitor whole-body dose. NPDWF currently conducts annual industrial hygiene assessment of lead, asbestos and mould within the facility.
	Public health	Potential Source(s) of Effects: - Potential leaching of soluble contaminants from degradation of grouted structure. Proposed Monitoring: Routine groundwater analyses for parameters of concern (chemical and/or radiological) as per the geological and hydrogeological environment,	Verify EA prediction (i.e., no adverse residual effect on groundwater quality or related VCs)	Sampling and analysis of groundwater: periodic.	NPDWF currently conducts non-periodic (i.e., occasional event-based) groundwater monitoring.
Other	Concrete monolith	Potential Source(s) of Effects: - Degradation of concrete monolith once installed Proposed monitoring: - Routine groundwater analyses for parameters of concern related to degradation (e.g., pH), as per geological and hydrogeological environment above. Trigger for further action: If groundwater monitoring results indicate potential for degradation or other performance issues (after accounting for changes to baseline), assess need to confirm integrity of concrete monolith.	Verify EA predictions (i.e., no degradation or performance issues during the Institutional Controls phase).	Sampling and analysis of groundwater: periodic.	NPDWF currently conducts non-periodic groundwater monitoring

Environmental Component	Environmental Subcomponent	Conceptual Monitoring Program	Monitoring Program Objective (See Note 1)	Suggested Duration	Relation to Current NPD Monitoring Program
Other	Stakeholders	Potential concerns: - Potential stakeholder concerns may arise during IC phase. Proposed monitoring: - Regular stakeholder engagement during the IC phase, to discuss follow-up monitoring results and identify potential concerns Trigger for further action: - If concerns raised, discuss options with CNL Communications Team. Consider adjustments to monitoring program.	Not applicable	Periodic	Through the Public Information Program, CNL routinely engages with stakeholders through the Environmental Stewardship Committee (quarterly) as well as social media and the CONTACT community newsletter. CNL also makes available the annual environmental performance reporting for the facility to sustain open and transparent communication with stakeholders and to assure that the impacts are acceptably low. NPDWF is currently conducting stakeholder engagement activities related to the NPD closure project.

Notes:

1 – Identifies which of the two generic program objectives (i.e., from CNSC 2016a) the activity is relevant to, i.e., verify EA predictions, or determine effectiveness of mitigation measures.

2 - Modification of an existing activity: For example, during grouting activities, a change in grouting location to a different part of the NPDWF where the potential for emissions may substantially increase, monitoring should start again.

12.6 Conclusions

Due to the conceptual nature of the NPD closure project at this point, further details of the follow-up program (e.g., statistical analyses and confidence, probable effect sizes) and schedule (e.g., timing, frequency, duration) will be developed at a later date according to the CNSC EIS guidelines (CNSC 2016a). Once these details are known, CNL will also develop contingency procedures, plans, or other adaptive management provisions as needed to address any unforeseen effects or correct for exceedances, in order to comply with benchmarks, regulatory standards and/or guidelines.

The final scope for the EA follow-up monitoring program will be designed to fulfill the requirements of REGDOC-2.9.1 (CNSC 2016b, Objectives 1 and 2, Section 12.2) and established through engagement with federal and provincial authorities, Aboriginal groups, and the public following submission of this draft EIS to the CNSC. During engagement, areas of concern from these stakeholders will be established and additional monitoring will be identified where required to address any potential effects in these areas. To date, one of the key issues raised during public and Aboriginal engagements has been the potential for impacts on the Ottawa River. Although the EIS has assessed and concluded there will be no residual effects n the Ottawa River due to the effectiveness in containing and isolating the majority of the waste inventory, CNL will continue to monitor surface water as per the current CRL monitoring program (DeWaele 2013b) to ensure the accuracy of these EA predictions. Similarly, CNL will continue to monitor the chimney swift population at the NPD site. Once completed, CNL will use this information to develop detailed environmental monitoring programs for the NPD site in accordance with CSA N288.4, N288.5 and N288.7 (CSA 2015a, 2016 and 2015b).

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APPENDIX A: MASTER LIST OF CANDIDATE VALUED COMPONENTS (VCs) for NPD

Appendix A – Master List of Candidate VCs for NPD (SAR status queries conducted in August 2016)

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
FEDERAL LEGAL REQUIREMENTS			
Species at Risk Act, Schedule 1			
American ginseng			• END • Has not been observed on the site (no known patch north of Pembroke).
Blanding's turtle	x	x	• CRL VC • THR • To be assessed for exposure-related effects • Sighting near the Local Study Area by Highway 17.
Butternut tree			• CRL VC • END • Butternut tree presence at NPD is linked to an old homestead. The NPD site is outside of the normal range for the species.
Canada warbler			• CRL VC • THR • Excluded as 300 minutes of audio files were analysed and species was not detected.
Cerulean warbler			• SC • There is no breeding evidence in regional study area (BSC *et al.* 2006).
Chimney swift	x	x	• CRL VC • THR • To be assessed for exposure- and habitat-related effects • Large roost in the NPD ventilation stack in the site study area.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Common nighthawk		x	• CRL VC • THR • Common nighthawks are territorial and would respond to calls played at NPD, if present. Therefore, despite a sighting at NPD, it is unlikely that common nighthawks are nesting there. • Represented by bald eagle (exposure) and chimney swift (habitat)
Eastern hog-nosed snake			• THR • No sightings in the regional study area (ON 2016).
Eastern milksnake	x	x	• CRL VC • SC • To be assessed for exposure- and habitat-related effects • A milksnake was found within the facility in 2015 (Morin 2016).
Eastern musk turtle (Stinkpot)			• CRL VC • THR • Has not been observed in the regional study area (ON 2016).
Eastern ribbonsnake (Great Lakes St. Lawrence populations)			• SC • Has not been observed in the regional study area (ON 2016).
Eastern spiny softshell turtle			• THR • Outside of typical range. No known sighting in regional study area.
Eastern whip-poor-will			• CRL VC • THR • Regional presence • Represented by ruffed grouse (similar diet).
Eastern wolf	x		• CRL VC • SC • Regional presence • No known sighting in the site study area.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Golden-winged warbler			• CRL VC • THR • Excluded as 300 minutes of audio files were analysed and species was not detected.
Kirtland's warbler			• END • No sightings in regional study area (BSC *et al.* 2006).
Least bittern			• THR • No sightings in regional study area (BSC *et al.* 2006).
Little brown myotis	x	x	• END • To be assessed for exposure- and habitat-related effects • Determined to be present within the site study area during a bat survey in 2015 (Murrant 2016).
Loggerhead shrike eastern subspecies			• END • No sightings in regional study area (BSC *et al.* 2006).
Monarch butterfly	x	x	• CRL VC • SC • Found in the site study area. • Monarchs are migrants and are sensitive to habitat fragmentation and disturbance.
Northern barrens tiger beetle			• END • The closest reported population is at Île aux Allumettes QC (COSEWIC 2009). The Canadian Wildlife Service conducted a survey in 2016 and no individuals were found.
Northern brook lamprey (Great Lakes – Upper St. Lawrence populations)			• SC • The northern brook lamprey is a sediment-dwelling filter feeder, and is represented by benthic invertebrates and lake sturgeon.
Northern map turtle			• CRL VC • SC • Confirmed sighting in regional study area, however no sightings have been made in the site or local study areas (ON 2016).

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Northern myotis	x	x	• END • To be assessed for exposure- and habitat-related effects • Determined to be present within the site study area during a bat survey in 2015 (Murrant 2016).
Olive-sided flycatcher			• CRL VC • THR • Excluded as 300 minutes of audio files were analysed and species was not detected.
Peregrine falcon			• SC • No breeding evidence in the site and local study area (BSC *et al.* 2006). • No suitable habitat for breeding (cliff).
Red-headed woodpecker			• CRL VC • THR • Represented by ruffed grouse (similar diet).
River redhorse			• SC • Represented by the white sucker.
Rusty blackbird			• SC • Regional breeding evidence (BSC *et al.* 2006). • No habitat in site study area
Rusty-patched bumble bee			• END • The only sightings of this bee in Canada since 2002 were at the Pinery Provincial Park near Lake Huron.
Short-eared owl			• SC • No breeding evidence in the regional study area (BSC *et al.* 2006).
Snapping turtle			• CRL VC • SC • No sightings in the site or local study area.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Tri-colored bat	x	x	• END • To be assessed for exposure- and habitat-related effects • Species known to be present at NPD.
Western chorus frog			• THR • Outside of typical range (ON 2016), unlikely to be found in the Ottawa River.
Wood turtle			• THR • No habitat in the site study area.
Migratory Birds Convention Act, 1994 and Regulations			
Great blue heron colony			• CRL VC • No known colony on site • Represented by great blue heron
Migratory birds		x	• CRL VC • Represented by specific species *e.g.,* bald eagle, chimney swift, great blue heron, and mallard.
Migratory bird eggs and nests		x	• CRL VC • Represented by individual species *e.g.,* bald eagle, chimney swift, great blue heron, and mallard.
Fisheries Act			
Fish		x	• CRL VC • Represented by individual species *e.g.,* white sucker, lake sturgeon, walleye, etc.
Fish habitat		x	• CRL VC • Pathway to biota *e.g.,* white sucker, lake sturgeon, walleye, etc.
Lakes, ponds and streams		x	• CRL VC • Pathway to biota *e.g.,* white sucker, lake sturgeon, walleye, etc.
Ottawa river water quality		x	• CRL VC • Pathway to VCs in other environmental components.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
PROPOSED FEDERAL LEGAL REQUIREMENTS AND POLICY			
Species at Risk Act, Schedule 2 and 3			
Red-shouldered hawk			• CRL VC • SC (Schedule 3) • Represented by bald eagle (similar diet and habitat)
The Federal Policy on Wetland Conservation			
Wetlands		x	• CRL VC • Pathway to VCs in other environmental components.
COSEWIC Assessment			
American eel			• THR (proposed) • The range of the eel has been reduced due to barriers in the Ottawa River (e.g. dams). Eels are uncommon upstream of the Cheneaux generating station (>100 km downstream) (Haxton and Chubbuck 2002)
Bank swallow			• THR (proposed) • No habitat in local study area.
Barn swallow			• THR (proposed) • No sightings in the site or local study area.
Bobolink			• THR (proposed) • No habitat in local study area.
Eastern meadowlark			• THR (proposed) • No habitat in local study area.
Eastern wood-pewee		x	• CRL VC • SC (proposed) • Confirmed sighting at NPD • Represented by ruffed grouse (similar diet)
Grasshopper sparrow			• SC (proposed) • No habitat in local study area.
Hickorynut			• END (proposed) • Represented by benthic invertebrates.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Lake sturgeon (Great Lakes – Upper St. Lawrence populations)	x	x	• CRL VC • THR (proposed) • Regional presence • Large, long-lived benthivorous fish • No habitat impact is expected. • The lake sturgeon is included for consideration of exposure-related effects.
Wood thrush			• CRL VC • THR (proposed) • Represented by ruffed grouse (similar diet).
Canadian Heritage Rivers System			
Ottawa River		x	• CRL VC • Pathway to VCs in other environmental components.
PROVINCIAL REQUIREMENTS			
Endangered Species Act and associated Regulations			
Bald eagle	x	x	• CRL VC • SC • Cultural and ecological significance • Known nest on the site.
Eastern cougar			• END • Represented by the eastern wolf.
Eastern small-footed myotis	x	x	• END • To be assessed for exposure- and habitat-related effects • Species determined to be present within the site study area during a bat survey in 2015 (Murrant 2016).
MNRF Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales			
Bat hibernacula			• Represented by specific bat species.
Occupied cavity tree		x	• CRL VC • Represented by specific tree species.
Occupied dens (all species)			• CRL VC • Represented by specific species.
Old-growth forest			• Not in site study area.
Provincially significant wetlands			• CRL VC • Not in local study area.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Stick nests (all species)		x	• CRL VC • Represented by specific species.
Waterfowl staging area			• CRL VC • Represented by mallard.
White-tailed deer wintering		x	• Represented by white-tailed deer.
REGIONALLY SIGNIFICANT FEATURES			
Ontario Landbird Conservation Plan			
Bay-breasted warbler			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Belted kingfisher			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Black-billed cuckoo			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Blackburnian warbler			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Black-throated blue warbler		x	• CRL VC • Represented by ruffed grouse (similar diet)
Black-throated green warbler		x	• Represented by the ruffed grouse.
Broad-winged hawk			• CRL VC • Represented by bald eagle (similar diet and habitat).
Brown thrasher			• CRL VC • Represented by ruffed grouse (similar diet)
Chestnut-sided warbler		x	• CRL VC Represented by ruffed grouse (similar diet)
Common yellowthroat		x	• Represented by the ruffed grouse.
Field sparrow			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Great gray owl			• Represented by bald eagle (diet).
Least flycatcher			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Mourning warbler			• CRL VC Excluded as 300 minutes of audio files were analysed and species was not detected.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Nashville warbler		x	• Represented by ruffed grouse.
Northern flicker			• CRL VC • Excluded as 300 minutes of audio files were analysed and species was not detected.
Northern goshawk			• Represented by bald eagle.
Northern rough-winged swallow			• No breeding evidence in regional study area (BSC et al. 2006).
Purple finch			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Red crossbill			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Rose-breasted grosbeak			• CRL VC • Excluded as 300 minutes of audio files were analysed and species was not detected.
Ruffed grouse	x	x	• CRL VC • Representative of ground birds. No habitat impact is expected. The ruffed grouse is included for consideration of exposure-related effects
Sedge wren			• No recent breeding evidence in regional study area (BSC et al. 2006).
Swamp sparrow			• CRL VC • Excluded as 300 minutes of audio files were analysed and species was not detected.
Veery		x	• Represented by ruffed grouse (similar diet and habitat).
White-throated sparrow		x	• CRL VC • Represented by ruffed grouse (similar diet).
Willow flycatcher			• No sightings in local study area.
Yellow-bellied sapsucker			• CRL VC • Regional presence (BSC et al. 2006) • Represented by ruffed grouse (similar diet)

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Conservation Priorities for the Birds of Southern Ontario			
American bittern			• CRL VC • No sightings in the local study area.
Black tern			• No breeding evidence in regional study area (BSC et al. 2006).
Clay-colored sparrow			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Common loon		x	• CRL VC • Represented by walleye (diet) and mallard (habitat)
Eastern bluebird			• CRL VC • Excluded as 300 minutes of audio files were analysed and species was not detected.
Magnolia warbler			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Northern mockingbird			• Excluded as 300 minutes of audio files were analysed and species was not detected.
Northern saw-whet owl			• No sightings in local study area.
Pied-billed grebe			• No habitat in site study area.
Savannah sparrow			• No sightings in local study area.
Sora			• No habitat in site study area.
Virginia rail			• No habitat in site study area.
NatureServe			
Crested arrowhead			• CRL VC • Not detected in local study area.
Halberd-leaved tear-thumb			• CRL VC • Not detected in local study area.
Houghton's flatsedge			• CRL VC • Not detected in local study area.
Prickly hornwort			• CRL VC • Not detected in local study area.
Schweinitz's flatsedge			• CRL VC • Not detected in local study area.
Red spruce			• CRL VC • Not detected in local study area.
Woolly beach-heath			• CRL VC • Not detected in local study area.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
North American Waterfowl Management Plan 2004			
American black duck			• CRL VC • Represented by mallard.
Blue-winged teal			• Represented by mallard.
Common goldeneye			• Represented by mallard.
Lesser scaup			• Represented by mallard.
Mallard	x		• CRL VC • The Ottawa river is an important stopover for waterfowl in the Atlantic flyway. • No habitat impact is expected. Mallard is included for consideration of exposure-related effects.
Northern pintail			• Represented by mallard.
Atlas of the Breeding Birds of Ontario 2005			
Alder flycatcher			• Represented by ruffed grouse (similar diet).
American crow			• Represented by ruffed grouse (similar diet).
American goldfinch			• Represented by ruffed grouse (similar diet).
American redstart			• Represented by ruffed grouse (similar diet).
American robin			• Represented by ruffed grouse (similar diet).
American woodcock			• Represented by ruffed grouse (similar diet).
Baltimore oriole			• Represented by ruffed grouse (similar diet).
Black-and-white warbler			• Represented by ruffed grouse (similar diet).
Black-backed woodpecker			• Represented by ruffed grouse (similar diet).
Black-capped chickadee			• Represented by ruffed grouse (similar diet).
Blue-headed vireo			• Represented by ruffed grouse (similar diet).
Blue jay		x	• Represented by ruffed grouse (similar diet).
Brown creeper			•
Canada goose			• Represented by mallard.
Cape May warbler			•

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Cedar waxwing			• Represented by ruffed grouse (similar diet).
Chipping sparrow			• Represented by ruffed grouse (similar diet).
Common grackle			• Represented by ruffed grouse (similar diet).
Common merganser			• Represented by ruffed grouse (similar diet).
Common raven			• Represented by common loon.
Dark-eyed junco			• Represented by ruffed grouse (similar diet).
Downy woodpecker			• Represented by ruffed grouse (similar diet).
Eastern kingbird			• Represented by ruffed grouse (similar diet).
Eastern phoebe			• Represented by ruffed grouse (similar diet).
Eastern towhee			• Represented by ruffed grouse (similar diet).
European starling			• Represented by ruffed grouse (similar diet).
Evening grosbeak			• Represented by ruffed grouse (similar diet).
Golden-crowned kinglet			• Represented by ruffed grouse (similar diet).
Gray catbird			• Represented by ruffed grouse (similar diet).
Great blue heron	x		• Large wading piscivorous bird • Sensitive to human disturbance • Regional presence
Great crested flycatcher			• Represented by ruffed grouse (similar diet).
Green-winged teal			• Represented by mallard.
Hairy woodpecker		x	• Represented by ruffed grouse (similar diet).
Hermit thrush			• Represented by ruffed grouse (similar diet).
Herring gull			• Represented by bald eagle.
House wren			• Represented by ruffed grouse (similar diet).
Indigo bunting			• Represented by ruffed grouse (similar diet).
Killdeer			• Represented by ruffed grouse (similar diet).

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Lincoln's sparrow			• Represented by ruffed grouse (similar diet).
Mourning dove			• Represented by ruffed grouse (similar diet).
Northern parula			• Represented by ruffed grouse (similar diet).
Northern waterthrush			• Represented by ruffed grouse (similar diet).
Ovenbird			• Represented by ruffed grouse (similar diet).
Pileated woodpecker		x	• Represented by ruffed grouse (similar diet).
Pine grosbeak			• Represented by ruffed grouse (similar diet).
Pine siskin			• Represented by ruffed grouse (similar diet).
Pine warbler			• Represented by ruffed grouse (similar diet).
Red-breasted nuthatch			• Represented by ruffed grouse (similar diet).
Red-eyed vireo			• Represented by ruffed grouse (similar diet)
Red-tailed hawk			• Represented by bald eagle.
Red-winged blackbird			• Represented by ruffed grouse (diet).
Rock pigeon			• Represented by ruffed grouse (diet).
Ruby-crowned kinglet			• Represented by ruffed grouse (diet).
Ruby-throated hummingbird			•
Scarlet tanager			• Represented by ruffed grouse (similar diet).
Song sparrow			• Represented by ruffed grouse (diet).
Spotted sandpiper			• Represented by ruffed grouse (diet).
Swainson's thrush			• Represented by ruffed grouse (diet).
Tennessee warbler			• Represented by ruffed grouse (similar diet).
Tree swallow			• Represented by ruffed grouse (diet).
Turkey vulture		x	• Represented by bald eagle.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Vesper sparrow			• Represented by ruffed grouse (similar diet).
Warbling vireo			• Represented by ruffed grouse (similar diet).
White-breasted nuthatch			• Represented by ruffed grouse (diet).
Wilson's warbler			• Represented by ruffed grouse (similar diet).
Winter wren			• Represented by ruffed grouse (diet).
Yellow warbler			• Represented by ruffed grouse (diet).
Yellow-rumped warbler			• Represented by ruffed grouse (diet).
Ontario Reptile and Amphibian Atlas			
American bullfrog		x	• Represented by green frog.
American toad			• Represented by green frog.
Eastern garter snake			• Represented by eastern milksnake.
Eastern red-backed salamander			• Represented by green frog.
Gray treefrog			• Represented by green frog.
Green frog	x	x	• Present in the local study area (e.g. wetlands) • No habitat impact is expected. Green frog is included for consideration of exposure-related effects.
Mink frog			• Represented by green frog.
Northern leopard frog			• Represented by green frog.
Spotted salamander			• Represented by green frog.
Spring peeper			• Represented by green frog.
Wood frog			• Represented by green frog.
OTHER CANDIDATE VCs			
Fish			
Black crappie			• Represented by walleye.
Brown bullhead			• Represented by lake sturgeon.
Burbot			• Represented by white sucker.
Channel catfish			• Represented by lake sturgeon.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Emerald shiner	x		• Numerically important pelagic forage species. • No habitat impact is expected. The emerald shiner is included for consideration of exposure-related effects.
Fallfish			• Represented by white sucker.
Lake herring			• Represented by emerald shiner.
Lake trout			• Represented by walleye.
Lake whitefish			• Represented by walleye.
Largemouth bass			• Represented by walleye.
Longnose gar			• Represented by walleye.
Mooneye			• Represented by walleye.
Muskellunge			• Represented by walleye.
Northern pike			• Represented by walleye.
Pumpkinseed			• Represented by emerald shiner.
Rock bass			• Represented by walleye.
Sauger			• Represented by walleye.
Shorthead redhorse			• Represented by white sucker.
Smallmouth bass			• Represented by walleye.
Walleye	x		• Socio-economic importance as a sportfish.
White sucker	x		• Bethivorous fish • Sufficient data availability • No habitat impact is expected. The white sucker is included for consideration of exposure-related effects.
Yellow perch			• Represented by walleye.
Reptiles			
Midland painted turtle			• Represented by Blanding's turtle.
Northern redbelly snake			• Represented by eastern milksnake
Northern ringneck snake			• Represented by eastern milksnake
Northern water snake			• Represented by eastern milksnake, and great blue heron (similar diet).
Birds			
American kestrel			• Represented by bald eagle.
Cliff swallow			• Represented by chimney swift (similar diet).
Common tern			• Represented by bald eagle.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Cooper's hawk			• Represented by bald eagle.
Green heron			• Represented by great blue heron.
Hooded merganser			• Represented by mallard.
Marsh wren			• Represented by ruffed grouse.
Merlin			• Represented by bald eagle.
Northern harrier			• Represented by bald eagle.
Osprey			• Represented by bald eagle (similar diet and habitat)
Purple martin			• Represented by chimney swift (diet).
Ring-billed gull		x	• Represented by bald eagle.
Ring-necked duck			• Represented by mallard.
Upland sandpiper			• Represented by mallard.
Wilson's Snipe			• Represented by mallard.
Wood duck			• Represented by mallard.
Mammals			
Beaver		x	• Represented by muskrat.
Big brown bat			• Represented by little brown myotis.
Black Bear	x	x	• Large terrestrial omnivore • Cultural significance and public interest.
Coyote			• Represented by eastern wolf.
Deer mouse			• Represented by meadow vole.
Eastern chipmunk		x	• Represented by meadow vole.
Eastern cottontail			• Represented by meadow vole.
Eastern gray squirrel			• Represented by meadow vole.
Ermine			• Represented by short-tailed shrew and muskrat.
Hoary bat			• Represented by little brown myotis.
Lynx			• Represented by eastern wolf.
Marten			• Represented by muskrat.
Meadow vole	x		• Soil-dwelling (burrowing) small herbivore • To be assessed for habitat- and exposure-related effects
Mink			• Represented by short-tailed shrew and muskrat.
Moose		x	• No habitat impact is expected. • Represented by bear (terrestrial exposure).

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Muskrat	x		• Aquatic piscivore/herbivore • Regional presence • No habitat impact is expected. The muskrat is included for consideration of exposure-related effects.
Northern flying squirrel			• Represented by meadow vole.
Northern water shrew			• Represented by short-tailed shrew.
Raccoon		x	• Represented by muskrat.
Porcupine			• Represented by meadow vole.
Red squirrel			• Represented by meadow vole.
Red fox		x	• Represented by eastern wolf.
Short-tailed shrew	x		• Sufficient data availability • Carnivorous small, burrowing mammal • No habitat impact is expected. The short-tailed shrew is included for consideration of exposure-related effects.
Snowshoe hare			• Represented by meadow vole.
Southern flying squirrel			• Represented by meadow vole.
Tri-colored bat			• Represented by little brown myotis.
Striped skunk			• Represented by short-tailed shrew.
White-footed mouse			• Represented by meadow vole.
White-tailed deer	x	x	• Socio-economic importance as a game species.
Woodchuck			• Represented by muskrat.
Vegetation			
Poplar		x	• Represented by red maple.
White water lily		x	• Represented by aquatic vegetation.
Red maple	x	x	• Upland/wetland deciduous tree common at NPD. • No physical impacts expected. The red maple is included for consideration of exposure-related effects.
White pine		x	• Represented by red maple.
Mixed upland conifers – clear cut		x	• Represented by red maple.
Red pine		x	• Represented by red maple.

Proposed Valued Components	Selected as NPD Project VC	Likely present at NPD Site	Rationale for Inclusion/ Exclusion as VC
Mixed woods – clear cut		x	• Represented by red maple.
Tolerant hardwoods		x	• Represented by red maple.
Aquatic Vegetation (see ELC TSD)	x	x	• A fundamental element of ecosystem health and function
Terrestrial vegetation (see ELC TSD)		x	• Represented by red maple.
Other			
Cultural and heritage sites			• No cultural or heritage sites likely within the Site Study Area (the project footprint).
Benthic Invertebrates	x	x	• Exposed to sediment • Used to evaluate overall ecosystem health
Soil invertebrates		x	• Soil-dwelling invertebrates (e.g. earthworm) • Exposure from soil
Fishing		x	• Represented as walleye, a common sportfish in the region.
Resident use and enjoyment of property	x		• Potential project-related nuisance effects (e.g. traffic, noise, dust).
Hunting/trapping			• Represented as white-tailed deer, a common game species in the region.
Land use planning	x	x	• Land use may change during the project.
Landscape and visual setting	x	x	• Potential impact on the quality of views from the Ottawa River
Highway 17	x	x	• Primary transportation route in the area.

Notes:

THR – Threatened, SC – Special Concern, END – Endangered.

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