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DRAFT ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM FOR THE NEAR SURFACE DISPOSAL FACILITY

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Revision 0

Accepted by: Martin Klukas 2021/02/25

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Environmental Assess Analyst

Date

GOLDER

REPORT

Draft Environmental Assessment Follow-up Monitoring Program for the Near Surface Disposal Facility

Revision 1

Submitted to:

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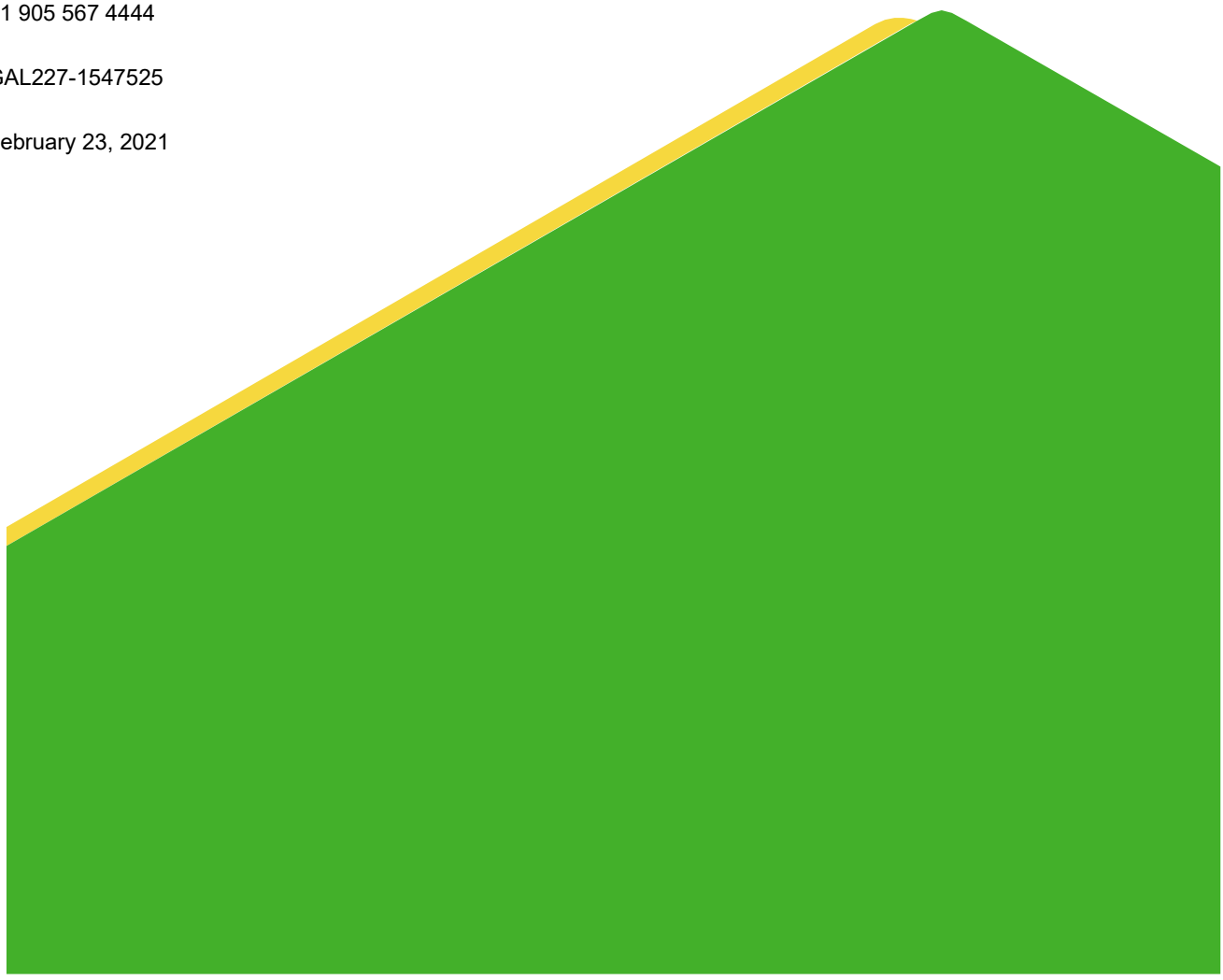
February 23, 2021



Revision History

Title	Draft Environmental Assessment Follow-up Monitoring Program for the Near Surface Disposal Facility

Revision No.	Revision 0
Date:	February 12, 2021
Prepared by:	Golder Associates Ltd.
Reviewed by:	John DeWilde, Callum Squires and Alyson Beal (Golder Associates Ltd.)
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Distribution

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1.0 INTRODUCTION

Canadian Nuclear Laboratories (CNL) is planning to construct and operate a Near Surface Disposal Facility (NSDF) for the disposal of solid, low-level radioactive waste (LLW) at the Chalk River Laboratories (CRL) – the NSDF Project. The NSDF Project is based on the mandate of Atomic Energy of Canada Limited, a federal crown corporation, to substantially reduce the risks associated with the waste and to create conditions for the revitalization of the CRL site. The NSDF Project will enable the site revitalization through improved environmental management of Government of Canada legacy waste liabilities and the decommissioning of outdated infrastructure at the CRL site and other business locations. The current CRL waste management practice is to store radioactive waste on-site in individual facilities in accordance with current licence conditions. The proposed NSDF Project would accommodate the disposal of current and future LLW at the CRL site in a manner that is protective of human health and the environment.

An element of the regulatory approvals process is the completion of an Environmental Assessment under the *Canadian Environmental Assessment Act, 2012*, the results of which are documented in an Environmental Impact Statement (EIS; Golder 2020a). The EIS includes an analysis of alternatives, a process of public and Indigenous engagement, studies of baseline conditions, and a description and assessment of project activities during the construction, operation, closure and post-closure phases of the NSDF Project. The EIS also recommends a number of follow-up studies or monitoring programs. This Environmental Assessment Follow-up Monitoring Program (EAFMP) provides the plans for these recommended sampling studies/programs.

The NSDF Project will be a Class I nuclear facility and therefore the EAFMP has been designed to comply with the following Canadian Standards Association (CSA) standards:

- Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills (CSA N288.4-19; CSA 2019);
- Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills (CSA N288.5-11; CSA 2011); and
- Groundwater protection programs at Class I nuclear facilities and uranium mines and mills (CSA N288.7-15; CSA 2015).

Some of the long-term monitoring activities for the NSDF will become part of ongoing CRL monitoring programs. As such, this EAFMP has been prepared to generally conform to the existing CNL monitoring plans, which are referenced where applicable. The EAFMP also proposes transition timing wherein the monitoring and reporting activities for the NSDF can be turned over to existing CNL programs. The objectives and other elements of all monitoring activities will remain as noted; however, the execution of the work, the groups executing the work, and reporting will be as conducted for the various CNL monitoring programs.

The sampling and monitoring programs included in this EAFMP may need to be updated in the future, to incorporate changes resulting from decisions by the Canadian Nuclear Safety Commission (CNSC) with regards to the NSDF Project, based on review of ongoing monitoring, and based on feedback from Indigenous communities and stakeholders.

1.1 Project Summary

The NSDF Project will be a waste disposal facility using an engineered containment mound (ECM) that will hold LLW waste at near-surface level on the CRL site, similar to a municipal landfill, yet with more robust measures to contain and isolate the wastes from the surrounding environment. The facility is expected to be operational for approximately 50 years and will receive up to 1,000,000 cubic metres (m^3) of LLW over its operational lifetime. The placement of the wastes in the ECM will be completed in phases as follows:

- **Phase 1:** with a design capacity of 525,000 m^3 to accommodate wastes currently in storage and wastes to be generated over the next 20 to 25 years, to create the conditions for the revitalization of the CRL site.
- **Phase 2:** during which the design capacity will be expanded to 1,000,000 m^3 to accommodate wastes expected to be generated following Phase 1.

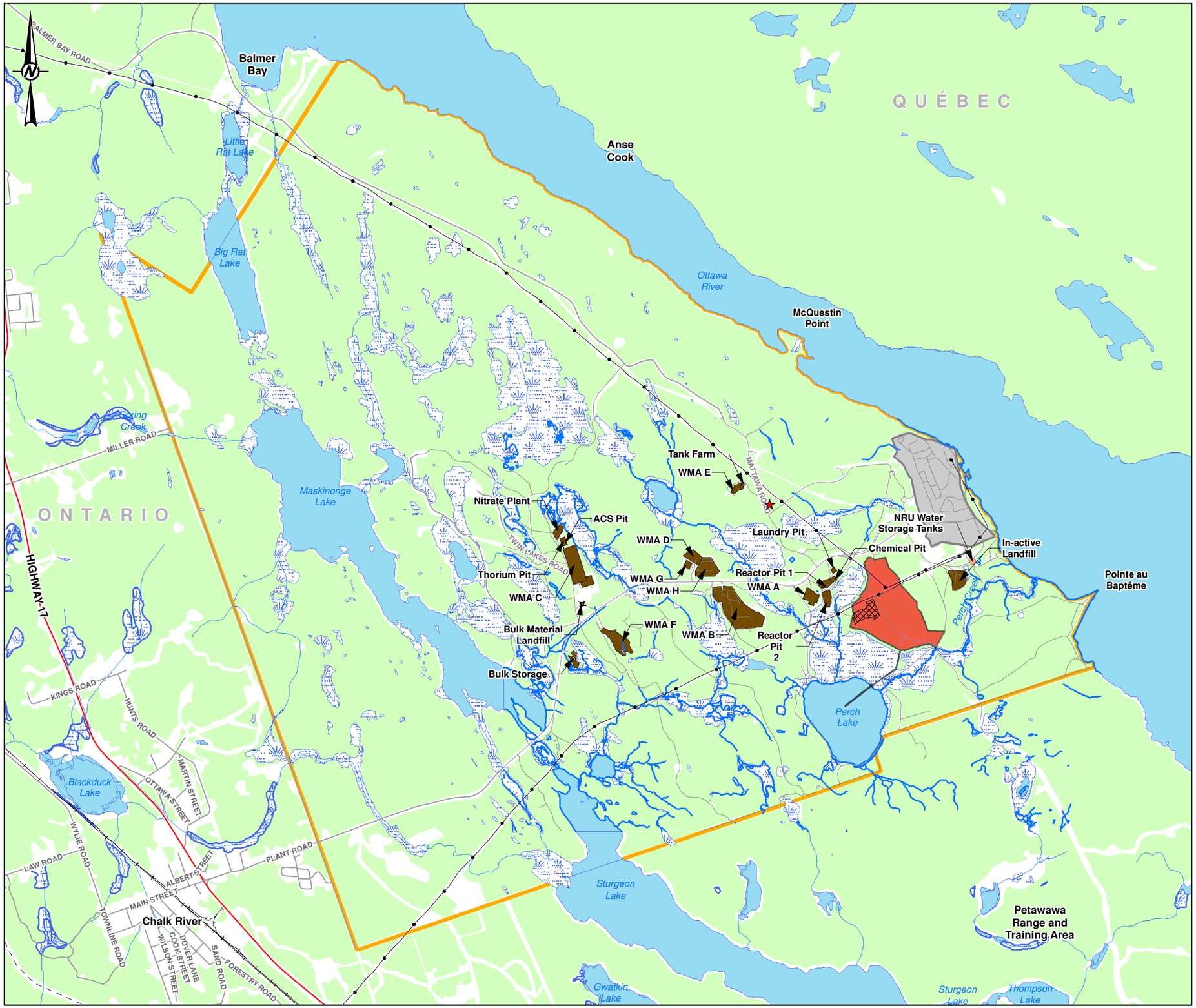
Phase 2 will allow for the inclusion of waste from future operations, decommissioning and remediation at the CRL site and off-site CNL-managed facilities. Following its closure, the ECM will resemble a grassy hillside, but will not be visible from the CRL main campus or the Ottawa River.

The main physical works related to the NSDF Project are the ECM that will contain the waste, the wastewater treatment plant (WWTP), operation support facilities and site infrastructure. These are briefly described below.

The ECM includes the following components.

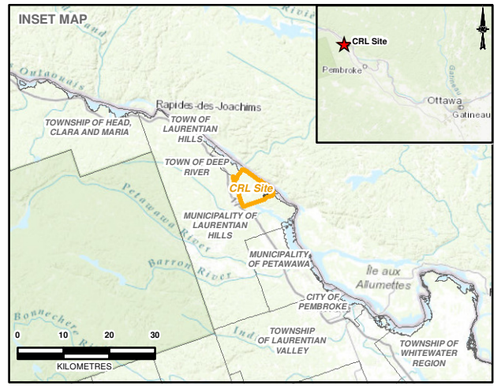
- Base liner system, which includes a primary and secondary liner to contain the waste and to limit the potential release of contamination to the subsurface and groundwater.
- Interim cover as each disposal cell is filled, including a sacrificial temporary geomembrane to limit water requiring treatment.
- Leachate collection and leak detection system.
- Surface water management system, which will control clean surface water on-site, and prevent contact with contaminated waste.
- Final cover system (i.e., cap for the mound); which will isolate the waste, provide radiation shielding, and prevent water from entering. The waste will be covered as each disposal cell is filled.
- Environmental monitoring systems, which will monitor air, surface water and groundwater consistent with existing CRL licence requirements.

The base liner system includes a primary and secondary liner to limit the potential release of contaminated water (i.e., leachate) to the subsurface and groundwater. The surface water management system is designed to control on-site surface water and prevent clean water from coming into contact with contaminated areas. The final cover system (i.e., cap for the mound) is designed to safely contain the waste and limit the infiltration of precipitation to the waste, thereby limiting leachate generation. The environmental monitoring systems will monitor air, surface water and groundwater consistent with existing CRL licence requirements. All waste to be disposed at the NSDF will be required to meet the waste acceptance criteria established thus ensuring operational and long-term safety requirements. Figure 1-1 and Figure 1-2 have been provided to show the location of the NSDF and other features as described.



LEGEND

- HIGHWAY
- ROAD
- RAILWAY
- TRANSMISSION LINE
- NATURAL GAS PIPELINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- WOODED AREA
- TREE RESEARCH PLANTATION
- NSDF PROJECT SITE
- CRL MAIN CAMPUS
- CRL SITE
- WASTE MANAGEMENT AREAS (WMA)[1]



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1:35,000 KILOMETRES

NOTE(S)
1. LIQUID DISPERSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)
1. BASEDATA ONTARIO MNRF 2016, CANVEC 2016, AND CNL 2016
2. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
LOCATION OF NEAR SURFACE DISPOSAL FACILITY

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-10
DESIGNED	SO
PREPARED	SO
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**1-1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

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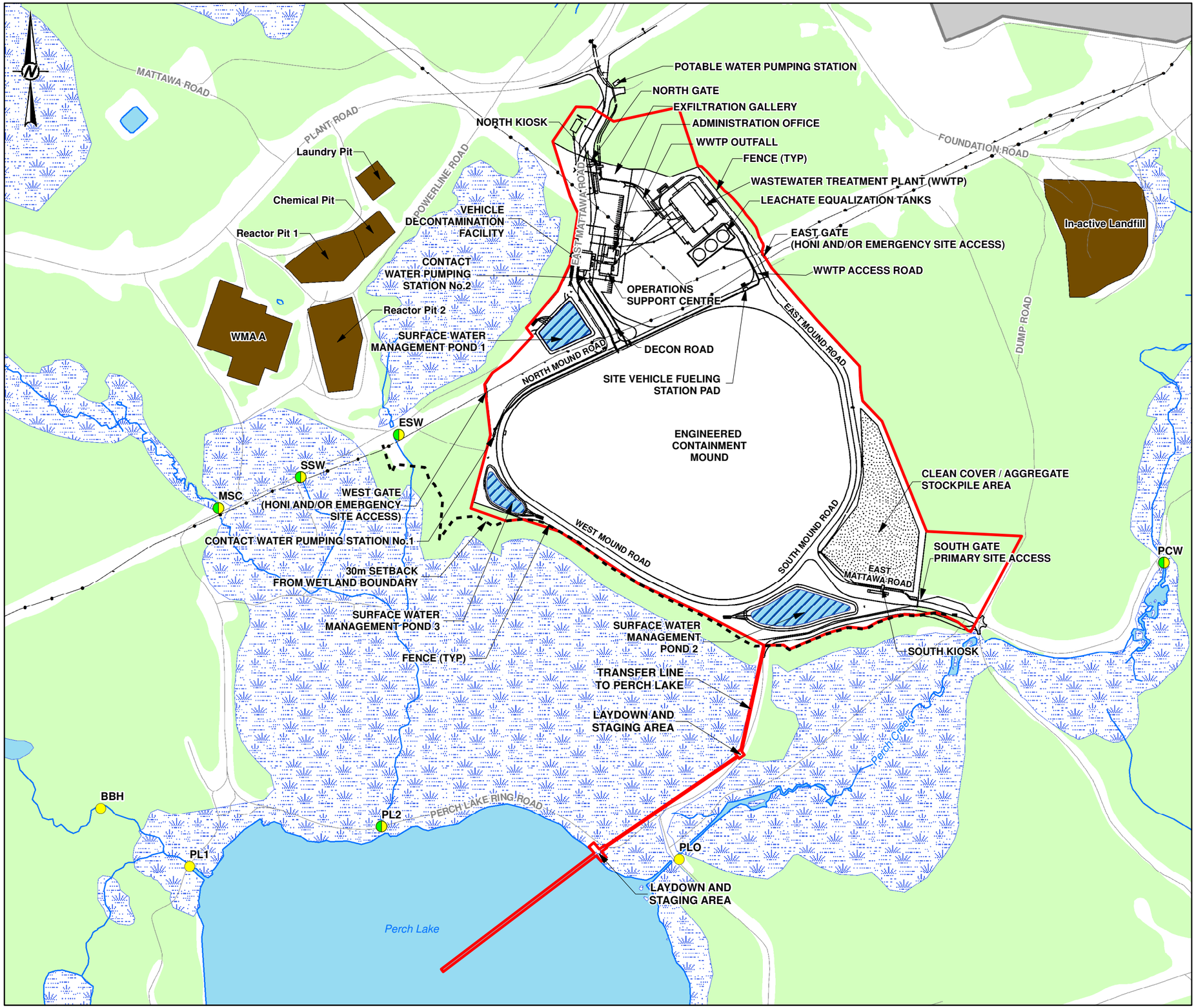

LEGEND

- SAMPLING LOCATION
- WEIR
- SAMPLING LOCATION AND WEIR
- ROAD
- TRANSMISSION LINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- WOODED AREA
- CRL MAIN CAMPUS
- NSDF PROJECT SITE
- WASTE MANAGEMENT AREA (WMA)[1]
- 30 m WETLAND SETBACK
- SURFACE WATER MANAGEMENT POND
- STOCKPILE AREA

100 0 100 200
1:6,000 METRES

NOTE(S)
1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)
1. BASEDATA ONTARIO MNRF 2016, CANVEC 2016, AND CNL 2016
2. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
NEAR SURFACE DISPOSAL FACILITY SITE LAYOUT

CONSULTANT
GOLDER

DATE	2021-02-10
DESIGNED	SO
PREPARED	SO
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**1-2**

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The WWTP is designed to treat leachate and contact surface water from the ECM and wastewater from the NSDF Project's supporting operations. Treated effluent will meet effluent discharge targets for the protection of the environment and human health and will be discharged to an approved discharge location or locations. The effluent from the WWTP will be discharged into an infiltration bed, to recharge the groundwater or to Perch Lake. The supporting infrastructure includes key installations such as a vehicle decontamination facility, weighing stations, laydown and stockpiling area, office and change room facilities, parking and security systems. Construction of a main access road to the NSDF Project site and a perimeter road will provide direct access for construction vehicles and maintenance activities, respectively. The footprint of the NSDF Site Study Area (SSA) is approximately 37 hectares.

Development of the NSDF Project is planned in several phases.

- The construction phase, which includes site preparation, is anticipated to start in early spring or fall 2021 and requires approximately 2 years to complete. This phase will include site clearing, construction of surface water management structures, ECM liner construction, construction of the road and support facilities, and management of surface water and wastes during construction.
- The operations phase is anticipated to begin in 2024 and end in approximately 2070 (i.e., an operating site life of 50 years). Activities associated with the operations phase include those activities necessary for placement of wastes that meet the Waste Acceptance Criteria in the ECM, including on-site transportation, staged development of disposal cells, progressive closure of these cells with installation of cover, treatment of wastewater, maintenance of facilities and establishment of long-term monitoring systems.
- The closure phase is expected to start in 2070 and continue through to 2100, after which the NSDF Project will transfer into the post-closure phase. During the closure phase, operations support facilities such as the WWTP will be considered for continued operation leading to eventual decommissioning and removal. Secure access to the site will remain and environmental monitoring will continue.
- The post-closure phase is defined by two distinct periods: institutional control and post-institutional control. The institutional control period begins following closure of the ECM, then includes implementation of both active and passive control throughout 2100 to 2400 (i.e., 300 years). During institutional control, environmental monitoring will be completed as required to confirm that the final cover is functioning as intended and to demonstrate compliance with the environmental assessment predictions. The post-institutional control period occurs after year 2400 and continues indefinitely.

More information related to the NSDF Project components, activities and phases can be found in the EIS (Golder 2020a).

1.2 Document Layout

This EAFMP is laid out to detail the monitoring required and to facilitate incorporation of the monitoring into CNL's existing monitoring programs. As such, following the introductory sections, the document provides the following information:

- Section 2.0 – presents the acronyms and abbreviations used in this document.
- Section 3.0 – a statement regarding the overall purpose of the EAFMP;
- Section 4.0 – a review of the existing CRL monitoring programs;
- Section 5.0 – A review of the EIS monitoring requirements with an indication of which monitoring program they are part of (i.e., environmental monitoring, effluent monitoring or groundwater monitoring);
- Section 6.0 – the criteria used to determine which monitoring program each EAFMP components falls under;
- Section 7.0 – details related to the EAFMP monitoring that are related to the Effluent Verification Monitoring Program (EVMP);
- Section 8.0– details related to the EAFMP monitoring that are related to the Environmental Monitoring Program (EMP);
- Section 9.0– details related to the EAFMP monitoring that are related to the Groundwater Monitoring Program (GWMP);
- Section 10.0– details related to the EAMP monitoring that are related to the Operations Control Monitoring Program (OCM); and
- Section 11.0 – considerations for Post-Closure Monitoring.

2.0 ACRONYMS AND ABBREVIATIONS

Table 2-1 presents the acronyms and abbreviations used in this document.

Table 2-1: List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
AAQC	Ambient Air Quality Criteria
ARU	Automated Recording Unit
ATG	Analytical Test Groups
CAAQS	Canadian Ambient Air Quality Standards
CBOD	Carbonaceous Biochemical Oxygen Demand
CEPA	Canadian Environmental Protection Act
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COD	Chemical Oxygen Demand
cpm	Counts Per Minute
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSM	Conceptual Site Model
DRL	Derived Release Limit
EAFMP	Environmental Assessment Follow-up Monitoring Program
ECCC	Environment and Climate Change Canada
ECM	Engineered Containment Mound
EDTA	Ethylene-diamine-tera acetic acid
EIS	Environmental Impact Statement
EMP	Environmental Monitoring Program
ERA	Environmental Risk Assessment
ESW	East Swamp Weir
EVMP	Effluent Verification Monitoring Program
FID	Flame Ionization Detector
FHR	Federal Halocarbon Regulations
GHG	Greenhouse Gas
GWMP	Groundwater Monitoring Program
GWPP	Groundwater Protection Program
ISO	International Organization for Standardization
LEL	Lower Explosive Limit
LLW	Low-Level Radioactive Waste
LSA	Local Study Area
mASL	Meters above sea level
MECP	Ministry of Environment, Conservation and Parks
MISA	Municipal/Industrial Strategy for Abatement
MNO	Métis Nation of Ontario
MPER	Maximum Probable Emission Rate
MSC	Main Stream Creek

Table 2-1: List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
NAPS	National Air Pollution Surveillance
NPRI	National Pollutant Release Inventory
NSDF	Near Surface Disposal Facility
PCB	Polychlorinated biphenyl
PLO	Perch Lake Outlet
QA/QC	Quality Assurance / Quality Control
REGDOC	Regulatory Document
RSA	Regional Study Area
SAR	Species at Risk
SARA	*Species At Risk Act*
SPM	Suspended Particulate Matter
SSA	Site Study Area
SSC	Structures, Systems, Components
SSW	South Swamp Weir
SWMP	Stormwater Management Pond
TEQ	Total Toxic Equivalent
TKLUS	Traditional Knowledge and Land Use Study
TLD	Thermoluminescent Dosimeter
TPC	Total Phenolic Content
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency
WWTP	Wastewater Treatment Plant

3.0 PURPOSE & SCOPE

The EAFMP has been developed to expand upon the monitoring and follow-up requirements outlined in the EIS and meet the requirements of both the CNSC as per REGDOC 2.9.1(CNSC 2020) and the *Canadian Environmental Assessment Act*, *2012*. This EAFMP provides the details required to implement the sampling recommendations of the EIS and these recommendations are expected to be part of the NSDF license. The EAFMP may require updating when the licence, and the associated licence condition handbook, are updated with NSDF requirements.

The general objective of each sampling element is to confirm the assessment provided in the EIS or to provide additional information that supports the assessment. The specific objectives for each sampling element are provided in Sections 7 through 10.

The scope of the EAFMP covers monitoring for the construction, operation and closure phases. Monitoring during the Post Closure phase expected to start in year 2100 is addressed at a conceptual level in Section 11.0. The objectives and purpose of monitoring activities established by this EAFMP will be maintained and will be ongoing throughout the Project's lifespan well after follow-up monitoring has transitioned into existing site-wide CRL programs.

Monitoring and follow-up programs are not specifically identified for traditional land and resource use; rather, monitoring for environmental pathways noted above (e.g., for air quality, surface water quality, groundwater quality and terrestrial biota) will be implemented to verify effects predictions for land and resource use, and to promote land user comfort around the safety of the local study area (LSA), regional study area (RSA) and surrounding areas for traditional land and resource use (i.e., to reduce perceptions of adverse NSDF Project effects on traditional land and resource use that are not anticipated to occur). CNL's Public Information Program and enhanced engagement with Indigenous peoples is meant to address these negative perceptions by providing educational opportunities and sufficient factual information. CNL will continue to work with Indigenous communities and organizations to address any of these negative perceptions.

As part of CNL's Public Information Program CNL will continue to engage with Indigenous communities, and share the results of the monitoring and follow-up programs recommended for air quality, surface water quality and groundwater quality data through an accessible format (e.g., NSDF Project website), a recognized best practice used by projects with high levels of perceived risk that may have the potential to alter or reduce land and resource use activity without primary or secondary pathways.

CNL has been carrying out discussions with some Indigenous communities on greater involvement by them in the follow-up monitoring programs. The form and level of this involvement has been discussed in only a preliminary fashion, but CNL is committed to greater Indigenous involvement in these programs.

4.0 REVIEW OF EXISTING CRL MONITORING PROGRAMS

CNL has a set of existing monitoring programs within their environmental protection program, including:

- An effluent verification monitoring program (EVMP) documented in CRL Non-Radioactive Effluent Verification Plan (CNL 2014a) and CRL Radioactive Effluent Verification Monitoring Plan (CNL 2014b). This program is developed to meet the requirements of CSA N288.5-11 (CSA 2011);
- An environmental monitoring program (EMP) documented in CRL Non-Radioactive Environmental Monitoring Plan (CNL 2014c) and CRL Radioactive Environmental Monitoring Plan (CNL 2014d). This program is developed to meet the requirements of CSA N288.4-19 (CSA 2019);

- A groundwater monitoring program (GWMP) documented in CRL Groundwater Protection and Monitoring Plan (CNL 2020a), This program is developed to meet the requirements of CSA N288.7-15 (CSA 2015); and
- An operational control monitoring program (facility-specific process monitoring) that serves to assist facility operators to take timely action to ensure effluents remain in control. CNL's requirements for an operational control monitoring program is found in CNL's standard for the management and monitoring of emissions (CNL 2018a).

Supporting documents for the programs and the EAFMP include:

- Environmental Monitoring Program Management System Document (CNL 2018b), which provides guidance on the development of EMPs for all CNL owned or operated properties.
- Management and Monitoring of Emissions (CNL 2018a), which provides guidance on the need to monitor or control emission and the types of control, treatment or monitoring that may be required. This is related primarily to the EVMP and OCM.
- Protection and Monitoring of Groundwater Management System Document (CNL 2020b) which provides guidance on the development of GWMPs for all CNL owned or operated properties.
- CRL's Integrated Environmental Monitoring Program Framework (CNL 2015), which provides a framework for elements that are common to the EVMP, EMP and GWMP as well as other properties. The elements include documentation, program reviews, objectives, responsibilities and training.
- Environmental Protection Program Radiological and Non-Radiological Monitoring Services Quality Assurance (QA) Plan (CNL 2016a), which provides general requirements for QA of monitoring at CRL.
- Environmental Protection Plan (AECOM 2018a), which details the environmental requirements and practices the NSDF construction contractor is to follow during the construction and operations of the NSDF. This document is not intended to be an EVMP or EMP, however it provides supporting documentation on how the NSDF will incorporate mitigation measures, monitoring of these mitigation measures and best management practices. The document was referenced to identify and minimize overlap between the contractor's monitoring and CNL's monitoring; however, some overlap is designed for QA and independent verification purposes (i.e., dust monitoring conducted as part of the Environmental Protection Plan [AECOM 2018a] and the EVMP).

The interaction of these programs is shown on Figure 4-1. There are numerous other plans and procedures that support CNL's overall monitoring framework. These plans and procedures are referenced within associated documents and in this EAFMP where appropriate.

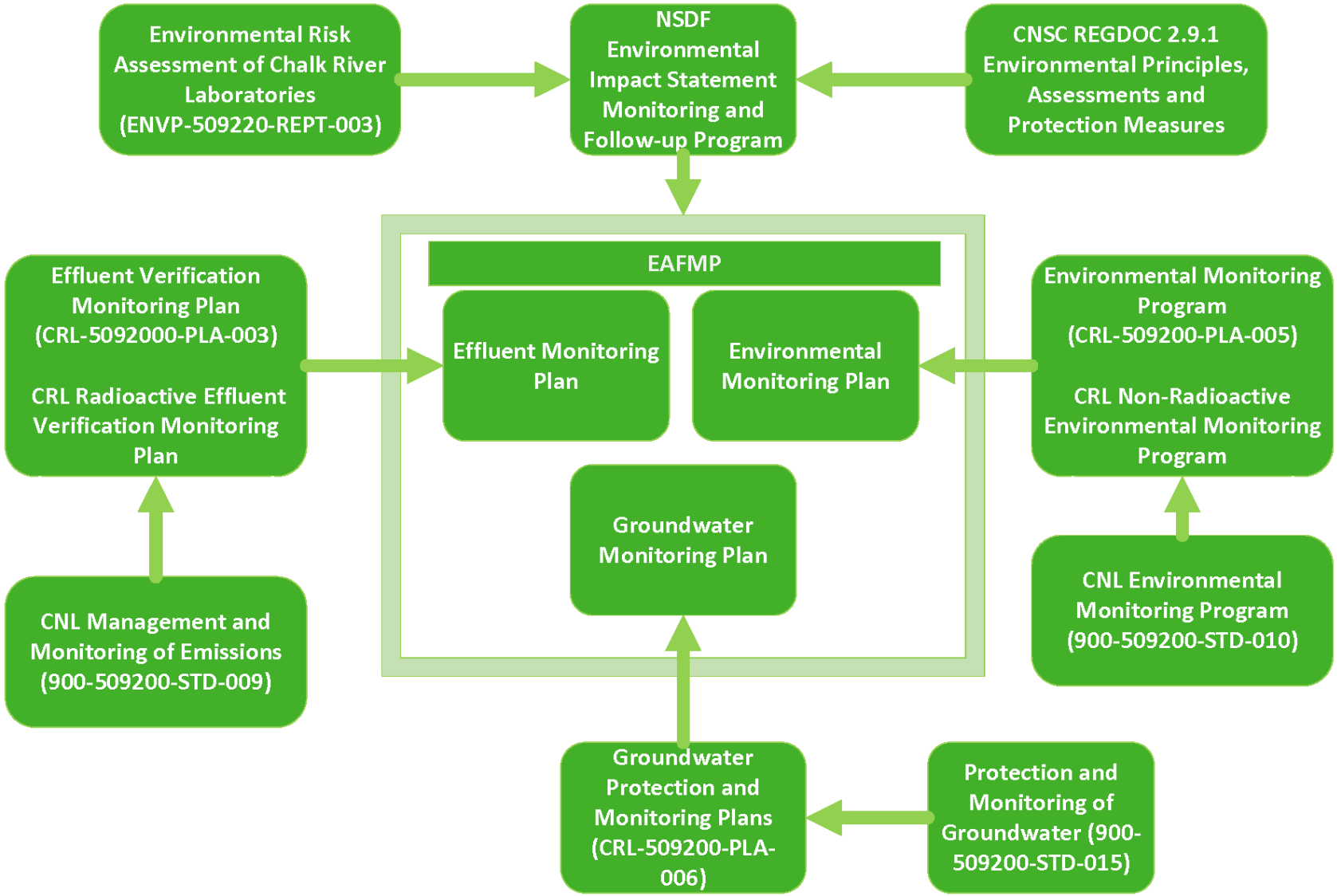


Figure 4-1: Overall Monitoring Framework

Note: All elements guided by CSA N288.4-19, N288.5-11 or N288.7-15 as applicable

5.0 PREVIEW OF ENVIRONMENTAL IMPACT STATEMENT REQUIREMENTS

The following is a review of the EIS requirements for the EAFMP and whether the elements are considered part of effluent, environmental or groundwater monitoring. Table 5-1 is adapted from the EIS (Golder 2020a, Table 11.0-1), with codes added to indicate the program an item belongs to (e.g., EVMP1a, EMP2, GWMP3 or OCM4). These codes have been added to allow for tracking of the various monitoring objective elements or monitoring program elements. The criteria for establishing each program are described in Table 6-1 and the objectives of each item, within the context of its specific program, are provided in the section for that program.

Table 5-1 indicates numerous sampling programs to be conducted as part of CNL's programs or NSDF plans (e.g., Dust Management Plan or CNL's Species at Risk Program). These have been included as part of the EVMP, EMP or GWMP as appropriate and will be transferred to appropriate CNL programs as discussed at the close of each program discussion.

Monitoring and follow-up programs are not specifically identified for selected media based on the recommendations of the EIS and a review of potential impacts. If findings indicate that monitoring of other media is required the indicators for this monitoring, and possible follow-up monitoring is provided in Table 8-2. Other monitoring, primarily at the NSDF, may be conducted as part of the NSDF Environmental Protection Plan (AECOM 2018a) to be implemented for the NSDF Project.

The Suggested Duration noted in Table 5-1 is directly from the EIS. More details regarding timing are provided in the various sections below including the transition of the monitoring and reporting to the CRL programs.

Monitoring items related to land use, socio-economic considerations, Indigenous interests and traditional land use were not specifically identified in the EIS; rather, monitoring for environmental pathways (i.e., for air quality, surface water quality and groundwater quality) will be implemented to verify effects predictions for these disciplines as described in Table 5-1. In addition, CNL will continue to proactively seek, engage and support meaningful discussion on issues and opportunities related to the NSDF Project as part of the Public Information Program (e.g., notification of residents before construction commences and complaint resolution mechanisms as mitigation).

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.2 Atmospheric Environment	Air Quality	Construction activities will result in fugitive dust emissions.	■ Verify that mitigation is being implemented effectively. (OCM1) ■ Verify predictions in the assessment are reasonable and conservative. (EVMP1a) ■ Verify predictions are within air quality criteria (Suspended Particulate Matter (SPM) monitoring). (EMP1a)	■ Application of aggregate to unpaved roads – a record will be kept of the date of each application of aggregate to unpaved roads. ■ Road misting and fixative application – a record will be maintained of dust suppression applications. ■ Site inspection – during periods of high dust susceptibility, regular inspections will be carried out to monitor the efficacy of dust mitigation and any potential concerns with regards to fugitive dust, and, if required, implementation of mitigation will be recommended. Environmental conditions will be recorded. ■ Particulate monitoring –SPM using a high volume sampler.	Through the construction phase	■ Dust Management Plan (AECOM 2018b) to be implemented for the NSDF Project.
		Operations activities will result in fugitive dust emissions.	■ Verify that the mitigation is being incorporated as planned, and are effective. (OCM2) ■ Verify predictions in the assessment are reasonable and conservative. (EVMP1b) ■ Verify predictions are within air quality criteria. (EMP1b)	■ Application of aggregate to unpaved roads – a record will be kept of the date of each application of aggregate to unpaved roads. ■ Road misting and fixative application – a record will be maintained of dust suppression application. ■ Site inspection – during periods of high dust susceptibility, regular inspections will be carried out to monitor the efficacy of dust mitigation and any potential concerns with regards to fugitive dust, and if required implementation of mitigation will be recommended. Environmental conditions will be recorded. ■ Particulate monitoring – SPM using a high volume sampler.	■ Monitored during operations. The need for and frequency of monitoring will be revaluated based on an annual review of monitoring data.	■ Captured through the implementation of the Dust Management Plan (AECOM 2018b) and CNL's procedure for Management and Monitoring of Emissions (CNL 2018a), which includes operational control monitoring and air verification monitoring.
	Greenhouse gases (GHG)	GHG emissions from the decomposition of waste during operations and closure.	■ Verify that the measures for controlling landfill gas generated from waste deposited in the ECM during operations and following final closure are adequate. (OCM3a,b) ■ Verify that methane emission rates used in the assessment are reasonable and conservative. (EVMP2a,b) ■ Verify that there is no combustion hazard from methane gas generation. (OCM4a,b)	■ Monitoring for methane will be performed using handheld portable combustible gas meter detectors. ■ A passive landfill gas venting system will be constructed contemporaneously with installation of the ECM cover system which will provide measured concentrations and emission rates. ■ The landfill gas monitoring probes will also be installed around the perimeter of the ECM to detect evidence of potential landfill gas migration away from the ECM.	Periodic monitoring during operations and for a specific period of time during closure phase (during which the frequency may be progressively reduced and possibly ultimately eliminated if no evidence of landfill gas migration from the ECM is detected)	■ Landfill Gas Management Plan (AECOM 2018c) to be implemented for the NSDF Project.
Section 5.2 Atmospheric Environment	GHGs	Construction and operations activities will result in increased GHG emissions.	■ Verify that GHG emission rates used in the assessment are reasonable, but conservative. Monitoring results will be used for GHG reporting requirements. (EVMP3a,b)	■ Fuel Usage – a record will be kept of the fuel usage related to the NSDF Project.	During construction and operations, annual estimations and GHG reporting to be conducted, as required	■ Captured through the implementation of CNL's procedure for Management and Monitoring of Emissions (CNL 2018a), which includes operational control monitoring and verification monitoring.

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.3 Geological and Hydrogeological Environment	Hydrogeology	The NSDF may affect groundwater quantity and quality during operations, closure and post-closure (institutional control).	■ Verify environmental assessment predictions on groundwater from the ECM (GWMP1a,b) and WWTP operation. (GWMP2a,b) ■ Verify the effectiveness of mitigation. (GWMP3a,b, and GWMP4a,b)	■ Groundwater elevation measurements to determine groundwater flow direction and gradients. ■ Sampling to confirm groundwater quality to detect potential releases of constituents from the ECM containment area. ■ Initial sampling frequency will likely be twice per year (Spring and Fall).	Groundwater monitoring will continue through operations, closure and post-closure (institutional control). The number of parameters, locations and frequency may change based on review of monitoring data.	■ NSDF Project groundwater monitoring will be integrated into the overall CNL GWMP, and will be compliant with CSA N288.7-15.
Section 5.4 Surface Water Environment	Hydrology	The installation of the ECM will physically alter drainage patterns, and may change downstream discharge, water levels in adjacent wetlands and channel and bank stability.	■ Operational monitoring – Verify the SWMPs are performing as designed. (OCM5)	■ Monitoring of water levels and sediment build up in the SWMPs.	The water level at the SWMP will be monitored during construction and operations. The need for and duration of monitoring will be revaluated based on an annual review of monitoring data.	■ Integrated into the NSDF Project Environmental Protection Plan (AECOM 2018a) to be implemented for the NSDF Project.
			■ Environmental monitoring – Confirm that the ecological function and structure of the wetland system is maintained. (EMP2)	■ Monitoring of wetland water elevations and surface water flows to verify changes from the presence of the ECM.	Water level and surface water flows monitoring of the wetland system will be initiated pre-construction (baseline) and continue through construction and operations. The need for and duration of monitoring will be evaluated based on an annual review of monitoring data.	■ Water level and surface water flows monitoring of the wetland system will be integrated into the CNL Environmental Monitoring Program.
	Surface Water Quality	■ Discharge of treated effluent from the WWTP to the East Swamp Wetland and/or Perch Lake can cause changes to downstream surface water quality. ■ Leakage of leachate from the ECM during the post-closure phase (i.e., after Year 2400) from liner and final cover degradation can cause changes to downstream surface water quality.	■ Environmental monitoring – Verify environmental assessment predictions related to surface water quality. (EMP3a,b)	■ Monitoring of surface water surrounding the ECM footprint area to evaluate whether the quality of the water is affected by the ECM or by operation of SWMP(s)	Water quality monitoring will continue through operations, closure and post-closure (institutional control). The number of parameters and locations may change based annual review of monitoring data.	■ Surface water monitoring in the receiving environment is integrated into the CNL Environmental Monitoring Program.
			■ Operational monitoring – Verify the SWMPs are performing as designed. (EVMP4a,b) ■ Demonstrate compliance with effluent discharge targets developed for the NSDF Project. (EVMP5)	■ Discharge from the SWMPs will be sampled to identify contact surface water or leachate contamination and to monitor total suspended solid concentrations. ■ WWTP effluent verification monitoring consistent with CSA Standard N288.5-11.	■ Routine visual inspections and surface water sampling during operations, closure and post-closure (institutional control) as required. ■ Effluent monitoring will continue throughout operation of the WWTP.	■ Effluent water quality monitoring will be integrated into the CRL Radioactive Effluent Verification Monitoring Program.

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.5 Aquatic Environment	■ Perch Creek and Perch Lake Watershed Fish Habitat (i.e., Fish Habitat) ■ Perch Creek and Perch Lake Watershed Fish Community (i.e., Fish Community) ■ Fish Species of Conservation Concern	Measurable residual effects on aquatic biodiversity VCs are not predicted as a result of the NSDF Project. Potential effects are related to: ■ Physical change to fish habitat and temporary riparian area disturbances from the installation of diffuser and transfer line construction and footprint that may affect fish and fish habitat. ■ Non-radiological air emissions and dust emissions (including sulphur dioxide, nitrogen oxides and particulate matter) and subsequent deposition may cause a change in surface water quality and fish habitat quality. ■ Discharge of treated effluent from the WWTP to the exfiltration gallery and Perch Lake may cause changes to groundwater quality and to downstream surface water quality, which can affect fish habitat quality, survival and reproduction. ■ Leakage of leachate from the ECM during the post-closure phase (i.e., after Year 2100 to 2400) from liner and final cover degradation as a result of normal evolution may cause changes to groundwater quality and downstream surface water quality in wetlands, affecting fish habitat quality, survival and reproduction.	■ Operational monitoring – Verify the SWMPs are performing as designed. (EVMP4a,b) ■ Demonstrate compliance with effluent discharge targets developed for the NSDF Project (EVMP5).	See Surface Water Quality. If the environmental monitoring program for surface water quality identifies that adverse environmental effects are greater than predicted, then CNL will evaluate the need for revised mitigation actions and management practices to manage effects. CNL's evaluation process for monitoring data include environmental performance criteria that are based on statistical measures and ecological health benchmarks. An exceedance of environmental performance criteria triggers CNL's non-conformance and corrective action process and includes notifying management and further investigation. Where the need for revised mitigations is identified they will be developed and implemented. The evaluation process is documented in Environmental Monitoring Programs (CNL 2013).	See Surface Water Quality	■ See Surface Water Quality

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.6 Terrestrial Environment	Canada warbler	■ **Habitat Availability**: Permanent, direct loss of 28 ha of suitable habitat. Long-term reduction in quality of nesting habitat and possible avoidance in the Local Study Area (LSA) from sensory disturbance. ■ **Habitat Distribution**: Small, permanent change in local movement. ■ **Survival and Reproduction**: Small reduction in reproductivity from habitat loss and sensory disturbance.	Verify environmental assessment predictions through collection of data on relative abundance and other key demographic parameters for breeding bird populations that overlap with the Regional Study Area (RSA). (EMP4a for most bird species and EMP4b for eastern whip-poor-will).	Data on relative abundance and other key demographic parameters for breeding birds in the RSA will be collected during pre- and post-construction surveys using automated recording units. Collected data will be used to evaluate trends in populations of breeding birds that overlap with the RSA, including Canada warbler, eastern whip-poor-will, eastern wood-pewee, golden-winged warbler and wood thrush. If declining trends are observed for these species in the RSA, then the need for additional mitigation will be evaluated.	During construction and operations with surveys conducted every 5 years.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
	Eastern whip-poor-will	■ **Habitat Availability:** Permanent, direct loss of 2 ha of suitable habitat. ■ **Habitat Distribution**: Small, permanent change in local movement. ■ **Survival and Reproduction**: Small reduction in reproductivity from habitat loss and sensory disturbance.				
	Eastern wood-pewee	■ **Habitat Availability:** Permanent, direct loss of 18 ha of suitable habitat. ■ **Habitat Distribution**: Small, permanent change in local movement. ■ **Survival and Reproduction**: Small reduction in reproductivity from habitat loss and sensory disturbance.				
	Golden-winged warbler	■ **Habitat Availability:** Permanent, direct loss of 27 ha of suitable habitat. ■ **Habitat Distribution**: Small, permanent change in local movement. ■ **Survival and Reproduction**: Small reduction in reproductivity from habitat loss and sensory disturbance.				
	Wood thrush	■ **Habitat Availability:** Permanent, direct loss of 28 ha of suitable habitat. ■ **Habitat Distribution:** Small, permanent change in local movement. ■ **Survival and Reproduction:** Small reduction in reproductivity from habitat loss and sensory disturbance.	Verify environmental assessment predictions through collection of data on relative abundance and other key demographic parameters for breeding bird populations that overlap with the RSA. (EMP4a)	Data on relative abundance and other key demographic parameters for breeding birds in the RSA will be collected during pre- and post-construction surveys using automated recording units. Collected data will be used to evaluate trends in populations of breeding birds that overlap with the RSA, including Canada warbler, eastern whip-poor-will, eastern wood-pewee, golden-winged warbler and wood thrush. If declining trends are observed for these species in the RSA, then the need for additional mitigation will be evaluated.	During construction and operations with surveys conducted every 5 years.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.6 Terrestrial Environment	Bats	■ **Habitat Availability:** Permanent, direct loss of 28 ha of potential maternity roosting habitat. ■ **Habitat Distribution:** Gap in potential maternity roosting habitat, but negligible change in local movement patterns. ■ **Survival and Reproduction:** No residual effects due to the NSDF Project.	Verify effectiveness of bat boxes as maternity roosting habitat offsetting measure, by determining number of individuals and species of bats using boxes for roosting habitat in the RSA. (EMP5)	■ Installation of bat boxes in suitable locations in the RSA was recommended to offset the incremental contribution of the NSDF Project to cumulative effects on *Species At Risk Act* (SARA)-listed bats. Monitoring is being conducted at least weekly during the maternity roost period to determine if bat boxes are being used. Boxes not being used may be moved to an alternate location. ■ A project in collaboration with Trent University is currently underway, where bats are being trapped and tracked back to their roost site (natural tree or bat box). ■ Guano collection is being performed as well. This work has a duration of two years and will provide CNL with a better understanding of habitat occupancy by the bat species at risk, including bat boxes, and habitat preference. This work will support the objective of addressing knowledge gaps on the three bat species at risk.	Bat boxes will remain in place throughout the construction and operations phases. Visual monitoring of bat boxes will be conducted weekly within the occupancy period (May to October) during the pre-construction phase and will continue through construction and for three years after start of operations.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
	Blanding's Turtle	■ **Habitat Availability:** Direct, permanent loss of 26 ha of critical habitat. ■ **Habitat Distribution:** Permanent change in local movement. ■ **Survival and Reproduction:** Reduced reproductive success and mortality of individuals over the lifespan of the NSDF Project.	Confirm effectiveness of mitigation through tracking wildlife mortality and use information for adaptive management. (EMP6)	Wildlife-vehicle collision monitoring will be conducted in the RSA—Vehicle-caused Blanding's turtle mortality will be reported and data will be compiled in the Environmental Data Management System (EDMS) to be used to inform adaptive management for the site.	■ Ongoing during the construction and operations phases and closure. ■ Weekly road mortality survey during the species active terrestrial period (May 1 to September 30).	■ Monitoring will be integrated into CNL's existing Species at Risk Program. ■ The monitoring is considered part of the EMP in this document.
			Identify and map critical habitat in the RSA. (EMP7)	■ As part of the SARA permitting process for the removal of critical habitat, critical habitat will be assessed annually to ensure no significant loss at CRL and to determine compensation measures initiated at CRL or elsewhere. ■ Monitoring will be integrated into CNL's existing Species at Risk Program.	Critical habitat will be assessed annually to ensure no significant loss at CRL and to determine compensation measures initiated at CRL or elsewhere.	■ Habitat compensation will be implemented as part of the SARA permitting process and consist of the creation of nest mounds for the species.
			Confirm integrity of the temporary and permanent exclusion fencing in the RSA. (OCM6)	Exclusion fencing will be inspected for integrity	■ Annually during the construction and operations phases and closure. ■ Weekly inspection of the temporary fencing during the species active terrestrial period (May 1 to September 30) during the construction phase.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
			Confirm integrity of culverts in the RSA. (OCM7)	Culverts will be inspected for barriers to turtle movements	Weekly during the active season for Blanding's turtle (April 15 to October 15) during the construction, operations and closure phases.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
			Confirm integrity of artificial nest mounds (created as habitat compensation for the loss of Blanding's turtle critical habitat) in the RSA (OCM7)	Nesting mounds will be inspected for suitability and mounds will be maintained by removing vegetation as needed	Annual maintenance required after Oct 15 during the construction, operations and closure of NSDF	■ Monitoring will be integrated into CNL's existing Species at Risk Program.

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.6 Terrestrial Environment	Blanding's Turtle	■ **Habitat Availability:** Direct, permanent loss of 26 ha of critical habitat. ■ **Habitat Distribution:** Permanent change in local movement. ■ **Survival and Reproduction:** Reduced reproductive success and mortality of individuals over the lifespan of the NSDF Project.	Artificial Nest Mound Survey for Nests (EMP8)	Nesting surveys to determine if adult females are using the artificial nest mounds.	Weekly during the nesting and hatchling emergence season for Blanding's turtle (May 15 to October 15) during the construction, operations and closure phases.	■ Monitoring will be integrated into CNL's existing Species at Risk Program. ■ EMP Criteria a), b) and c)
			Confirm integrity of nest cages in the RSA (OCM9)	Nest cages will be inspected for integrity	Weekly during the nesting and hatchling emergence season for Blanding's turtle (May 15 to October 15) during the construction, operations and closure phases.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
			Confirm use of culverts by Blanding's turtles in the RSA (EMP9)	Cameras will be installed at culverts and will record photographs on a time-lapse basis (1-minute intervals). Photographs will be reviewed and data compiled.	Continuously throughout the active terrestrial season for Blanding's turtle (April 15 to October 15) Monitoring to start as soon as the culverts are in place during the construction phase and be conducted annually for the next 5 years, after which, it will be turn over to the routine EMP.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
	Eastern Milksnake	■ **Habitat Availability:** Direct, permanent loss of habitat. ■ **Habitat Distribution:** Permanent change in local movement. ■ **Survival and Reproduction:** increased risk of injury/mortality on roads	Confirm effectiveness of road mitigation to minimize or eliminate the potential for road mortality in the LSA. (OCM10)	Exclusion fencing will be inspected for integrity.	Annually during the construction and operations phases and closure.	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
			Confirm effectiveness of road mitigation to minimize or eliminate the potential for road mortality in the LSA (EMP10)	Road mortality surveys to be conducted weekly during pre-construction and operations within the NSDF Project site and surrounded road network. During construction, mortality survey to be conducted daily during the species active terrestrial period (April 15 to September 30).	Weekly during the active season (April 15-October) during construction and operation phases	■ Monitoring will be integrated into CNL's existing Species at Risk Program.
	Monarch butterfly	■ **Habitat Availability:** Permanent, direct loss of 5 ha of suitable habitat. ■ **Habitat Distribution**: Small, permanent change in local movement. ■ **Survival and Reproduction**: Small reduction in reproductivity from habitat loss.	NA	No monitoring proposed as the EIS predicts that changes to monarch butterfly habitat availability, habitat distribution, and survival and reproduction in the RSA as a result of the NSDF Project are within the resilience and adaptability limits of the species.	NA	■ NA

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
■ Section 5.7 Ambient Radioactivity and Ecological Health ■ Section 5.8 Human Health	All VCs	During the operations and closure phases: ■ Airborne emissions may be released from the ECM from contaminated dust created during handling of bulk materials and emissions of gases may be released during storage and disposal of radioactive materials. ■ Emissions may be released from the WWTP to air during operations and closure. ■ Discharge of treated effluent from the WWTP to the East Swamp Wetland and Perch Lake can cause changes to groundwater quality in the wetland and downstream surface water quality, which can affect ecological health. During the post-closure phase (institutional control): ■ Volatiles (e.g., radon, tritium) may be released to air; ■ Leachate may be released to soil via overtopping the berm; and ■ Leachate may be released through the base liner to groundwater.	Verify effectiveness of mitigation. (see column to the right for the programs identified)	■ Air quality (i.e., dust) will be monitored at the SSA (EVMP1 to EVMP4) and air effluent verification monitoring may be required at the WWTP (EVMP6). ■ Dust samples collected in the high-volume air sampler during construction and operations will be screened for radioactivity (EMP11). ■ Treated effluent from the WWTP (EVMP5, stormwater pond effluent (EVMP4a,b) and surrounding surface water quality will be monitored (EMP3a,b). ■ Ambient radioactivity will be measured at the SSA (EMP12a,b). ■ Groundwater monitoring will be performed surrounding the ECM, to confirm groundwater quality and detect potential releases of constituents from the ECM containment area (GWMP3a,b).	Ongoing during operations, closure and post-closure (institutional control). The need for and duration of monitoring will be reviewed based on annual review of monitoring data.	■ Integrated into the existing EVMP, GWMP and EMP as applicable. ■ Monitoring required is addressed above with the exception of “Ambient radioactivity will be measured at the SSA.”.
Section 5.9 Land and Resource Use	■ Land and Resource Tenures and Other Registered Interests ■ Outdoor Tourism and Recreation ■ Archaeological Sites	■ No residual adverse effects identified. Potential effects are related to: ▪ Change in access to or availability of tenured land use opportunities and other registered interests ▪ Changes in access to or quality and quantity of outdoor tourism and recreation activities (except trapping) ▪ Ground disturbance from the NSDF Project during construction may cause disturbance or destruction to archaeological sites.	Verify mitigation is effective (as noted, this is addressed through other programs).	■ Monitoring and follow-up programs are not specifically identified for land and resource use; rather, monitoring for environmental pathways (i.e., for air quality, surface water quality and groundwater quality) will be implemented to verify effects predictions for land and resource use, and to promote land user comfort around the safety of the Land and Resource Use LSA, RSA and surrounding areas for land and resource use, outdoor tourism and recreation, and commercial (i.e., tenured) land use activities (i.e., to reduce perceptions of adverse NSDF Project effects on land and resource use that are not anticipated to occur). ■ Monitoring will be used to identify unanticipated archaeological resources and apply adaptive management through the implementation of the CNL Archaeological Master Plan and Cultural Resource Management Program.	■ Ongoing during operations, closure and post-closure (institutional control) phases. ■ The need for and duration of monitoring will be reviewed based on an annual review of monitoring data.	■ Integrated into CNL’s Environmental Monitoring Program. ■ Executed as part of CNL’s Public Information Program. ■ CNL’s Archaeological Master Plan and Cultural Resource Management Program. ■ Monitoring required is addressed above and no further environmental monitoring required.

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 5.10 Socio-economic Environment	■ Labour Market ■ Economic Development ■ Government Finances ■ Housing and Accommodations ■ Services and Infrastructure ■ Quality of Life ■ Public Safety	Employment of personnel, procurement of goods and services, and expenditures from the NSDF Project: ■ Increased pressure on commercial accommodations ■ Increased road degradation due to increased traffic volume from the transportation of workers, supplies and equipment. ■ Increased demand for emergency services ■ Increased demand for protective services	Verify mitigation is effective (as noted, this is addressed through other programs).	■ Monitoring and follow-up programs are not specifically identified for socio-economics; rather, monitoring for environmental pathways (i.e., for air quality, surface water quality and groundwater quality) will be implemented to verify effects predictions. ■ CNL will proactively seek, engage and support meaningful discussion on issues and opportunities related to the NSDF Project as part of the Public Information Program (e.g., notification of residents before construction commences and complaint resolution mechanisms as mitigation). CNL will continually evaluate both the process and the outcome of the ongoing engagement and communication activities to address and manage issues as they arise.	■ Ongoing during the construction, operations and closure phases and the need for and duration of monitoring will be reviewed based annual review of monitoring data. ■ The level and nature of engagement with the communities will depend on feedback received.	■ Integrated into CNL's Environmental Monitoring Program. ■ Executed as part of CNL's Public Information Program. ■ Monitoring required is addressed above and no further environmental monitoring required.
Section 5.10 Socio-economic Environment	■ Quality of Life (noise)	Increase in traffic during construction will result in increased noise levels	Verify baseline traffic volumes and composition used in the noise prediction modelling (OCM11)	■ A traffic count study will be completed along Highway 17 and Plant Road as a pre-construction activity.	■ One field study during pre-construction	Not applicable as this is a one time study.
Section 6 Indigenous Interests - Traditional Land and Resource Use	Traditional Land and Resource Use by Indigenous Peoples	No residual adverse effects identified. Potential effects are related to: ■ Changes in access to or quality and quantity of trapping opportunities ■ Changes in access to the quality and quantity of traditional land and resource use – trapping	Verify mitigation is effective (as noted, this is addressed through other programs).	■ Monitoring and follow-up programs are not specifically identified for traditional land and resource use; rather, monitoring for environmental pathways (i.e., for air quality, surface water quality, groundwater quality and terrestrial biota) will be implemented to verify effects predictions for traditional land and resource use, and to promote land user comfort around the safety of the traditional land and resource use LSA, RSA and surrounding areas for traditional land and resource use (i.e., to reduce perceptions of adverse NSDF Project effects on traditional land and resource use that are not anticipated to occur). ■ As part of CNL's Public Information Program, CNL will continue to engage with Indigenous peoples, and share the results of the air quality, surface water quality, groundwater quality and terrestrial biota monitoring through an accessible format (e.g., NSDF Project website), a recognized best practice used by projects with high levels of perceived risk that may have the potential to alter or reduce land and resource use activity without primary or secondary pathways. ■ Monitoring will be used to identify unanticipated archaeological resources and apply adaptive management through the implementation of the CNL Archaeological Master Plan and Cultural Resource Management Program.	■ Ongoing during operations, closure and post-closure (institutional control) phases. ■ The need for and duration of monitoring will be reviewed based on an annual review of monitoring data.	■ Integrated into CNL's Environmental Monitoring Program. ■ Executed as part of CNL's Public Information Program. ■ CNL's Archaeological Master Plan and Cultural Resource Management Program.

Table 5-1: Environmental Assessment Monitoring and Follow-up Programs Proposed for the NSDF Project

EIS Section	Valued Component	Project Phase and Potential Effect	Monitoring Program Objective	Conceptual Monitoring Program	Suggested Duration	Implementing Program
Section 6 Indigenous Interests - Indigenous Socio-economic Environment	■ Decision-making ■ Population and demographics ■ Economy and employment ■ Housing and infrastructure ■ Indigenous resident – use and enjoyment of private property	No residual adverse effects identified. Potential effects are related to: ■ The NSDF Project could affect air quality through the generation of emissions and fugitive dust ■ The NSDF Project could affect ambient noise levels due to construction traffic ■ The NSDF Project could affect ambient noise levels due to blasting activities ■ The NSDF Project could have a negative effect on visual aesthetics ■ Direct and indirect employment requirements may affect employment and income within the LSA and RSA. ■ The NSDF Project may provide contracting and supplier opportunities to Indigenous local and regional businesses. ■ Involvement with the NSDF Project may require more time on the part of Indigenous governance bodies.	Verify mitigation is effective (as noted, this is addressed through other programs).	■ Monitoring and follow-up programs are not specifically identified for Indigenous socio-economics; rather, monitoring for environmental pathways (i.e., for air quality, surface water quality and groundwater quality) will be implemented to verify effects predictions. ■ CNL will proactively seek, engage and support meaningful discussion on issues and opportunities related to the NSDF Project as part of the Public Information Program (e.g., notification of residents before construction commences and complaint resolution mechanisms as mitigation). CNL will continually evaluate both the process and the outcome of the ongoing engagement and communication activities to address and manage issues as they arise.	■ Ongoing during the construction, operations and closure (institutional control) phases and the need for and duration of monitoring will be reviewed based annual review of monitoring data. ■ The level and nature of engagement with the Indigenous peoples will depend on feedback received.	■ Integrated into CNL's Environmental Monitoring Program. ■ Executed as part of CNL's Public Information Program.

6.0 MONITORING PROGRAMS

The various monitoring components are related to CNL's overall environmental monitoring criteria as indicated in Table 5-1. Table 6-1 provides detail on the criteria related to the need for a monitoring program. The systematic planning process used to develop the sampling plans is discussed in Section 6.2.

The various monitoring components will be addressed for each of the NSDF Project phases, noting that the post-closure phase will be addressed at the conceptual level only as this is over 70 years in the future and will likely require review and modification as will be determined by existing monitoring and compliance programs at the CRL site.

The development of the specific monitoring programs also identifies where there are existing monitoring programs for the CRL site (i.e., EVMP, EMP or GWMP) and how the EAFMP reporting fits into the reporting requirements for the CRL site, identifying opportunities for consolidation of the programs to avoid redundancy.

The programs are not split by radioactive and non-radioactive concerns (as is the case for CRL's EMP and EVMP) as there are few solely radiologically related requirements in the EAFMP (e.g., leachate monitoring in SWMPs is both radiological and conventional).

6.1 Need for the EAFMP

The proposed monitoring/sampling programs for the EAFMP are linked to the EMP, EVMP or GWMP based on the criteria in CSA standards N288.4-19, N288.5-11 and N288.7-15, respectively. These criteria are described in Table 6-1 either as part of CNL documents (EVMP - CNL 2018a; EMP - CNL 2018b; or GWMP - CNL 2020b). These criteria are used to justify the need for monitoring for the various EAFMP components in Table 5-1 as part of the EVMP, EMP or GWMP.

As noted in Table 5-1, there are several items that do not fall within the EVMP, EMP or GWMP and these are noted as part of the Operational Control Monitoring (OCM) Program. As stated in the Management and Monitoring of Emissions (CNL 2018a), an OCM Program may be established if requested by an environmental program. To this effect, the OCM monitoring elements (under the Monitoring Program Objectives column in Table 5-1) are those that are not considered part of the EVMP, EMP or GWMP. These are discussed in Section 10.0.

Table 6-1: Criteria for the Need of a Monitoring Program

Criteria Number	Criteria Description	Criteria Met for NSDF (Yes/No)
An EVMP for monitoring of radioactive and non-radioactive emissions from NSDF shall be established if (CNL 2018a):		
EVMP a)	A governing statute, regulation, licence, or permit requires it.	Yes – There are various pieces of federal legislation that apply to the NSDF EVMP.
EVMP b)	The results of an Environmental Risk Assessment (ERA) indicate potential concern.	Yes - The results of the EIS (similar to an ERA) have predicted potential concerns requiring monitoring. These are the EIS follow-up recommendations.
EVMP c)	There is a need for having the capability of identifying an unplanned emission.	Yes - Aspects of the NSDF operations (i.e., the WWTP) will require monitoring for unplanned emissions.
EVMP d)	The EVMP would support a radiation dose assessment or assessment of potential exposure to hazardous substances.	No – The dose assessment was conducted as part of the EIS. The EVMP may provide information that is used to calculate dose but this is not an objective.

Table 6-1: Criteria for the Need of a Monitoring Program

Criteria Number	Criteria Description	Criteria Met for NSDF (Yes/No)
An EMP for monitoring of radioactive and non-radioactive contaminants, physical stressors, or environmental effects within the environment on and surrounding the NSDF shall be established if (CNL 2018b):		
EMP a)	A governing statute, regulation, licence, or permit requires it	No – There are no specific regulations that apply to the NSDF EMP.
EMP b)	The results of an 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)	Yes – The results of the EIS (similar to an ERA) have predicted potential concerns requiring monitoring. These are the EIS follow-up recommendations.
EMP c)	The effective dose to members of an off-site critical group from all radioactive emissions from the site during normal operations and anticipated transients is estimated to exceed 5×10^{-5} Sv (or 0.05 mSv) per year.	No – the effective dose to members of the public is predicted to be less than 0.05 mSv per year.
EMP d)	The potential effective dose to members of an off-site critical group from all radioactive emissions from the site in the event of an accident is estimated to exceed 1×10^{-3} Sv (or 1 mSv) per year, which is the public dose limit prescribed by Section 1(3) of the Nuclear Safety and Control Act *Radiation Protection Regulations*	No – the potential effective doses for disruptive events assessed in the EIS are predicted to be less than 1 mSv per year.
EMP e)	There are uncertainties in environmental transfer parameters such that emissions from the site could potentially cause doses exceeding the levels in c) or d)	No – there are no uncertainties regarding environmental transfer parameters that are significant enough to warrant further study.
EMP f)	There are other business reasons, i.e., stakeholder concerns, due diligence, etc.	Yes – an overall objective of the EAFMP is to address stakeholder concerns.
A Groundwater Monitoring Program for monitoring of impacts to groundwater shall be established at CNL operated sites if (CNL 2020b):		
GWMP a)	A governing statute, regulation, licence or permit requires it	No – There are no specific regulations that apply to the NSDF EMP.
GWMP b)	There are significant inventories of dispersible nuclear or hazardous substances that warrant the establishment of a GWMP.	No – Although there will be an inventory of contaminants contained within the ECM, the engineered barriers and a robust leachate collection system will provide containment of these materials.
GWMP c)	The results of other studies (such as the ERA, events or activities indicate that an important characteristic of the site are inadequately understood and would be better understood by implementing a GWMP	No – Potential risks to human health and the environment are assessed in the EA and its supporting documents. No areas were identified where a monitoring program was needed in order to fill gaps in the EIS.
GWMP e)	It is required to support other studies or activities (such as feasibility studies or decommissioning activities)	Yes – The primary need for establishing a GWMP is to provide monitoring data to verify the EA's predictions.

Table 6-1: Criteria for the Need of a Monitoring Program

Criteria Number	Criteria Description	Criteria Met for NSDF (Yes/No)
A Groundwater Monitoring Program for monitoring of impacts to groundwater shall be established at CNL operated sites if (CNL 2020b):		
GWMP f)	For other business reasons (e.g., stakeholder concerns, due diligence)	Yes – Related to item c above, there is stakeholder and Indigenous interest in many aspects of the NSDF Project including groundwater quality and potential impacts of the project on the Perch Creek and Perch Lake watershed and Ottawa River.

6.2 Systematic Informed Planning Process

The planning process for the development of the EAFMP follows the systematic planning process identified in CSA standards N288.4-19, N288.5-11 and N288.7-15. A general schematic of this plan is provided on Figure 6-1, although there are minor differences between various standards. The objectives of the EAFMP monitoring components are provided in Table 5-1 and reiterated where applicable in subsequent sections. Other elements of the systematic planning process (i.e., boundaries and how the data collected is to be used) are described in Sections 7.0 through 9.0. Post-closure monitoring is discussed in Section 11.0.

To facilitate implementation of the EAFMP a two-tier approach to assessing data is used where possible. In general, Tier 1 Criteria are used to identify deviations from baseline or EIS predictions and actions resulting from exceedances of Tier 1 Criteria are to perform data review, investigate source of exceedances and modify the monitoring as may be appropriate. Tier 2 Criteria are typically risk based values and actions taken for exceedances may include possible monitoring or operational modifications. While Tier 1 and Tier 2 Criteria are generally hierarchical both are commonly used to meet specific objectives (e.g., Tier 1 Criteria may be used to meet the objective of confirming EIS predictions and Tier 2 Criteria may be used to meet the objective of assessing potential impacts to human health or the environment). Further details on these criteria are provided in the monitoring programs along with a summary of the criteria.

Figure 6-1 Systematic Planning Process

7.0 EFFLUENT VERIFICATION MONITORING PROGRAM

This section of the EAFMP details the EVMP for the NSDF and particularly as it relates to the EIS follow-up monitoring (as noted in Section 5.0). The EVMP section provides the development of the program and specific details for the execution of the program as well as transition to existing CNL programs.

7.1 Systematic Informed Planning Process

As a result of the identified need to develop an EVMP as outlined in Section 6.1, this monitoring plan was developed following a systematic, informed planning process, as defined by the following five steps (CNL 2014b):

1) Define the objectives of the EVMP (Section 7.1.1);
2) Identify the information required to meet the defined objectives (Section 7.1.1);
3) Determine how the data collected will be used to achieve the defined objectives (Section 7.1.1);

4) Specify performance and acceptance criteria (Section 7.1.4); and

5) Develop the detailed design of the EVMP that will be implemented to obtain the required data (Section 7.1.2).

Section 7.4 provides details on how the EAFMP EVMP reporting will be transitioned to the current CRL EVMP (CNL 2014a, 2014b).

7.1.1 Objectives

The various effluents from the NSDF are evaluated against the objectives for an EVMP in Table 7-1 below. The primary and secondary objectives of the existing CRL EVMP, as defined in CNL's Management and Monitoring of Emissions (CNL 2018a), are listed in lettered sequence below. Each EVMP objective is sequentially evaluated in Table 7-1 to determine whether each will be applicable to the NSDF effluent monitoring objectives, the monitoring program elements which are identified in Table 5-1 (e.g., EVMP1a, 1b, etc.). Table 7-1 also specifies how the information collected from monitoring activities will be used to meet these objectives.

The primary EVMP objectives are:

a) To demonstrate compliance with regulatory release limits and any other regulatory requirements (e.g., Action Levels) concerning the emission of nuclear/hazardous substances from the source;

b) To demonstrate adherence to internal levels set on emission amounts (e.g., Administrative Levels), for purposes of effluent control;

c) To confirm the adequacy of controls on emissions from the source;

d) To provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring;

e) To provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear/hazardous substances of concern released from the facility; and

f) To confirm predictions in environmental assessments.

The secondary EVMP objectives are to:

g) To provide data for trend analysis;

h) To provide assurance to employees and the public on the effectiveness of effluent control;

i) To provide data which, when combined with the results of environmental monitoring and modelling, can be used to test or refine the models of the environment used in the ERA or dose/exposure assessments;

j) To provide baseline data and capability for monitoring and assessment in emergency conditions; and

k) Other business purposes (e.g., demonstrating due diligence, meeting a stakeholder commitment, etc.)

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Primary EVMP Objectives			
a) To demonstrate compliance with authorized release limits and any other regulatory requirements (e.g., Action Levels) concerning the release of nuclear/hazardous substances from the source.	Yes: An objective of the Effluent Verification Monitoring Program is to demonstrate compliance with:		
	Federal Legislation: *Canadian Environmental Protection Act* (CEPA)		
	National Pollutant Release Inventory (NPRI) reporting Notices Monitoring Program Elements: EVMP1a, 1b	Need knowledge of the site's manufacturing, production or otherwise use and releases of any substances in Parts 1 to 5 of the NPRI.	*Are any NPRI substances reportable for the site*? Compare site's manufacturing, production or otherwise use and releases of any substances in Parts 1 to 5 of the NPRI to NPRI reporting thresholds for the overall CRL Site (Tier 2 Criteria, Table 7-31) and report, if required.
	GHG Emissions reporting Notices Monitoring Program Elements: EVMP2a, 2b, 3a, 3b, 6	Need knowledge of the site's GHG emissions (quantities).	*Are the site's GHG emissions reportable?* Compare site's GHG emissions to Environment and Climate Change Canada (ECCC) yearly reporting threshold for the overall CRL Site (Tier 2 Criteria, Table 7-33) and report annually under the GHG Reporting Program (GHGRP) (Governement of Canada 2020), if required.
	Federal Halocarbon Regulations	Need knowledge of any halocarbon releases greater than 10 kg from refrigeration systems, air-conditioning systems, and fire-extinguishing systems.	*Were there any reportable halocarbon release events?* Compare each individual event (halocarbon release quantity) to *Federal Halocarbon Regulations, 2003* (FHR) reporting threshold of 10 kg or more (Tier 1 Criteria) (CNL 2019a). For all releases >10 kg, report these collectively on a semi-annual basis (CNL 2019a). For each individual release greater than 100 kg (Tier 2 criteria), report immediately (in addition to semi-annually).

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Primary EVMP Objectives (cont'd)			
b) To demonstrate adherence to internal levels set on emission amounts (e.g., Administrative Levels), for purposes of effluent control.	Yes – treated effluent from the WWTP will need to meet effluent discharge targets Monitoring Program Element: EVMP5	Treated water from the WWTP is to be analyzed prior to discharge to confirm it meets effluent discharge targets. Further details provided in Objective c) below.	*Are internal emission targets being met?* WWTP discharge is permitted only if concentrations in treated water meet effluent discharge targets indicated in Table 7-29 (Tier 2 Criteria). For each batch of water to be discharged, the sampling is to meet the effluent discharge targets noted. Further details provided in Objective c) below.
c) To confirm the adequacy of controls on emissions from the source.	Yes – The effluent sources noted below are controlled and monitoring is required to confirm controls are performed so that EIS predictions are maintained.		
	The three SWMPs are to be maintained to adequately treat surface water as designed. Monitoring Program Elements: EVMP4a, 4b	The SWMPs are designed to treat sediment content of runoff and are also used to detect issues related to the collection of contact surface water and leachate. Sampling of SWMP discharges will be used to assess the SWMP's performance and to assess potential issues with contact surface water collection.	*Is the SWMP effluent quality acceptable and has no indications of contact surface water?* As a Tier 1 Criteria, stormwater effluent sample analysis of indicator parameters (Table 7-30) is to be evaluated for trends in contaminant concentrations. In particular, tritium and other indicator parameters identified in WWTP effluent, will be evaluated to assess whether potential issues with mitigation are resulting in a general decrease in water quality (Tier 1 Criteria). Where an upward sustained trend is confirmed, further evaluation/monitoring is to be conducted and a plan developed to address the trend, if required. An upward trend of TSS, however, may be indicative of issues with the SWMP performance, construction/operations controls or possible presence of contact surface water. Tier 2 Criteria (Table 7-30) may be used to evaluate potential effects, if required.

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Primary EVMP Objectives (cont'd)			
c) To confirm the adequacy of controls on emissions from the source. [cont'd]	Leachate and contact surface water to be treated to maintain water quality requirements as designed. Monitoring Program Element: EVMP5	Waterborne effluent from the WWTP is required to meet effluent discharge targets prior to discharge. Sample analysis from each batch discharge of treated water is required to demonstrate compliance.	*Is the WWTP effluent quality acceptable?* Each treated effluent sample analysis is to be compared to the Tier 2 Criteria noted in Table 7-29. Treated effluent that reports an exceedance of a discharge target concentration for any parameter is to be re-processed to address the exceedance. Treated effluent exceeding the effluent discharge targets is not to be discharged to the environment. If, in the case of water volumes in excess of that which can be treated at the WWTP operations (e.g., a 100 year rainfall and water cannot be processed at the rate it is generated) and where treated effluent needs to be discharged but the treated effluent in the tanks exceeds one or more of the parameter requirements, or if analysis cannot be conducted at the required timing, the following is recommended as a basis for dealing with this event: ■ Evaluate changes to operations and possible alternative discharge of water. If still required to discharge, obtain approval from the Environmental Protection Program following the process in Acceptability Criteria for Routine and Non-Routine Discharge of Liquids (CNL 2019a).

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Primary EVMP Objectives (cont'd)			
d) To provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring.	Yes –, SWMP monitoring, and WWTP monitoring serves to identify lack of control from related components of the NSDF. Monitoring Program Elements: EVMP4a, 4b; EVMP5	Further details provided in Objective c) above.	*Are there unusual or unforeseen conditions that may require corrective action or further monitoring?* Where monitoring of SWMP effluent identifies an unusual condition (e.g., an upward trend/Tier 1 Criteria exceedance) that requires corrective action or further monitoring, additional actions are to be conducted as required. For the WWTP unusual conditions will be identified prior to discharge. In these cases, the effluent would be re-processed to meet the Tier 2 Criteria or the process discussed in Objective c) implemented. As a conservative measure, tritium concentrations in effluent will be assessed for a significant increased trend (Tier 1 Criteria) and an evaluation of potential impacts and/or mitigation measures conducted.
e) To provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear/hazardous substances of concern released from the facility.	Yes – dust monitoring data and WWTP data may be used for future ERAs. In particular, radiological data from the WWTP could be used in dose assessments along with data collected from the EMP. Monitoring Program Elements: EVMP1a, 1b; EVMP4a, 4b; EVMP5	Further details provided in Objective c) above.	*Does the data allow for an assessment of risk?* Further details provided in Objective c) above. Comparison of the data collected to the Tier 2 Criteria (Table 7-31) will allow for risk screening. Exceedances of these benchmark values can be further evaluated in a risk assessment or other evaluation.

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Primary EVMP Objectives (cont'd)			
f) to confirm predictions in environmental assessments.	Yes – the monitoring from various effluent streams is to be compared to EIS (Golder 2020a) predictions.		
	Dust monitoring Monitoring Program Elements: EVMP1a, 1b	Need knowledge of EIS's particulate emissions predictions per phase and NSDF's actual particulate releases during each of the phases.	*Do the dust emissions meet the EIS predictions?* The estimated SPM, PM_{10} and $PM_{2.5}$ emissions will be compared to the values in the EIS (Tier 1 Criteria, Table 7-31) to verify that the assumptions used in the EIS were reasonable and conservative Exceedance(s) of EIS predictions are not indicative of adverse effects and the nonconformance process is discussed in Section 7.1.5.
	Other airborne emissions monitoring Monitoring Program Elements: EVMP2a, 2b, 3a, 3b, 6	Need knowledge of EIS's airborne emission predictions for the construction and operations phase and NSDF's actual releases during each of these phases.	*Do the emissions of all other airborne contaminants meet the EIS predictions?* The estimated NOx, SO_2, CO, Hg, Pb and C_2H_3Cl emissions will be compared to the values in the EIS (Tier 1 Criteria, Table 7-31) to verify that the assumptions used in the EIS were reasonable and conservative. Exceedance(s) of EIS predictions are not indicative of adverse effects and the nonconformance process is discussed in Section 7.1.5.
	GHG Emissions estimate Monitoring Program Elements: EVMP2a, 2b, 3a, 3b, 6	Need knowledge of EIS's GHG emission predictions per phase and NSDF's actual releases during each of the phases.	*Do the GHG estimates meet the EIS predictions?* GHG emission estimates will be calculated according to federal requirements (Government of Canada 2020a). Predictions of the EIS (Golder 2020a) (Tier 1 Criteria) are provided in Table 7-33 and estimates obtained during construction, operations and closure phases are to be compared to these EIS estimates. Exceedance(s) of EIS predictions are not indicative of adverse effects and the non-conformance process discussed in Section 7.1.5 can be followed if there is Tier 1 Criteria exceedance.

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Secondary EVMP Objectives			
g) To provide data for trend analysis.	Yes – data trends from SWMP monitoring can be used to evaluate potential issues with the ECM or SWMP performance. Monitoring Program Elements: EVMP4a, 4b	Further details on the monitoring provided in Objective c) above.	*Does the data allow for trend analysis?* Tier 1 Criteria (trend analysis) of indicator compounds (Table 7-30) can be used to identify possible issues with mitigations. Several years of data may be required to identify trends; however, this is acceptable given the relatively slow nature in which potential issues may evolve. TSS data in particular may also be evaluated for an upward trend over time to assess SWMP performance and potential maintenance requirements.
h) To provide assurance to employees and the public on the effectiveness of effluent control.	Yes – the data collected will provide assurances to employees and the public regarding effluent with regards to dust, GHGs, the SWMPs and WWTP. Monitoring Program Elements: All EVMP elements	Further details provided in Objectives above.	*Does the data provide assurances to the public?* Further details provided in Objectives above. The data evaluation conducted as part of the EVMP program can be used to assure employees and the public that emissions are acceptable with respect to potential risks and within EIS predictions.
i) To provide data which, when combined with the results of environmental monitoring and modelling, can be used to test or refine the models of the environment used in the ERA or dose/exposure assessments.	No – the data are not proposed to be used in updated models. The data could be used to updated models if required, however, this is not the intended objective at this time.		

Table 7-1: The Required Information to be Collected and How the Resulting Data Will Be Used to Achieve the EVMP Objectives

Objectives to be Considered	EVMP Objective? (Yes/No and Explanation)	Information Required to Meet Objective	How Collected Data will be Used to Achieve Objective
Secondary EVMP Objectives (cont'd)			
j) To provide baseline data and capability for monitoring and assessment in emergency conditions.	No – baseline data are not being collected as the effluents monitored are part of processes related to the NSDF project and do not require baseline monitoring.		
k) Other business purposes (e.g., demonstrating due diligence, meeting a stakeholder commitment, etc.).	Yes – several parameters are analyzed for due diligence (Section 7.1.2.2). The monitoring elements themselves are being conducted for objectives as noted above and evaluation of data will be conducted for these objectives.		

7.1.2 Evaluation of Effluent Stream and Parameters Against Monitoring Criteria

The criteria for what monitoring need to take place to the meet the objectives of the program has been defined by CNL in the Management and Monitoring of Emission (CNL 2018a). The criteria are designed to help identify more precisely the information required to meet the program's defined objectives. In addition to these criteria, guidance is provided on further monitoring details such as frequency and duration of monitoring.

For effluent streams, the following are the monitoring criteria:

a) If monitoring of the effluent stream is designated for monitoring in-, or is required to demonstrate compliance with-, a site or facility operating/decommissioning licence, statute, regulation, or permit, then that effluent stream shall be monitored.

b) In the case of effluent streams not subject to Derived Release Limits (DRL), if the total Maximum Probable Emission Rate (MPER) for an effluent stream may exceed 1% of the applicable limits specified by the CNSC, then that effluent stream shall be monitored.

c) If the total MPER for an effluent stream exceeds 5.0×10^{-4} mSv per year to a member of an off-site critical group, then that effluent stream should be monitored. Normal emission rates, instead of MPER, may be used if the effluent stream has an operational control monitoring program in place.

d) If the effluent stream has potential to contribute to biological effects (as determined in an ERA or equivalent risk assessment), based on its constituent radioactive or non-radioactive contaminants, then that effluent stream should be monitored.

e) If the effluent stream contributes significantly to the dose/exposure for a receptor that has been identified as needing a dose/exposure assessment in an ERA or equivalent risk assessment, then that effluent stream should be monitored.

f) If monitoring of the effluent stream is triggered under the Municipal/Industrial Strategy for Abatement (MISA) MISA Protocol (MOECC 2016), then that effluent stream should be monitored.

g) In addition to the effluent streams mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EVMP as reference.

In the selection of contaminants to monitor, the following are the monitoring criteria:

h) If effluent monitoring of a contaminant or physical stressor is explicitly specified by a site or facility operating/decommissioning licence or required by a statute, regulation or permit to discharge, then that contaminant or physical stressor shall be monitored.

i) If the results of an ERA or equivalent risk assessment indicate potential concern with the release of a contaminant, or with a physical stressor, then that contaminant or physical stressor shall be monitored.

j) If effluent monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored.

k) If there is an operational need to identify an unplanned or uncontrolled emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored.

l) If the site-wide MPER for a radioactive contaminant exceeds 1.0×10^{-4} mSv per year to a member of an off-site critical group, then that radioactive contaminant should be monitored.

m) In the case of a waterborne effluent stream, and when no ERA (or equivalent risk assessment) exists that can provide more specific guidance on the parameter(s) to be monitored, if annual average contaminant concentrations at a point of discharge from CNL site property or to a permanent surface waterbody on-site may exceed Guidelines for Canadian Drinking Water Quality (or equivalent) for a radioactive contaminant, then that contaminant should be monitored.

n) If a contaminant is likely to approach or has the potential to exceed regulatory emission limits or internal emission limits, then that contaminant should be monitored.

o) If a non-radioactive contaminant is a reportable substance under the National Pollutant Release Inventory (NPRI) and is released in an effluent stream at greater than 10% of the mass or concentration threshold for that contaminant, then it should be monitored.

p) If effluent monitoring of a non-radioactive contaminant is triggered under the MISA Protocol, then that contaminant should be monitored

For both the selection of effluent streams and contaminants the following other criteria applies:

q) If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).

7.1.2.1 Effluent Streams

A comparison of the NSDF EAFMP effluent streams compared to the Need for Monitoring Criteria noted above is provided in Table 7-2 to Table 7-4 with one table provided for each of the phases: construction, operations, and closure. It is considered too far into the future to develop a post-closure monitoring program and this is discussed further in Section 11.0.

Table 7-2: EVMP Effluent Streams – Construction Phase

Effluent Stream	Monitoring Program Element	Source Description	Effluent Stream Type	Need for Monitoring Criteria	Monitoring Required?	Justification
Airborne Effluent Streams						
Road Dust, Material Handling, Grading Activities, Blasting Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1a	Vehicular traffic travelling on unpaved surfaces on the NSDF Project site is a source of airborne dust/particulate releases. Material handling involves the removal of material as well as the addition of material (soil, fill, rock etc.). This handling is a source of airborne dust/particulate releases as a result of the disturbance of material during handling. The grading of unpaved roads within the NSDF footprint will take place on an as needed basis for road maintenance. This activity is a source of airborne dust/particulate releases. Blasting activities will take place during construction to complete the necessary rock excavation to prepare the site for the construction of the ECM. This activity is a source of airborne dust/particulate releases. Stockpiling of material including material being removed and brought into the site is a source of fugitive dust/particulate releases. Note: Exhaust emissions from fuel related activities (e.g., vehicles, equipment) is captured under "Mobile Equipment – Exhaust/GHG Emissions".	Airborne – Fugitive - Intermittent	a) d) e)	Monitoring Required	a) CEPA: Particulate emissions (SPM, PM_{10} and $PM_{2.5}$) from material handling activities need to be monitored to determine if the site-wide reporting thresholds under the *National Pollutant Release Inventory Program* are met. d) The EIS (Golder 2020a) states that fugitive dust has the potential to affect aquatic, human and terrestrial wildlife health. Although the EIS concludes that it would not, this should be monitored to verify these predictions. e) The EIS (Golder 2020a) identifies construction activities as a significant source of dust emissions. Monitoring will provide data for use in future ERAs.
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP3a	Non-road and on-road vehicle traffic (heavy and light) burning various fuels (e.g., gas, diesel) produce exhaust emissions (GHG and indicator compounds)	Airborne - Point - Intermittent	a) e)	Monitoring Required	a) CEPA: Emissions from mobile equipment activities at CRL need to be monitored to determine if the site-wide reporting thresholds under the Federal GHG Reporting Program e) The EIS (Golder 2020a) identifies construction activities as a significant source of vehicle tailpipe emissions, Monitoring will allow for comparison against the EIS predictions to confirm that the assumptions made were reasonable and conservative
Waterborne Effluent Streams						
SWMP waterborne Effluent Stormwater runoff from construction areas and non-operational areas of NSDF → one of three SWMPs → Perch Lake Watershed →Perch Creek→ Ottawa River	EVMP4a	At the start of construction stormwater will be managed by standard construction practices and an Environmental Protection Plan prepared by the contactor and accepted by CNL. Once constructed, the stormwater ponds will be used to manage stormwater and sediment and can be monitored... Each pond weir outlet will be sampled for water quality. The location of the three SWMPs are shown on Figure 1-2.	Waterborne – Point - Continuous	d) f)	Monitoring Required	d) The effluent from the SWMP may cause an effect to the environment if not maintained properly (e.g., excess sediment may be discharged from run-off). Monitoring of the SWMP effluent is required to verify water quality is as predicted. f) MISA recommends monitoring final effluent entering the environment. Note: With respect to Criteria e), it is not anticipated that the data from the SWMPs would be used in risk assessment as the surface water data are a better indicator of environmental risk.
WWTP – no liquid effluent monitoring for the WWTP during the construction phase as the WWTP will not be in operation.						

Table 7-3: EVMP Effluent Streams – Operations Phase

Effluent Stream	Monitoring Program Element	Source Description	Effluent Stream Type	Need for Monitoring Criteria	Monitoring Required?	Justification
Airborne Effluent Streams						
Road Dust, Material Handling, Grading Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1b	Vehicular traffic travelling on unpaved surfaces on the NSDF Project site is a source of airborne dust/particulate releases. Material handling involves the deposition of waste and cover. This handling is a source of airborne dust/particulate releases as a result of the disturbance of material during handling. The grading of unpaved roads within the NSDF footprint will take place on an as needed basis for road maintenance. This activity is a source of airborne dust/particulate releases. Stockpiling of material including material being brought into the site is a source of fugitive dust/particulate releases. Note: Exhaust emissions from fuel related activities (e.g., vehicles, equipment) is captured under "Mobile Equipment – Exhaust/GHG Emissions".	Airborne – Fugitive – Intermittent	a) d) e)	Monitoring Required	a) CEPA: Particulate emissions (SPM, PM_{10} and $PM_{2.5}$) from material handling activities need to be monitored to determine if the site-wide reporting thresholds under the National Pollutant Release Inventory Program are met. d) The EIS (Golder 2020a) states that fugitive dust has the potential to affect aquatic, human and terrestrial wildlife health. Although concludes that it would not. This should be monitored to verify these predictions. e) The EIS (Golder 2020a) identifies operational dust emissions from road traffic as a significant source of dust emissions. Monitoring will provide data for use in future ERAs.
Decomposition of wastes within the NSDF mound → Vent/ECM Cover → Atmosphere	EVMP2a	As waste is placed in the ECM, its decomposition results in GHG as well as other indicator volatile compounds being released to the atmosphere through the venting system and ECM cover.	Airborne - Fugitive - Continuous	a) e)	Monitoring Required	a) CEPA: ECM Landfill gas emissions at CRL need to be monitored in order to determine if the site-wide reporting thresholds under the GHG Reporting Program (Government of Canada 2020a) and National Pollutant Release Inventory are met. e) The EIS (Golder 2020a) included an assessment of ECM GHG and VOC emissions based on assumptions of waste inputs. Monitoring will allow for comparison against the EIS predictions to confirm that the assumptions made were reasonable and conservative
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP3b	Non-road and on-road vehicle traffic (heavy and light) burning various fuels (e.g., gas, diesel) produce exhaust emissions.	Airborne - Point Intermittent	a) e)	Monitoring Required	a) CEPA: Emissions from mobile equipment activities at CRL need to be monitored to determine if the site-wide reporting thresholds under the GHG Reporting Program are met. e) The EIS (Golder 2020a) included an assessment of exhaust emissions based on operational vehicle tailpipe emissions based on assumptions of activity data, Monitoring will allow for comparison against the EIS predictions to confirm that the assumptions made were reasonable and conservative
Natural Gas Combustion for: ■ Comfort heating at the WWTP, Vehicle Decontamination Centre, Administration Office, and Operations Support ■ Treatment process at WWTP; and, ■ Emergency Power Generation → Atmosphere	EVMP3b	Natural gas is burned in boilers/heaters in each of the four facilities for heating purposes as well as in the WWTP fueling the treatment process. The natural gas is brought into the site from the main natural gas line on plant road. Its combustion produces exhaust which enters atmosphere through roof vents on each of the facilities. The amount of fuel used for heating is dependent on the weather conditions. Emergency power equipment will only operate periodically during monthly routine maintenance testing and for short durations. Additionally it will be used to supply electricity during power outages when other equipment is not in operation. The natural gas combustion produces exhaust which enters atmosphere.	Airborne - Point - Intermittent	a) e)	Monitoring Required	a) CEPA: Emissions from natural gas combustion need to be monitored in order to determine if the site-wide reporting thresholds under the *Greenhouse Gas Reporting Program* and National Pollutant Release Inventory are met. e) The EIS (Golder 2020a) included an assessment of exhaust emissions based on Natural gas combustion based on assumptions of activity data, Monitoring will allow for comparison against the EIS predictions to confirm that the assumptions made were reasonable and conservative
Stationary Diesel pumps and air compressors will use diesel or gasoline for fuel → Exhaust emissions → Atmosphere	EVMP3b	Equipment will operate periodically and for short durations. Combustion of fuel produces exhaust, which enters the atmosphere.	Airborne - Point – Intermittent	a)	Monitoring Required	a) CEPA: Emissions from fuel combustion in stationary equipment need to be monitored in order to determine if the site-wide reporting thresholds under the GHG Reporting Program and National Pollutant Release Inventory are met.
Portable generators for lighting equipment will use diesel or gasoline for fuel → Exhaust emissions → Atmosphere	EVMP3b	Equipment will operate periodically and for short durations. Combustion of fuel produces exhaust, which enters the atmosphere.	Airborne - Point – Intermittent	a)	Monitoring Required	a) CEPA: Emissions from fuel combustion in portable equipment need to be monitored in order to determine if the site-wide reporting thresholds under the National Pollutant Release Inventory are met.

Table 7-3: EVMP Effluent Streams – Operations Phase

Effluent Stream	Monitoring Program Element	Source Description	Effluent Stream Type	Need for Monitoring Criteria	Monitoring Required?	Justification
Airborne Effluent Streams (cont'd)						
Potential Halocarbon Releases → Atmosphere	NA	Refrigeration systems, air-conditioning systems, and fire extinguishing systems containing halocarbons are a potential source of release to the environment.	Airborne - Fugitive – Intermittent	a)	Monitoring Required	a) FHR: All releases from refrigeration systems, air-conditioning systems and fire-extinguishing systems greater that 10kg are reportable under the FHR.
Process emissions from the WWTP → Atmosphere	EVMP6	The WWTP's treatment process treats primary contact leachate water from the NSDF. Resulting airborne emissions (radiological and non-radiological) are emitted though a stack equipped with emission control. Odours and radionuclides may be generated from the WWTP operations and venting of tanks.	Airborne - Point – Continuous	None	No Monitoring Required	The treatment of wastewater may result in the release of hydrogen sulfide (H_2S), mercaptans, chlorine, and various other chemicals to a lesser extent. With the exception of odour, the emissions from the WWTP are expected to have a negligible effect on the overall air quality (EIS; Golder 2020a, Table 5.2.1-13). Odour emissions were estimated in the EIS from the wastewater treatment activities and estimated to be orders of magnitude below air quality guideline/standards. Odour was not considered to warrant further monitoring. The atmospheric emissions of radionuclides from the WWTP were also considered negligible. Based on conservative assumptions, the releases from a single collection tank vent and from the filter press feed tank vent were estimated to be 0.04% and 0.004% of the CRL DRL, respectively (EIS Section 5.7.6.1.2.1; Golder 2020a). Based on this, Criteria c) does not apply.
GHG emissions from the WWTP → Atmosphere	EVMP6	The WWTP's treatment process may result in the release of GHG emissions	Airborne - Fugitive – Continuous	a)	Monitoring Required	a) CEPA: Emissions from wastewater treatment or processing need to be monitored in order to determine if the site-wide reporting threshold under the GHG Reporting Program is met.
Waterborne Effluent Streams						
SWMP Waterborne Effluent Stormwater runoff from parking lots and non-operational areas of NSDF → one of three SWMPs → Perch Lake Watershed →Perch Creek→ Ottawa River	EVMP4a	The designed source of water entering the SWMPs is precipitation runoff that has not been in contact with waste in the ECM. The SWMPs may collect contact surface water from the ECM if mitigation is not operating as designed. Each pond weir outlet will be sampled for water quality. The location of the three SWMPs are shown on Figure 1-2.	Waterborne – Point - Continuous	d) f)	Monitoring Required	d) The effluent from the SWMP may cause an effect to the environment if not maintained properly (e.g., excess sediment may be discharged from run-off) or if the ECM is not operated as planned (e.g., if the ECM cover is breached). Monitoring of the SWMP effluent is required to verify water quality is as predicted. f) MISA recommends monitoring final effluent entering the environment. NOTE: With respect to Criteria e) it is not anticipated that the data from the SWMPs would be used in risk assessment as the surface water data are a better indicator of environmental risk.
WWTP Waterborne Effluent Final Effluent (during low groundwater conditions) → infiltration gallery → East Swamp Stream → Perch Lake → Ottawa River Final Effluent (during high groundwater conditions) → direct transfer line to Perch Lake → Ottawa River	EVMP5	Sources of water entering the WWTP for treatment include: ■ The ECM, which generates leachate and contact water; ■ The Operations Support Centre, which generates decontamination water; and ■ The WWTP process related drains. The treated wastewater is directed to holding tanks prior to discharge.	Waterborne – Point - Batch	d) e) f)	Monitoring Required	d) The sampling is required to confirm the adequacy of the treatment at the WWTP and protection of downstream biota. e) The ERA may use data from the WWTP emissions including dose estimates. f) MISA recommends monitoring final effluents after all treatment and inputs but prior to entering the environment. NOTE: with respect to Criteria c), the MPER is calculated to be 4.45×10^{-5} mSv per year, which is less than the stated criteria (Klukas 2020a) .

Table 7-4: EVMP Effluent Streams – Closure Phase

Effluent Stream	Monitoring Program Element	Source Description	Effluent Stream Type	Need for Monitoring Criteria	Monitoring Required	Justification
Airborne Effluent Streams						
Road Dust, Material Handling, Grading Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1b	Vehicular traffic travelling on unpaved surfaces on the NSDF Project site is the primary source of airborne dust/particulate releases. Material handling involves the placement of cover. This handling is a source of airborne dust/particulate releases as a result of the disturbance of material during handling. The grading of unpaved roads within the NSDF footprint will take place on an as needed basis for road maintenance. This activity is a source of airborne dust/particulate releases. Stockpiling of cover material is a source of fugitive dust/particulate releases. Note: Exhaust emissions from fuel related activities (e.g., vehicles, equipment) is captured under “Mobile Equipment – Exhaust/GHG Emissions”.	Airborne – Fugitive – Intermittent	a) d)	Monitoring Required	a) CEPA: Particulate emissions (SPM, PM_{10} and $PM_{2.5}$) from material handling activities need to be monitored to determine if the site-wide reporting thresholds under the National Pollutant Release Inventory Program are met. d) The EIS (Golder 2020a) states that fugitive dust has the potential to affect aquatic, human and terrestrial wildlife health. Although concludes that it would not. This should be monitored to verify these predictions.
Decomposition of wastes within the NSDF mound → ECM cover/vent → Atmosphere	EVMP2b	As waste is placed in ECM, its decomposition results in GHG as well as indicator compounds being released to the atmosphere. Emissions may be released fugitively through the venting system or ECM Cover.	Airborne - Fugitive - Continuous	a)	Monitoring Required	a) CEPA: ECM Landfill gas emissions at CRL need to be monitored in order to determine if the site-wide reporting thresholds under the GHG Reporting Program and National Pollutant Release Inventory are met.
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP3b	Non-road and on-road vehicle traffic (heavy and light) burning various fuels (e.g., gas, diesel) produce exhaust emissions.	Airborne - Point Intermittent	a)	Monitoring Required	a) CEPA: Emissions from mobile equipment activities at CRL need to be monitored to determine if the site-wide reporting thresholds under the GHG Reporting Program are met.
Potential Halocarbon Releases → Atmosphere	NA	Refrigeration systems, air-conditioning systems, and fire extinguishing systems containing halocarbons are a potential source of release to the environment.	Airborne - Fugitive – Intermittent	a)	Monitoring Required	a) FHR: All releases from refrigeration systems, air-conditioning systems and fire-extinguishing systems greater that 10kg are reportable under the *Federal Halocarbon Regulations* (FHR) .
Natural Gas Combustion for: ■ Comfort heating at the buildings that continue operation. These may include the WWTP, Vehicle Decontamination Centre, Administration Office, and Operations Support ■ Treatment process at WWTP; and, ■ Emergency Power Generation → Atmosphere	EVMP3b	Natural gas is burned in boilers/heaters in each of the four facilities for heating purposes as well as in the WWTP fueling the treatment process. The Natural gas is brought into the site from the main NG line on plant road. Its combustion produces exhaust which enters atmosphere through roof vents on each of the facilities. The amount of fuel used for heating is dependent on the weather conditions. Emergency power equipment will only operate periodically during monthly routine maintenance testing and for short durations. Additionally, it will be used to supply electricity during power outages when other equipment is not in operation. The natural gas combustion produces exhaust which enters atmosphere.	Airborne - Point - Intermittent	a)	Monitoring Required	a) CEPA: Emissions from natural gas combustion need to be monitored in order to determine if the site-wide reporting thresholds under the *Greenhouse Gas Reporting Program* and National Pollutant Release Inventory are met.

Table 7-4: EVMP Effluent Streams – Closure Phase

Effluent Stream	Monitoring Program Element	Source Description	Effluent Stream Type	Need for Monitoring Criteria	Monitoring Required	Justification
Process emissions from the WWTP → Atmosphere	EVMP6	The treatment process in the WWTP treats primarily leachate water from the NSDF. Resulting airborne emissions (radiological and non-radiological) are emitted though a stack equipped with emission control. Odours and radionuclides may be generated from the WWTP operations and venting of tanks.	Airborne - Point – Continuous	None	No Monitoring Required	The treatment of wastewater may result in the release of H_2S, mercaptans, chlorine and various other chemicals, to a lesser extent. With the exception of odour, the emissions from the WWTP are expected to have a negligible effect on the overall air quality (EIS; Golder 2020a, Table 5.2.1-13). Odour emission were estimated in the EIS from the wastewater treatment activities and estimated to be orders of magnitude below the air quality guideline/standard. Odour was not considered to warrant further monitoring. The atmospheric emissions of radionuclides from the WWTP were also considered negligible. Based on conservative assumptions, the releases from a single collection tank vent and from the filter press feed tank vent were estimated to be 0.04% and 0.004% of the CRL DRL, respectively (EIS; Golder 2020a, Section 5.7.6.1.2.1). Based on this, Criteria c) does not apply.
Airborne Effluent Streams (cont'd)						
GHG emissions from the WWTP → Atmosphere	EVMP6	The WWTP's treatment process may result in the release of GHG emissions	Airborne - Fugitive – Continuous	a)	Monitoring Required	a) CEPA: Emissions from wastewater treatment or processing need to be monitored in order to determine if the site-wide reporting threshold under the GHG Reporting Program is met.
Waterborne Effluent Stream						
SWMP waterborne Effluent Stormwater runoff from parking lots and to closed/covered ECM → one of three SWMPs → Perch Lake Watershed →Perch Creek→ Ottawa River	EVMP4b	The designed source of water entering the SWMPs is precipitation runoff from the closed ECM. The SWMPs may collect contact surface water if mitigation is not operating as designed. Each pond weir outlet will be sampled for water quality. The location of the three SWMPs are shown on Figure 1-2.	Waterborne – Point - Continuous	d) f)	Monitoring Required	d) The effluent from the SWMP may cause an effect to the environment if not maintained properly (e.g., excess sediment may be discharged from run-off) or if the ECM is not operated as planned (e.g., if the ECM cover is breached). Monitoring of the SWMP effluent is required to verify water quality is as predicted. f) MISA recommends monitoring final effluent entering the environment NOTE: With respect to Criteria e), It is not anticipated that the data from the SWMPs would be used in risk assessment as the surface water data are a better indicator of environmental risk.
WWTP Waterborne Effluent Final Effluent (during low groundwater conditions) → infiltration gallery → East Swamp Stream → Perch Lake → Ottawa River Final Effluent (during high groundwater conditions) → direct transfer line to Perch Lake → Ottawa River	EVMP5	Sources of water entering the WWTP for treatment include: ■ The ECM, which generates leachate and contact water; ■ The Operations Support Centre, which generates decontamination water; and ■ The WWTP process related drains. The treated wastewater is directed to holding tanks prior to discharge.	Waterborne – Point - Batch	d) e) f)	Monitoring Required	d) The sampling is required to confirm the adequacy of the treatment at the WWTP and protection of downstream biota. e) The ERA may use data from the WWTP emissions including dose estimates. f) MISA recommends monitoring final effluents after all treatment and inputs but prior to entering the environment. NOTE: with respect to Criteria c), The MPER is calculated to be 4.45×10^{-5} mSv per year, which is less than the stated criteria (Klukas 2020a).

7.1.2.2 Parameters for Analysis and Monitoring Frequency

The parameters for analysis and monitoring frequency were assessed as part of the systematic planning process. A comparison of the NSDF EAFMP parameters compared to the Need for Monitoring Criteria noted above (Section 7.1.2) is provided in Table 7-5 to Table 7-25 below.

Table 7-5: EVMP Analysis and Monitoring Frequency – Construction Phase – Road and Operational Dust to Atmosphere – EVMP1a

EVMP1a

Description: Construction activities including material handling, grading, blasting, vehicle movements on unpaved roads and wind erosion from stockpiles will result in the generation of fugitive dust emissions. Emissions will vary depending on quantity of material handled, vehicle movements, control activities and meteorological conditions.

Source term: Airborne contaminants generated by material handling, grading, vehicle movements on unpaved roads and wind erosion from stockpiles

Potential Non-radiological contaminants: SPM, PM_{10} and $PM_{2.5}$

Potential Radiological contaminants: The EIS indicated that radiological releases are not a concern for fugitive dust emissions

Discharge Characterization: The EIS (Golder 2020a) predicts that construction activities are a significant source of SPM, PM_{10} and $PM_{2.5}$ emissions from the NSDF

Monitoring Strategy: Estimation using site-specific emission factors, where possible and generic emission factors where site-specific are not available. Tracking of various information will be required in order to prepare site-specific emission factors

Emissions of construction dust will be estimated annually, added to the site total particulate emissions which will then be compared to the NPRI reporting thresholds (Tier 2 Criteria, Table 7-31). Additionally, Construction dust emissions will be used to help verify EIS particulate emission predictions for the site (Tier 1 criteria, Table 7-31) Emissions will vary annually depending on the amount and type of construction activity undertaken.

Analytical Test Group (ATG)	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	SPM, PM_{10} and $PM_{2.5}$	h) i) o) q)	h) Emissions of SPM, PM_{10} and $PM_{2.5}$ are required to be tracked for reporting as part of NPRI providing site-wide emissions meet reporting thresholds (Tier 2 Criteria, Table 7-31). i) The EIS has indicated that dust may be a potential concern. Monitoring required to verify EIS predictions (Tier 1 Criteria, Table 7-31) o) Based on the EIS prediction, SPM, PM_{10} and $PM_{2.5}$ emissions from construction activities will exceed their respective NPRI reporting thresholds (not just 10% of threshold). q) Particulate emissions have the largest potential to generate nuisance dust during construction activities and monitoring is required for due diligence	Estimated	Calculated annually, but data collected daily	1. Daily data collection will provide necessary information to estimate annual emissions 2. Measurement of annual particulate emissions from fugitive sources is not feasible. SPM, PM_{10} and $PM_{2.5}$ calculated from recorded activity and operational data (e.g., quantity of material handled). Estimation is both acceptable under the NPRI as well as the method used in EIS predictions.	Throughout the Construction Phase	The data obtained from monitoring are required for annual reporting to NPRI for the life of the construction phase.

Table 7-6: EVMP Analysis and Monitoring Frequency – Construction Phase – Mobile Equipment – Exhaust/GHG Emissions to Atmosphere – EVMP3a

EVMP3a

Description: Construction activities will include the use of mobile equipment (on-road and off-road vehicles including heavy equipment). Emissions will vary depend on the type and amount of mobile equipment on site, equipment usage and distance travelled.

Source term: Airborne contaminants and GHG generated by the use of on-site vehicles.

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, Pb, SPM, PM_{10}, $PM_{2.5}$ and CO_2e

Potential Radiological contaminants: NA – there are no radiological releases associated with mobile equipment exhaust.

Discharge Characterization: The EIS (Golder 2020a) predicts that emissions from mobile equipment during construction activities are a significant source of emissions (>10% of NPRI or GHG reporting thresholds) for a number of parameters: Namely NOx, SPM, PM_{10}, $PM_{2.5}$ and CO_2e. The EIS does not predict significant releases (i.e., <10% NPRI and GHG reporting thresholds) for SO_2, CO, VOC or Pb releases as a result of NSDFs vehicle use during construction activities.

Monitoring Strategy:

GHG emission estimations from the use of mobile equipment will be estimated annually, added to the site total GHG emissions which will be used to determine GHG reporting (Tier 2, Table 7-33). As well, these mobile equipment emissions will be used to help verify EIS emission predictions for: (1) select indicator compounds (Tier 1 criteria, Table 7-31) and (2) GHG emissions (Tier 1 Criteria, Table 7-33). Emissions will vary annually depending on the amount and type of mobile equipment on-site. Tracking of various information, including fuel usage will be required and used with standard emission factors to calculate emission estimates.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x), Carbon Monoxide (CO) SPM, PM_{10} and $PM_{2.5}$	i)	Monitored: i) These five parameters are predicted by the EIS (Golder 2020a) to be emitted at rates which are at least 10% of the annual NPRI reporting threshold (tonnes/yr) and are therefore considered to be significant for this release type. Emissions are estimated based on annual consumption of the site's fuel use and vehicle kilometers travelled (using standard emission factors). Estimation of emission rates will be completed for comparison against EIS predictions. Note: Emissions from mobile equipment are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b).	Estimated	Calculated based on Calendar Year but data collected daily	1. Daily data collection will provide necessary information to estimate annual emissions 2. Estimation of emissions for each parameter is based on fuel consumption and Vehicle kilometres travelled as per the methods used in the EIS (Golder 2020a)	Monitoring is expected to be required for the duration of the construction phase	Due to the short duration of the construction phase and variability expected in emissions, monitoring is recommended for the duration of the construction phase to confirm the EIS predictions
NA	Sulphur Dioxide (SO_2) Total Volatile Organic Compounds (VOCs) Lead (Pb)	NA	Not Monitored: Emissions from mobile equipment are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). The EIS does not predict significant releases of SO_2, VOCs or Lead (not >10% of NPRI threshold) as a result of NSDF's vehicle use therefore there is no need to verify these EIS predictions.	NA	NA	NA	NA	NA

Table 7-6: EVMP Analysis and Monitoring Frequency – Construction Phase – Mobile Equipment – Exhaust/GHG Emissions to Atmosphere – EVMP3a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a), therefore the estimation of all releases is required to determine reportability. i) To verify predictions of EIS. CO_2e emissions are estimated based on annual consumption of fuel used on site (using standard emission factors). Estimation is of loading (Tonnes/year) as required by the Federal Notice (Government of Canada 2020a)	Estimated	Calculated annually based on the Calendar Year but data collected daily	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. EIS predictions can be verified using annual calculations completed for GHGRP. 2. Estimation of CO_2e based on fuel consumption is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a)	As long as mobile equipment burning fuel is being used on site.	As long as fuel is being consumed by motorized equipment, GHG emissions will need to be estimated for reporting under the GHGRP. Due to the short duration of the construction phase and variability expected in emissions, monitoring is recommended for the duration of the construction phase to confirm the EIS predictions

Table 7-7: EVMP Analysis and Monitoring Frequency – Construction Phase – SWMP Waterborne Effluent – EVMP4a

EVMP4a

Description: Sources of water entering the SWMP will consist of surface water from precipitation runoff from areas of construction and completed areas not yet in operations. Only SWMPs that are used to manage stormwater require monitoring and this may change over the course of construction. The water within the SWMP receives treatment in the form of sediment removal and discharges to downstream surface water.

Source term: Sediment from stormwater runoff and potential contaminants associated with this run-off (e.g., contaminants from vehicles, salt application on roads).

Potential Non-radiological Contaminants: Contaminants include those associated with stormwater runoff from roads and a construction site (e.g., suspended solids, oil and grease, chloride).

Potential Radiological Contaminants: No radiological contaminants are associated with construction stormwater runoff as no wastes are handled in this phase.

Discharge Characterization: The EIS predicts SWMP effluent will be free of impacts with adequate controls.

Monitoring Strategy: Manual sampling of effluent from each of the SWMPs in operation is required at the discharge weir. As samples will be collected from the outfall of the SWMP, the sample is considered representative and flow proportional or time weighted composites are not required. Monitoring will be based on a storm event where a "storm event" is considered any storm forecasted to be 5 mm or more within a 24-hour period (MECP 2019). A single grab sample is to be collected for each operational weir during each storm event, between 1h and 24h from storm initiation while water continues to flow from the SWMP. This timeframe is considered appropriate as it will allow for sampling from flow related to the storm. Sampling is required during daylight hours only and not during nights for safety purposes. If, during the first year of sampling, some short lived storms are not sampled this is considered acceptable given the amount of data collected. Flow monitoring is to be conducted with the use of a flow meter and area velocity sensor placed in the SWMP discharge pipe (or suitable alternative).

Choice of monitored parameters is based on potential contaminants in effluents (listed above) as well as the recommended parameters under the MISA Stormwater Control Study as evaluated by CNL for their effluent monitoring program (CNL 2014a).

Tier 1 Criteria for stormwater consist of trend assessment of indicator compounds. Evaluation of parameters that may be indicative of poor SWMP performance is also conducted by comparison to Tier 2 Criteria. If exceedances of Tier 2 Criteria (Table 7-30) for parameters other than TSS are identified in monitoring, the full list of parameters (Table 7-27) should be re-evaluated. Indicator parameters are listed below as applicable and where there are multiple parameters in an analysis, the indicator parameters are noted in brackets.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Physical Parameters								
NA	Flow	p)	Monitored: p) Core physical characteristic under MISA used to determine loading from a source.	Measured	Flow monitoring to be conducted for the duration of each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, flow monitoring to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Continuous reading: data collected is flow (commonly m^3/min) over time for each storm event.	1. Monitoring during storms will provide data required to calculate contaminant loading. 2. Continuous measurement during a storm event is appropriate because this provides data that can be used to calculate potential effects. An estimate cannot be provided based on rainfall depth due to the changing nature of the catchment areas during construction.	During construction phase of the ECM once each SWMP is complete.	SWMPs in use during construction require monitoring based on the use of the MISA monitoring criteria.

Table 7-7: EVMP Analysis and Monitoring Frequency – Construction Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Conventional Parameters								
3	pH	p)	Monitored: p) Core parameter recommended under MISA for final effluents as a gross indicator of effluent quality	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction phase of the ECM once each SWMP is complete.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.
7	Conductivity	q)	Monitored: q) Parameter monitored as it is an indicator of potential road salt impacts.	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction phase of the ECM once each SWMP is complete.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.
8	TSS	k) p)	Monitored: k) The main treatment objective of a SWMP is to reduce sediment in effluent. TSS analysis is an indicator parameter to ensure the SWMPs meet the treatment objective. p) Core parameter recommended under MISA for final effluents as a gross indicator of effluent quality.	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during Storms will evaluate the effectiveness of the SWMP for sediment removal under extreme conditions as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction of the ECM.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.

Table 7-7: EVMP Analysis and Monitoring Frequency – Construction Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Conventional Parameters (cont'd)								
9	Additional Metals (aluminum, copper, zinc)	p)	Monitored: p) Metals are recommended under MISA for final effluents as a gross indicator of effluent quality. Aluminum, copper and zinc are considered indicator parameters from road runoff (e.g., particulate from vehicles) and temporary buildings.	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab Sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent.2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction of the ECM.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.
9a	Additional Metals (iron)	p)	Monitored: p) Metals are recommended under MISA for final effluents as a gross indicator of effluent quality. Iron is considered an indicator parameter from road runoff (e.g., particulate from vehicles) and is identified as a contaminant of potential concern from contact surface water.	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab Sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent.2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction of the ECM.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.
25	Solvent Extractables (Oil and Grease)	k) p)	Monitored: k) With the extensive use of mobile equipment, the source exists in the SWMP drainage area and an oil and grease release is a reasonably foreseeable event. p) Oil and Grease is a MISA core parameter required under MISA for final effluents as a gross indicator of effluent quality	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal under extreme conditions as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction of the ECM.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.
27	Polychlorinated biphenyls (PCBs)	NA	Not Monitored: Despite being a MISA recommended parameter for monitoring of effluent quality. PCBs are not considered a contaminant of concern for stormwater during construction.	NA	NA	NA	NA	NA

Table 7-7: EVMP Analysis and Monitoring Frequency – Construction Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Conventional Parameters (cont'd)								
30	Chloride	q)	Monitored: q) Parameter monitored as it is an indicator of potential road salt impacts.	Measured	Sampling to be conducted during each storm event which results in stormwater discharge from a SWMP during the first year of construction. Following the first year, sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab Sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to construction management. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During construction of the ECM.	SWMPs in use during construction phase require monitoring throughout this phase to evaluate controls.

Table 7-8: EVMP Analysis and Monitoring Frequency – Operations Phase – Road and Operational Dust to Atmosphere – EVMP1b

EVMP1b

Description: Operational activities including material handling, grading, vehicle movements on unpaved roads and wind erosion from stockpiles will result in the generation of fugitive dust emissions. Emissions will vary depending on quantity of material handled, vehicle movements, control activities and meteorological conditions.

Source term: Airborne contaminants generated by material handling, grading, vehicle movements on unpaved roads and wind erosion from stockpiles

Potential Non-radiological contaminants: SPM, PM_{10} and $PM_{2.5}$

Potential Radiological contaminants: The EIS indicated that radiological releases are not a concern for fugitive dust emissions

Discharge Characterization: The EIS (Golder 2020a) predicts that operational activities are a significant source of SPM, PM_{10} and $PM_{2.5}$ emissions from the NSDF

Monitoring Strategy: Estimation using site-specific emission factors, where possible and generic emission factors where site-specific are not available. Tracking of various information will be required in order to prepare site-specific emission factors

Emissions of dust will be estimated annually, added to the site total particulate emissions which will then be compared to the NPRI reporting thresholds (Tier 2 Criteria, Table 7-31). As well, Construction dust emissions will be used to help verify EIS particulate emission predictions for the site (Tier 1 criteria, Table 7-31). Emissions will vary annually depending on the amount and type of construction activity undertaken.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	SPM, PM_{10} and $PM_{2.5}$	h) i) o) q)	h) Emissions of SPM, PM_{10} and $PM_{2.5}$ are required to be tracked for reporting as part of NPRI providing site-wide emissions meet reporting thresholds (Tier 2 Criteria, Table 7-31). i) the EIS has indicated that dust may be a potential concern. Monitoring required to verify EIS predictions (Tier 1 Criteria, Table 7-31) o) based on the EIS prediction, SPM, PM_{10} and $PM_{2.5}$ emissions from the operations phase activities will exceed their respective NPRI reporting thresholds (not just 10% of threshold). q) Particulate emissions have the potential to generate nuisance dust during operational activities and monitoring is required for due diligence	Estimated	Calculated annually but data collected daily	1. Daily data collection will provide necessary information to estimate annual emissions 2. Measurement of annual particulate emissions from fugitive sources is not feasible. SPM, PM_{10} and $PM_{2.5}$ calculated from recorded activity and operational data (e.g., quantity of material handled). Estimation is both acceptable under the NPRI as well as method used in EIS predictions.	Throughout the Operations Phase	The data obtained from monitoring are required for annual reporting to NPRI for the life of the Operations phase

Table 7-9: EVMP Analysis and Monitoring Frequency – Operations Phase – Decomposition of Waste from within NSDF Mound to Vent/ECM Cover to Atmosphere – EVMP2a

EVMP2a

Description: The decomposition of waste within the NSDF will result in the release of fugitive emissions through the cap. Emissions will vary over time depending on the age and quantity of waste.

Source term: GHGs and air contaminants are generated by the decomposition of waste.

Potential Non-radiological contaminants; GHGs (including methane) CO, Hg, H_2S and C_2H_3Cl emissions

Potential Radiological contaminants: The radiological contaminants are not considered a significant emission source in the Safety Analysis Report (CNL 2020c). The radiological contaminants are also monitored as part of EMP11 in the Environmental Monitoring Program (Section 8.0)

Discharge Characterization: The EIS indicates that the decompositions of waste in the NSDF mound during the operations phase is a source of significant GHG emissions (>10% of the GHGRP reporting threshold) in addition to insignificant (<10% of NPRI reporting thresholds) emissions of CO, Hg, H_2S and C_2H_3Cl emissions

Monitoring Strategy:

Emission estimations from the decomposition of waste will be estimated annually and results will be used in the determination of GHG and NPRI reporting (Tier 2 Criteria, Tables 7-31 and 7-33).

EIS predictions for CO_2e emissions were predicted to be significant (>10% of GHGRP reporting threshold) and will therefore be verified (Tier 1, Table 7-33). Emissions of CO, Hg, H_2S and C_2H_3Cl were predicted to be insignificant and therefore will not be verified. Emissions will vary depending on the decomposition of waste and the composition of the landfill gas. Tracking of waste inputs will be required in order to create a LandGEM model and complete these estimates.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a); therefore, the estimation of all releases is required to determine reportability. i) CO_2e is predicted by the EIS (Golder 2020a) to be emitted at a rate of >10% of the GHGRP reporting threshold and is therefore considered to be significant for this release type. Monitoring will therefore take place in order to confirm EIS predictions. CO_2e emissions are estimated based on LandGEM modelling. Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a).	Estimated	Annual	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on landfill gas generated is standard industry practice and acceptable by the Federal Notice(Government of Canada 2020a).	Monitoring for GHGRP will be required throughout the Operations Phase.	As long as the landfill is generating gas, atmospheric emissions will need to be estimated in order to report under the GHGRP. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.
NA	Carbon Monoxide (CO) Mercury (Hg) Hydrogen Sulphide (H_2S) Vinyl Chloride (C_2H_3Cl)	h)	Monitored: h): Emissions of each are tracked as fugitive emissions and included in CRL site cumulative emission estimates to determine reportability under the NPRI (Government of Canada 2020b) Emissions are estimated using LandGEM modelling. Estimation is of loading (kg/year or Tonnes/year) as required by the Federal Notice (Government of Canada 2020b)	Estimated	Annual	1. ECCC NPRI Notice (Government of Canada 2020b) requires reporting annually if any of the site's reporting thresholds are met. 2. Emission estimates using LandGem model is acceptable method under the NPRI Notice (Government of Canada 2020b)	Throughout the Operations Phase	As long as the ECM is generating gas, atmospheric emissions will need to be estimated in order to report under the NPRI.

Table 7-10: EVMP Analysis and Monitoring Frequency – Operations Phase – Mobile Equipment – Exhaust/GHG Emissions to Atmosphere – EVMP3b

EVMP3b.

Description: Operational activities will include the use of mobile equipment (on-road and off-road vehicles including heavy equipment). Emissions will vary depend on the type and amount of mobile equipment on site, equipment usage and distance travelled.

Source term: Airborne contaminants and GHG generated by the use of on-site vehicles

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, Pb, SPM, PM_{10}, $PM_{2.5}$ and CO_2e

Potential Radiological contaminants: NA – there are no radiological releases associated with mobile equipment exhaust

Discharge Characterization: The EIS (Golder 2020a) predicts that emissions from mobile vehicles during the operations phase are a significant source of emissions (>10% of NPRI or GHG reporting thresholds) for a number of parameters: Namely PM_{10}, $PM_{2.5}$, NOx, CO and CO_2e. The EIS does not predict significant releases (i.e., <10% NPRI and GHG reporting thresholds) for SPM, SO_2, VOC or Pb releases as a result of NSDFs vehicle use during operations activities.

Monitoring Strategy:

GHG emission estimations from the use of mobile equipment will be estimated annually, added to the site total GHG emissions which will be used to determine GHG reporting (Tier 2, Table 7-33). As well, these mobile equipment emissions will be used to help verify EIS emission predictions for: (1) select indicator compounds (Tier 1 criteria, Table 7-33) and (2) GHG emissions (Tier 1 Criteria, Table 7-33). Emissions will vary annually depending on the amount and type of mobile equipment on-site. Tracking of various information, including fuel usage will be required and used with standard emission factors to calculate emission estimates.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x) CO, PM_{10} and $PM_{2.5}$	i)	Monitored: i) These four parameters are predicted by the EIS (Golder 2020a) to be emitted at rates which are at least 10% of the annual NPRI reporting threshold (tonnes/yr) and are therefore considered to be significant for this release type. Emissions are estimated based on annual consumption of the site's fuel use and vehicle kilometers travelled (using standard emission factors). Estimation is of emissions (g/s) will be completed for comparison against EIS predictions Note: Emissions from mobile equipment are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b)	Estimated	Calculated based on calendar year but data collected daily	1. Daily data collection will provide necessary information to estimate annual emissions 2. Estimation of emissions for each parameter is based on fuel consumption and Vehicle kilometres travelled as per the methods used in the EIS (Golder 2020a)	Monitoring will be completed for at least the first year of operations.	As long as fuel is being consumed, atmospheric emissions will need to be estimated. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.
NA	SPM Sulphur Dioxide (SO_2) Total Volatile Organic Compounds (VOCs) Lead (Pb)	NA	Not Monitored: Emissions from mobile equipment are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). The EIS does not predict significant releases of SPM, SO_2, VOC,or Pb (not >10% of NPRI threshold) as a result of NSDF's vehicle use therefore there is no need to verify these EIS predictions.	NA	NA	NA	NA	NA

Table 7-10: EVMP Analysis and Monitoring Frequency – Operations Phase – Mobile Equipment – Exhaust/GHG Emissions to Atmosphere – EVMP3b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a); therefore, the estimation of all releases is required to determine reportability. i) To verify predictions of EIS. CO_2e emissions are estimated based on annual consumption of fuel used on site (using standard emission factors). Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a)	Estimated	Calculated annually based on calendar year but data collected daily	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. EIS predictions can be verified using annual calculations completed for GHGRP. 2. Estimation of CO_2e based on fuel consumption is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a)	Monitoring for GHGRP will be required as long as mobile equipment burning fuel is being used on site.	As long as fuel is being consumed by mobile equipment on the NSDF site, atmospheric GHG emissions will need to be estimated in order to report under the GHGRP. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.

Table 7-11: EVMP Analysis and Monitoring Frequency – Operations Phase – Use of Natural Gas for Comfort Heating, Process Equipment and Emergency Supply to Atmosphere – EVMP3b

EVMP3b

Description:

Natural gas is burned in boilers/heaters in each of the four facilities (WWTP, Vehicle Decontamination Centre, Administration Office and Operations Support building) for heating purposes as well as in the WWTP fueling the treatment process. The natural gas is brought into the site from the main natural gas line on plant road. Its combustion produces exhaust which enters atmosphere through roof vents on each of the facilities. The amount of fuel used for heating is dependent on the weather conditions.

Natural gas is also burned in emergency power equipment which will only operate periodically during monthly routine maintenance testing and for short durations. Additionally, this equipment will be used to supply electricity during power outages when other equipment is not in operation.

Source term: Airborne contaminants and GHG generated by the use of natural gas. Emissions will vary depending on the amount of fuel consumed and the equipment using it.

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, SPM, PM_{10}, $PM_{2.5}$, Lead, Mercury and CO_2e

Potential Radiological contaminants: NA – there are no radiological releases associated with natural gas combustion.t

Discharge Characterization: The EIS (Golder 2020a) predicts that natural gas combustion in the Operations Phase is not a significant source of emissions of indicator compounds (<10% of NPRI reporting threshold) but is a significant source of CO2e emissions (>10% of GHGRP reporting threshold). Emissions will vary annually depending on the amount of natural gas usage

Monitoring Strategy:

Estimations of GHG and indicator compound emissions from the use of natural gas within stationary buildings for comfort heating and process equipment in WWTP will be completed annually to help determine reportability under the NPRI and GHGRP reporting Notices (Tier 2 Criteria, Tables 7-31 and 7-33). As indicator compound emissions were determined to be insignificant (<10% of NPRI reporting thresholds) in the EIS, their emission verification of EIS prediction is not required. EIS predictions for CO_2e emissions were significant however (>10% of GHGRP reporting threshold) and will therefore be verified). Tracking of various information, including fuel usage will be required and used with standard emission factors to calculate emission estimates.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x) Sulphur Dioxide (SO_2) Carbon Monoxide (CO) SPM, PM_{10} and $PM_{2.5}$ Total Volatile Organic Compounds (VOCs) Lead (Pb), Mercury (Hg)	h)	Monitored: h) Total emissions from all Site releases may be reportable under ECCC's *National Pollutant Release Inventory* Notices (Government of Canada 2020b); therefore, the estimation of all releases is required to determine reportability. Lead and mercury are two metals identified as releases from natural gas consumption as these two metals are typically reported for the CRL site and are therefore tracked routinely. Emissions are estimated based on annual consumption of the site's natural gas use (using standard emission factors for type of equipment burning fuel). Estimation is of loading (kg/y or tonnes/year) as required by the Federal Notice (Government of Canada 2020b).	Estimated	Calculated annually based on calendar year	1. ECCC's *National Pollutant Release Inventory Notices* (Government of Canada 2020b) require reporting annually if reporting thresholds are met for each parameter emissions. 2. Estimation of emissions for each parameter is based on fuel consumption is standard industry practice and acceptable by the federal Notice (Government of Canada 2020b).	As long as natural gas burning equipment is being used on site.	As long as natural gas is being consumed, atmospheric emissions will need to be estimated for reporting under the NPRI.
NA	Speciated Volatile Organic Compounds (VOCs)	NA	Not Monitored: Total VOC emissions from all CRL site's current operations are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). The EIS does not predict a significant increase of VOC releases as a result of NSDFs use of natural gas and therefore there is no need to determine (or report) speciated VOC emissions.	NA	NA	NA	NA	NA

Table 7-11: EVMP Analysis and Monitoring Frequency – Operations Phase – Use of Natural Gas for Comfort Heating, Process Equipment and Emergency Supply to Atmosphere – EVMP3b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a) therefore, the estimation of all releases is required to determine reportability. i) To verify predictions of EIS. CO_2e emissions are estimated based on annual consumption of natural gas used on site (using standard emission factors based on the equipment type consuming the gas). Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a).	Estimated	Calculated annually based on calendar year, and estimated with monthly fuel consumption tracking	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. EIS predictions can be verified using annual calculations completed for GHGRP. 2. Estimation of CO_2e based on fuel consumption is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a).	As long as natural gas burning equipment is being used on site.	As long as natural gas is being consumed, atmospheric emissions will need to be estimated for reporting under the GHGRP. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.

Table 7-12: EVMP Analysis and Monitoring Frequency – Operations Phase – Stationary Diesel Pumps, Air Compressors Will Use Diesel or Gasoline for Fuel – Exhaust/GHG Emissions to Atmosphere – EVMP3b

EVMP3b

Description: The use of stationary diesel and gasoline in pumps and air compressors will result in emissions from the combustion of fuel. Emissions will vary depend on the amount of fuel consumed. Equipment will operate periodically and for short durations.

Source term: Airborne contaminants and GHG generated by the use of diesel in stationary diesel pumps and air compressors.

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, SPM, PM_{10}, $PM_{2.5}$, Mercury and CO_2e

Potential Radiological contaminants: NA – there are no radiological releases associated with the diesel equipment use.

Discharge Characterization: Not estimated in EIS as emissions were considered minor compared to emissions from other equipment on the site.

Monitoring Strategy: Estimation using site-specific emission factors, where possible and generic emission factors where site-specific are not available. Tracking of various information will be required in order to prepare site-specific emission factors

Estimations of GHG and indicator compound emissions from the use of stationary combustion equipment will be estimated annually to help determine reportability under the NPRI and GHGRP reporting Notices (Tier 2 Criteria, Table 7-31 and Table 7-33) and results will be used for GHG and NPRI reporting. Tracking of various information including fuel usage and hours of operations will be required in order to complete these estimates.

Note: As the EIS did not provide predictions, there is no need to complete any verification.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x) Sulphur Dioxide (SO_2) Carbon Monoxide (CO) SPM, PM_{10} and $PM_{2.5}$ Total Volatile Organic Compounds (VOCs) Mercury (Hg)	h)	Monitored: h) Total emissions from all Site releases may be reportable under ECCC's *National Pollutant Release Inventory* Notices (Government of Canada 2020b); therefore, the estimation of all releases is required to determine reportability. Mercury is a metal identified as released from diesel consumption as this metal is typically reported for the CRL site and is therefore tracked routinely. Emissions are estimated based on annual consumption of the site's diesel use (using standard emission factors). Estimation is of loading (kg/yr or tonnes/year) as required by the Federal Notice (Government of Canada 2020b). NOTE: The EIS did not estimate emissions from the use of stationary diesel equipment as it was felt that the emissions would be insignificant compared to other emissions as the result of NSDF operations, therefore there is no need to verify EIS predictions.	Estimated	Annual	1. ECCC's *National Pollutant Release Inventory Notices* (Government of Canada 2020b) require reporting annually if reporting thresholds are met for the site for each parameter emissions. 2. Estimation of emissions for each parameter is based on fuel consumption is standard industry practice and acceptable by the federal Notice (Government of Canada 2020b).	As long as fuel burning equipment is being used on site.	As long as fuel is being consumed, atmospheric emissions will need to be estimated in order to report to the NPRI.
NA	Speciated Volatile Organic Compounds (VOCs)	NA	Not Monitored: Total VOC emissions from all CRL site's current operations are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). It is not felt that the emissions from NSDF's stationary equipment will increase the overall site's VOC to reach the reporting threshold therefore there is no need to determine (or report) speciated VOC emissions.	NA	NA	NA	NA	NA

Table 7-12: EVMP Analysis and Monitoring Frequency – Operations Phase – Stationary Diesel Pumps, Air Compressors Will Use Diesel or Gasoline for Fuel – Exhaust/GHG Emissions to Atmosphere – EVMP3b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices; therefore, the estimation of all releases is required to determine reportability. CO_2e emissions are estimated based on annual consumption of fuel used on site (using standard emission factors for the type of equipment using the fuel). Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a) NOTE: The EIS did not estimate GHG emissions from the use of stationary diesel equipment as it was felt that the emissions would be insignificant compared to other emissions as the result of NSDF operations, therefore there is no need to verify EIS predictions.	Estimated	Annual	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on fuel consumption is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a)	As long as fuel burning equipment is being used on site.	As long as fuel is being consumed, atmospheric emissions will need to be estimated for reporting under the GHGRP.

Table 7-13: EVMP Analysis and Monitoring Frequency – Operations Phase – Portable Diesel Generators for Lighting – Exhaust/GHG Emissions to Atmosphere – EVMP3b

EVMP3b

Description: The use of diesel in portable generators will result in emissions from the combustion of fuel. Emissions will vary depend on the amount of fuel consumed. Equipment will operate periodically and for short durations.

Source term: Airborne contaminants and GHG generated by the burning of diesel in site's portable diesel generators

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, SPM, PM_{10}, $PM_{2.5}$, Mercury and CO_2e

Potential Radiological contaminants: NA – there are no radiological releases associated with portable diesel generator exhaust

Discharge Characterization: Not estimated in EIS as emissions were considered minor compared to emissions from other equipment on the site.

Monitoring Strategy: Estimation using site-specific emission factors, where possible and generic emission factors where site-specific are not available. Tracking of various information will be required in order to prepare site-specific emission factors

NPRI substance emission estimations from the use of portable diesel generators for lighting will be estimated annually, added to the site total NPRI emissions which will be used to determine NPRI reporting (Tier 2, Table 7-31). Tracking of various information including fuel usage and hours of operations will be required in order to complete these estimates.

Note: The GHGRP (Government of Canada 2020a) does not include emissions from portable equipment

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x) Sulphur Dioxide (SO_2) Carbon Monoxide (CO) SPM, PM_{10} and $PM_{2.5}$ Total Volatile Organic Compounds (VOCs) Mercury (Hg)	h)	Monitored: h) Emissions from portable equipment are reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). Mercury is a metal identified as released from diesel consumption as this metal is typically reported for the CRL site and is therefore tracked routinely. Note: The EIS did not estimate emissions from the use of portable diesel generators for lighting as it was felt that the emissions would be insignificant compared to other emissions as the result of NSDF operations, therefore there is no need to verify EIS predictions.	Estimated	Calculated annually but data collected daily	1. ECCC's *National Pollutant Release Inventory Notices* (Government of Canada 2020b) require reporting annually if reporting thresholds are met for the site for each parameter emissions. Daily data collection will provide necessary information to estimate annual emissions 2. Estimation is an acceptable method under the NPRI.	As long as fuel burning equipment is being used on site.	The data obtained from monitoring are required for annual reporting to NPRI for the life of the Operations phase
NA	Speciated Volatile Organic Compounds (VOCs)	NA	Not Monitored: Total VOC emissions from all CRL site's current operations are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). It is not felt that the emissions from NSDF's portable equipment will increase the overall site's VOC to reach the reporting threshold therefore there is no need to determine (or report) speciated VOC emissions.	NA	NA	NA	NA	NA
NA	Carbon Dioxide Equivalent (CO_2e)	NA	Not Monitored: GHG emissions from portable equipment are not reportable under the GHGRP (Government of Canada 2020a)]. The EIS did not anticipate these emissions to be significant and therefore did not estimate them, therefore there is no emission values to verify.	NA	NA	NA	NA	NA

Table 7-14: EVMP Analysis and Monitoring Frequency – Operations Phase – Potential Halocarbon Releases to Atmosphere – EVMP3b

EVMP3b

Description: There are equipment on site (air conditioning, fire-extinguishing system and refrigeration systems) that use Halocarbons and periodically have releases to the atmosphere.

Source term: Periodic releases from the use of air conditioning, fire-extinguishing and refrigeration systems.

Potential Non-radiological contaminants: Halocarbons

Potential Radiological contaminants: Not applicable as this monitoring relates to Halocarbons only

Discharge Characterization: Releases are only expected from problems with the operation of the equipment. Releases can occur from acute failure where release occurs in very short period or can result from chronic failure which release occurs over longer period of time.

Monitoring Strategy: Tracking of all halocarbon leaks

There are equipment on site (air conditioning, fire-extinguishing system and refrigeration systems) that use Halocarbons and periodically have releases to the atmosphere. Preventative maintenance is performed on equipment in order to reduce the number of unanticipated releases. Releases are typically identified through problems with the operation of the equipment. Volume of release is identified through the recharging of the equipment once fixed or capacity of the equipment if being decommissioned for example.

Note: All minor halocarbon leaks (<10kg) are tracked but are not reportable under the FHR.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Halocarbons	h)	Monitored: h) Releases of greater than 10 kg are reportable under ECCC's *Federal Halocarbon Regulations* (FHR)	Estimated	Per Release	1. ECCC's *Federal Halocarbon Regulations* requires reporting for each release greater than 10 kg on a semi-annual basis and each release greater than 100 kg within 24 hours; therefore, per release monitoring is required. 2. As releases are due to some sort of failure, their measurement is not possible. Therefore, estimations are made based on quantity of halocarbon needed to recharge the system once repaired or capacity of the equipment if being decommissioned for example. Estimation is an acceptable method under the FHR.	As long as halocarbon containing equipment is on site.	As long as halocarbons are on site, there is the chance for a reportable release, therefore monitoring needs to continue through the length of time the equipment is on site.

Table 7-15: EVMP Analysis and Monitoring Frequency – Operations Phase – GHGs Generated from Wastewater Treatment to Stacks/Tanks to Atmosphere – EVMP6

EVMP6

Description: The WWTP's treatment process treats primary contact leachate water from the NSDF, which may result in minor releases of GHGs. Emissions will vary depending on the amount of wastewater processed and are required to be estimated.

Source term: The treatment of wastewater may result in the release of greenhouse gases

Potential Non-radiological contaminants: CO_2e

Potential Radiological contaminants: Not applicable as this monitoring relates to GHG only

Discharge Characterization: Minor releases of GHGs may occur from water treatment (<1% of sitewide emissions).

Monitoring Strategy: Monitoring of GHG only for comparison to ECCC's GHG Reporting Notices (Government of Canada 2020a)

GHG emission estimations from wastewater treatment processing will be estimated annually and results will be used for GHG reporting. Emissions will vary depending on the amount of wastewater processed and are required.

Note: The EIS identified that emissions from wastewater treatment were negligible (<1% of total emissions and therefore <10% GHGRP threshold). As a result, verification is not required.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Airborne Parameters								
NA	Carbon Dioxide Equivalent (CO_2e)	h)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a) therefore, the estimation of all releases is required to determine reportability. CO_2e emissions are estimated based on wastewater treatment waterborne monitoring results (using either COB or BOD and nitrogen quarterly results) – see Table 7-16. Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a).	Estimated	Annual	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on waterborne COD or BOD and nitrogen Quarterly results is recommended by the Federal Notice (Government of Canada 2020a) and recommended in the reporting requirements (ECCC 2019)	As long as wastewater is being treated by the WWTP.	As long as wastewater is being treated, emissions will need to be estimated for reporting under the GHGRP Notice (Government of Canada 2020a).

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

EVMP4a

Description: Sources of water entering the SWMP will consist of surface water from precipitation runoff that has not been in contact with waste. This non-contact surface water may include drainage from parking lots and areas of the ECM not in use for receipt of wastes or still under construction. The SWMPs may also receive contact surface water if mitigation is not operating as designed. The water within the SWMP receives treatment in the form of sediment removal and discharges to downstream surface water continuously.

Source term: Sediment from stormwater runoff and potential contaminants associated with this run-off (e.g., contaminants from vehicles, salt application on roads). Potential stormwater impacts from contact surface water.

Potential Non-radiological Contaminants: Contaminants include those associated with typical stormwater runoff (e.g., suspended solids, oil and grease, chlorides) and contact surface water (Table 7-27). Where an analysis for various parameters is required the indicator parameters (i.e., those required for reporting) are provided in brackets and summarized in Table 7-30.

Potential Radiological Contaminants: No radiological contaminants are associated with planned stormwater runoff. Radiological parameters associated with contact surface water are discussed below.

Discharge Characterization: The EIS predicts SWMP effluent will be free of impacts with adequate controls.

Monitoring Strategy: Manual sampling of effluent from each of the SWMPs in operation is required at the discharge weir. As samples will be collected from the outfall of the SWMP the sample is considered representative and flow proportional or time weighted composites are not required. Monitoring will be based on storm events where a “storm event” is considered any storm forecasted to be 5 mm or more within a 24-hour period (MECP 2019). A single grab sample is to be collected for each operational weir during each storm event between 1h and 24h from storm initiation while water continues to flow from the SWMP. This timeframe is considered appropriate as it will allow for sampling from flow related to the storm. Sampling is required during daylight hours only and not during nights for safety purposes. If, during the first year of sampling, some short lived storms are not sampled this is considered acceptable given the amount of data collected. Flow monitoring to be conducted with the use of a flow meter and area velocity sensor placed in the SWMP discharge pip (or suitable alternative).

To assess waterborne parameters that will be monitored, an evaluation of contaminants of potential concern (COPCs) that may be associated with leachate or contact surface water was conducted for the operation of the NSDF (AECOM 2019a). These potential maximum COPC concentrations were compared to effluent discharge targets related to environmental protection (conventional parameters) and drinking water (radiological parameters) (CNL 2019b), with the exception of tritium, gross alpha and gross beta. The target for tritium concentrations is set to ensure tritium concentrations above background are below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. Gross alpha and gross beta are set at a screening level determined by CNL. Gross Alpha, Gross Beta and Tritium are the radiological indicator parameters which will be monitored in order to identify whether any contact water has entered the SWMPs. The findings of the assessment are provided in Table 7-26 and Table 7-27. This evaluation, as well as the recommended parameters under the MISA Stormwater Control Study as evaluated by CNL for their effluent monitoring program (CNL 2014a), form the basis of the discussion related to waterborne parameters below.

Tier 1 Criteria for stormwater consist of trend assessment of indicator compounds. Evaluation of parameters that may be indicative of contact surface water or poor SWMP performance is also conducted by comparison to Tier 2 Criteria. If exceedances of Tier 2 Criteria (Table 7-30) for parameters other than TSS are identified in monitoring, the full list of parameters (Table 7-27) should be re-evaluated. During review, the parameters to be monitored should be compared to findings from surface water sampling and WWTP influent sampling and changes to the SWMP monitoring or the surface water management program made based on these results. TSS should be retained as an indicator parameter of SWMP performance. Other indicator parameters are listed below as applicable and where an analysis for various parameters is required the indicator parameters (i.e., those required for reporting) are provided in brackets and summarized in Table 7-30. .

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Physical Parameters								
NA	Flow	p)	Monitored: p) Core physical characteristic under MISA used to determine loading from a source.	Measured	Flow monitoring to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Continuous Reading: Data collected is flow (commonly m^3/min) over time.	1. Monitoring during storms will provide data required to calculate contaminant loading. 2. Continuous measurement during a storm event is appropriate because this provides data that can be used to calculate potential effects.	During the operations phase of the ECM.	SWMPs in use during operations phase require monitoring for flow so that chemical data can be converted to a loading.

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Radiological Parameters								
NA	Gross Alpha Gross Beta Tritium	k) q)	**Monitored:** **Gross alpha, gross beta, , tritium, – these items are considered indicator parameters:** k): Monitoring is required to identify an unplanned emission or to collect information from this event. The maximum gross beta concentration in wastewater comprised of leachate and contact water may exceed the effluent discharge criteria (Table 7-26). q) Monitoring is conducted for due diligence. Contact surface water or leachate are not expected to be in the SWMPs. Gross alpha and gross beta are bulk parameters that indicate the presence of several alpha and beta emitters, respectively. They are selected for their simplicity of analysis and cost effectiveness. Where gross alpha and gross beta monitoring indicates concentrations above Tier 2 screening levels, radionuclide specific analysis is performed (e.g., gamma spectroscopy).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate potential issues related to closure. Storms are considered the highest risk times for contact surface water to enter the SMWPs. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
Non-Radiological Parameters								
1b	Carbonaceous Biochemical Oxygen Demand (CBOD)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). CBOD is the measure of the affect the sample will have on oxygen available to living organisms in the waters into which the waste is discharged. In contrast to BOD, this analysis excludes oxygen consumption by nitrogen fixing bacteria more commonly associated with sewage.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
3	pH	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum pH of contact water may exceed effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) Core parameter recommended for MISA stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
4b	Nitrogen (nitrate and nitrite)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water to be treated exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). Nitrate in particular is an effective indicator parameter of changes in water quality.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
6	Phosphorus	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) Core parameter recommended for MISA stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
7	Conductivity	q)	Monitored: q) Parameter monitored as it is an indicator of potential road salt impacts.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
8	TSS	k) p)	Monitored: k) The main treatment objective of a SWMP is to reduce sediment in effluent. TSS analysis is an indicator parameter to ensure the SWMPs meet the treatment objective. Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water may exceed effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) TSS is a MISA recommended parameter for stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
9	All Metals in ATG 9 (Aluminum, cobalt, copper, zinc)	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Predicted maximum concentrations of aluminum and cobalt exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) Aluminum, copper and zinc are MISA recommended parameters for stormwater monitoring (CNL 2014a). Aluminum and cobalt are selected as indicator parameters as the maximum predicted in leachate/contact surface water exceeds effluent discharge targets. Aluminum, copper and zinc are considered indicator parameters from road runoff (e.g., particulate from vehicles) and temporary buildings.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
9a	Additional Metals (Iron)	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. The predicted maximum concentration of iron exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). Iron is considered an indicator parameter for monitoring. Compounds other than iron are not reported as they are not predicted to exceed effluent discharge targets in contact surface water. p) Iron is a MISA recommended parameter for stormwater monitoring (CNL 2014a). Note: Parameters in ATG 9a other than iron will not be reported as they are not predicted to exceed effluent discharge targets in contact surface water (Table 7-27).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
10	Hydrides (Sb, As, Se)	none	Not Monitored: These metals are not considered key indicator parameters as issues with contact surface water entering the SWMPs will be identified by other metals being analysed in ATG 9. Nor do their maximum predicted concentrations exceed effluent discharge targets (Table 7-27).	NA	NA	NA	NA	NA
12	Mercury, Unfiltered Total	NA	Not Monitored: Mercury is not considered a key indicator parameter as issues with contact surface water entering the SWMPs will be identified by other metals being analysed in ATG 9. Nor does its maximum predicted conc exceed the effluent discharge target (Table 7-27).	NA	NA	NA	NA	NA
14	Total Phenolic Content (TPC)	NA	Not Monitored: Phenols are not considered a key indicator parameter as the maximum concentration is not predicted to exceed effluent discharge targets (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
16	Volatiles, Halogenated (chloroform, ethylene dibromide)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions. The predicted maximum concentration of chloroform and ethylene dibromide exceeds effluent discharge targets if no treatment is conducted (Table 7-27). Parameters in ATG16 other that chloroform and ethylene dibromide are not reported as they are not predicted to exceed effluent discharge targets in contact surface water.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
17	Volatiles, Non-Halogenated (benzene)	q)	Monitored: q) Analysis of parameters predicted to be below effluent discharge targets (Table 7-27) is conducted for due diligence purposes. Benzene is considered an indicator parameter of potential organic issues associated with road and equipment use. All parameters in this ATG are not predicted to exceed effluent discharge targets in contact surface water. Only benzene requires reporting as a potential fuel compound.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
19	Extractables, Base Neutral	NA	Not Monitored: While the maximum predicted concentration of select base neutral extractables are predicted to exceed effluent discharge targets (i.e., anthracene, chrysene and fluoranthene from Table 7-27), they are not considered key parameters as they are often sorbed onto particulate matter and would be indicated by other analysis proposed (e.g., These compounds are considered to be addressed by the indicator parameters related to ATG16, ATG17 and ATG25).	NA	NA	NA	NA	NA

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
20	Extractables, Acid (phenolics)	NA	Not Monitored: Acid extractable phenolics are not considered key parameters as the maximum concentrations are not considered to exceed effluent discharge targets (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA
24	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	NA	Not Monitored: Dioxins and furans are not considered key parameters as the maximum concentrations are not predicted to exceed effluent discharge (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA
25	Oil and Grease	k) p)	Monitored: k) With the extensive use of mobile equipment, an oil and grease release is a reasonably foreseeable event. p) Oil and Grease is a MISA recommended parameter for stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal under extreme conditions as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
27	Polychlorinated biphenyls (PCBs)	NA	Not monitored: PCBs are not considered key parameters as the maximum concentrations are not predicted to exceed effluent discharge targets (Table 7-27) and are considered to be addressed by the indicator parameters related to ATG25.	NA	NA	NA	NA	NA

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
30	Anions (chloride, sulphate)	k) p) q)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions. The predicted maximum concentration of sulphate exceeds effluent discharge targets if no treatment is conducted (Table 7-27). Sulphate is considered an indicator parameter for monitoring. p) Chloride is a MISA recommended parameter for stormwater monitoring (CNL 2014a). q) Chloride is an indication of salt impacts from possible operations. Note: Fluoride is not reported as it is not predicted to exceed effluent discharge targets in contact surface water (Table 7-27).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
NA	Other metals or inorganics (manganese)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions. The predicted maximum concentration of manganese exceeds effluent discharge targets if no treatment is conducted (See Table 7-27).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the operations phase of the ECM.	SWMPs in use during the operations phase require monitoring throughout this phase to evaluate controls.
NA	Other Organics (acetone, bis(2-ethylhexyl) phthalate)	NA	Not Monitored: Other organics are not considered key parameters as the maximum concentrations are not predicted to exceed effluent discharge targets (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA

Table 7-16: EVMP Analysis and Monitoring Frequency – Operations Phase – SWMP Waterborne Effluent – EVMP4a

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
NA	Petroleum hydrocarbons (C6-C10)	NA	Not Monitored: This compound was not predicted to be present in appreciable concentrations and fuel and oil related risks are addressed by the oil and grease analysis as well as non-halogenated volatiles.	NA	NA	NA	NA	NA
NA	Tannic acid	NA	Not Monitored: There is no environmental concern with this parameter as the presence of wetlands and organic-rich waterbodies (e.g., Perch Lake) in the drainage area results in the surface waters possessing naturally elevated tannins and other coloured compounds (i.e., humic acids) sourced from the wetland and macrophyte vegetation. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA
NA	Ethylene-diamine-tera acetic acid (EDTA)	NA	Not Monitored: The Canadian Government completed a screening assessment - ecological hazard and exposure potentials of EDTA and associated salts were classified using the Ecological Risk Classification of Organic Substances Approach, with the risk posed by these substances deemed low at common levels of exposure (Health Canada 2018). It was concluded that these substances are not harmful to human health or to the environment. They have a low ecological hazard potential, and the Government concluded that these substances are not entering the environment at levels that are harmful to the environment. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA

NA = not applicable, NA within the ATG column indicates the contaminant(s) are not part of the MISA protocol.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

EVMP5

Description: The WWTP is a batch plant water treatment facility that includes: influent equalization; chemical precipitation; membrane filtration; pH adjustment; granular activated carbon; ion exchange; and final effluent storage. These treatment elements will be employed as required by the influent. The effluent is treated prior to being released to one of 2 locations: (1) during low groundwater conditions, effluent is released to the infiltration gallery, entering the ground and making its way to Perch Lake through East Swamp Stream; or (2) during high groundwater conditions, effluent in releases to Perch Lake through a direct transfer line.

Source term: Sources of water entering the WWTP for treatment include: the ECM which generates leachate and contact water; the operations support center which generated decontamination water; and the WWTP process related drains

This wastewater is treated by the WWTP and enters holding tanks for sampling prior to discharge. Sanitary sewage is not treated at the WWTP.

Potential Non-radiological Contaminants: An evaluation of potential non-radiological contaminants associated with leachate and contact surface water is discussed below. .

Potential Radiological Contaminants: An evaluation of potential radiological contamination associated with leachate and contact surface water is discussed in the paragraphs below.

Discharge Characterization: The effluent will be held or reprocessed until it meets the Tier 1 criteria noted. Dealing with upset conditions is discussed in Table 7-1.

Monitoring Strategy: Manual sampling of effluent from each of batch of treated water is required prior to discharge. The effluent storage tanks are equipped with sampling ports that allow for collection of a composite samples from the mixed tank. Flow meters will measure and totalize the effluent discharged. Flow will be monitored from the effluent batch discharge with the use of a flow totalizer.

To assess waterborne parameters that will be monitored, an evaluation of contaminants of potential concern (COPCs) that may be associated with leachate or contact surface water was conducted for the operation of the NSDF (AECOM 2019a). These potential maximum COPC concentrations were compared to effluent discharge targets related to environmental protection (conventional parameters) and drinking water (radiological parameters) (CNL 2019b), with the exception of tritium, gross alpha and gross beta. The target for tritium concentrations is set to ensure tritium concentrations above background are below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. Gross alpha and gross beta are set at screening levels determined by CNL. The findings of the assessment are provided in Table 7-26 and Table 7-27. This evaluation forms the basis of the discussion related to waterborne parameters below. In addition, various compounds are required to be analyzed for MISA compliance. CNL's EVMP indicates core parameters to be analyzed for a new monitoring location based on original characterization work related to MISA (Section 5.3 of CRL's non radiological EVMP (CNL 2014a). Indicator parameters for WWTP effluent are summarized, along with Tier 2 Criteria in Table 7-29.

Data obtained from each batch of water to be discharged is to be compared to the Tier 2 Criteria noted in Table 7-29. Water that does not meet this requirement is to undergo further treatment prior to discharge. Emergency conditions are discussed in Section 7.1.1

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Physical Parameters								
NA	Volume Discharged	p)	Monitored: p) Core physical characteristic under MISA used to determine loading from a source (CNL 2014a).	Measured	Monitoring to be conducted for each batch discharge Data collected is m^3 per batch.	1. Monitoring of discharges will provide data required to calculate contaminant loading for each individual batch released. 2. Total cubic meters of each discharge provides data that can be used to calculate potential effects.	As long as batch discharges are being released from the WWTP.	The WWTP is in use during the operations phase of the NSDF and requires monitoring for MISA compliance.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Radiological Parameters comp								
NA	Gross Alpha Gross Beta Gamma Emitters (Co-60) Tritium C-14 Sr-90	j) k) q)	**Monitored:** **<u>Sr-90 & Co-60:</u>** k): Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-26) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. j): Monitoring serves to provide data that may be used for radiation dose assessments for the CRL ERA **Others (i.e., gross alpha, gross beta, gamma emitters, tritium, C-14):** j): Monitoring serves to provide data that may be used for radiation dose assessments for the CRL ERA q) Monitoring is conducted for due diligence. Predicted effluent concentrations are below effluent discharge targets without treatment, in many cases several orders of magnitude below. Monitoring will confirm that predicted effluent concentrations are below effluent discharge targets. It is proposed to evaluate gross alpha, gross beta, Co-60, Cs-137, tritium, Sr-90, C-14 rather than the full suite of radionuclides shown in Table 7-26. This limited suite of radiological constituents of potential concern (COPCs) is proposed based on the low relative risks of many other radiological compounds (e.g., in many cases, the predicted leachate/contact surface water concentrations are orders of magnitude below the discharge criteria) and the ability for several parameters to provide an indication of the presence of leachate/contact surface water.	Measured	Analysis prior to release of batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
Non-radiological Parameters								
1	Carbonaceous Oxygen Demand (COD)	p)	Monitored p) COD is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
1b	Carbonaceous Biochemical Oxygen Demand (CBOD)	k)	Monitored: k). Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
3	pH	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) pH is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
4b	Nitrogen (nitrate and nitrite)	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Nitrogen compounds are core parameters recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a)	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
5a	Dissolved Organic Carbon (DOC)	p)	Monitored p) DOC is a core parameter recommended under MISA for treatment facility final effluent that have the potential to be contaminated with hydraulic oils, greases, lubricating oils (CNL 2014a). Since the ECM will require heavy equipment operation, there is a potential source.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
5b	Total Organic Carbon (TOC)	p)	Monitored p) TOC is a core parameter recommended under MISA for treatment facilities final effluent that have the potential to be contaminated with hydraulic oils, greases, lubricating oils (CNL 2014a). Since the ECM will require heavy equipment operation, there is a potential source.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operations throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
6	Phosphorus	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Phosphorus is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
7	Conductivity	p) q)	Monitored p) Conductivity is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a). q) Parameter monitored as it is an indicator of potential road salt impacts.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
8	TSS	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) TSS is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
9	All Metals in ATG 9 (aluminum, boron, cobalt)	k) p)	Monitored: k) Aluminum, Boron, Cobalt: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) All metals in ATG 9 (with the exception of silver) are considered core parameters recommended for monitoring under MISA for treatment facility final effluent (CNL 2014a). Aluminum, boron, and cobalt are considered indicator parameters as the predicted maximum concentration for these parameters exceeds the Effluent Discharge Criteria.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
9a	Additional Metals (iron)	k) p)	Monitored: k) Iron: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) The parameters are recommended for monitoring under MISA for final treatment facility effluent (CNL 2014a). Iron is considered an indicator parameter as the predicted maximum concentration for these parameters exceeds the Effluent Discharge Criteria.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
10	Hydrides (Sb, As, Se)	q)	Monitored: q) Despite the maximum predicted concentrations of these parameters being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as metals are common in stormwater runoff and these metals were identified as contaminants of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
12	Mercury, Unfiltered Total	p) q)	Monitored: p) Mercury is a core parameter recommended under MISA for final treatment facility effluent where there is a source of mercury entering effluent waste stream (CNL 2014a). q) Despite the parameter's maximum concentration predicted to be below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as metals are common in stormwater runoff and mercury was identified as contaminant of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
14	Total Phenolic Content (TPC)	p) q)	Monitored: p) TPC is a core parameter recommended under MISA for those treatment facilities final effluent which have a potential source of phenols (CNL 2014a). q) Despite predicted maximum concentrations of TPC being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as phenolic compounds were identified as contaminants of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
16	Volatiles, Halogenated (chloroform and ethylene dibromide)	k) p)	Monitored: k) Chloroform and Ethylene Dibromide: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Halogenated volatiles are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). Chloroform and ethylene dibromide are considered indicator parameters as the predicted maximum concentrations for these parameters exceeds the Effluent Discharge Criteria	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
17	Volatiles, Non-Halogenated (benzene)	p) q)	Monitored: p) Halogenated volatiles are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). q) Despite predicted maximum concentrations being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as benzene was identified as a potential contaminant in leachate/contact surface water. Benzene is considered an indicator parameter of potential organic issues associated with road and equipment use and leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
19	Extractables, Base Neutral (anthracene, chrysene and fluoranthene)	k) p)	Monitored: k) Anthracene, Chrysene and Fluoranthene: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Base Neutral Extractables are core parameters required under MISA for final effluent as an indicator of effluent quality (CNL 2014a). Anthracene, chrysene and fluoranthene are considered indicator parameters as they were predicted to possibly exceed benchmarks.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
20	Extractables, Acid (phenol)	p) q)	Monitored: p) Acid Extractables are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). q) Despite predicted maximum concentrations of parameters predicted to be below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as phenol was identified as a potential contaminant in leachate/contact surface water. Phenol is considered an indicator parameter as it was identified as a potential contaminant in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
23	Extractables, Chlorinated (Hexachlorobutadiene)	p)	Monitored: p) Chlorinated Extractables are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). Hexachlorobutadiene is chosen as an indicator parameter as it has the lowest benchmark value of the group of compounds.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP (	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
24	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	q)	Monitored: q) Despite predicted maximum concentrations being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as dioxin and furan was identified as a potential contaminant in leachate/contact surface water. The total toxic equivalent (TEQ) for dioxins and furans are to be used for data evaluation (MOECC 2016).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
25	Solvent Extractables (Oil and Grease)	k) p)	Monitored: k) With the extensive use of heavy equipment in the ECM, a fluid release making its way to the treatment facility is a reasonable foreseeable event and monitoring is recommended to identify uncontrolled emissions. p) Solvent Extractables are core parameters recommended under MISA for treatment facility that have a chance of coming in contact with oils, hydraulic fluid, greases etc. (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
27	PCBs	q)	Monitored: q) Despite the maximum predicted concentrations of these parameters being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as PCBs were identified as contaminants of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
30	Anions (chloride, fluoride, sulphate)	k)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
NA	Other metals or inorganics (manganese)	k) q)	Monitored: k) Manganese: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. q) Barium and calcium: Despite predicted maximum concentrations being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as these compounds were identified as a potential contaminants in leachate/contact surface water. Manganese is considered an indicator parameter as it was predicted to possibly exceed benchmark.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-17: EVMP Analysis and Monitoring Frequency – Operations Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
NA	Other Organics (acetone)	q)	Monitored: q) Analysis of parameters predicted to be below effluent discharge targets (Table 7-27) is conducted for due diligence purposes as this compound was identified as a potential contaminant in leachate/contact surface water	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the operations phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
NA	Petroleum hydrocarbons (C6-C10)	N/A	Not Monitored: This compound was not predicted to be present in appreciable concentrations and fuel and oil related risks are addressed by the oil and grease analysis as well as non-halogenated volatiles.	NA	NA	NA	NA	NA
NA	Tannic acid	NA	Not Monitored: There is no environmental concern with this parameter as the presence of wetlands and organic-rich waterbodies (e.g., Perch Lake) in the drainage area results in the surface waters possessing naturally elevated tannins and other coloured compounds (i.e., humic acids) sourced from the wetland and macrophyte vegetation. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA
NA	EDTA	NA	Not Monitored: The Canadian Government completed a screening assessment - ecological hazard and exposure potentials of EDTA and associated salts were classified using the Ecological Risk Classification of Organic Substances Approach, with the risk posed by these substances deemed low at common levels of exposure (Health Canada 2018). It was concluded that these substances are not harmful to human health or to the environment. They have a low ecological hazard potential, and the Government concluded that these substances are not entering the environment at levels that are harmful to the environment. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA

Note:
ATG – analytical test group (MOECC 2016),
NA = not applicable, NA within the ATG column- indicates the contaminant(s) are not part of the MISA protocol.

Table 7-18: EVMP Analysis and Monitoring Frequency – Closure Phase – Road and Operational Dust to Atmosphere – EVMP1b

EVMP1b

Description: Closure activities including material handling, grading, vehicle movements on unpaved roads and wind erosion from cover material stockpiles will result in the generation of fugitive dust emissions. Emissions will vary depending on quantity of material handled, vehicle movements, control activities and meteorological conditions.

Source term: Airborne contaminants generated by material handling, grading, vehicle movements on unpaved roads and wind erosion from stockpiles

Potential Non-radiological contaminants: SPM, PM_{10} and $PM_{2.5}$

Potential Radiological contaminants: The EIS indicated that radiological releases are not a concern for fugitive dust emissions

Discharge Characterization: Emissions from closure activities were not calculated as part of the EIS as they were anticipated to be less than construction and operations

Monitoring Strategy: Estimation using site-specific emission factors, where possible and generic emission factors where site-specific are not available. Tracking of various information will be required in order to prepare site-specific emission factors

Emissions of dust will be estimated annually, added to the site total particulate emissions which will then be compared to the NPRI reporting thresholds (Tier 2 Criteria, Table 7-31). Emissions will vary annually depending on the amount and type of construction activity undertaken.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	SPM, PM_{10} and $PM_{2.5}$	h) o) q)	Monitored: h) Emissions of SPM, PM_{10} and $PM_{2.5}$ are required to be tracked for reporting as part of NPRI providing site-wide emissions meet reporting thresholds (Tier 2 Criteria, Table 7-31). o) SPM, PM_{10} and $PM_{2.5}$ emissions from closure activities are likely to be at least 10% of the NPRI reporting threshold. q) Particulate emissions have the largest potential to generate nuisance dust during closure activities and monitoring is required for due diligence	Estimated	Calculated annually but data collected daily	1. Daily data collection will provide necessary information to estimate annual emissions. 2. Measurement of annual particulate emissions from fugitive sources is not feasible. SPM, PM_{10} and $PM_{2.5}$ calculated from recorded activity and operational data (e.g., quantity of material handled) Estimation is acceptable under the NPRI	Throughout the closure Phase	The data obtained from monitoring are required for annual reporting to NPRI for the life of the Closure phase

Table 7-19: EVMP Analysis and Monitoring Frequency – Closure Phase– Decomposition of Waste from Within NSDF Mound to Vent/ECM Cover to Atmosphere – EVMP2b

EVMP2b

Description: The decomposition of waste within the NSDF will result in the release of fugitive emissions through the cap. Emissions will vary over time depending on the age and quantity of waste.

Source term: GHGs and air contaminants are generated by the decomposition of waste.

Potential Non-radiological contaminants: GHGs (including methane) CO, Hg, H_2S and C_2H_3Cl emissions

Potential Radiological contaminants: The radiological contaminants are not considered a significant emission source in the Safety Analysis Report (CNL 2020c) and are predicted to be less than during operations.

Discharge Characterization: Emissions from closure activities were not calculated as part of the EIS as they were anticipated to be less than construction and operations.

Monitoring Strategy: Emission estimations from the decomposition of waste will be estimated annually and results will be used in the determination of GHG and NPRI reporting (Tier 2 Criteria, Table 7-31 and Table 7-33).

Emissions will vary depending on the decomposition of waste and the composition of the landfill gas. Tracking of waste inputs will be required in order to create a LandGEM model and complete these estimates.

Note: As emissions of air contaminants were not estimated as part of the NSDF EIS, there is no need to verify the EIS predictions. Emissions of GHGs from closure were identified in the EIS to be less than those from operations, therefore emissions of GHGs from closure will be compared to EIS predictions from operations to confirm that they are lower.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a) therefore, the estimation of all releases is required to determine reportability. i) To verify predictions of EIS. CO_2e emissions are estimated based on LandGEM modelling. Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a).	Estimated	Annual	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on landfill gas generated is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a).	Throughout the Closure Phase	As long as the ECM is generating gas, atmospheric emissions will need to be estimated in order to report under the GHGRP. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.
NA	Carbon Monoxide (CO) Mercury (Hg) Hydrogen Sulphide (H_2S) Vinyl Chloride (C_2H_3Cl)	h)	Monitored: h) Emissions of each are tracked as fugitive emissions and included in CRL site cumulative emission estimates to determine reportability under the NPRI (Government of Canada 2020b). Emissions are estimated using LandGEM modelling. Estimation is of loading (kg/year or tonnes/year) as required by the Federal Notice (Government of Canada 2020b)	Estimated	Annual	1. ECCC NPRI Notice (Government of Canada 2020b) requires reporting annually if any of the site's reporting thresholds are met. 2. Emission estimates using LandGEM model is acceptable method under the NPRI Notice (Government of Canada 2020b)	Throughout the Closure Phase	As long as the ECM is generating gas, atmospheric emissions will need to be estimated in order to report under the NPRI.

Table 7-20: EVMP Analysis and Monitoring Frequency – Closure Phase- Mobile Equipment to Exhaust / GHG Emissions to Atmosphere – EVMP3b

EVMP3b.

Description: Operational activities will include the use of mobile equipment (on-road and off-road vehicles including heavy equipment). Emissions will vary depend on the type and amount of mobile equipment on site, equipment usage and distance travelled.

Source term: Airborne contaminants and GHG generated by the use of on-site vehicles.

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, Pb, SPM, PM_{10}, $PM_{2.5}$ and CO_2e

Potential Radiological contaminants: NA – there are no radiological releases associated with mobile equipment exhaust.

Discharge Characterization: Emissions from closure activities were not calculated as part of the NSDF EIS but were instead anticipated to be less than construction and operations phases.

Monitoring Strategy: GHG estimations (CO_2e) from the use of mobile equipment during the closure phase will be estimated annually, added to the site total GHG emissions which will be used to determine GHG reporting (Tier 2, Table 7-33). Emissions will vary annually depending on the amount and type of mobile equipment on-site. Tracking of various information, including fuel usage will be required and used with standard emission factors to calculate emission estimates.

Note: As air contaminant emissions were not estimated as part of the NSDF EIS, there is no need to verify the EIS predictions. Emissions of GHGs from closure were identified in the EIS to be less than those from operations, therefore emissions of GHGs from closure will be compared to EIS predictions from operations to confirm that they are lower.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x) Sulphur Dioxide (SO_2) Carbon Monoxide (CO) SPM, PM_{10} and $PM_{2.5}$ Total Volatile Organic Compounds (VOCs) Lead (Pb)	NA	Not Monitored: Emissions from mobile equipment are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b), nor were they estimated in the NSDF EIS.	NA	NA	NA	NA	NA
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a); therefore, the estimation of all releases is required to determine reportability. i) To verify predictions of EIS. CO_2e emissions are estimated based on annual consumption of fuel used on site (using standard emission factors). Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a)	Estimated	Calculated annually based on Calendar Year but data collected daily	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on fuel consumption is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a)]	As long as mobile equipment burning fuel is being used on site.	As long as fuel is being consumed by mobile equipment on the NSDF site, GHG emissions will need to be estimated for reporting under the GHGRP. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.

Table 7-21: EVMP Analysis and Monitoring Frequency – Closure Phase – Potential Halocarbon Releases to Atmosphere – EVMP3b

EVMP3b

Description: There are equipment on site (air conditioning, fire-extinguishing system and refrigeration systems) that use Halocarbons and periodically have releases to the atmosphere

Source term: Periodic releases from the use of air conditioning, fire-extinguishing and refrigeration systems

Potential Non-radiological contaminants: Halocarbons

Potential Radiological contaminants: NA

Discharge Characterization: Releases are only expected from problems with the operation of the equipment. . Releases can from acute failure where release occurs in very short period or can result from chronic failure which release occurs over longer period of time.

Monitoring Strategy: Tracking of all halocarbon leaks. There are equipment on site (air conditioning, fire-extinguishing system and refrigeration systems) that use Halocarbons and periodically have releases to the atmosphere. Preventative maintenance is performed on equipment in order to reduce the number of unanticipated releases. Releases are typically identified through problems with the operation of the equipment. Volume of release is identified through the recharging of the equipment once fixed or capacity of the equipment if being decommissioned for example.

Note: All minor halocarbon leaks (<10kg) are tracked but are not reportable under the FHR.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Halocarbons	h)	Monitored: h) Releases of greater than 10 kg are reportable under ECCC's *Federal Halocarbon Regulations* (FHR)	Estimated	Per Release	1. ECCC's *Federal Halocarbon Regulations* requires reporting for each release greater than 10 kg semi-annually and for each release greater than 100 kg within 24 hours; therefore, per release monitoring is required. 2. As releases are due to some sort of failure, their measurement is not possible. Therefore, estimations are made based on quantity of halocarbon needed to recharge the system once repaired or capacity of the equipment if being decommissioned for example. Estimation is an acceptable method under the FHR.	As long as halocarbon containing equipment is on site.	As long as halocarbons are on site, there is the chance for a reportable release, therefore monitoring needs to continue through the length of time the equipment is on site.

Table 7-22: EVMP Analysis and Monitoring Frequency – Closure Phase – Use of Natural Gas for Comfort Heating, Process Equipment and Emergency Supply to Atmosphere – EVMP3b

EVMP3b

Description: Natural gas is burned in boilers/heaters in each of the four facilities (WWTP, Vehicle Decontamination Centre, Administration Office and Operations Support building) for heating purposes (Note; Some of these buildings may be removed prior to or during the closure phase) as well as in the WWTP fueling the treatment process. The natural gas is brought into the site from the main natural gas line on plant road. Its combustion produces exhaust which enters atmosphere through roof vents on each of the facilities. The amount of fuel used for heating is dependent on the weather conditions.

Natural gas is also burned in emergency power equipment which will only operate periodically during monthly routine maintenance testing and for short durations. Additionally this equipment will be used to supply electricity during power outages when other equipment is not in operation.

Source term: Airborne contaminants and GHG generated by the use of natural gas. Emissions will vary depending on the amount of fuel consumed and the equipment using it.

Potential Non-radiological contaminants: NO_x, SO_2, CO, VOCs, SPM, PM_{10}, $PM_{2.5}$, Lead, Mercury and CO_2e

Potential Radiological contaminants: NA - there are no radiological releases associated with natural gas combustion

Discharge Characterization: Emissions from closure activities were not calculated as part of the NSDF EIS (Golder 2020a) but were instead anticipated to be less than construction and operations phases regulations

Monitoring Strategy: Estimation using site-specific emission factors, where possible and generic emission factors where site-specific are not available. Tracking of various information will be required in order to prepare site-specific emission factors

Estimations of GHG and indicator compound emissions from the use of natural gas within stationary buildings for comfort heating and process equipment in WWTP will be completed annually to determine reportability under the NPRI and GHGRP reporting Notices (Tier 2 Criteria, Tables 7-31 and 7-33).

Note: As air contaminant emissions were not estimated as part of the NSDF EIS, there is no need to verify the EIS predictions. Emissions of GHGs from closure were identified in the EIS to be less than those from operations, therefore emissions of GHGs from closure will be compared to EIS predictions from operations to confirm that they are lower. Tracking of various information, including fuel usage will be required and used with standard emission factors to calculate emission estimates.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Nitrogen Oxides (NO_x) Sulphur Dioxide (SO_2) Carbon Monoxide (CO) SPM, PM_{10} and $PM_{2.5}$ Total Volatile Organic Compounds (VOCs) Lead (Pb) Mercury (Hg)	h)	Monitored: h) Total emissions from all Site releases may be reportable under ECCC's *National Pollutant Release Inventory* Notices (Government of Canada 2020b); therefore, the estimation of all releases is required to determine reportability. Lead and mercury are two metals identified as releases from natural gas consumption as these two metals are typically reported for the CRL site and are therefore tracked routinely. Emissions are estimated based on annual consumption of the site's natural gas use (using standard emission factors). Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020b)	Estimated	Calculated annually based on Calendar Year	1. ECCC's *National Pollutant Release Inventory Notices* (Government of Canada 2020b) require reporting annually if reporting thresholds are met for each parameter emissions. 2. Estimation of emissions for each parameter is based on fuel consumption is standard industry practice and acceptable by the federal Notice (Government of Canada 2020b)	As long as natural gas burning equipment is being used on site.	As long as natural gas is being consumed, atmospheric emissions will need to be estimated for reporting under the NPRI.
NA	Speciated Volatile Organic Compounds (VOCs)	NA	Not Monitored: Total VOC emissions from all CRL site's current operations are not reportable under Environment Canada's *National Pollutant Release Inventory* Notices (Government of Canada 2020b). It is not expected that natural gas use will result in a significant increase of VOC releases and therefore there is no need to determine (or report) speciated VOC emissions.	NA	NA	NA	NA	NA

Table 7-22: EVMP Analysis and Monitoring Frequency – Closure Phase – Use of Natural Gas for Comfort Heating, Process Equipment and Emergency Supply to Atmosphere – EVMP3b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h) i)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a), therefore, the estimation of all releases is required to determine reportability. i) To verify predictions of EIS.CO_2e emissions are estimated based on annual consumption of natural gas used on site (using standard emission factors). Estimation is of loading (tonnes/year) required by the Federal Notice (Government of Canada 2020a)].	Estimated	Annual estimate with monthly fuel consumption tracking	1. ECCC'sGHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on fuel consumption is standard industry practice and acceptable by the Federal Notice (Government of Canada 2020a).	As long as natural gas burning equipment is being used on site.	As long as natural gas is being consumed, atmospheric emissions will need to be estimated for reporting under the GHGRP. The duration of monitoring to confirm EIS predictions will be reviewed as the program is implemented based on the results of previous comparisons and any changes to operational procedures.

Table 7-23: EVMP Analysis and Monitoring Frequency – Closure Phase – GHGs Generated from Wastewater Treatment to Stacks/Tanks to Atmosphere – EVMP6

EVMP6

Description: The WWTP's treatment process treats primary contact leachate water from the NSDF, which may result in minor releases of GHGs. Emissions will vary depending on the amount of wastewater processed and are required to be estimated.

Source term: The treatment of wastewater may result in the release of greenhouse gases

Potential Non-radiological contaminants: CO_2e

Potential Radiological contaminants: Not applicable as this monitoring relates to GHG only

Discharge Characterization: Minor releases of GHGs may occur from water treatment (<1% of sitewide emissions).

Monitoring Strategy: Monitoring of GHG only for comparison to ECCC's GHG Reporting Notices (Government of Canada 2020a)

GHG emission estimations from wastewater treatment processing will be estimated annually and results will be used for GHG reporting. Emissions will vary depending on the amount of wastewater processed and are required.

Note: The EIS identified that emissions from wastewater treatment were negligible (<1% of total emissions and therefore <10% GHGRP threshold). As a result, verification is not required.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
NA	Carbon Dioxide Equivalent (CO_2e)	h)	Monitored: h) Total CO_2e emissions from all site activities may be reportable under ECCC's GHG Reporting Notices (Government of Canada 2020a), therefore the estimation of all releases is required to determine reportability. CO_2e emissions are estimated based on wastewater treatment waterborne monitoring results (using either COB or BOD and nitrogen quarterly results) – see Table 7-19. Estimation is of loading (tonnes/year) as required by the Federal Notice (Government of Canada 2020a)	Estimated	Annual	1. ECCC's GHG Reporting Notices (Government of Canada 2020a) require reporting annually if reporting threshold is met for site CO_2e emissions. 2. Estimation of CO_2e based on waterborne COD or BOD and nitrogen Quarterly results is recommended by the Federal Notice (Government of Canada 2020a) with methodology identified in the quantification guidelines (ECCC 2019).	As long as wastewater is being treated by the WWTP,	As long as wastewater is being treated, emission will need to be estimated for reporting under the GHGRP Notice (Government of Canada 2020a).

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

EVMP4b

Description: Sources of water entering the SWMP will consist of surface water from precipitation runoff that has not been in contact with waste. This non-contact surface water may include drainage from parking lots and the ECM cover. The SWMPs may also receive contact surface water if mitigation is not operating as designed. The water within the SWMP receives treatment in the form of sediment removal and discharges to downstream surface water as water enters the SWMP.

Source term: Sediment from stormwater runoff and potential contaminants associated with this run-off (e.g., contaminants from vehicles, salt application on roads). Potential stormwater impacts from surface water in contact with waste if mitigation not managed appropriately.

Potential Non-radiological Contaminants: Contaminants include those associated with typical stormwater runoff: Suspended solids, oil and grease, chlorides and contact surface water (Table 7-27).

Potential Radiological Contaminants: No radiological contaminants are associated with planned stormwater runoff. Radiological parameters are associated with contact surface water and are discussed below. .

Discharge Characterization: The EIS predicts SWMP effluent will be free of impacts with adequate controls

Monitoring Strategy: Manual sampling of effluent from each of the SWMPs in operation is required at the discharge weir. As samples will be collected from the outfall of the SWMP the sample is considered representative and flow proportional or time weighted composites are not required. Monitoring will be based on storm events where a "storm event" is considered any storm forecasted to be 5 mm or more within a 24-hour period (MECP 2019). A single grab sample is to be collected for each operational weir during each storm event between 1h and 24h from storm initiation while water continues to flow from the SWMP. This timeframe is considered appropriate as it will allow for sampling from flow related to the storm. Sampling is required during daylight hours only and not during nights for safety purposes. If, during the first year of sampling, some short lived storms are not sampled this is considered acceptable given the amount of data collected. Flow monitoring to be conducted with the use of a flow meter and area velocity sensor placed in the SWMP discharge pipe (or suitable alternative).

To assess waterborne parameters that will be monitored, an evaluation of contaminants of potential concern (COPCs) that may be associated with leachate or contact surface water was conducted for the operation of the NSDF (AECOM 2019a). These potential maximum COPC concentrations were compared to effluent discharge targets related to environmental protection (conventional parameters) and drinking water (radiological parameters) (CNL 2019b), with the exception of tritium, gross alpha and gross beta. The target for tritium concentrations is set to ensure tritium concentrations above background are below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. Gross alpha and gross beta are set at a screening level determined by CNL. Gross Alpha, Gross Beta and Tritium are the radiological indicator parameters which will be monitored in order to identify whether any contact water has entered the SWMPs. The findings of the assessment are provided in Table 7-26 and Table 7-27. This evaluation, as well as the recommended parameters under the MISA Stormwater Control Study as evaluated by CNL for their effluent monitoring program (CNL 2014a), form the basis of the discussion related to waterborne parameters below.

Tier 1 Criteria for stormwater consist of trend assessment of indicator compounds. Evaluation of parameters that may be indicative of contact surface water or poor SWMP performance is also conducted by comparison to Tier 2 Criteria. If exceedances of Tier 2 Criteria (Table 7-30) for parameters other than TSS are identified in monitoring, the full list of parameters (Table 7-27) should be re-evaluated. During review, the parameters to be monitored should be compared to findings from surface water sampling and WWTP influent sampling and changes to the SWMP monitoring or the surface water management program made based on these results. TSS should be retained as an indicator parameter of SWMP performance. Other indicator parameters are listed below as applicable and where an analysis for various parameters is required the indicator parameters (i.e., those required for reporting) are provided in brackets and summarized in Table 7-30.

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Physical Parameters								
NA	Flow	p)	Monitored: p) Core physical characteristic under MISA used to determine loading from a source.	Measured	Flow monitoring to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Continuous Reading: Data collected is flow (commonly m^3/min) over time.	1. Monitoring during storms will provide data required to calculate contaminant loading. 2. Continuous measurement during a storm event is appropriate because this provides data that can be used to calculate potential effects.	During the closure phase of the ECM.	SWMPs in use during closure require monitoring for MISA SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
Radiological Parameters								
NA	Gross Alpha Gross Beta Tritium	k) q)	**Monitored:** **Gross alpha, gross beta, , tritium, – these items are considered indicator parameters:** k): Monitoring is required to identify an unplanned emission or to collect information from this event. The maximum gross beta concentration in wastewater comprised of leachate and contact water may exceed the effluent discharge criteria (Table 7-26). q) Monitoring is conducted for due diligence. Contact surface water or leachate are not expected to be in the SWMPs. Gross alpha and gross beta are bulk parameters that indicate the presence of several alpha and beta emitters, respectively. They are selected for their simplicity of analysis and cost effectiveness. Where gross alpha and gross beta monitoring indicates concentrations above Tier 2 screening levels, radionuclide specific analysis is performed (e.g., gamma spectroscopy).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate potential issues related to closure. Storms are considered the highest risk times for contact surface water to enter the SMWPs. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters								
1b	Carbonaceous Biochemical Oxygen Demand (CBOD)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). CBOD is the measure of the affect the sample will have on oxygen available to living organisms in the waters into which the waste is discharged. In contrast to BOD, this analysis excludes oxygen consumption by nitrogen fixing bacteria more commonly associated with sewage.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
3	pH	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum pH of contact water may exceed effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) Core parameter recommended for MISA stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
4b	Nitrogen (nitrate and nitrite)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water to be treated exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). Nitrate in particular is an effective indicator parameter of changes in water quality.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
6	Phosphorus	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) Core parameter recommended for MISA stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
7	Conductivity	q)	Monitored: q) Parameter monitored as it is an indicator of potential road salt impacts.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
8	TSS	k) p)	Monitored: k) The main treatment objective of a SWMP is to reduce sediment in effluent. TSS analysis is an indicator parameter to ensure the SWMPs meet the treatment objective. Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Parameter selected because predicted maximum concentration of contact water may exceed effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) TSS is a MISA recommended parameter for stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
9	All Metals in ATG 9 (Aluminum, cobalt, copper, zinc)	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. Predicted maximum concentrations of aluminum and cobalt exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). p) Aluminum, copper and zinc are MISA recommended parameters for stormwater monitoring (CNL 2014a). Aluminum and cobalt are selected as indicator parameters as the maximum predicted in leachate/contact surface water exceeds effluent discharge targets. Aluminum, copper and zinc are considered indicator parameters from road runoff (e.g., particulate from vehicles) and temporary buildings.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
9a	Additional Metals (Iron)	k) p)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions in the reasonably foreseeable upset event that contact water enters the SWMPs. The predicted maximum concentration of iron exceeds effluent discharge targets if no treatment is conducted (i.e., if contact water were to enter SWMPs) (See Table 7-27). Iron is considered an indicator parameter for monitoring. Compounds other than iron are not reported as they are not predicted to exceed effluent discharge targets in contact surface water. p) Iron is a MISA recommended parameter for stormwater monitoring (CNL 2014a). Note: Parameters in ATG 9a other than iron will not be reported as they are not predicted to exceed effluent discharge targets in contact surface water (Table 7-27).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
10	Hydrides (Sb, As, Se)	NA	Not Monitored: These metals are not considered key indicator parameters as issues with contact surface water entering the SWMPs will be identified by other metals being analysed in ATG 9. Nor do their maximum predicted concentrations exceed effluent discharge targets (Table 7-27).	NA	NA	NA	NA	NA
12	Mercury, Unfiltered Total	NA	Not Monitored: Mercury is not considered a key indicator parameter as issues with contact surface water entering the SWMPs will be identified by other metals being analysed in ATG 9. Nor does its maximum predicted concentration exceed the effluent discharge target (Table 7-27).	NA	NA	NA	NA	NA
14	Total Phenolic Content (TPC)	NA	Not Monitored: Phenols are not considered a key indicator parameter as the maximum concentration is not predicted to exceed effluent discharge targets (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
16	Volatiles, Halogenated (chloroform, ethylene dibromide)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions. The predicted maximum concentration of chloroform and ethylene dibromide exceeds effluent discharge targets if no treatment is conducted (See Table 7-27). Parameters in ATG16 other that chloroform and ethylene dibromide are not reported as they are not predicted to exceed effluent discharge targets in contact surface water.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
17	Volatiles, Non-Halogenated (benzene)	q)	Monitored: q) Analysis of parameters predicted to be below effluent discharge targets (Table 7-27) is conducted for due diligence purposes. Benzene is considered an indicator parameter of potential organic issues associated with road and equipment use. All parameters in this ATG are not predicted to exceed effluent discharge targets in contact surface water. Only benzene requires reporting as a potential fuel compound.	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
19	Extractables, Base Neutral	NA	Not Monitored: While the maximum predicted concentration of select base neutral extractables are predicted to exceed effluent discharge targets (i.e., anthracene, chrysene and fluoranthene from Table 7-27), they are not considered key parameters as they are often sorbed onto particulate matter and would be indicated by other analysis proposed (e.g., These compounds are considered to be addressed by the indicator parameters related to ATG16, ATG17 and ATG25).	NA	NA	NA	NA	NA
20	Extractables, Acid (phenolics)	NA	Not Monitored: Acid extractable phenolics are not considered key parameters as the maximum concentrations are not considered to exceed effluent discharge targets (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA
24	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	NA	Not Monitored: Dioxins and furans are not considered key parameters as the maximum concentrations are not predicted to exceed effluent discharge (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
25	Oil and Grease	k) p)	Monitored: k) With the extensive use of mobile equipment, an oil and grease release is a reasonably foreseeable event. p) Oil and Grease is a MISA recommended parameter for stormwater monitoring (CNL 2014a).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal under extreme conditions as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
27	Polychlorinated biphenyls (PCBs)	NA	Not monitored: PCBs are not considered key parameters as the maximum concentrations are not predicted to exceed effluent discharge targets (Table 7-27) and are considered to be addressed by the indicator parameters related to ATG25.	NA	NA	NA	NA	NA
30	Anions (chloride, sulphate)	k) p) q)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions. The predicted maximum concentration of sulphate exceeds effluent discharge targets if no treatment is conducted (See Table 7-27). Sulphate is considered an indicator parameter for monitoring. p) Chloride is a MISA recommended parameter for stormwater monitoring (CNL 2014a). q) Chloride is an indication of salt impacts from possible operations. Note: Fluoride is not reported as it is not predicted to exceed effluent discharge targets in contact surface water (Table 7-27).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	SWMPs in use during the closure phase require monitoring throughout this phase to evaluate controls.
NA	Other metals or inorganics (manganese)	k)	Monitored: k) Monitoring serves to identify unplanned or uncontrolled emissions. The predicted maximum concentration of manganese exceeds effluent discharge targets if no treatment is conducted (See Table 7-27).	Measured	Sampling to be conducted during a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). Grab sample	1. Sampling during storms will evaluate the effectiveness of the SWMP for sediment removal as well as potential issues related to closure. As samples will be collected from the outfall of the SWMP, a grab sample is considered representative of the final effluent. 2. Measurement is appropriate because this provides certainty regarding the quality of the data effluent.	During the closure phase of the ECM.	The SWMPs will be in use during the closure phase of the ECM. Monitoring is required to will serve as an early monitoring location for failure of mitigation measures.

Table 7-24: EVMP Analysis and Monitoring Frequency – Closure Phase – SWMP Waterborne Effluent – EVMP4b

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration	Justification of Monitoring Duration
Non-Radiological Parameters (cont'd)								
NA	Other Organics (acetone, bis(2-ethylhexyl) phthalate)	NA	Not Monitored: Other organics are not considered key parameters as the maximum concentrations are not predicted to exceed effluent discharge targets (Table 7-27) and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.	NA	NA	NA	NA	NA
NA	Petroleum hydrocarbons (C6-C10)	N	Not Monitored: This compound was not predicted to be present in appreciable concentrations and fuel and oil related risks are addressed by the oil and grease analysis as well as non-halogenated volatiles.	NA	NA	NA	NA	NA
NA	Tannic acid	NA	Not Monitored: There is no environmental concern with this parameter as the presence of wetlands and organic-rich waterbodies (e.g., Perch Lake) in the drainage area results in the surface waters possessing naturally elevated tannins and other coloured compounds (i.e., humic acids) sourced from the wetland and macrophyte vegetation. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA
NA	Ethylene-diamine-tera acetic acid (EDTA)	NA	Not Monitored: The Canadian Government completed a screening assessment - ecological hazard and exposure potentials of EDTA and associated salts were classified using the Ecological Risk Classification of Organic Substances Approach, with the risk posed by these substances deemed low at common levels of exposure (Health Canada 2018). It was concluded that these substances are not harmful to human health or to the environment. They have a low ecological hazard potential, and the Government concluded that these substances are not entering the environment at levels that are harmful to the environment. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

EVMP5

Description: The WWTP is a batch plant water treatment facility that includes: influent equalization; chemical precipitation; membrane filtration; pH adjustment; granular activated carbon; ion exchange; and final effluent storage. These treatment elements will be employed as required by the influent. The effluent is treated and captured in batches prior to being released to one of 2 locations: (1) During low groundwater conditions, effluent is released to the infiltrations gallery, entering the ground and making its way to Perch Lake through East Swamp Stream; or (2) During high groundwater conditions, effluent in releases to Perch Lake through a direct transfer line.

Source term: Sources of water entering the WWTP for treatment include: the ECM which generates leachate; contact surface water while waste is exposed, the operations support center which generated decontamination water; and the WWTP process related drains

This wastewater is treated by the WWTP and enters holding tanks for sampling prior to discharge. Sanitary sewage is not treated at the WWTP.

Potential Non-radiological Contaminants: An evaluation of potential non-radiological contaminants associated with leachate and contact surface water is discussed below. .

Potential Radiological Contaminants: An evaluation of potential radiological contamination associated with leachate and contact surface water is discussed below.

Discharge Characterization: The effluent will be held or reprocessed until it meets the Tier 1 criteria noted. Dealing with upset conditions is discussed in Table 7-1.

Monitoring Strategy: Manual sampling of effluent from each of batch of treated water is required prior to discharge. The effluent storage tanks are equipped with sampling ports that allow for collection of a composite samples from the mixed tank. Flow meters will measure and totalize the effluent discharged. Flow will be monitored from the effluent batch discharge with the use of a flow totalizer.

To assess waterborne parameters that will be monitored, an evaluation of contaminants of potential concern (COPCs) that may be associated with leachate or contact surface water was conducted for the operation of the NSDF (AECOM 2019a). These potential maximum COPC concentrations were compared to effluent discharge targets related to environmental protection (conventional parameters) and drinking water (radiological parameters) (CNL 2019b), with the exception of tritium, gross alpha and gross beta. The target for tritium concentrations is set to ensure tritium concentrations above background are below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. Gross alpha and gross beta are set at screening levels determined by CNL. The findings of the assessment are provided in Table 7-26 and Table 7-27. This evaluation forms the basis of the discussion related to waterborne parameters below. In addition, various compounds are required to be analyzed for MISA compliance. CNL's EVMP indicates core parameters to be analyzed for a new monitoring location based on original characterization work related to MISA (Section 5.3 of CRL's non radiological EVMP (CNL 2014a). To simplify reporting indicator parameters are noted in brackets in the Parameter Name column where there are various compounds in an analysis. Indicator parameters for WWTP effluent are summarized, along with Tier 2 Criteria in Table 7-29.

Data obtained from each batch of water to be discharged is to be compared to the Tier 2 Criteria noted in Table 7-29. Water that does not meet this requirement is to undergo further treatment prior to discharge. Emergency conditions are discussed in Section 7.1.1

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Physical Parameters								
NA	Volume Discharged	p)	Monitored: p) Core physical characteristic under MISA used to determine loading from a source (CNL 2014a).	Measured	Monitoring to be conducted for each batch discharge. Data collected is m^3 per batch.	1. Monitoring of discharges will provide data required to calculate contaminant loading for each individual batch released. 2. Total cubic meters of each discharge provides data that can be used to calculate potential effects.	As long as batch discharges are being released from the WWTP.	The WWTP is in use during the closure phase of the NSDF and requires monitoring for MISA compliance.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Radiological Parameters comp								
NA	Gross Alpha Gross Beta Gamma Emitters (Co-60) Tritium C-14 Sr-90	j) k) q)	**Monitored:** **<u>Sr-90 & Co-60:</u>** k): Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-26) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. j): Monitoring serves to provide data that may be used for radiation dose assessments for the CRL ERA **Others (i.e., gross alpha, gross beta, gamma emitters, tritium, C-14):** j): Monitoring serves to provide data that may be used for radiation dose assessments for the CRL ERA q) Monitoring is conducted for due diligence. Predicted effluent concentrations are below effluent discharge targets without treatment, in many cases several orders of magnitude below. Monitoring will confirm that predicted effluent concentrations are below effluent discharge targets. It is proposed to evaluate gross alpha, gross beta, Co-60, Cs-137, tritium, Sr-90, C-14 rather than the full suite of radionuclides shown in Table 7-26. This limited suite of radiological constituents of potential concern (COPCs) is proposed based on the low relative risks of many other radiological compounds (e.g., in many cases, the predicted leachate/contact surface water concentrations are orders of magnitude below the discharge criteria) and the ability for several parameters to provide an indication of the presence of leachate/contact surface water.	Measured	Analysis prior to release of batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters								
1	Carbonaceous Oxygen Demand (COD)	p)	Monitored p) COD is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
1b	Carbonaceous Biochemical Oxygen Demand (CBOD)	k)	Monitored: k). Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
3	pH	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) pH is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
4b	Nitrogen (nitrate and nitrite)	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Nitrogen compounds are core parameters recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
5a	Dissolved Organic Carbon (DOC)	p)	Monitored p) DOC is a core parameter recommended under MISA for treatment facility final effluent that have the potential to be contaminated with hydraulic oils, greases, lubricating oils (CNL 2014a). Since the ECM will require heavy equipment operation, there is a potential source.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
5b	Total Organic Carbon (TOC)	p)	Monitored p) TOC is a core parameter recommended under MISA for treatment facilities final effluent that have the potential to be contaminated with hydraulic oils, greases, lubricating oils (CNL 2014a). Since the ECM will require heavy equipment operation, there is a potential source.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
6	Phosphorus	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Phosphorus is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
7	Conductivity	p) q)	Monitored p) Conductivity is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a). q) Parameter monitored as it is an indicator of potential road salt impacts.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
8	TSS	k) p)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) TSS is a core parameter recommended under MISA for treatment facility final effluent as a gross indicator of effluent quality (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
9	All Metals in ATG 9 (aluminum, boron, cobalt)	k) p)	Monitored: k) Aluminum, Boron, Cobalt: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) All metals in ATG 9 (with the exception of silver) are considered core parameters recommended for monitoring under MISA for treatment facility final effluent (CNL 2014a). Aluminum, boron, and cobalt are considered indicator parameters as the predicted maximum concentration for these parameters exceeds the Effluent Discharge Criteria.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
9a	Additional Metals (iron)	k) p)	Monitored: k) Iron: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) The parameters are recommended for monitoring under MISA for final treatment facility effluent (CNL 2014a). Iron is considered an indicator parameter as the predicted maximum concentration for these parameters exceeds the Effluent Discharge Criteria.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
10	Hydrides (Sb, As, Se)	q)	Monitored: q) Despite the maximum predicted concentrations of these parameters being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as metals are common in stormwater runoff and these metals were identified as contaminants of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
12	Mercury, Unfiltered Total	p) q)	Monitored: p) Mercury is a core parameter recommended under MISA for final treatment facility effluent where there is a source of mercury entering effluent waste stream (CNL 2014a). q) Despite the parameter's maximum concentration predicted to be below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as metals are common in stormwater runoff and mercury was identified as contaminant of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
14	Total Phenolic Content (TPC)	p) q)	Monitored: p) TPC is a core parameter recommended under MISA for those treatment facilities final effluent which have a potential source of phenols (CNL 2014a). q) Despite predicted maximum concentrations of TPC being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as phenolic compounds were identified as contaminants of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
16	Volatiles, Halogenated (chloroform and ethylene dibromide)	k) p)	Monitored: k) Chloroform and Ethylene Dibromide: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Halogenated volatiles are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). Chloroform and ethylene dibromide are considered indicator parameters as the predicted maximum concentrations for these parameters exceeds the Effluent Discharge Criteria	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
17	Volatiles, Non-Halogenated (benzene)	p) q)	Monitored: p) Halogenated volatiles are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). q) Despite predicted maximum concentrations being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as benzene was identified as a potential contaminant in leachate/contact surface water. Benzene is considered an indicator parameter of potential organic issues associated with road and equipment use and leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge..
19	Extractables, Base Neutral (anthracene, chrysene and fluoranthene)	k) p)	Monitored: k) Anthracene, Chrysene and Fluoranthene: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. p) Base Neutral Extractables are core parameters required under MISA for final effluent as an indicator of effluent quality (CNL 2014a). Anthracene, chrysene and fluoranthene are considered indicator parameters as they were predicted to possibly exceed benchmarks.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
20	Extractables, Acid (phenol)	p) q)	Monitored: p) Acid Extractables are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). q) Despite predicted maximum concentrations of parameters predicted to be below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as phenol was identified as a potential contaminant in leachate/contact surface water. Phenol is considered an indicator parameter as it was identified as a potential contaminant in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
23	Extractables, Chlorinated (Hexachlorobutadiene)	p)	Monitored: p) Chlorinated Extractables are core parameters recommended under MISA for final effluents of treatment facilities accepting sources of a variety of chemicals/waste (CNL 2014a). Hexachlorobutadiene is chosen as an indicator parameter as it has the lowest benchmark value of the group of compounds.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP (	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
24	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	q)	Monitored: q) Despite predicted maximum concentrations being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as dioxin and furan was identified as a potential contaminant in leachate/contact surface water. The total toxic equivalent (TEQ) for dioxins and furans are to be used for data evaluation (MOECC 2016).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
25	Solvent Extractables (Oil and Grease)	k) p)	Monitored: k) With the extensive use of heavy equipment in the ECM, a fluid release making its way to the treatment facility is a reasonable foreseeable event and monitoring is recommended to identify uncontrolled emissions. p) Solvent Extractables are core parameters recommended under MISA for treatment facility that have a chance of coming in contact with oils, hydraulic fluid, greases etc. (CNL 2014a).	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
27	PCBs	q)	Monitored: q) Despite the maximum predicted concentrations of these parameters being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as PCBs were identified as contaminants of potential concern in leachate/contact surface water.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
30	Anions (chloride, fluoride, sulphate)	k)	Monitored: k) Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
NA	Other metals or inorganics (manganese)	k) q)	Monitored: k) Manganese: Predicted maximum concentration exceeds effluent discharge targets if no treatment is conducted (See Table 7-27) therefore, this monitoring serves to identify unplanned or uncontrolled emissions in the instance where treatment was not efficient. q) Barium and calcium: Despite predicted maximum concentrations being below effluent discharge targets (Table 7-27), monitoring is conducted for due diligence purposes as these compounds were identified as potential contaminants in leachate/contact surface water. Manganese is considered an indicator parameter as it was predicted to possibly exceed benchmark.	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
NA	Other Organics (acetone)	q)	Monitored: q) Analysis of parameters predicted to be below effluent discharge targets (Table 7-27) is conducted for due diligence purposes as this compound was identified as a potential contaminant in leachate/contact surface water	Measured	Per batch Composite	1. A sample from each batch for discharge is required as the batches of effluent may vary considerably. A composite sample is appropriate to represent the treated water. One sample per batch is considered appropriate given the tank volumes. 2. Measurement is appropriate because this provides certainty regarding the quality of water being discharged.	During operation of the WWTP	The WWTP will be operational throughout the closure phase of the NSDF and as long as batch discharges are taking place, the effluent will be monitored prior to discharge.
NA	Petroleum hydrocarbons (C6-C10)	NA	Not Monitored: This compound was not predicted to be present in appreciable concentrations and fuel and oil related risks are addressed by the oil and grease analysis as well as non-halogenated volatiles.	NA	NA	NA	NA	NA

Table 7-25: EVMP Analysis and Monitoring Frequency – Closure Phase – WWTP Waterborne Effluent – EVMP5

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification of: 1) Monitoring Frequency & Sample Type 2) Estimation or Measurement	Monitoring Duration[1]	Justification of Monitoring Duration
Non-radiological Parameters (cont'd)								
NA	Tannic acid	NA	Not Monitored: There is no environmental concern with this parameter as the presence of wetlands and organic-rich waterbodies (e.g., Perch Lake) in the drainage area results in the surface waters possessing naturally elevated tannins and other coloured compounds (i.e., humic acids) sourced from the wetland and macrophyte vegetation. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA
NA	EDTA	NA	Not Monitored: The Canadian Government completed a screening assessment - ecological hazard and exposure potentials of EDTA and associated salts were classified using the Ecological Risk Classification of Organic Substances Approach, with the risk posed by these substances deemed low at common levels of exposure (Health Canada 2018). It was concluded that these substances are not harmful to human health or to the environment. They have a low ecological hazard potential, and the Government concluded that these substances are not entering the environment at levels that are harmful to the environment. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.	NA	NA	NA	NA	NA

Note:
ATG – analytical test group (MOECC 2016),
NA = not applicable, NA within the ATG column- indicates the contaminant(s) are not part of the MISA protocol.

Table 7-26: Maximum Predicted Radionuclide Concentrations in Wastewater Prior to Treatment and Effluent Discharge Targets

Radionuclide	Maximum Predicted Concentration in Wastewater (Bq/L) Prior to Treatment	Effluent Discharge Target (Bq/L)	Treatment Required?	Reference for Effluent Discharge Target
Gross Alpha		0.2		CNL 2019b
Gross Beta	8.97 (as Strontium-90)	5	Yes	CNL 2019b
Gross Gamma		40		CNL 2019b
Ag-108m (metastable isotope silver-108)	1.8×10^{-4}	60	No	Health Canada 2009
Am-241 (isotope Americium-241)	0.0028	0.7	No	Health Canada 2009
Am-243 (isotope Americium-243)	1.7×10^{-6}	0.7	No	Health Canada 2009
C-14 (isotope carbon-14)	3.1	200	No	Health Canada 2009
Cl-36 (isotope chlorine-36)	0.059	100	No	Health Canada 2009
Co-60 (isotope cobalt-60)	1300	40	Yes	Health Canada 2009
Cs-135 (isotope caesium-135)	4.1×10^{-5}	70	No	Health Canada 2009
Cs-137 (isotope caesium-137)	0.93	10	No	Health Canada 2009
H-3 (isotope hydrogen-3 [Tritium])	1.4×10^{5}	3.6×10^{5}	No	CNL 2019b
I-129 (isotope Iodine-129)	0.091	1	No	Health Canada 2009
Mo-93 (isotope molybdenum-93)	4.1×10^{-7}	40	No	Health Canada 2009
Nb-94 (isotope Niobium-94)	0.015	80	No	Health Canada 2009
Ni-59 (isotope nickel-59)	1.7×10^{-4}	2000	No	Health Canada 2009
Ni-63 (isotope nickel-63)	0.044	900	No	Health Canada 2009
Np-237 (isotope neptunium-237)	6.3×10^{-7}	1	No	Health Canada 2009
Pu-239 (isotope plutonium-239)	0.0044	0.6	No	Health Canada 2009
Pu-241 (isotope plutonium-241)	0.079	30	No	Health Canada 2009
Pu-242 (isotope plutonium-242)	3.3×10^{-5}	0.6	No	Health Canada 2009
Ra-226 (isotope radium-226)	6.4×10^{-4}	0.5	No	Health Canada 2009
Se-79 (isotope selenium-79)	2.4×10^{-5}	50	No	Health Canada 2009
Sn-126 (isotope tin-126)	7.2×10^{-6}	30	No	Health Canada 2009
Sr-90 (isotope strontium-90)	9.6	5	Yes	Health Canada 2009
Tc-99 (isotope technetium-99)	5.7	200	No	Health Canada 2009
Th-230 (isotope thorium-230)	2.2×10^{-4}	0.9	No	Health Canada 2009
Th-232 (isotope thorium-232)	9.6×10^{-4}	0.6	No	Health Canada 2009
U-233 (isotope uranium-233)	2.9×10^{-5}	3	No	Health Canada 2009
U-234 (isotope uranium-234)	0.0078	3	No	Health Canada 2009
U-235 (isotope uranium-235)	3.3×10^{-4}	3	No	Health Canada 2009
U-238 (isotope uranium-238)	0.0076	3	No	Health Canada 2009
Zr-93 (isotope zirconium-93)	0.044	100	No	Health Canada 2009

Source: Adapted from (AECOM 2019a) and (CNL 2019b)

Note: The effluent discharge target for radiological parameters is based primarily on the drinking water guideline as noted in the table.

Yes and No related to the column Treatment Required? Indicate if the maximum predicted concentration exceeds the effluent discharge target.

Bq/L = Becquerel per litre.

Table 7-27: Maximum Predicted Non-Radionuclide Constituent Concentrations in Wastewater Prior to Treatment and Effluent Discharge Targets

Constituent	Maximum Predicted Concentration in Wastewater (mg/L) Prior to Treatment	Effluent Discharge Target (mg/L)	Treatment Required?	Reference for Effluent Discharge Target
Cations				
Aluminum	0.15	0.05	Yes	CCME 1999
Antimony	3.3×10^{-7}	0.02	No	MOEE 1994
Arsenic	3.1×10^{-4}	0.005	No	CCME 1999
Barium	7.1×10^{-4}	0.004	No	Suter and Tsao 1996
Beryllium	1.9×10^{-6}	0.011	No	MOEE 1994
Boron	0.12	0.2	Possible	MOEE 1994
Cadmium	2.9×10^{-6}	9.0×10^{-5}	No	CCME 1999
Calcium	100	116	No	Suter and Tsao 1996
Chromium (total) (3)	2.5×10^{-4}	0.001	No	CCME 1999
Cobalt	0.0027	0.0009	Yes	MOEE 1994
Copper	8.0×10^{-4}	0.002	No	CCME 1999
Iron	125	0.3	Yes	CCME 1999
Lead	2.4×10^{-5}	0.001	No	CCME 1999
Magnesium	68	82	No	Suter and Tsao 1996
Manganese	5.8	0.12	Yes	Suter and Tsao 1996
Mercury	2.3×10^{-6}	2.6×10^{-5}	No	CCME 1999
Molybdenum	0.0039	0.04	No	MOEE 1994
Nickel	5.5×10^{-5}	0.025	No	CCME 1999
Potassium	26	53	No	Suter and Tsao 1996
Selenium	4.8×10^{-5}	0.001	No	CCME 1999
Silica	5	*	No	
Silver	3.2×10^{-6}	1.0×10^{-4}	No	MOEE 1994
Sodium	100	680	No	Suter and Tsao 1996
Thallium	3.8×10^{-6}	3.0×10^{-4}	No	MOEE 1994
Tin	5.8×10^{-4}	0.073	No	Suter and Tsao 1996
Uranium	6.1×10^{-4}	0.005	No	MOEE 1994
Vanadium	4.3×10^{-4}	0.006	No	MOEE 1994
Zinc	0.0016	0.007	No	CCME 1999
Anions				
Bicarbonate Alkalinity as $CaCO_3$	542	*	*	
Chloride	17	120	No**	CCME 1999
Fluoride	0.12	0.012	No	CCME 1999
Nitrate as NO_3	29.3	13 (1)	Yes(1)	CCME 1999
Nitrite as N	0.265	0.06 (1)	Yes(1)	CCME 1999
Phosphorus	1.3	0.01	No(2)	MOEE 1994
Sulphate	270	128 (1)	Yes(1)	AEP 2018
Organics				
Acetone	0.69	1.5	No	Suter and Tsao 1996
Anthracene	4.3×10^{-6}	8.0×10^{-7}	Yes	MOEE 1994
Benzene	0.0015	0.1	No	MOEE 1994
Benzo(a)pyrene	1.1×10^{-7}	1.5×10^{-5}	No	CCME 1999
Bis(2-ethylhexyl) phthalate	4.4×10^{-6}	6.0×10^{-4}	No	MOEE 1994
Carbon tetrachloride	0.0029	0.0133	No	CCME 1999
Chlorobenzene	7.6×10^{-4}	0.0013	No	CCME 1999
Chloroform	0.0066	0.0018	Yes	CCME 1999

Table 7-27: Maximum Predicted Non-Radionuclide Constituent Concentrations in Wastewater Prior to Treatment and Effluent Discharge Targets

Constituent	Maximum Predicted Concentration in Wastewater (mg/L) Prior to Treatment	Effluent Discharge Target (mg/L)	Treatment Required?	Reference for Effluent Discharge Target
Organics (cont'd)				
Chrysene	3.7×10^{-7}	1.0×10^{-7}	Yes	MOEE 1994
1,4 Dichlorobenzene	3.5×10^{-4}	0.004	No	MOEE 1994
Dioxin (TEQ)	2.7×10^{-13}	1.0×10^{-8}	No	Suter and Tsao 1996
Ethylene-Diamine-Tetra ace tic Acid	1	*	*	
Ethylene dibromide	0.0081	0.005	Yes	MOEE 1994
Fluoranthene	1.3×10^{-6}	8.0×10^{-7}	Yes	MOEE 1994
Fluorene	7.8×10^{-6}	2.0×10^{-4}	No	MOEE 1994
Furan (TEQ)	2.7×10^{-13}	1.0×10^{-8}	No	Suter and Tsao 1996
Methylene chloride	0.028	0.0981	No	CCME 1999
Phenol	5.7×10^{-4}	0.004	No	CCME 1999
Phenolic compounds – no c hlorine	7.0×10^{-4}	0.004	No	CCME 1999
PCBs	2.5×10^{-8}	1.0×10^{-6}	No	MOEE 1994
Tannic acid	50	*	*	
1,1,2,2 Tetrachloroethane	0.0014	0.07	No	MOEE 1994
Tetrachloroethylene	0.0014	0.05	No	MOEE 1994
1,1,2 Trichloroethylene	0.0022	0.8	No	MOEE 1994
Other Constituents				
Carbonaceous 5-day bioche mical oxygen demand	62	25	Yes	CCME 2008
Petroleum hydrocarbons (C 6-C10)	***	0.15	***	AEP 2018
pH	+	6.5 to 9	+	CCME 1999
Suspended solids	+	25	+	CCME 1999

Source: Adapted from (AECOM 2019a) and (CNL 2019b)

Note: The effluent discharge targets for conventional parameters are based primarily on effects-based benchmarks developed for the protection of aquatic life. The references for these benchmarks are noted in the table.

1) The concentration of nitrates and nitrites in the final effluent is predicted based on conservative assumptions and the actual concentration of the nitrate and nitrite in the effluent is expected to be less than the predictions. The flexibility of the WWTP design allows CNL to modify the treatment approach based upon the actual wastewater characteristics. CNL will sample the leachate before treatment begins and at several times during the treatment process to ensure that the treatment processes are working as expected. If they are not, CNL can make adjustments to the treatment strategy to deal with the unexpected waste constituents through the use of different ion exchange resins or chemistry changes. The treated effluent goes to a Final Effluent Tank where it is sampled, and the sample analysed prior to discharging the treated effluent. If the treated effluent does not meet the effluent discharge targets, it would be returned to the beginning of the WWTP process and go through the treatment process again to remove the species that exceed the effluent discharge targets. For sulphate, nitrate and nitrite, an anion exchange resin would be used to remove these species.

2) Similar to Note 1, the predicted concentration of phosphorus is based on conservative assumptions and the general discussion of the WWTP treatment approach applies to phosphorus. Specifically for phosphorus, it will be removed during the chemical precipitation step by the ferric chloride that is part of the normal treatment strategy. In the event that higher than normal phosphorus concentrations are observed in the wastewater feed to the WWTP treatment processes, the chemical precipitation step using ferric chloride can be optimized for phosphorus removal at this time. If the concentration of phosphorus in the Final Effluent Tank prior to discharge exceeds the discharge criterion, this liquid would be returned to the beginning of the process and undergo further treatment to remove it.

3) The Chromium (total) effluent discharge target is based on the Canadian Water Quality Guideline for Chromium (VI).

* = no limit established.

** = Present at an elevated concentration in groundwater used to estimate leachate characteristics; not expected to be present in excess in effluent limit in leachate.

*** = Not expected to be present in significant concentrations based on projected bulk waste characteristics.

+ May be present at concentrations exceeding the discharge requirement based on preliminary bulk waste characteristics.

7.1.3 Data Evaluation Criteria

The information for evaluation of data is provided in the discussion of objectives (Section 7.1.1) with additional details provided below. For convenience, the Tier 1 and 2 criteria are summarized conceptually in Table 7-28 below.

Table 7-28: Summary of Evaluation Criteria

Effluent Stream	Monitoring Program Element	Tier 1 Criteria	Tier 2 Criteria
Construction Phase			
Airborne Effluent Streams			
Road Dust, Material Handling, Grading Activities, Blasting Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1a	EIS predictions	Site-Wide NPRI Reporting Thresholds
Mobile Equipment → Exhaust/GHG Emissions →Atmosphere	EVMP3a	EIS predictions	Site-Wide GHGRP yearly reporting threshold
Waterborne Effluent Streams			
Stormwater runoff from construction areas and non-operational areas of NSDF → one of three SWMPs → Perch Lake Watershed →Perch Creek→ Ottawa River	EVMP4a	Trend analysis	Effluent Discharge Targets
Operations Phase			
Airborne Effluent Streams			
Road Dust, Material Handling, Grading Activities, , Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1b	EIS predictions	Site-Wide NPRI Reporting Thresholds
Decomposition of wastes within the NSDF mound → Vent/ECM Cover → Atmosphere	EVMP2a	EIS predictions	Site-Wide GHGRP and NPRI yearly reporting thresholds
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP 3b	EIS predictions	Site-Wide GHGRP yearly reporting threshold
Natural Gas Combustion for: ■ Comfort heating at the WWTP, Vehicle Decontamination Centre, Administration Office, and Operations Support ■ Treatment process at WWTP; and, ■ Emergency Power Generation → Atmosphere	EVMP3b	EIS predictions	Site-Wide GHGRP yearly reporting threshold
Stationary Diesel pumps and air compressors will use diesel or gasoline for fuel → Exhaust emissions → Atmosphere	EVMP3b	NA - The EIS did not estimate emissions from the use of stationary diesel equipment as it was felt that the emissions would be insignificant compared to other emissions as the result of NSDF operations, therefore there is no need to verify EIS predictions.	Site-Wide GHGRP yearly reporting threshold

Table 7-28: Summary of Evaluation Criteria

Effluent Stream	Monitoring Program Element	Tier 1 Criteria	Tier 2 Criteria
Operations Phase			
Airborne Effluent Streams (cont'd)			
Portable generators for lighting equipment will use diesel or gasoline for fuel → Exhaust emissions → Atmosphere	EVMP3b	NA - The EIS did not estimate emissions from the use of portable diesel generators for lighting as it was felt that the emissions would be insignificant compared to other emissions as the result of NSDF operations, therefore there is no need to verify EIS predictions	Site-Wide NPRI yearly reporting threshold
Potential Halocarbon Releases → Atmosphere	NA	10 kg (reportable semi-annually) (FHR)	100 kg (reportable within 24 hours) (FHR)
GHG emissions from the WWTP → Atmosphere	EVMP6	NA - The EIS did not estimate emissions of GHGs from water treatment as it was felt that the emissions would be insignificant compared to other emissions as the result of NSDF operations, therefore there is no need to verify EIS predictions	Site-Wide GHGRP yearly reporting threshold
Waterborne Effluent Streams			
SWMP Waterborne Effluent Stormwater runoff from parking lots and non-operational areas of NSDF → one of three SWMPs → Perch Lake Watershed → Perch Creek → Ottawa River	EVMP4a	Trend analysis	Effluent Discharge Targets
WWTP Waterborne Effluent Final Effluent (during low groundwater conditions) → infiltration gallery → East Swamp Stream → Perch Lake → Ottawa River Final Effluent (during high groundwater conditions) → direct transfer line to Perch Lake → Ottawa River	EVMP5	Trend analysis for tritium as tritium is not removed by the WWTP. Trend analysis for parameters without Tier 2 Criteria.	Effluent Discharge Targets

Table 7-28: Summary of Evaluation Criteria

Effluent Stream	Monitoring Program Element	Tier 1 Criteria	Tier 2 Criteria
Closure Phase			
Airborne Effluent Streams			
Road Dust, Material Handling, Grading Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1b	N/A - EIS did not include predictions for Closure phase	Site-wide NPRI Reporting Thresholds
Decomposition of wastes within the NSDF mound → ECM cover/vent → Atmosphere	EVMP2b	EIS predictions for GHGs from Operations Phase, as an upper bound.	Site-wide GHGRP and NPRI yearly reporting thresholds
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP3b	EIS predictions for GHGs Operations Phase, as an upper bound	Site-wide GHGRP yearly reporting threshold
Potential Halocarbon Releases → Atmosphere	NA	10 kg (reportable semi-annually) (FHR)	100 kg (reportable within 24 hours) (FHR)
Natural Gas Combustion for: ■ Comfort heating at the WWTP, Vehicle Decontamination Centre, Administration Office, and Operations Support ■ Treatment process at WWTP; and, ■ Emergency Power Generation → Atmosphere	EVMP3b	EIS predictions for GHGs from Operations Phase, as an upper bound	Site-wide GHGRP and NPRI yearly reporting threshold
GHG emissions from the WWTP → Atmosphere	EVMP6	NA - EIS identified that GHG emissions from the WWTP process emissions are anticipated to be negligible	Site-wide GHGRP yearly reporting threshold
Waterborne Effluent Streams			
SWMP waterborne Effluent Stormwater runoff from parking lots and to closed/covered ECM → one of three SWMPs → Perch Lake Watershed →Perch Creek → Ottawa River	EVMP4b	Trend analysis	Effluent Discharge Targets
WWTP Waterborne Effluent Final Effluent (during low groundwater conditions) → infiltration gallery → East Swamp Stream → Perch Lake → Ottawa River Final Effluent (during high groundwater conditions) → direct transfer line to Perch Lake → Ottawa River	EVMP5	Trend analysis for tritium as tritium is not removed by the WWTP. Trend analysis for parameters without Tier 2 Criteria.	Effluent Discharge Targets

Based on the discussion provided in the parameter tables above, the full list of conventional and radionuclide parameters is reduced to a limited list of indicator parameters for the purposes of reporting. The list of contaminants for the WWTP effluent is based on the evaluation of predicted concentrations in leachate/contact surface water and a comparison to risk-based benchmarks. Rationale for the reduced list of radiological constituents of potential concern (COPCs) is based on the low relative risks of many other radiological compounds. For example, the predicted surface water concentrations of many of the radiological compounds are orders of magnitude below the effluent discharge target. Additionally, several of the reduced list of parameters provide an indication of the potential presence of some of the other radiological parameters in surface water.

The criteria for radionuclides are generally based on a conservative use of drinking water standards, with the exception of tritium, gross alpha, and gross beta. The criteria for tritium concentrations is set to ensure tritium concentrations above background are below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. The gross alpha and gross beta criteria are obtained from the Health Canada Drinking Water Guidelines (Health Canada 2009) using Lead-210 for gross alpha (the lowest criteria of the alpha emitters) and Stontium-90 for gross beta (the lowest criteria of the beta emitters).

Tier 2 Criteria for conventional non-radiological parameters are based on the protection of aquatic life. In this list, there are several compounds that do not have aquatic life protection benchmarks (i.e., COD, DOC, TOC, conductivity and furans); note that these are assessed through Tier 1 Criteria only.

Table 7-29: Tier 2 Criteria for WWTP Effluent

Constituent	Units	Tier 2 Criteria	Reference for Criteria
Radiological Compounds			
Gross Alpha	Bg/L	0.2	CNL 2019b
Gross Beta	Bg/L	5	CNL 2019b
Gamma Emitters	Bg/L	40	CNL 2019b
Tritium	Bg/L	3.6×10^5	CNL 2019b
C-14	Bg/L	200	Health Canada 2009
Co-60 (part of Gamma Emitters Analysis)	Bg/L	40	Health Canada 2009
Sr-90	Bg/L	5	Health Canada 2009
Conventional Compounds			
CBOD (ATG1b)	mg/L	25	CCME 2008
pH (ATG3)	NA	6.5 to 9	CCME 1999
Nitrate as NO_3 (ATG4b)	mg/L	13	CCME 1999
Nitrite as N (ATG4b)	mg/L	0.06	CCME 1999
Phosphorus (ATG6)	mg/L	0.01	MOEE 1994
Suspended solids (TSS – ATG8)	mg/L	25	CCME 1999
Metals (ATG9)			
Aluminum	mg/L	0.05	CCME 1999
Boron	mg/L	0.2	MOEE 1994
Cobalt	mg/L	0.0009	MOEE 1994
Iron (ATG9a)	mg/L	0.3	CCME 1999

Table 7-29: Tier 2 Criteria for WWTP Effluent

Constituent	Units	Tier 2 Criteria	Reference for Criteria
Conventional Compounds (cont'd)			
Hydrides (ATG10)			
Antimony	mg/L	0.02	MOEE 1994
Arsenic	mg/L	0.005	CCME 1999
Selenium	mg/L	0.001	CCME 1999
Mercury (ATG12)	mg/L	2.6×10^{-5}	CCME 1999
Phenolics (ATG14)	mg/L	0.004	CCME 1999
Volatiles, Halogenated (ATG16)			
Chloroform	mg/L	0.0018	CCME 1999
Ethylene dibromide	mg/L	0.005	MOEE 1994
Benzene (ATG17)	mg/L	0.1	MOEE 1994
Extractables, Base Neutral (ATG19)			
Anthracene	mg/L	8.0×10^{-7}	MOEE 1994
Chrysene	mg/L	1.0×10^{-7}	MOEE 1994
Fluoranthene	mg/L	8.0×10^{-7}	MOEE 1994
Phenol (ATG20)	mg/L	0.004	CCME 1999
Hexachlorobutadiene (ATG23)	mg/l	0.0013	CCME 1999
Dioxins TEQ (ATG24)	mg/L	1×10^{-8}	Suter and Tsao 1996
Furans TEQ (ATG24)	mg/L	1×10^{-8}	Suter and Tsao 1996
Oil and Grease (ATG25)	mg/L	15	Note (1)
PCBs (ATG27)	mg/L	1.0×10^{-6}	MOEE 1994
Anions (ATG30)			
Chloride	mg/L	120	CCME 1999
Sulphate	mg/L	128	AEP 2018
Fluoride	mg/L	0.012	CCME 1999
Manganese	mg/L	0.12	Suter and Tsao 1996
Acetone	mg/L	1.5	Suter and Tsao 1996

(1) Oil or petrochemicals should not be present in concentrations that: can be detected as a visible film, sheen, or discolouration on the surface; can be detected by odour; can cause tainting of edible aquatic organisms; can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or are deleterious to resident aquatic organisms (CNL 2019d). The Tier 2 Criteria is based upon commonly accepted guidelines.

For stormwater, Tier 2 Criteria for conventional parameters are developed based on the effluent discharge targets, which are considered protective of the environment (i.e., aquatic life). The criteria for tritium are set to ensure tritium concentrations above background are below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. Gross alpha and gross beta are set at a screening level determined by CNL. The parameters noted are the indicator parameters identified in Section 7.1.2.2. There are no effects-based criteria for conductivity, therefore conductivity will be assessed through Tier 1 Criteria only.

Table 7-30: Tier 2 Criteria for Stormwater

Constituent	Units	Tier 2 Criteria	Reference for Criteria
Gross Alpha	Bg/L	0.2	CNL 2019b
Gross Beta	Bg/L	5	CNL 2019b
Tritium	Bg/L	3.6×10^5	CNL 2019b
CBOD (ATG1b)	mg/L	25	CCME 2008
pH[1]	NA	6.5 to 9	CCME 1999
Nitrate as NO_3 (ATG4b)	mg/L	13	CCME 1999
Nitrite as N (ATG4b)	mg/L	0.06	CCME 1999
Phosphorus (ATG6)	mg/L	0.01	MOEE 1994
TSS[1] (ATG8)	mg/L	25	CCME 1999
Metals (ATG9)			
Aluminum[1]	mg/L	0.05	CCME 1999
Cobalt	mg/L	0.0009	MOEE 1994
Copper[1]	mg/L	0.002	CCME 1999
Zinc[1]	mg/L	0.007	CCME 1999
Iron[1] (ATG9a)	mg/L	0.3	CCME 1999
Volatiles, Halogenated (ATG16)			
Chloroform	mg/L	0.0018	CCME 1999
Ethylene dibromide	mg/L	0.005	MOEE 1994
Benzene (ATG17)	mg/L	0.1	MOEE 1994
Oil and Grease[1] (ATG25)	mg/L	15	Note 2
Chloride[1] (ATG30)	mg/L	120	CCME 1999
Sulphate (ATG30)	mg/L	128	AEP 2018
Manganese	mg/L	0.12	Suter and Tsao 1996

1) Parameter reported during the Construction Phase.
2) Oil or petrochemicals should not be present in concentrations that: can be detected as a visible film, sheen, or discolouration on the surface; can be detected by odour; can cause tainting of edible aquatic organisms; can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or are deleterious to resident aquatic organisms (CNL 2019d). The Tier 2 Criteria is based upon commonly accepted guidelines.

Table 7-31: Air Contaminants – Tier 1 and Tier 2 Criteria

Indicator	NPRI Reporting Threshold[a] – Tier 2 Criteria (tonnes/year)	EIS Application Case[b] - Construction Phase – Tier 1 Criteria (kg/day)	EIS Application Case[b,c] – Operation Phase – Tier 1 Criteria (kg/day)
SPM	20	577	62
PM_{10}	0.5	165	20
$PM_{2.5}$	0.3	28	5
NOx	20	400	116
SO_2	20	0.48	0.15
CO	20	78	25
Hg	0.005	—	6.91×10^{-7}
Pb	0.05	—	1.26×10^{-5}
C_2H_3Cl	10	—	0.003
H_2S	10	—	0.03

a)NPRI Reporting Criteria (Government of Canada 2020b)

b)EIS modelled emission rates (Golder 2020a), Note: EIS did not predict emissions for the closure phase, therefore, only comparison to construction and operations phase can be completed. Values will not be compared on a daily basis. The daily criteria will be multiplied by the number of construction days each year for comparison of the annual estimates.

c)"—" implies there is no Tier 1 criteria required for this substance.

SPM = suspended particulate matter; PM_{10} = Particulate matter less than 10-micron diameter, $PM_{2.5}$= Particulate matter less than 2.5 micron diameter, NOx = Nitrogen oxides, SO_2 = sulphur dioxide; CO= Carbon monoxide, Hg = mercury, Pb = Lead, C_2H_3Cl = Vinyl Chloride, H_2S = Hydrogen sulphide.

Table 7-32: Halocarbon Releases – Tier 1 and Tier 2 Criteria

Indicator	Reporting Threshold[a] – Tier 1 Criteria (kg/release)	Reporting Threshold[a] – Tier 2 Criteria (kg/release)
Total Releases	10	100

a) ECCC *Federal Halocarbon Regulations*

Table 7-33: GHG – EIS Predictions and Benchmarks – Tier 1 and 2 Criteria

GHG	GHGRP Reporting Threshold[a] – Tier 2 Criteria (tonnes/year)	EIS Application Case [b] - Construction Phase – Tier 1 Criteria (tonnes/year)	EIS Application Case [b] – Operation Phase – Tier 1 Criteria (tonnes/year)	EIS Application Case [b] – Closure Phase – Tier 1 Criteria (tonnes/year)
CO_2	—	26,986	6,888	<6,888
CH_4	—	1.3	83	<83
N_2O	—	4.1	1	<1
CO_2e	10,000	28,721	8,897	<8,897

a) Federal GHG reporting threshold (Government of Canada 2020a)

b) EIS modelled emission rates (Golder 2020a), Note: EIS did not predict GHG emissions for the closure phase, therefore, only comparison to Operations phase can be completed.

tonnes = metric tonnes; CO_2 = Carbon dioxide, CH_4 = methane, N_2O = Nitrous Oxide, CO_2e = carbon dioxide equivalent.

It should be noted that the EIS did not predict GHG emissions for the closure phase as they were expected to be lower than the operations phase. As a result, the only confirmation CNL can make for emissions of GHGs during this closure phase is that they were indeed lower than the operations phase.

7.1.4 Performance and Acceptance Criteria

The performance and acceptance criteria required to ensure data collected is adequate for their intended purpose(s) are outlined in this section.

7.1.4.1 Acceptance Criteria

The acceptance criteria for Quality Verification (QV) measurements for results from field samples collected at CRL are provided in the CRL non-radionuclide effluent monitoring plan (CNL 2014a), which are summarized in Table 7-34 below.

Table 7-34: Field Sample Quality Verification Acceptance Criteria

Field QV Samples	Quality Verification	Test Acceptance Criteria (CNL 2014a)
Travelling Blank	Contamination	Results below 3 times LMDL
Travelling Spiked Blank	Accuracy	Recovery (Determined Value/Expected *100) between 30 – 150%
Duplicate	Precision	Ratio of the two replicate results between 0.5 and 2.0

The handling of sample data for those samples which do not meet these acceptance criteria is common within CNL and is discussed in the program's Management and Monitoring of Emissions procedure (CNL 2018a).

The method detection limits for all radiological and non-radiological compounds should be consistent or lower than the effluent discharge targets indicated in Table 7-26 and Table 7-27 or as required by the MISA protocol (MOECC 2016); the intent for this approach is that monitoring results should allow for comparison to the effluent discharge targets and provide detectable concentrations where possible.

Where a method detection limit at or below the effluent discharge target cannot be reasonably obtained, this deficiency should be documented as well as an assessment of the effects that this elevated method detection limit may have on the overall objectives.

7.1.4.2 Performance Criteria

To assess field and laboratory performance, quality control samples such as duplicates and/or spiked blanks will be collected and analyzed as necessary. Trip blanks may also be used when sampling for volatile compounds (e.g., VOCs) as they pose a risk for cross-contamination and where further assessment of a particular issue is required.

Field instruments are to be calibrated as per the manufacturer's instructions and a record of calibration maintained with the field files.

CNL's Management and Monitoring of Emissions (CNL 2018a) outlines the steps that need be taken to compensate for any missed data. Sample unavailability could be the result of a number of circumstances; for example, sampling according to the monitoring schedule was missed, the collected sample was contaminated or lost, etc. The target is that 95% of the planned samples are to be obtained with results meeting data acceptance criteria.

7.1.5 Non-Conformance Process

The data evaluation criteria discussed in Table 7-1 and the sections above allow for interpretation of monitoring data and provides a tiered system to increase or decrease monitoring based on the results. The responses to these exceedances are commensurate with the level of risk associated with that respective tier. In general, exceedances are to be addressed as follows:

Tier 1 Criteria Exceedances

i) Data review (e.g., trend evaluation, and secondary sampling to confirm exceedance);

ii) Investigate source of exceedance; and

iii) Consider increased monitoring frequency.

Tier 2 Criteria Exceedances

i) Data review (e.g., trend evaluation, and secondary sampling to confirm exceedance);

ii) Investigate source of exceedance;

iii) Apply additional mitigation measures, consider remediation (if applicable)

iv) Consider stop work; and

v) Increase monitoring (e.g., increased frequency, additional parameters, additional locations).

The above actions for Tier 2 Criterial Exceedances do not apply where Tier 2 criteria are NPRI or GHG reporting thresholds as exceedances of these thresholds are not indicative of adverse effects on the environment.

7.2 Quality Assurance / Quality Control

Numerous aspects of a QA/QC program are provided in the performance and acceptance criteria (Section 7.1.4). In addition to these requirements the following elements are also considered part of the QA/QC program for the NSDF EVMP program.

7.2.1 Roles and Responsibilities

The roles and responsibilities are those that apply to the CNL EVMP overall and are defined in CNL's Management and Monitoring of Emissions (CNL 2018a). Tasks may be contracted (i.e., laboratory analysis, sample collection) and these roles and responsibilities should be clearly defined.

7.2.2 Equipment Maintenance

Equipment that is used in conjunction with the NSDF EVMP (e.g., flow meters) is subject to maintenance and calibration activities on a regular basis. Use of equipment is part of CNL's routine procedures and policies used for the overall CRL EVMP or alternatively the equipment suppliers' procedure manuals. Each procedure provides information on the methods used for equipment/instrumentation maintenance, the frequency of maintenance and calibrations, and the documentation of information. All equipment issues, such as equipment malfunctions, calibration issues, cross-contamination events, and procedural errors are brought to the attention of the Chemist during the year. The matters are raised by documenting the occurrence in the CRL ImpAct system and during the annual program review.

7.3 Continual Improvement of the EVMP

The majority of processes and requirements for the execution of NSDF EAFMP EVMP can be found in CNL's Management and Monitoring of Emissions procedure (CNL 2018a) and the CRL Integrated Environmental Monitoring Program Framework (CNL 2015). In addition to the information in these two documents, this section covers the information that is specific to the continual improvement of the NSDF EVMP.

As outlined in the CRL Integrated Environmental Monitoring Program Framework (CNL 2015), many of the required changes for the NSDF EVMP will be identified during the formal reviews that take place for the program. There are instances, however, where changes to the program need to take place in between these reviews. In either case, changes to the program are formally documented as per the requirement in Management and Monitoring of Emissions procedure (CNL 2018a).

This section describes processes which are followed by the program when changes to the monitoring schedule or locations are required (either during routine reviews or between routine reviews). Review may identify other changes such as new parameters to analyze, removing sampling of effluent streams or other changes. This process will continue following transition to CRL site (e.g., during the closure, and post-closure phases).

7.3.1 Decreasing Parameter Monitoring Frequency

Reductions in monitoring are, at times, required in order to ensure that the monitoring program does not grow to a size that overwhelms monitoring staff and facilities and to refine the program to ensure only meaningful monitoring is taking place.

Despite meeting one or more of the Need for Monitoring Criteria – Parameter (Section 7.1.2.2), in instances where the absence of anomalous results and/or the absence of results above the method detection limit are observed over a period of time, the monitoring frequency may be reduced based on the professional judgment of CNL Staff. Consideration should be given to the purpose and history of the monitoring of that parameter at that location.

For sample frequency to be decreased, the sample results at the decreased frequency (e.g., annual) are compared to the current sampling frequency (e.g., quarterly) using the appropriate statistical method and determined to not be significantly different. This 3-Step process is depicted in Figure 5-1 of the CRL non-Rad EVMP (CNL 2014a) as shown below (Figure 7-1).

A further reduction in frequency or elimination of monitoring should be considered where reduced frequency has taken place and the parameter continues to not be of concern in any area of the integrated monitoring program. Again, professional judgement of CNL staff should be used and consideration given to the purpose and history of the monitoring of that parameter at that location when making this decision.

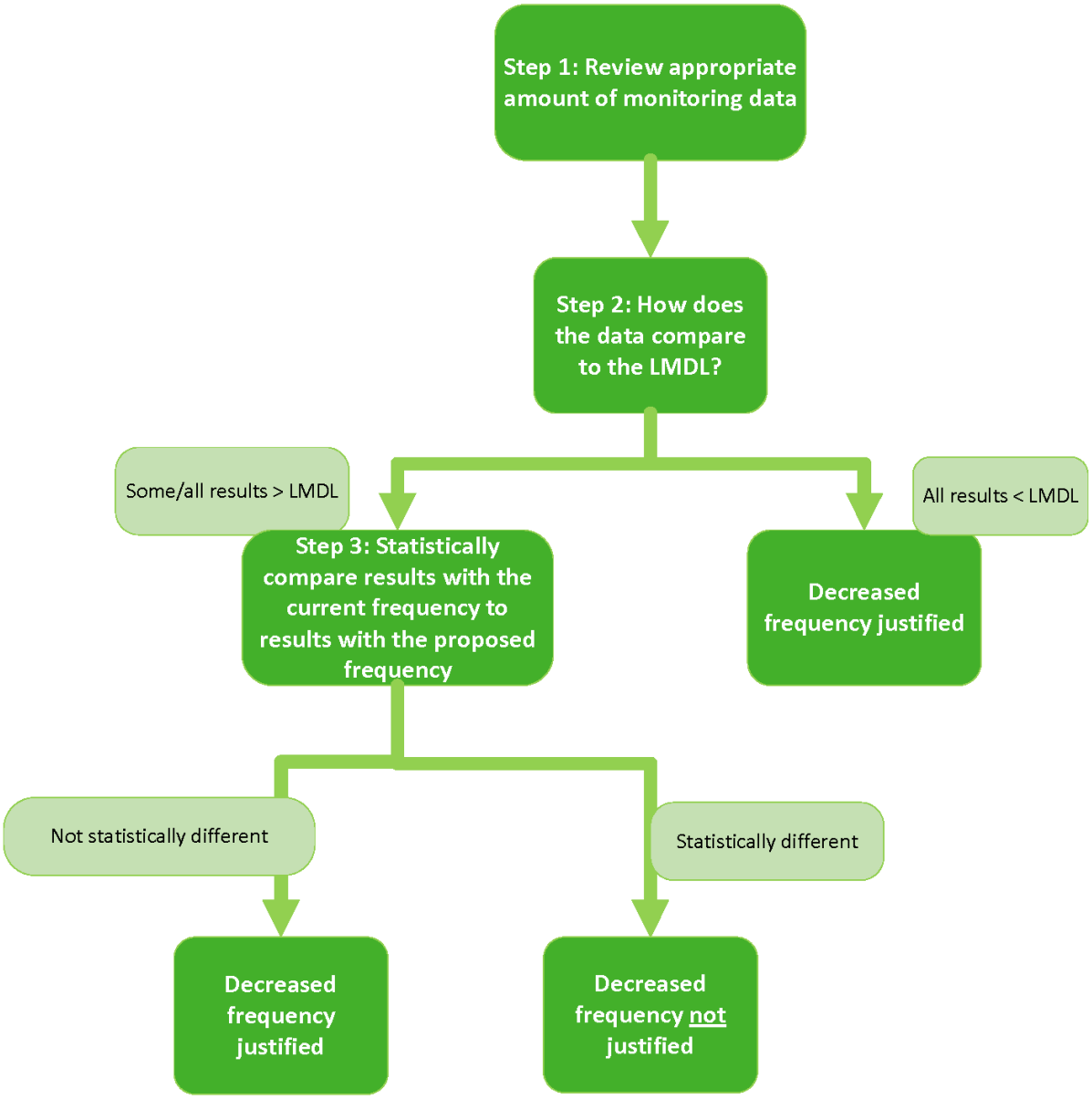


Figure 7-1: Three-step Process Used to Determine Whether a Decrease in Monitoring Frequency is Acceptable

7.3.2 Increasing Parameter Monitoring Frequency or Addition of a New Parameter

In the event that anomalous results are observed and the monitoring objectives warrant a higher monitoring frequency, the frequency of monitoring may be increased in order to better determine the variability in the monitoring results. This is done through a special investigation (outside of the routine monitoring program) or within the routine monitoring program (added to the monitoring schedule) and again, is based on the professional judgement of CNL staff.

Note, if this occurs in the instance where the frequency of the parameter monitoring was previously reduced due to the absence of anomalous result, the original monitoring frequency will be considered.

The EIS provides a comprehensive review of potential compounds and concentrations of these compounds, which may be released into the environment as a result of the NSDF project. In order to confirm the EIS's initial characterization of NSDF effluent streams, a periodic verification of effluent releases will occur every five years following the start of operations (during the operational phase) to ensure that the monitoring strategy remains appropriate.

7.3.3 Parameters for New Effluent Monitoring Locations

If an additional location meets the Need for Monitoring Criteria – Location (Section 7.1.2.1) and is to be monitored, the parameters to be analyzed and frequency are to be evaluated based on the criteria for selection of parameters and the assessments conducted in Section 7.1.2.2. The list of waterborne parameters may be updated based on sampling results from the WWTP influent and effluent. When and where appropriate, waterborne monitoring should also be in line with MISA's sampling protocol (MOECC 2016).

7.4 Moving Monitoring from Follow-up Monitoring to Routine EVMP Program

Monitoring of emissions from the NSDF for each project phase is not currently included in the existing CRL EVMP and is required as described in the preceding sub-sections. The reporting for the EAFMP EVMP will be incorporated into the CRL EVMP after appropriate verification of monitoring data and comparison with predictions in the EIS as noted in Table 7-35 below. The objectives and specifics of the monitoring activities established by this EAFMP will be maintained within the CRL monitoring and findings related to these objectives provided in the site-wide reporting.

Table 7-35: Moving Reporting from Follow-up Monitoring to Routine EVMP Program

Effluent Stream	Monitoring Program Element	Duration of Separate Reporting under the EAFMP	Justification
Construction Phase			
Airborne Effluent Streams			
Road Dust, Material Handling, Grading Activities, Blasting Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1a	The extent of construction	As the construction period is relatively short, the reporting related to the EVMP program will remain separate from the CRL EVMP during this phase.
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP3a	The extent of construction	As the construction period is relatively short, the reporting related to the EVMP program will remain separate from the CRL EVMP during this phase.
Waterborne Effluent Streams			
Stormwater runoff from construction areas and non-operational areas of NSDF → one of three SWMPs → Perch Lake Watershed →Perch Creek→ Ottawa River	EVMP4a	The extent of construction	As the construction period is relatively short, the reporting related to the EVMP program will remain separate from the CRL EVMP during this phase.
Operations Phase			
Airborne Effluent Streams			
Road Dust, Material Handling, Grading Activities, , Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1b	Following two years of operations assuming results have verified EIS predictions.	Two years is considered an adequate amount of time to evaluate initial potential issues.
Decomposition of wastes within the NSDF mound → Vent/ECM Cover → Atmosphere	EVMP2a	Following two years of operations assuming results have verified EIS predictions.	Two years is considered an adequate amount of time to evaluate initial potential issues.
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP 3b	Following two years of operations assuming results have verified EIS predictions.	Two years is considered an adequate amount of time to evaluate initial potential issues.
Natural Gas Combustion for: ■ Comfort heating at the WWTP, Vehicle Decontamination Centre, Administration Office, and Operations Support ■ Treatment process at WWTP; and, ■ Emergency Power Generation → Atmosphere	EVMP3b	Following two years of operations assuming results have verified EIS predictions.	Two years is considered an adequate amount of time to evaluate initial potential issues.
Stationary Diesel pumps and air compressors will use diesel or gasoline for fuel → Exhaust emissions → Atmosphere	EVMP3b	Following two years of operations	Two years is considered an adequate amount of time to evaluate initial potential issues.

Table 7-35: Moving Reporting from Follow-up Monitoring to Routine EVMP Program

Effluent Stream	Monitoring Program Element	Duration of Separate Reporting under the EAFMP	Justification
Operations Phase (cont'd)			
Airborne Effluent Streams (cont'd)			
Portable generators for lighting equipment will use diesel or gasoline for fuel → Exhaust emissions → Atmosphere	EVMP3b	Following two years of operations.	Two years is considered an adequate amount of time to evaluate initial potential issues. .
Potential Halocarbon Releases → Atmosphere	NA	Following two years of operations	Two years is considered an adequate amount of time to evaluate initial potential issues. Monitoring and evaluation will continue under the CRL EVMP.
GHG emissions from the WWTP → Atmosphere	EVMP6	Following two years of operations	Two years is considered an adequate amount of time to evaluate initial potential issues. .
Waterborne Effluent Streams			
SWMP Waterborne Effluent Stormwater runoff from parking lots and non-operational areas of NSDF → one of three SWMPs → Perch Lake Watershed → Perch Creek → Ottawa River	EVMP4a	Following two years of operations assuming the SWMPs are performing as designed.	Two years is considered an adequate amount of time to evaluate initial potential issues. Monitoring and evaluation will continue under the CRL EVMP.
WWTP Waterborne Effluent Final Effluent (during low groundwater conditions) → infiltration gallery → East Swamp Stream → Perch Lake → Ottawa River Final Effluent (during high groundwater conditions) → direct transfer line to Perch Lake → Ottawa River	EVMP5	Following two years of operations provided the treated effluent targets are consistently met.	Two years is considered an adequate amount of time to evaluate initial potential issues. Monitoring and evaluation will continue under the CRL EVMP.

Table 7-35: Moving Reporting from Follow-up Monitoring to Routine EVMP Program

Effluent Stream	Monitoring Program Element	Duration of Separate Reporting under the EAFMP	Justification
Closure Phase			
Airborne Effluent Streams			
Road Dust, Material Handling, Grading Activities, Stockpiling of Material → Dust Emissions → Atmosphere	EVMP1b	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
Decomposition of wastes within the NSDF mound → ECM cover/vent → Atmosphere	EVMP2b	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
Mobile Equipment → Exhaust/GHG Emissions → Atmosphere	EVMP3b	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
Potential Halocarbon Releases → Atmosphere	NA	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
Natural Gas Combustion for: ■ Comfort heating at the WWTP, Vehicle Decontamination Centre, Administration Office, and Operations Support ■ Treatment process at WWTP; and, ■ Emergency Power Generation → Atmosphere	EVMP3b	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
GHG emissions from the WWTP → Atmosphere	EVMP6	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
Waterborne Effluent Streams			
SWMP waterborne Effluent Stormwater runoff from parking lots and to closed/covered ECM → one of three SWMPs → Perch Lake Watershed →Perch Creek → Ottawa River	EVMP4b	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.
WWTP Waterborne Effluent Final Effluent (during low groundwater conditions) → infiltration gallery → East Swamp Stream → Perch Lake → Ottawa River Final Effluent (during high groundwater conditions) → direct transfer line to Perch Lake → Ottawa River	EVMP5	NA	Reporting will have been transitioned to the CRL EVMP well before closure occurs.

NA – not applicable or not transitioned to the CRL EVMP.

8.0 ENVIRONMENTAL MONITORING PROGRAM

8.1 Systematic Informed Planning Process

The EMP for the NSDF EAFMP has been developed based on the existing CRL plans and the EIS follow-up requirements as indicated in Table 5-1. The EMP follows the requirements of CSA N288.4-19 and CNL's existing Environmental Monitoring Program.

This monitoring plan was developed following a systematic, informed planning process, as defined by the following six steps:

1) Define the objectives of the EMP (see Section 8.1.1).
2) Identify the information required to meet the defined objectives (see Sections 8.1.2).
3) Define the boundaries of the EMP (see Section 8.1.3).
4) Determine how the data collected will be used to achieve the defined objectives (see Section 8.1.4.2 to 8.1.4.7).
5) Specify performance and acceptance criteria (see Section 8.2).
6) Develop the detailed design of the EMP that will be implemented to obtain the required data (see Section 8.1.4.1).

Guidance to consider during the continual improvement of the monitoring program over time is outlined in Section 8.4. Guidance on the transition of reporting from the NSDF EMP to the routine Chalk River EMP is provided in Section 8.5.

8.1.1 Objectives of the Environmental Monitoring Program

This Section covers Step 1 of the Systematic Planning Process: *Define the objectives of the EMP.*

Each element identified in the NSDF EIS recommendations was evaluated against the CRL site-wide objectives for an EMP. These are separated into primary and secondary objectives; the EMP for the NSDF shall be designed to meet these objectives as summarized in Table 8-1 below. The inclusion or exclusion of the primary and secondary EMP objectives into the NSDF Project-specific EMP are justified below and includes reference to any applicable monitoring program elements identified in Table 5-1 (e.g., EMP1a, 1b, etc.).

Primary EMP Objectives

a) To assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility.

   Yes – dust monitoring data (EMP1a, 1b), surface water sampling data (EMP3a, 3b), radiological dust screening data (EMP11) and radiological ambient air quality data (EMP12a, 12b) may be used to assess the level of risk related to contaminants of potential concern related to the NSDF operations. This is done primarily by comparing data to established benchmarks. Wetland monitoring (EMP2) and biota are being monitored (EMP4a, 4b; EMP5, EMP6, EMP7, EMP8, EMP9, EMP10) to evaluate the effects of physical stressors on these receptors.

b) To demonstrate compliance with limits on the concentration and/or intensity of contaminants and physical stressors in the environment or their effect on the environment.

   No – none of the monitoring proposed is related to specific regulatory limits. Data are compared to criteria as part of other objectives (e.g., Objective a).

c) To check, independently of effluent monitoring, the effectiveness of containment and effluent control, and provide public assurance of the effectiveness of containment and effluent control.

Yes – the monitoring of dust (EMP1a, 1b), wetland (EMP2), surface water (EMP3a, 3b), radiological dust screening (EMP11) and radiological ambient air quality (EMP12a, 12b) are being conducted to assess the effectiveness of mitigation measures.

d) Further to the objective described above, which provides an indication on the effectiveness of effluent control where waste storage facilities and contaminated lands exist, an additional goal is to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring.

Yes – the monitoring of dust (EMP1a, 1b), wetland integrity (EMP2), surface water (EMP3a, 3b), radiological dust screening (EMP11) and radiological air quality (EMP12a, 12b) will provide an indication of unusual or unforeseen conditions related to the NSDF. This objective is considered similar to Objective c) and monitoring is considered to address both these objectives concurrently.

e) To verify the predictions made by an ERA (or equivalent), DRL model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA.

Yes – the monitoring will serve to verify/confirm predictions made in the EIS (Golder 2020a) regarding dust (EMP1a, 1b), wetland integrity (EMP2), surface water (EMP3a, 3b), biota (EMP4a, 4b; EMP5, EMP6, EMP7, EMP8, EMP9, EMP10), and radiological dust screening (EMP11). Radiological predictions regarding ambient air in the immediate area of the NSDF were not provided in the EIS and therefore radiological air quality (EMP12a, 12b) is not applicable to this objective. Dose estimates are provided for workers in the EIS; however, monitoring associated with this receptor is considered part of the radiation protection plan for operations and not part of the EAFMP.

Secondary EMP Objectives

f) To provide data required to support site restoration programs, site operations or to plan for future stages of the facility lifecycle (e.g., decommissioning).

No – there is no requirement to collect additional information to support the site operations or design. Some pre-construction monitoring is specified for biota however, this data are not used in planning.

g) To provide resources and data that can be of value during the response to an accident or upset, and in the recovery from such an event.

Yes – the data collected will provide information regarding unsuspected conditions as it serves to verify EIS predictions. The main objective, however, is not to identify significant accident or upset conditions. The data collected under Objective c)/d) or e) are considered to meet this requirement.

h) To demonstrate due diligence.

Yes – as noted in Section 5.0 monitoring of environmental pathways will be implemented to verify effects predictions for land and resource use and to promote land user comfort. In addition, monitoring of environmental pathways will be conducted to verify effects predictions for traditional land and resource use and to promote traditional land user comfort related to the safety of traditional land and resource use. The objectives noted above serve this purpose.

i) To meet a stakeholder commitment.

No – there are no specific stakeholder commitments related to the NSDF EMP.

j) For other business purposes (e.g., monitoring emissions to support international treaties).

No – there are no other business purposes that require the NSDF EMP.

In addition to summarizing the evaluation of the applicability of the above objectives for the NSDF EMP, Table 8-1 also specifies the applicable criteria for sampling locations, parameters and media along with the details of information required to meet the EMP objectives applicable to the NSDF.

8.1.2 Information Required to Meet Each Objective

This section covers Step 2 of the Systematic Planning Process: *Identify information required to meet each objective.*

Defining the information required to meet each objective of the Environmental Monitoring Program is a useful pre-cursor to development of the detailed design of the program (i.e., Step 6 of the Systematic Planning Process). In order to do this, each objective has been translated into clear specific criteria about receptors, locations, environmental media, contaminants, physical stressors and measures of biological effect that need to be monitored. These criteria, indicated below, were obtained from a comprehensive review of environmental monitoring criteria provided in Environmental Monitoring Programs (CNL 2018b), which are based on the guidance provided in Clause 7.2 through Clause 7.7 of the CSA N288.4-19 Standard, and those most pertinent have been identified in Table 8-1 below. The full list of these criteria is provided as items a) to v) below. In addition, Table 8-2 provides a systematic evaluation of all media.

The locations to be monitored are defined by the criteria associated with the Need for Monitoring Criteria – Location. These include:

a) (shall) If environmental monitoring of a location is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that location shall be included in the EMP.

b) (shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP.

c) (should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP.

d) (should) Any locations in which contaminant BVs have been exceeded or are predicted to be exceeded should be included in the EMP.

e) (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.

f) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.

g) (should) If environmental monitoring at a location is triggered by the MISA Protocol (MOECC 2016), then this location should be included in the EMP.

h) (should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EMP as reference areas.

i) (should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.

The criteria for monitoring selected parameters are defined in CNL's Environmental Monitoring Program document and are stated below. These also apply to physical stressors and effects. A parameter, physical stressor or effect is to be monitored if the following applies:

j) (shall) The concentration of a contaminant, intensity of a physical stressor, or effect on the environment shall be measured if required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or as otherwise directed by a regulator.

k) (shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.

l) (should) The EMP should include contaminants relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent).

m) (should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.

n) (should) The non-radioactive contaminant(s) chosen for monitoring should be those triggered by the MISA Protocol (MOECC 2016).

o) (may) The choice of contaminants to monitor in the environment may also be based on the following:

    i) The level of risk from a potential spill or other unintended release of contaminants from a facility is unknown or has been determined by the ERA (or equivalent) to be of concern;

    ii) The level of risk from unmonitored releases of contaminants from a facility is unknown or has been determined by an ERA (or equivalent) to be of concern;

    iii) The emission of contaminants is highly variable; and/or

    iv) There are other business reasons, i.e., stakeholder concerns, due diligence, etc.

p) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.

The criteria for monitoring by specific media are defined in CNL's Environmental Monitoring Program document and are stated below. A media is to be monitored if the following applies:

q) (shall) If environmental monitoring of specific media is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that media shall be included in the EMP.

r) (shall consider) Any environmental media that could contribute to the dose/exposure of a receptor that is anticipated to experience an effect shall be considered for inclusion in the EMP.

s) (should) Any environmental media for which contaminants/physical stressors of concern were identified in an ERA (or equivalent) should be included in the EMP.

t) (should) Any environmental media in which contaminant BVs have been exceeded or are predicted to be exceeded should be considered for inclusion in the EMP for measurement of those same contaminants.

u) (should) Selection of the environmental media to be monitored should be based on the following principles:

   i) Where practical, monitoring should be done near the end of a pathway (i.e., closer to the receptor) to give dose/exposure estimates with fewer uncertainties that arise from inaccuracies in the models and transfer coefficients;

   ii) The fate and distribution of contaminants along the pathway linking the source to the receptor should be considered when selecting the media to be sampled; and

   iii) The mobility of the receptor relative to the area of contamination should be considered when selecting the media to be sampled.

v) (should) Final selection of environmental media to be sampled and of contaminants to be measured in each medium should consider the feasibility of:

   i) Sampling the medium;

   ii) Obtaining quantitative results distinguishable from background; and

   iii) Obtaining measurements when estimated concentrations have high uncertainty.

Table 8-1: EMP Information Required to Meet Each Objective

Objective	Monitoring Criteria	Information Required to Meet the Objective
Primary Objectives		
a) To assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility	(b) (shall) If a **location** is representative of a site's identified critical group(s), then this location shall be included in the EMP. (c) (should) If a **location** represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent, i.e., the EIS), then this location should be included in the EMP. (h) (should) In addition to the locations mentioned above, **locations** with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EMP as reference areas. (k) (shall) The concentration of a **contaminant** or the intensity of a **physical stressor** shall be measured if based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment. (l) (should) The EMP should include **contaminants** relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent). (r) (shall consider) Any **environmental media** that could contribute to the dose/exposure of a receptor that is anticipated to experience an effect shall be considered for inclusion in the Environmental Monitoring Program. (s) (should) Any **environmental media** for which contaminants/physical stressors of concern were identified in an ERA (or equivalent) should be included in the EMP. (u) (should) Selection of the **environmental media** to be monitored should be based on the following principles: a) Where practical, monitoring should be done near the end of a pathway (i.e., closer to the receptor) to give dose/exposure estimates with fewer uncertainties that arise from inaccuracies in the models and transfer coefficients; b) The fate and distribution of contaminants along the pathway linking the source to the receptor should be considered when selecting the media to be sampled; & c) The mobility of the receptor relative to the area of contamination should be considered when selecting the media to be sampled.	**Assess the level of risk that contaminants may pose to human and ecological receptors – environmental pathways monitoring and comparison to benchmark values:** Need to monitor contaminants relevant to the dose/exposure assessments that are part of the EIS (including both Human Health and Ecological Risk Assessments), along exposure pathways relevant to the receptors of interest for the site. Specifically, this needs to include air quality monitoring and surface water quality monitoring (i.e., two environmental compartments that can potentially be impacted by the NSDF Project). The generated data are to be compared to Benchmark Values that allow for an assessment of level of risk. **Assess the potential for biological effects in the environment as a result of physical stressors – biological effects monitoring:** The NSDF Project will involve physical disturbance to the natural environment which can potentially have an effect on site hydrology and the ensuing ecological health of adjacent wetland systems. Physical disturbance can also potentially have an effect on various breeding birds' habitat availability and habitat distribution and an ensuing population impact, and similarly a potential impact on bats, Blanding's turtle, and the Eastern milksnake. To assess the potential for such biological effects, monitoring of wetland elevations and surface water flows is required. As well, monitoring relative abundance and other key demographic parameters for breeding birds is required, as is studying the effectiveness of bat boxes, vehicle collision –induced mortality of turtles, assessment of habitat availability, studying effectiveness of culverts, etc. The collected data will be evaluated and conclusions drawn on the health of these various species and the neighboring wetland systems.

Table 8-1: EMP Information Required to Meet Each Objective

Objective	Monitoring Criteria	Information Required to Meet the Objective
c) To check, independently of effluent monitoring, on the effectiveness of containment and effluent control, and provide public assurance of the effectiveness of containment and effluent control; and d) Further to the objective described above, which provides an indication on effectiveness of effluent control, where waste storage facilities and contaminated lands exist, the objective is to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring.	(c) (should) If a **location** represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent, i.e., the EIS), then this location should be included in the EMP. (f) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in **locations** within reasonable proximity to the points of discharge and in the likely path of the discharges. (h) (should) In addition to the **locations** mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EMP as reference areas. (p) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those **contaminants** that could potentially be present in effluent discharges. (r) (shall consider) Any **environmental media** that could contribute to the dose/exposure of a receptor that is anticipated to experience an effect shall be considered for inclusion in the EMP. (s) (should) Any **environmental media** for which contaminants/physical stressors of concern were identified in an ERA (or equivalent) should be included in the EMP.	**Monitoring to assess the effectiveness of dust control and radionuclide air emissions:** Need to monitor dust, and radionuclides in dust and air, to confirm required controls are being practiced during construction and operations. **Monitoring as a confirmation of no breach of containment of the ECM:** Need to monitor the surface water quality downstream of the ECM as an independent check on the effectiveness of containment, and to ensure the detection of any releases from the facility. Leakage of leachate from the ECM from liner and final cover degradation during the post-closure phase could cause changes to downstream surface water quality. **Monitoring downstream of WWTP effluent discharge:** Need to monitor the surface water quality downstream of the WWTP effluent discharge location as an independent check on the effectiveness of effluent control. Discharge of treated effluent from the WWTP discharges to the East Swamp wetland and/or Perch Lake could cause changes to downstream surface water quality.

Table 8-1: EMP Information Required to Meet Each Objective

Objective	Monitoring Criteria	Information Required to Meet the Objective
e) To verify the predictions made by an ERA (or equivalent), DRL model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA.	(c) (should) If a **location** represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent, i.e., the EIS), then this location should be included in the EMP. (h) (should) In addition to the **locations** mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EMP as reference areas. (k) (shall) The concentration of a **contaminant** or the intensity of a **physical stressor** shall be measured if based on the results of an ERA (or equivalent, i.e., the EIS), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment. (r) (shall consider) Any **environmental media** that could contribute to the dose/exposure of a receptor that is anticipated to experience an effect shall be considered for inclusion in the EMP. (s) (should) Any **environmental media** for which contaminants/physical stressors of concern were identified in an ERA (or equivalent, i.e., the EIS) should be included in the EMP. (u) (should) Selection of the **environmental media** to be monitored should be based on the following principles: i) Where practical, monitoring should be done near the end of a pathway (i.e., closer to the receptor) to give dose/exposure estimates with fewer uncertainties that arise from inaccuracies in the models and transfer coefficients; ii) The fate and distribution of contaminants along the pathway linking the source to the receptor should be considered when selecting the media to be sampled; and iii) The mobility of the receptor relative to the area of contamination should be considered when selecting the media to be sampled.	The NSDF Project EIS includes a description and assessment of project activities during the construction, operation, closure, and post-closure phases of the NSDF Project. Based on this assessment, the EIS recommends a number of follow-up monitoring programs to verify impact predictions. The following monitoring needs to take place to verify these predictions. Post-closure monitoring is not part of this EMP and discussed further in Section 11.0: **Ambient air particulate monitoring to verify predictions that fugitive dust emissions are within air quality criteria:** Suspended Particulate Matter (SPM) monitoring during Construction and Operations is required to compare against EIS predictions. **Wetland water elevations and surface water flows monitoring to verify peak flows remain below pre-development condition:** The installation of the ECM and associated features will physically alter drainage patterns, and may change downstream discharge, water levels in adjacent wetlands and channel and bank stability. Wetland monitoring is needed to verify predictions of EIS. **Surface Water Quality downstream of the WWTP and ECM to verify predictions of the EIS:** Discharge of treated effluent from the WWTP to the East Swamp Wetland and/or Perch Lake and possible stormwater discharges can cause changes to downstream surface water quality, as can leakage of leachate from the ECM from liner and final cover degradation. Need to monitor downstream of these features to verify environmental assessment predictions related to surface water quality. **Verify EIS prediction that the breeding bird population in the RSA will not be adversely affected:** Construction and operations of the NSDF will have an impact on various breeding birds' habitat availability and habitat distribution, and hence a predicted small reduction in survival and reproduction. Need to collect data on relative abundance and other key demographic parameters for breeding birds in the RSA. Collected data will be used to evaluate trends in populations and verify environmental assessment predictions of low impact on breeding birds. **Verify EIS prediction that the local SAR bat population will not be adversely affected:** Construction and operations of the NSDF will have an impact on bats' habitat availability and habitat distribution, but no predicted reduction in survival and reproduction because bat boxes are to be used as an offsetting measure. **Verify EIS prediction that the Blanding's turtle population will not be adversely affected:** From Construction to Closure, the NSDF will have an impact on the Blanding's Turtle habitat availability and habitat distribution, with a predicted reduced reproductive success and mortality of individuals. Need to monitor the mitigation measures, the habitat provided and nesting success to evaluate the EIS prediction. **Verify EIS prediction that the Eastern milksnake population will not be adversely affected:** From Construction to Closure, the NSDF will have an impact on the Eastern milksnake habitat distribution. Need to monitor mitigation measures, to evaluate the EIS prediction.
g) To Provide Resources and Data that can be of Value during the Response to an Accident or Upset, and in the Recovery from such an Event	*There are no specific criteria about receptors, locations, environmental media, contaminants, physical stressors and measures of biological effect which are specific to this objective. Instead, the monitoring activities designed to meet other objectives are used to meet this objective.*	In the event of an emergency, routine baseline data collected through the NSDF Environmental Monitoring Program can be shared and monitoring capabilities (i.e., resources and equipment) can be provided.
h) To demonstrate due diligence	*There are no specific criteria about receptors, locations, environmental media, contaminants, physical stressors and measures of biological effect which are specific to this objective. Instead, the monitoring activities designed to meet other objectives are used to meet this objective.*	The monitoring activities designed to meet other objectives also serve to increase the credibility of the NSDF Project in the eyes of the public and foster a trusting relationship. This is especially true for areas where the EIS has not suggested any likelihood of adverse NSDF Project effects (e.g., outdoor tourism and recreation, traditional land and resource use, etc.). Collecting data for air quality, surface water quality, and performing biodiversity monitoring can help reduce perceptions of adverse NSDF Project effects on land and resource use that are not anticipated to occur.

Table 8-2 below has been prepared to confirm that all media have been considered in the NSDF EMP and to document cases where a new media may require monitoring based on the findings of other monitoring activities (e.g., EVMP, GWMP). Items that are not proposed for monitoring are shaded grey. For new media that may be triggered, the need for monitoring and the monitoring plans (e.g., locations, parameters and frequencies) will depend on the magnitude and nature of the exceedance that triggered the additional monitoring.

Table 8-2: Selection of Environmental Media to Monitor

Environmental Media	Criteria for Monitoring Media[1]	Justification
Atmospheric Environment		
Air Quality	r) s) u)	r) excessive dust may lead to adverse impacts on surrounding receptors. s) dust was identified as a concern in the EIS u) the monitoring is being conducted where receptors may be present. Other air quality concerns (e.g., emissions from equipment or the ECM are addressed in the NSDF EVMP (Section 7.0) and the NSDF OCM (Section 10.0)
Noise	NA	Noise levels directly associated with Project traffic was identified as a potential concern in the EIS. A traffic volume monitoring program will be implemented as part of the NSDF OCM Program (Section 10.0) to confirm the baseline traffic volumes considered in the EIS which will help verify the modelled noise levels.
Surface Water Environment		
Site Drainage	NA	Stormwater monitoring is addressed in the NSDF EVMP (Section 7.0). Stormwater has the potential to produce effects in the receiving environment if not adequately controlled. Stormwater monitoring will be used to confirm treatment and control of the stormwater and to monitor for potential contact surface water management issues.
Surface Water Quantity	s)	s) potential changes to surface water quantity (i.e., excessive surface water leading to erosion) was identified as a concern in the EIS.
Surface Water Quality	r) s)	r) if the ECM is not managed as predicted, impacts to surface water may lead to adverse impacts on surrounding receptors. s) potential changes to surface water quality was identified as a concern in the EIS
Sediment Quality	None	The EIS predicts no effects to sediment. However, if exceedances of Tier 2 Criteria are measured for contaminants in the surface water or groundwater quality sampling, sediments may also become impacted and contribute to receptor dose/exposure. Sampling, if triggered, should be conducted downstream of where the exceedance identified.

Table 8-2: Selection of Environmental Media to Monitor

Environmental Media	Criteria for Monitoring Media[1]	Justification
Aquatic Environment		
Fish	None	The EIS predicted no effects on fish. However, if exceedances of Tier 2 Criteria for surface water are identified in Perch Lake and Perch Creek, fish at these locations may require monitoring. Monitoring of radionuclides in Ottawa River fish is conducted as part of CRL's ongoing Environmental Monitoring Program.
Benthic Macroinvertebrate Community	None	The EIS predicted no effects on benthic invertebrate communities. If sediment sampling is triggered based on exceedances of Tier 2 Criteria for contaminants in surface water or groundwater quality, benthic invertebrate community monitoring may be required. Sampling for benthic invertebrate community metrics, if required, would be conducted at locations of concern identified for sediment as well as upgradient and downgradient to provide reference locations.
Terrestrial Environment		
Species at Risk	s)	s) potential effects to Species at Risk were identified as a concern in the EIS.
Wildlife, game, other biota	None	Monitoring is conducted for SAR only however, additional monitoring may be required if the SAR monitoring indicates significant effects. The additional monitoring, if required would be designed based on the effects identified. Some of the existing monitoring may be used to evaluate other species (e.g., the breeding bird monitoring will identify all birds).
Vegetation	None	The EIS predicted no effects to vegetation. If exceedances of Tier 2 Criteria for atmospheric compounds or groundwater compounds are identified there may be a need to monitor vegetation. Monitoring would occur in the area of confirmed exceedances (e.g., WWTP or ECM). Vegetation in the area of the NSDF or affected groundwater plumes will be sampled for radiological compounds as part of the CRL EMP. This data may be used to evaluate potential radiological concerns if they arise.
Geological Environment		
Soil Quality	None	The EIS predicted no effects to soil quality. If exceedances of Tier 2 Criteria for groundwater are identified or if spills or unforeseen conditions occur, soil monitoring may be required. If monitoring is triggered by groundwater criteria the sampling may occur upgradient of the groundwater impacts to assess potential sources of the impact. If there are spills or unforeseen events that warrant soil sampling the sampling is to occur in the area of the event (post remediation if actions taken to address the issue).
Wet and dry deposition	None	The EIS predicted no effects via wet or dry deposition. If exceedances of Tier 2 Criteria for atmospheric emissions are identified soil may be impacted and soil monitoring may be triggered. Soil monitoring would be conducted in the area of the atmospheric emission issue and beyond the area to assess the extent.
Groundwater Quality	NA	Groundwater quality is monitored as part of the NSDF Groundwater Monitoring Plan (Section 9.0)
Groundwater Quantity	NA	Groundwater quantity is monitored as part of the NSDF Groundwater Monitoring Plan (Section 9.0)

Table 8-2: Selection of Environmental Media to Monitor

Environmental Media	Criteria for Monitoring Media[1]	Justification
Radiation		
Ambient Radioactivity	r) s)	r) radiation in ambient air can contribute to ecological dose s) the EIS identified ambient air radiation as a concern.
Worker Dose	NA	Tracking and management of worker dose is an expected requirement of the NSDF license and the Nuclear Safety Control Act. Dose will be assessed as part of CNL's Dosimetry Program.

Note: rows shaded light grey denote media that does not require monitoring, unless triggered as discussed.
1 – Criteria for monitoring media provided in text above Table 8-1 from CNL's Environmental Monitoring Program (CNL 2018b).

8.1.3 Boundaries of the Environmental Monitoring Program

This section covers Step 3 of the Systematic Planning Process *Defining the Boundaries of the EMP.*

The EMP requirements for the NSDF are all within the immediate area of the NSDF or within the LSA. Monitoring is not required at the SSA itself as worker safety will be ensured through health and safety processes and environmental receptors will be actively discouraged from the area. This monitoring addresses the potential biological effects and exposure pathways for ecological receptors that were identified in the EIS.

Monitoring further downstream of the NSDF (e.g., the Ottawa River) is addressed by the Chalk River EMP (CNL 2014c, 2014d) Specific biota monitoring is recommended within the larger RSA area but only as part of larger Chalk River biodiversity monitoring.

In the future, if on-site monitoring results begin to indicate a possible off-site effect, off-site monitoring would be initiated as appropriate either through the EAFMP or CRL's EMP.

8.1.4 Design by Objective

This section covers Step 4 and Step 6 of the Systematic Planning Process:

- Step 4: *Determine how the data collected will be used to achieve the defined objectives.*
- Step 6: *Develop the detailed design of the Environmental Monitoring Program.*

Section 8.1.4.1 captures the decisions on environmental media; monitoring locations; contaminants, physical stressors or measures of biological effect; and monitoring frequency and duration for the NSDF EMP. The criteria noted above in Table 8-1 were used to identify and justify the various decisions in the tables below. Several of the criteria provide guidance on decisions and this guidance was also utilized. The detailed design tables are separated by the various phases of the project and the requirements of the EIS.

The detailed design of the NSDF EMP outlined in Section 8.1.4.1 is then followed by Sections 8.1.4.2 through 8.1.4.7, each of which describes how the data collected from the monitoring program are used to achieve each NSDF EMP objective.

8.1.4.1 Detailed Design

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Air (dust) EMP1a	Two sampling locations have been selected for co-location with existing ambient monitors. These locations are A60 (Plant Rd) and A61 (Perch Lake) to represent both upwind and downwind of the predominant winds (Figure 8-1)	SPM (defined as <44 µm diameter) to be analyzed using a high volume sampler. Results from the SPM sampling to be analysed for lead and mercury at a minimum three times during construction to establish a relationship between SPM and predicted parameters. Flow rate to be recorded for each SPM sample.	Measurement	High Volume Air Sampler Filter: Dust	Sampling to start at the commencement of construction and throughout construction. Samples will be collected for a 24 hour period, every 6th day, on operational days. Lead and mercury analysis are required three times at relatively equally spaced intervals during the construction period.	a)	r) Excessive dust may lead to adverse impacts on surrounding receptors. s) airborne dust was a concern identified in the EIS. u) the sampling is being conducted where receptors may be present.	c) the results of the modelling completed in the EIS indicated that maximum concentrations occur close to the locations of construction activities and within the property boundary. Locating the monitor at the site boundary in the prevailing wind direction will provide information on the dust concentrations leaving the site, and potential impacts at surrounding off-site receptors. h) the location upwind will provide a relative background that can be used in evaluation of effects.	k) The EIS has indicated that excess SPM concentration may produce effects without proper construction controls. SPM alone is required for routine analysis as acceptable levels of SPM will provide information on acceptable levels of exposure. Results from the SPM sampling can be used as a surrogate for potential PM_{10} and $PM_{2.5}$ ambient air concentrations Lead and mercury emissions from CRL main campus are routinely reported to NPRI, therefore, given that there are already emissions from the site of these two metals, they were selected for analysis to provide further information on the level of risk to human health as a result of any potential dust impacts Flow rate is required to convert the measured particulate mass to a concentration in µg/m³ for comparison against health based standards	Measurement of SPM, lead and mercury is considered appropriate as it is the only method available to obtain data. $PM_{2.5}$ is a subset of PM_{10}, which is itself a subset of SPM. The results of the EIS indicate that of the three dust size fractions, SPM has the highest predicted concentrations relative to the health based standards, therefore, SPM was identified for measurement as the particle size fraction of greatest concern and PM_{10} and $PM_{2.5}$ results can be estimated from SPM concentrations	The six day frequency stated is an industry standard for dust analysis and is referenced in the National Air Pollution Surveillance (NAPS) quality control guidelines (Environment Canada 2004a). The three samples of lead and mercury is considered adequate to establish a relationship between these items and SPM given the likely minor risk from these elements. Monitored concentrations will fluctuate with changes in on-site activity and meteorological conditions. Monitoring of SPM will therefore continue throughout the construction period to maintain an understanding of risk to off-site receptors.

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
						c) d)	r) Mitigation measures are being conducted to address excessive dust which may lead to adverse impacts at surrounding receptors.	f) the A61 Perch Road location (predominantly downwind), will provide information on the effectiveness of control measures. Locating the monitor at the site boundary will inform the effectiveness of mitigation activities on predicted air concentrations leaving the site and potential impacts at surrounding off-site receptors. h) the A60 Plant Road Monitoring location (Predominantly upwind) will provide a relative background that can be used in evaluation of effectiveness of control measures.	p) monitoring is being conducted to assess the effectiveness of dust control and SPM is the primary indicator of dust. SPM alone is required for routine analysis as acceptable levels of SPM will provide information on acceptable levels of exposure. Results from the SPM sampling can be used as a surrogate for potential PM_{10} and $PM_{2.5}$ ambient air concentrations Flow rate is required to convert the measured particulate mass to a concentration in $\mu g/m^3$ for comparison against health based standards	Measurement is considered appropriate as it is the only method available to obtain data to assess the mitigation efforts. $PM_{2.5}$ is a subset of PM_{10}, which is itself a subset of SPM. The results of the EIS indicate that of the three dust size fractions, SPM has the highest predicted concentrations relative to the health based standards and is the most easily mitigated, therefore, SPM was identified for measurement and PM_{10} and $PM_{2.5}$ results can be estimated from SPM concentrations.	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). Monitored concentrations and effectiveness of control measures will fluctuate with changes in on-site activity and meteorological conditions. Monitoring of SPM will therefore continue throughout the construction period to maintain an understanding of the effectiveness of mitigation activities.

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
						e)	r) Dust levels were modelled in the EIS to evaluate effects and analysis is required to compare to predictions. s) airborne dust was a concern identified in the EIS. u) the sampling is being conducted where receptors may be present	c) the results of the modelling completed in the EIS indicated that maximum concentrations occur close to the locations of construction activities and within the property boundary	k) the EIS modelled SPM values to assess effects and sampling is required to compare to predictions. SPM alone is required for routine analysis as acceptable levels of SPM will provide information on acceptable levels of exposure. Results from the SPM sampling can be used as a surrogate for potential PM_{10} and $PM_{2.5}$ ambient air concentrations. Flow rate is required to convert the measured particulate mass to a concentration in $\mu g/m^3$ for comparison against predicted concentrations in EIS	Measurement is considered appropriate as it is the only method available to obtain data to compare to the predicted EIS values. $PM_{2.5}$ is a subset of PM_{10}, which is itself a subset of SPM. The results of the EIS indicate that of the three dust size fractions, SPM has the highest predicted concentrations relative to the health based standards, therefore, SPM was identified for measurement as the particle size fraction of greatest concern and PM_{10} and $PM_{2.5}$ results can be estimated from SPM concentrations	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). Monitored concentrations will fluctuate with changes in on-site activity and meteorological conditions. Monitoring of SPM will therefore continue throughout the construction period to maintain an understanding of risk to off-site receptors as airborne dust was identified as a concern in the EIS..

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Water (wetlands) EMP2	Existing monitoring stations downstream of the construction area and stormwater management ponds (SWMPs): ■ East Swamp Weir (ESW) ■ Perch Creek Wier (PCW) A background location (Main Stream Creek [MSC]) is also to be monitored. The monitoring locations are shown on Figure 8-1:Dust and Radiation Monitoring Locations Figure 8-2.	The hydroperiod (assessed through water levels and flow) in the wetland system will be monitored to ensure that negative effects are not observed due to construction. The level and surface flow measurements in the wetlands will be carried out using either an existing weir and gauge board with stage-discharge relationship defined, an automatic flow meter (e.g., Flo-Dar), or via an alternative flow measurement method (e.g., dye dilution measurement)	Measurement	Water level measurements at the weir and surface water flows (calculated from the water levels at the weir).	Water levels will be monitored on a weekly basis throughout construction.	a)	s) excessive water levels and flow were identified as a concern in the EIS.	c) Locations ESW and PCW represent a hydrological area downstream of construction that may be affected as identified in the EIS. Measuring at these locations will provide information on the level of impact. h) Location MSC provides background information on flows and changes to flow over time. MSC is in an area unlikely to be significantly affected by the NSDF construction.	k) changes to water levels and flow rates are identified in the EIS as physical stressors to the receiving environment.	Measurement is considered appropriate to ensure that negative effects are not observed during construction.	Weekly monitoring is considered suitable to evaluate effects over time and will assess effects over a full range of conditions that include storms, dry periods and normal flows.
						c) d)	s) Monitoring of water levels and flow are intended to confirm the adequacy of the stormwater management design and operation.	f) Locations ESW and PCW are located in areas in the path of potential effects. h) Location MSC provides background information on flows and changes to flow over time. MSC is in an area unlikely to be significantly affected by the NSDF construction.	p) significant changes to water levels and flow are mitigated by the planned construction design and practices.	Measurement is considered appropriate to ensure the effectiveness of the design and construction implementation.	Weekly monitoring is to confirm mitigation measures and allows for controls to be evaluated for a full range of conditions that include storms, dry periods and normal flows.
						e)	s) Water levels and flow predicted to be maintained at pre-development condition during storm events and monitoring is required to confirm this prediction.	c) Locations ESW and PCW are located downstream of the general construction area (ECM and supporting structures). h) Location MSC provides background information on flows and changes to flow over time. MSC is in an area unlikely to be significantly affected by the NSDF construction.	k) changes to water levels and flow are identified in the EIS as physical stressors to the receiving environment.	Measurement is considered appropriate to ensure that negative effects are not observed during construction as was predicted in the EIS.	Weekly monitoring is considered suitable to evaluate effects over time to allow for comparison to EIS predictions to a full range of conditions that include storms, dry periods and normal flows.

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Canada Warbler, Eastern Wood-peewee, Golden winged Warbler, Wood Thrush) EMP4a	Automated recording unit (ARU) monitoring is currently being conducted throughout the RSA for the Long-Term Forest Songbird Monitoring Program. ARU monitoring of forest songbirds to continue for NSDF in the LSA/RSA at the locations depicted on Figure 8-3 which are the locations of the past surveys	An ARU is a stationary automated recording device that can be pre-programmed to capture auditory breeding calls from a variety of bird species in an area for a pre-determined duration. Data to be collected from the ARU is a count of the number of birds detected and the species composition (i.e., presence/non-detect of federally listed bird species). Birds to assess include, but are not limited to, Canada Warbler, Eastern Wood-peewee, Golden-winged Warbler and Wood Thrush. ARUs can be used to augment or in place of traditional point count methods (AESRD 2013). A set of ARUs such as Song Meter SM2 or SM3 Model ARUs are deployed in the field and programmed to passively record bird songs at selected times and dates. Recordings are stored on memory cards and the data retrieved and transcribed in the office. Data collected can be used to determine presence of federally listed bird species, site occupancy, relative abundance, and habitat relationships/classification of songbirds within a study area.	Measurement	Bird call / song recordings	The monitoring is currently being conducted and is to continue on a frequency of every five years. The monitoring is conducted during the breeding bird season (generally May 24 to July 7). The duration for the ARU deployment should match previous studies to allow for comparison of data.	a)	s) the ARU data will be used to assess birds that were identified as being of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota was identified as an area of concern in the EIS. The past monitoring locations, were determined based on habitat relevance and are required as the objective is to assess the prevalence of the bird species over time.	k) ARU data are needed to document the relative abundance and occurrence of breeding birds over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are a reasonable method to determine the continued presence of federally listed bird species.	Monitoring every 5 years corresponds to the five year update of the ERA which is required by CSA N288.6-12 (CSA 2012). The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).
						e)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota was identified as an area of concern in the EIS. The past monitoring locations were determined based on habitat relevance and are required as the objective is to verify changes over time as the EIS predicted the continued presence of these birds.	k) ARU data are needed to document the relative abundance and occurrence of breeding birds over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are a reasonable method to determine the continued presence of federally listed bird species.	Breeding bird baseline data were collected using audio files analysis in 2013. 2016, 2018 and 2019 (pre-construction conditions). Monitoring is recommended every 5 years to evaluate effects from the project. The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Eastern Whip-poor-will) EMP4b	ARU monitoring is currently being conducted through Nightjar Monitoring Program. ARU monitoring of nightjars to continue for NSDF in the LSA/RSA during construction and operation at the locations depicted on Figure 8-4, which are the locations of the past survey.	An ARU is a stationary automated recording device that can be pre-programmed to capture auditory breeding calls from a variety of bird species in an area for a pre-determined duration. Data to be collected from the ARU is a count of the number of nightjars detected and the species composition (i.e., presence/non-detect of federally listed bird species). Birds to assess: Eastern Whip-poor-will ARUs can be used in place of traditional point count methods (AESRD 2013). A set of ARUs such as Song Meter SM2 or SM3 Model ARUs are deployed in the field on a pre-determined route and programmed to passively record wildlife at selected times and dates. Recordings are retrieved and transcribed in the office. Data collected can be used to determine site occupancy, relative abundance, and habitat relationships/classification of songbirds within a study area.	Measurement	Bird call / song recordings	The monitoring is currently being conducted and is to continue every five years up to and during construction. Monitoring to continue through construction after which, it will be turned over to routine monitoring. Eastern whip-poor-will is a nocturnal species, calling after dusk and before dawn and as such ARUs will be programmed to record data for a period of 6 minutes at each point , as per the Canadian Nightjar Survey Protocol (Knight 2019), starting 30 minutes after sunrise. Nightjar survey locations are to be monitored once during the preferred window (MNRF 2014). The dates within which to survey for Eastern Whip-poor-will vary from year to year is dependent on the full moon cycle during the months of May and June. Because moon phase is known to affect Eastern Whip-poor-will calling rates, the moon should be >50% illuminated, and above the horizon (generally one week on either side of date of full moon). Therefore, the monitoring window using ARUs to cover all the survey locations is open for a period of two weeks on either side of the full moon within the monitoring period.	a)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. The past monitoring locations are required as the objective is to assess the prevalence of the bird species over time.	k) ARU data are needed to document the relative abundance and occurrence of breeding birds over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are a reasonable method to determine the continued presence of federally listed bird species	Monitoring is recommended every 5 years to evaluate effects from the project. The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).
						e)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. The past monitoring locations established on a pre-determined route as per the Canadian Nightjar Survey protocol are required as the objective is to verify changes over time as the EIS predicted the continued presence of these birds.	k) ARU data are needed to document the relative abundance and occurrence of nightjars over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are the best reasonable method to determine the continued presence of federally listed bird species	Nightjars baseline data were collected using audio files analysis in 2013, and 2020 (pre-construction conditions). Monitoring is recommended every 5 years to evaluate effects from the project. The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey and the Breeding Bird Atlas of Ontario.

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Bats) EMP5	In the LSA/RSA during construction operations. At the 16 bat boxes located in the LSA and also at established detector sites within mature forest stands in the vicinity of the Project such as HAB100, HAB81, HAB77, HAB51, HAB75, HAB2, HAB55 Figure 8-5	The number of individuals and species of bats using boxes for roosting habitat. This information is obtained by the visual and auditory recordings. This data will provide an understanding of habitat occupancy by the bat species at risk, including bat boxes, and habitat preference.	Measurement / Estimation	Visual and auditory recordings of bats (presence / non-detect of SAR bats)	Monitoring of the bat boxes to be performed weekly during the construction phase Monitoring consists of once a week visual inspection of the boxes during the maternity roost period of June 1 – July 31 with instrument monitoring conducted if bats are identified.	a)	s) bats were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. Bat boxes were installed in 8 different locations in good foraging habitat in periphery of the proposed NDSF site.	k) the number of individuals and species using bat boxes for roosting habitat is needed to document the relative abundance and continued occurrence of federally listed bats in the LSA / RSA.	Verify effectiveness of bat boxes as maternity roosting habitat offsetting measure, by determining number of individuals and species using boxes for roosting habitat.	Monitoring is to be conducted at least weekly during the maternity roost period to determine if bat boxes are being used. Boxes not being used may be moved to an alternate location. .
						e)	s) bats were of concern based on the physical stressors identified in the EIS. The EIS predicted the population would not be adversely affected and monitoring is required to confirm this prediction.	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. Monitoring at existing locations is required to identify changes over time. Bat boxes were installed in 8 different locations in good foraging habitat in periphery of the proposed NDSF site.	k) the number of individuals and species using bat boxes for roosting habitat is needed to document potential changes in the relative abundance and continued occurrence of federally listed bats in the LSA / RSA.	Verify effectiveness of bat boxes as maternity roosting habitat offsetting measure, as predicted in the EIS, by determining number of individuals and species using boxes for roosting habitat.	Monitoring is to be conducted at least weekly during the maternity roost period to determine if bat boxes are being used. Boxes not being used may be moved to an alternate location.

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Blanding's Turtle - Wildlife mortality) EMP6	Roads throughout the RSA with particular focus on the main travel route for NSDF traffic	Road mortality surveys conducted to track Blanding's turtle mortality.	Measurement	Walking and driving surveys using visual observations and written documentation of the occurrence of Blanding's turtle roadkill / injury	Weekly during the Blanding's turtle terrestrial season (May – September) during construction and will be turned over to routine monitoring during operations. Written reports will be sent directly to CNL environmental staff as soon as possible after the observation.	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS.	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) road mortality occurrences provide information on potential effects.	Written reports of occurrences will provide documentation that can be used in an evaluation of effects.	Weekly surveys during Blanding's turtle terrestrial season (May to September; ECCC 2018) can be used to evaluate measures that may be required to reduce effects to biota.
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS. The EIS predicted the population would not be adversely affected and monitoring is required to confirm this prediction.	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) road mortality occurrences provide information that can be compared to the EIS prediction. .	Written reports of occurrences will provide documentation that can be used to compare to EIS predictions.	Weekly surveys during Blanding's turtle terrestrial season (May to September; ECCC 2018) can be assess whether the mitigation will reduce Blanding's turtle road mortality as precited by the EIS.
Biota (Blanding's Turtle - critical habitat) EMP7	Within the boundaries of the NSDF project site (SSA) including all proposed disturbance footprints	Blanding's turtle habitat (or loss of habitat)	Measurement/Estimation	Visual encounter surveys to look for the habitat of the Blanding's turtle to be conducted. This assessment is a visual inspection for Blanding turtle based on the methods from the Ontario Survey Protocol for Blanding's Turtle (MNRF 2015) Assessment of CRL critical habitat based on critical habitat definition as defined in the species Recovery strategy document.	The visual encounter survey will search for Blanding's turtle habitat and will be conducted annually (in terrestrial season (May – September)) during construction of the NSDF and will be turned over during operation to routine monitoring program.	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Blanding's turtle habitat are critical to the survival of the species	Mapping of critical habitat will provide an understanding of the habitat that may be lost.	The critical habitat will be assessed annually to evaluate potential effects to the habitat. .
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Blanding's turtle habitat are critical to the survival of the species. As part of the prediction of no adverse effects it was concluded that habitat would be maintained.	Mapping of critical habitat will confirm the assumptions of the EIS that there is to be no significant loss of habitat.	The critical habitat will be assessed annually to allow for comparison to EIS predictions.

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Blanding's Turtle – Artificial Nest Mounds) EMP8	The entire CRL site (RSA)	Effectiveness of the mitigation plan to keep Blanding's turtle and other herpetofauna off roads and therefore lessen the risk of road mortality, but still provide nesting habitat	Measurement	Monitor usage of artificial nest sites and success of caged nest sites in producing hatchlings	Monitoring of artificial nesting sites to occur once a week during nesting and hatchling emergence season for Blanding's turtle (May 15 to October 15). If turtle nesting is observed and nest cages are implemented, monitor the caged nests for integrity and for hatchlings once a week until the eggs hatch (i.e., until late September / early October and again in the early spring). Cages are to be removed from nest sites by early May to prepare for new nesting. Artificial nesting mounds to be inspected once a year for 5 consecutive years after they are created.	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS and monitoring of nest mounds allow for evaluation of effects.	k) Nest mound surveys will be used to assess ongoing reproductive success of the biota.	Nesting surveys are required to determine if adult females are using the artificial nest mounds	Weekly surveys during nesting season should indicate if nests are being used. Nesting season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020).
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Nest mound monitoring will be used to evaluate the EIS prediction that there will be no significant impacts to Blanding's turtle reproductive success.	Nesting surveys to determine if adult females are using the artificial nest mounds	Weekly surveys during nesting season (May 15-June 30) should indicate if nests are being used. Nesting season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020).

Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Blanding's Turtle – Use of Culverts) EMP9	The entire CRL site (RSA)	Effectiveness of the road crossing mitigation plan to keep Blanding's turtle and other herpetofauna off roads and therefore lessen the risk of road mortality. Photos from the remote cameras will be reviewed and analyzed using camera detection software, and all animal species sightings will be documented. The findings of the camera monitoring program will be documented and summarized in the annual monitoring reports	Estimation	Data to be collected consists of photos from the remote cameras.	Camera traps will be used to detect turtle passage throughout the terrestrial period (May – September 30). Camera memory cards will be checked on a weekly basis and either switched for a new card or data downloaded and memory card cleared when nearing maximum capacity	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) monitoring of culverts determines effectiveness of the mitigation measures in place	Surveys determine if there is usage of turtle crossing systems	The terrestrial season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020). The frequency and process of collecting photos is based on the *Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species at Risk in Ontario* (MNRF 2016).
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) monitoring of culverts assists in evaluating if the EIS prediction that the mitigation plan would result in no adverse population effects.	Surveys determine if there is usage of turtle crossing systems which is used to support the EIS predictions.	The terrestrial season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020). The frequency and process of collecting photos is based on the *Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species at Risk in Ontario* (MNRF 2016).

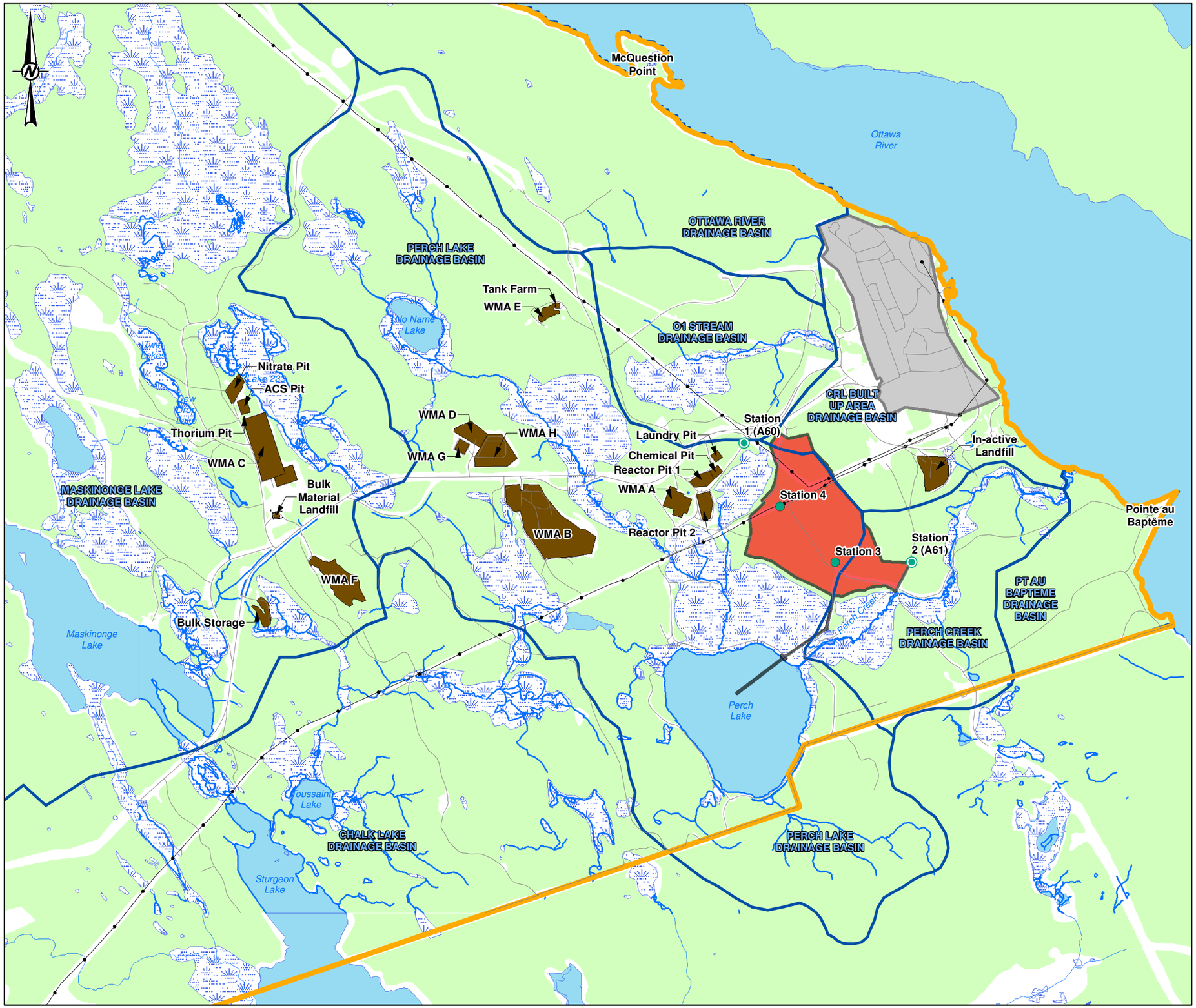
Table 8-3: EMP Detailed Design, Construction

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Eastern Milksnake) EMP10	Reptile exclusion fence surrounding the NSDF SSA. Mortality surveys on the road within the LSA.	Fence condition, mortality for herpetofauna	Measurement	Data to be collected includes weekly inspection reports and daily mortality survey reports when applicable.	Temporary exclusion fencing to be inspected weekly during construction. During construction mortality survey to be conducted weekly during the species active period (April 15 to September 30)	a)	s) Eastern milksnake were of concern based on the physical stressors identified in the EIS	c) road crossings were considered a significant risk to this species.	K) road mortality occurrences provide information for regarding effects.	Written reports of occurrences will provide documentation of potential effects.	Weekly surveys during Eastern milksnake active season (April 15 to September 30; (Environment Canada 2015) can be used to evaluate effects
						e)	s) Eastern milksnake were of concern based on the physical stressors identified in the EIS	c) in the EIS road crossings were predicted to be a significant risk to this species and mitigation therefore recommended	k) road mortality occurrences provide information for adaptive management.	Written reports of occurrences will provide documentation that can be compared to EIS predictions.	Weekly surveys during Eastern milksnake active season (April 15 to September 30; (Environment Canada 2015) can be used to evaluation the prediction of no adverse effects.

Note:

1) Objectives noted in Section 8.1.1.

2) Criteria for monitoring noted in Section 8.1.2.



LEGEND

- ROADS
- RAILWAY
- TRANSMISSION LINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- WOODED AREA
- DRAINAGE BASIN
- SITE STUDY AREA (NSDF PROJECT SITE)
- CRL MAIN CAMPUS
- CRL SITE
- WASTE MANAGEMENT AREA (WMA) [1]
- AMBIENT AIR MONITORING AND RADIOLOGICAL AMBIENT AIR MONITORING LOCATION
- RADIOLOGICAL AMBIENT AIR MONITORING

500 0 500
1:20,000 METRES

NOTE(S)
1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)
1. BASEDATA ONTARIO MNRF 2016, CANVEC 2016, AND CNL 2016
2. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
DUST AND RADIATION MONITORING LOCATIONS

CONSULTANT
GOLDER

DATE	2021-02-10
DESIGNED	SO
PREPARED	SO
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**8-1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

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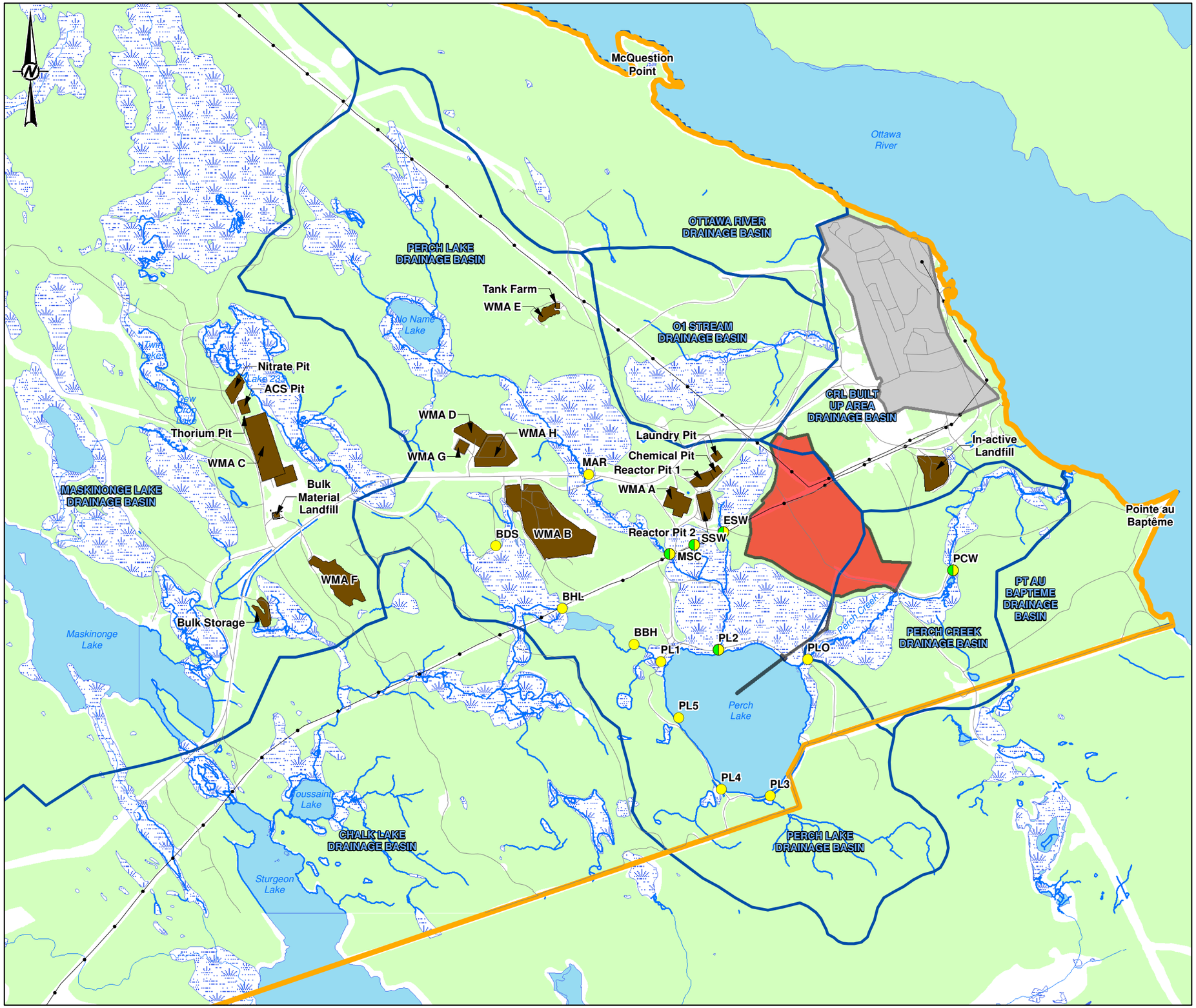

LEGEND

- ROADS
- RAILWAY
- TRANSMISSION LINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- WOODED AREA
- DRAINAGE BASIN
- SITE STUDY AREA (NSDF PROJECT SITE)
- CRL MAIN CAMPUS
- CRL SITE
- WASTE MANAGEMENT AREA (WMA) [1]
- SAMPLING LOCATION
- WEIR
- SAMPLING LOCATION AND WEIR

500 0 500

1:20,000 METRES

NOTE(S)

1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)

1. BASEDATA ONTARIO MNRF 2016, CANVEC 2016, AND CNL 2016
2. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
LOCATIONS OF SURFACE WATER MONITORING STATIONS AND WEIRS

CONSULTANT
GOLDER

DATE	2021-02-10
DESIGNED	SO
PREPARED	SO
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**8-2**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 25mm

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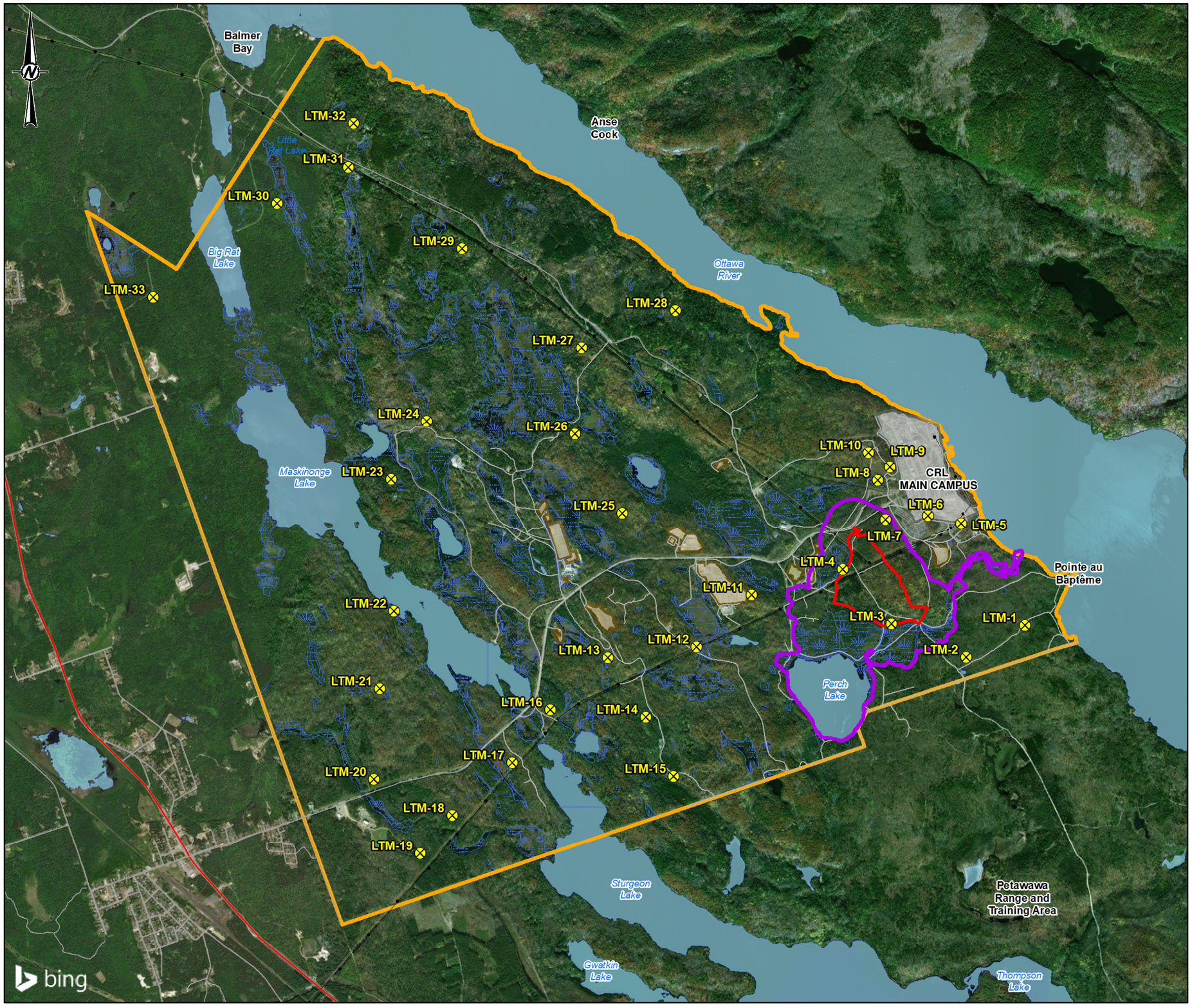

LEGEND

- HIGHWAY
- ROAD
- TRANSMISSION LINE
- NATURAL GAS PIPELINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- CRL MAIN CAMPUS
- WASTE MANAGEMENT AREA (WMA)[1]
- REGIONAL STUDY AREA (CRL PROPERTY)
- LOCAL STUDY AREA
- SITE STUDY AREA (NSDF PROJECT SITE)
- LONG TERM FOREST SONGBIRD MONITORING STATION

DRAFT

1 0 1
1:35,000 KILOMETRES

NOTE(S)
1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)
1. BASEDATA MNRF 2016 AND CANVEC 2016
2. IMAGERY: © 2021 MICROSOFT CORPORATION © 2021 MAXAR ©CNES (2021) DISTRIBUTION AIRBUS DS
3. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
CNL LONG TERM FOREST SONGBIRD MONITORING STATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-10
DESIGNED	SO
PREPARED	SO
REVIEWED	EG
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**8-3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 25mm

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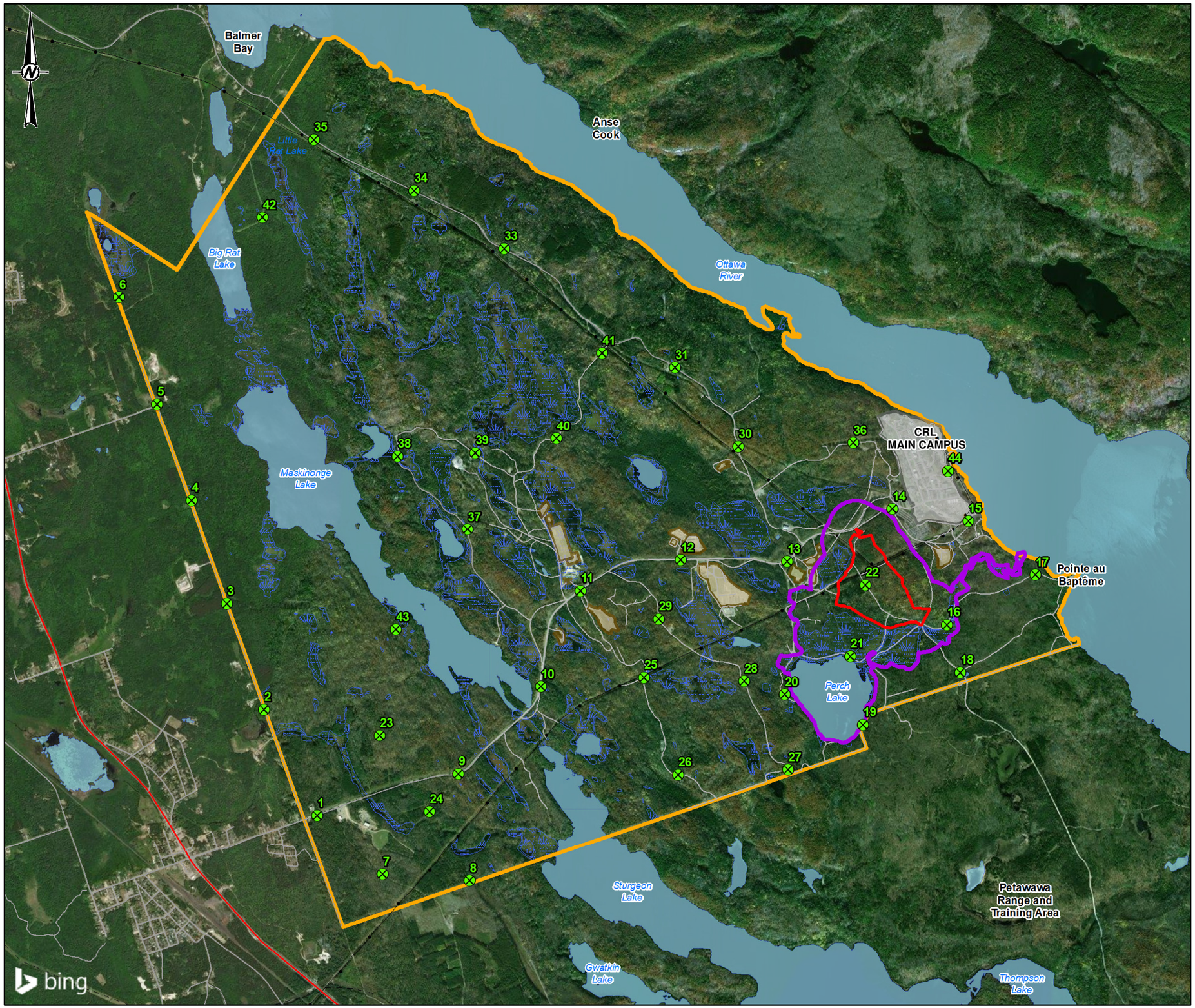

LEGEND

- HIGHWAY
- ROAD
- TRANSMISSION LINE
- NATURAL GAS PIPELINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- CRL MAIN CAMPUS
- WASTE MANAGEMENT AREA (WMA)[1]
- REGIONAL STUDY AREA (CRL PROPERTY)
- LOCAL STUDY AREA
- SITE STUDY AREA (NSDF PROJECT SITE)
- WHIP-POOR-WILL MONITORING STATIONS

DRAFT

1 0 1

1:35,000 KILOMETRES

NOTE(S)
1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)
1. BASEDATA MNRF 2016 AND CANVEC 2016
2. IMAGERY: © 2021 MICROSOFT CORPORATION © 2021 MAXAR ©CNES (2021) DISTRIBUTION AIRBUS DS
3. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
CNL WHIP-POOR-WILL MONITORING STATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-10
DESIGNED	SO
PREPARED	SO
REVIEWED	EG
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**8-4**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 25mm

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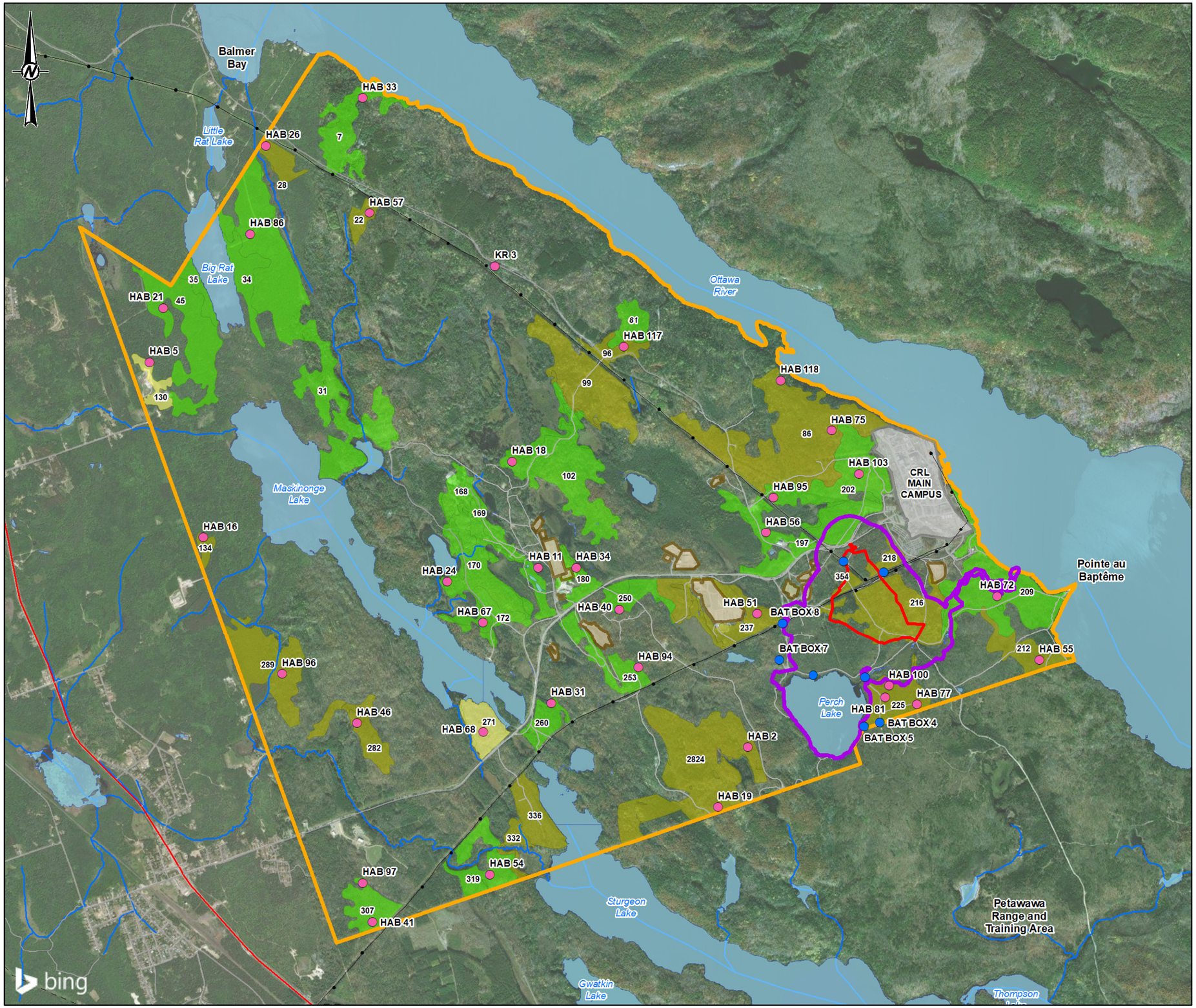

LEGEND

- HIGHWAY
- ROAD
- TRANSMISSION LINE
- NATURAL GAS PIPELINE
- RIVER/STREAM
- WATERBODY
- CRL MAIN CAMPUS
- WASTE MANAGEMENT AREA (WMA)[1]

EIS ASSESSMENT BOUNDARIES FOR TERRESTRIAL ENVIRONMENT

- REGIONAL STUDY AREA (CRL PROPERTY)
- LOCAL STUDY AREA
- SITE STUDY AREA (NSDF PROJECT SITE)

FRI STANDS WITH FOREST STAND ASSESSMENT PLOTS[2]

- MATURE (FRI STAND ID)
- IMMATURE (FRI STAND ID)
- SAPLING (FRI STAND ID)

ACOUSTIC MONITORING LOCATIONS[3]

- BAT BOXES (DETECTOR SITE ID)
- RSA RANDOM POINTS (DETECTOR SITE ID)

1 0 1

1:35,000 KILOMETRES

NOTE(S)

1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.
2. FRI STAND AGE CLASS AS DETERMINED BY GOLDER IN THE EIS.
3. SEE FIGURE 2 FOR ACOUSTIC MONITORING LOCATIONS WITHIN THE LOCAL STUDY AREA.

REFERENCE(S)

1. BASEDATA MNRF 2016 AND CANVEC 2016
2. IMAGERY: © 2021 MICROSOFT CORPORATION © 2021 MAXAR ©CNES (2021) DISTRIBUTION AIRBUS DS
3. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
STAND ASSESSMENT AND ACOUSTIC MONITORING LOCATIONS – RSA

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-10
DESIGNED	PR
PREPARED	PR
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**8-5**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

S:\Clients\Canadian_Nuclear_Laboratories\NSDF-99_PROJ\1547525_NSDF_EIS-v40_PROD\0038_EAFMP_Final\1547525-0038-G-0009.mxd

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Air (dust) EMP1b	Two sampling locations have been selected for co-location with existing ambient monitors. These locations are A60 (Plant Rd) and A61 (Perch Lake) to represent both upwind and downwind of the predominant winds (Figure 8-1).	SPM (defined as <44 µm diameter) to be analyzed using a high volume sampler. Results from the SPM sampling to be analysed for lead and mercury at a minimum three times during operations to establish a relationship between SPM and predicted parameters. Flow rate to be recorded for each SPM sample.	Measurement	High Volume Air Sampler: Dust	Sampling to start at the commencement of operations and continue throughout operations. SPM samples will be collected for a 24 hour period on a six day frequency (i.e., one sample collected every 6 days). Lead and mercury analysis are required three times at relatively equally spaced intervals during first year of operations.	a)	r) Excessive dust may lead to adverse impacts at surrounding receptors. s) airborne dust was a concern identified in the EIS.	c) the results of the modelling completed in the EIS indicated that maximum concentrations occur close to ECM activities and within the property boundary. Locating the monitor at the site boundary will inform the effectiveness of mitigation activities on predicted air concentrations leaving the site and potential impacts at surrounding off-site receptors. h) the location upwind will provide a relative background that can be used in evaluation of effects.	k) The EIS has indicated that excess SPM concentration may produce effects without proper operations controls. SPM alone is required for routine analysis as acceptable levels of SPM will provide information on acceptable levels of exposure. Results from the SPM sampling can be used as a surrogate for potential PM_{10} and $PM_{2.5}$ ambient air concentrations. Lead and mercury emissions from CRL main campus are routinely reported to NPRI, therefore, given that there are already emissions from the site of these two metals, they were selected for analysis to provide further information on the level of risk to human health as a result of any potential dust impacts. Flow rate is required to convert the measured particulate mass to a concentration in µg/m³ for comparison against health based standards	Measurement is considered appropriate as it is the only method available to obtain data. $PM_{2.5}$ is a subset of PM_{10}, which is itself a subset of SPM. The results of the EIS indicate that of the three dust size fractions, SPM has the highest predicted concentrations relative to the health based standards and is the most easily mitigated, therefore, SPM was identified for measurement and PM_{10} and $PM_{2.5}$ results can be estimated from SPM concentrations.	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). Monitored concentrations will fluctuate with changes in on-site activity and meteorological conditions. Monitoring of SPM will therefore continue throughout the operations period to maintain an understanding of risk to off-site receptors.The three samples of lead and mercury during the first year of operation is considered adequate given the likely minor risk from these elements.

Table 8-4: EMP Detailed Design - Operations

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						c) d)	r) Mitigation measures are being conducted to address excessive dust which may lead to adverse impacts at surrounding receptors.	f) the A61 Perch Road location (predominantly downwind), will provide information on the effectiveness of control measures. Locating the monitor at the site boundary will inform the effectiveness of mitigation activities on predicted air concentrations leaving the site and potential impacts at surrounding off-site receptors. h) the A60 Plant Road Monitoring location (Predominantly upwind) will provide a relative background that can be used in evaluation of effectiveness of control measures.	p) monitoring is being conducted to assess the effectiveness of dust control and SPM is the primary indicator of dust. SPM alone is required for routine analysis as acceptable levels of SPM will provide information on acceptable levels of exposure. Results from the SPM sampling can be used as a surrogate for potential PM_{10} and $PM_{2.5}$ ambient air concentrations Flow rate is required to convert the measured particulate mass to a concentration in µg/m³ for comparison against health based standards	Measurement is considered appropriate as it is the only method available to obtain data to assess the mitigation efforts.	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). Monitored concentrations will fluctuate with changes in on-site activity and meteorological conditions. Monitoring of SPM will therefore continue throughout the operations period to maintain an understanding of risk to off-site receptors.

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						e)	r) Dust levels were modelled in the EIS to evaluate effects and analysis is required to compare to predictions. s) airborne dust was a concern identified in the EIS. u) the sampling is being conducted where receptors may be present	c) the results of the modelling completed in the EIS indicated that maximum concentrations occur close to the locations of ECM activities and within the property boundary	k) the EIS modelled SPM values to assess effects and sampling is required to compare to predictions. SPM alone is required for routine analysis as acceptable levels of SPM will provide information on acceptable levels of exposure. Results from the SPM sampling can be used as a surrogate for potential PM_{10} and $PM_{2.5}$ ambient air concentrations. Lead and mercury emissions from CRL main campus are routinely reported to NPRI, therefore, given that there are already emissions from the site of these two metals, they were selected for analysis to provide further information on the level of risk to human health as a result of any potential dust impacts. Flow rate is required to convert the measured particulate mass to a concentration in µg/m³ for comparison against health-based standards.	Measurement of SPM, mercury and lead is considered appropriate as it is the only method available to obtain data to compare to the predicted EIS values. $PM_{2.5}$ is a subset of PM_{10}, which is itself a subset of SPM. The results of the EIS indicate that of the three dust size fractions, SPM has the highest predicted concentrations relative to the health-based standards, therefore, SPM was identified for measurement as the particle size fraction of greatest concern and PM_{10} and $PM_{2.5}$ results can be estimated from SPM concentrations	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). The three samples of lead and mercury for the first year of operations is considered adequate given the likely minor risk from these elements Monitored concentrations will fluctuate with changes in on-site activity and meteorological conditions. Monitoring of SPM will therefore continue throughout the operations phase to maintain an understanding of risk to off-site receptors as airborne dust was identified as a concern in the EIS.

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Water (wetlands) EMP2	Existing monitoring stations downstream of the ECM, WWTP and SWMPs: ■ ESW ■ PCW A Background location in the area (Main Stream Creek [MSC]) is also to be monitored. The monitoring locations are shown on Figure 8-1:Dust and Radiation Monitoring Locations Figure 8-2.	The hydroperiod (assessed through water levels and flow) in the wetland system will be monitored to ensure that negative effects are not observed due to operations. The level and surface flow measurements in the wetlands will be carried out using either an existing weir and gauge board with stage-discharge relationship defined, an automatic flow meter (e.g., Flo-Dar), or via an alternative flow measurement method (e.g., dye dilution gauging measurement).	Measurement	Water level measurements at the weir and surface water flows (calculated from the water levels at the weir).	Water levels will be monitored on a weekly basis throughout operations.	a)	s) excessive water levels and flow were identified as a concern in the EIS.	c) Locations ESW and PCW represent a hydrological area downstream of the ECM, WWTP and SWMPs that may be affected as identified in the EIS. Measuring at these locations will provide information on the level of impact. h) Location MSC provides background information on flows and changes to flow over time. MSC is in an area unlikely to be significantly affected by the NSDF construction.	k) potential changes to water levels and flow rates are identified in the EIS as physical stressors to the receiving environment.	Measurement is considered appropriate to ensure that negative effects are not observed during operations.	Weekly monitoring is considered suitable to evaluate effects over time and will assess effects over a full range of conditions that include storms, dry periods and normal flows.
						c) d)	s) Monitoring of water levels and flow are intended to confirm the adequacy of the stormwater management design and operation.	f) The existing monitoring stations are located in areas in the path of potential effects. h) Location MSC provides background information on flows and changes to flow over time. MSC is in an area unlikely to be significantly affected by the NSDF construction.	p) significant changes to water levels and flow are mitigated by the planned operations design and practices.	Measurement is considered appropriate to ensure the effectiveness of the design and operations implementation.	Weekly monitoring is to confirm mitigation measures and allows for controls to be evaluated a full range of conditions that include storms, dry periods and normal flows.

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						e)	s) Water levels and flow predicted to be maintained at pre-development condition during storm events and monitoring is required to confirm this prediction.	c) The existing monitoring stations are located downstream of the general operations area (ECM and supporting structures). h) Location MSC provides background information on flows and changes to flow over time. MSC is in an area unlikely to be significantly affected by the NSDF construction.	k) changes to water levels and flow are identified in the EIS as potential physical stressors to the receiving environment.	Measurement is considered appropriate to ensure that negative effects are not observed during operations as was predicted in the EIS.	Weekly monitoring is considered suitable to evaluate effects over time to allow for comparison to EIS predictions to a full range of conditions that include storms, dry periods and normal flows.

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Water (surface water) EMP3a	Existing monitoring locations in Perch Lake and Perch Creek ■ East Swamp Weir (ESW) ■ Perch Lake Inlet 2 (PL2) ■ Perch Lake Outlet (PLO) ■ Perch Creek Weir (PCW) Figure 8-2	Analysis for surface water is discussed further in Section 8.1.4.1.1 COPCs including radiological and non-radiological parameters is outlined in Section 8.1.4.1.1	Measurement	Grab Sample: Concentration of COPCs in water	Sampling will typically be performed on a weekly or monthly basis and analysis frequency specific to the COPCs as is currently conducted by CRL's EMP (CNL 2018c) For parameters not identified in the CRL schedule sampling is to take place monthly. Monitoring to continue though operations.	a)	r) Several of the COPCs that may be present in the contact surface water or leachate are radionuclides and the analysis can be used to assess potential effects to non-human biota. s) several COPCs that may be present in the contact surface water or leachate were identified in the EIS as being of concern.	c) Need to monitor surface water quality downstream of the WWTP discharge location and in the area surrounding the ECM footprint area as these were locations of concern in the EIS. Perch Creek is the creek draining the Perch Creek and Perch Lake Watershed and discharging into the Ottawa River	Parameter selection is discussed in Section 8.1.4.1.1.	Measurement is considered appropriate as it is the only method available to obtain data to evaluate potential effects.	During the discharge period, WWTP discharge will disperse through the receiving environment and attenuate downstream. This attenuation will not be immediate (discharge will assimilate with natural flows and move downstream under the existing hydrograph), so the proposed sampling frequency at each of the downstream assessment nodes is required to track the discharge. This monitoring will remain in place for the duration of operational discharge from the WWTP.
						c) d)	s) several COPCs were identified in the EIS as being of concern.	f) monitoring at the locations specified (downstream of the WWTP discharge point and in the area surrounding the ECM footprint) is being conducted to confirm mitigation measures are being effectively implemented.	Parameter selection is discussed in Section 8.1.4.1.1.	Measurement is considered appropriate as it is the only method assess the potential presence of leachate or contact surface water in the surface water.	During the discharge period, WWTP discharge will disperse through the receiving environment and attenuate downstream. This attenuation will not be immediate (discharge will assimilate with natural flows and move downstream under the existing hydrograph), so the proposed sampling frequency at each of the downstream assessment nodes is required to track the discharge. This monitoring will remain in place for the duration of operational discharge from the WWTP.

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						e)	r) Several of the COPCs that may be present in the contact surface water or leachate are radionuclides and the analysis can be used to assess potential effects to non-human biota. s) several COPCs were identified in the EIS as being of concern.	c) Need to monitor surface water quality downstream of the WWTP discharge location and in the area surrounding the ECM footprint area as these were locations of concern in the EIS. Perch Creek is the creek draining the Perch Creek and Perch Lake Watershed and discharging into the Ottawa River	Parameter selection is discussed in Section 8.1.4.1.1.	Measurement is considered appropriate as it is the only method available to obtain data to compare to the predicted EIS values.	During the discharge period, WWTP discharge will disperse through the receiving environment and attenuate downstream. This attenuation will not be immediate (discharge will assimilate with natural flows and move downstream under the existing hydrograph), so the proposed sampling frequency at each of the downstream assessment nodes is required to track the discharge and confirm water quality remains within EIS predictions. This monitoring will remain in place for the duration of operational discharge from the WWTP.

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Biota (Canada Warbler, Eastern Wood-peewee, Golden winged Warbler, Wood Thrush) EMP4a	ARU monitoring is currently being conducted throughout the RSA for the Long-Term Forest Songbird Monitoring Program. ARU monitoring of forest songbirds to continue for NSDF in the LSA/RSA during operations at the locations depicted on Figure 8-3, which are the locations of the past survey	An ARU is stationary automated recording device that can be pre-programmed to capture auditory breeding calls from a variety of bird species in an area for a pre-determined duration. Data to be collected from the ARU is a count of the number of birds detected and the species composition (i.e., presence/non-detect of federally listed bird species). Birds to assess include, but are not limited to, Canada Warbler, Eastern Wood-peewee, Golden-winged Warbler and Wood Thrush. ARUs can be used to augment or in place of traditional point count methods (AESRD 2013). A set of ARUs such as Song Meter SM2 or SM3 Model ARUs are deployed in the field and programmed to passively record bird songs at selected times and dates. Recordings are stored on memory cards and the data retrieved and transcribed in the office. Data collected can be used to determine presence of federally listed bird species, site occupancy, relative abundance, and habitat relationships/classification of songbirds within a study area.	Measurement	Bird call / song recordings	The monitoring is currently being conducted and is to continue on a frequency of every five years throughout operations. The monitoring is conducted during the breeding bird season (generally May 24 to July 7). The duration for the ARU deployment should match previous studies to allow for comparison of data.	a)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota was identified as a area of concern in the EIS. The past monitoring locations were determined based on habitat relevance and are required as the objective is to assess the prevalence of the bird species over time.	k) ARU data are needed to document the relative abundance and occurrence of breeding birds over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are a reasonable method to determine the continued presence of federally listed bird species.	Monitoring every 5 years corresponds to the five year update of the ERA which is required by CSA N288.6-12 (CSA 2012). The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).
						e)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota was identified as a area of concern in the EIS. The past monitoring locations were determined based on habitat relevance and are required as the objective is to verify changes over time as the EIS predicted the continued presence of these birds.	k) ARU data are needed to document the relative abundance and occurrence of breeding birds over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are a reasonable method to determine the continued presence of federally listed bird species.	Monitoring is recommended every 5 years to evaluate effects from the project. The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).

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Biota (Eastern Whip-poor-will) EMP4b	ARU monitoring is currently being conducted throughout the RSA for the Long-Term Forest Songbird Monitoring Program. ARU monitoring of forest songbirds to continue for NSDF in the LSA/RSA during operations at the locations depicted on	An ARU is a stationary automated recording device that can be pre-programmed to capture auditory breeding calls from a variety of bird species in an area for a pre-determined duration. Data to be collected from the ARU is a count of the number of birds detected and the species composition (i.e., presence/non-detect of federally listed bird species). Birds to assess: Eastern Whip-poor-will	Measurement	Bird call/song recording	The monitoring is currently being conducted and is to continue every five years up to and during operations under routine monitoring. Eastern whip-poor-will is a nocturnal species, calling after dusk and before dawn and as such ARUs will be programmed to record data a period	a)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. The past monitoring locations are required as the objective is to assess the prevalence of the bird species over time.	k) ARU data are needed to document the relative abundance and occurrence of breeding birds over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are a reasonable method to determine the continued presence of federally listed bird species	Monitoring is recommended every 5 years to evaluate effects from the project. The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).

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	Figure 8-4, which are the locations of the past survey. It is assumed Station 22 will be removed or relocated.	ARUs can be used to augment or in place of traditional point count methods (AESRD 2013) A set of ARUs such as Song Meter SM2 or SM3 Model ARUs are deployed in the field and programmed to passively record wildlife at selected times and dates. Recordings are retrieved and transcribed in the office. Data collected can be used to determine site occupancy, relative abundance, and habitat relationships/classification of songbirds within a study area.			of 6 minutes at each point, as per the Canadian Nightjar Survey Protocol (Knight 2019). starting 30 minutes after sunrise. Nightjar survey locations are to be monitored once during the preferred window (CNL 2018c). The dates within which to survey for Eastern Whip-poor-will vary from year to year is dependent on the full moon cycle during the months of May and June (MNRF 2020). Because moon phase is known to affect Eastern Whip-poor-will calling rates, the moon should be >50% illuminated, and above the horizon (generally one week on either side of date of full moon). Therefore, the monitoring window using ARUs to cover all the survey locations is open for a period of two weeks on either side of the full moon within the monitoring period.	e)	s) these birds were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. The past monitoring locations established on a pre-determined route as per the Canadian Nightjar Survey protocol are required as the objective is to verify changes over time as the EIS predicted the continued presence of these birds.	k) ARU data are needed to document the relative abundance and occurrence of nightjars over time including the continued presence of federally listed bird species before and after habitat changes occur.	The ARU counts are the best reasonable method to determine	Nightjars baseline data were collected using audio files analysis in 2013, and 2020 (pre-construction conditions). Monitoring is recommended every 5 years to evaluate effects from the project. The breeding bird season is defined by ECCC, Canadian Breeding Bird Survey (Downes and Collins 2003) and the Breeding Bird Atlas of Ontario (Cadman et al. 2007).

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Biota (Bats) EMP5	In the LSA/RSA during operations. At the 16 bat boxes located in the LSA and also at established detector sites within mature forest stands in the vicinity of the Project such as HAB100, HAB81, HAB77, HAB51, HAB75, HAB2, HAB55 Figure 8-5	The number of individuals and species of bats using boxes for roosting habitat. This information is obtained by the visual and auditory recordings. This data will provide an understanding of habitat occupancy by the bat species at risk, including bat boxes, and habitat preference.	Measurement / Estimation	Visual and auditory recordings of bats (presence / non-detect of SAR bats)	Monitoring of the bat boxes to be performed weekly for three years once construction starts. Monitoring consists of a once a week visual inspection of the boxes during the maternity roost period of June 1 – July 31 with instrument monitoring conducted if bats are identified.	a)	s) bats were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. Bat boxes were installed in 8 different locations in good foraging habitat in periphery of the proposed NSDF site	k) the number of individuals and species using bat boxes for roosting habitat is needed to document the relative abundance and continued occurrence of federally listed bats in the LSA / RSA.	Verify effectiveness of bat boxes as maternity roosting habitat offsetting measure, by determining number of individuals and species using boxes for roosting habitat.	Monitoring is to be conducted at least weekly during the maternity roost period to determine if bat boxes are being used. Boxes not being used may be moved to an alternate location.
						e)	s) bats were of concern based on the physical stressors identified in the EIS	c) the suitability of habitat surrounding the NSDF in the LSA and RSA for these biota were identified as an area of concern in the EIS. Monitoring at existing locations is required to identify changes over time. Bat boxes were installed in 8 different locations in good foraging habitat in periphery of the proposed NSDF site.	k) the number of individuals and species using bat boxes for roosting habitat is needed to document potential changes in the relative abundance and continued occurrence of federally listed bats in the LSA / RSA.	Verify effectiveness of bat boxes as maternity roosting habitat offsetting measure, as predicted in the EIS, by determining number of individuals and species using boxes for roosting habitat.	Monitoring is to be conducted at least weekly during the maternity roost period to determine if bat boxes are being used. Boxes not being used may be moved to an alternate location.

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Biota (Blanding's Turtle - Wildlife mortality) EMP6	Roads throughout the RSA with particular focus on the main travel route for NSDF traffic	Road mortality surveys conducted to track Blanding's turtle mortality.	Measurement	Walking or driving surveys using visual observations and written documentation of the occurrence of Blanding's turtle roadkill / injury	Weekly during the Blanding's turtle terrestrial season (May-September and will be routine monitoring during operations. Written reports will be directly to CNL environmental staff as soon as possible after the observation.	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS.	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) road mortality occurrences provide information on potential effects.	Written reports of occurrences will provide documentation that can be used in an evaluation of effects.	Weekly surveys during Blanding's turtle terrestrial season (May-September). Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020) can be used to evaluate measures that may be required to reduce effects to biota.
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS. The EIS predicted the population would not be adversely affected and monitoring is required to confirm this prediction.	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) road mortality occurrences provide information that can be compared to the EIS prediction.	Written reports of occurrences will provide documentation that can be used to compare to EIS predictions.	Weekly surveys during Blanding's turtle terrestrial season (May-September). Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020) can be used to assess whether the mitigation will reduce Blanding's turtle road mortality as precited by the EIS.
Biota (Blanding's Turtle - critical habitat) EMP7	Within the boundaries of the NSDF project site (SSA) including all proposed disturbance footprints	Blanding's turtle habitat (or loss of habitat)	Measurement/Estimation	Visual encounter surveys to look for the habitat of the Blanding's turtle to be conducted. This assessment is a visual inspection for Blanding turtle. The methods is from the Ontario Ministry of Natural Resources and Forestry *Survey Protocol for Blanding's Turtle in Ontario* (MNRF 2015). Assessment of CRL critical habitat based on critical habitat definition as defined in the species recovery strategy document (ECCC 2018).	The visual encounter survey will search for Blanding's turtle habitat and will be conducted annually (in terrestrial season (May – September)) during construction of the NSDF and will be turned over during operation to routine monitoring program.	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Blanding's turtle habitat are critical to the survival of the species	Mapping of suitable habitat will provide an understanding of the habitat that may be lost.	The critical habitat will be assessed annually to evaluate potential effects to the habitat.
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Blanding's turtle habitat are critical to the survival of the species. As part of the prediction of no adverse effects it was concluded that habitat would be maintained.	Mapping of critical habitat will confirm the assumptions of the EIS that there is to be no significant loss of habitat.	The critical habitat will be assessed annually to allow for comparison to EIS predictions.

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Blanding's Turtle – Artificial Nest Mounds) EMP8	The entire CRL site (RSA)	Effectiveness of the mitigation plan to keep Blanding's turtle and other herpetofauna off roads and therefore lessen the risk of road mortality, but still provide nesting habitat	Measurement	Monitor usage of artificial nest sites and success of caged nest sites in producing hatchlings	Monitoring of artificial nesting sites to occur once a week during the nesting season (May 15 – June 30). If turtle nesting is observed and nest cages are implemented, monitor the caged nests for integrity and for hatchlings once a week until the eggs hatch (i.e., until late September / early October and again in the early spring). Cages are to be removed from nest sites by early May to prepare for new nesting. Artificial nesting mounds to be inspected once a year for 5 consecutive years after they are created.	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS and monitoring of nest mounds allow for evaluation of effects.	k) Nest mound surveys will be used to assess ongoing reproductive success of the biota.	Nesting surveys are required to determine if adult females are using the artificial nest mounds	Weekly surveys during nesting season should indicate if nests are being used. Nesting season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020).
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Nest mound monitoring will be used to evaluate the EIS prediction that there will be no significant impacts to Blanding's turtle reproductive success.	Nesting surveys to determine if adult females are using the artificial nest mounds	Weekly surveys during nesting season should indicate if nests are being used. Nesting season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020).

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Blanding's Turtle – Use of Culverts) EMP9	The entire CRL site (RSA)	Effectiveness of the road crossing mitigation plan to keep Blanding's turtle and other herpetofauna off roads and therefore lessen the risk of road mortality. Photos from the remote cameras will be reviewed and analyzed using camera detection software, and all animal species sightings will be documented. The findings of the camera monitoring program will be documented and summarized in the annual monitoring reports	Estimation	Data to be collected consists of photos from the remote cameras.	Camera traps will be used to detect turtle passage throughout the terrestrial period (May – September 30). Camera memory cards will be checked on a weekly basis and either switched for a new card or data downloaded and memory card cleared when nearing maximum capacity	a)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) monitoring of culverts determines effectiveness of the mitigation measures in place	Surveys determine if there is usage of turtle crossing systems.	The terrestrial season is defined by the Ontario Ministry of Natural Resources and Forestry and in 2016 revisions to Forest management: conserving biodiversity at the stand and site scales (MNRF 2020). The frequency and process of collecting photos is based on Ontario Ministry of the Environment, Conservation and Park's *Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species in Ontario* (MNRF 2016).
						e)	s) Blanding's turtle were of concern based on the physical stressors identified in the EIS	c) the critical habitat for these biota were identified as an area of concern in the EIS.	k) Monitoring of culverts assists in evaluating if the EIS prediction that the mitigation plan would result in no adverse population effects.	Surveys determine if there is usage of turtle crossing systems which is used to support the EIS predictions.	The terrestrial season is defined by Ontario's forest management guide and recent direction on Blanding's turtle habitat (MNRF 2020). The frequency and process of collecting photos is based on Ontario Ministry of the Environment, Conservation and Park's *Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species in Ontario* (MNRF 2016).

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Biota (Eastern Milksnake) EMP10	Reptile exclusion fence surrounding the NSDF SSA. Mortality surveys on the road within the LSA.	Fence condition, mortality for herpetofauna	Measurement	Data to be collected includes weekly inspection reports and daily mortality survey reports when applicable.	Temporary exclusion fencing to be inspected weekly during operations During operations mortality survey to be conducted weekly during the species active period (April 15 to September 30)	a)	s) Eastern milksnake were of concern based on the physical stressors identified in the EIS	c) road crossings were considered a significant risk to this species.	K) road mortality occurrences provide information for regarding effects.	Written reports of occurrences will provide documentation of potential effects.	Weekly surveys during Eastern milksnake active season (April 15 to September 30; Environment Canada 2015) can be used to evaluate effects
						e)	s) Eastern milksnake were of concern based on the physical stressors identified in the EIS	c) in the EIS road crossings were predicted to be a significant risk to this species and mitigation therefore recommended	k) road mortality occurrences provide information for adaptive management.	Written reports of occurrences will provide documentation that can be compared to EIS predictions.	Weekly surveys during Eastern milksnake active season (April 15 to September 30; Environment Canada 2015) can be used to evaluation the prediction of no adverse effects.

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Air (dust - radionuclides) EMP11	The sampling locations are the same as for EMP1b. Two sampling locations have been selected for co-location with existing ambient monitors. These locations are A60 (Plant Rd) and A61 (Perch Lake) to represent both upwind and downwind of the predominant winds (Figure 8-1).	SPM samples are to be screened for radioactivity – screening to be conducted for alpha and beta radiation. To detect these items, a Ludlum 3030E Swipe Castle with a 43-10-1 Sample Counter Head is recommended. An alternative may be used that can also identify the radionuclides identified above. To ensure significance of the results air volume passed through the filter shall exceed 1,000m^3. Caution should be taken running the hi-vol for low volumes.	Measurement	High Volume Air Sampler – Filter: Dust	Sampling to start at the commencement of operations and continue throughout operations period. Samples will be collected and screened in parallel with the sample collection in EMP1b. Samples will be collected for a 24-hour period every 6 days.	a)	s) airborne contaminated dust was a concern identified in the EIS.	c) the general area was identified as an area of concern in the EIS . Locating one monitor at the site boundary in the prevailing wind direction and one monitor at the boundary upwind will provide information on the dust concentrations entering and leaving the site, to provide information on potential impacts at surrounding off-site receptors. By monitoring up and downwind locations any release to the environment will be measured and impacts to human or non-human biota outside of the controlled Area can be defined.	k) the EIS has indicated that there is no concern related to inhalation of radionuclides provided proper controls are implemented. Radiological screening is recommended to confirm the absence of effects. The NSDF evaluation of waste inventory (CNL 2020d) indicates the contaminants that may pose a threat to dose via inhalation. The top three radionuclides are Cs-137, Co-60 and Am-241. Alpha and beta screening is considered suitable to confirm no effects from these contaminants of concern.	Measurement is considered appropriate as it is the only method available to obtain data. Activity in Air will be measured and compared against dose benchmarks and baseline values.	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). The monitoring is to continue throughout operations as dust associated with waste may continue to be generated during operations.

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
						c) d)	r) mitigation measures are being conducted to address excessive dust (and possible radiological impacts) which may lead to adverse impacts at surrounding receptors.	f) the location downwind, positioned in the likely impacted area, will provide information on the effectiveness of control measures. Locating the monitor at the site boundary will inform the effectiveness of mitigation activities on predicted air concentrations leaving the site and potential impacts at surrounding off-site receptors. h) the location upwind will provide a relative background that can be used in evaluation of effectiveness of controls.	p) monitoring is being conducted to assess the effectiveness of dust control and SPM is the primary indicator of dust. The radiological screening is recommended as a confirmation of the mitigation. The NSDF evaluation of waste inventory (CNL 2020d) indicates the contaminants that may pose a threat to dose via inhalation. The top three radionuclides are Cs-137, Co-60 and Am-241. Alpha and beta screening is considered suitable for monitoring the controls related to these contaminants of concern. The screening alone is required as a confirmation of control measures	Measurement is considered appropriate as it is the only method available to obtain data to compare to assess the mitigation efforts.	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). The monitoring is to continue throughout operations as dust associated with waste may continue to be generated during operations.

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
						e)	r) Excessive dust may lead to adverse impacts at surrounding receptors. s) airborne contaminated dust was identified was a concern identified in the EIS.	c) The EIS did not identify radiation related to dust as a concern however, the monitoring proposed will serve to verify EIS predictions.	k) Exposure from dust was considered in the EIS. Radiation associated with dust was evaluated relative to other risks and found to be acceptable. The NSDF evaluation of waste inventory (CNL 2020d) indicates the contaminants that may pose a threat to dose via inhalation. The top three radionuclides are Cs-137, Co-60 and Am-241. Alpha and beta screening is considered suitable for confirming EIS predictions related to these contaminants of concern. The screening alone is required to confirm EIS predictions.	Measurement is considered appropriate as it is the only method available to obtain data to compare to the predicted EIS values.	The six day frequency stated is an industry standard for dust analysis and is referenced in the NAPS quality control guidelines (Environment Canada 2004a). The monitoring is to continue throughout operations as dust associated with waste may continue to be generated during operations.

Table 8-4: EMP Detailed Design - Operations

Media	Location	Parameter, etc.	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Ambient air monitoring EMP12a	Monitoring to be conducted at four locations both upwind and downwind of the ECM based on predominant winds (Figure 8-1). Two locations will be at the same location as dust monitoring and two will be along the fenced perimeter of the ECM to provide upwind and downwind coverage.	Sampling for tritium, radon and other volatile radionuclides is to be conducted to match ambient air sampling conducted in the current EMP (CNL 2014d) with the addition of radon. This calls for sampling and analysis of tritium-oxide and carbon-14 using passive samplers; and thermoluminescent dosimeters (TLD) analysis for gamma radiation. Radon can be analyzed with the use of an alpha track detector. Note that noble gas monitoring is not required as there is no source term at the ECM.	Measurement	Passive Samplers, and TLDs: Ambient Air	Sampling to continue as long as the site is generating landfill gas Sampling to be done as part of the EMP (CNL 2014d) with sampling to occur on a continuous basis. Sample and data collection will occur on a: Quarterly basis for tritium oxide and carbon-14; Semi-annual basis for gamma (TLDs); Quarterly basis for radon.	a)	r) Radiation in ambient air during operations can contribute to ecological dose. s) ambient air radiation was identified as a concern in the EIS.	b) The areas beyond the ECM are considered potential habitat and therefore the critical group for future risk/dose evaluation. The locations provide upwind and downwind coverage as close as possible to the ECM and at a distance moderately removed.	k) The EIS has indicated there will be some dose to non-human biota on site and therefore radiological monitoring should be conducted to allow for the calculation of dose as part of future ERAs if needed.	Measurement is considered appropriate as it is the only method available to obtain data.	Continuous sampling will provide the most accurate dose information over the course of a year. Passive Samplers (tritium oxide, carbon-14, radon): Quarterly sample collection from the field permits for the description of seasonal cycles and the interpretation against other environmental media in terms of recent air concentrations. TLDs: Semi-annual sample collection from the field is appropriate given the stability of the medium, and still sufficient to capture seasonal cycles.
						c) d)	r) Mitigation measures are being conducted to minimize dose and the monitoring of ambient air will assess these measures.	f) As the sampling is being conducted to assess mitigation the sample points are located near the discharge but in areas of ecological receptor access.	p) monitoring is being conducted to assess the effectiveness of mitigation measures. The radiological screening is recommended as a confirmation of the mitigation.	Measurement is considered appropriate as it is the only method available to obtain data to compare to assess the mitigation efforts.	Continuous sampling collection will provide the most accurate dose information over the course of a year. Passive Samplers (tritium oxide, carbon-14, radon): Quarterly sample collection from the field permits for the description of seasonal cycles and the interpretation against other environmental media in terms of recent air concentrations. TLDs: Semi-annual sample collection from the field is appropriate given the stability of the medium, and still sufficient to capture seasonal cycles.

Note:
1) Objectives noted in Section 8.1.1.
2) Criteria for monitoring noted in Section 8.1.2.

Table 8-5: EMP Detailed Design - Closure

Media	Location	Parameter, etc	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Water (surface water) EMP3b	Existing monitoring locations in Perch Lake and Perch Creek ■ ESW ■ PL2 ■ PLO ■ PCW Figure 8-2	Analysis for surface water is discussed further in Section 8.1.4.1.1 COPCs including radiological and non-radiological parameters outlined in Table 8-6.	Measurement	Grab Sample: Concentration of COPCs in water	Sampling will typically be performed on a weekly or monthly basis and analysis frequency specific to the COPCs as is currently conducted by CRL's EMP (CNL 2018c) For parameters not identified in the CRL schedule sampling is to take place monthly. Surface water monitoring may also continue if there are indications of leachate leakage from the ECM as indicated by the GWMP.	a)	r) Several of the COPCs that may be present in the contact surface water or leachate are radionuclides and the analysis can be used to assess potential effects to non-human biota. s) several COPCs were identified in the EIS as being of concern.	c) Need to monitor surface water quality downstream of the WWTP discharge location and in the area surrounding the ECM footprint area as these were locations of concern in the EIS. Perch Creek is the creek draining the Perch Creek and Perch Lake Watershed and discharging into the Ottawa River	Parameter selection is discussed in Section 8.1.4.1.1.	Measurement is considered appropriate as it is the only method available to obtain data to evaluate potential effects.	During the discharge period, WWTP discharge will disperse through the receiving environment and attenuate downstream. This attenuation will not be immediate (discharge will assimilate with natural flows and move downstream under the existing hydrograph), so the proposed sampling frequency at each of the downstream assessment nodes is required to track the discharge and confirm water quality remains within EIS predictions. This monitoring will remain in place for the duration of operational discharge from the WWTP.
						c) d)	s) several COPCs were identified in the EIS as being of concern.	f) monitoring at the locations specified is being conducted to confirm mitigation measures are being effectively implemented.	Parameter selection is discussed in Section 8.1.4.1.1.	Measurement is considered appropriate as it is the only method assess the potential presence of leachate or contact surface water in the surface water.	During the discharge period, WWTP discharge will disperse through the receiving environment and attenuate downstream. This attenuation will not be immediate (discharge will assimilate with natural flows and move downstream under the existing hydrograph), so the proposed sampling frequency at each of the downstream assessment nodes is required to track the discharge and confirm water quality remains within EIS predictions. This monitoring will remain in place for the duration of operational discharge from the WWTP.

Table 8-5: EMP Detailed Design - Closure

Media	Location	Parameter, etc	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
						e)	r) Several of the COPCs that may be present in the contact surface water or leachate are radionuclides and the analysis can be used to assess potential effects to non-human biota. s) several COPCs were identified in the EIS as being of concern.	c) Need to monitor surface water quality downstream of the WWTP discharge location and in the area surrounding the ECM footprint area as these were locations of concern in the EIS. Perch Creek is the creek draining the Perch Creek and Perch Lake Watershed and discharging into the Ottawa River.	Parameter selection is discussed in Section 8.1.4.1.1.	Measurement is considered appropriate as it is the only method available to obtain data to compare to the predicted EIS values.	During the discharge period, WWTP discharge will disperse through the receiving environment and attenuate downstream. This attenuation will not be immediate (discharge will assimilate with natural flows and move downstream under the existing hydrograph), so the proposed sampling frequency at each of the downstream assessment nodes is required to track the discharge and confirm water quality remains within EIS predictions. This monitoring will remain in place for the duration of operational discharge from the WWTP.

Table 8-5: EMP Detailed Design - Closure

Media	Location	Parameter, etc	Measurement or Estimation	Sample Type	Frequency & Duration	Applicable Objective[1]	Justification for Media[2]	Justification for Location[2]	Justification for Parameter[2]	Justification for Measurement vs. Estimation	Justification for Frequency & Duration
Ambient air monitoring EMP12b	Monitoring to be conducted at four locations both upwind and downwind of the ECM based on predominant winds (Figure 8-1). Two locations will be at the same location as dust monitoring and two will be along the fenced perimeter of the ECM.	Sampling for tritium, radon and other volatile radionuclides is to be conducted to match ambient air sampling conducted in the current EMP (CNL 2014d) with the addition of radon. This calls for sampling and analysis of tritium-oxide and carbon-14 using passive samplers; and thermoluminescent dosimeters analysis for gamma radiation. Radon can be analyzed with the use of an alpha track detector. Noble gas monitoring is not required as these are not a source term at the ECM.	Measurement	Passive Samplers & TLDs: Ambient Air	Sampling to continue as long as the site is generating landfill gas Sampling to be done as part of the EMP(CNL 2014d) with sampling to occur on a continuous basis Sample and data collection will occur on a: Quarterly basis for tritium oxide and carbon-14; Semi-annual basis for gamma (TLDs). Quarterly basis for radon.	a)	r) Radiation in ambient air during operations can contribute to ecological dose. s) ambient air radiation was identified as a concern in the EIS.	b) the areas beyond the ECM are considered potential habitat and therefore the critical group for future risk/dose evaluation. The locations provide upwind and downwind coverage as close as possible to the ECM and at a distance moderately removed.	k) The EIS has indicated there will be some dose to ecological receptors and this should be measured to calculate dose as part of future ERAs if needed	Measurement is considered appropriate as it is the only method available to obtain data.	Continuous sampling will provide the most accurate dose information over the course of a year. Passive Samplers (tritium oxide, carbon-14, radon): Quarterly sample collection from the field permits for the description of seasonal cycles and the interpretation against other environmental media in terms of recent air concentrations. TLDs: Semi-annual sample collection from the field is appropriate given the stability of the medium, and still sufficient to capture seasonal cycles.
						c) d)	r) Mitigation measures are being conducted to minimize dose and the monitoring of ambient air will assess these measures.	f) as the sampling is being conducted to assess mitigation the sample points are located near the discharge but in areas of ecological receptor access.	p) monitoring is being conducted to assess the effectiveness of mitigation measures. The radiological screening is recommended as a confirmation of the mitigation.	Measurement is considered appropriate as it is the only method available to obtain data to compare to assess the mitigation efforts.	Continuous sampling will provide the most accurate dose information over the course of a year. Passive Samplers (tritium oxide, carbon-14, radon): Quarterly sample collection from the field permits for the description of seasonal cycles and the interpretation against other environmental media in terms of recent air concentrations. TLDs: Semi-annual sample collection from the field is appropriate given the stability of the medium, and still sufficient to capture seasonal cycles.

Note:

1) Objectives noted in Section 8.1.1.

2) Criteria for monitoring noted in Section 8.1.2.

8.1.4.1.1 Surface Water Parameters for Analysis

Surface water analysis is discussed separately from the tables above due to the complexity of selecting parameters for analysis.

8.1.4.1.1.1 General

The NSDF sits within the CRL site, which is located within the Perch Creek and Perch Lake Watershed, which drains to the Ottawa River. Surface drainage from approximately 18% of the CRL site flows through Perch Creek. The Perch Creek and Perch Lake Watershed represents the LSA for this project because most of the drainage from the NSDF footprint will be directed to the Perch Creek and Perch Lake Watershed. However, the NSDF will not be the only facility within the CRL site that will influence Perch Creek and Perch Lake Watershed; the watershed also includes the CRL Built Up Area Drainage Basin, where most of the operational nuclear and industrial facilities are located. The CRL Built Up Area Drainage Basin includes several landfill facilities, including the non-radiological landfill currently in operation, and two groundwater contaminant plumes from the National Research Experimental and National Research Universal reactor facilities that slowly discharge to the Ottawa River through regions of the riverbed. The landfills include legacy waste management areas that represent past waste storage practices at CRL (e.g., Liquid Dispersal Areas). As a result of historic waste practices, some localized areas of the Perch Creek and Perch Lake Watershed remain impacted within the CRL site. These areas of concern are evaluated through annual Environmental Monitoring and CRL's Environmental Risk Assessment conducted on a five-year cycle.

Sources of inflow to surface water in the area of the NSDF are primarily stormwater from non-operational areas and treated water from the WWTP, which may discharge to the exfiltration gallery or Perch Lake. Monitoring is required to confirm the level of risk (Objective a), to provide assurances regarding effluent controls (Objectives c and d) and to confirm the predictions of the EIS (Objective e).

To assess surface water parameters for analysis an evaluation of contaminants of potential concern (COPCs) that may be associated with leachate or contact surface water was conducted (AECOM 2019a). Parameters selected for monitoring in surface water and the justification for these are listed in Table 8-6.

The same suite of analysis is proposed for both operations and closure; however, it is realized that the list of parameters may change based on the data collected and routine reviews. As data are obtained from ongoing monitoring and the WWTP influent and effluent, the parameters to be monitored will be reviewed to ensure all applicable parameters are monitored.

8.1.4.1.1.2 Physical Parameters

Field measurements of physico-chemical parameters, such as pH, specific conductivity, and dissolved oxygen, and temperature, will provide a firm basis to characterize the water quality condition of the assessment nodes within wetlands, Perch Lake, and Perch Creek during open water conditions when discharge is occurring. These data will supplement the chemistry data reported for samples collected for laboratory analysis, and particularly for pH and dissolved oxygen, can also inform the habitat quality of the waterbodies. These parameters are also considered exposure and toxicity modifying factors, which can be used to inform potential for toxicity of specific metals (e.g., varying pH, specific conductivity, and temperature can modify the toxicity potential of aluminum and ammonia to aquatic life), which is important when evaluating potential of water quality data for effects to aquatic life. Additionally, physico-chemical parameters, such as pH and dissolved oxygen, can only be measured and reported reliably from the field, as their hold times are very short, prohibiting their sampling and laboratory analysis.

8.1.4.1.1.3 Radiological Parameters

The radiological parameters for analysis are reduced from the full list of potential elements listed in wastewater (Table 7-26) based on an evaluation of risk and ability to detect issues. It is proposed to monitor for gross alpha, gross beta, gamma emitters, and tritium. The reduced list is based on low relative risks of many of the radionuclides, (e.g., in many cases predicted concentrations in leachate and wastewater are orders of magnitude below discharge criteria) and the ability of a few parameters to provide an indication of potential impacts to surface water.

Gross alpha and gross beta are bulk parameters that indicate the presence of several alpha and beta emitters, respectively. They are selected for their relative simplicity of analysis and cost effectiveness. Gross alpha analysis provides an indication of presence of alpha emitters such as plutonium and uranium isotopes. Gross beta analysis provides an indication of the presence of strontium-90. Where gross alpha and gross beta monitoring indicates elevated concentrations radionuclide specific analysis is performed.

Gamma spectroscopy will provide concentrations of a large suite of gamma emitters including Co-60, a radionuclide predicted to be present in leachate and wastewater at levels that may exceed effluent discharge targets.

8.1.4.1.1.4 Non-Radiological Parameters

Similar to the radionuclides, the selection of conventional contaminants is based on several key indicator compounds and an evaluation of risk. The full list of compounds identified to be present in leachate and contact surface water (Table 7-27) was reduced to the following based on the rationale provided below.

- Hydrides and mercury are not expected to exceed effluent discharge targets and possible issues with these metals are expected to be identified by other metals analyzed.
- The maximum predicted CBOD may exceed benchmarks; however, the presence of leachate and contact surface water is considered to be sufficiently identified by the other radionuclide and conventional contaminants being analyzed.
- Base Neutral Extractables, phenolics, acid extractable phenolics, Chlorinated Dibenzo-p-dioxins and Dibenzofurans, PCBs and PHCs are not expected to exceed effluent discharge targets (with the exception of several base neutral extractables) and the identification of issues related to leachate or contact surface water is better conducted by other organic analysis.
- Tannic acid is not considered a parameter of concern as the wetlands and organic-rich waterbodies (e.g., Perch Lake) associated with the wetlands results in the waters possessing tannins and other coloured compounds (i.e., humic acids).
- Ethylene-diamine-tera acetic acid is also not considered to warrant analysis as this compound is not considered to be harmful to human health and the environment at concentrations predicted.

The justification for the analysis being conducted on surface water is provided in Table 8-6 and in summary the conventional analysis being conducted is:

- Field-measured Temperature, Specific Conductivity, pH, and Dissolved Oxygen
- Nitrogen (nitrate and nitrite)
- Phosphorus
- TSS
- All Metals in ATG 9

- Additional Metals (Fe, U, Mg)
- Volatiles, Halogenated
- Volatiles, Non-Halogenated
- Anions (chloride, fluoride, sulphate)
- Other metals or inorganics (barium, manganese, calcium)

8.1.4.1.1.5 Justification of Parameters For Surface Water Sampling

A summary of the radiological and non-radiological parameters to be monitored is provided in Table 8-6 along with the justification for choosing the parameter for each applicable objective. Non-radiological parameters are monitored by Analytical Test Groups (ATG) identified in the table. It is expected that all parameters within the ATG are analyzed however, where there is more than one applicable parameter, only those noted in brackets under the Parameter Name require review and reporting as indicator parameters. Other analysis conducted as part of an ATG will be retained, since it is opportunistically generated, but is not required to be evaluated.

Table 8-6: EMP Analysis to be Conducted for Surface Water and Justification

ATG	Parameter Name	Justification for Monitoring of Parameter (by Objective)
NA	Temperature, Specific Conductivity, pH and Dissolved oxygen (field)	Objective a) – Criteria l) These field parameters are of usefulness in the evaluation of water quality and potential effects. Temperature is used to evaluate specific conductivity and relative dissolved oxygen saturation. Objective c) d) – Criteria p) The field parameters (and significant changes in them over time) can be indicative of leachate and contact surface water and therefore monitoring of these parameters is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
NA	Gross Alpha	Objective a) – Criteria l) Several of the COPCs that may be present in the contact surface water or leachate are alpha emitting radionuclides and the analysis can be used to assess ecological risk Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
NA	Gross Beta	Objective a) – Criteria l) Several of the COPCs that may be present in the contact surface water or leachate are beta emitting radionuclides and the analysis can be used to assess ecological risk Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
NA	Gamma Emitters (Co-60, Cs-137)	Objective a) – Criteria l) Many of the COPC's that may be present in leachate or contact surface water are gamma emitting isotopes. These include Co-60, Cs-137, Nb-95, Ra-226 and U-235. The analysis can be used to assess ecological risk Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.

Table 8-6: EMP Analysis to be Conducted for Surface Water and Justification

ATG	Parameter Name	Justification for Monitoring of Parameter (by Objective)
NA	Tritium	Objective a) – Criteria l) Tritium is a COPC's that may be present in leachate or contact surface water (and treated WWTP effluent) and the analysis can be used to assess ecological risk Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation and modelling predicted in the EIS.
3	pH	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for pH from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
4b	Nitrogen (nitrate and nitrite)	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for nitrate from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
6	Phosphorus	Objective a) – Criteria k) the maximum predicted concentration of this parameter is not expected to exceed effluent discharge targets however, this parameter is a good indicator of water quality. Objective c) d) – Criteria p) monitoring of this indicator parameter is useful to verify the effectiveness of mitigation however exceedance of benchmarks is not predicted. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
8	TSS	Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. TSS would be an indicator of stormwater management issues. Objective e) – Criteria p) Monitoring is required to verify the mitigation and modelling predicted in the EIS.
9	All Metals in ATG 9 (aluminum and cobalt)	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for aluminum and cobalt from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.

Table 8-6: EMP Analysis to be Conducted for Surface Water and Justification

ATG	Parameter Name	Justification for Monitoring of Parameter (by Objective)
9a	Additional Metals (iron)	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for iron from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
16	Volatiles, Halogenated (chloroform, ethylene dibromide)	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for chloroform and ethylene dibromide from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
17	Volatiles, Non-Halogenated (benzene)	Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Benzene, in particular, is a good indicator of potential leachate and is being analyzed in stormwater and groundwater also.
30	Anions (sulphate)	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for sulphate from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.
NA	Other metals or inorganics (manganese)	Objective a) – Criteria k) There is a potential to exceed effluent discharge targets for manganese from contact surface water or leachate (if present in surface water) and this will be assessed by analysis. Objective c) d) – Criteria p) monitoring of this indicator parameter is required to verify the effectiveness of mitigation. Objective e) – Criteria p) Monitoring is required to verify the mitigation predicted in the EIS.

8.1.4.2 Criteria Used for Evaluation

The information for evaluation of data is provided in the discussion of objectives (Section 8.1.4.3 to Section 8.1.4.7) with additional details provided below. For convenience, the Tier 1 and 2 criteria are summarized conceptually in Table 8-7 below.

Table 8-7: Summary of Evaluation Criteria

Monitoring Program Element	Tier 1 Criteria	Tier 2 Criteria
EMP1a - Air Quality, Dust - Construction	EIS predictions, trend analysis	Ontario Ambient Air Quality Criteria
EMP1b - Air Quality, Dust -Operations	EIS predictions, trend analysis	Ontario Ambient Air Quality Criteria
EMP2 - Hydrology, Environmental monitoring –Construction and Operations	Trend analysis	Comparison to baseline flow (mean plus three standard deviations) where similarly increased flow not observed at MSC
EMP3a - Surface Water Quality, Environmental monitoring – Construction and Operations	EIS predictions, trend analysis	Risk based benchmarks for surface water
EMP3b - Surface Water Quality, Environmental monitoring –Closure	EIS predictions, trend analysis	Risk based benchmarks for surface water
EMP4a - Canada Warbler, Eastern Wood-peewee, Golden winged Warbler, Wood Thrush - Construction, Operations	Continued presence of the species over one monitoring cycle (5 years).	Ongoing presence of the species over at least two monitoring period (10 years).
EMP4b – Eastern Whip-poor-will - Construction, Operations	Continued presence of the species over one monitoring cycle (5 years).	Ongoing presence of Eastern Whip-poor-will (SAR bird) over at least two monitoring periods.
EMP5 - Bats - - baseline (prior to Construction), Construction, Operations	Presence of bats in the bat boxes. Trend analysis to be conducted in occupancy seem to decrease.	Bat boxes abandonment. Review of regional and provincial population trend data.
EMP6 – Blanding's Turtle road mortality- baseline (prior to Construction), Construction, Operations	A Blanding's turtle on the road (alive).	A Blanding's turtle mortality
EMP7 – Blanding's Turtle loss of habitat- (prior to Construction)	Loss of Critical Habitat (mapping exercise)	Decline of local population
EMP8 – Blanding's Turtle - Artificial Nest Mound Survey for Nests	Nest mounds occupancy within 5 years of creation.	Nest mounds occupancy. If not used by the species after 5 years consider additional measures (either add nest mounds, relocate, increase monitoring etc.)
EMP9 – Blanding's Turtle using the turtle crossing systems - baseline (prior to Construction), Construction, Operations	Non detection of BLTU using the turtle crossing systems within 2 years	Non detection of BLTU using the turtle crossing systems after 5 years
EMP10 - Eastern Milksnake - Construction and Operations	Eastern Milksnake found on the road (alive)	An Eastern Milksnake mortality
EMP11 - Air Quality –Radioactivity in Dust, Operations	Trend analysis, 1/5th of Tier 2 criteria	Screening based on potential dose of 0.3 mSv/a
EMP12a - Ambient Radioactivity and Ecological Health - Ambient monitoring for radionuclides - Operations	Trend analysis, 1/5th of Tier 2 criteria	Calculated dose of 0.3 mSv/a
EMP12b - Ambient Radioactivity and Ecological Health - Ambient monitoring for radionuclides - Closure	Trend analysis, 1/5th of Tier 2 criteria	Calculated dose of 0.3 mSv/a

The various criteria used for evaluation of COCs identified in the EMP are listed in Table 8-8 and Table 8-9, which are applied according to a two-tier approach of data assessment discussed in Section 6.2 above. The use of these criteria is discussed in Sections 8.1.4.3 to 8.1.4.7, as they relate to specific EMP monitoring objectives.

The EIS identified the following values based on modelling of specific scenarios which can be used for comparison with EAFMP findings and also provides regulatory standards that are considered indicative of risk.

Table 8-8: Airborne Dust SPM, Lead and Mercury – EIS Predictions and Benchmarks – Tier 1 and 2 Criteria

Indicator	Averaging Period	Tier 1 – EIS Prediction – Construction Phase (µg/m³)	Tier 1 – EIS Prediction – Operation Phase (µg/m³)	Tier 2 Air Quality Guideline/Standard[(a)] (µg/m³)
SPM	24-hour	85.51	38.19	120
SPM	Annual	19.12	14.98	60
PM_{10}	24- hour	31.13	17.83	50
$PM_{2.5}$	24-hour	10.30	8.40	27
$PM_{2.5}$	Annual	3.81	3.66	8.8
Pb	24-hour	—[(b)]	0.0046	0.5
Pb	30-day	—[(b)]	5.00×10^{-7}	0.2
Hg	24-hour	—[(b)]	4.44×10^{-8}	2

Note: Source EIS Table 5.2.1-14.

a) Tier 2 air quality criteria taken from Ontario Ambient Air Quality Criteria (MOE 2012) and Canadian Ambient Air Quality Standards (CCME 2020). Predicted concentrations of lead and mercury from construction activities were not estimated as part of EIS.

For surface water predictions for the surface water contaminants of interest (Tier 1 Criteria) are shown below in Table 8-9 along with risk-based concentrations (Tier 2 Criteria). The Tier 1 criteria represent the maximum predicted concentrations in potentially impacted surface water bodies for two assessed effluent discharge scenarios: 50% discharge to the Exfiltration Gallery and Perch Lake; and 100% discharge to Perch Lake. For some parameters the background concentrations exceed the risk-based benchmarks. For a subset of the parameters (e.g., aluminum, cobalt, iron, manganese, nitrate, nitrite, sulphate and others), the maximum predicted surface water concentration was higher than the effluent discharge targets noted in Table 7-27. In these cases, the risk benchmarks indicated in the EIS (Golder 2020a, Table 5.4.2-5) have been used. Where no risk benchmark is provided in the EIS or where predicted values also exceed the risk benchmarks, there is no Tier 2 Criteria and Tier 1 Criteria alone are to be used (i.e., aluminum, sulphate). Where exceedances are a result of background concentration in surface water, no measurable change to concentrations of these parameters is anticipated as a result of the NSDF project. There are no criteria for physical parameters (e.g., flow, temperature) and these parameters may be used to evaluate potential effects if needed.

The Tier 2 criteria for radiological parameters represent concentrations below which no adverse effects are expected at the population level. The no effect concentrations are derived from radiation benchmarks established for the protection of biota (i.e., 100 microGray per hour [μ Gy/hr] for terrestrial biota and 400 μ Gy/hr for aquatic biota) as discussed in CRL Environmental Risk Assessment. An exceedance of a no effect concentrations does not indicate an effect, rather that there may be the potential for effects. The one exception is tritium concentration in Perch Creek for which the Tier 2 criteria represents the drinking water guideline (Golder 2020a).

The PLO sampling can be compared to the PL modelled point. Perch Lake was modelled as a mixed system and the PLO monitoring point would serve to sample the mixed water from Perch Lake.

The indicator parameters are noted in italics for convenience.

Table 8-9 Surface Water – Tier 1 and Tier 2 Criteria

Parameter	Units	Tier 1 Criteria EIS Scenario 1 – 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake				Tier 1 Criteria EIS Scenario 2 – 100% Direct Discharge to Perch Lake				Tier 2 Criteria Surface Water Criteria	Refence for Tier 2 Criteria
		ESW	PL2	PL	PCW	ESW	PL2	PL	PCW		
Conventional Parameters											
Hardness	mg/L	166	49	30	28	61	40	30	28	NA	NA
pH	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.5 to 9	CCME 1999
Total suspended solids	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	25	CCME 1999
Major Ions											
Calcium	mg/L	46	10	6.6	6.1	7.5	7.4	6.6	6.1	116	Suter and Tsao 1996
Chloride	mg/L	53	108	68	61	16	107	68	61	120	CCME 1999
Fluoride	mg/L	0.043	0.0032	0.0011	9.3×10^{-4}	0	0	0.0011	9.3×10^{-4}	0.12	CCME 1999
Magnesium	mg/L	31	4.6	2.5	2.4	2.5	2.4	2.5	2.4	82	Suter and Tsao 1996
Potassium	mg/L	20	2.4	1.2	1.1	1.0	0.96	1.2	1.1	53	Suter and Tsao 1996
Sodium	mg/L	249	43	22	21	8.4	25	22	21	680	Suter and Tsao 1996
Sulfate	mg/L	229	19	6.9	5.9	2.0	1.5	6.9	5.9	NA[6]	NA
Ammonia	mg N/L	0.0072	5.4×10^{-4}	NCB	NCB	NCB	NCB	NCB	NCB	NA [7]	NA
Nitrate	mg N/L	2.4	0.22	0.087	0.076	0.055	0.041	0.087	0.076	13	CCME 1999
Nitrite	mg N/L	0.11	0.0081	0.0028	0.0023	<MDL	<MDL	0.0028	0.0023	Narrative[4]	AESRD 2014
Phosphorus	mg/L	0.12	0.062	0.046	0.042	0.061	0.058	0.046	0.042	NA[8]	NA
Metals and Metalloids											
Aluminum	µg/L	169	154	112	102	169	154	112	102	NA[6]	NA
Antimony	µg/L	7.2	0.58	0.21	0.18	0.05	0.038	0.21	0.18	180	Suter and Tsao 1996
Barium	µg/L	17	19	14	13	17	19	14	13	110	Suter and Tsao 1996
Boron	µg/L	80	13	7.5	7.0	13	8.1	7.5	7.0	200	MOEE 1994
Cadmium	µg/L	0.065	0.062	0.043	0.039	0.052	0.062	0.043	0.039	0.09	CCME 1999

Table 8-9 Surface Water – Tier 1 and Tier 2 Criteria

Parameter	Units	Tier 1 Criteria EIS Scenario 1 – 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake				Tier 1 Criteria EIS Scenario 2 – 100% Direct Discharge to Perch Lake				Tier 2 Criteria Surface Water Criteria	Refence for Tier 2 Criteria
		ESW	PL2	PL	PCW	ESW	PL2	PL	PCW		
Metals and Metalloids (cont'd)											
Chromium	µg/L	1.4	0.86	0.64	0.59	1.4	0.85	0.64	0.59	1,700	Suter and Tsao 1996
Cobalt	µg/L	0.61	0.37	0.3	0.27	0.45	0.35	0.3	0.27	0.9	MOEE 1994
Copper	µg/L	3.5	8.4	6.2	5.6	3.5	8.4	6.2	5.6	Narrative(1)	AESRD 2014
Iron	µg/L	2.9	2.8	1.8	1.6	2.9	2.8	1.8	1.6	300	CCME 1999
Lead	µg/L	1.2	2.0	1.6	1.4	1.2	2.0	1.6	1.4	7	AESRD 2014
Manganese	µg/L	97	58	50	46	84	56	50	46	2,300	Suter and Tsao 1996
Mercury	µg/L	0.015	0.0085	0.0063	0.0058	0.0085	0.008	0.0063	0.0058	0.026	CCME 1999
Molybdenum	µg/L	15	1.4	0.6	0.53	0.3	0.31	0.6	0.53	40	MOEE 1994
Nickel	µg/L	9.6	1.5	0.9	0.83	0.96	0.83	0.9	0.83	25	CCME 1999
Selenium	µg/L	0.75	1.3	0.89	0.81	0.61	1.3	0.89	0.81	20	Suter and Tsao 1996
Silver	µg/L	1.0	1.0	0.8	0.73	1.0	1.0	0.8	0.73	4.1	Suter and Tsao 1996
Strontium	µg/L	564	101	57	53	39	62	57	53	15,000	Suter and Tsao 1996
Thallium	µg/L	0.12	0.028	0.018	0.017	0.02	0.021	0.018	0.017	0.3	MOEE 1994
Tin	µg/L	26	2.0	0.69	0.57	0.002	0.0021	0.69	0.57	73	Suter and Tsao 1996
Uranium	µg/L	1.8	0.18	0.079	0.071	0.059	0.044	0.079	0.071	5	MOEE 1994
Vanadium	µg/L	3.2	1.1	0.78	0.72	1.6	0.98	0.78	0.72	6	MOEE 1994
Zinc	µg/L	6.4	6.6	5.1	4.7	6.1	6.6	5.1	4.7	7	CCME 1999
Organics											
Chloroform	µg/L	NA	NA	NA	NA	NA	NA	NA	NA	1.8	CCME 1999
Ethylene dibromide	µg/L	NA	NA	NA	NA	NA	NA	NA	NA	5	MOEE 1994
Benzene	µg/L	NA	NA	NA	NA	NA	NA	NA	NA	100	MOEE 1994

Table 8-9 Surface Water – Tier 1 and Tier 2 Criteria

Parameter	Units	Tier 1 Criteria EIS Scenario 1 – 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake				Tier 1 Criteria EIS Scenario 2 – 100% Direct Discharge to Perch Lake				Tier 2 Criteria Surface Water Criteria		Refence for Tier 2 Criteria
		ESW	PL2	PL	PCW	ESW	PL2	PL	PCW			
Radiological												
Caesium-137	Bq/L	3.7	0.29	0.11	0.089	0.15	0.018	0.11	0.089	72.7		CNL 2019e
Cobalt-60	Bq/L	15	1.1	0.4	0.33	0.34	0.038	0.4	0.33	135		CNL 2019e
Gross Beta[3]	Bq/L	293	37	30	28	293	37	30	28	366		CNL 2019e
Gross Alpha[5]	Bq/L	NA	NA	NA	NA	NA	NA	NA	NA	0.385		CNL 2019f
Tritium	Bq/L	1.29×10^5	12,463	5,206	4,903	355	2,802	5,206	4,903	Perch Creek(2)	7.0×10^3	CNL 2019e
										Perch Lake Watershed(2)	1.74×10^7	

Note: The Tier 1 Criteria are the maximum of modelled monthly concentrations from operation conditions during years 45 to 50 of the NSDF Project.

Parameters in italics indicate indicator parameters.

(1) - Other factors need to be considered in the risk assessment (e.g., water hardness).

(2) – The Tier 2 benchmark Perch Creek which discharges to the Ottawa River is set at 7,000 Bq/L, the Health Canada drinking water guideline. Elsewhere in the Perch Lake watershed, the risk benchmark for protection of aquatic biota of 1.74×10^7 (CNL 2019e) is applied.

(3) - Gross Beta assuming Sr-90 is the only contributor. Tier 2 surface water criteria represent Sr-90 and its daughter Y-90 in secular equilibrium. It is noted that the No Effects Concentration (Tier 2 equivalent) for Gross Beta used in the EIS Rev 2, see Table 5.4.2-6, did not credit Y-90 decay and was therefore a factor of two less, that is 183 Bq/L.

(4) - The risk benchmark varies with chloride (AESRD 2014). For chloride concentrations greater than 10 mg/L, the nitrite risk benchmark concentration = 0.6 mg N/L.

(5) – Gross Alpha Tier 2 benchmark represents the Americium-241 no effects concentration. Am-241 is selected to represent gross alpha as it may be present in low concentrations in wastewater and is present in low concentrations in groundwater downgradient of the Liquid Dispersal Areas in the Perch Lake watershed.

(6) As noted in the text above benchmark values for aluminum (100 ug/L) and sulphate (128 ug/L) are not included. This is considered acceptable as aluminum concentrations above 100 ug/L result from naturally elevated baseline concentrations, which are projected to attenuate downstream. For sulphate, the predicted exceedance of the criteria is limited to East Swamp Wier and rapidly attenuates downstream

(7) - Ammonia toxicity is dependent on pH and temperature, and unlikely to exert any toxicity (chronic or acute) at the Effluent Discharge Target of 0.02 mg N/L (Table 7-27). If Tier 1 Criteria are exceeded a Tier 2 Criteria can be obtained based on the pH and temperature obtained during monitoring.

(8) - This specific treated effluent discharge target is not toxicity- or risk-based but is associated with the transition between lake and steam productivity (or trophic status) characteristics (Environment Canada 2004b). Limiting the load of phosphorus in a discharge to a receiving environment is a mitigation tool to manage the risk of increasing productivity in a receiving environment.
NCB – indicates that an incremental increase in the parameter is expected not to be measurable so the projection is no change from existing baseline conditions.

NA – not applicable.

mg/L – milligrams per litre, ug/L – micrograms per litre, Bq/L - Becquerel per litre.

8.1.4.3 OBJECTIVE a) To Assess the Level of Risk on Human Health and Safety, and the Potential Biological Effects in the Environment of the Contaminants and Physical Stressors of Concern Arising from the Facility

A key aspect of environmental monitoring is to assess the level of risk that contaminants and/or physical stressors can pose to humans and the environment. To accomplish this, it is important to measure contaminant concentrations along pathways that are relevant to the human and ecological receptors of interest, in areas that are potentially impacted by site activities, and compare them to baseline concentrations and/or to effects-based criteria (i.e., benchmark values) to identify areas where there is a potential risk. In terms of physical stressors, it is important to collect data on relative abundance and other key demographic parameters for potentially affected biota, and evaluate trends in populations.

In order to assess the level of risk that contaminants and physical stressors may pose to ecological receptors residing on and around the CRL site, and to the public residing in nearby communities, the CRL site-wide Environmental Monitoring Program performs environmental pathways monitoring and identifies the receptors, locations, media, contaminants and physical stressors to be monitored (CNL 2014c, 2014d), and performs biodiversity monitoring to evaluate the population health of various species residing on the CRL site. By virtue of its location within the CRL site, potential effects of the NSDF Project will be subject to the monitoring already in place on a CRL site-wide level.

The information below summarizes those monitoring activities pertaining specifically to the NSDF Project, and performed as part of the NSDF EMP in order to gather the information needed to assess (1) the level of risk that contaminants may pose to human and ecological receptors residing around the NSDF Project site, and (2) the potential for biological effects in the environment as a result of physical stressors arising from the NSDF Project (e.g., habitat loss). The criteria in Section 8.1.4.1, together with information from the EIS (Golder 2020a), were used to identify locations, media, and parameters to be monitored, as well as to identify those biota requiring biological effects monitoring whether through monitoring the characteristics of populations (e.g., relative abundance) or monitoring habitat health. The subsections below provide information on how the data will be used to achieve the defined objectives.

8.1.4.3.1 To Assess the Level of Risk that Contaminants May Pose to Human and Ecological Receptors

Levels of risk are evaluated based on comparison to accepted benchmarks. This evaluation of risk also provides information that can be used to provide assurance to the public and that may relate to Traditional Land Use.

- For airborne dust (EMP1a and 1b), the SPM concentrations obtained are to be compared to the Ontario Ambient Air Quality Criteria (AAQC) (MOE 2012), considered the Tier 2 Criteria (Table 8-8), for a 24-hour sample of 120 µg/m³. The SPM Tier 2 criteria has a nuisance based standard and is used as a surrogate for PM_{10} and $PM_{2.5,}$ which have ambient health based standards (MOE 2012). Three samples are to be analyzed for lead and mercury and the results plotted against SPM values to obtain an SPM trigger level that may be unacceptable for lead or mercury. The acceptable 24-hour air quality standard for lead is 0.5 µg/m³ and for mercury is 2 µg/m³. These Tier 2 Criteria are obtained from the Ontario AAQC (MOE 2012). This assessment is expected to result in an acceptable SPM value less than 120 µg/m³. If this is not the case, a revised acceptable SPM concentration is to be derived and additional lead and/or mercury analysis may be warranted. The airborne dust sampling results are applicable to all VCs.
- Surface water sample (EMP3a, 3b) analysis will be compared to Tier 2 Criteria provided (Table 8-9) as an initial screening. Where exceedances of the Tier 2 criteria are identified further assessment and possibly increased monitoring is required. Comparison to Tier 2 is considered suitable as these concentrations are considered protective of the aquatic habitat. The data can be used to assess potential effects in future ERAs.

- It is noted that some radiological and non-radiological parameters may exceed benchmarks in the environment prior to the NSDF Project being implemented. The EIS (Golder 2020a) indicated several parameters that exceed benchmarks in the Ottawa River. These include aluminium, copper, lead, zinc and iron. Where it is suspected an exceedance of benchmarks is naturally occurring, it should also be compared to historical data and the upper limit of background (i.e., mean plus three standard deviations of background locations) to assess the need for further evaluation. Non-radioactive data that exceeds a benchmark but is below the upper limit of background is not considered an ecological concern (Section 4.4.2.1.2 of the Non-Radioactive EMP (CNL 2014c). Pre-construction sampling for the suite of analytes is recommended at sampling points to establish this baseline if it is not in place already. It is also noted that the tritium Tier 2 Criteria will be dependant on the location of sampling. Overall, the objective for tritium is that water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River (the PCW monitoring point), remain below the tritium drinking water guideline (7,000 Bq/l).
- Radiological screening of dust samples (EMP11) is used to confirm the absence of concerns from this route of exposure. An evaluation was conducted to develop a screening level for radionuclides in dust (Golder 2020b). In this evaluation a human health-based limit of 0.3 mSv/a was used as it was considered more conservative than an ecological dose limit. Based on the dose limit stated, contaminants of concern likely in dust, and the volume of air drawn through the HiVol sampler and a 10-minute count time a Tier 2 Criteria of 40 counts per minute (cpm) above background was considered the Tier 2 Criteria for alpha radiation and 12,000 cpm above background for beta radiation.
- Ambient air radiological analysis (EMP12a and 12b) is to be used to assess potential effects on non-human biota in future ERAs (by calculation of dose, or comparison to benchmark values). Unacceptable effects are not considered likely; however, if estimates are considered unacceptable, changes in placement of waste practices may be warranted and/or further analysis may be required. The Tier 1 criteria for radiation dose is the predicted worker dose rate at the NSDF fence line of 0.625 uSv/hr (CNL 2020c). Tier 1 criteria were also evaluated for Carbon 14 and Tritium in air. Given the low estimates as shown in the Safety Analysis Report (CNL 2020c), Tier 1 criteria will be set at the background values prior to waste emplacement. A limit of 0.3 mSv/a (the human health dose constraint, which is considered a conservative limit for non-human biota) will be considered Tier 2 Criteria and will be evaluated as screening data is acquired. At a minimum it will include committed effective doses from sources such as airborne Tritium, Carbon-14 and Radon, should values above background be found. Doses will be calculated using dose coefficients found in ICRP 119 (ICRP 2012) using the proper chemical from of the radionuclide, or the most restrictive value if the chemical form is not known. Assumptions of a standard breathing rate of 1.2 m^3/hr and an appropriate amount of time for a receptor at site boundaries will be used to calculate a total dose. Radon will be evaluated using a long-term Alpha Track type monitor. Dose will be calculated using the coefficient of 9 nSv/(h X Bq/m^3) multiplied by an equilibrium factor of no more than 0.3 (UNSCEAR 2000).

8.1.4.3.2 To Assess the Potential for Biological Effects in the Environment as a result of Physical Stressors

Monitoring is being conducted of various biota to evaluate the effects of physical stressors on these receptors. The data obtained from this monitoring will be used as follows however, all data are to also be considered along with the CRL site-wide biodiversity monitoring program:

- Surface water elevation and flow data (EMP2) will be evaluated to assess potential risk to ecological receptors and habitat. The concern identified in the EIS was a potentially significant increase in flows with associated erosion. The data collected as part of this monitoring (during construction and operations) will be compared to historical/baseline pre-construction data. Flows that exceed mean plus three standard

deviations from the baseline (Tier 2 Criteria), and where similarly increased flow is not observed at MSC, will be evaluated further. Given the variability in flows each instance of this occurrence should be recorded and the evaluation documented; if specific trends are identified (e.g., storm flows are consistently higher than pre-construction) the wetlands may require further evaluation related to the impact to this habitat (e.g., inspections for erosion). Note that flows can vary considerably naturally, and this should be considered carefully in the evaluation of the data.

- The ARU information (EMP4a and 4b) will provide information related to the prevalence of federally listed bird species. Data collected from the ARU surveys can be used to determine diversity and relative abundance of the songbird population through time as defined by Ralph et al. (1995). The target is to maintain viable populations of native breeding songbirds in the study areas.
- The visual and auditory recordings of bats (EMP5) will provide information on the prevalence of federally listed bats to verify effectiveness of bat boxes as a maternity roosting habitat offsetting measure, by determining number of individuals and species of bats using boxes for roosting habitat. The monitoring is conducted to confirm the ongoing presence of this SAR.
- The assessment of the Blanding's Turtle (EMP6, 7, 8, 9) is to be evaluated and assess whether a viable population of Blanding's turtle remains on the CRL site. Low reproductive success and low recruitment make this species especially vulnerable to extinction even with a very small increase of the annual mortality rate (less than 5%) from anthropogenic activities (Gibbs and Shriver 2002). Therefore, one Blanding's turtle mortality per year is considered significant and, based on the mitigation fence inspections, may require additional mitigation or other measures.
- The mortality surveys for the Eastern Milksnake (EMP10) are to be evaluated to identify the potential effects to the population. More than one identified Eastern Milksnake mortality per year is considered significant and, based on the mitigation fence inspections, may require additional mitigation or other measures.

8.1.4.4 OBJECTIVE c) To Check, Independently of Effluent Monitoring, on the Effectiveness of Containment and Effluent Control, and Provide Public Assurance of the Effectiveness of Containment and Effluent Control, and OBJECTIVE d) Further to the Objective described above, which Provides an Indication on Effectiveness of Effluent Control, where Waste Storage Facilities and Contaminated Lands Exist, the Objective is to Provide an Indication of Unusual or Unforeseen Conditions that might Require Corrective Action or Additional Monitoring such as Groundwater Monitoring.

As noted in Section 8.1.4.1, various monitoring elements are being conducted to assess the effectiveness of mitigation. For these items, the data will be used to meet this objective as follows. The assessment conducted will help foster public trust in the mitigation implemented and/or ensure that corrective actions are taken as appropriate.

- For airborne dust (EMP1a and 1b) the data will be compared to the accepted Ontario AAQC (MOE 2012) for a 24-hour sample of 120 µg/m³, which is a nuisance based standard or an alternative criteria that may be derived as noted in Section 8.1.4.3.1. Mitigation to meet the air quality criteria is considered adequate. If exceedances are identified mitigation measures are to be re-evaluated. Trends are to be evaluated to help identify if there are underlying issues.
- Surface water elevation and flow data (EMP2) collected will be evaluated to assess significant changes from the baseline. The data collected as part of this monitoring (during construction and operations) will be compared to historical/baseline pre-construction data. Flows that exceed mean plus three standard

deviations from the baseline (Tier 2 Criteria), and where similarly increased flow is not observed at MSC, will be evaluated further. Given the variability in flows each instance of this occurrence should be recorded and the evaluation documented. If specific trends are identified (e.g., storm flows are consistently higher than pre-construction) the stormwater management system and SWMPs should be evaluated further (Tier 1 Criteria). Note that flows can vary considerably naturally, and this should be considered carefully in the evaluation of the data.

- Trends in surface water sample (EMP3a, 3b) analysis (Tier 1 Criteria), in particular tritium or other key parameters identified in WWTP effluent, will be analyzed to assess whether potential issues with mitigation are resulting in a general decrease in water quality. Where an upward sustained trend is confirmed further evaluation/monitoring is to be conducted and a plan developed to address the trend, if required.
- Radiological screening of dust samples (EMP11) is used to evaluate the controls at the ECM. An evaluation was conducted to develop a screening level for radionuclides in dust (Golder 2020b). In this evaluation a human health-based limit of 0.3 mSv/a was used as it was considered more conservative than an ecological dose limit. Based on the dose limit stated, contaminants of concern likely in dust, and the volume of air drawn through the HiVol sampler and a 10-minute count time a Tier 2 Criteria of 40 cpm above background was considered the Tier 2 Criteria for alpha radiation and 12,000 cpm above background for beta radiation. A Tier 1 Criteria to evaluate changes from background was determined based on one fifth of the Tier 2 Criteria. This Tier 1 Criteria is 8 cpm above background for alpha radiation and 2,400 cpm above background for beta radiation. These values are approximately three times above the background limit for the instrument.

  Trends in radiological dust screening results (EMP11) may also be used to identify decreasing effectiveness of the mitigation measures (Tier 1 Criteria). In this case the data will need to be evaluated along with data regarding the waste being placed and an upward trend may be the result of waste characteristics rather than mitigation measures. If, when waste characteristics are considered, an upward and sustained trend is identified, improvement to dust management should be considered.
- Ambient air radiological analysis (EMP12a and 12b) data should be reviewed for trends and any observed upward and sustained trends (Tier 1 Criteria), after considering waste characteristics, should be addressed by considering potential changes to waste handling and placement.

8.1.4.5 OBJECTIVE e) To verify Predictions by an ERA (or equivalent), Derived Release Limit (DRL) Model and/or Environmental Assessment (EA), Refine the Models used in the ERA (or equivalent), DRL Model, and/or EA, or Reduce the Uncertainty in Predictions made by the ERA (or equivalent), DRL Model, and/or EA

As indicated in Section 8.1.4.1 various monitoring elements are to be conducted to verify the predictions of the EIS. To meet this objective the data are to be used as follows:

- For airborne dust (EMP1a, 1b) the EIS predicted that SPM concentrations would be less than air quality criteria. The monitoring data are compared to the accepted Ontario AAQC (MOE 2012) for a 24-hour sample of 120 µg/m³, protective of nuisance or an alternative criterion that may be derived as noted in Section 8.1.4.3.1. Exceedances of the EIS values (Tier 1 Criteria, Table 8-8) do not necessarily indicate risk, however, should result in an evaluation of the results.
- The EIS predicted that the peak stormwater flows would be attenuated to pre-construction levels based on the operation of the stormwater management system, SWMPs and WWTP operation (when operational).

Surface water elevation and flow data (EMP2) collected will be evaluated to assess changes over time. The data collected as part of this monitoring (during construction and operations) will be compared to historical/baseline pre-construction data. Flows that exceed mean plus three standard deviations from the baseline (Tier 2 Criteria), and where similarly increased flow is not observed at MSC, will be evaluated further. Given the variability in flows each instance of this occurrence should be recorded and the evaluation documented. If specific trends are identified (e.g., storm flows are consistently higher than pre-construction) the wetlands may require further evaluation related to the impact to this habitat (e.g., inspections for erosion). Note that flows can vary considerably naturally, and this should be considered carefully in the evaluation of the data.

- The EIS predicted surface water would not adversely affect the wetlands, Perch Lake, and Perch Creek for each of the discharge scenarios (50% of the WWTP to the Exfiltration Gallery and 50% to Perch Lake, and 100% to Perch Lake). Surface water sample (EMP3a, 3b) analysis will be compared to the Tier 1 Criteria (Table 8-9) as an initial screening. Where exceedances of the Tier 1 Criteria are identified, further assessment and possibly monitoring is required. The data can be used to assess exposure/dose in future ERAs if needed and an exceedance of a Tier 1 Criteria is not indicative of effects.
- The EIS predicted that the breeding bird population in the RSA will not be adversely affected because habitat is unlikely to be a limiting factor in the RSA and the breeding songbird population is resilient and adaptable (EMP4a, 4b). If the predictions are not true and there is a decline in the diversity and relative abundance of the local breeding songbird population (steeper decline than in other comparable local populations determined through breeding bird records and/or long term monitoring programs such as the Ontario Breeding Bird Atlas; Cadman et al. 2007), then results from the ARU surveys will be used to consider the implementation of additional mitigation (Tier 1 Criteria).
- The EIS predicted that the local population of SAR bats (EMP5) would not be adversely affected as viable alternative maternity roosting habitat remains in the RSA and artificial bat roosting habitat (bat boxes) have been deployed. The SAR bat populations are already being significantly affected by White Nose syndrome and the NSDF Project is not anticipated to have a detectable change to bat populations,
- The EIS predicted that the local Blanding's turtle population would not be adversely affected (EMP6 to EMP9) as the appropriate comprehensive mitigation plan will be applied. The annual report of camera monitoring (EMP9), in particular, will be used to refine future plans for culvert replacement and installation of exclusion fencing. If the predictions are not true and the population is becoming adversely impacted then an adaptive management plan as outlined in the *Blanding's Turtle Road Mortality Mitigation Plan* (Golder 2019) will be implemented. As part of the adaptive management component the results from the road mortality surveys will be used to consider the implementation of additional mitigation. For example, if there are additional or new road mortality hotspots, permanent exclusion fencing, crossing structures, and/or reduced speed limits during the nesting period may be implemented at these locations. Depending on results of monitoring, CNL is committed to taking additional actions, as required, to achieve a neutral or positive contribution to Blanding's turtles.
- The EIS predicted that the local Eastern milksnake population would not be adversely affected given their resilience and adaptability (EMP10). If the predictions are not true and the population is becoming adversely impacted, then additional actions may be taken by CRL to protect and mitigate further impacts to the species
- Radiological screening of dust samples (EMP11) is used primarily to confirm the absence of concerns from this route of exposure. The EIS considered this a negligible source of ecological dose. If Tier 1 or 2 Criteria indicates this is not the case further evaluation and monitoring should be considered. The levels of concern should be based on the radionuclides identified in the waste and specifics of the analysis conducted.

8.1.4.6 OBJECTIVE g) To Provide Resources and Data that can be of Value during the Response to an Accident or Upset, and in the Recovery from such an Event

The CRL site-wide Environmental Monitoring Program provides standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of contaminants. The environmental monitoring in place for the NSDF is no different - all data provided by the environmental monitoring program and described throughout Section 8.0 in this document, can contribute to this objective.

8.1.4.7 OBJECTIVE h) To Demonstrate Due Diligence

This objective serves to build trust and increase the credibility of CNL in the eyes of the public. Since the EIS has not suggested any likelihood of adverse NSDF Project effects on outdoor tourism and recreation, traditional land and resource use, nor on Indigenous use and enjoyment of private property, monitoring and follow-up programs are not specifically identified for these. Much of the environmental monitoring activities performed to meet other objectives are also used to demonstrate due diligence in this regard. The monitoring activities for air quality, surface water hydrology and quality, terrestrial biota and ambient radiation serve to promote land user comfort around the safety of the traditional land and resource use within the LSA, RSA and surrounding areas.
The monitoring activities can help reduce perceptions of adverse NSDF Project effects on land and resource use that are not anticipated to occur.

8.2 Performance and Acceptance Criteria

This Section covers Step 5 of the Systematic Planning Process *Specify Performance and Acceptance Criteria* (see Figure 6-1).

The performance and acceptance criteria, which the program's monitoring data are required to achieve in order to ensure that they are adequate for their intended purpose(s), are outlined in this Section.

8.2.1 Acceptance Criteria

The acceptance criteria in place for water based samples at the Chalk River site are as follows:

Table 8-10: Field Sample QV Acceptance Criteria

Field QV Samples	Quality Verification Test	Acceptance Criteria (CNL 2014a)
Travelling Blank	Contamination	Results below 3 times LMDL
Travelling Spiked Blank	Accuracy	Recovery (Determined Value/Expected *100) between 30 – 150%
Duplicate	Precision	Ratio of the two replicate results between 0.5 and 2.0

The handling of sample data for those samples which do not meet these acceptance criteria for a number of reasons (e.g., variance in sample and duplicate collected, laboratory issues) is discussed in CNL's Environmental Monitoring Programs (CNL 2013).

The method detection limits for all radiological and non-radiological compounds should be consistent or lower than the the Tier 1 and 2 Criteria indicated in Table 8-9. The intent for this approach is that monitoring results should allow for comparison to these criteria.

Where a required method detection limit cannot be reasonably obtained, this deficiency should be documented as well as an assessment of the effects that this elevated method detection limit may have on the overall objectives.

8.2.2 Performance Criteria

The performance criteria for the various monitoring types is provided below.

8.2.2.1 Sample Unavailability

Sample unavailability could be the result of a number of circumstances; for example, sampling according to the monitoring schedule was missed, the collected sample was contaminated or lost, etc. As outlined in CNL's Environmental Monitoring Programs (CNL 2013), the performance of EMP monitoring systems shall be monitored and instances of unavailability (e.g., ARU not functioning, missing passive sampler for radiological ambient air) shall be documented in the annual EMP report to the CNSC. Whenever an unavailability of an EMP monitoring system occurs, an ImpAct shall be raised. Samples that are unavailable should be documented as well as the reason for not obtaining the data.

It is expected that a certain number of samples each year will be unavailable due to sampling equipment malfunction or other logistical reasons. The minimum targets for the number of planned samples to be obtained for acceptable EMP performance are listed in Table 8-11 below, with all parameters meeting data acceptance criteria. The 90% and 75% targets are based on the potential effect that missing a monthly or quarterly sample would have on the annual average concentrations. In both cases, based on expected variability among samples, one missing sample would not significantly affect the annual average, or unacceptably reduce the precision in dose assessments based on average concentrations.

Table 8-11: Targets for Percentage of Planned Samples to be Obtained in all Environmental Media

Collection Frequency	Minimum Target for% of Planned Samples Obtained
Weekly	90%
Quarterly	75%
Quarterly	75%
Semi-annual	100%
Annual (or greater)	100%

8.2.2.2 Dust Monitoring Performance Criteria

SPM analysis will be performed by a qualified laboratory with a management system meeting or exceeding the requirements of CNL monitoring services' Radiological and Non-Radiological Monitoring Services QA Plan (CNL 2016a).

A travelling blank sample will be completed on a monthly basis.

8.2.2.3 Surface Water Monitoring Performance Criteria

To assess field and laboratory performance, quality control samples such as duplicates, spiked blanks, and/or field blanks will be collected and analysed as necessary. Trip blanks may also be used when sampling for volatile compounds (e.g., VOCs) as they pose a risk for cross-contamination and where further assessment of a particular issue is required.

Field instruments are to be calibrated as per the manufacturer's instructions and a record of calibration maintained with the field files.

8.2.2.4 Species at Risk (SAR) Monitoring Performance Criteria

Audio breeding bird point counts are to be transcribed by an avian biologist with extensive experience conducting breeding bird point counts in the sampled region or by Kaleidoscope.

Using the clustering capabilities of Kaleidoscope, each recording will be assessed for ‘like or similar’ vocalizations based on a specific set of clustering parameters; whereby ‘like or similar’ vocalizations will be grouped together into clusters based on similarity. Once the data are batch process, each cluster will be manually reviewed in the Kaleidoscope viewer to determine species present per survey station. The cluster analysis capabilities of Kaleidoscope eliminate the need to manually listen to large dataset of audio files. It is important to note that the analysis will determine species richness per survey station only.

For each cluster Kaleidoscope will produce, the top 10% of vocalizations (i.e., the best ‘like or similar’ vocalizations within the cluster) will be manually assessed to determine species identification and breeding evidence (i.e., possible or probable) per survey station. With respect to breeding evidence, the Ontario Breeding Bird Atlas (Bird Studies Canada 2001-2005) includes four breeding categories (i.e., observed, possible, probable and confirmed). Based on the breeding criteria associated with each of the four breeding categories, and given species identification will be based on audio alone, only possible and probable breeding evidence will be provided for each species identification.

Regardless of the method of data analysis, 10% of the data is to be verified by a senior biologist (i.e., senior reviewer).

8.2.2.5 Ambient Air Monitoring for Radionuclides

Detection limits for the analysis are those provided in Table 5-10 of the EMP (CNL 2014d). For radon, the detection limit is recommended to be equivalent to concentrations in background ambient air. Care should be taken in the evaluation of radon data to consider the potential effects of other alpha emitting radionuclides that may be present in outdoor air.

8.3 Quality Assurance and Quality Control

Numerous aspects of a QA/QC program are provided in the performance and acceptance criteria above (Section 8.2). In addition to these requirements the following elements are also considered part of the QA/QC program for the NSDF EMP program.

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring (e.g., on-site chemistry labs, external labs) for the NSDF have comprehensive QA/QC programs as required by CNL monitoring services’ Radiological and Non-Radiological Monitoring Services QA Plan (CNL 2016a) which complies with the requirements of N288.4-19 (CSA 2019).

Specific sampling and analysis methods for surface water monitoring are those used by CNL in other programs such as the CRL site-wide EMP (CNL 2014c).

Analysis of SPM (EMP1a) is to be conducted by an accredited laboratory with a management system meeting or exceeding the requirements of CNL monitoring services’ Radiological and Non-Radiological Monitoring Services QA Plan (CNL 2016a).

8.3.1 Roles and Responsibilities

The roles and responsibilities are those that apply to the CNL EMP overall and are defined in CNL's Environmental Monitoring Programs document (CNL 2018b). Tasks may be contracted (i.e., laboratory analysis, sample collection) and these roles and responsibilities should be clearly defined.

8.3.2 Equipment Maintenance

Equipment that is used in conjunction with the NSDF EMP (e.g., HiVol samplers, ARUs) is subject to maintenance and calibration activities on a regular basis. Use of equipment is part of CNL's routine procedures and policies used for the overall CRL EMP or alternatively the equipment suppliers' procedure manuals. Each procedure provides information on the methods used for equipment/instrumentation maintenance, the frequency of maintenance and calibrations, and the documentation of information. All equipment issues, such as equipment malfunctions, calibration issues, cross-contamination events, and procedural errors are brought to the attention of line management during the year. The matters are raised by documenting the occurrence in the CRL ImpAct system and during the annual program review.

8.4 Continual Improvement of the EMP

The majority of processes and requirements for the execution of the EMP for the Chalk River site can be found in CNL's Environmental Monitoring Programs procedure (CNL 2013) and the CRL Integrated Environmental Monitoring Program Framework (CNL 2015).

In addition to the information in these two documents, this section covers the information which is specific to the continual improvement of the EMP. As outlined in the CRL Integrated Environmental Monitoring Program Framework (CNL 2015), many of the required changes for the EMP will be identified during the formal reviews which take place for the program. There are instances, however, where changes to the program need to take place in between these reviews. In either case, changes to the program are formally documented as per the requirements of CNL's Environmental Monitoring Programs procedure (CNL 2013).

This section describes processes which are followed by the EMP when changes to the monitoring schedule are required (either during routine reviews or between routine reviews).

8.4.1 Decreasing Parameter Monitoring Frequency

Reductions in monitoring are at times required in order to ensure that the monitoring program does not grow to a size that overwhelms CNL's monitoring staff and facilities and to refine the program to ensure only meaningful monitoring is taking place.

Despite meeting one or more of the Need for Monitoring Criteria- Parameter (Section 8.1.4.1), in instances where the absence of anomalous results and/ or the absence of results above the detection limit are observed over a period of time, the monitoring frequency may be reduced based on the professional judgment of CNL EMP Staff. Consideration is given to the purpose and history of the monitoring of that parameter at that location.

For sample frequency to be decreased, the sample results at the decreased frequency (e.g., annual) are compared to the current sampling frequency (e.g., quarterly) using the appropriate statistical method and determined to not be significantly different. This 3-Step process is depicted in Figure 8-6. Where a NSDF phase is relatively short and sampling infrequent there may not exist sufficient data to decrease frequency within a phase.

A further reduction in frequency or elimination of monitoring should be considered where reduced frequency has taken place and the parameter continues to not be of concern in any area of the integrated monitoring program. Again, professional judgement of EMP staff should be used and consideration given to the purpose and history of the monitoring of that parameter at that location when making this decision.

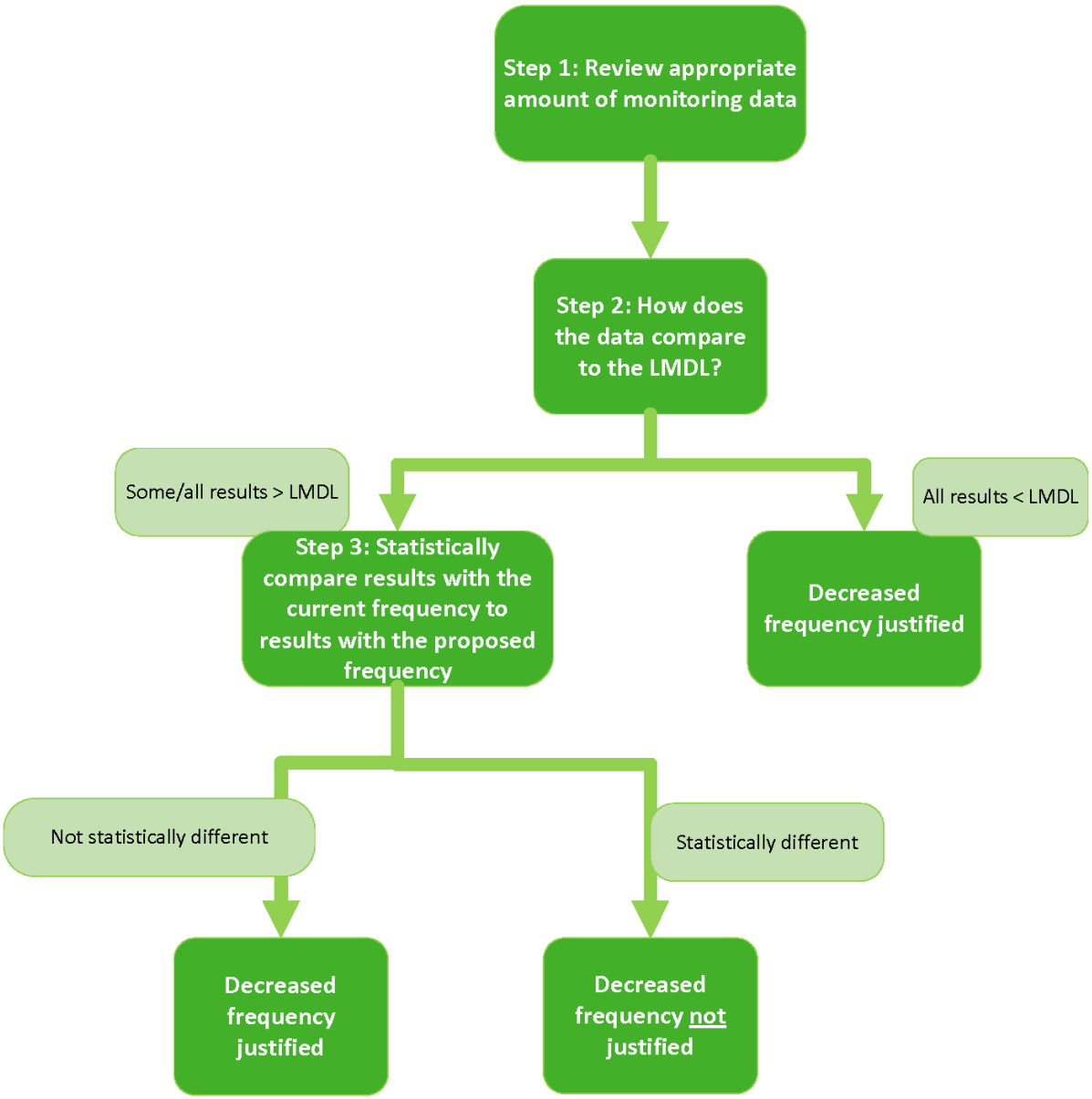


Figure 8-6: Three Step Process Used to Determine Whether a Decrease in Monitoring Frequency is Acceptable

8.4.2 Increasing Parameter Monitoring Frequency or Addition of a New Parameter

In the event that anomalous results are observed and the monitoring objectives warrant a higher monitoring frequency and/or the addition of a new parameter the frequency of monitoring may be increased in order to better determine the variability in the monitoring results. Parameters may be added based on information obtained from sampling programs, including those not necessarily related to the EMP (e.g., data from the WWTP influent). The increase in frequency or addition of parameters is done through a special investigation (outside of the routine monitoring program) or within the routine monitoring program (added to the monitoring schedule) and again, is based on the professional judgement of CNL's EMP staff.

Note: If this occurs in the instance where the frequency of the parameter monitoring was previously reduced due to the absence of anomalous result, the original monitoring frequency and/or original set of parameters to be analyzed will be considered.

8.5 Moving Monitoring from Follow-up Monitoring to Routine EMP Program

Monitoring conducted during the construction phase is considered relatively short term and therefore is not recommended to be moved to the routine EMP program. The long-term monitoring can be incorporated into the existing EMP immediately as any effects would occur in the longer term and operation of this program is best implemented within the overall EMP. Shorter term monitoring of effects on surface water levels and flow from installation of the ECM and WWTP operations would also be incorporated into the existing EMP. When incorporated into the CRL EMP, evaluation and reporting can be conducted within the EMP however, separate reporting (or a summary of the monitoring specific to NSDF) may be required as a condition of the NSDF licence.

Table 8-12 provides proposed duration of separate reporting under the EAFMP for EMP monitoring elements.

Table 8-12: EMP – Moving from EAFMP to CRL EMP

Monitoring Program Element	CRL Program	Duration of Separate Reporting under the EAFMP	Justification
EMP1a - Air Quality, Dust - Construction	NA	NA	As this monitoring is conducted during construction only, it is not practical to conduct reporting as part of the overall EMP for the limited timeframe.
EMP1b - Air Quality, Dust - Operations	CRL EMP	Following two years of operations	After the first two years of operation, there will be a significant dataset and assuming the objectives are met at the time, the reporting will be transitioned from the EAFMP to the CRL EMP. It is realized that there may be insufficient data for trend analysis; however, this is not considered a limitation to transition the reporting to the CRL EMP. Data collection and trends analysis will continue in the CRL EMP.
EMP2 - Hydrology, Environmental monitoring – Construction and Operations	CRL EMP	Following two years of operations	After the first two years of operation there will be a significant dataset, and assuming the findings indicate values below the Tier 2 Criteria, the reporting will be transitioned from the EAFMP to the CRL EMP.
EMP3a - Surface Water Quality, Environmental monitoring – Construction and Operations	CRL EMP	Following two years of operations	After the first two years of operation, there will be a significant dataset and assuming the objectives are met at the time, the reporting will be transitioned from the EAFMP to the CRL EMP. It is realized that there may be insufficient data for trend analysis; however, this is not considered a limitation to transition the reporting to the CRL EMP. Data collection and trends analysis will continue in the CRL EMP.
EMP3b - Surface Water Quality, Environmental monitoring –Closure	CRL EMP	NA	This reporting will have been transitioned to the CRL EMP prior to Closure.
EMP4a - Canada Warbler, Eastern Wood-peewee, Golden winged Warbler, Wood Thrush - Construction, Operations	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented at CRL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.

Table 8-12: EMP – Moving from EAFMP to CRL EMP

Monitoring Program Element	CRL Program	Duration of Separate Reporting under the EAFMP	Justification
EMP4b – Easter Whip-poor-will - Construction, Operations	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP5 - Bats - - baseline (prior to Construction), Construction, Operations	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP6 – Blanding's Turtle - baseline (prior to Construction), Construction, Operations	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP7 – Blanding's Turtle - (prior to Construction)	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP8 – Blanding's Turtle - Artificial Nest Mound Survey for Nests	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP9 – Blanding's Turtle - baseline (prior to Construction), Construction, Operations	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP10 - Eastern Milksnake - Construction and Operations	CRL site-wide biodiversity monitoring program	Immediately	The monitoring element is being implemented by CNL at this time and given that the data should be evaluated for the NSDF and the entire CRL site, it is considered practical to maintain the monitoring and reporting within the existing CRL EMP.
EMP11 - Air Quality - Operations	CRL EMP	Following two years of operations	After the first two years of operation, there will be a significant dataset and assuming the findings indicate values below the appropriate criteria, the reporting will be transitioned from the EAFMP to the CRL EMP.
EMP12a - Ambient Radioactivity and Ecological Health - Ambient monitoring for radionuclides - Operations	CRL EMP	Immediately	A very similar monitoring element is being implemented at the CRL site at this time and given the complexity of the monitoring, it is most efficient and effective to conduct this as part of the CRL EMP at the time of operations.
EMP12b - Ambient Radioactivity and Ecological Health - Ambient monitoring for radionuclides - Closure	CRL EMP	NA	This reporting will have been transitioned to the CRL EMP prior to Closure

9.0 GROUNDWATER MONITORING PROGRAM

The NSDF EAFMP Groundwater Monitoring Plan (GWMP) is based on the steps defined by CSA N288.7-15 (CSA 2015) and Chalk River's standard for the protection and monitoring of groundwater (CNL 2020b). These steps are part of a systematic informed planning process and are listed below along with the sections indicating where they are located in the document:

1) Define the objectives of the GWMP (Section 9.2);
2) Identify the information required to meet each objective including the:
    a) monitoring strategy (Section 9.4);
    b) location of boreholes and monitoring wells (Section 9.5);
    c) sampling and monitoring frequencies (Section 9.6); and
    d) nuclear and hazardous substances to be monitored (Section 9.7).
3) Define the spatial and temporal boundaries of the GWMP (Section 9.2.1);
4) Determine how the data collected will be used to evaluate whether the defined objectives are met (Sections 9.2 and 9.13);
5) Data quality considerations: performance and acceptance criteria (Section 9.11);
6) Develop groundwater evaluation criteria as needed to interpret GWMP results (Section 9.13); and
7) Identify the process for addressing exceedances of the groundwater evaluation criteria (Section 9.13).

The GWMP is part of the larger GWPP (CNL 2020b) and GWMP (CNL 2020a) at Chalk River which includes general and specific goals. The general goals of the GWPP are to:

- Demonstrate compliance with requirements of the CNSC (e.g., REGDOC 2.9.1; CNSC 2020) concerning protection of groundwater and monitoring for the release of nuclear and hazardous substances from facilities;
- Have control measures to prevent or minimize the release of nuclear or hazardous substances directly or indirectly to groundwater by design and operation of structures, systems, components (SSCs);
- Understand the potential risks to human and ecological receptors from releases that affect groundwater;
- Have in place a GWMP to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to signal when and where, and
- Protect the identified groundwater end-uses that are potentially affected by releases to groundwater.

The specific groundwater protection goals of the CRL GWPP shall:

- Be developed based on the conceptual site model (CSM);
- Include protection of human and ecological receptors potentially affected by groundwater contamination; and
- Include consideration of risks from potential contamination of the soil by groundwater or by non-releases and plumes for the effects of radiological and chemical contaminants.

9.1 Conceptual Site Model

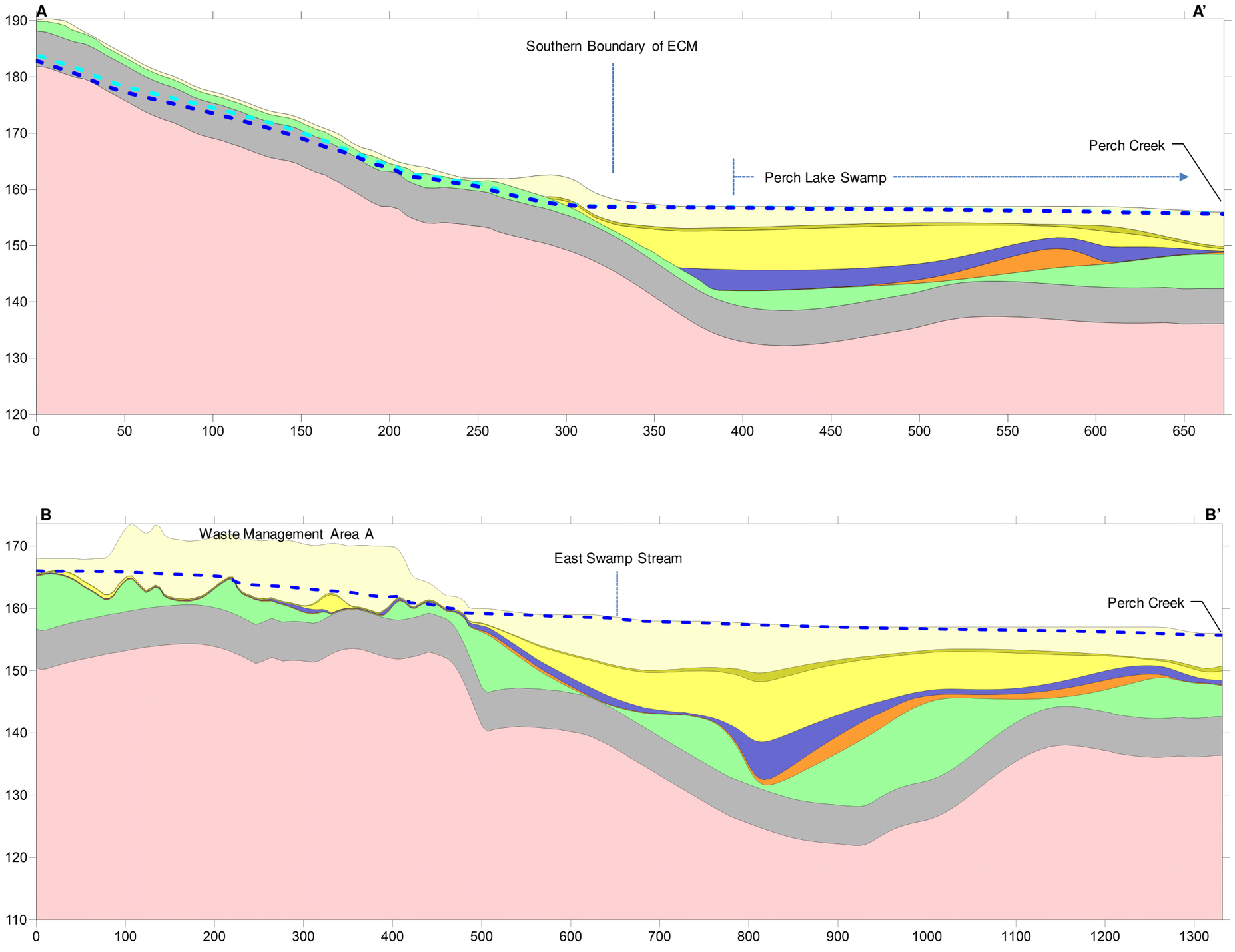
The conceptual site model that described the hydrogeological environment within the SSA, and its setting in a regional context is discussed in the EIS (Section 5.3.2.4 of the EIS (Golder 2020a) and within CNL's memorandum regarding proposed operational control groundwater monitoring for the NSDF (CNL 2018d) The reader is referred to these documents for further details regarding the conceptual hydrogeological model. An overview of the conceptual site model is provided below.

9.1.1 Hydrogeology

The water table elevation within the NSDF Project site, and throughout the lower Perch Lake Basin is shown on Figure 9-1. Within the Lower Perch Lake Basin, groundwater flow within the overburden is influenced by local topography (and bedrock topography) and is interpreted to be primarily horizontal (CNL 2016b). In the overburden deposits, groundwater flow occurs mainly within the basal sand and gravel, middle sand, and upper sand units where present (CNL 2016b). As the silty clay and interstratified silt and sand units that separate these aquifers are not continuous throughout the valley, groundwater elevations, groundwater flow directions, and horizontal hydraulic gradients are not differentiated between units.

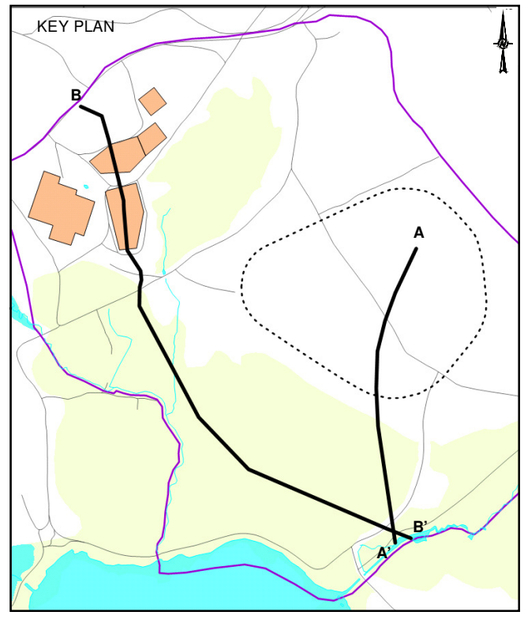
The available data includes monitoring wells located at the peak of the bedrock ridge to the northeast of the ECM (e.g., W8, PH17-005, PH17-008, PH17-009, BH2-6, etc.). Data from these locations indicate the presence of a northeast to southwest groundwater divide corresponding to the topographic high along the ridge. Hydrogeological mapping of the CRL site completed by Raven Beck Environmental Limited (Raven Beck 1994) also infers the presence of a groundwater divide along this ridge.

Within the southern portion of the Perch Lake Basin, groundwater flow is generally towards Perch Lake to the south with a component of flow to the southeast towards Perch Creek. Within the NSDF Project site, groundwater flow to the north of the Powerline Cut is generally to the northwest towards the East Swamp. In this area hydraulic gradients are low. South of the Powerline Cut, groundwater flow is generally to the south towards Perch Lake Swamp.



LEGEND

- Simulated Water Table (Average Conditions)
- Simulated Water Table (Seasonal High Conditions) Shown for Section A Only
- Upper Sand
- Interstratified Silt and Sand
- Middle Sand
- Clayey Silt
- Basal Sand
- Till
- Bedrock (upper 6 m)
- Bedrock (>6 m depth)



NOTE(S)
1. VERTICAL EXAGGERATION IS 3.0.

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM, CHALK RIVER, ONTARIO

TITLE
HYDROSTRATIGRAPHIC CROSS-SECTIONS WITH SIMULATED WATER TABLE ELEVATION

CONSULTANT
GOLDER

DATE	2021-02-10
DESIGNED	NFB/MIB
PREPARED	SO
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
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9.1.2 Water Quality

To date, 21 wells in and adjacent to the proposed SSA have been sampled for inorganic water quality parameters and for a number of radiological parameters. Although the wells were purged repeatedly to remove drilling water prior to sampling, at some locations drilling water may still have been present. As discussed in CNL's *Baseline Groundwater Chemistry Evaluation of the Proposed NSDF Site* (CNL 2018e), the results of the sampling (neglecting the potential influence of drilling water) indicate the following:

- Groundwater collected from wells screened in rock had pH levels of between 5.9 and 8.0, and in groundwaters from well screened in overburden (or straddling the overburden/bedrock contact) pH levels were between 5.4 and 7.2.
- Total dissolved solids concentrations ranged from 43 to 370 mg/L. Bedrock groundwater was either dominated by sodium and bicarbonate or by calcium-magnesium bicarbonate with sulphate at concentrations between 4 and 22 mg/L as the next most abundant anion. The one exception was water from bedrock well W-7, which contained 115 mg/L of sulphate and 15 mg/L of chloride.
- Overburden groundwater chemistry is characterized as dilute calcium-magnesium bicarbonate-sulphate, although most of the wells located downgradient (west) of the East Mattawa Road also feature low levels of road salt contamination. Nitrate concentrations are generally less than 1 mg/L, with one sample containing 1.5 mg/L, and one trace detection of nitrite. Phosphate and total phosphorus were not detected in any of the samples.
- Groundwater from well SH-4 contained 6.8 mg/L of iron, indicating moderately reducing conditions in the groundwater at that location. This well is located at the margin of the Perch Lake Swamp and the top of the well screen is at the base of the surficial organic-rich sand; this may account for the relatively high iron concentration. Otherwise, iron concentrations range from 4 to 990 µg/L, indicating moderately to highly oxidizing conditions in the local flow system.
- Most trace elements are present at concentrations below the background concentration limits expected in *Ontario Regulation 153/04* (Table 1). The exceptions to this are cobalt (well W-5), copper (wells W-5 and W-2S), nickel (wells W-5 and W-2S), and zinc (wells W-7, W-8, W-2S, W-3, and W-4). Elevated copper and nickel concentrations are highly correlated with each other and moderately correlated with elevated nickel. This, coupled with the general decreases in their concentrations between 2016 and 2017, argue for a drilling-related source of these metals. The cause of the zinc anomalies remains unexplained.
- The radiological analyses of the 2017 September samples did not encounter elevated concentrations of tritium, alpha or beta emitting radionuclides, or gamma emitters.

Groundwater sampling and water level monitoring is ongoing at wells noted as installed in Table 9-3 as part of CNL's OCM program (CNL 2018d). Date from this program is be used when evaluating effects from the NSDF.

9.1.3 Potential Impacts

9.1.3.1 Groundwater Elevations and Flow Pathways

The potential hydrogeological impacts resulting from the project were identified to be primarily related to the WWTP and the ECM. During operations, the WWTP will discharge a portion of its treated effluent to an exfiltration gallery located downgradient of the facility. The ECM is designed with a double baseliner and will be subsequently filled one cell at a time. Each cell will be covered with an impermeable cover after it is filled. Overall, these engineered impermeable barriers will result in a reduction in surficial recharge to the water table in the local vicinity of the ECM. Cell development within the ECM will be staged, and as such, potential effects in early stages of development of ECM will be limited to cells where waste has been placed (i.e., active cells, filled cells).

During normal operating and closure/post-closure conditions, the ECM is expected to isolate and contain waste and leachate is expected to be effectively treated in the WWTP. Discharge of treated effluent from the WWTP to the receiving environment is expected to meet effluent discharge targets (CNL 2019b).

Hydrogeological modelling for the NSDF was completed to estimate the groundwater flow pathways from the ECM, and the rates of groundwater flow from the SSA to downstream receptors. This was accomplished by constructing a groundwater flow model based on the conceptual model and calibrating it to the existing conditions. The model was configured to represent operations and post-closure project conditions, including scenarios where the cover and liner of the ECM were assumed to be compromised. The results of the modelling indicated the following:

- During operations, when the WWTP is operational, groundwater particles released from the exfiltration gallery area travel towards the west, ultimately discharging at the East Swamp. The majority of the particles discharge to the East Swamp immediately downgradient from the exfiltration gallery. During the operations phase, the additional infiltration applied at the exfiltration gallery results in a localized increase in water table elevation of up to 1 m compared to the current conditions.
- The modelling demonstrated that the covering and lining of the ECM will result in a decrease in groundwater elevations of up to 8 m in the central portion of the ECM, decreasing to 1 m at the periphery of the ECM. Similarly, there was simulated to be localized drawdown in the vicinity of the SWMPs (which are lined) of up to approximately 1 m, limited to the area of SWMP #1.
- Post-closure Scenarios were simulated assuming the ECM cover and liner were compromised. For these simulations, groundwater from beneath the ECM followed a flow path towards the south-southeast, with the majority of particles discharging to Perch Creek (a small portion of the particles released from the westernmost and easternmost spillover area locations discharged at surface to the Perch Lake Swamp). Groundwater travel times between the ECM and Perch Creek ranged from approximately 5 years to 15 years with the majority of groundwater arriving between approximately 7 and 10 years.

9.1.3.2 Groundwater Quality

During operations, the impacts on groundwater from discharge of treated WWTP effluent will be negligible as the treated effluent will meet effluent discharge targets that are protective of the environment and human health. The discharge targets for non-radiological contaminants are sourced from federal and provincial guidelines for protection of aquatic biota. The discharge targets for radionuclides are the Canadian Drinking Water Guidelines with the exception of tritium. The target for tritium concentrations is set to ensure tritium concentrations, expected to be above baseline, remain below a site-specific target developed to ensure water in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline. As mentioned previously, the ECM will provide containment through the cover and liner, and significant impacts on groundwater quality are not expected.

9.2 Objectives

The objectives to be considered as part of the GWMP as per the CRL site wide GWMP include the following:

a) support the overall, general, and specific goals of the GWPP;

b) demonstrate compliance with requirements of the CNSC concerning the release of nuclear and hazardous substances from the source;

c) provide data to verify the predictions made and models used in the EA or ERA, or reduce the uncertainty in predictions;

d) characterize groundwater flow and baseline groundwater quality conditions at a site;

e) characterize groundwater flow and groundwater quality during other phases of a site's lifecycle;

f) provide information to assess risks from site-affected groundwater to human health and the environment;

g) evaluate monitoring data against groundwater evaluation criteria related to nuclear and hazardous substances in groundwater;

h) provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring;

i) to the extent possible, monitor for releases from high risk SSCs associated with a given facility; and

j) other objectives identified by the facility operator (e.g., demonstrate due diligence, meet a stakeholder commitment, or other business reasons).

Baseline monitoring has occurred as part of the Chalk River GWMP (east and west of the SSA) and other studies. GWMP baseline monitoring will continue from pre-construction of the NSDF and through construction until the operations phase. This is not considered part of the EAFMP.

In Table 9-1 below, the objectives of the CRL site-wide GWMP are evaluated against recommendations made in the EIS related to the protection of the groundwater environment. In Table 9-2, the applicable objectives are refined to be more specific to NSDF Project activities and are supported by required information such as what type of monitoring data will be collected and how it will be collected. The specific GWMP monitoring program elements (e.g., GWMP1a, 1b, etc.) are obtained from the EIS and is summarized in Section 5.0 (Table 5-1).

Table 9-1: Objectives for the Groundwater Monitoring Plan and Linkage to GWMP Elements

GWMP Objective to be Considered (CSA N288.7 and CNL GWMP Standard)	Applicability to the NSDF Project (Yes, No and Explanation)
a) support the overall general and specific goals of the CRL GWPP	Yes, groundwater monitoring will confirm protection of groundwater flow and ecological and human health at the ECM and WWTP sites Monitoring Program Elements: GWMP1a,1b; GWMP2a, 2b; GWMP3a, 3b; GWMP4a, 4b
b) demonstrate compliance with requirements of the CNSC concerning the release of nuclear and hazardous substances from the source	Yes, monitoring will confirm the effectiveness of ECM and WWTP mitigations on groundwater quality as well as compliance with CSA N288.7-15 (CSA 2015) as a CNSC requirement. Monitoring Program Elements: GWMP3a, 3b; GWMP4a, 4b

Table 9-1: Objectives for the Groundwater Monitoring Plan and Linkage to GWMP Elements

GWMP Objective to be Considered (CSA N288.7 and CNL GWMP Standard)	Applicability to the NSDF Project (Yes, No and Explanation)
c) provide data to verify the predictions made and models used in the EA or ERA, or reduce the uncertainty in predictions	Yes, monitoring will confirm predictions on groundwater flow as summarized in the EIS during ECM and WWTP operations. Monitoring Program Elements: GWMP1a, 1b; GWMP2a, 2b
d) characterize groundwater flow and baseline groundwater quality conditions at a site	No, groundwater flow and baseline condition have been characterized as part of the EIS
e) characterize groundwater flow and groundwater quality during other phases of a site's lifecycle	Yes, monitoring will provide data to characterize groundwater flow and quality at the ECM and WWTP during the operation and closure of the NSDF. Such data will support any monitoring of the site that will continue during the institutional control of the CRL property in the NSDF Project's post-closure phase. Monitoring Program Elements: GWMP1a,1b; GWMP2a, 2b; GWMP3a, 3b; GWMP4a, 4b
f) provide information to assess risks from site-affected groundwater to human health and the environment	No, ECM and WWTP are located upgradient of groundwater affected by CRL site operations
g) evaluate monitoring data against groundwater evaluation criteria related to nuclear and hazardous substances in groundwater.	Yes, groundwater quality at the ECM and WWTP will be evaluated against groundwater evaluation criteria to confirm protection of ecological and human receptors. Monitoring Program Elements: GWMP3a, 3b; GWMP4a, 4b
h) provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring	Yes, groundwater quality monitoring will identify unusual or unforeseen effects on groundwater quality at the ECM and WWTP. Monitoring Program Elements: GWMP3a, 3b; GWMP4a, 4b
i) to the extent possible, monitor for releases from high risk SSCs associated with a given facility	No, the ECM and WWTP are modern engineered facilities designed for the management and treatment of solid and liquid low level radioactive waste. Releases from the ECM are not expected and WWTP effluent discharges will be monitored to confirm that effluent discharge targets are met. The ECM and WWTP are therefore not considered high risk. The data collected will, however, assist in identifying possible releases.
j) other objectives identified by the facility operator (e.g., demonstrate due diligence, meet a stakeholder commitment, or other business reasons)	Yes, there is stakeholder interest in many aspects of the NSDF Project, in particular the long-term effectiveness of the ECM as a containment facility and potential impacts of the project on the Ottawa River. Monitoring Program Elements: GWMP1a,1b; GWMP2a, 2b; GWMP3a, 3b; GWMP4a, 4b

The objectives that are applicable to the NSDF GWMP are refined and organized by individual Monitoring Program Elements in Table 9-2 along with the information required to meet objectives and how the monitoring data will be used to meet objectives. More details on the how the information is obtained and how the data will be used if provided in the sections following.

Table 9-2: Objectives and Information Required to Meet Objectives

Facility & Project Phase	GWMP Program Element[1]	Objective[2]	Information Required to Meet Objective	How Data will be Used to Meet the Objective
ECM Operations Phase	GWMP1a	Verify environmental assessment predictions on groundwater flow and direction from ECM during Operations	Groundwater elevation measurements to determine groundwater flow direction and gradients.	The measured data will be compared against EIS predictions with respect to groundwater elevations and flow.
ECM Closure	GWMP1b	Verify environmental assessment predictions on groundwater flow and direction from ECM during Closure	Similar to GWMP1a, noting that the ECM will be at capacity at the time of NSDF Project closure.	Similar to GWMP1a, noting that the ECM will be at capacity at the time of NSDF Project closure.
WWTP Operations Phase	GWMP 2a	Verify environmental assessment predictions on groundwater flow and direction from WWTP during operations	Groundwater elevation measurements to determine groundwater flow direction and gradients.	The measured data will be compared against EIS predictions with respect to groundwater elevations and flow directions.
WWTP Closure Phase	GWMP 2b	Verify environmental assessment predictions on groundwater flow and direction from WWTP during closure	Groundwater elevation measurements to confirm return of GW conditions to baseline levels.	The measured data will be compared against baseline with respect to groundwater elevations and flow directions.
ECM Operations Phase	GWMP3a	Verify the effectiveness of ECM mitigation measures to protect groundwater quality	Sampling to measure parameters defining groundwater quality and detect potential releases of constituents from the ECM containment area.	Measured groundwater quality data will be compared against baseline data and groundwater evaluation criteria.
ECM Closure	GWMP 3b	Verify the effectiveness of ECM mitigation measures to protect groundwater quality	See GWMP3a	Similar to GWMP3a, noting that the ECM will be at capacity at the time of NSDF Project closure.
WWTP Operations	GWMP 4a	Verify the effectiveness of mitigation measures to protect groundwater quality (WWTP)	Sampling to confirm groundwater quality to detect potential releases of constituents from the WWTP effluent discharged to exfiltration gallery.	The analytical data will be used to verify the WWTP discharges are not adversely affecting the groundwater environment and data will be used in future risk assessments.
WWTP Closure	GWMP 4b	Verify the effectiveness of mitigation measures to protect groundwater quality (WWTP)	Similar to GWMP4a, noting that the volume of WWTP treated effluent discharges during closure will be a small fraction of those during the Operations phase.	Similar to GWMP4a,

Note:

1) GWMP program elements are defined and discussed in Section 5.0.

2) All required items support the GWPP goals.

9.2.1 Geology

9.2.1.1 Bedrock

Bedrock in the area consists of highly altered gneissic rock and felsic igneous rock (upper amphibolite to granulite grade metamorphism under dynamic ductile conditions during the Grenville Orogeny) of late Precambrian-early Paleozoic age. Bedrock at the CRL site has been grouped into 3 main assemblages (CNL 2016c). The bedrock within the Perch Lake basin and the NSDF Project site has been mapped as quartz monzonitic, monzonitic, and monzodioritic gneisses of Assemblage B. Assemblage C (composed of granitic, granodioritic, and leucodioritic gneisses) has been mapped at the bedrock surface under the eastern portion of the NSDF Project site, while a mafic dyke has been mapped near the north-west corner of the NSDF Project site. Transitions between these relatively low permeability rock types were not expected to be significant to the environmental assessment.

The bedrock topography in the area of the NSDF is dominated by the ridge that delineates the eastern boundary of the Perch Lake Basin and the depression or valley that runs from the northwest corner of Waste Management Area A, to the southeast towards Perch Creek. The bedrock ridge reaches an elevation of approximately 192 m above sea level (mASL) and dips to the northwest and southeast, to an elevation of 165 mASL at Plant Road and 155 mASL at Perch Creek.

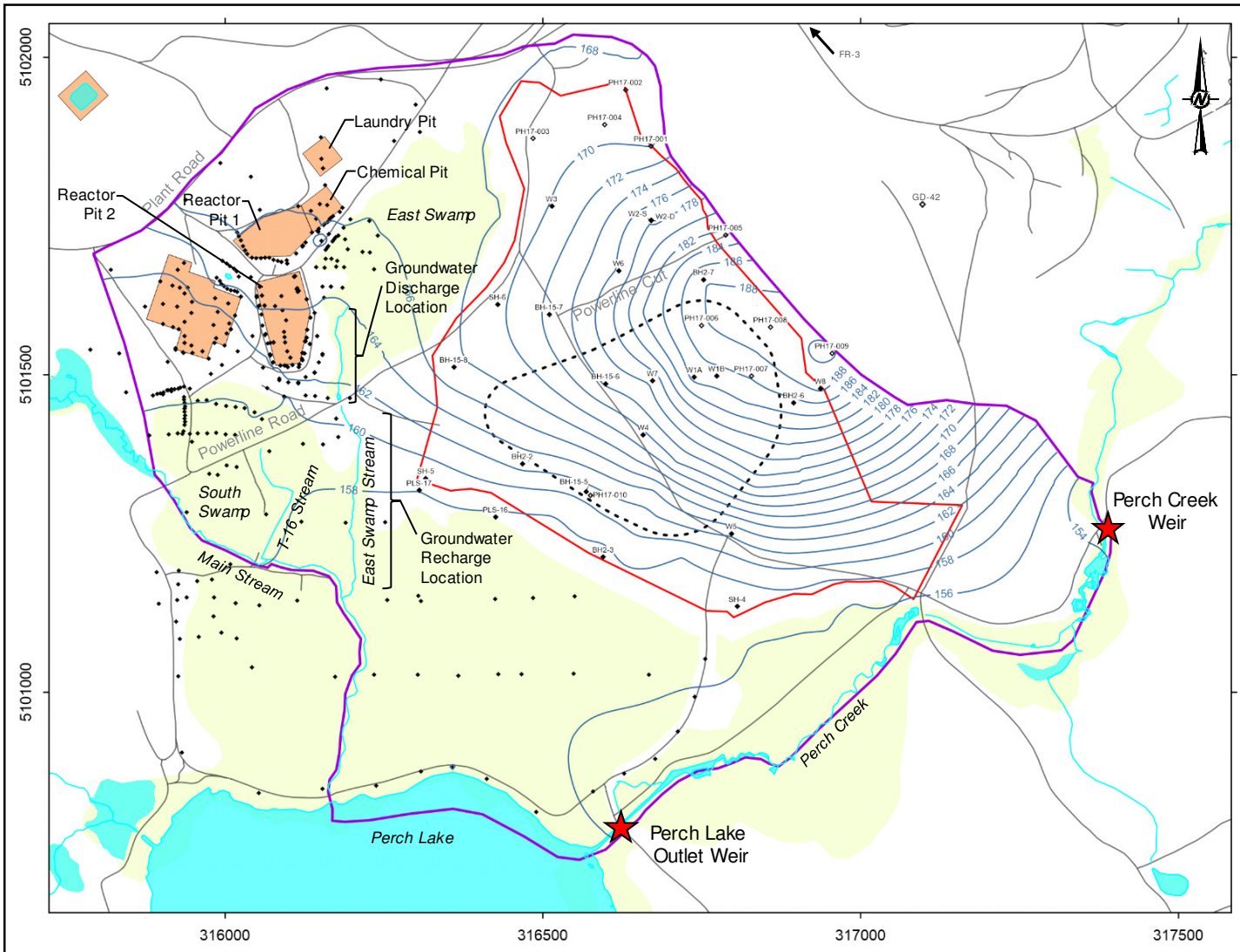
A total of 41 hydraulic response tests were completed in the bedrock at 24 borehole locations within the NSDF Project site. Of these tests, 26 were suitable for analysis and interpretation and the remainder were not analyzable due to slow recovery or instrument malfunction. Hydraulic conductivity was found to range from $2.3x10^{-9}$ to $1.5x10^{-5}$ m/s with a geometric mean of $1.4x10^{-7}$ m/s, which is within the range of values from historical testing. No significant trend in hydraulic conductivity with depth is observed through the tested interval.

9.2.1.2 Overburden

The overburden geology at the NSDF Project site consists primarily of fine sands, underlain locally by glacial till. The sands are interpreted to be the result of aeolian reworking of precursor fluvial sands and silts laid down in the late Pleistocene/early Holocene period by an early phase of the Ottawa River. Unconsolidated glacial and post-glacial deposits in the Perch Lake Basin (which includes the Local Study Area (LSA) and NSDF Project site) have been subdivided into six main units (ordered from oldest to youngest): glacial till; basal sand and gravel; clayey silt; middle sand; interstratified silt and sand; and upper sand. The stratigraphic layering is illustrated on Figure 9-2.

The thickness of the unconsolidated sediments is generally lowest on the eastern bedrock ridge (in the vicinity of the NSDF Project site). The thickness of these sediments increases to the west and is highest in the bedrock valley, reaching over 36 m in the bedrock low. Within the area of the NSDF Project site unconsolidated deposits are locally thicker in the area to the north and east, reaching over 26 m thick at the northern terminus of the bedrock ridge. Elsewhere on the CRL site, overburden thickness ranges from 0 m to greater than 25 m, being greatest in topographic lows.

Hydraulic testing of the overburden has been completed using multiple methods on each of the stratigraphic units. Results of the testing found that the silty clay and till units generally have relatively lower horizontal hydraulic conductivities (on the order of 10^{-8} m/s and 10^{-7} m/s, respectively), with the sand units generally have higher hydraulic conductivities (10^{-5} to 10^{-4} m/s range). Anisotropy (vertical to horizontal) was greatest for the stratified silt and sand and silty clay units, where vertical conductivities were up to 2 orders of magnitude less than the horizontal values.



LEGEND

- Groundwater Model Boundary
- Roads
- ECM Location
- Site Study Area (NSDF Project Site)
- Stream
- Waste Management Area
- Groundwater Table Data Point
- Swamp

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PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT
FOLLOW-UP MONITORING PROGRAM, CHALK RIVER, ONTARIO

TITLE
AVERAGE GROUNDWATER TABLE ELEVATION MAP

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GOLDER

DATE	2021-02-10
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PREPARED	SO
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
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REFERENCE(S)
1. PERCH LAKE SUB-BASINS OBTAINED FROM E. ROBERTSON & P.J. BARRY (1985) THE WATER AND ENERGY BALANCES OF PERCH LAKE (1969–1980), ATMOSPHERE-OCEAN, 23:3, 238-253, DOI: 10.1080/07055900.1985.96492270)

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9.3 Spatial and Temporal Boundary

The groundwater modelling conducted to assess potential groundwater effects from the NSDF was conducted in the NSDF Project site shown in (Figure 9-3) and beyond to Perch Lake and the East Swamp. This area is considered adequate to define the spatial boundaries for the monitoring required for the NSDF.

Monitoring for baseline groundwater flow and quality was initiated in the early planning phases of the project and is ongoing. The time frame for effects monitoring is related to the duration of the Operations and Closure. Monitoring is to be initiated when Operations begin. Post-Closure monitoring will be required; however, this phase is considered too far into the future to address as part of the EAFMP and is discussed further in Section 11.0.

9.4 Monitoring Strategies

There are generally three types of monitoring strategies that can be utilized to meet the objectives noted in Section 9.2. These consist of:

1) Perimeter monitoring - Evaluation, by conducting perimeter monitoring downgradient of each location, of the general environmental performance of a feature.
   - Wells related to the ECM and two wells related to the WWTP are considered to be perimeter monitoring wells.
2) Facility Specific Monitoring - Evaluation, by conducting facility specific (near source) monitoring, of the environmental performance of buildings, structures or features that handle or contain significant quantities of liquid hazardous materials that could be released to the subsurface without prompt detection by the facility.
   - One well immediately downgradient of the WWTP infiltration area is considered to be a facility specific well.
3) Plume Monitoring - Evaluation and mitigation assessments, by conducting plume monitoring in and around contaminated groundwater flow systems, related to contaminants already released to groundwater flow systems that potentially impact the environment.
   - No impacts on groundwater quality are anticipated from the ECM. Potential impacts on groundwater from WWTP discharges to the exfiltration gallery will be evaluated through perimeter and facility specific monitoring noted above. Plume monitoring is therefore not required.

There are also several background wells, as noted in Table 9-3.

9.5 Location of Boreholes and Monitoring Wells

The proposed locations for the monitoring wells used in the NSDF GWMP are shown on Figure 9-3. The status and criteria for selecting the well locations are provided in Table 9-3. Additional text regarding well justification is provided in the text below and details regarding the locations are provided in Table 9-4 below.

The criteria for selecting monitoring wells locations are (CNL 2020b):

a) If a location is needed for detection, and possibly quantification, of leakage from a specific SSC;(i.e., proximity or near source monitoring)

b) If a location is needed for the detection of COPC release from a distributed source;

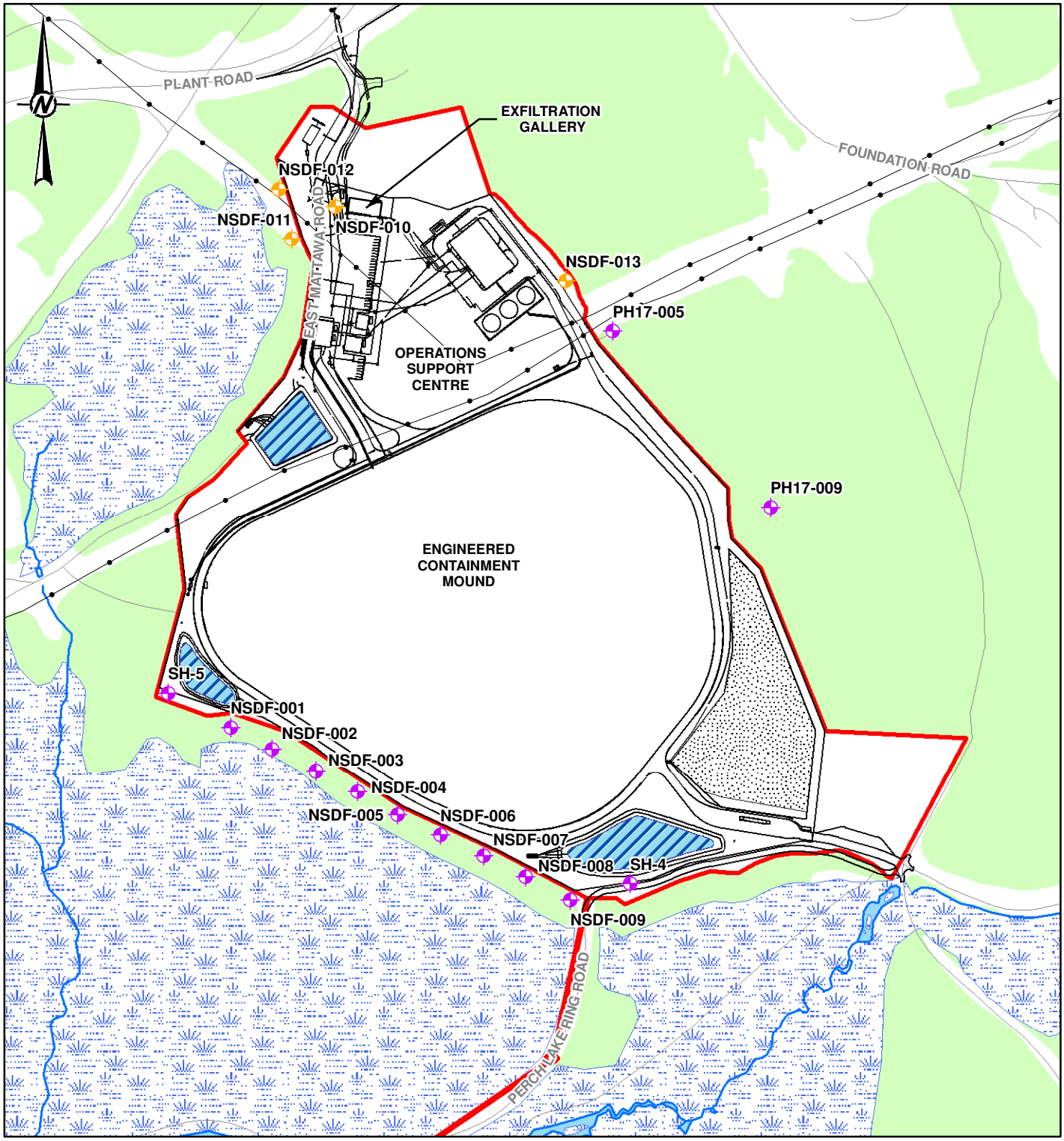
c) If a location is needed for detection of COPC releases from a region or site containing multiple potential sources;

d) Locations upgradient of the facility should be included in the GWMP as baseline conditions;

e) If a location is needed for periodic evaluation of ongoing COPC migration from a past or ongoing release to the subsurface (i.e., Plume Monitoring);

f) If a location is needed for monitoring at the perimeter of a facility or an operation. Note that perimeter can refer to the legal property boundary or a defined area of interest within the site;

g) If a location is needed to further characterize the groundwater flow system or other aspects of the conceptual site model.



LEGEND

- MONITORING WELL
- PROPOSED MONITORING WELL
- TRANSMISSION LINE
- ROAD
- RIVER/STREAM
- WATERBODY
- WETLAND
- WOODED AREA
- NSDF PROJECT SITE

DRAFT

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REFERENCE(S)

1. BASEDATA ONTARIO MNRF 2016, CANVEC 2016, AND CNL 2016
2. MONITORING WELL LOCATIONS OBTAINED FROM CANADIAN NUCLEAR LABORATORIES. 2018. PROPOSED INITIAL (BASELINE) OPERATIONAL CONTROL MONITORING FOR THE NEAR SURFACE DISPOSAL SITE. REPORT NO. 232-10122-401-001. REVISION 0. APRIL 2018
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE18N

CLIENT
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PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
GROUNDWATER MONITORING LOCATIONS

CONSULTANT
GOLDER

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PREPARED	PR
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APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
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Table 9-3: Status of Well and Criteria for Selecting Monitoring Well Locations

Borehole	Existing or Proposed	Criteria for Well Location	Justification
Background			
PH17-005	Existing	d) g)	d) The location is upgradient of the ECM and provides baseline groundwater quality data g) The location is needed to confirm EIS predictions on groundwater flow
PH17-009	Existing		
NSDF-013	Proposed	d) g)	d) The location is upgradient of the WWTP and provides baseline groundwater quality data g) The location is needed to confirm EIS predictions on groundwater flow
ECM			
SH-4	Existing	c) f) g)	c) the ECM will affect groundwater flow over a region and a potential issue with ECM mitigation could occur in any one location along the large ECM liner. f) the ECM related wells are not immediately downgradient of the ECM so that potential flow effects over a larger scale can be evaluated and to increase the likelihood of detecting an ECM mitigation failure if present. Based on their distance from the ECM they can be considered perimeter wells. g) the ECM wells will be used to characterize the long term flow system during and following the ECM installation.
SH-5	Existing		
NSDF-001	Existing		
NSDF-002	Existing		
NSDF-003	Existing		
NSDF-004	Existing		
NSDF-005	Existing		
NSDF-006	Existing		
NSDF-007	Existing		
NSDF-008	Existing		
NSDF-009	Existing		
WWTP			
NSDF-010	Proposed	a) g)	a) the well will be installed immediately downgradient of the infiltration gallery to assess groundwater elevations and quality g) the well will be used to characterize the long term flow system during and following the ECM installation
NSDF-011	Proposed	b) f) g)	b) the well will be installed further downgradient of the infiltration gallery to assess groundwater elevation changes and quality from this distributed source. f) the WWTP related wells are not immediately downgradient of the WWTP infiltration gallery so that potential flow effects over a larger scale can be evaluated and to increase the likelihood of detecting a water quality issue present. Based on their distance from the ECM they can be considered perimeter wells. g) the wells will be used to characterize the long term flow system during and following the WWTP and infiltration gallery operation.
NSDF-012	Proposed		

9.5.1 Location of Wells for ECM Monitoring

- Wells are required downgradient of the ECM to assess the area of highest risk from potential liner leakage or a bathtub effect from the liner and to assess changes in groundwater flow.
- New wells have been installed between the ECM and Perch Lake (i.e., the groundwater flow pathway between the ECM and downgradient receiving environment). Wells NSDF-001 to NSDF-009 and SH4 and SH5 have been installed as part of the Chalk River GWMP and are currently being monitored. These well are approximately 75m to 150m from the construction perimeter to minimize the potential for damage to the ECM liner and within a one year predicted travel time from the ECM.

- The density of the 11 wells (approximately every 50 m) is considered adequate for the ECM based on extent of the ECM (e.g., several hundred meters).
- Any wells damaged during construction are to be replaced. Details regarding these wells (elevation, depth, screen type) are provided in Table 9-4 below.
- The wells are installed with a 3.05 m screen at depths near the top of water table to assess the area of highest risk from potential liner leakage or a bathtub effect from the liner.

9.5.2 Location of Wells for WWTP Monitoring

- For the modelled scenario where there is a release from the WWTP, the modelled plume width with a 0- to 1-year travel time is approximately 120 m and a travel distance of 100 m to 200 m. This would also apply to tritium, for example, discharged to the exfiltration gallery. Two wells are proposed approximately 50 m apart approximately 50 to 100 m downgradient of the discharge to capture effects within a one-year travel time. The spacing is considered warranted as the leachate discharge will be monitored and the groundwater monitoring is conducted as confirmation of the risk mitigation. One well is proposed immediately downgradient of the infiltration gallery to assist with assessing groundwater flow direction.
- Wells NSDF-011 and NSDF-012 are to be located downgradient of the infiltration gallery of the WWTP and should be placed based on the final location of the gallery. This may require re-installation of wells installed previously. The treated leachate will be discharged as infiltration. There are no specific COPCs that are denser than water and in the absence of a significant vertical gradient sampling the top of the water table will provide the suspected “worst case” effects. It is realized that the 3 m screen may intersect bedrock, however this is considered acceptable to ensure the wells yield sufficient water for sampling and analysis.
- Well NSDF-010 is to be located immediately (5 to 10 m) downgradient of the infiltration gallery. The screen for this well is to be placed near surface (i.e., 1 to 4 m bgs) to allow for monitoring of the groundwater in the immediate area.
- Wells are to be installed with a 3.05 m screen length that intersects the water table (to the extent possible).
- In addition to the three wells specified, inspections should be conducted at surface immediately downgradient of the exfiltration gallery to confirm that groundwater elevations remain below-grade during WWTP operation.

9.5.3 Location of Wells for Baseline Condition Verification

- Two reference wells are currently being sampled for assessment of baseline conditions at the NSDF site and it is proposed that this sampling will continue. These are PH17-005 and PH17-009 shown on Figure 9-3. Two wells are considered adequate for baseline monitoring of the ECM. It is noted that these wells are screened in bedrock as there is limited overburden in the area of PH17-009. If longer term Operational Control monitoring indicates significant differences between PH17-005 / PH17-009 and wells downgradient of the proposed ECM additional baseline wells should be considered. A shallower well can be installed in the area of PH17-005.
- NSDF-013 is required for baseline monitoring of the WWTP. This proposed well is upgradient of the modelled groundwater direction in the future.

Table 9-4: Summary Information Regarding GWMP Wells for the NSDF

Borehole	UTM Coordinates (NAD83 m)		Grade Elev (mASLl)	Stickup (m)	Top of Pipe Elev (mASL)	Monitor Diam (cm)	Monitor Type	Screen		Below Grade Depth of Screen (m)		Screen Elev (mASL)		Stratigraphic Unit at Well Screen
	Easting	Northing						Type	Length (m)	From	To	From	To	
PH17-005	316787.5	5101720.0	193.50	0.98	194.48	5.1	PVC	Slotted PVC	3.05	17.95	21.00	175.55	172.50	Bedrock
PH17-009	316954.9	5101533.7	191.30	0.95	192.25	5.1	PVC	Slotted PVC	3.05	9.80	12.85	181.50	178.45	Bedrock
SH-4	316806.0	5101135.0	156.40	0.76	157.16	5.1	PVC	Slotted PVC	3.05	1.05	4.10	155.35	152.30	Silty Sand / Bedrock
SH-5	316316.0	5101337.0	160.96	1.03	161.99	5.1	PVC	Slotted PVC	3.05	2.44	5.49	158.52	155.47	Silty Sand
NSDF-001	316379.9	5101300.7	159.49	1.00	160.49	3.2	PVC	Slotted PVC 0.010"	3.05	1.52	4.57	157.97	154.92	Fine Sand / Bedrock
NSDF-002	316427.1	5101277.2	158.45	1.05	159.50	5.1	PVC	Slotted PVC 0.010"	3.05	1.52	4.57	156.93	153.88	Fine Sand / Sand and Silt
NSDF-003	316473.0	5101249.3	158.48	0.99	159.47	5.1	PVC	Slotted PVC 0.010"	3.05	1.57	4.62	156.91	153.86	Fine Sand
NSDF-004	316519.9	5101233.7	157.86	1.04	158.90	5.1	PVC	Slotted PVC 0.010"	3.05	1.60	4.65	156.26	153.21	Fine Sand
NSDF-005	316551.8	5101205.5	157.61	1.10	158.71	5.1	PVC	Slotted PVC 0.010"	3.05	1.67	4.72	155.94	152.89	Fine Sand
NSDF-006	316596.0	5101188.3	157.39	1.01	158.40	5.1	PVC	Slotted PVC 0.010"	3.05	1.52	4.57	155.87	152.82	Fine Sand
NSDF-007	316650.0	5101163.5	156.78	1.06	157.84	5.1	PVC	Slotted PVC 0.010"	3.05	1.52	4.57	155.26	152.21	Fine Sand
NSDF-008	316695.3	5101147.2	156.96	1.05	158.02	5.1	PVC	Slotted PVC 0.010"	3.05	1.52	4.57	155.44	152.39	Fine Sand
NSDF-009	316738.3	5101116.0	156.78	1.10	157.88	5.1	PVC	Slotted PVC 0.010"	3.05	1.52	4.57	155.26	152.21	Fine Sand
NSDF-010	to be installed – location based on final location of exfiltration gallery; however, based on Figure 9-3, this is 316493E, 5101852N constructed with a 3.05-m screen intercepting the water table													
NSDF-011	to be installed – location based on final location of exfiltration gallery; however, based on Figure 9-3, this is 316447E, 5101818N constructed with a 3.05m screen intercepting the water table													
NSDF-012	to be installed – location based on final location of exfiltration gallery; however, based on Figure 9-3, this is 316433E, 5101870N constructed with a 3.05m screen intercepting the water table													
NSDF-013	to be installed – location based on final location of exfiltration gallery; however, based on Figure 9-3, this is 316737E, 5101770N constructed with a 3.05m screen intercepting the water table													

Date regarding existing wells obtained from CNL's memo regarding baseline monitoring for the NSDF (CNL 2018d).

9.6 Sampling and Measurement Frequencies

Generally, contaminants migrate much slower in groundwater systems than other types of systems (i.e., cm/year, m/year vs cm/sec or m/min in surface water), however, it is the requirements of each groundwater monitoring strategy that determines the sampling frequency.

The sampling and measurement frequencies, at this time, are proposed to be the same for both operations and closure. Sampling and measurement frequencies can be increased or reduced based on review findings as discussed in Section 9.14.

The sampling and measurement frequencies are discussed below and summarized in Table 9-5.

9.6.1 ECM

9.6.1.1 Sampling Frequency

Sampling is to occur semi annually for both operations and closure as the ECM will continue to be at risk of failure during closure. Semi-annually is considered adequate as a sampling frequency due to the relatively slow migration of potential impacts to the downgradient wells.

Some discretion can be used in the sampling and measurement for the ECM related wells based on the staged manner of filling the ECM. When evaluating sampling frequencies at the start of operations (e.g., when not all cells are constructed) the nature of the operations and potential locations of impact is to be evaluated.

9.6.1.2 Water Level Measurement Frequency

Water levels are to be taken at all wells during sampling as this is standard procedure when collecting samples. Continuous water level logging will continue at the existing wells (SH-4, SH-5, PH17-005 and PH17-009) to evaluate potential seasonal or episodic fluctuations of groundwater over time. The level loggers can collect a reading every two hours. The four downgradient wells, along with semi-annual levels on other wells will be sufficient to assess changes in water levels over time. Two hours is considered adequate to identify long-term and short-term (e.g., precipitation events) changes and allows for the data loggers to stay in place for a prolonged period. A baro-logger is to be placed at one borehole location to allow for correction of barometric pressure for all NSDF data logger readings.

9.6.2 WWTP

9.6.2.1 Sampling Frequency

Sampling of the inspection noted is to occur semi annually for operations and closure as the WWTP will continue to operate during closure. Semi-annual sampling is considered appropriate for the early stages of discharges and when steady state conditions are reached. The WWTP effluent is monitored and therefore the potential effects to groundwater should be known. The sampling will confirm effects in the immediate area and further downgradient.

The potential for leachate flow will be reduced when the ECM cover is in place. At that time, if not earlier, annual sampling is considered warranted.

9.6.2.2 Water Level Measurement Frequency

Water levels to be obtained with a level logger on a two-hour basis at wells so that the effects of WWTP tank discharges can be evaluated over time. This will be conducted in addition to the semi-annual water level measurements obtained as part of sampling. Two hours is considered adequate to identify long term and short term (e.g., precipitation events) changes and allows for the data loggers to stay in place for a prolonged period.

9.6.3 Baseline Conditions

9.6.3.1 Sampling frequency

Reference wells are to be sampled on a semi-annual basis. This sampling is recommended to correspond with other groundwater sampling conducted for the NSDF as noted above.

9.6.3.2 Water Level Measurement Frequency

Reference wells are to be monitored for water level on a semi-annual basis. This monitoring is recommended to correspond with other groundwater sampling conducted for the NSDF as noted above.

Table 9-5: GWMP Sampling Frequency

Borehole	Operations – Sampling Frequency	Operations – Measurement Frequency	Closure – Sampling Frequency	Closure – Measurement Frequency
Background				
PH17-005	Semi-annual	Every 2 hours	Semi-annual	Semi-annual
PH17-009	Semi-annual	Every 2 hours	Semi-annual	Semi-annual
NSDF-013	Semi-annual	Semi-annual	Semi-annual	Semi-annual
ECM				
SH-4	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours
SH-5	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours
NSDF-001	Semi-annual	Semi-annual	Semi-annual	Semi-annual
NSDF-002	Semi-annual	Semi-annual	Semi-annual	Semi-annual
NSDF-003	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours
NSDF-004	Semi-annual	Semi-annual	Semi-annual	Semi-annual
NSDF-005	Semi-annual	Semi-annual	Semi-annual	Semi-annual
NSDF-006	Semi-annual	Semi-annual	Semi-annual	Semi-annual
NSDF-007	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours
NSDF-008	Semi-annual	Semi-annual	Semi-annual	Semi-annual
NSDF-009	Semi-annual	Semi-annual	Semi-annual	Semi-annual
WWTP				
NSDF-010	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours
NSDF-011	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours
NSDF-012	Semi-annual	Every 2 hours	Semi-annual	Every 2 hours

9.7 Parameters Selected for Monitoring

9.7.1 Need for Monitoring Criteria

The criteria for monitoring a specific parameter have been developed as part of CNL' Standard for Protection and monitoring of Groundwater and are listed below (CNL 2020b). These criteria are applied to all monitoring well locations and for all phases. The results of the evaluation of parameters against these criteria is provided in Table 9-6.

Nuclear and hazardous substances to be monitored should be established according to the criteria below.

a) The monitoring program shall address the COPC's and physical stressors required by any statute, regulation, license or permit that governs the operation of a nuclear facility.

b) The monitoring program should address the COPCs derived from the evaluation of the source term.

c) The parameters selected for groundwater monitoring should be integrated with the parameters used in the EMP to track the fate of COPC migration throughout different environmental media (i.e., integration of pathways monitoring). Complete accordance between COPCs monitored in groundwater and downgradient surface water bodies is not required due to the limited mobility of many COPC's.

d) In addition to monitoring for the presence of nuclear and hazardous substances, physical parameters such as conductivity and hydraulic head should also be considered. Physical parameters can serve well in indicating changing conditions.

e) Bulk or gross analyses (e.g., gross alpha, gross beta, total PCBs) should be considered for cost-effective routine monitoring purposes.

f) Surrogate parameters are radiological or non-radiological substances that have a well-defined correlation with contaminants of potential concern present in a source term, have similar migration behavior in the flow system of interest and are easier to sample or analyze for. Surrogate parameters should be considered for routine monitoring purposes. Am-241 is an example of a surrogate parameter for the more difficult to measure plutonium isotopes.

g) Indicator parameters are parameters used to characterize groundwater quality and assess potential impacts on groundwater. Indicator parameters should be considered to provide early identification of a COPC released to the subsurface versus monitoring that was limited to the contaminants of more concern. Tritium owing to its mobility in groundwater can be an indicator parameter for radiological releases from engineered containment facilities.

9.7.2 General

Groundwater monitoring parameters comprise of physical parameters (hydraulic head, pH and conductivity), radiological and non-radiological parameters.

To assess parameters for analysis, an evaluation of COPCs that may be associated with leachate or contact surface water was conducted (AECOM 2019a). These potential maximum COPC concentrations were compared to effluent discharge targets related to environmental protection (conventional parameters) and drinking water (radiological parameters with the exception of tritium) (CNL 2019b). The findings of the assessment are provided in Table 9-7 and Table 9-8. This evaluation forms the basis of the discussion related to waterborne parameters below.

Also provided in Table 9-7 and Table 9-8 are effluent discharge targets for the WWTP's. They are included here as they provide an indication of the level of hazard of leachate and wastewater. The effluent discharge targets represent maximum concentrations in drinking water for radionuclides, with the exception of tritium, and

federal/provincial guidelines for protection of aquatic biota for non-radionuclides (CNL 2019b). The effluent discharge target for tritium of 3.6 x 10^5 Bq/L represents the concentration level which will ensure that tritium concentrations in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline of 7,000 Bq/L.

Parameters selected for monitoring at the ECM and WWTP and the justification for these are listed in Table 9-6. A summary of the parameters selected for monitoring is provided in Table 9-9. The contaminants of potential concern in leachate and contact surface water are assumed to be the same for both the WWTP and the ECM as the source for both contaminants is the same.

The same suite of analysis is proposed for both operations and closure; however, it is realized that the list of parameters may change based on the data collected and routine reviews. As data are obtained from the WWTP influent and effluent and groundwater monitoring, the parameters to be monitored will be reviewed to ensure all applicable parameters are monitored.

9.7.3 Physical Parameters

Physical parameters monitored are hydraulic head, pH and conductivity. Hydraulic head measurements are used to determine groundwater table elevation and groundwater flow directions and rates. The pH and conductivity are indicators of groundwater quality.

9.7.4 Radiological Parameters

The radiological parameters for analysis listed in Table 9-6 are reduced from the full list indicated in Table 9-7 based on an evaluation of risk and ability to detect issues. It is proposed to monitor for gross alpha, gross beta, gamma emitters and tritium. The reduced list is based on low relative risks of many of the radionuclides, (e.g., in many cases predicted concentrations in leachate and wastewater are orders of magnitude below the effluent discharge target) and the ability of a few parameters to provide an indication of impacts on groundwater from the ECM and WWTP discharges. For example, tritium will be the primary indicator of the presence of leakage of leachate from the ECM because of its mobility in groundwater.

Gross alpha and gross beta are bulk parameters which indicate the presence of several alpha and beta emitters respectively. They are selected for their simplicity of analysis and cost effectiveness. Gross alpha analysis provides an indication of presence of alpha emitters such as plutonium and uranium isotopes. Gross beta analysis provides an indication of the presence of carbon-14 and stontium-90, a contaminant with a maximum predicted concentration in leachate and wastewater at levels above effluent discharge targets. The use of gross parameters as opposed to radionuclide specific analysis is encouraged by CSA N288.7-15. Where gross alpha and gross beta monitoring indicates elevated concentrations, radionuclide specific analysis is performed.

Gamma spectroscopy will provide concentrations of a large suite of gamma emitters including Co-60, a radionuclide predicted to be present in leachate and wastewater at levels that may exceed effluent discharge targets.

9.7.5 Non-radiological Parameters

The full list of contaminants of potential concern provided in Table 9-8 are discussed by their Analytical Test Group (ATG) (MOECC 2016) Each parameter group is evaluated for analysis and based on the criteria provided below. Various compounds are not analyzed as several parameters are proposed as indicator analyses and these are considered sufficient to monitor for potential leachate or contact surface water.

9.7.6 Justification of Parameters for Analysis

A summary of the radiological and non-radiological parameters to be monitored is provided in Table 9-6 along with the criteria and justification for including each parameter. Non-radiological parameters are monitored by Analytical Groups identified in the table.

Table 9-6: Radiological and Non-radiological Parameters to be Monitored

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter
NA	Hydraulic head	d)	d) hydraulic head measurements are required to confirm EIS predictions of changes to groundwater levels and flow at the ECM
NA	Temperature	d)	d) temperature is required during well sampling to confirm representative groundwater and is also an indicator of water quality and changing groundwater conditions
NA	Conductivity	d)	d) conductivity is required during well sampling to confirm representative groundwater and is also an indicator of water quality and changing groundwater conditions
NA	pH (field)	d)	d) pH is required during well sampling to confirm representative groundwater and is also an indicator of water quality and changing groundwater conditions
NA	Gross Alpha	b) c) e) g)	b) Several of the COPCs that may be present in the ECM and WWTP emissions are alpha emitting radionuclides. This parameter helps evaluate potential releases from the ECM and unplanned releases from the WWTP. c) This parameter is integrated with surface water monitoring in Perch Lake watershed e),g) Gross alpha, in addition to being a cost effective gross analysis parameter, is an indicator parameter for various alpha emitting isotopes (e.g., Pu-239, uranium isotopes, Am-241) which are COPC's within the ECM and WWTP effluent
NA	Gross Beta	b) c) e) g)	b) Several of the COPC's that may be present in the ECM are beta emitting radionuclides. This parameter helps evaluate potential releases from the ECM and unplanned releases from the WWTP. c) Gross beta is integrated with surface water monitoring in Perch Lake watershed e),g) Gross beta, in addition to being a cost effective gross analysis parameter, is an indicator parameter for various beta emitting isotopes (e.g., Sr-90, C-14) which are COPCs within the ECM and WWTP effluent.
NA	Gamma Emitters[1]	b)	Many of the COPC's that may be present in the ECM and WWTP effluent are gamma emitting isotopes. These include Co-60, Cs-137, Nb-95, Ra-226 and U-235. This parameter helps evaluate potential releases from the ECM and unplanned releases from the WWTP.

Table 9-6: Radiological and Non-radiological Parameters to be Monitored

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter
NA	Tritium	b) c) g)	b) Tritium is a COPC for the ECM and the WWTP. It is of particular interest because of its mobility as it does not sorb to soil and migrates at the same rate as groundwater. c) Tritium is integrated with surface water monitoring in the Perch Lake watershed. g) Tritium is an indicator parameter for the performance of the ECM. In the event of leakage from the ECM, tritium, would be the first radionuclide observed at downgradient monitoring wells.
1b	CBOD	k)	k) Monitoring serves to identify unplanned or uncontrolled emissions. Predicted concentration exceeds effluent discharge targets if no treatment is conducted (See Table 9-8).
4b	Nitrogen (nitrate and nitrite)	b) g)	b) The maximum predicted concentration of nitrate and nitrite exceed benchmark values. This parameter is mobile and helps evaluate potential releases from the ECM and unplanned releases from the WWTP. g) Nitrate and nitrite are considered indicator parameters for other anions
6	Phosphorus	None	Parameter not monitored - Phosphorus is not predicted to be as prevalent as indicated in Table 9-8 Note 2. Nitrogen is considered to be an indicator parameter for phosphorus.
8	TSS	None	Parameter not monitored - TSS is not considered a contaminant of concern in groundwater.
9	All Metals in ATG 9	b) g)	b) The maximum predicted concentration of aluminum and cobalt exceed benchmark values. These metals can be mobile and help evaluate potential releases from the ECM and unplanned releases from the WWTP. g) These metals are considered indicator parameters for other cations
9a	Additional Metals (Fe, U, Mg)	b) g)	b) The maximum predicted concentration of iron exceeds benchmark values. These metals can be mobile and help evaluate potential releases from the ECM and unplanned releases from the WWTP. g) These metals are considered indicator parameters for other cations
10	Hydrides (Sb, As, Se)	None	Parameter not monitored - The maximum predicted concentration of these elements are not predicted to exceed benchmark values and these parameters are considered to be addressed by the indicator parameters related to ATG9
12	Mercury, Unfiltered Total	None	Parameter not monitored - The maximum predicted concentration of this element is not predicted to exceed benchmark values and mercury is considered to be addressed by the indicator parameters related to ATG9
14	Phenolics	None	Parameter not monitored - The maximum predicted concentration of this compound is not predicted to exceed benchmark values and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.

Table 9-6: Radiological and Non-radiological Parameters to be Monitored

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter
16	Volatiles, Halogenated	b) g)	b) The maximum predicted concentration of chloroform and ethylene dibromide exceeds the benchmark value. This compound can be mobile and will help evaluate potential releases from the ECM and unplanned releases from the WWTP. g) Chloroform is considered indicator parameter for other organic compounds
17	Volatiles, Non-Halogenated	g)	g) Benzene in particular is considered a general indicator of leachate related to demolition and construction waste.
19	Extractables, Base Neutral	None	Parameter not monitored - While several of these compounds have a maximum predicted concentration that may exceed benchmark values (e.g., anthracene, chrysene) these are relatively immobile compared to chloroform. These compounds are considered to be addressed by the indicator parameters related to ATG16 and ATG17.
20	Extractables, Acid (phenolics)	None	Parameter not monitored - The maximum predicted concentration of this compound is not predicted to exceed benchmark values and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.
24	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	None	Parameter not monitored - The maximum predicted concentration of this compound is not predicted to exceed benchmark values and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.
27	PCBs	None	Parameter not monitored - The maximum predicted concentration of this compound is not predicted to exceed benchmark values and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.
30	Anions (chloride, fluoride, sulphate)	b),c),g)	b) The maximum predicted concentration of sulphate exceed benchmark values. This parameter is mobile helps evaluate potential releases from the ECM and unplanned releases from the WWTP. c) Chloride and fluoride monitoring provides integration of groundwater and surface water monitoring. g) Sulphate is considered an indicator parameter for other anions It is noted that baseline chloride concentrations in the area range from 13. 4 to 96.7 mg/l and the maximum concentration predicted is 17 mg/l (Golder 2020a). Based on the baseline concentrations and the relatively low concentrations predicted from leachate chloride should not be used as an indicator compound.
NA	Other metals or inorganics (barium, manganese, calcium)	b) c),g)	b) The maximum predicted concentration of manganese exceeds benchmark values. This metal can be mobile and help evaluate potential releases from the ECM and unplanned releases from the WWTP. c) Barium and calcium monitoring provides integration of groundwater and surface water monitoring. g) Manganese is considered an indicator parameter for other cations
NA	Other inorganics (acetone, bis(2-ethylhexyl) phthalate)	None	Parameter not monitored - The maximum predicted concentration of this compound is not predicted to exceed benchmark values and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.

Table 9-6: Radiological and Non-radiological Parameters to be Monitored

ATG Group	Parameter Name	Criteria for Monitoring Contaminant	Justification for Monitoring (or not Monitoring) of Parameter
NA	Petroleum hydrocarbons (C6-C10)	None	Parameter not monitored - The maximum predicted concentration of this compound is not predicted to exceed benchmark values and is considered to be addressed by the indicator parameters related to ATG16 and ATG17.
NA	Tannic acid	None	Parameter not monitored - There is no environmental concern with this parameter as the presence of wetlands and organic-rich waterbodies (e.g., Perch Lake) in the drainage area results in the surface waters possessing naturally elevated tannins and other coloured compounds (i.e., humic acids) sourced from the wetland and macrophyte vegetation. As there is no environmental benchmark for this parameter, monitoring is not warranted for due diligence.
NA	EDTA	None	Parameter not monitored - The Canadian Government completed a screening assessment. Ecological hazard and exposure potentials of EDTA and associated salts were classified using the Ecological Risk Classification of Organic Substances Approach, with the risk posed by these substances deemed low at common levels of exposure (Health Canada 2018). It was concluded that these substances are not harmful to human health or to the environment. They have a low ecological hazard potential, and the Government concluded that these substances are not entering the environment at levels that are harmful to the environment. As there is no environmental benchmark for this parameter monitoring is not warranted for due diligence.

NA – not applicable.

Table 9-7: Radionuclide Concentrations in Wastewater and Effluent Discharge Targets

Radionuclide	Maximum Predicted Concentration in Wastewater (Bq/L) Prior to Treatment	Effluent Discharge Target (Bq/L)	Treatment Required?	Reference for Effluent Discharge Target
Gross Alpha	-	0.2	-	CNL 2019b
Gross Beta	8.97 (as Strontium-90)	5	Yes	CNL 2019b
Gross Gamma	-	40	-	CNL 2019b
Ag-108m (metastable isotope silver-108)	1.8×10^{-4}	60	No	Health Canada 2009
Am-241 (isotope Americium-241)	0.0028	0.7	No	Health Canada 2009
Am-243 (isotope Americium-243)	1.7×10^{-6}	0.7	No	Health Canada 2009
C-14 (isotope carbon-14)	3.1	200	No	Health Canada 2009
Cl-36 (isotope chlorine-36)	0.059	100	No	Health Canada 2009
Co-60 (isotope cobalt-60)	1300	40	Yes	Health Canada 2009
Cs-135 (isotope caesium-135)	4.1×10^{-5}	70	No	Health Canada 2009
Cs-137 (isotope caesium-137)	0.93	10	No	Health Canada 2009
H-3 (isotope hydrogen-3 [Tritium])	1.4×10^{5}	3.6×10^{5}	No	CNL 2019b
I-129 (isotope Iodine-129)	0.091	1	No	Health Canada 2009
Mo-93 (isotope molybdenum-93)	4.1×10^{-7}	40	No	Health Canada 2009
Nb-94 (isotope Niobium-94)	0.015	80	No	Health Canada 2009
Ni-59 (isotope nickel-59)	1.7×10^{-4}	2000	No	Health Canada 2009
Ni-63 (isotope nickel-63)	0.044	900	No	Health Canada 2009
Np-237 (isotope neptunium-237)	6.3×10^{-7}	1	No	Health Canada 2009
Pu-239 (isotope plutonium-239)	0.0044	0.6	No	Health Canada 2009
Pu-241 (isotope plutonium-241)	0.079	30	No	Health Canada 2009
Pu-242 (isotope plutonium-242)	3.3×10^{-5}	0.6	No	Health Canada 2009
Ra-226 (isotope radium-226)	6.4×10^{-4}	0.5	No	Health Canada 2009
Se-79 (isotope selenium-79)	2.4×10^{-5}	50	No	Health Canada 2009
Sn-126 (isotope tin-126)	7.2×10^{-6}	30	No	Health Canada 2009
Sr-90 (isotope strontium-90)	9.6	5	Yes	Health Canada 2009
Tc-99 (isotope technetium-99)	5.7	200	No	Health Canada 2009
Th-230 (isotope thorium-230)	2.2×10^{-4}	0.7	No	Health Canada 2009
Th-232 (isotope thorium-232)	9.6×10^{-4}	0.6	No	Health Canada 2009
U-233 (isotope uranium-233)	2.9×10^{-5}	3	No	Health Canada 2009
U-234 (isotope uranium-234)	0.0078	3	No	Health Canada 2009
U-235 (isotope uranium-235)	3.3×10^{-4}	3	No	Health Canada 2009
U-238 (isotope uranium-238)	0.0076	3	No	Health Canada 2009
Zr-93 (isotope zirconium-93)	0.044	100	No	Health Canada 2009

Source: Source: Adapted from (AECOM 2019a) and (CNL 2019b)

Note: The effluent discharge target for radiological parameters is based primarily on the drinking water guideline as noted in the table.

Yes and No related to the column Treatment Required? Indicate if the maximum predicted concentration exceeds the effluent discharge target.

Bq/L = Becquerel per litre.

Table 9-8: Non-radionuclide Constituent Concentrations in Wastewater and Effluent Discharge Target and Environmental Protection Benchmarks

Constituent	Maximum Predicted Concentration in Wastewater (mg/L) Prior to Treatment	Effluent Discharge Target (mg/L)	Treatment Required?	Reference for Effluent Discharge Target
Cations				
Aluminum	0.15	0.05	Yes	CCME 1999
Antimony	3.3×10^{-7}	0.02	No	MOEE 1994
Arsenic	3.1×10^{-4}	0.005	No	CCME 1999
Barium	7.1×10^{-4}	0.004	No	Suter and Tsao 1996
Beryllium	1.9×10^{-6}	0.011	No	MOEE 1994
Boron	0.12	0.2	Possible	MOEE 1994
Cadmium	2.9×10^{-6}	9.0×10^{-5}	No	CCME 1999
Calcium	100	116	No	Suter and Tsao 1996
Chromium (total)	2.5×10^{-4}	0.001 (3)	No	CCME 1999
Cobalt	0.0027	0.0009	Yes	MOEE 1994
Copper	8.0×10^{-4}	0.002	No	CCME 1999
Iron	125	0.3	Yes	CCME 1999
Lead	2.4×10^{-5}	0.001	No	CCME 1999
Magnesium	68	82	No	Suter and Tsao 1996
Manganese	5.8	0.12	Yes	Suter and Tsao 1996
Mercury	2.3×10^{-6}	2.6×10^{-5}	No	CCME 1999
Molybdenum	0.0039	0.04	No	MOEE 1994
Nickel	5.5×10^{-5}	0.025	No	CCME 1999
Potassium	26	53	No	Suter and Tsao 1996
Selenium	4.8×10^{-5}	0.001	No	CCME 1999
Silica	5	*	No	
Silver	3.2×10^{-6}	1.0×10^{-4}	No	MOEE 1994
Sodium	100	680	No	Suter and Tsao 1996
Thallium	3.8×10^{-6}	3.0×10^{-4}	No	MOEE 1994
Tin	5.8×10^{-4}	0.073	No	Suter and Tsao 1996
Uranium	6.1×10^{-4}	0.005	No	MOEE 1994
Vanadium	4.3×10^{-4}	0.006	No	MOEE 1994
Zinc	0.0016	0.007	No	CCME 1999

Table 9-8: Non-radionuclide Constituent Concentrations in Wastewater and Effluent Discharge Target and Environmental Protection Benchmarks

Constituent	Maximum Predicted Concentration in Wastewater (mg/L) Prior to Treatment	Effluent Discharge Target (mg/L)	Treatment Required?	Reference for Effluent Discharge Target
Anions				
Bicarbonate Alkalinity as $CaCO_3$	542	*	*	
Chloride	17	120	No**	CCME 1999
Fluoride	0.12	0.012	No	CCME 1999
Nitrate as NO_3	29.3	13 (1)	Yes(1)	CCME 1999
Nitrite as N	0.265	0.06 (1)	Yes(1)	CCME 1999
Phosphorus	1.3	0.01	No(2)	MOEE 1994
Sulphate	270	128 (1)	Yes(1)	AEP 2018
Organics				
Acetone	0.69	1.5	No	Suter and Tsao 1996
Anthracene	4.3×10^{-6}	8.0×10^{-7}	Yes	MOEE 1994
Benzene	0.00151.5 x 10^{-3}	0.1	No	MOEE 1994
Benzo(a)pyrene	1.1×10^{-7}	1.5×10^{-5}	No	CCME 1999
Bis(2-ethylhexyl) phthalate	4.4×10^{-6}	6.0×10^{-4}	No	MOEE 1994
Carbon tetrachloride	0.0029	0.0133	No	CCME 1999
Chlorobenzene	7.6×10^{-4}	0.0013	No	CCME 1999
Chloroform	0.0066	0.0018	Yes	CCME 1999
Chrysene	3.7×10^{-7}	1.0×10^{-7}	Yes	MOEE 1994
1,4 Dichlorobenzene	3.5×10^{-4}	0.004	No	MOEE 1994
Dioxin (TEQ)	2.7×10^{-13}	1.0×10^{-8}	No	Suter and Tsao 1996
Ethylene-Diamine-Tetra acetic Acid	1	*	*	
Ethylene dibromide	0.0081	0.005	Yes	MOEE 1994
Fluoranthene	1.3×10^{-6}	8.0×10^{-7}	Yes	MOEE 1994
Fluorene	7.8×10^{-6}	2.0×10^{-4}	No	MOEE 1994
Furan (TEQ)	2.7×10^{-13}	1.0×10^{-8}	No	Suter and Tsao 1996
Methylene chloride	0.028	0.0981	No	CCME 1999
Phenol	5.7×10^{-4}	0.004	No	CCME 1999
Phenolic compounds – no chlorine	7.0×10^{-4}	0.004	No	CCME 1999
PCBs	2.5×10^{-8}	1.0×10^{-6}	No	MOEE 1994
Tannic acid	50	*	*	
1,1,2,2 Tetrachloroethane	0.0014	0.07	No	MOEE 1994
Tetrachloroethylene	0.0014	0.05	No	MOEE 1994
1,1,2 Trichloroethylene	0.0022	0.8	No	MOEE 1994

Table 9-8: Non-radionuclide Constituent Concentrations in Wastewater and Effluent Discharge Target and Environmental Protection Benchmarks

Constituent	Maximum Predicted Concentration in Wastewater (mg/L) Prior to Treatment	Effluent Discharge Target (mg/L)	Treatment Required?	Reference for Effluent Discharge Target
Other Constituents				
Carbonaceous 5-day biochemical oxygen demand	62	25	Yes	CCME 2008
Petroleum hydrocarbons (C6-C10)	***	0.15	***	AEP 2018
pH	+	6.5 to 9	+	CCME 1999
Suspended solids	+	25	+	CCME 1999

Source: Source: Adapted from (AECOM 2019a) and (CNL 2019b)

Note: The effluent discharge targets for conventional parameters are based primarily on effects-based benchmarks developed for the protection of aquatic life. The references for these benchmarks are noted in the table.

Additional constituents may be identified. Effluent discharge targets for these would be defined as required.

1) The concentration of nitrates and nitrites in the final effluent is predicted based on conservative assumptions and the actual concentration of the nitrate and nitrite in the effluent is expected to be less than the predictions. The flexibility of the WWTP design allows CNL to modify our treatment approach based upon the actual wastewater characteristics. CNL will sample the leachate before treatment begins and at several times during the treatment process to ensure that the treatment processes are working as expected. If they are not, CNL can make adjustments to the treatment strategy to deal with the unexpected waste constituents through the use of different ion exchange resins or chemistry changes. The treated effluent goes to a Final Effluent Tank where it is sampled, and the sample is analysed prior to discharging the treated effluent. If the treated effluent does not meet the effluent discharge targets, it would be returned to the beginning of the WWTP process and go through the treatment process again to remove the species that exceed the effluent discharge targets. For sulphate, nitrate and nitrite, an anion exchange resin would be used to remove these species.

2) Similar to Note 1, the predicted concentration of phosphorus is based on conservative assumptions and the general discussion of the WWTP treatment approach applies to phosphorus. Specifically for phosphorus, it will be removed during the chemical precipitation step by the ferric chloride that is part of the normal treatment strategy. In the event that higher than normal phosphorus concentrations are observed in the wastewater feed to the WWTP treatment processes, the chemical precipitation step using ferric chloride can be optimized for phosphorus removal at this time. If the concentration of phosphorus in the Final Effluent Tank prior to discharge exceeds the discharge criterion, this liquid would be returned to the beginning of the process and undergo further treatment to remove it.

3) The Chromium (total) effluent discharge target is based on the Canadian Water Quality Guideline for Chromium (VI).

4) Yes and No related to the column Treatment Required? Indicate if the maximum predicted concentration exceeds the effluent discharge target/benchmark.

* = no limit established.

** = Present at an elevated concentration in groundwater used to estimate leachate characteristics; not expected to be present in excess in effluent limit in leachate.

*** = Not expected to be present in significant concentrations based on projected bulk waste characteristics.

+ May be present at concentrations exceeding the discharge requirement based on preliminary bulk waste characteristics.

Table 9-9: Summary of Parameters Monitored

ATG Group	Parameter Name
NA	Gross Alpha Gross Beta Gamma Emitters (including Co-60) Tritium
1b	CBOD
3	pH
4b	Nitrogen (nitrate and nitrite)
9	All Metals in ATG 9
9a	Additional Meals (Fe, U, Mg)
16	Volatiles, Halogenated
17	Volatiles, Non-Halogenated
30	Anions (chloride, fluoride, sulphate)
29	Other metals or inorganics (barium, manganese, calcium)

ATG – analytical test group (MOECC 2016)

9.8 Sampling, Analysis and Analytical Methodologies

Sampling and analysis to be conducted as required by CNL's standard for the protection and monitoring of groundwater (CNL 2020b).

Collection of water level data and sample collection is to follow CNL's standard operating procedures as are the storage, preparation and handling of samples (CNL 2018f, 2018g). As impacts are not expected at the initiation of sampling, purged water can be discharged to ground provided the concentrations identified at a well have consistently met the benchmarks provided in Table 9-7 and Table 9-8. Samples for metals and inorganics are to be field filtered. Samples are to be shipped to allow for analysis no later than their required hold times for the specific analysis.

Analysis to be conducted in accordance with MISA analysis protocol (MOECC 2016) and internal CNL standard operating procedures and requirements.

9.9 Detailed Design

The GWMP for the NSDF is summarized in the Table 9-10 and Table 9-11 below for the operations and closure phases respectively. As noted in various locations in this plan the wells, parameters/measurements and the frequency may be adapted as further information is obtained through monitoring.

Table 9-10: Summary of the GWMP during the Operations Phase

Sampling Location	Analysis/Measurement Required	Monitoring Frequency
ECM Wells (SH-4, SH-5, NSDF-001 to NSDF-009, PH17-005, PH17-009)	GWMP1a Physical measurement of water level at all wells Level loggers at wells: SH-4, SH-5, PH17-005 and PH17-009	Physical measurements to be taken with sampling on a semi-annual basis Level loggers to collect water level data every two hours
	GWMP3a Wellhead parameters (pH, temperature, conductivity) Radiological (Gross Alpha, Gross Beta, Gamma Emitters, Tritium) Conventional (pH, Nitrogen (nitrate and nitrite), CBOD, All Metals in ATG 9 and 9a, Halogenated Volatiles, Non-Halogenated Volatiles, Anions (chloride, fluoride, sulphate), Other metals or inorganics (barium, manganese, calcium)	Sampling and analysis semi-annually
WWTP Wells (NSDF-010 to NSDF-013)	GWMP2a Physical measurement of water level at all wells Level loggers at wells: NSDF-010, NSDF-011, NSDF-012.	Physical measurements to be taken with sampling on a semi-annual basis Level loggers to collect water level data every two hours
	GWMP4a Wellhead parameters (pH, temperature, conductivity) Radiological (Gross Alpha, Gross Beta, Gamma Emitters, Tritium) Conventional (pH, Nitrogen (nitrate and nitrite), CBOD, All Metals in ATG 9 and 9a, Halogenated Volatiles, Non-Halogenated Volatiles, Anions (chloride, fluoride, sulphate), Other metals or inorganics (barium, manganese, calcium)	Sampling and analysis semi-annually

Table 9-11: Summary of the GWMP during the Closure Phase

Sampling Location	Analysis/Measurement Required	Monitoring Frequency
ECM Wells (SH-4, SH-5, NSDF-001 to NSDF-009, PH17-005, PH17-009)	GWMP1b Physical measurement of water level at all wells Level loggers at wells: SH-4, SH-5, PH17-005 and PH17-009	Physical measurements to be taken with sampling on a semi-annual basis Level loggers to collect water level data every two hours
	GWMP3b Wellhead parameters (pH, temperature, conductivity) Radiological (Gross Alpha, Gross Beta, Gamma Emitters, Tritium) Conventional (pH, Nitrogen (nitrate and nitrite), CBOD, All Metals in ATG 9 and 9a, Halogenated Volatiles, Non-Halogenated Volatiles, Anions (chloride, fluoride, sulphate), Other metals or inorganics (barium, manganese, calcium)	Sampling and analysis semi-annually
WWTP Wells (NSDF-010 to NSDF-013)	GWMP2b Physical measurement of water level at all wells Level loggers at wells: NSDF-010, NSDF-011, NSDF-012.	Physical measurements to be taken with sampling on a semi-annual basis Level loggers to collect water level data every two hours
	GWMP4b Wellhead parameters (pH, temperature, conductivity) Radiological (Gross Alpha, Gross Beta, Gamma Emitters, Tritium) Conventional (pH, Nitrogen (nitrate and nitrite), CBOD, All Metals in ATG 9 and 9a, Halogenated Volatiles, Non-Halogenated Volatiles, Anions (chloride, fluoride, sulphate), Other metals or inorganics (barium, manganese, calcium)	Sampling and analysis semi-annually

9.10 Data Preparation

The preparation, and ultimately the evaluation, processes for data collected under the GWMP are comprised of a series of analytical, data quality, and performance reviews. Initially, the analytical data are prepared by compiling and subjecting the information to a data gap analysis and a review of abnormal data. Data gaps can be a result of sampling difficulties or incomplete reporting of analytical results. Abnormal results are investigated and supplemental sampling may be required if there is no resolution. Once the initial data review is complete and the information is in the data repository, a second review is initiated. Again, data irregularities (outliers) are scrutinized and corrective actions are initiated if required. At this point, QA/QC data is examined as well as other quality indicators such as method detection limits. Barring any further investigations and/or corrective actions, the data set can now be evaluated and authorized for use and is assessed for any changes in environmental performance.

9.11 Data Quality Considerations: Performance and Acceptance Criteria

The work completed under the GWPP and GWMP must offer confidence to regulators, stakeholders, and the public that CRL is carrying out work over and above the requirements expected by these groups.

The data provided by groundwater monitoring under the GWMP must be assessed against a set of QA and QC measures to ensure the data quality objectives of the GWMP are met and that the groundwater conditions at NSDF are adequately represented. Specific CNL documents outline the QA policies which ensure the data has integrity, the data are in control, and the work is defensible.

The Environmental Protection QA Plan (CNL 2018h) is applicable to the GWMP.

9.11.1 Data Performance Criteria

To assess field and laboratory performance one blind duplicate sample and one field blank sample are to be collected for every ten groundwater samples collected as per industry standard. Spiked blank samples may be used to determine recovery rates, if necessary. Trip blanks may also be used when sampling for volatile compounds (e.g., VOCs) as they pose a risk for cross-contamination and where further assessment of a particular issue is required.

Field instruments are to be calibrated as per the manufacturer's instructions and a record of calibration maintained with the field files.

Sampling or measurements are to be collected at wells specified at the frequency specified. Where a well cannot be sampled or measurements are not taken, an assessment is to be made of the reason for not collecting the information and the results documented. It is realized that a certain number of samples each year will not be collected due to sampling equipment malfunction, not enough water in a well to gain a representative sample, wells may be damaged, level loggers may malfunction and wells may be inaccessible. The target is that 95% of the planned samples are to be obtained with results meeting data acceptance criteria.

9.11.2 Data Acceptance Criteria

The data acceptance criteria in place for groundwater samples are as follows.

Table 9-12: Field Sample QV Acceptance Criteria

Field QV Samples	Quality Verification	Test Acceptance Criteria (CNL 2019g)
Field Blank	Contamination	Results below 3 times LMDL
Travelling Spiked Blank (if necessary)	Accuracy	Recovery (Determined Value/Expected *100) between 30 – 150%
Duplicate	Precision	Ratio of the two replicate results between 0.5 and 2.0

The handling of sample data for those samples which do not meet these acceptance criteria is common and discussed in the program's Management and Monitoring of Emissions procedure (CNL 2018a).

The method detection limits for all analysis is to meet the effluent discharge targets indicated in Table 9-7 and Table 9-8, as well as the baseline screening criteria in Table 9-14 (as updated), and should preferably result in detectable concentrations. For conventional parameters in water, the detection limit should be those from the MISA protocol (MOECC 2016). For radionuclides, the detection limits should meet those commonly used by the CRL GWMP. Where a method detection limit at or below the effluent discharge target cannot be reasonably obtained this should be documented as well as an assessment of the effects of this method detection limit of the objectives to be achieved.

9.11.3 Laboratory Performance Verification

Each laboratory utilized by the NSDF GWMP assesses data quality using specific in-house laboratory QC protocols to provide confidence in the analytical processes and methods and to meet the objectives of the NSDF GWMP. Precision, accuracy, sensitivity, and reproducibility are measured by analyzing samples, such as duplicates, replicates, laboratory blanks, and control/reference samples (CNL 2019g) The laboratory requirements for each of the necessary analyses are part of the laboratory's procedures and QC processes. All laboratories used are to comply with ISO 17025 and are to provide supply quality verification data. Each external analytical laboratory utilized under the GWMP must have a set of QA/QC standards in place that have the same or higher expectations than those at CNL.

9.12 Quality Assurance / Quality Control

Numerous aspects of a QA/QC program are provided in the data quality considerations (Section 9.11). In addition to these requirements the following elements are also considered part of the QA/QC program for the NSDF GWMP program.

9.12.1 Roles and Responsibilities

The roles and responsibilities are those that apply to the CNL GWMP overall (CNL 2020b) Tasks may be contracted (i.e., laboratory analysis, sample collection) and these roles and responsibilities should be clearly defined.

9.12.2 Equipment Maintenance

Equipment that is used in conjunction with the NSDF GWMP is subject to maintenance and calibration activities on a regular basis. In addition, all wells are to be inspected prior to sampling or collecting measurements to confirm the integrity of the well. These are part of CNL's routine procedures and policies used for the overall CRL GWMP. Each procedure provides information on the methods used for equipment/instrumentation maintenance, the frequency of maintenance and calibrations, and the documentation of information. All equipment issues, such as equipment malfunctions, calibration issues, cross-contamination events, and procedural errors are brought to the attention of the Chemist during the year. The matters are raised by documenting the occurrence in the CRL ImpAct system and during the annual program review.

9.13 Data Interpretation and Evaluation Criteria

Three types of groundwater evaluation criteria are used by CNL: evaluation against baseline concentrations (Section 9.13.4), statistical based evaluation (Section 9.13.3), and comparison to risk based benchmarks (Section 9.13.5). Baseline concentration evaluation and statistical evaluation are conducted to assess changes that may be indicative of ECM and WWTP performance. These methods may also identify anomalous conditions. Comparison to risk based benchmarks is required to evaluate protection of human health and the environment. The application of these criteria facilitates the establishment of any exceedances which lead to reviews, evaluations, and reports within a formal management process (non-conformance procedure outlined in Section 9.13.8). If any of the criteria are exceeded, a non-conformance process is initiated (Section 9.13.8). This formal reporting process, using the CNL event notification system ImpAct, is used to investigate the cause of the exceedance, potential environmental consequences, and necessary remedial actions.

Data interpretation begins with a discussion on indicator wells and parameters (Section 9.13.1), as well as a discussion on various data interpretation considerations (Section 9.13.2). The treatment of groundwater flow data is also addressed in Section 9.13.6. A summary of the data interpretation based on objectives is provided in Section 9.13.7.

The information for evaluation of data is provided in the discussion below. For convenience, the Tier 1 and 2 criteria are summarized conceptually in Table 9-13 below.

Table 9-13: Groundwater Monitoring Criteria Summary

GWMP Program Element	Tier 1 Criteria	Tier 2 Criteria
GWMP1a – ECM Groundwater flow – Operations Phase	EIS predictions (drawdown comparison to baseline, trend analysis)	NA- A site specific evaluation will be conducted to evaluate potential effects where Tier 1 Criteria are exceeded.
GWMP 2a – WWTP Groundwater Flow – Operations Phase	EIS predictions (comparison to baseline, trend analysis)	NA- A site specific evaluation will be conducted to evaluate potential effects where Tier 1 Criteria are exceeded.
GWMP3a – ECM Groundwater quality – Operations Phase	Statistical evaluation (trend analysis, mean plus three standard deviations), Baseline screening concentrations	Protection based benchmarks
GWMP 4a WWTP Groundwater Quality – Operations Phase	Statistical evaluation (trend analysis, mean plus three standard deviations), Baseline screening concentrations	Protection based benchmarks

9.13.1 Indicator Wells and Indicator Parameters

Indicator parameters are used to streamline the evaluation and reporting. Additional parameters may be evaluated during the evaluation as may be required and as indicated in reviews. Parameters may also be reduced as data is obtained. The process to add or remove parameters is discussed in Section 9.14. In particular, the ongoing analysis of WWTP influent and effluent may indicate the need to revise parameters used for evaluation. Based on the evaluation discussed in Table 9-6, the indicator parameter used for evaluation and reporting are considered to be:

- **Radionuclides:** Gross Beta, Gross Alpha and tritium – in general these parameters were chosen as indicator parameters and they provide indication of a broad suite of radiological parameters. Tritium is selected in particular due to it's predicted prevalence in waste and it's mobility; and
- **Non-radionuclides:** aluminum, cobalt, manganese, sulphate, nitrates (as NO3), nitrite, chloroform and benzene – in general these parameters were chosen as indicator parameters based on an assessment of potential leachate/contact surface water concentrations that indicate concentrations of these compounds may exceed Tier 2 Criteria.

Depending on the project phase and staging of the project, indicator wells may also be defined during the course of reviews. For example, if operations are occurring only on the western portions of the NSDF several indicator wells on this side of the ECM may be used to meet this objective rather than all wells.

9.13.2 Data Interpretation

Monitoring data is interpreted by comparing against groundwater evaluation criteria and EIS predictions while assessing trend changes over time. Sources of uncertainty in any dataset should be considered and statistically quantified and the data should be interpreted within the appropriate context of the NSDF Project phase (i.e., distinguish data gathered during the initial years of operations and the beginning of closure). These are detailed in Sections 9.13.3 to 9.13.6 and are based on a two-tier evaluation approach as discussed in Section 6.2.

9.13.2.1 Uncertainty

Both the sampling and measurement uncertainty in results should be considered when interpreting the results. In the presentation of results, the number of significant figures in any datapoint should not imply a degree of accuracy greater than warranted by sources of uncertainty. However, more significant figures should be carried through during calculations.

9.13.2.2 Outliers

Outliers should be verified by investigation and analysis (when feasible), and a disposition documented, prior to removal from the data set, since removing the outlier could influence consistency and bias in the results. Verification can occur by re-sampling, re-analysis (e.g., there are statistical tests that can be used to identify outliers), or other investigations as required. Additional measurements should replace an outlier, or an outlier should be removed if deemed appropriate based on the results of an appropriate test/analysis. The complete dataset, including any outliers should be retained as part of records and data management.

9.13.2.3 Non-Detect Results

Data quality criteria (see Section 9.11) help to ensure that calculated means are well-characterized when near or above a criterion. However, if non-detect values occur, then they should be included as part of the valid dataset for interpretation purposes. Where applicable, statistics will help give visibility to number of samples with non-detect results. There are a variety of ways to evaluate data that includes values below the non-detect level, but there are no general procedures that are applicable in all cases. Best practices should be used in the selection of methods to consider non-detect values, with documented supporting rationale.

9.13.3 Statistical Based Groundwater Data Evaluation (Tier 1 Criteria)

Environmental performance monitoring through statistical based groundwater evaluation provides the ability to quantify changes in environmental conditions at each location that is monitored (CNL 2020b). Statistical criteria for each indicator parameter at each well (or indicator wells) are calculated using the “mean plus three standard deviations” (M3SD) approach. This method offers adequate sensitivity and is recognized as an industry standard for measuring spread from the mean value. It is also used as a statistical method of data evaluation at other conventional waste management facilities such as municipal landfills. When 10 years of data has been obtained, the M3SD values are to be calculated. An exceedance of MS3D will trigger further investigation and will used as a Tier 1 Criteria within the NSDF annual reporting.

Trend analysis should also be considered (e.g., plotting sampling results over time) to assess potential project-related changes to the groundwater regime. This is particularly important for wells downgradient of the ECM as leachate concentrations may increase over time. If a possible trend is observed in plotting data, a statistical evaluation can be completed of the possible trend using Mann-Kendal hypothesis testing. Parameters such as tritium, conductivity and chloride can be used as a conservative (i.e., non-attenuated) indicator of potential leakage.

9.13.4 Baseline Screening Criteria (Tier 1 criteria)

Although groundwater results are typically consistent from year to year, as contaminants tend to migrate at levels much slower than groundwater flow, spills or releases can be discovered at any time. Screening is a measurement tool used to evaluate data from facility specific monitoring strategies. Data collected from non-affected wells (baseline wells upgradient of contamination) are analyzed on a semi-annual basis. Screening values are generally defined as those that are outside of the 97.5% confidence interval of the mean. The screening values are updated using information from the previous 10 years of sampling. As there is insufficient data at this time for a statistical limit, maximum values are used at this time (Table 9-14). These values are obtained from overburden wells where samples were collected from a baseline sampling program within the

NSDF area in three sampling events in 2015 and 2016 (CNL 2018i) and from three sampling events in 2018 and 2019 from the existing wells noted in Table 9-4 (Klukas 2020b). It is noted that some of these maximum baseline concentrations exceed the maximum predicted concentration of leachate (e.g., uranium, zinc, chloride) and some of the maximum baseline concentrations exceed the effluent discharge targets (e.g., aluminum, cobalt, iron and lead). The treatment of these items is discussed further in Section 9.13.5.

For non-radiological parameters of anthropogenic origin (e.g., VOCs which do not naturally occur in the environment and are a direct result of operational activities), the Tier 1 values are twice the method detection limits (MDL). Using twice these minimum values eliminates results of uncertain validity. Non-detect values are given a value of the detection limit for Tier 1 screening purposes. The Tier 1 Criteria are to be used in the annual reporting for the NSDF or the Annual Groundwater Monitoring Report.

Where anomalous conditions in the groundwater analyses are identified the parameters with anomalous results are subjected to trend plotting, trend evaluation, and discussion while other pertinent information is also reviewed before disclosure in the annual report. Trend plots from different parameters can also be compared to see if there are any correlations between the trends. Screening is meant to highlight data that needs attention and to flag certain parameters; it does not indicate any data that is above limits that can cause human or ecological health risks. Indicator parameters for reporting are noted in italics.

Table 9-14: Initial Baseline Screening Criteria (Tier 1)

Parameter[1]	Maximum Concentration (or detection limit if no detectable concentrations)	Tier 1 Screening Criteria	Unit
Radionuclides			
Gross Alpha	0.293	0.293	Bq/L
Gross Beta	0.32	0.32	Bq/L
Tritium	970	970	Bq/L
Halogenated Volatiles and Non-Halogenated Volatiles			
1,1,2,2-Tetrachloroethane	<0.5	1.0	µg/L
1,1,2-Trichloroethane	<0.4	0.8	µg/L
1,1-Dichloroethane	<0.5	1.0	µg/L
1,1-Dichloroethylene	<0.5	1.0	µg/L
1,2-Dichlorobenzene	<0.5	1.0	µg/L
1,2-Dichloroethane	<0.6	1.2	µg/L
1,2-Dichloropropane	<0.6	1.2	µg/L
1,3-Dichlorobenzene	<0.4	0.8	µg/L
1,4-Dichlorobenzene	<0.4	0.8	µg/L
Acrolein	<4	8	µg/L
Acrylonitrile	<4	8	µg/L
Benzene	<0.5	1	µg/L
Bromodichloromethane	<0.6	1.2	µg/L
Bromoform	<3	6	µg/L
Bromomethane	<0.7	1.4	µg/L
Carbon Tetrachloride	<0.6	1.2	µg/L
Chlorobenzene	<0.5	1	µg/L
Chloroform	6.3	6.3	µg/L
Chloromethane	<0.9	1.8	µg/L
cis-1,3-Dichloropropylene	<0.5	1	µg/L
Dibromochloromethane	<1	2	µg/L

Table 9-14: Initial Baseline Screening Criteria (Tier 1)

Parameter[1]	Maximum Concentration (or detection limit if no detectable concentrations)	Tier 1 Screening Criteria	Unit
Halogenated Volatiles and Non-Halogenated Volatiles (cont'd)			
Ethylbenzene	<0.5	1.0	µg/L
Ethylene dibromide	<0.5	1.0	µg/L
m,p-Xylene	<0.5	1.0	µg/L
Methylene chloride	<0.7	1.4	µg/L
Methyl-t-butyl ether	<1.5	3.0	µg/L
o-Xylene	<0.5	1.0	µg/L
o-xylene	<0.3	0.6	µg/L
Tetrachloroethylene	<0.5	1.0	µg/L
Toluene	4.5	9	µg/L
trans-1,2-Dichloroethylene	<0.5	1.0	µg/L
Trans-1,2-Dichloroethylene	<0.5	1.0	µg/L
trans-1,3-Dichloropropylene	<0.5	1.0	µg/L
Trichloroethylene	<0.7	1.4	µg/L
Trichlorofluoromethane	<0.5	1.0	µg/L
Vinyl chloride	<0.7	1.4	µg/L
Field Parameters			
pH (field)	8.41	NA	NA
Temperature	13	NA	°C
Conductivity	503	503	µS/cm
Anions			
Nitrate (NO3-)	2.9	2.9	mg/L
Nitrate + Nitrite (NO3- + NO2-)	0.65	0.65	mg/L as N
Nitrite (NO2-)	<0.07	0.14	mg/L
Sulphate (SO42-)	144.5	144.5	mg/L
Fluoride (F-)	0.19	0.19	mg/L
Chloride (Cl-)	57.8	57.8	mg/L
Sulphate (SO42-)	144.5	144.5	mg/L
Cations			
Aluminum (Al)	4600	4600	µg/L
Antimony (Sb)	0.14	0.14	µg/L
Arsenic (As)	0.8	0.8	µg/L
Barium (Ba)	92	92	µg/L
Beryllium (Be)	3.4	3.4	µg/L
Boron (B)	44	44	µg/L
Cadmium (Cd)	0.062	0.062	µg/L
Calcium (Ca)	44000	44000	µg/L
Chromium (Cr)	6.2	6.2	µg/L
Cobalt (Co)	3	3	µg/L
Copper (Cu)	28	28	µg/L
Iron (Fe)	7500	7500	µg/L
Lead (Pb)	17.3	17.3	µg/L
Lithium (Li)	11.5	11.5	µg/L
Magnesium (Mg)	8300	8300	µg/L

Table 9-14: Initial Baseline Screening Criteria (Tier 1)

Parameter[1]	Maximum Concentration (or detection limit if no detectable concentrations)	Tier 1 Screening Criteria	Unit
Cations (cont'd)			
Manganese (Mn)	310	310	µg/L
Molybdenum (Mo)	14.6	14.6	µg/L
Nickel (Ni)	111	111	µg/L
Selenium (Se)	<3	6	µg/L
Silver (Ag)	<2	4	µg/L
Strontium (Sr)	630	630	µg/L
Styrene	<0.5	1.0	µg/L
Thallium (Tl)	0.51	0.51	µg/L
Uranium (U)	19.3	19.3	µg/L
Vanadium (V)	11.6	11.6	µg/L
Zinc (Zn)	220	220	µg/L

Note
1. Indicator parameters for reporting are noted in *italics*.

9.13.5 Protection-based Groundwater Benchmarks (Tier 2 Criteria)

The effluent discharge targets identified in Table 9-7 and Table 9-8 are used as Tier 2 Criteria (risk-based benchmarks) for groundwater data evaluation as these are used throughout the NSDF EAFMP. The Tier 2 Criteria provide an indication of the level of hazard related to leachate and contact surface water as well as effluent from the WWTP. The Tier 2 Criteria represent maximum allowable concentrations in drinking water for radionuclides with the exception of tritium, and federal/provincial guidelines for protection of aquatic biota for non-radionuclides (CNL 2019b). The effluent discharge target for tritium of 360,000 Bq/L represents the concentration level which will ensure that tritium concentrations in Perch Creek, the creek draining the Perch Creek and Perch Lake watershed and discharging to the Ottawa River, remain below the tritium drinking water guideline of 7,000 Bq/L. The targets for conventional contaminants are based on federal and provincial guidelines for the protection of aquatic life and the reference documents are provided in Table 9-8.

Exceedances of Tier 2 Criteria are to be evaluated and reported as discussed in Section 9.13.8. As these Tier 2 Criteria are established from surface water exposures for biota and ingestion for humans, these values are considered conservative with regards to groundwater for two reasons. First, as humans and biota do not exist in, or presently have exposure to, the groundwater at the NSDF, they are not considered key receptors when the water is in the ground. Nevertheless, surface water values are used because the groundwater may eventually discharge to the surface and/or aquatic environments where these receptors may be exposed. Second, a sample collected from an aquifer may indicate an exceedance of a benchmark value at that moment in time; however, by the time the groundwater from the sampling location comes to surface, the concentrations of parameters may be substantially lower. This can be a result of dilution from dispersion, radioactive decay, or other natural attenuation mechanisms encountered along a groundwater flow path. Accordingly, an exceedance of a Tier 2 protective criteria is not expected to result in an effect on human health or biota. Changes to the Tier 2 Criteria, where required, can be made based on the process noted in Section 9.13.9.

For parameters where exceedances of the Tier 2 Criteria may be present with existing baseline groundwater results, the Tier 2 Criteria is not to be used and the Tier 1 Criteria alone is to be used. These parameters include aluminum, cobalt, iron and lead.

9.13.6 Groundwater Flow Evaluation (Tier 1 criteria)

The groundwater elevation data collected from ongoing monitoring of wells will be used to assess potential project-related changes to the groundwater flow direction and gradients. These data can be used as a basis for comparison to the predicted changes to the groundwater flow regime documented in Section 5.3.2 of the EIS. This evaluation is considered a Tier 1 Criteria evaluation. Further details on these findings and the use of the data collected is provided below.

For reference the predicted/modelled groundwater change due to operations at each well is provided in the table below.

Table 9-15: Predicted Groundwater Drawdown During Operations

Monitoring Well	Calculated Drawdown During Operations relative to Predevelopment Conditions (m)
PH17-005	1.4
PH17-009	1.0
SH-4	-0.1
SH-5	0.0
NSDF-001	-0.6
NSDF-002	-0.4
NSDF-003	-0.2
NSDF-004	-0.2
NSDF-005	-0.2
NSDF-006	-0.2
NSDF-007	-0.4
NSDF-008	-0.4
NSDF-009	-0.2
NSDF-010	-1.4
NSDF-011	-0.7
NSDF-012	-0.6
NSDF-013	0.9

9.13.7 Summary of Use of Data by Objective

As part of the systematic planning process information is provided on how the data are to be used to meet each objective.

9.13.7.1 GWMP1a, ECM, Operations Phase

Objective: Verify environmental assessment predictions on groundwater flow and direction from ECM during Operations

- For predictive model scenarios evaluated for Operations where the SWMPs are lined, there was localized drawdown in the simulated water table in the vicinity of the SWMPs. The maximum drawdown for all scenarios was approximately 1 m and was limited to the area of SWMP #1. The extent of the drawdown beneath the lined ponds is limited by infiltration applied at the pond spillover location (i.e., immediately downgradient of the pond locations) (Figure 9-4 and Figure 9-5). Given the limited potential for groundwater impacts at the SWMPs, monitoring of these features specifically is not necessary.

  Groundwater drawdown associated with the cover and liner placement over the ECM was estimated to be up to 8 m within the ECM footprint, with localized drawdown of up to 2 m extending beyond the ECM footprint to the north and east (Figure 9-4 and Figure 9-5). At the location of monitoring (75 to 150 from the ECM), the groundwater depression is predicted to be negligible. The EIS predicted drawdown has been provided in Table 9-15 for use as a possible Tier 1 Criteria.
- A comparison of groundwater elevations before and after installation of the cover and liner is to be completed to confirm that the extent and magnitude of drawdown are similar to model predictions and that groundwater flow directions towards Perch Creek are maintained. The Tier 1 Criteria (Table 9-15) is to be used with caution and understanding of the CSM as the modelling is conservatively based on a high water table condition which is unlikely to represent typical conditions. Where a Tier 1 exceedance is identified a site specific evaluation, as noted in the items below, is to be conducted.
- Plot measured groundwater levels by time, by location. Compare measured groundwater levels (and calculated flow and direction) to baseline conditions and assess trends of data. Simple statistics such as number of samples, arithmetic mean, standard deviation and geometric mean may be prepared for measured data and for baseline data, and the means compared. Trend analysis can be conducted by use of the Mann-Kendall Test (Tier 1 Criteria).
- When assessing water levels, changes in background groundwater elevations is also to be considered.

9.13.7.2 GWMP1b, ECM, Closure Phase

Objective: Verify environmental assessment predictions on groundwater flow and direction from ECM during Operations

- For the Post-closure Scenario evaluated as a part of predictive modelling (similar to the Closure Phase for the purposes of this objective) with an intact final cover (i.e., the scenario where runoff is directed to the SWMPs, and the pond liners are compromised), there were localized rises in the simulated water table in the vicinity of the SWMPs. The maximum rise was approximately 2 m in the vicinity of the SWMP #1 (Figure 9-6). The extent of the rise in the water table was limited to the area located between the SWMP#1 and the boundary of East Swamp, extending approximately 50 m northwest of the SWMP #1 (as defined by the -1 m drawdown contour). The simulated change in groundwater elevation in the area of the ponds remained below ground surface (under high water table conditions). As such, the infiltration of runoff applied in the pond areas is anticipated to have a limited impact on the surface water regime.

  For the Post-closure Scenario where the final cover was assumed to be compromised, infiltration through the ECM cover collects above the ECM baseliner and seeps to the groundwater table over the southern portion of the ECM, resulting in leachate-impacted groundwater. Groundwater in this area follows a flow path towards the south-southeast, with the majority of particles discharging to Perch Creek. A small portion of the particles released from the westernmost and easternmost spillover area locations discharged at surface to the Perch Lake Swamp. Groundwater travel times between the spillover and Perch Creek for the majority of particles ranged from approximately 5 years to 15 years with the majority of particles arriving between approximately 7 years to 10 years (Figure 9-7). Based on the position of the water table, the groundwater particles began at the spillover location travelling through the till unit, then transitioned to the upper sand units before reaching their ultimate discharge location. An example of a conservative (i.e., early arriving) groundwater particle is illustrated on Figure 9-7; see the path with points marked from A through D). At this location, the groundwater particle reaches Perch Creek in approximately 6 years, and has a groundwater velocity ranging from 0.15 m/day to 0.26 m/day depending on its position in the groundwater flow path.
- Plot measured groundwater levels by time, by location. Compare measured groundwater levels (and calculated flow and direction) to baseline conditions and assess trends of data. Simple statistics such as number of samples, arithmetic mean, standard deviation and geometric mean should be prepared for measured data and for baseline data, and the means compared. Trend analysis can be conducted by use of Mann-Kendall Test (Tier 1 Criteria).
- Measurements of groundwater elevation should be evaluated to confirm the groundwater flow direction and travel times between the ECM and Perch Creek.
- If, following operations monitoring, a trend showing a sustained decrease in groundwater levels at the ECM monitoring locations are identified, the model can be re-evaluated. Though it is unlikely that such changes to groundwater conditions would pose a significant risk to water quantity groundwater travel time and flow direction should be evaluated for potential adverse effects.
- When assessing water levels, changes in background groundwater elevations is also to be considered.

9.13.7.3 GWMP 2a, WWTP, Operations Phase

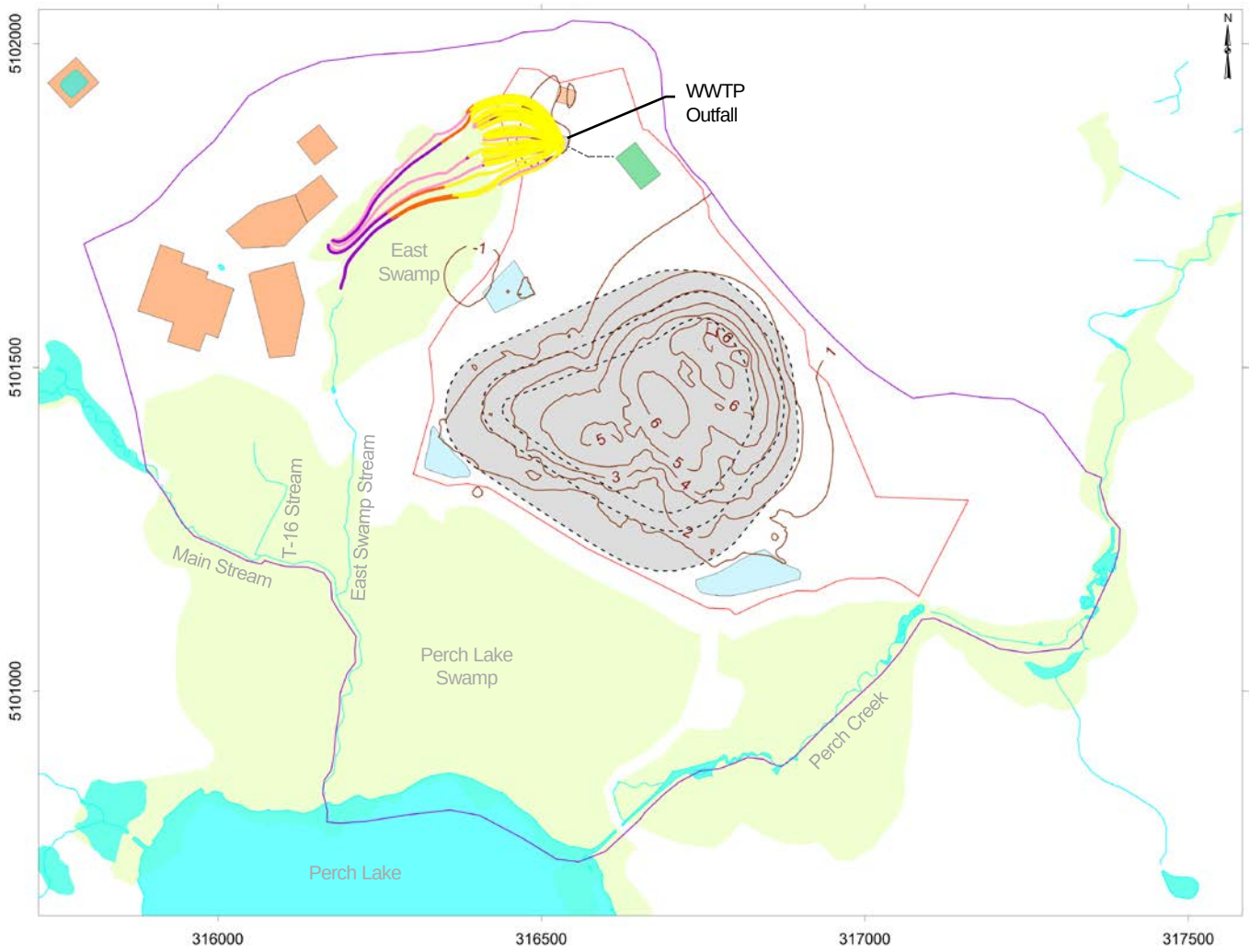
Objective: Verify environmental assessment predictions on groundwater flow and direction from ECM during operations

- For the scenarios evaluated using the predictive model where the WWTP is operational, groundwater particles released from the exfiltration gallery area travel towards the west, ultimately discharging at the East Swamp. The majority of the particles discharge to the East Swamp immediately downgradient from the exfiltration gallery, whereas the remaining particles follow a deeper flow path and discharge at the East Swamp Stream after approximately 3 years (Figure 9-4). During the operations phase, the additional infiltration applied at the exfiltration gallery results in a localized increase in water table elevation of up to 1 m compared to the current conditions and minimal increase in water table is expected at the monitoring locations NSDF-011 and NSDF-012.
- Plot measured groundwater levels by time, by location. Compare measured groundwater levels (and calculated flow and direction) to baseline conditions and assess trends of data. Simple statistics such as number of samples, arithmetic mean, standard deviation and geometric mean should be prepared for measured data and for baseline data, and the means compared. Trend analysis can be conducted by use of Mann-Kendall Test (Tier 1 Criteria).
- Groundwater elevation data collected from WWTP wells (including the background well NSDF-013) is to be reviewed to confirm that the groundwater flow direction from the WWTP exfiltration gallery is towards East Swamp. If the groundwater flow direction is not as predicted, an additional well(s) may be required to ensure monitoring is conducted downgradient of the exfiltration gallery. The EIS predicted drawdown has been provided in Table 9-15 for use as a possible Tier 1 Criteria however this prediction is to be used with caution and understanding of the CSM as the modelling is conservatively based on a high-water table condition which is unlikely to represent typical condition.
- Monitoring for groundwater at surface immediately downgradient of the exfiltration gallery (NSDF-010) should be completed to confirm that groundwater elevations remain below-grade during WWTP operation. Groundwater elevations above grade are to be avoided and if present, may require changes to the WWTP effluent discharge process.
- Although beyond the EAFMP objective, the water level data obtained from NSDF-010 may also be used operationally by the WWTP to inform periods when discharge to the exfiltration gallery is acceptable or not.
- Where there is an exceedance of Tier 1 Criteria a site specific evaluation for potential adverse effects is to be conducted as Tier 2 Criteria.

9.13.7.4 GWMP 2b, WWTP, Closure Phase

Objective: Verify environmental assessment predictions on groundwater flow and direction from ECM during closure.

- While the WTTP is operational the evaluation indicated for GWMP2a can be utilized.
- For the Post-closure phase of the project operation where the WWTP is no longer operational, treated water will no longer be discharged from the exfiltration gallery. As such, no groundwater-related impacts are expected in this area under post-closure conditions. Monitoring of groundwater elevations in the vicinity of the exfiltration gallery could be completed to confirm the return of groundwater elevations to pre-operational conditions.



LEGEND

- Model Boundary
- Simulated Change in Water Table Elevation – Calibration minus Forecast (m)
- Groundwater Particle Traces
  - 0 to 1-year
  - 1 to 2-year
  - 2 to 5-year
  - Steady-State
- Stream
- ECM Outline
- Waste Management Area
- Swamp

NOTES:

1) Scenario A represents the case where 1 cell is active, 11,000 m^3 is collected in the ECM with half of this volume discharged to the WTP exfiltration gallery over a four month period;
2) Recharge distribution is representative of long term average conditions
3) Runoff collection and re-routing to SWM ponds for the remaining cells;
4) Particle traces are shown from the WTP infiltration area;

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PROJECT
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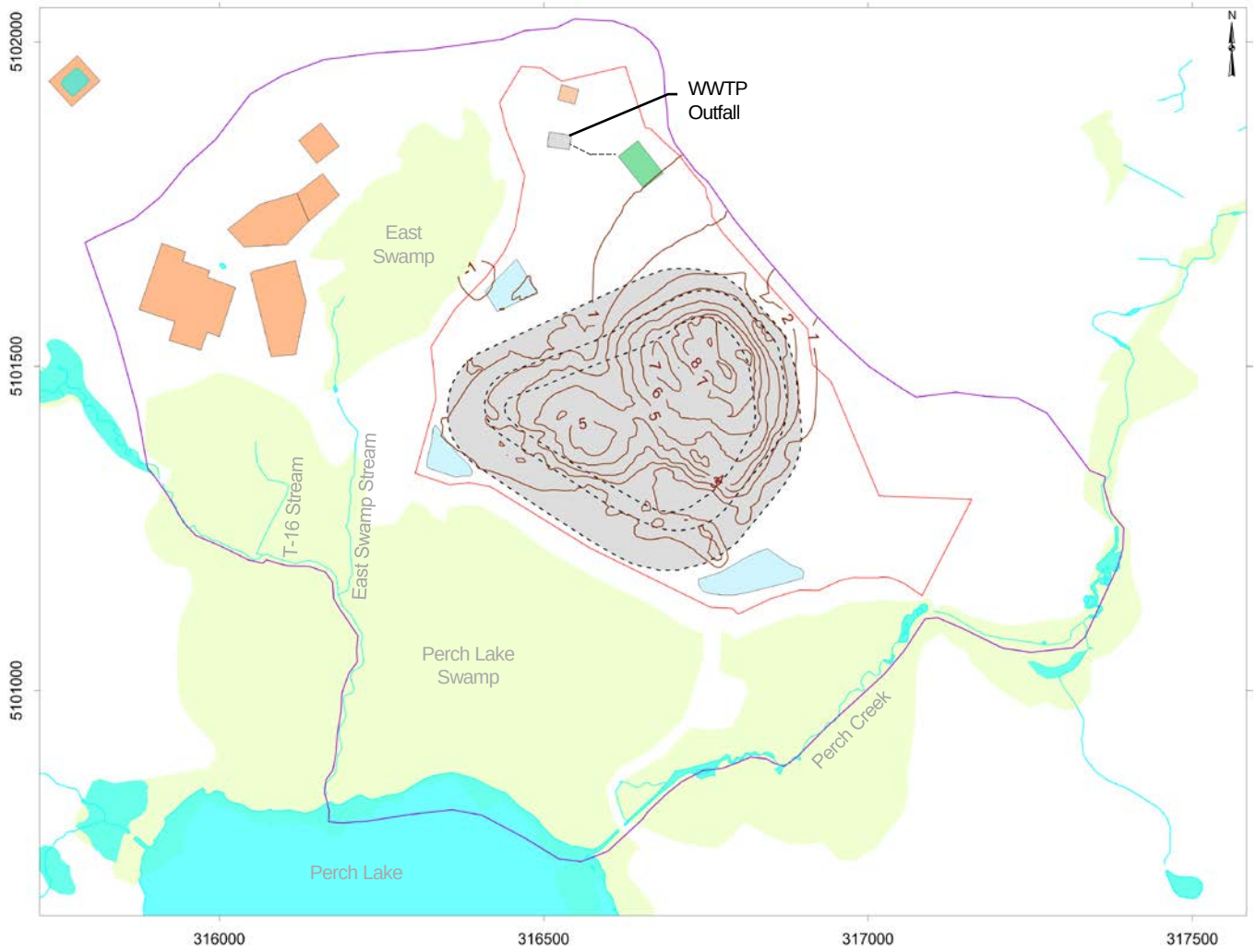
CONSULTANT
Golder Associates

YYYY-MM-DD	2019-07-18
PREPARED	MIB
DESIGN	NFB
REVIEW	SD
APPROVED	SD

TITLE
Groundwater Flow Model Results – Operations Scenario A

PROJECT No.	PHASE	Rev.	FIGURE
1547525	**4300**	**2**	**9-4**



LEGEND

- Model Boundary
- Simulated Change in Water Table Elevation – Calibration minus Forecast (m)
- Stream
- ECM Outline
- Waste Management Area
- Swamp

NOTES:

1) Scenario B represents the case where 1 cell is active, and all water collected in the open cell is treated at the WTP and pumped to Perch Lake
2) Recharge distribution is representative of seasonal high water table conditions
3) Runoff collection and re-routing to SWM ponds for the remaining cells

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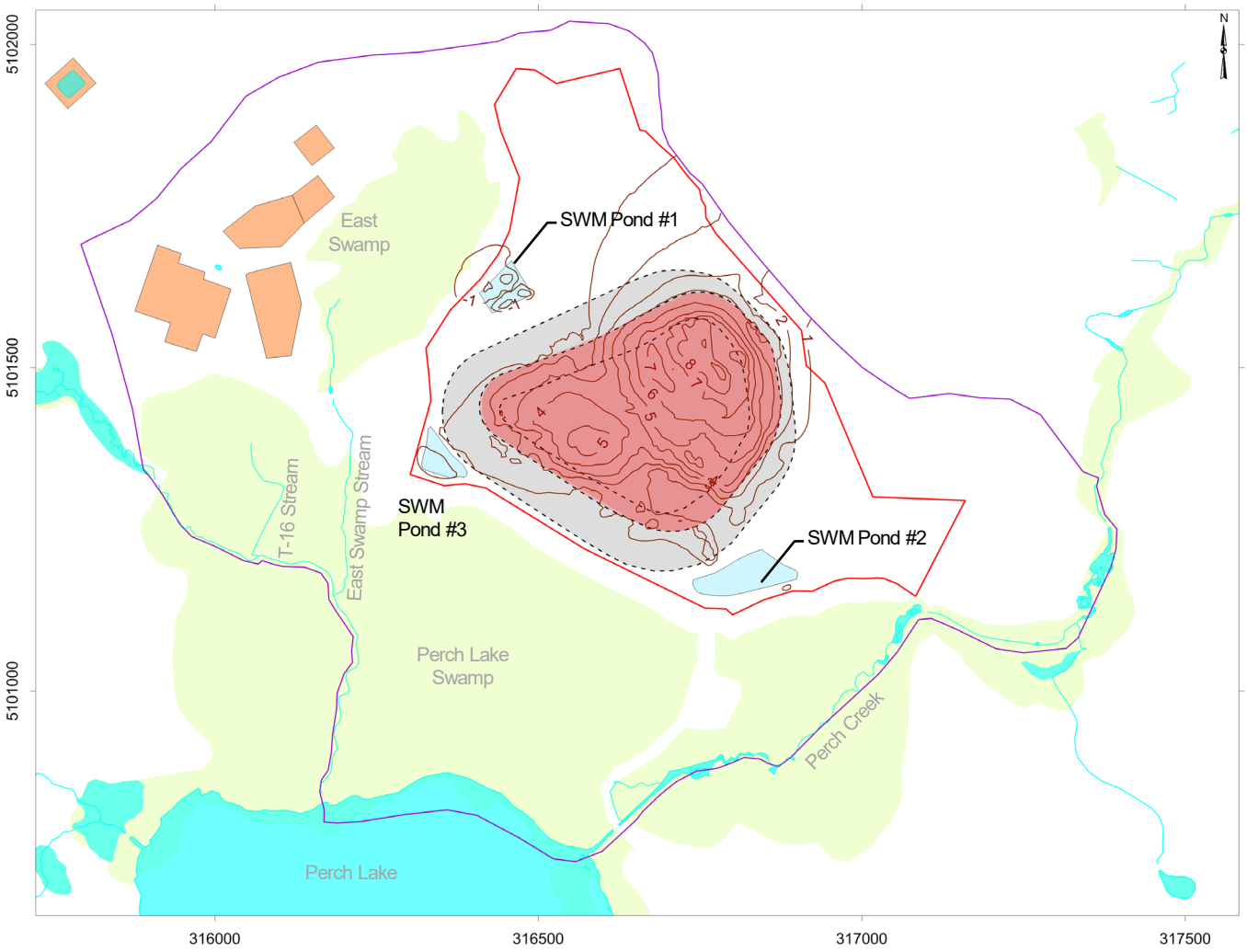
DESIGN	NFB
REVIEW	SD
APPROVED	SD

TITLE
Groundwater Flow Model Results – Operations Scenario B

PROJECT No.	PHASE	Rev.	FIGURE
1547525	**4300**	**2**	**9-5**



LEGEND

- Model Boundary
- Simulated Change in Water Table Elevation – Calibration minus Forecast (m)
- Stream
- ECM Outline
- Closed Cells
- Waste Management Area
- Swamp

NOTES:

1) All cells are closed with zero infiltration occurring over the ECM footprint.
2) Surface runoff from ECM directed to surface water ponds. Infiltration occurs through the base of the ponds bottoms as their liners are assumed to be compromised

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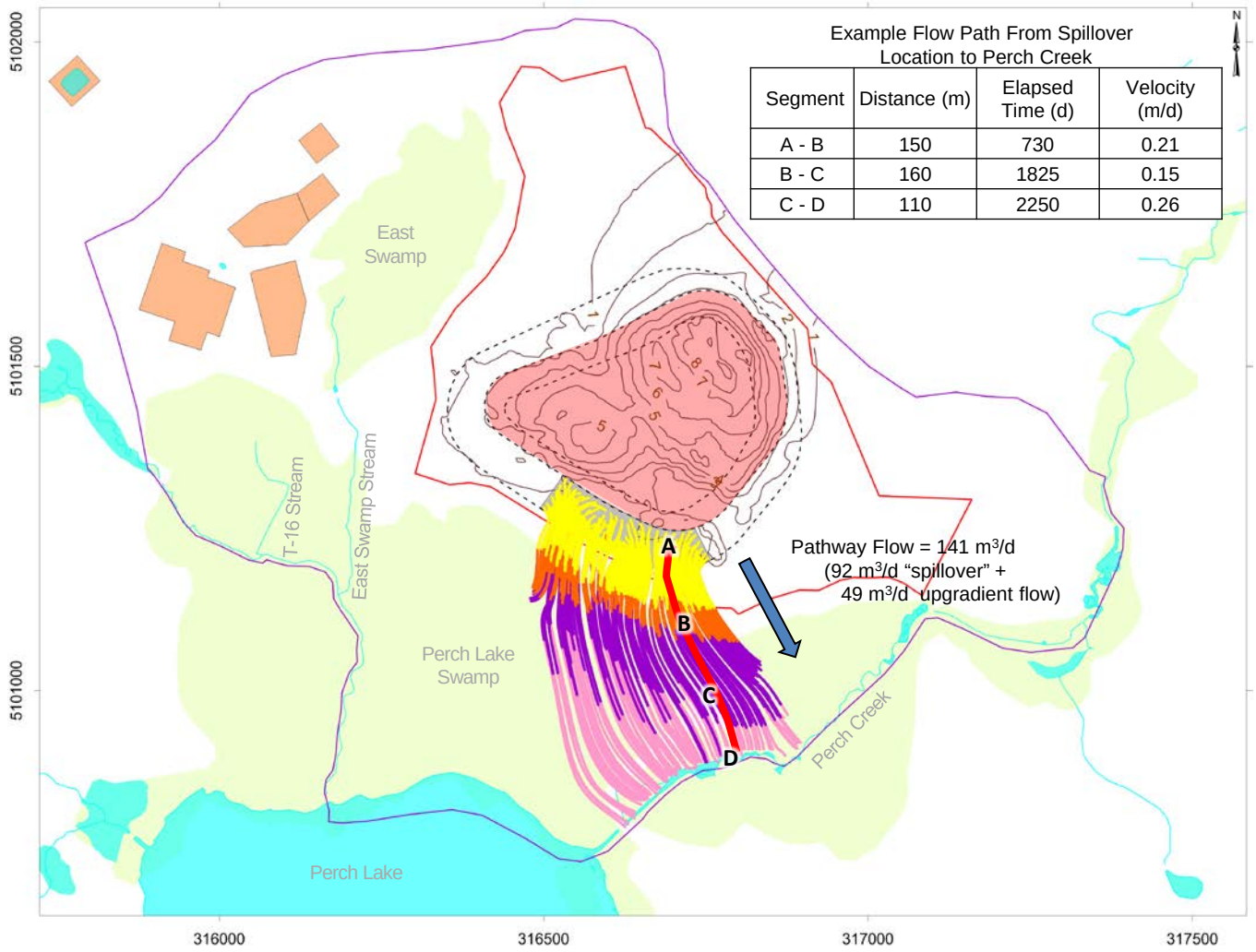
DESIGN	NFB
REVIEW	SD
APPROVED	SD

TITLE
Groundwater Flow Model Results – Post Closure with Final Cover Intact

PROJECT No.	PHASE	Rev.	FIGURE
1547525	**4300**	**2**	**9-6**



LEGEND

- Model Boundary
- Simulated Change in Water Table Elevation – Calibration minus Forecast (m)
- Groundwater Particle Traces
  - 0 to 1-year
  - 1 to 2-year
  - 2 to 5-year
  - Steady-State
- Stream
- ECM Outline
- Spillover Infiltration Area
- Closed Cells
- Waste Management Area
- Swamp

NOTES:
1) Natural/background infiltration the exfiltration gallery and ponds;
2) No runoff collection;
3) 0.3 m/yr infiltration occurs through the cover. This is applied as infiltration at the spillover location.

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PREPARED	MIB
DESIGN	NFB
REVIEW	SD
APPROVED	SD

TITLE
Groundwater Flow Model Results – Post Closure with Compromised Final Cover

PROJECT No.	PHASE	Rev.	FIGURE
1547525	**4300**	**2**	**9-7**

9.13.7.5 GWMP3a, ECM, Operations Phase

Objective: Verify the effectiveness of ECM mitigation on groundwater quality

- Monitoring of groundwater quality between the ECM and Perch Creek is to be completed to evaluate the potential presence of leachate-impacted groundwater in the operations phase. Specific solutes considered for this assessment are selected based on the leachate water quality (Section 9.7).
- Analysed data are to be compared to the Tier 1 Criteria (Section 9.13.4). Where exceedances of the screening criteria are identified, further assessment and trend analysis is to be conducted.
- Analysed data are also to be compared to the groundwater protection Tier 2 Criteria (Section 9.7.6). As noted in Section 9.13.4, there are also several parameters where the background concentration exceeds the groundwater protection Tier 2 Criteria. This is considered to be naturally occurring and not a hazard to the environment. Upon the initiation of operations, the data collected at that time should be evaluated for parameters where background concentrations exceed groundwater protection Tier 2 Criteria. These parameters are to be evaluated by trend analysis and comparison to Tier 1 statistical criteria of MS3D.
- Exceedances are to be addressed as discussed in the non-conformance process (Section 9.13.8).
- Evaluation of the data may result in further groundwater assessment (e.g., additional wells or sampling), further investigations into the ECM operations or the ECM mitigation features.
- Reporting can be conducted using the indicator parameters and indicator wells, if established.

9.13.7.6 GWMP 3b, ECM, Closure

Objective: Verify the effectiveness of ECM mitigation on groundwater quality

- Monitoring of groundwater quality between the ECM and Perch Creek is to be completed to evaluate the potential presence of leachate-impacted groundwater in the operations phase. Specific solutes considered for this assessment are selected based on the leachate water quality (Section 9.7).
- Analysed data are to be compared to the Tier 1 Criteria (Section 9.13.4). Where exceedances of the screening criteria are identified, further assessment and trend analysis is to be conducted.
- Analysed data are also to be compared to the groundwater protection Tier 2 Criteria (Section 9.7.6). As noted in Section 9.13.4, there are several parameters where the background concentration exceeds the groundwater protection Tier 2 Criteria. This is considered to be naturally occurring – part of baseline conditions – and not a hazard to the environment. Upon the initiation of operations, the data collected at that time should be evaluated for parameters where background concentrations exceed groundwater protection Tier 2 Criteria. These parameters are to be evaluated by trend analysis and comparison to Tier 1 statistical criteria of MS3D..
- Exceedances are to be addressed as discussed in the non-conformance process (Section 9.13.8).
- Evaluation of the data may result in further groundwater assessment (e.g., additional wells or sampling), or the ECM mitigation features.
- Reporting can be conducted using the indicator parameters and indicator wells, if established.

9.13.7.7 GWMP 4a, WWTP, Operations

Objective: Verify the effectiveness of mitigation on groundwater quality (WWTP)

- Monitoring of groundwater quality between the WWTP and East Swamp is to be completed to evaluate the impact of WWTP effluent to the surrounding environment. Specific solutes considered for this assessment are be selected based on the predicted leachate water quality (Section 9.7).
- Analysed data are to be compared to the statistically based Tier 1 Criteria (Section 9.13.4) developed through the operations phase. The treated effluent may contain elements and compounds exceeding background concentrations but that meet the effluent discharge targets. Based on this the Tier 1 Criteria is not considered an appropriate screening tool. It will take several years to obtain sufficient data to conduct the statistical assessment and upward trends can be expected in the initial years of operations (e.g., 5 years or more). Tritium in particular is considered a good indicator of when effluent affected groundwater has reached downgradient wells and when steady state may be reached. The statistical analysis should be conducted when values have stabilized. Where exceedances of the screening criteria are identified further assessment and trend analysis is to be conducted.
- Analysed data are also to be compared to the groundwater protection Tier 2 Criteria (Section 9.7.6) and this can be done as soon as operation of the NSDF commences. NSDF-010, located immediately downgradient of the exfiltration gallery, is an indicator well of potential water quality issues. On the other hand, NSDF-011 and NSDF-012 are located further downstream and considered representative of groundwater that may affect ecological receptors. As noted in Section 9.13.4, there are several parameters where the background concentration exceeds the groundwater protection Tier 2 Criteria. This is considered to be naturally occurring – part of baseline conditions at the site – and not a hazard to the environment. Upon the initiation of operations the data collected at that time should be evaluated for parameters where background concentrations exceed groundwater protection Tier 2 Criteria. These parameters are to be evaluated by trend analysis and comparison to Tier 1 statistical criteria of MS3D.
- Exceedances are to be addressed as discussed in the non-conformance process (Section 9.13.8).
- Evaluation of the data may result in further groundwater assessment (e.g., additional wells or sampling), or further evaluation of the WWTP operations or effluent discharge methods. Reporting can be conducted using the indicator parameters and indicator wells, if established.

9.13.7.8 GWMP 4b WWTP, Closure

Objective: Verify the effectiveness of mitigation on groundwater quality (WWTP)

- While the WWTP is in operation, monitoring of groundwater quality between the WWTP and East Swamp is to be completed to evaluate the impact of WWTP effluent to the surrounding environment. Specific solutes considered for this assessment are be selected based on the predicted leachate water quality (Section 9.7).
- During operations, the groundwater quality is expected to have reached a steady state and analysed data are to be compared to the Tier 1 Criteria (Section 9.13.4). Where exceedances of the screening criteria are identified, further assessment and trend analysis is to be conducted.
- Analysed data are also to be compared to the Tier 2 Criteria (Section 9.7.6). NSDF-010 is an indicator well of potential water quality issues. On the other hand, NSDF-011 and NSDF-012 are considered representative of groundwater that may affect ecological receptors. As noted in Section 9.13.4, there are several parameters where the background concentration exceeds the Tier 2 Criteria. This is considered to be naturally occurring – part of baseline conditions at the site – and not a hazard to the environment. Upon the initiation of operations, the data collected at that time should be evaluated for parameters where background concentrations exceed groundwater protection benchmarks. These parameters are to be evaluated by trend analysis and comparison to Tier 1 statistical criteria of MS3D.
- Exceedances are to be addressed as discussed in the non-conformance process (Section 9.13.8).
- Evaluation of the data may result in further groundwater assessment (e.g., additional wells or sampling), or further evaluation of the WWTP operations or effluent discharge methods. Reporting can be conducted using the indicator parameters and indicator wells, if established.

9.13.8 Non-conformance Process

The Tier 1 and Tier 2 Criteria are discussed in sections above which allow for interpretation of monitoring data and provides a tiered system to increase or decrease monitoring based on the results. The responses to these exceedances are commensurate with the level of risk associated with that respective tier. In general, exceedances are to be addressed as follows:

Tier 1 Exceedances

i) Data review (e.g., trend evaluation, and secondary sampling to confirm exceedance);

ii) Investigate source of exceedance; and

iii) Consider increased monitoring frequency.

Tier 2 Exceedances

i) Data review (e.g., trend evaluation, and secondary sampling to confirm exceedance);

ii) Investigate source of exceedance;

iii) Apply additional mitigation measures, consider remediation (if applicable)

iv) Consider stop work; and

v) Increase monitoring (e.g., increased frequency, additional parameters, additional locations).

The non-conformance process for groundwater analyses is a formal evaluation and reporting system for environmental performance issues within the program. If a Tier 1 or Tier 2 Criteria exceedance is established, the non-conformance is investigated and potential remedial actions can be initiated (CNL 2020b).

The suspected non-conformance is initially subjected to re-sampling or a data review from the previous sampling campaign to confirm that the value is truly an exceedance or not. If there is a definite exceedance, an event notification is written within the CNL ImpAct system and CNL management notified. . If the exceedance is deemed severe, it may be judged as a reportable event and the regulator shall be notified. Specific actions will occur under this process and are dependent upon the parameter, the exceedance circumstances, and the seriousness of the exceedance. In any case, a memo is compiled at the end of the year listing all of the exceedances and ImpActs accordingly for line management and program compliance.

Depending on several factors, such as the number of exceedances in one location, or the results of a historical review, a special investigation or increased sampling campaign (e.g., monthly) may be initiated if a precedent is decided and further characterization is needed. New wells may also be installed to determine the extent of the exceedance or the spatial location of the source. For Tier 2 Criteria exceedances, other sampling techniques may be introduced such as soil and vegetation surveys to determine if the contaminant has increased the risk to ecological receptors. It is the responsibility of the facility line management to establish whether these or any other corrective actions are required. However, with the slow migration rates of groundwater, there is not normally an immediate need for remedial action (CNL 2020b). It can also be decided at that time whether remediation or decommissioning plans or schedules need adjusting, or mitigative actions need to be commenced based upon the new information.

9.13.9 Assessing and Modifying Protection Based Groundwater Benchmarks

At CRL, ecological health based groundwater benchmarks are established using surface water standards. Unless some of these benchmarks are adjusted, the values can be very conservative and not necessarily practical for certain parameters at particular locations.

A process has been developed at CRL to address specific situations and locations where continual radiological or non-radiological benchmark exceedances are observed. These assessments are conducted on a periodic basis to determine whether a continued ecological benchmark exceedance is an actual ecological risk, or only a perception of risk because of recorded exceedances, and only after discussions by stakeholders and groundwater personnel.

9.14 Continual Improvement of the GWMP

To establish the effectiveness of the GWMP, periodic reviews and audits confirm the processes used are successful in maintaining the groundwater program objectives and help identify changes to deliver effective management of the program. The results lead to program improvements furthering the overall program effectiveness and benefits. Audits can be conducted by both internal and external parties while the CNSC provides reviews of the annual reports and other program documentation.

The NSDF GWMP shall be reviewed as per N288.7-15 (CSA 2015) Section 11.2 and updated accordingly. In particular, an update shall be made when there are changes to documents such as the ERA, CSMs, or legal documents for monitoring requirements; when there are changes in the environment affecting groundwater receptors or pathways; or if there is a change at a facility itself which can affect the risk to groundwater or groundwater pathways.

An annual operational feedback review will be held where the findings from the last relevant sampling campaign are presented and discussed with pertinent stakeholders before the annual program review. Stakeholders include representation from facility management (source area), groundwater monitoring core staff, compliance program staff, and other departments interested in the performance of the facilities with respect to groundwater.

Following the annual operational feedback review, the annual program review is conducted to assess the suitability of the current GWMP, and to introduce changes meant to improve the processes ensuring the GWMP objectives are being met. Changes may be a consequence of feedback from staff, monitoring results, field investigations, site characterizations, audits, changes in industry practices, or regulatory requirements.

As a general guide, sampling and measurement frequencies can be reduced if, after five (5) years of monitoring or 10 previous sampling events, the concentrations were below detection or anomalous. However, this does not apply for radiological indicator parameters which require ongoing monitoring. The changes are to consider specific locations, frequencies and parameters as discussed in Sections 9.5, 9.6, and 9.7. In all cases, changes must be documented and addressed in the annual program review.

Outside of the annual reviews, occasionally there is a need to evaluate and implement changes discovered during the year. These special purpose reviews typically are meant to improve the integration of sampling and analysis between environmental monitoring activities. Staff participating in the evaluation will document the information in minutes and subsequently formalize the minutes as a record of change. These records are addressed in the next annual program review to ensure they are referenced and acknowledged. Audits may also be conducted as may be required. As required by CSA N288.7-15, the entire program is to be reviewed at least every 5 years.

All reviews are to be documented and the rationale to be provided for all changes to the program. Actions, such as changes to program sampling or analyses, are to be documented so they can be tracked.

9.15 Moving Monitoring from Follow-up Monitoring to Routine GWMP Program

The groundwater monitoring will be conducted as part of the overall CRL GWPP and GWMP (CNL 2020a). The proposed sampling frequency is bi-annual (i.e., two times per year) and can be accommodated in CRL's spring and fall sampling events.

Reporting for the NSDF GWMP will be conducted separately from the CRL GWMP for approximately 5 years and then incorporated into the overall CRL GWMP reporting. The objectives and actions for each monitoring element will be retained within the overall program. Table 9-16 provides proposed duration of separate reporting under the EAFMP for groundwater monitoring elements during the operations phase. Reporting during the closure phase will be determined prior to transitioning to closure in 2070.

Table 9-16: GWMP Proposed Duration of Separate Reporting under the EAFMP

GWMP Program Element	CRL Program	Duration of Separate Reporting under the EAFMP	Justification
GWMP1a – ECM Groundwater flow – Operations Phase	CRL GWMP	Following five years of operations	After the first five years of operations, there will be a significant dataset to confirm EIS predictions of impacts on groundwater flow. Reporting will transition from the EAFMP to the CRL GWMP provided that no adverse impacts are observed.
GWMP 2a – WWTP Groundwater Flow – Operations Phase	CRL GWMP	Following five years of operations	After the first five years of operations, there will be a significant dataset to confirm EIS predictions of impacts on groundwater flow. Reporting will transition from the EAFMP to the CRL GWMP provided that no adverse impacts observed.
GWMP3a – ECM Groundwater quality – Operations Phase	CRL GWMP	Following 5 years of operations	The groundwater transit time from the ECM to the nearest groundwater monitoring wells is approximately one year. After 5 years of operations, there will be a significant dataset to confirm that ECM is functioning as intended with no impacts on groundwater quality. Reporting will transition from the EAFMP to the CRL GWMP provided that no adverse impacts are observed.
GWMP 4a WWTP Groundwater Quality – Operations Phase	CRL GWMP	Following five years of operations	After the first five years of operations, there will be a significant dataset to verify effectiveness of mitigation measures to protect groundwater quality. Reporting will transition from the EAFMP to the CRL GWMP provided that there are no adverse impacts on groundwater.

10.0 OPERATIONAL CONTROL MONITORING PROGRAM

Operational control monitoring (OCM) is required where requested by CNL's standard for the management and monitoring of emissions (CNL 2018a). In this case the OCM program is required to meet the requirements of EIS monitoring elements that do not fall within the EVMP, EMP or GWMP. As described in CNL's Management and Monitoring of Emissions (CNL 2018a) the OCM program, where required, shall be designed and established for individual facilities or processes to achieve the objectives noted below. The objectives of the OCM are provided below along with discussion on whether these may apply to the EAFMP OCM program for the NSDF Project:

a) To provide feedback to facility operators on system performance with respect to emissions to the environment within a time frame consistent with routine operational control decisions;

   No– while the GHG monitoring for the ECM cap (OCM3a, 3b) and assessing potential combustions hazards (OCM4a, 4b) provides information with regards to the potential for ECM emissions these are not provided in such a manner that they support operational control decisions.

b) To confirm the adequacy of controls on emissions from the source;

   Yes– the dust monitoring (OCM1 and OCM2), the GHG monitoring for the ECM cap (OCM3a, 3b) and assessing potential combustions hazards (OCM4a, 4b) provides information with regards to the adequacy of the controls on ECM emissions. The SWMP monitoring (OCM5) is related to the facility operations but is directly related to sediment accumulation rather than emissions.

c) To provide timely indication to facility operators of abnormal emissions that may be in excess of emission limits in order to initiate corrective action, incident reporting, quantitative monitoring, investigations or emergency actions as appropriate; and

   Yes– the dust monitoring (OCM1 and OCM2), the GHG monitoring for the ECM cap (OCM3a, 3b) and assessing potential combustions hazards (OCM4a, 4b) provides information that can be compared to limits and that can be used to initiate further actions.

d) To differentiate sources of abnormal emissions where there is more than one facility, system or subsystem that discharges to the environment through a single or common effluent stream.

   No – the monitoring is not being conducted to differentiate sources of emissions.

10.1 Design of the NSDF OCM Program

Some OCM elements related to NSDF Project activities do not meet the objectives listed in Section 10.0. These are nevertheless included in the OCM to ensure they are monitored as required by the EIS (Golder 2020a) and as indicated in Section 5.0. The full list of OCM items are provided in Table 10-1 along with the specific objectives, the information required to meet the objectives and a discussion on how the data will be used to achieve the objectives.

The OCM program is designed based on the objectives of the specific monitoring elements. Table 10-1 provides the details for the monitoring required.

Table 10-1: Detailed Design of OCM

Monitoring Program Element	Applicable NSDF Phase	Objective(s)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
OCM1 - Air Quality, Dust	Construction	b)To confirm adequacy of dust mitigation controls on dust emissions from the various NSDF sources; c) To provide timely indication to facility operators of abnormal f that may be in excess of emission limits in order to initiate corrective action, incident reporting, quantitative monitoring, investigations or emergency actions as appropriate;	The information to be collected for this element is field information that includes: 1. Visual observations of any dust in area where activities are taking place; 2. Continuous monitoring data for particulates data will be obtained from upwind and downwind of active work areas using portable dust monitors	The records are to be summarized on an annual basis along with records obtained as part of the EVMP. If dust generation is observed during visual inspections, handheld monitors will be used to take spot measurements to provide real-time dust concentrations. Monitoring results will be compared to a set of two-tiered levels for the NSDF site. If any exceedances are observed, correct action in the form of additional mitigation measures will be taken right away. If dust exceeding the Ontario AAQC (MOE 2012) of 120 µg/m³, protective of nuisance, on a 24-hour basis is identified, the records are to be reviewed and improvements made to the dust mitigation process.
OCM2 - Air Quality, Dust	Operations	b)To confirm adequacy of dust mitigation controls on dust emissions from the various NSDF sources; c) To provide timely indication to facility operators of abnormal emissions that may be in excess of emission limits in order to initiate corrective action, incident reporting, quantitative monitoring, investigations or emergency actions as appropriate;	The information to be collected for this element is field information that includes: 1. Visual observations of any dust in area where activities are taking place; 2. Continuous monitoring data for particulates data will be obtained from upwind and downwind of active work areas using portable dust monitors;	The records are to be summarized on an annual basis along with records obtained as part of the EVMP. If dust generation is observed during visual inspections, handheld monitors will be used to take spot measurements to provide real-time dust concentrations. Monitoring results will be compared to a set of two-tiered levels for the NSDF site. If any exceedances are observed, correct action in the form of additional mitigation measures will be taken right away. If dust exceeding the Ontario AAQC (MOE 2012) of 120 µg/m³, protective of nuisance, on a 24-hour basis is identified, the records are to be reviewed and improvements made to the dust mitigation process.
OCM3a - GHG	Operations	b) Verify that the measures for controlling landfill gas generated from waste deposited in the ECM are adequate c) Verify that landfill gas is not migrating laterally from the ECM	Measurement of methane concentrations migrating through the cover using a portable Flame Ionization Detector (FID) or gas chromatograph calibrated to methane. Readings are to be recorded on a grid of 30 m on the capped ECM on a weekly basis. This grid spacing and frequency is specified in US EPA Guidance (US EPA 2016). Monthly monitoring for bulk gases will be performed using handheld portable combustible gas meter detectors. The monitoring equipment is to measure percent levels of carbon dioxide, methane, oxygen and H_2S. Oxygen is useful in assessing explosivity. Carbon dioxide and H_2S are commonly collected but are not required. Subsurface probes will be installed around the perimeter of the ECM and will be monitored periodically during ECM operations to detect evidence of potential LFG migration. A grab sample may also be taken periodically using SUMMA canister or Tedlar bag, which can be analysed for NMOCs including mercaptans and sulphur compounds. The frequency of grab sample collection is expected to be periodic depending on sampling results (e.g., annually to once every 5 years)	Measurements will be compared against the limits in the Landfill Gas Management Plan (AECOM 2018c) (2.5% methane, corresponding to 50% Lower Explosive Limit (LEL) for methane) and 500 ppm (US EPA 2016). Where concentrations are recorded in excess of the limits in the Landfill Gas Management Plan (AECOM 2018c) and 500 ppm (US EPA 2016), additional measurements should be made and the corresponding GPS co-ordinates logged to determine the geographic extent of the “hot-spot” before further assessment and/or mitigation is identified.
OCM3b - GHG	Closure	b) Verify that the measures for controlling landfill gas generated from waste deposited in the ECM are adequate c) Verify that landfill gas is not migrating laterally from the ECM	Measurement of methane concentrations migrating through the cover using a portable FID or gas chromatograph calibrated to methane. Readings are to be recorded on a grid of 30 m on the capped ECM at a frequency indicated by the findings at the time. The frequency may vary from weekly to annual. This grid spacing and frequency is specified in US EPA Guidance (US EPA 2016). Subsurface probes around the perimeter of the ECM and will be monitored periodically during ECM closure to detect evidence of potential LFG migration (Landfill Gas Management Plan (AECOM 2018c) Sections 2.4.2 and 2.4.3).	Measurements will be compared against the limits in the Landfill Gas Management Plan (AECOM 2018c) (2.5% methane, corresponding to 50% LEL for methane) and 500 ppm (US EPA 2016). Where concentrations are recorded in excess of the limits in the Landfill Gas Management Plan (AECOM 2018c) and 500 ppm(US EPA 2016), additional measurements should be made and the corresponding GPS co-ordinates logged to determine the geographic extent of the “hot-spot” before further assessment and/or mitigation is identified.

Table 10-1: Detailed Design of OCM

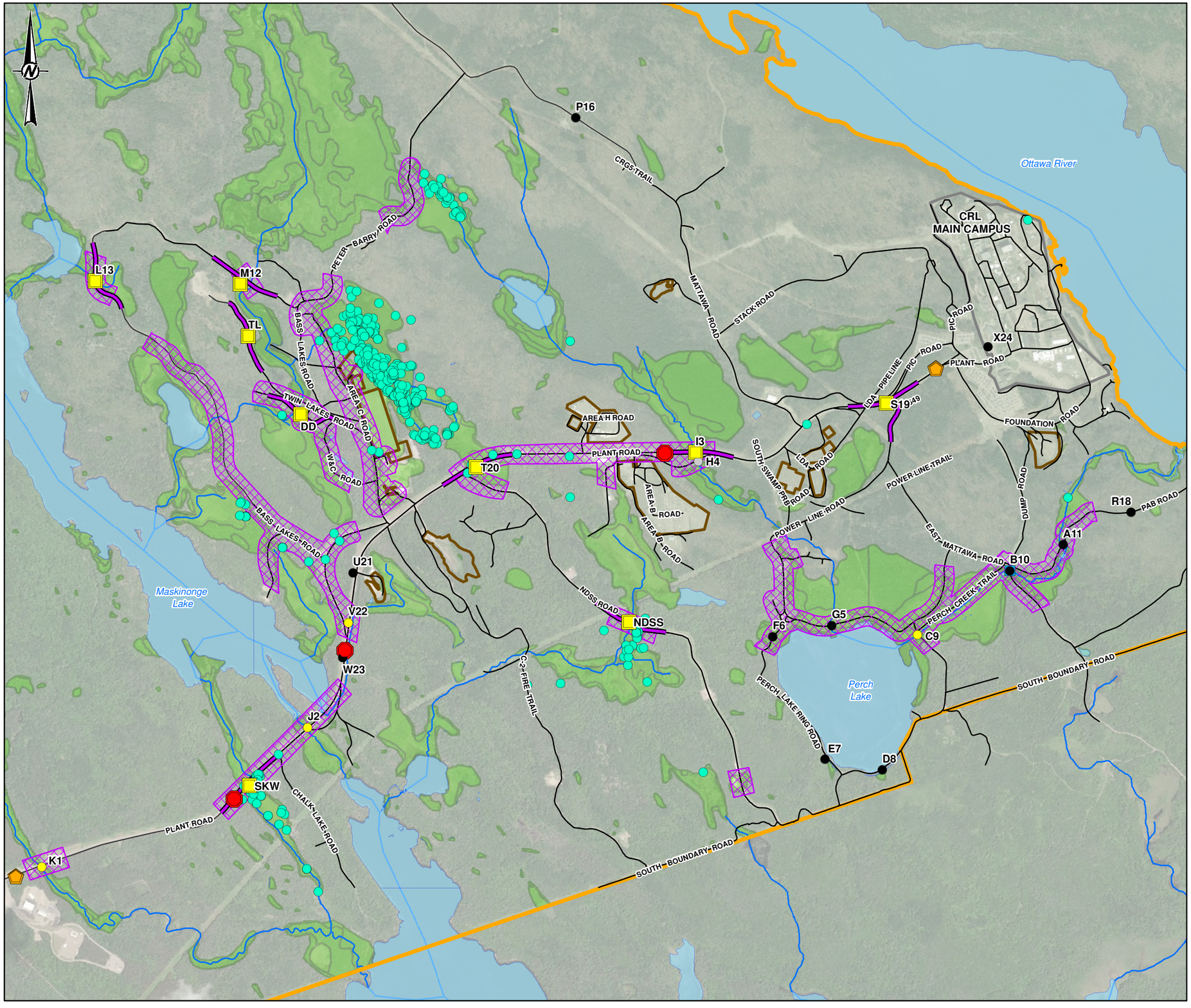
Monitoring Program Element	Applicable NSDF Phase	Objective(s)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
OCM4a - GHG	Operations	d) Verify that there is no combustion hazard from methane gas generation	Landfill gas monitoring probes will be installed around the perimeter of the ECM to detect evidence of potential landfill gas migration away from the ECM (Landfill Gas Management Plan (AECOM 2018c) Sections 2.4.2 and 2.4.3). Monthly monitoring for bulk gases will be performed using handheld portable combustible gas meter detectors. The monitoring equipment is to measure methane LEL.	Measurements will be compared against the limits *O. Reg. 232/98 Landfilling Site*s which is: 2.5% methane (50% Lower Explosive Limit (LEL)) in open areas. If buildings are present on-site the following is to be used; 1% methane (20% LEL) inside on-site buildings; or 0.05% methane (1% LEL) in a building or its foundation off-site. If results exceed these values, further sampling, assessment or mitigation is required.
OCM4b - GHG	Closure	c) Verify that there is no combustion hazard from methane gas generation	Landfill gas monitoring probes will be installed around the perimeter of the ECM to detect evidence of potential landfill gas migration away from the ECM (Landfill Gas Management Plan (AECOM 2018c) Sections 2.4.2 and 2.4.3). Monitoring for bulk gases will be performed using handheld portable combustible gas meter detectors. The monitoring equipment is to measure methane LEL.Monthly to annual monitoring for methane will be performed using handheld portable combustible gas meter detectors. The monitoring equipment is to measure percent levels of carbon dioxide and methane. The frequency is to be determined based on the monitoring prior to closure.	Measurements will be compared against the limits *O. Reg. 232/98 Landfilling Sites* which is: 2.5% methane (50% Lower Explosive Limit (LEL)) in open areas. If buildings are present on-site the following is to be used; 1% methane (20% LEL) inside on-site buildings; or 0.05% methane (1% LEL) in a building or its foundation off-site. If results exceed these values, this indicates that LFG is further sampling, assessment or mitigation is required.
OCM5 - Hydrology	Construction, Operations and Closure.	b) Verify the SWMPs are performing as designed	Water Levels ■ Starting during construction, water levels at each of the SWMPs will be monitored following a storm event on a quarterly basis during open water conditions (i.e., 3 times per year). As a guide, the MISA protocol (MECP 2019) may be used for determining a storm event. The level can be measured by a staff gauge within the SWMP surveyed to a geodetic datum (installed at the headwall of the inlet or outlet). ■ A surface water level is required to be taken within 8 hours following the end of the event and preferably after inflow to the SWMP has ceased. Notes should be kept regarding any residual flow into the SWMP. ■ The performance of the SWMP can be evaluated based on the rate of discharge (i.e., the drop in water level over time). TSS Reduction and Sediment Accumulation ■ Depth of sediment is to be monitored annually for two years and then every five years if results indicate sediment accumulation as predicted by the surface water management plan (AECOM 2019b). ■ Sediment depth will be measured by going out onto the water surface (i.e., with a boat) and measuring the depth to bottom at three fixed locations within each SWMP – one location in the sediment forebay (if there is a forebay) and two within the main pool/cell. A sediment probe can be used to determine the sediment surface. Alternatively, a rod with a plate on the bottom can be used to measure the top of the sediment surface. The sediment depth sampling is to be conducted at the same location in each monitoring event. The depth of the water level is also to be recorded during the sampling to allow for the elevation of the sediment to be calculated.	Water Levels ■ The drawdown time information is to be compared to the information provided below in Table 10-2 as extracted from Table 8 of the Surface Water Management Plan (AECOM 2019b). The information from the table has also been summarized in Figure 10-2. The actual drawdown time for a specific depth of water is to be compared to this table and historical data. The elapsed time to the end of the drawdown can be obtained from the records of the flow monitoring data obtained as part f the EVMP. This will show when the flow is near zero. ■ If a discrepancy of 20% between the predicted or as-built drawdown time and the actual time is identified, the discharge orifices should be inspected for blockages. If the drawdown is much shorter than the predicted the orifices should be inspected to confirm they are still in place. ■ If there are no blockages of the orifices, an assessment should be conducted to assess the change in depth-time and the effect on the SWMP performance. ■ The tail of the hydrograph curves (drawdown portion) obtained from the flow monitoring should also have a similar shape and slope to the predicted SWMP drawdown curve (if the axis are scaled accordingly). If this comparison notes a discrepancy of 20% from predicted, then an assessment can be completed to identify effects on performance. TSS Reduction and Sediment Accumulation ■ The SWMP is to be maintained (i.e., sediment removed) when the pond's ability to settle solids is reduced by 5% or based on the depth of sediments noted below for each pond (AECOM 2019b): SWMP 1 - ≥ 0.50m depth of sediment in forebay or ≥ 0.10m depth in the main cell SWMP 2 – ≥0.50m depth of sediment in forebay or ≥0.15m depth in the main cell SWMP 3 – ≥ 0.25m depth in the main cell (no forebay for SWMP 3) Details on the SWMP construction, forebay and main cells are provided in the NSDF surface water management plan (AECOM 2019b). In addition, if there are repeated TSS exceedances of the Tier 2 Criteria noted in the NSDF EVMP (Section 7, 25 mg/l), pond maintenance should be considered.

Table 10-1: Detailed Design of OCM

Monitoring Program Element	Applicable NSDF Phase	Objective(s)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
OCM6 – Blanding's Turtle	Construction, Operations	Confirm effectiveness of the temporary and permanent exclusion fencing in the RSA	Visual inspections of the reptile exclusion fencing around the perimeter of NSDF Project site and at turtle crossing systems will be conducted once a week for temporary fencing and annually for permanent fencing during the turtle active season (April-October). Additional inspection visits should be conducted after heavy rain (7mm or more per hour; ECCC 2018). Visual inspections entail a person walking the entire length of all reptile exclusion fencing, looking for and documenting any failures in the fencing. Figure 10-1 depicts the location of the reptile exclusion fencing.	Inspection data such as any fencing defaults such as tears, loose edges, collapse, branch overhangs will be documented and reported to CNL and the party responsible for maintaining the fence. Any fencing defaults that require repair or replacement will be undertaken as soon as possible.
OCM7 – Blanding's Turtle	Baseline (prior to construction), Construction, Operations	Confirm integrity of culverts in the RSA	In addition to the camera inspections conducted as part of the EMP (EMP9, Section 8.1.4) the culverts are to be inspected by visual observation for barriers to turtle movements. Inspections are be conducted at either end of the culvert with a flashlight used to inspect the overall culvert. This inspection is to be conducted weekly during the active season for Blanding's turtle (April 15 to October 15)	The data will be used to confirm the integrity of the culverts and to take immediate action on issues that may include debris or other obstructions at the ends of the culvert. If obstructions are identified further into the culvert a plan should be implemented to remove the obstruction.
OCM8 – Blanding's Turtle	Baseline (prior to Construction), Construction, Operations	Confirm integrity of artificial nest mounds (artificial nesting habitat created as mitigation for the loss of connectivity resulting from the exclusion fencing) in the RSA	The suitability of the artificial nest mounds is to be confirmed by visual inspections once a year. Artificial nest mounds to be inspected once a year for 5 consecutive years after they are created. As part of annual inspection, vegetation density and height on the nest mounds will be evaluated to determine the need for maintenance to retain the sparse vegetative characteristics preferred by Blanding's turtle. Vegetation adjacent to the nest mounds will also be evaluated during the annual inspection to determine the need to remove any woody vegetation that shades the nest mounds.	The findings of the visual inspections of the artificial nest mounds will be documented and summarized in the annual monitoring reports. Specifically, the annual report will evaluate the success of the artificial nest mounds, identify areas for improvement as well as draw conclusions about the requirement for subsequent years of the mitigation plan. Based on the annual inspection results, any required vegetation maintenance and/or removal activities will be undertaken prior to the next nesting period (i.e., prior to May 15 of the following year).

Table 10-1: Detailed Design of OCM

Monitoring Program Element	Applicable NSDF Phase	Objective(s)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
OCM9 – Blanding's Turtle	Baseline (prior to Construction), Construction, Operations	Monitor artificial nest mounds to determine if they are being used by Blanding's turtles for nesting. Confirm the integrity of nest cages (implemented to protect Blanding's turtle active nests on artificial nest mounds and in turn improve the chance of reproductive success) in the RSA.	Visual inspection of the artificial nest mound is to occur at least once per week during the nesting period (May 15 – June 30; MNR 2012) to look for signs that Blanding's turtles are using them for nesting. ■ Timing: Observations of turtles (any species) along roads are often indicative of the onset of nesting activity and help inform survey timing. In addition, nesting activity tends to peak after rainfall or periods of light rain. Therefore, survey timing should be adjusted where possible to coincide with peak activity periods and maximize probability of detection. ■ Nesting surveys should be conducted between 7 pm and 11 pm, when possible, to maximize the potential to observe turtles. ■ Nest mounds should first be visually inspected from a distance to avoid disturbing females that may be present. If females are present, surveyors should remain as far away from the nest mound as possible while maintaining line of sight. All efforts should be made to remain inconspicuous (quiet, slow movement). Binoculars or a spotting scope should be used where possible to maximize observation distance from the nest mound. ■ If females are not present, surveyors should cautiously approach and inspect the nest mound for evidence of nesting including turtle tracks, signs of digging (soil disturbance), as well as signs of depredated and hatched nests. All evidence of nesting activity should be recorded, photographed and the location of all nests will be recorded with a global positioning system (GPS). Visual inspection of artificial nest mounds where wire mesh has been placed over the area where the eggs are laid. Weekly checks of cages should be conducted until all turtles have hatched (i.e., late September to early October MNR 2012). ■ Monitors will check the cages for any apparent damage caused by predators to access the eggs. ■ All evidence of cage damage will be recorded and photographed. ■ Weekly monitoring will resume the following spring (i.e., following ground thaw) at any nest sites for which hatchlings do not emerge in the fall (as some hatchlings may overwinter at nest sites).	The findings of the nest monitoring program will be documented and summarized in the annual monitoring report. Specifically, the annual monitoring report will evaluate the success of the artificial nest mounds based on the use of the mounds by females for egg laying. The annual monitoring report will also identify areas for improvement as well as draw conclusions about the requirement for subsequent years of the mitigation plan. Nest mounds that are not being used for five consecutive years should be evaluated for suitability and alternative locations may be considered. Damaged cages will be repaired or replaced as soon as possible. Cages should be removed by May 15 so that the nest mounds are accessible to gravid females.
OCM10 - Eastern Milksnake	Construction and Operations	Confirm effectiveness of road mitigation to minimize or eliminate the potential for road mortality in the LSA.	Visual inspections of the reptile temporary exclusion fencing around the perimeter of the NSDF Project site and at turtle crossing systems will be conducted once a week each during the Eastern Milksnake active season (April 15 -September 30). Additional inspection visits should be conducted after heavy rain (7mm or more per hour; MNRF 2016). Visual inspections entail a person walking the entire length of all reptile exclusion fencing, looking for and documenting any failures in the fencing. Figure 10-1 depicts the location of the reptile exclusion fencing.	Inspection data such as any fencing defaults like tears, loose edges, collapse, branch overhangs will be documented and reported to CNL and the party responsible for maintaining the fence. Any fencing defaults that require repair or replacement will be undertaken as soon as possible.
OCM11 – Traffic	Baseline (prior to Construction)	Verify baseline traffic volumes and composition used in the noise prediction modelling presented in Noise Impact Study of CNL NSDF Project Construction-Related Road Traffic on Human Receptors(Golder 2020c) which is referenced in Section 5.10 of the EIS.	A traffic count study will be completed along Highway 17 and Plant Road where traffic counts will be obtained along both Highway 17 and Plant Road to establish an Annual Average Daily Traffic (AADT) count in accordance with accepted practices. The study will consider Highway 17 north and south of Plant Road. Data will be collected using Automatic Traffic Recorders (ATR) over 24-hour periods for up to one week in duration, which will provide average hourly distributions and vehicle classification for Highway 17 and Plant Road. The program will be scheduled with the consideration of potential seasonal variability of traffic volumes.	The collected traffic count data will be used to verify the baseline traffic volumes presented in Tables 2, 3 and 4 of (Golder 2020c) and the baseline and Project noise modelling results in Tables 5 through 10 of(Golder 2020c). If required, additional noise modelling will be completed which will identify if additional mitigation will be required.



LEGEND

- ROAD
- RIVER/STREAM
- WATERBODY
- CRL MAIN CAMPUS
- WASTE MANAGEMENT AREA (WMA)[1]
- CRL PROPERTY
- WETLANDS

DESCRIPTION

- CULVERT
- PRIORITY 1 CULVERT
- PRIORITY 2 CULVERT
- PRIORITY 3 CULVERT
- CULVERT TO BE INSTALLED IN 2019
- CULVERT TO BE REMOVED IN 2019
- BLANDING'S TURTLE OBSERVATION
- BOX TUNNEL CROSSING

MITIGATION MEASURES

- ARTIFICIAL NEST MOUNDS
- ELECTRONIC SLOW SPEED SIGN (MAY 15-JUNE 30)
- PERMANENT TURTLE CROSSING SIGN; SLOW SPEED LIMIT POSTING (MAY 15 - JUNE 30)
- EXCLUSION FENCING
- REPTILE HOTSPOT

0.5 0 0.5
1:20,000 KILOMETRES

NOTE(S)
1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)
1. BASEDATA MNRF 2016 AND CANVEC 2016
2. IMAGERY: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY
3. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM, CHALK RIVER, ONTARIO

TITLE
BLANDING'S TURTLE ROAD MITIGATION MEASURES TO BE IMPLEMENTED AT THE CRL PROPERTY

CONSULTANT
GOLDER

DATE	2021-02-10
DESIGNED	PR
PREPARED	PR
REVIEWED	CS
APPROVED	AB

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	**10-1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 25mm

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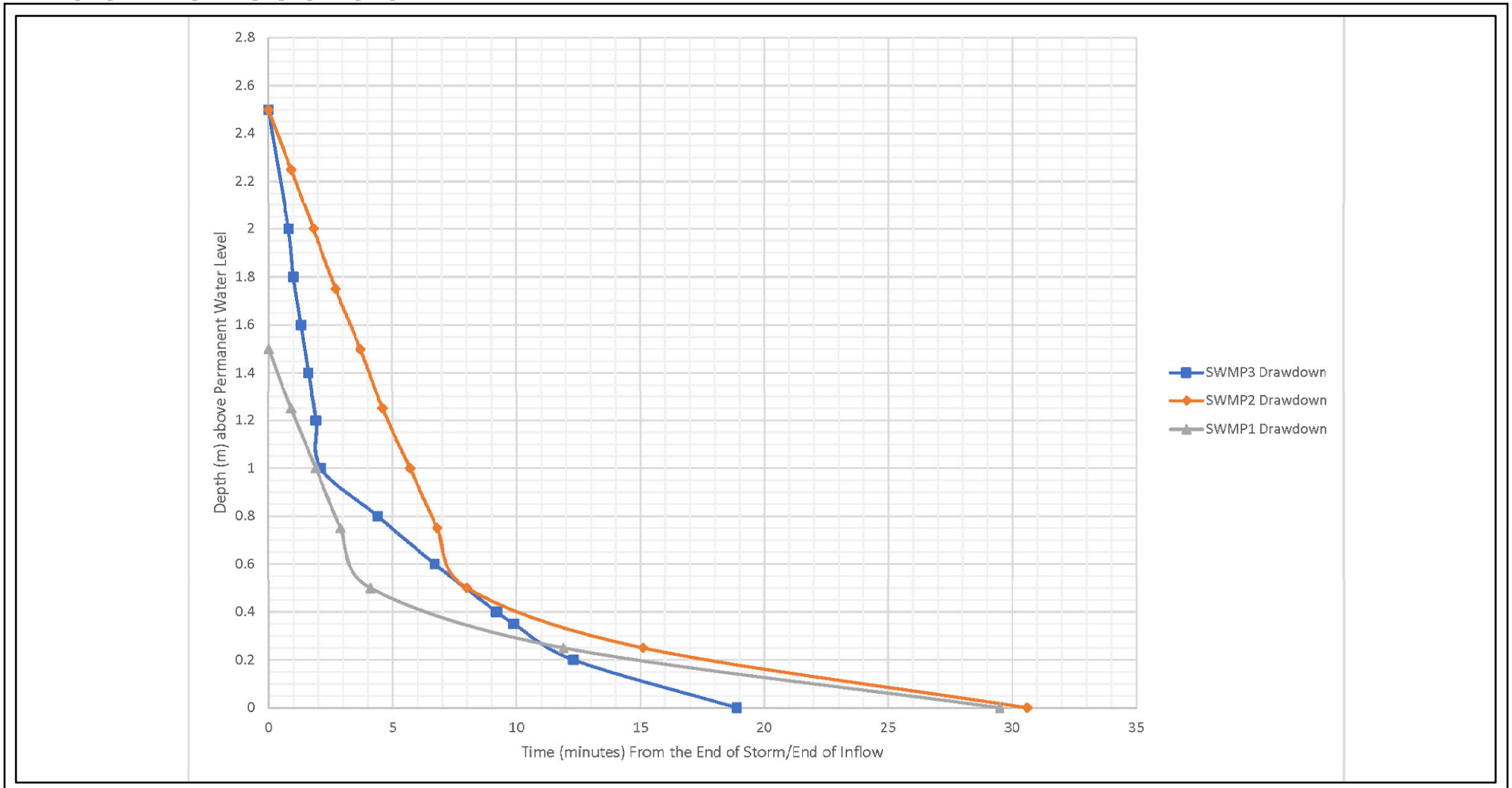

LEGEND

NOTE(S)

REFERENCE(S)

CLIENT
CANADIAN NUCLEAR LABORATORIES

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-10
DESIGNED	-
PREPARED	SO/PR
REVIEWED	CS
APPROVED	JDW

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL ASSESSMENT FOLLOW-UP MONITORING PROGRAM

TITLE
STORMWATER MANAGEMENT POND DRAWDOWN CURVES

PROJECT NO.	CONTROL	REV.	FIGURE
1547525	0038	0	10-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
25mm
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Table 10-2: Stormwater Management Pond – Depth/Time Relationship

Elevation (m)	Depth (m)*	Drawdown Time	
		(min)	(hr)
SWMP1			
171.00	1.50	1769	29.5
170.75	1.25	1713	28.6
170.50	1.00	1655	27.6
170.25	0.75	1593	26.6
170.00	0.50	1522	25.4
169.75	0.25	1058	17.6
169.50	0.00	0	0.0
SWMP 2			
160.50	2.50	1837	30.6
160.25	2.25	1782	29.7
160.00	2.00	1728	28.8
159.75	1.75	1672	27.9
159.50	1.50	1616	26.9
159.25	1.25	1557	26.0
159.00	1.00	1495	24.9
158.75	0.75	1430	23.8
158.50	0.50	1357	22.6
158.25	0.25	929	15.5
158.00	0.00	0	0.0
SWMP 3			
162.50	2.50	1132	18.9
162.00	2.00	1088	18.1
161.80	1.80	1071	17.9
161.60	1.60	1054	17.6
161.40	1.40	1038	17.3
161.20	1.20	1022	17.0
161.00	1.00	1006	16.8
160.80	0.80	871	14.5
160.60	0.60	730	12.2
160.40	0.40	579	9.7
160.35	0.35	538	9.0
160.20	0.20	397	6.6
160.00	0.00	0	0.0

* Depths above are noted above the permanent water level.

10.2 Performance and Acceptance Criteria

This section outlines the performance and acceptance criteria that the program's monitoring data are required to achieve in order to ensure that they are adequate for their intended purpose(s).

10.2.1 Acceptance Criteria

There are generally no specific acceptance criteria for the OCM elements as there are no physical samples collected or laboratory analysis completed. If analysis is completed (e.g., for TSS samples) the acceptance criteria is the same as those of the EVMP.

10.2.1.1 Sediment Monitoring Acceptance Criteria

The sediment monitoring is to be conducted at the same location for each monitoring event. The GPS used to identify the location for monitoring is to have a +/- 10 cm accuracy.

10.2.2 Performance Criteria

The performance of the OCM program is to be monitored and instances of unavailability (e.g., a missed inspection) shall be documented and managed via the ImpAct process.

Sample/monitoring unavailability for the OCM could be the result of a number of circumstances; for example, sampling/monitoring according to the monitoring schedule was missed or the monitoring location was inaccessible.

10.2.2.1 Dust Monitoring Performance Criteria

The field instrumentation used for on-site dust monitoring is to be maintained and calibrated as per the manufacturer's specifications.

10.2.2.2 Landfill Gas Monitoring Performance Criteria

Weekly methane measurements should be completed using a FID or similar gas chromatograph, calibrated to methane with measurements taken in accordance with EPA guidance (US EPA 2016). The equipment should be calibrated in accordance with manufacturers recommendations. Data quality can be directly influenced by the meteorological conditions prevailing before and during the monitoring period. In particular, emission rates may be directly impacted by temperature, barometric pressure and precipitation so these should be recorded before and during each survey to assist with comparison of data taken during different days.

Monthly monitoring for methane will be performed using handheld portable combustible gas meter detectors. The monitoring equipment is to measure percent levels of carbon dioxide and methane and should be calibrated in accordance with manufacturer's recommendations.

10.3 Quality Assurance and Quality Control

Numerous aspects of a QA/QC program are provided in the details above. In addition to these requirements the following elements are also considered part of the QA/QC program for the NSDF OCM program.

10.3.1 Roles and Responsibilities

The roles and responsibilities are those that apply to CNL monitoring overall. Tasks may be contracted (i.e., sediment monitoring, traffic study) and these roles and responsibilities should be clearly defined.

10.3.2 Equipment Maintenance

Equipment that is used in conjunction with the NSDF OCM is subject to maintenance and calibration activities on a regular basis. There may be internal CNL procedures developed for specific tasks (e.g., sediment depth

monitoring) and each of these procedures, where present, provides information on the methods used for equipment/instrumentation maintenance, the frequency of maintenance and calibrations, and the documentation of information. All equipment issues, such as equipment malfunctions, calibration issues, cross-contamination events, and procedural errors are brought to the attention of the Chemist during the year. The matters are raised by documenting the occurrence in the CRL ImpAct system and during the annual program review.

10.4 Moving OCM Monitoring to Routine OCM Program

As there is no formal OCM program, the monitoring and reporting will be conducted as part of the NSDF operations. Reporting the results of follow-up monitoring will occur as part of the NSDF annual monitoring report for as long as justified. The table below provides justification of when reporting will cease for specific elements of OCM. Although a separate NSDF annual reporting ceases after a certain point during NSDF operation, monitoring of significant events (i.e., non-conformance) will continue to be tracked through ImpAct. Where reporting is required, this may continue as part of NSDF operations or as part of another program (e.g., a SAR program).

Where changes are proposed to the EAFMP based on results of monitoring, the changes will be confirmed with the regulator.

Table 10-3: Timeframe for OCM Reporting

Monitoring Program Element	Applicable NSDF Phase	Duration of Separate EAFMP Reporting	Justification
OCM1 – Air Quality, Dust	Construction	NA	Reporting will be conducted as part of the NSDF annual report during this phase as construction is relatively short.
OCM2 – Air Quality, Dust -	Operations	Following two years of operations	After the first two years of operation, there will be a significant dataset to be reported in the EAFMP. After these initial years, if monitoring verifies that mitigation measures for fugitive emissions are effective, the formal reporting as part of NSDF annual report will cease.
OCM3a – GHG	Operations	Following two years of operations	After the first two years of operation, there will be a significant dataset to be reported in the EAFMP. After these initial years, if monitoring indicates values below the air quality criteria, the formal reporting as part of the NSDF annual report will cease.
OCM3b – GHG	Closure	NA	At the time of closure, separate EAFMP reporting will have ceased.
OCM4a – GHG	Operations	Following two years of operations	After the first two years of operation, there will be a significant dataset to be reported in the EAFMP. After these initial years, if monitoring indicates values below the air quality criteria, the formal reporting as part of the NSDF annual report will cease.
OCM4b – GHG	Closure	NA	At the time of closure, separate EAFMP reporting will have ceased, .
OCM5 – Hydrology	Construction, Operations and Closure	Following two years of operations	After the first two years of operation, there will be sufficient data to be reported in the EAFMP. After these initial years, if the SWMPs are operating as planned, formal reporting as part of the NSDF annual report will cease.

Table 10-3: Timeframe for OCM Reporting

Monitoring Program Element	Applicable NSDF Phase	Duration of Separate EAFMP Reporting	Justification
OCM6 – Blanding's Turtle	Construction, Operations	Following two years of operations	After the first two years of operation, there will be sufficient data related to this monitoring, and assuming the mitigation measures are operating as planned, formal reporting as part of the NSDF annual report will cease.
OCM7 – Blanding's Turtle	Baseline (prior to Construction), Construction, Operations	Following two years of operations	After the first two years of operation, there will be sufficient data related to this monitoring, and assuming the mitigation measures are operating as planned, formal reporting as part of the NSDF annual report will cease.
OCM8 – Blanding's Turtle	Baseline (prior to Construction), Construction, Operations	Following two years of operations	After the first two years of operation, there will be sufficient data related to this monitoring, and assuming the mitigation measures are operating as planned, formal reporting as part of the NSDF annual report will cease.
OCM9 – Blanding's Turtle	Baseline (prior to Construction), Construction, Operations	Following two years of operations	After the first two years of operation, there will be sufficient data related to this monitoring, and assuming the mitigation measures are operating as planned, formal reporting as part of the NSDF annual report will cease.
OCM10 – Eastern Milksnake	Construction, Operations	Following two years of operations	After the first two years of operation, there will be sufficient data related to this monitoring, and assuming the mitigation measures are operating as planned, formal reporting as part of the NSDF annual report will cease.
OCM11 – Traffic	Baseline (prior to Construction)	One time reporting	The traffic study will be completed prior to construction and reported in the year completed. It will not be conducted or reported on again.

11.0 POST-CLOSURE

Details regarding post closure requirements cannot be effectively determined at this time given this phase will not start until approximately the year 2100. The information collected in the construction, operational and closure phases and the regulatory requirements at that time are to be evaluated to determine the requirements of the post-closure monitoring. Conceptual post closure elements for monitoring are described in Table 11-1 and may change as information is gathered through the implementation and management of the NSDF Project.

Table 11-1: Post Closure Monitoring Elements

Monitoring Element	Conceptual Monitoring Program
EVMP4b - Surface Water Quality - Verify the SWMPs are performing as designed	Discharge from the SWMPs will be sampled to identify contact surface water contamination and to monitor total suspended solid concentrations.
EMP3b - Surface Water Quality, Environmental monitoring – Verify environmental assessment predictions related to surface water quality related to WWTP effluent and leakage of ECM	Monitoring of surface water surrounding the ECM footprint area to evaluate whether the quality of the water is affected by the ECM or by operation of SWMP(s)
EMP12b - Ambient Radioactivity and Ecological Health - Ambient monitoring for radionuclides	Ambient radioactivity will be measured at the SSA.
GWMP1b - Verify environmental assessment predictions on groundwater from the ECM operation	Groundwater elevation measurements to determine groundwater flow direction and gradients. These parameters can be used to calculate groundwater flow.
GWMP3b - Verify the effectiveness of mitigation (ECM)	Sampling to confirm groundwater quality to detect potential releases of constituents from the ECM containment area. Initial sampling frequency will likely be twice per year (Spring and Fall).

Signature Page

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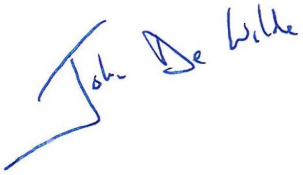

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