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2022

Bruce Power Environmental Quantitative Risk Assessment

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PUBLIC

BRUCE POWER 2022 ENVIRONMENTAL QUANTITATIVE RISK ASSESSMENT

B-REP-03443-00024

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EXECUTIVE SUMMARY

The 2022 Environmental Risk Assessment (ERA) was prepared in accordance with CNSC *REGDOC-2.9.1 Environmental Principles, Assessments and Protection Measures* and the approach described in Canadian Standards Association (CSA) Standard N288.6-12 entitled *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills*. The purpose of the 2022 ERA is to identify and assess any risks that may have emerged or changed since the 2017 ERA, in accordance with the ERA update requirements specified in N288.6-12, Clause 5.3. Specifically, it provides updated information through to 2020-2021 and associated ERA predictions, as well as forms the basis for forward-looking predictions within the Predictive Environmental Risk Assessment (PERA). The purpose of the ERA and the PERA is to demonstrate that Bruce Power has made adequate provision for the protection of the environment as part of Life Extension for the health and safety of persons, as described in the *Nuclear Safety and Control Act* and as required under REGDOC-2.9.1.

Site Description

Bruce Power has safely operated the Bruce Nuclear Facility (referred to as the “Site” herein) located near Tiverton, Ontario since May 2001. The Site is located on the east shore of Lake Huron about 18 kilometres (km) north of Kincardine. The Site includes Bruce Nuclear Generating Station A (Bruce A) and Bruce Nuclear Generating Station B (Bruce B), which each comprise four CANDU reactors, as well as ancillary facilities. Currently, seven of the eight reactors are operational. One reactor (Unit 6) is undergoing a Major Component Replacement until 2023, with two additional reactors (Units 3 and 4) starting MCR within the next five years.

In December 2015, Bruce Power reached an amended, long-term agreement with the Independent Electricity System Operator (IESO) to secure 6,400 megawatts (MW) of electricity from the Bruce Power site through a multi-year investment program. This amended agreement allowed Bruce Power to move forward with the Life-Extension Program, which includes MCR for Units 3 to 8. Bruce Power began its Life Extension Program on January 1, 2016, which includes preparations for the MCR Project for Units 3 to 8. The Life Extension Program runs from 2016 to 2033. To advance Life Extension, Bruce Power received renewal of the existing licence under the *Nuclear Safety and Control Act* in 2018. The Life Extension Program is extending the safe operating life of the site through to 2064. Bruce Power is also beginning the production of Lu-177, a medical isotope, in 2022.

The Site is currently being leased by Bruce Power, but also encompasses lands occupied by Ontario Power Generation (OPG), Canadian Nuclear Laboratories (CNL) Douglas Point and Hydro One. This update to the ERA includes only lands leased by Bruce Power and does not consider environmental impacts due to activities occurring on non-Bruce Power leased lands. The assessment of the Bruce Nuclear Facility included the Bruce A Generating Station and the Bruce B Generating Station and all of the currently operating support facilities such as sewage treatment facilities, storage areas and warehouses, as well as historic support facilities, including former landfill sites and storage facilities.

While CNL, OPG and Hydro One were not explicitly involved in the assessment, the influence of these facilities is implicitly included in the assessment, particularly for surface water, given that it is not practical to isolate any potential effects from the Site as a whole. The 2022 ERA was completed using environmental quality data collected from 2016-2017 to 2020-2021 for the various environmental media including Bruce A and Bruce B discharges, air, soil, groundwater, surface water, sediment, and drinking water.

The Site, as assessed, includes a range of natural features such as forested areas, open grasslands, previously disturbed areas undergoing natural revegetation, lawns and manicured greens, on-site permanent watercourses (e.g., Stream C), permanent drainage features (e.g., B31 Pond and the Former Sewage Lagoon), and interactions with Lake Huron.

Environmental Protection and Monitoring

Since Bruce Power took over operations of the Site in 2001, a number of environmental assessment (EA) studies have been conducted at key licensing and operational milestones. In conjunction, Bruce Power's environmental programs continue to collect environmental data as part of ongoing operations. Results of Bruce Power's environmental protection program are reported annually to the CNSC and are publicly available on the Bruce Power external website (www.brucepower.com). In addition, monitoring data are incorporated into the updated Environmental Risk Assessment every 5 years for evaluation of risks.

Indigenous Interests

The Bruce Power Site lies within the boundaries of the traditional territories of Indigenous communities. As such, we take great pride in continuing and expanding our relationships with local Indigenous communities. During our 20-year history, Bruce Power and our Indigenous partners have collaborated successfully in the areas of employment, education, training, community sponsorship, business development, and regulatory matters.

Bruce Power routinely engages with all three local Indigenous communities: Saugeen Ojibway Nation (SON, which is the Chippewas of Nawash Unceded First Nation together with the Chippewas of Saugeen First Nation), Region 7 of the Métis Nation of Ontario (MNO) and the Historic Saugeen Métis (HSM). The company has a formal relationship with each of these communities through established protocol/relationship agreements. These agreements function as a broad umbrella, under which meaningful routine discussion, information sharing, and annual funding occur which provides the framework for continued collaboration.

Routine discussions on regulatory and non-regulatory items related to environmental interactions are held with Indigenous Nations and Communities. Over the last 5 years, topics of focus have included climate change, thermal effluent, fish impingement and entrainment (I&E), monitoring and assessment, mitigation measures and dietary surveys. Thermal effluent and I&E are related to regulatory files subject to technical discussions for many years via other government permitting processes, specifically the Ministry of Environment, Conservation and Parks (MECP) Environmental Compliance Approval process related to thermal flexibility and the Fisheries and Oceans Canada (DFO) permit process, for the *Fisheries Act* Authorization.

Overall ERA Approach

The 2022 ERA consisted of human health and ecological risk assessments for chemical substances (non-radiological substances), radionuclides and physical stressors.

The Human Health Risk Assessment (HHRA) for chemical substances focused on potential off-site health risks to members of Indigenous communities, local residents, seasonal users, and non-Nuclear Energy Workers (i.e., Bruce Eco-Industrial Park worker). Given that the Site is fenced and access to the Site is restricted and monitored 24 hours per day by Site security personnel, there is no potential for on-site exposure of these human receptor groups. On-site, Nuclear Energy Workers were considered to be protected by the facility's health and safety programs and were not included in the assessment. The HHRA for radionuclides was performed for 19 different locations within 20 km of the Site. The group of individuals comprised non-farm residents, farm residents, subsistence farm residents, hunter/fisher residents, dairy farm residents and a Bruce Eco-Industrial Park (BEC) worker. For each location, the effect to three age categories was assessed: an adult, a child and an infant.

The Ecological Risk Assessment (EcoRA) focused on potential on-site health risks to a range of species including plants, invertebrates, fish, birds, mammals, reptiles and amphibians that were identified on the Site. Risks to these species (referred to as receptors) were considered with respect to exposure to air, soils, sediment, surface water and groundwater based on data collected on the Site. Off-site areas, namely Lake Huron and Baie du Doré, were considered with respect to exposure to surface water and sediment.

The EcoRA for physical stressors considered physical effects from cooling water, impingement and entrainment, thermal effluent, habitat alteration, bird strikes and vehicle-wildlife collisions.

The EcoRA specifically focused on those areas on-site where suitable habitat existed for the receptor species. Therefore, building sites, or other developed areas such as parking lots and roadways were not considered as areas where receptors could be exposed to COPCs. Developed areas and roadways were considered under physical stressors. OPG retained lands located within the boundaries of the Bruce Site were not assessed in the 2022 ERA.

The general ERA approach consisted of the following steps:

1. Based on a review of the Site monitoring data for chemical substances, a list of Chemicals of Potential Concern (COPCs) was selected. The non-radiological COPCs were determined on the basis of those substances that exceeded existing guidelines, site-specific regulatory limits and/or background levels in adjacent areas. The selection of COPCs for screening included those in air from air emissions, in shallow soil and shallow groundwater from current and previous on-site activities and in on-site and off-site surface waters and sediments from waterborne effluents. All radiological COPCs identified were carried forward for assessment in the 2022 ERA without screening.

2. Suitable human health and ecological receptors that could potentially be exposed were determined based on the conditions at the Site and its surrounding area. For human health receptors, these included adjacent residents, their lifestyles, and the age groups that would be present and could reasonably be exposed to COPCs emitted from the Site. For human receptors, considerations of Indigenous use of the land in the vicinity of the Site and community concerns were incorporated into the selection of receptors and receptor characteristics. Diet surveys of Indigenous communities were used to refine the hunter/fisher receptor for the radiological HHRA. Ecological receptors were selected on the basis of the habitat that was available on-site and off-site in Lake Huron, the species that were known through previous studies to be present on the Site, their life history including feeding patterns, habitat and feeding preferences and migratory habits and their cultural and/or socio-economic importance. The assessment included vulnerable, threatened or endangered species known to occur at the Site.

3. Activity patterns that could bring human and ecological receptors into contact with sources of the COPCs were determined. These provided the basis for the exposure assessment in which the degree to which each receptor could be exposed was determined. For the assessment of conventional contaminants, these activities were updated from those considered in the 2017 ERA to be more realistic in potential occurrence.

4. Toxicological benchmarks, developed from studies in the literature, were selected for each receptor-pathway-COPC combination. The benchmarks, also referred to as Toxicity Reference Values (TRVs), were based on conservative assumptions. For all substances, these benchmarks consisted of effects levels developed on the basis of long-term (chronic) exposure to the COPCs.

5. Risks were characterized based on whether the concentration to which the receptor could be exposed, and the conditions under which exposure could occur (e.g., length of time, source such as diet or inhalation), could result in adverse effects through long-term exposure.

This report has been prepared by Bruce Power, with contributions from Calian Nuclear and Golder Associates Ltd. (Golder).

Human Health Risk Assessment

Chemical Substances

Surface water, sediment, soils and air quality data were reviewed to determine the COPCs for the HHRA for chemical substances.

Off-site receptors assessed in the HHRA included the following:

- Members of Indigenous Communities, represented by a hunter/fisher receptor that is inclusive of members of the Chippewas of Saugeen First Nation and Chippewas of Nawash Unceded First Nation Cape Crocker Reserve No. 27 (which collectively comprise SON), members of the Historic Saugeen Métis and members of Region 7 of the Métis Nation of Ontario whose citizens are integrated into the population of the local surrounding municipalities. These are the Indigenous communities that were identified as being closest to the Site.

- Local residents, including people who live at the nearest homes, including farms and cottages if they are used year-round; these include non-farm residents, farm residents, subsistence farm residents, hunter/fisher residents, dairy farm residents (including three age categories: adult, child and infant).

- Seasonal cottagers and campers at several nearby provincial parks. Provincial parks are located along the shores of Lake Huron, including neighbouring Inverhuron Provincial Park, part of which is within the Site's fence line.

- Workers at the Bruce Eco-Industrial Park that are non-Nuclear Energy Workers. Since exposure of these workers was considered to be bounded by the exposure of the above receptors, they were not considered separately in the HHRA.

The review of Site data and selection of the COPCs was based on exceedances of available human health guidelines and/or background levels. As a result of the screening process, no chemicals were identified as COPCs in the 2022 HHRA and no further assessment was required.

Radionuclides

The airborne radionuclides selected for the assessment were: tritium oxide as water vapour (HTO), noble gases, carbon-14, mixed fission iodines (represented as iodine-131) and radioactive particulate (represented as cobalt-60 and neptunium-237). The waterborne radionuclides were: HTO, carbon-14 and radioactive particulate (represented as cobalt-60 and plutonium-239).

The majority of the data incorporated into the exposure assessment for the radiological HHRA was derived from the exposure concentrations measured as part of Bruce Power's radiological environmental monitoring. Where environmental concentrations did not exist for a specific radionuclide, airborne and waterborne effluents from the Site were entered as sources in the IMPACT model to simulate the transport of that radionuclide in the environment. In either case, the IMPACT model was used to determine the radiation dose to humans resulting from all exposure pathways.

For both the radiological effluents and the exposure concentration data, average and upper range were determined to enable a calculation of the average as well as the upper range risk to humans. The majority of water usage and dietary intake information was taken from the 2021 Site Specific Survey Report; all other exposure parameters were derived from CSA Standard N288.1. The 2021 Site Specific Survey Report included an uptake to the hunter/fisher receptor derived from diet surveys completed with SON, MNO and HSM.

There were a number of sources of uncertainty for which conservative assumptions were made in the exposure assessment. These include:

- The use of effluent and environmental data reported as less than a detection limit (L_d);
- The assumption that site survey data and generic exposure factors apply to all receptors considered in this assessment;
- The use of average, non location-specific radionuclide concentrations for the majority of environmental media;
- The use of the IMPACT model to determine concentrations that are not measured; and
- The use of a single radionuclide (e.g., cobalt-60) to represent a group of radionuclides (e.g., airborne radioactive particulate).

A summary of the results of the HHRA for radionuclides are provided below for each receptor category:

- The non-farm receptor with the highest radiation dose is an adult at BR48, who is located at the southern tip of Baie du Doré. The range of calculated doses for the adult has an average value of 1.56 µSv/year and an upper range value of 2.13 µSv/year. Approximately 38% of the total effective dose is due to inhalation of HTO in air.
- The farm receptor with the highest radiation dose is an adult at BF14, who is located at the eastern border of Inverhuron Provincial Park. The range of calculated doses for the adult has an average value of 1.87 µSv/year and an upper range value of 2.58 µSv/year. The radionuclides and pathways that are the highest contributors to the total effective dose are inhalation of HTO in air (25%) and ingestion of HTO C-14 in local produce (21%).
- The subsistence farm receptor with the highest radiation dose is an adult at BSF3, who is located near the intersection of Highway 21 and Concession Road 4. The range of calculated doses for the adult has an average value of 2.52 µSv/year and an upper range value of 3.28 µSv/year. The largest dose contributors for this receptor are ingestion of local produce (41% from carbon-14 and 12% from HTO) and ingestion of terrestrial animal products (23% from carbon-14).

- The dairy farm receptor with the highest radiation dose is an adult at BDF12, located approximately 13 km east of Bruce A. The range of calculated annual doses for the adult has an average value of 1.71 µSv/year and an upper range value of 2.23 µSv/year. The largest dose contributors for this receptor are ingestion of carbon 14 from terrestrial plant and animal products (29% and 21%, respectively), and inhalation of HTO in air (18%).

- Among the hunter/fisher representative group, the adult receives the highest calculated dose, with an average value of 1.73 µSv/year and an upper range value of 3.57 µSv/year. The largest dose contributor for this receptor is external exposure from Co-60 in soil (39%).

- The range of calculated doses for the BEC worker has an average value of 0.11 µSv/year and an upper range value of 0.14 µSv/year. The upper-range annual radiation dose to the most exposed receptor (an adult at BHF1) is approximately 3.57 µSv/y. All other doses are less than this value, which is considered to be negligible compared to the annual dose received by Canadians due to background sources of radiation (approximately 2,000 µSv/y).

Furthermore, all of the radiation doses discussed above are less than 1% of the Canadian Nuclear Safety Commission (CNSC) effective dose limit for a member of the public (1 mSv/y). With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.

Ecological Risk Assessment

Chemical Substances

Air, surface water, sediment, soil and shallow groundwater data were reviewed to determine the COPCs for the EcoRA for chemical substances. The receptors that could be exposed included the following:

- Terrestrial and aquatic plants;

- Soil and benthic invertebrates;

- Zooplankton and fish species;

- Mammals (meadow vole, northern short-tailed shrew, red fox, white-tailed deer, muskrat, and mink);

- Birds (mourning dove, American woodcock, short-eared owl, green-winged teal, spotted sandpiper and belted kingfisher), and;

- Reptiles and amphibians (common garter snake, wood frog, snapping turtle, northern water snake and the aquatic stage of amphibians).

Receptor exposure was considered on the basis of the feeding and/or foraging habits of the receptors, the typical feeding range, the availability of suitable habitat on the Site, the medium to which they could be exposed, the ingestion rate, and the life stages that could be present on-site (for example, nesting birds).

The review of Site data and selection of the COPCs was based on exceedances of available guidelines and/or background levels using a preliminary and secondary screening approach. Where guidelines and background levels were exceeded, toxicological benchmarks and TRVs that would be protective of the receptor under conservative exposure conditions were derived from published scientific studies. The risks to receptors were based on the potential exposure of each receptor to the exposure concentration relative to the toxicological benchmark or TRV (i.e., based on the Hazard Quotient [HQ]). An HQ of less than one indicates negligible risks to receptors while an HQ of greater than one indicates the potential for risks to receptors and the need for follow-up assessment.

The EcoRA for chemical substances resulted in the following conclusions:

Summary of EcoRA Conclusions

Area	Media Assessed	Hazard Quotient (HQ) Above 1.0	
		Receptor Group	COPC
TERRESTRIAL			
Construction Landfill #4	Soil	Terrestrial wildlife	Zinc and HMW PAHs
Fire Training Facility	Soil	Plants and soil invertebrates	TPH Light
Distribution Station #1	Soil	Plants and soil invertebrates	TPH Light
General Surface Soil Samples	Soil	Plants and soil invertebrates	Boron (HWS), selenium and PHC F2/F3
		Terrestrial wildlife	Lead and selenium
PERMANENT WATER COURSE			
Lake Huron shoreline and nearshore habitat	Surface Water	Aquatic communities.	Zinc
PERMANENT DRAINAGE FEATURE			
FSL	Sediment	Aquatic communities	PHC F3
	Surface Water	Aquatic communities	Copper and zinc
B31 Pond (at CL4)	Surface Water	Aquatic communities	Copper
Distal Eastern Drainage Ditch	Sediment	Aquatic communities	PHC F3
		Insectivorous, semi-aquatic wildlife	Vanadium

COPC: Chemical of Potential Concern HWS: Hot Water Soluble PHC: Petroleum Hydrocarbons
F2: Fraction 2 F3: Fraction 3
HMW PAH: High Molecular Weight Polycyclic Aromatic Hydrocarbons

The risks due to COPCs identified in the EcoRA are likely low due to the conservative assumptions included in the risk assessment. These included the following:

- Conservative toxicological benchmarks and TRVs, that may have resulted in the over-estimation of risks; and
- Assumptions regarding potential exposure (time spent on-site, use of habitat, feeding habits), that may have resulted in over-estimating exposure and risk.

The assumptions and uncertainties are discussed in the assessment with respect to each receptor and COPC.

Additional follow-up sampling is planned in all areas with average HQs above 1. For COPCs with HQs above 1 that were retained for follow-up sampling, a site-specific target level (SSTL) was established to guide future assessments. The SSTL represents the concentration within the contaminant media that would result in an HQ of 1; therefore, all concentrations measured below the SSTL are considered to present no unreasonable risk. For the soil samples with HQ>1, SSTLs were used to determine the exact location of the areas with HQ>1 and these results will be used to target sampling to these specific locations within the area assessed.

Radionuclides

The EcoRA for radionuclides selected reference organisms based on consideration of the ecological receptors chosen in the EcoRA for chemicals. The intent of the generic use of reference organisms in the radiological ERA was to apply exposure parameters (e.g., concentration ratios and dose coefficients) that are assumed to generally apply to a given set of biota. As with the EcoRA for chemicals, if the resulting HQ is close to or greater than 1, a more detailed examination of the specific organisms and their exposure parameters would be required; otherwise the use of reference organisms was deemed appropriate in concluding that there was no radiological risk to the respective set of biota.

The radionuclides selected for the EcoRA were similar to those selected for the HHRA. For the purpose of the assessment, all terrestrial biota were assumed to reside and remain on the Site, specifically north of Bruce A, where the highest on-site concentrations of carbon-14 in air were measured (excluding the WWMF). All aquatic biota were assumed to reside and remain in Baie du Doré or the on-site Former Sewage Lagoon, where the highest concentrations of tritium in water and gamma-emitting radionuclides in sediment were measured. All exposure point concentrations were taken or derived from data collected as part of radiological environmental monitoring. This included measured tissue concentrations for deer as well as pelagic and benthic fish, and on-site measurements of gamma-emitting radionuclides in soil.

The radiation dose to non-human biota resulting from external exposure (i.e., exposure to radiation emitted from contaminated air, soil, water or sediment) was calculated based on concentration in the respective media and the corresponding external dose coefficient. The dose resulting from internal exposure was calculated using empirically-derived Concentration Ratios (CRs), which correlated the radionuclide concentration in environmental media to the concentrations in the biota tissue. These concentration ratios accounted for ingestion via the entire food chain in a simplified manner. All of the concentration ratios and dose coefficients were taken from the ERICA Tool: Ecological Risk from Ionizing Contaminants: Assessment and Management. The exposure equations were based on the guidance provided in CSA Standard N288.6-12. There were a number of sources of uncertainty for which conservative assumptions were made in the exposure assessment. These include:

1. The use of effluent and environmental data reported as less than a detection limit (L_d);

2. The use of generic CRs for reference organisms to quantify the uptake of radionuclides through the food chain;

3. The use of the IMPACT model to determine concentrations that are not measured; and

4. The use of 100% occupancy factors at the location of highest radioactivity.

The aquatic species with the highest total radiation dose rate (2×10^{-3} mGy/d) was the benthic invertebrate at the Former Sewage Lagoon, which was representative of bottom-dwelling invertebrates and aquatic insect larvae. The total radiation dose rate to aquatic biota in Baie du Dore ranges from 7×10^{-6} to 2×10^{-4} mGy/d. Doses to aquatic biota in the Former Sewage Lagoon were therefore shown to be higher than in Baie du Doré. This was primarily due to higher measured concentrations of tritium in water and cesium-137 in sediment, as well as modelled concentrations of C-14 from airborne deposition.

The dose rate for all terrestrial species for which there was no measured radioactivity concentrations in tissue was approximately equivalent (2×10^{-3} mGy/d); the dose rate for deer, incorporating measured concentrations, was lower (2×10^{-4} mGy/d).

The effects assessment for non-human biota was based on radiological benchmarks defined by UNSCEAR: 2.4 mGy/d for terrestrial biota and 9.6 mGy/d for aquatic biota. Radiological benchmarks are set at the level below which radiation effects on biota are not expected to be detectable (i.e., quantifiable in terms of a measurable response). Since all dose rates are less than 1% of the benchmark values, there was no radiological risk to non-human biota resulting from normal operations on the Site.

Physical Stressors

Potential interactions between the site and the environment included physical stressors, such as changes in noise level, surface water flow, thermal effluent, habitat alteration and direct mortality as a result of entrainment and impingement.

Noise effects on human receptors was excluded after noise monitoring found that noise levels attributable to the facility in 2015/2016, 2017, 2019 and 2020 complied with the applicable night-time noise limit of 40 dBA. There are no noise benchmarks available that are protective of health effects to wildlife populations. The scientific literature focused on behavioural adaptations to elevated noise levels (e.g., avoidance) rather than health effects. As a result, noise effects to wildlife were not quantitatively assessed.

A more complete description of the interaction of the surface water flow from the discharge channel with the prevailing currents and the potential impact on the local ecosystem was included in the ERA. The discharge surface water flow enters the lake at the end of the discharge channels at one to two orders of magnitude above the ambient current speed. Given this, the discharge surface water flow has the potential to interact with the local ecosystem. However, based on extensive literature reviews and field studies of the shoreline areas where the discharge cooling water interacts with the local environment, there has not been any observable evidence of impacts to aquatic plants, plankton, benthic invertebrates, or fish and fish habitat.

A comprehensive thermal risk assessment was completed in the 2022 ERA. The results of the thermal risk assessment showed a low risk to the egg stage of Lake Trout, Lake Whitefish, Round Whitefish, Walleye and Brown Bullhead, the larval stage of Lake Whitefish, Deepwater Sculpin and Walleye, the growth stage of Chinook Salmon, Rainbow Trout, Lake Whitefish, Gizzard Shad, Walleye and Yellow Perch and the parent stage of Smallmouth Bass and Brown Bullhead. In response to the low risk posed by thermal effluent to these fish species, Bruce Power will continue to execute thermal monitoring through logger deployments and thermal modelling work to monitor the risk posed by thermal effluent in the local study area.

No effect thresholds for fish impingement or entrainment are available from federal or provincial authorities. Bruce Power obtained a Fisheries Act Authorization (FAA) from Fisheries and Oceans Canada (DFO) in 2019 that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time.

The assessment of the physical effects of habitat alteration showed no unreasonable risk to ecological receptors due to limited habitat alteration and a small number of bird strikes and vehicle wildlife interactions.

Predictive Environmental Risk Assessment (PERA)

Future site activities including Lu-177 production, Life Extension and MCR activities were evaluated for potential interactions with the environment in the PERA. In all cases, the current conditions were considered bounding or the predicted conditions were screened as being acceptable. No adverse environmental interactions are anticipated as a result of future activities on site.

Conclusions

The ERA demonstrates that the operation of the Bruce Nuclear Facility has not resulted in adverse effects on human health of nearby residents or visitors or on non-human biota as a result of exposure to physical stressors or to radiological or chemical substances.

The baseline radiation doses to members of the public residing in the area surrounding the Site as calculated based on current operational conditions are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). There is no radiological risk to human health for members of the public resulting from normal operations on the Site. The human health risk assessment for chemicals identified no unreasonable risk for people using the land around the Site for recreational or residential/agricultural uses.

The radiation doses to non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value. There is no radiological risk to non-human biota resulting from normal operations on the Site. The conventional EcoRA identified potential risks to terrestrial ecological receptors at Construction Landfill #4, Fire Training Facility, Distribution Station #1 and at five general soil sampling sites, to semi-aquatic receptors at Eastern Drainage Ditch and to aquatic receptors in Lake Huron, FSL, B31 Pond and Eastern Drainage Ditch. Additional follow-up monitoring will be completed at each of the identified locations to refine these potential risks.

For thermal effluent, a low risk to several mainly cold and cool water species and life stages located in the Local Study Area was assessed during the thermal risk assessment process. Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected. For impingement and entrainment, Bruce Power has obtained a Fisheries Act Authorization (FAA) from Fisheries and Oceans Canada (DFO) that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time. For other physical stressors, the assessment of the physical effects noise to human receptors and cooling water discharge and habitat alteration to ecological receptors has shown no unreasonable risk.

As the current operational conditions are demonstrated to be bounding of future activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities. Therefore, there is no additional radiological or non-radiological risk to human or non-human biota resulting from anticipated future activities.

ABSTRACT OF PRESENT REVISION:

Initial issue

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Acronyms

Acronym	Definition
AAL	Acceptable Ambient Level
AAQC	Ambient Air Quality Criteria
ACGIH	American Conference for Governmental Industrial Hygienists
ACRP	Advisory Committee on Radiation Protection
ACU	Air Conditioning Units
ADCP	Acoustic Doppler Current Profiler
AECL	Atomic Energy of Canada Limited
AFMM	Assessment of Feasible Mitigation Measures
AL	Action Level
ALARA	As Low As Reasonably Achievable
ALW	Active Liquid Waste
ANS	Area of Natural Significance
AOO	Anticipated Operational Occurrence
APV	Aquatic Protection Values
ASDV	Atmospheric Steam Discharge Valves
AST	Aboveground Storage Tank
BA	Bruce A
BACI	Before-After-Control-Impact Study
BACM	Bruce A Construction Maintenance Yard (Site #8)
BAF	Bioaccumulation Factor
BASC	Bruce A Storage Compound (Site #5)
BASG	Bruce A Standby Generators (Site #9)
BASM	Bruce A Scrap Metal Yard (Site #6)
BATR	Bruce A Transformer Area (Site #49)
BB	Bruce B
BBAB	Bruce B Administrative Building
BBCL	Bruce B Construction Laydown Area (Site #17)
BBED	Bruce B Empty Drum Laydown Area (Site #58)
BBEG	Bruce B Emergency Generators (Site #47)

Acronym	Definition
BBSG	Bruce B Standby Generators (Site #46)
BBTR	Bruce B Transformer Area (Site #50)
BCF	Bioconcentration Factor
BC MOE	British Columbia Ministry of Environment
BCO	Bunker C Oil Tanks & Ignition Oil Day Tanks (Site #13)
BCO-AWP	Bunker C Oil Tanks & Ignition Oil Day Tanks – Acid Wash Pond (Site #13A)
BCO-ODS	Bunker C Oil – Aboveground Storage Tank and Oil Delivery System
BDF	Dairy Farm Resident
BEC	Bruce Energy Centre (current Bruce Eco-Industrial Centre)
BEDS	Biological Effects Database for Sediments
BEM	Biological Effects Monitoring
BF	Farm Resident
BHF	Hunter/Fisher Resident
BHWP	Bruce Heavy Water Plant
BNSG	Bruce Nuclear Standby Generators (Site #36)
BPRIA	Bruce Power Refurbishment Implementation Agreement
Bq	Becquerel
BR	Non-Farm Resident
BSAF	Biota Sediment Accumulation Factor
BSF	Subsistence Farm Resident
BSP	Bruce Steam Plant
BSSC	Bruce Nuclear Stores Storage Compound (Site #30)
BSV	Boiler Safety Valves
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
BW	Body Weight
Cal EPA	California Environmental Protection Agency
CANDU	Canada Deuterium Uranium
C_b	Concentration in Benthos Tissue
CBOD	Carbonaceous Compounds
CCME	Canadian Council of Ministers of the Environment

Acronym	Definition
CCW	Condensing Cooling Water
CDWQ	Canadian Drinking Water Quality
C_e	Concentration in Earthworm Tissue
CEPA	Canadian Environmental Protection Act
CGLR	Council of the Great Lakes Region
C_f	Concentration in Fish Tissue
C_{fj}	Wet Weight Concentration of COPC in Food Item j
CFM	Commercial Fishery Management
Ci	Curie
CL1	Construction Landfill #1 (Site #1)
CL2	Construction Landfill #2 (Site #2)
CL3	Construction Landfill #3 (Site #44)
CL4	Construction Landfill #4 (Site #33)
CLM	Chronic Lethal Maximum
C_m	Concentration in Mammals
CMF	Central Maintenance Facility
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
COPC	Chemical of Potential Concern
CPE	Catch per Effort
COS	Center of Site
COSSARO	Committee on the Status of Species at Risk in Ontario
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
C_p	Concentration in Plant Tissue
CR	Concentration Ratio
CRI	Climate Risk Institute
C_s	Concentration in Soil/Sediment
CSA	Canadian Standards Association
C_{sed}	Concentration in Sediment

Acronym	Definition
CSF	Central Storage Facility
CSL	Former Clarifloccculator Sludge Lagoon (Site #45)
CSM	Conceptual Site Model
CSQG	Canadian Soil Quality Guidelines
$CSQG_E$	Canadian Soil Quality Guidelines for the Protection of Ecological Health
$CSQG_{HH}$	Canadian Soil Quality Guidelines for the Protection of Human Health
CTM	Critical Thermal Maximum
C_w	Concentration in Water
CWMP	Coastal Waters Monitoring Program
CWQG	Canadian Water Quality Guidelines
CWQG-PAL	Canadian Water Quality Guidelines for the Protection of Aquatic Life
D	Dose
DAF	Dose Adjustment Factor
DAT	Total Adjusted Dose
dB	Decibel
dBA	Decibel A
DBA	Design Basis Accident
DC	Dose Coefficient
DF	Dilution Factor
DF	Dose from Food
DFO	Fisheries and Oceans Canada
DGR	Deep Geologic Repository
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DPWMF	Douglas Point Waste Management Facility
DQRA	Detailed Quantitative Risk Assessment
DRL	Derived Release Limits
DS	Dose from Soil
DS	Downstream
DS1	Distribution Station #1 (Site #57)

Acronym	Definition
DS2	Distribution Station #2 (Site #57)
DS3	Distribution Station #3 (Site #57)
DS4	Distribution Station #4 (Site #57)
DS5	Distribution Station #5 (Site #57)
DS8	Distribution Station #8 (Site #57)
DSC	Dry Storage Containers
DUT	Total Unadjusted Dose
dw	Dry Weight
DW	Dose from Water
EA	Environmental Assessment
EAL	Environmental Action Level
EBR	Environmental Bill of Rights
EC	Environment and Climate Change Canada
EC_X	Effect Concentration to X% of Test Organisms
ECA	Environmental Compliance Approval
EcoRA	Ecological Risk Assessment
Eco-SSL	Ecological Soil Screening Level
EDD	Eastern Drainage Ditch
EDI	Estimated Daily Intake
EIO	Electrical Insulating Oil
EIW	Environmental Impact Worksheets
ELC	Ecological Land Classification
EMEL	Effluent Monitoring and Effluent Limits
EMP	Environmental Management Plans
EMP	Environmental Monitoring Plans
EOL	End of Life
EPA	Environmental Protection Act
EPC	Exposure Point Concentration
EPG/SG	Emergency Power Generators and Standby Generators
ERA	Environmental Risk Assessment

Acronym	Definition
ERICA	Ecological Risk from Ionizing Contaminants: Assessment and Management
E & S	Environment and Sustainability
ESA	Environmental Site Assessment
ESA	Endangered Species Act
ESDM	Emission Summary and Dispersion Modelling
ESL	Effect Screening Levels
ETMFS	Exposure and Toxicity-Modifying Factors
FAA	Fisheries Act Authorization
FASSET	Framework for Assessment of Environmental Impact
FCSAP	Federal Contaminated Sites Action Plan
FEQGS	Federal Environmental Quality Guidelines
FFA	Film Forming Amines
FFYM	Foregone Fishery Yield Model
FIAM	Free Ion Activity Model
FIGQG	Federal Interim Groundwater Quality Guidelines
FIR	Food Ingestion Rate
FME	Foreign Material Exclusion
FNFNES	First Nations Food, Nutrition and Environmental Study
FPS	Former Large Bore Pipe Shops (Site #23)
FRF	Foraging Range Factor
FSL	Former Sewage (Commissioning Waste) Lagoon (Site #21)
FTF	Fire Training Facility (Site #32)
FUP	Follow-up Program
fw	Fresh Weight
GBT	Gas Bubble Trauma
GCDWQ	Health Canada Guidelines for Canadian Drinking Water Quality
GCM	Global Climate Model
GHG	Greenhouse Gas
GIS	Geographic Information System
GWMP	Groundwater Monitoring Program

Acronym	Definition
GWPP	Groundwater Protection Program
HC	Health Canada
HECA	High Efficiency Charcoal Air
HEPA	High Efficiency Particulate Air
HHRA	Human Health Risk Assessment
HHT MIKE3	Huron Hydrothermal MIKE3
HLC	Heavy Lift Crane
HMW	High Molecular Weight
HPI	Habitat Productivity Index
HQ	Hazard Quotient
HSM	Historic Saugeen Métis
HTO	Tritium Oxide as Water Vapour
HVAC	Heating, Ventilation and Air Conditioning
HWS	Hot Water Soluble
HZI	Hydraulic Zone of Influence
IAEA	International Atomic Energy Agency
IC_X	Inhibitory Concentration to X% of Test Organisms
ICRP	International Commission on Radiological Protection
I&E	Impingement and Entrainment
IEMP	Independent Environmental Monitoring Program
IESO	Independent Electricity System Operator
ILL	Internal Investigation Level
ILW	Intermediate Level Waste
IMPACT	Integrated Model for the Probabilistic Assessment of Contamination Transport
IPCC	Invasive Phragmites Control Centre
IPS	Isotope Production System
IRIS	Integrated Risk Information System
ISO	International Organization for Standardization
ISQG	Interim Sediment Quality Guidelines
ITRC	Interstate Technology and Regulatory Council

Acronym	Definition
JSL	Jurisdictional Screening Levels
K_d	Solid-liquid Distribution Coefficient
kg	Kilograms
K_{oc}	Soil Organic Carbon-water Partition Coefficient
L	Litres
LANL	Los Alamos National Laboratory
LCH	License Condition Handbook
LC_X	Lethal Concentration to X% of Test Organisms
LD_X	Lethal Dose to X% of Test Organisms
L_d	Limit of Detection
LEL	Lowest Effect Level
L&ILW	Low and Intermediate Level Waste
LLW	Low Level Waste
LMW	Low Molecular Weight
LNAPL	Liquid Non-Aqueous Phase Liquids
LOAEL	Lowest Observed Adverse Effect Level
LOEC	Lowest Observed Effect Concentration
LPSW	Low Pressure Service Water
LSA	Local Study Area
MATC	Maximum Acceptable Toxicant Concentration
M & B	Mammals and Birds
MassDENR	Massachusetts Department of Environmental Protection
mbgs	Meters Below Ground Surface
MCR	Major Component Replacement
MDL	Method Detection Limit
MDL	Minimum Detection Limit
MECP	Ministry of Environment, Conservation and Parks
MFO	Mixed Function Oxygenase
MGLC	Maximum Ground Level Concentration
MISA	Municipal/Industrial Strategy for Abatement

Acronym	Definition
MNA	Monitored Natural Attenuation
MNO	Métis Nation of Ontario
MNRF	Ministry of Natural Resources and Forestry
MOE	Ministry of Environment
MOECC	Ministry of the Environment and Climate Change
MPER	Maximum Probable Emission Rate
MPOI	Maximum Point of Impingement
MRL	Minimum Reference Level
mSv	Millisievert
MTE	Maximum Temperature for Embryos
MW	Megawatt
MWAT	Maximum Weekly Average Temperature
NA	Natural Attenuation
NC	Not Calculated
NCDENR	North Carolina Department of Environment and Natural Resources
NCRP	National Council on Radiation Protection and Measurements
NEW	Nuclear Energy Worker
NHIC	National Heritage Information Centre
NII	Nuclear Innovation Institute
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NOL	Normal Operating Level
NORM	Naturally Occurring Radioactive Materials
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxide
NPRI	National Pollutant Release Inventory
NSCA	Nuclear Safety and Control Areas
NSTP	National Status and Trends Program
NV	No Value

Acronym	Definition
NWMO	Nuclear Waste Management Organization
OBA	Operations Building A
OBT	Organically Bound Tritium
OCFA	Ontario Commercial Fisheries Association
ODWS	Ontario Drinking Water Standards
OF	Occupancy Factor
OHN	Ontario Hydro Nuclear
OPEX	Operating Experience
OPG	Ontario Power Generation
OPGSS	Over Poisoned Guaranteed Shutdown State
ORP	Oxygen Reduction Potential
OSG	Old Steam Generators
OTR_{98}	Ontario Typical Range (97.5th percentile)
PAH	Polycyclic Aromatic Hydrocarbon
PAPR	Powered Air Purification Respirator
PCB	Polychlorinated Biphenyl
PEL	Probable Effect Level
PERA	Predictive Environmental Risk Assessment
PFAS	Polyfluorinated Alkylated Substances
P_{Fj}	Proportion of Prey Item j in the Diet
PGMIS	Provincial Groundwater Monitoring Information Systems
PHC	Petroleum Hydrocarbons
PHT	Primary Heat Transport
PING	Particulate, Iodine and Noble Gas
PIRI	Atlantic Partnership in Risk-Based Corrective Action Implementation
pKa	Acid Dissociation Constant
PM	Particulate Matter
POI	Point of Impingement
PROL	Power Reactor Operating License
PTTW	Permit to Take Water

Acronym	Definition
PWQMN	Provincial Water Quality Monitoring Network
PWQO	Provincial Water Quality Objectives
PQRA	Preliminary Quantitative Risk Assessment
PSB	Former PCB Storage Building (Site #7)
P&SO	Plants and Soil Organisms
PSS	Paint and Sandblast Shop (Site #51)
PSW	Provincially Significant Wetland
QA/QC	Quality Assurance/Quality Controls
RBE	Relative Biological Effectiveness
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
RDL	Reportable Detection Limit
REL	Reference Exposure Level
REM	Radiological Environmental Monitoring
REMP	Radiological Environmental Monitoring Program
RMSE	Root Mean Square Error
RSL	Regional Screening Level
SAR	Species at Risk
SARA	Species at Risk Act
SCA	Station Containment Outage
SCS	Site Condition Standard
SEL	Severe Effect Level
S&FI	Soil and Food Ingestion
SGR	Steam Generator Replacement
SIR	Soil/Sediment Ingestion Rate
SLRA	Screening Level Risk Assessment
SMA	Soil Management Area
ST_{max}	Short Term Maximum Temperature
SOC	Secondary Oil Containment
SON	Saugeen Ojibway Nations

Acronym	Definition
SPCP	Spill Prevention and Contingency Plans
SQG	Sediment Quality Guideline
SRD	South Railway Ditch
SSD	Species Sensitivity Distribution
SST	Safety System Test
SSTF	Former Spent Solvent Treatment Facility (Site #48)
SSTL	Site-Specific Target Level
STP	Sewage Treatment Plant
SVCA	Saugeen Valley Conservation Authority
TC	Transport Container
TC68	Bruce B PCB Storage Facility
TCEQ	Texas Commission on Environmental Quality
TDG	Total Dissolved Gas
TDS	Total Dissolved Solids
TEL	Threshold Effect Level
TFT	Target Finger Tubes
TIS	Traffic Impact Study
TJF	Triple Joint Frequency
TLV	Threshold Limit Value
T_{max}	Maximum Hourly Temperature
TMB	Technical Mock-up Building
TMF	Toxicity Modifying Factor
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
T_{pref}	Preferred Temperature
TRA	Thermal Risk Assessment
TRV	Toxicity Reference Value
TSS	Total Suspended Solids
TQP	Tool Qualification Program
UCLM	Upper Confidence Limit of the Mean

Acronym	Definition
UF	Uncertainty Factor
UILT	Upper Incipient Lethal Temperature
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
US	Upstream
U.S. DOE	United States Department of Energy
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VBO	Vacuum Building Outage
VC	Valued Component
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compounds
VSD	Variable Speed Drive
VVR	Vault Vapour Recovery
WCTF	Waste Chemical Transfer Facility (Site #28)
WFI	Wetland Fish Index
WHO	World Health Organization
WIR	Drinking Water Ingestion Rate
WMI	Wetland Macrophyte Index
WSC	Water and Steam Cycle
WSER	Wastewater Systems Effluent Regulations
WVRF	Waste Volume Reduction Facility
Ww	Wet Weight
WWMF	Western Waste Management Facility

1.0 INTRODUCTION

Bruce Power has safely operated the Bruce Nuclear Facility (referred to herein as the “Site”) located near Tiverton, Ontario since May 2001. The Site is located on the east shore of Lake Huron about 18 kilometres (km) north of Kincardine, and includes Bruce Nuclear Generating Station A (Bruce A) and Bruce Nuclear Generating Station B (Bruce B), which each comprise four CANDU reactors, as well as ancillary facilities. The Site also encompasses lands currently occupied by Ontario Power Generation (OPG), Canadian Nuclear Laboratories (CNL) Douglas Point and Hydro One.

Currently, seven reactors are operational and Unit 6 is undergoing Major Component Replacement. The facility includes radioactive waste storage among other supporting facilities. Since 2001, a number of environmental assessment (EA) studies were conducted at key licensing and operational milestones. These include the following:

- 2000 Bruce Power Development Ecological Effects Review [R-1];
- 2001 EA Study Report for the Bruce A Units 3&4 Restart [R-2];
- 2004 EA Study Report for the Bruce B New Fuel Project [R-3];
- 2006 EA Study Report for the Bruce A Refurbishment Project (Units 1&2 Restart) [R-4]; and
- 2008 Environmental Impact Statement for the Bruce New Nuclear Power Plant Project (eventually withdrawn) [R-5].

With the completion of each of the above EAs, progressively more environmental data has been collected for the Site, and follow-up monitoring was proposed and executed to confirm that effects were as predicted in the EAs. The Unit 1&2 restart follow-up monitoring data collection completed in 2015 and results, as reported annually to the CNSC, were as predicted in the EA. Follow-up monitoring included ambient air monitoring, thermal effluents, smallmouth bass nesting, fishing pressure and gas bubble trauma. In addition, Bruce Power’s environmental monitoring has continued to collect environmental data as part of regular operations. Results of Bruce Power’s environmental protection program are reported annually to the CNSC and are publicly available on the Bruce Power external website (www.brucepower.com).

In 2015, a Preliminary Quantitative Risk Assessment (PQRA) ERA for the Site was submitted to and accepted by the CNSC in conjunction with CNL. The 2015 PQRA ERA consolidated the above-mentioned environmental monitoring data to assess the potential environmental risks due to historical and ongoing operations from the Site. While OPG and Hydro One were not explicitly involved in the assessment, the influence of their existing operations are implicitly included in the assessment given that it is not possible to isolate any potential effects from the Site as a whole. In 2017, an ERA for the Site was submitted to and accepted by the CNSC [R-6].

Bruce Power entered into an amended, long-term agreement with the Independent Electricity System Operator (IESO) in 2015 to secure 6,400 megawatts (MW) of electricity from the Bruce Power site through a multi-year investment program. This amended agreement allowed Bruce Power to move forward with Life Extension activities, which includes major component replacement (MCR) for Units 3 to 8. Bruce Power began its Life-Extension Program on January 1, 2016, including preparations for MCR Projects for Units 3 to 8. The Life-Extension Program runs from 2016 to 2053. To advance Life Extension, Bruce Power renewed the existing licence under the *Nuclear Safety and Control Act* in 2018. The licence renewal term is typically 10 years. The Life-Extension Program will extend the safe operating life of the site through to 2064. The first unit to undergo MCR is Unit 6, starting on January 17, 2020. Bruce Power is also beginning the production of the medical isotope Lu-177 in 2022.

The purpose of this update to the 2017 ERA is to provide updated information and risk assessment through to 2021, as well as form the basis for forward-looking predictions within the Predictive Environmental Risk Assessment (PERA) for changes to activities occurring on-site. The purpose of the ERA and the PERA is to demonstrate that Bruce Power has made adequate provision for the protection of the environment and for the health and safety of persons, as described in the *Nuclear Safety and Control Act* and as required under *REGDOC-2.9.1 Environmental Principles, Assessments and Protection Measures* [R-7].

This report has been prepared by Bruce Power, with contributions from Golder Associates Ltd. (Golder) and Calian Nuclear.

1.1 Background

Environmental protection for nuclear facilities and activities is done in accordance with the *Nuclear Safety and Control Act* and the regulations made under it [R-8][R-9]. Expectations for environmental protection considerations as part of licence applications are outlined in CNSC's *REGDOC-2.9.1 Environmental Principles, Assessments and Protection Measures* [R-7].

The 2017 ERA was based on hundreds of environmental reports with environmental quality data and information related to habitats and human use of the area. These reports represent the culmination of decades of environmental monitoring at the Site. This included assessments by Bruce Power under the *Nuclear Safety and Control Act* (i.e., Bruce Nuclear Ecological Effects review in 2000 [R-1]), monitoring associated with EAs completed since 2001 under the *Canadian Environmental Assessment Act* (e.g., for the Restart of Bruce A) [R-3][R-4][R-10], as well as associated EA follow-up programs [R-11], environmental permitting and environmental monitoring.

The January 2015 ERA was submitted to the CNSC incorporating the above baseline data as well as environmental monitoring data from 2009 to 2013. To address gaps, recommendations and comments received on the January 2015 ERA, a number of additional studies and updates to ERA studies were undertaken. An updated ERA was submitted in 2017 and revised in 2018 [R-12][R-13].

The 2022 ERA was prepared in accordance with the approach described in Canadian Standards Association (CSA) Standard N288.6 entitled *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* [R-14]. The purpose of the ERA is to systematically identify potential risks to either human health or the environment as a result of historical and ongoing operations at the Site (i.e., those from the Bruce Nuclear Facility), including determination of the magnitude and extent of the potential effects associated with the Site. The ERA considers potential modifications to the current monitoring commitments for the Site while upholding the requirements described in CSA Standard N288.4 entitled *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [R-15] and CSA Standard N288.5 entitled *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [R-16]. The primary intent of this examination is to provide a risk-based rationale for the relative priority of monitoring for effects or sampling specific media for analysis as part of Environmental Monitoring. As per its Environmental Management System, Bruce Power strives to continually improve the Environmental Protection Program. Predominantly, this refers to environmental and effluent/emission monitoring which are based on CSA Standards N288.4 and N288.5, respectively. As required by these Standards, Bruce Power routinely reviews, assesses and, as necessary, revises its environmental and effluent/emission monitoring design and processes. The ERA is one of the inputs to this routine review and assessment, and therefore will be considered as necessary as part of the review and assessment process. Any corrective action that is identified will be managed in accordance with existing adaptive management procedures at Site.

A Predictive Environmental Risk Assessment (PERA) has also been prepared to demonstrate consideration of environmental protection during future site activities, including Lu-177 production and Life Extension and MCR activities. The PERA has been prepared following the guidance of CSA N288.6. The information provided in the PERA is as per the known status of projects as of June 1, 2021.

The ERA supports environmental protection throughout the regulatory lifecycle of a facility or activity. The ERA and PERA provide sufficient information to the CNSC to support their preparation of an EA under the *Nuclear Safety Control Act* as indicated in REGDOC-2.9.1 [R-7].

1.1.1 Revisions since Last Version

This 2022 ERA report represents the five year update to the ERA and includes the following revisions:

- Update of the analytical data (i.e., surface water, sediment, air quality) to be representative of the most recent five years (2016/2017 to 2020/2021);
- Update of the associated radiological exposure dose modelling, with the predominant modifications being:
    - Update of hunter/fisher receptor that is representative of Indigenous Peoples, based on additional surveys undertaken from 2019-2021 (see Section 1.3.4.6);

  - Incorporation of more recent Dose Conversion Coefficients and Concentration Ratios for non-human biota, based on Version 2.0 of the ERICA Assessment Tool released in July 2021;
  - Added additional representative species “Aquatic Bird” to the radiological ecological risk assessment;
  - Added the “Former Sewage Lagoon” receptor location to the radiological environmental risk assessment, representing the bounding on-site waterbody.
- Incorporation of recent aquatic monitoring information, including information related to fish impingement and entrainment, aquatic life habitat information, and thermal effluent.
- Incorporation of additional baseline information collected from 2017 to 2021, including:
  - Bioinventory studies, vegetation and wildlife surveys;
  - Soil quality monitoring;
  - Water and sediment quality monitoring both in nearshore Lake Huron, and on-site inland streams and ponds;
  - Shallow groundwater monitoring; and
  - Noise monitoring.
- Incorporation of Indigenous input including:
  - Traditional Knowledge regarding terrestrial and aquatic biota; and
  - Environmental monitoring data from the Coastal Water Monitoring Program (CWMP).

1.2 Goals, Objectives and Scope

The objectives of the 2022 ERA were as follows:

- Identify the presence or absence of risks to human health and the environment associated with potential exposure to residual impact in environmental media as a result of historical and ongoing operations at the Site;
- If potential risks are determined, identify whether these potential risks need to be addressed by further refinement of the exposure assessment and/or risk characterization steps of the quantitative risk assessment, or by considering other lines of evidence; and,
- Provide a basis for assessing risks for future Site activities and informing future monitoring commitments.

Some key assumptions that guided the scope of this update to the ERA are as follows:

- The risk assessment approach is in accordance with CSA Standard N288.6 [R-14].
- The Site is currently being leased by Bruce Power, but also encompasses lands occupied by OPG, CNL Douglas Point and Hydro One. This update to the ERA includes only lands leased by Bruce Power and does not consider environmental impacts due to activities occurring on non-Bruce Power leased lands. The assessment of the Bruce Nuclear Facility included the Bruce A Generating Station and the Bruce B Generating Station and all of the currently operating support facilities such as sewage treatment facilities, storage areas and warehouses, as well as historic support facilities, including former landfill sites and storage facilities. Investigations have included the collection of surface water and sediment samples at several points along the shoreline of Lake Huron and therefore the assessment includes the adjacent waters of Lake Huron. These locations were also considered to be within the spatial boundaries of the assessment.
- The 2022 ERA is supported by environmental quality data collected within the past five years (i.e., from 2016/2017 to 2020/2021), where data were available, for the various environmental media including Bruce A and Bruce B discharges, air, soil, groundwater, surface water, sediment, and drinking water. Soil data from 2000 to 2021 was considered due to the low turnover of soil as a media and to enable a more detailed quantitative assessment of reptiles and amphibians. These environmental quality data are also considered to represent historical and ongoing impacts. While CNL, OPG and Hydro One were not explicitly involved in the assessment, the influence of these facilities is implicitly included in the assessment, particularly for surface water, given that it is not practical to isolate any potential effects from the Site as a whole.
- The Human Health Risk Assessment (HHRA) focused on potential off-site health risks of local residents (including non-farm residents, farm residents, subsistence farm residents [previously referred to as Mennonite farm residents in Bruce Power Environmental Programs documentation], dairy farm residents), seasonal users, hunter/fisher residents, and non-Nuclear Energy Workers (i.e., Bruce Eco-Industrial Park worker). This is based on the rationale that the Site is fenced and access to the Site is restricted and monitored 24 hours per day by site security personnel. On-site, Nuclear Energy Workers (including contractors) were considered to be protected by the facility's health and safety programs in accordance with CNSC's Radiation Protection Regulations [R-17]. There is one location on-site that may be visited occasionally by Indigenous members of the community (i.e., an Indigenous Spirit Site). The Spirit Site is located on OPG retained lands and is not assessed in the 2022 ERA.
- The Ecological Risk Assessment (EcoRA) focused on potential on-site ecological health risks with respect to exposure to soils, sediment, surface water and groundwater. Off-site areas were considered with respect to exposure to surface water (e.g., in Lake Huron waters adjacent to the Site) and sediment. The EcoRA for radionuclides also considered exposure to air. Baseline environmental investigations have collected soil, groundwater, sediment, surface water and air quality data within the Site and the

potential risks to terrestrial, semi-aquatic, and aquatic life were assessed for on-site ecological receptors.

- The ERA for physical stressors considered noise, the physical effect of cooling water discharges, thermal effluent, entrainment and impingement, habitat alternation and wildlife-vehicle interactions and bird strikes.

1.3 Indigenous Interests

The Bruce Power Site lies within the traditional territories of Indigenous communities. Bruce Power takes great pride in continuing and expanding our relationships with local First Nation and Métis communities. During our 20-year history, Bruce Power and Indigenous partners have collaborated successfully and continue to make progress in the areas of employment, education, training, community sponsorship, business development, and regulatory matters. The Life-Extension Program extending the facility operations to 2064 presents an opportunity to continue the growing and strengthening Bruce Power's relationship with local Indigenous communities. This section provides a summary of Bruce Power's engagement activities with Indigenous communities, including rights and interests identified, and how they are incorporated into the ERA or other licensing activities.

As part of the 2018 licence process, Bruce Power conducted a comprehensive review of publicly available literature pertaining to the Saugeen Ojibway Nation (SON), Historic Saugeen Métis Community (HSM), and the Métis Nation of Ontario (MNO) interests in relation to the Bruce site and surrounding area. In addition, a literature review of documentation providing information on socio-economic and cultural heritage elements for Ojibway and Métis peoples in Ontario was also completed. This information was shared and discussed with each of the three communities, forming the basis of engagement for the licence renewal process. Significant feedback was received and has been incorporated throughout this ERA. This comprehensive review allowed for a better understanding of historical interests, collated concerns that have been raised, and demonstrated where items of concern have been addressed.

Bruce Power is committed to ongoing engagement, consultation and communication with the SON, HSM and MNO in accordance with Bruce Power's Indigenous Relations Policy, Protocol, and Relationship Agreements with the communities and regulatory requirements. These agreements function as a framework for continued collaboration, under which information sharing and meaningful engagement can occur on regulatory matters supported by annual funding as well as joint efforts and discussions on addressing other share priorities. Through ongoing engagement, open communication and other activities Bruce Power continues to [R-18]:

- Work to build and maintain a positive, long term relationship with local Indigenous communities that are based on mutual understanding, respect and open and honest communication.

- Develop strategies in several key areas including employment, business development, education, training and community sponsorship that appropriately reflect the interests of Indigenous peoples.
- Enter into appropriate "Relationship/Protocol Agreements" with local Indigenous communities who wish to be informed and involved with the key areas of our business.
- Conduct timely and meaningful consultation with Indigenous communities whose Treaty or Indigenous rights may be directly affected by elements of our operations.
- Enhance our employees' and suppliers' understanding of Indigenous history and culture and the role Indigenous communities play in Canada and in our communities.
- Identify opportunities to increase our knowledge of the local environment and ways we can work together with Indigenous communities to preserve or enhance that environment for all to enjoy.

In addition to Bruce Power's Indigenous Relations Policy, Bruce Power also follows the engagement guidance provided in REGDOC-3.2.2 [R-19] under the Nuclear Safety and Control Act. This regulatory document provides requirements and guidance on Indigenous engagement for licence renewal applications. Through this, the Crown's commitment to consult can be upheld through information sharing, relationship building and promoting reconciliation [R-19].

1.3.1 Relationship/Protocol Agreements

Since 2012, Bruce Power has had Relationship/Protocol Agreements in place with SON, MNO and HSM, which ensure that they have full and meaningful participation in Site related projects such as environmental assessments, Licence Renewals and other regulatory processes. These agreements provide a framework for engagement and consultation as well as the necessary mechanism by which to discuss and provide capacity support. These agreements remain confidential between Bruce Power and the respective community and provide a foundation for ongoing collaboration.

1.3.2 Community Rights and Interests

1.3.2.1 Saugeen Ojibway Nation

At the 2018 CNSC Licence Renewal Hearing for Bruce Power, and in other documentation as cited, SON describe themselves and their traditional territory as follows: :

SON is comprised of the Chippewas of Nawash Unceded First Nation and the Chippewas of Saugeen First Nation. The SON people are among the Anishinaabek people of the Great Lakes region. They are the Indigenous peoples of the Anishinaabe-aki or Anishinaabekiing, or what is now known as the Bruce And Grey region. These are the treaty lands of SON and the source of their rights and identity as a People, and the basis of their cultural, spiritual, and economic survival [R-20].

The lands that comprise the SON Territory extend east from Lake Huron to the Nottawasaga River and south from the northern tip of the Saugeen Peninsula (also known as the Bruce Peninsula) to the Maitland River system, eleven miles south of Goderich. The waters that comprise the SON Territory are the waters surrounding these lands and include the lakebed of Lake Huron from the shore to the international boundary with the United States and the lakebed of Georgian Bay to halfway across the Bay. The SON communities occupy large, unceded communal lands (reserves) bordering Lake Huron and Georgian Bay. SON also has exclusive use of a large hunting reserve in the northern part of the Saugeen Peninsula [R-20].

SON describe their asserted and established Aboriginal and treaty rights as follows: .

- *The right to continue to be a distinct people living within their Traditional Territory;*
- *The right to maintain their culture, language and way of life;*
- *The right to be sustained by the lands, waters and resources of their Traditional Territory;*
- *The right to the exclusive use and occupation of their communal lands;*
- *The right to continued use of all of their Traditional Territory;*
- *The right to harvest for sustenance, cultural and livelihood purposes;*
- *The right to be meaningfully involved in decisions that will affect their Traditional Territory so that they can protect their way of life for many generations to come and;*
- *The right to be the stewards of their Traditional Territory.*

SON has a proven and exclusive Aboriginal and Treaty Right to a commercial fishery in the waters of Georgian Bay and Lake Huron, within SON Territory, including the waters adjacent to Bruce Nuclear site. Members of SON and their ancestors have been fishing these waters for sustenance and as the basis of trade and commerce for many hundreds of generations, and they continue to do so today [R-21].

1.3.2.2 Métis Nation of Ontario

MNO described themselves as follows at the 2015 Licence Renewal Hearing for Bruce Power:

The MNO was formed in 1993 as a representative organization with the objective to protect, assert and support the distinct culture, traditions, economic well-being, and Métis constitutional rights embodied in the Constitution Act, 1982, section 35, within the Métis Homelands of Ontario. It has 29 Community councils across the province. Three of these councils (Moon River Métis Council, Georgian Bay Métis Council, and the Great Lakes Métis Council) represent the regional rights-bearing Métis community defined as the Georgian Bay Traditional Harvesting Territory which includes the area surrounding the Bruce site [R-22].

The MNO and their Regional Consultation Committee assert that their people exercise Aboriginal rights throughout the territory surrounding the Bruce site, including, among other things, hunting, fishing (food and commercial), trapping (food and commercial), gathering, sugaring, wood harvesting, use of sacred and communal sites (i.e., incidental cabins, family group assembly locations etc.) and use of water [R-22].

1.3.2.3 Historic Saugeen Métis

The HSM described themselves as follows at the 2018 Licence Renewal Hearing for Bruce Power:

The local Historic Saugeen Métis (HSM) consists of the politically independent historic Métis, beginning with trader Pierre Piché in 1818, whom have resided along the Lake Huron proper shoreline from the islands at the tip of the Bruce Peninsula to the Ausable River in the vicinity of Port Franks, Ontario.

Upon Piche's arrival in the traditional Saugeen territory in 1818 the Ojibwe Piché "dish with one spoon" bead wampum exchange took place inviting the Piché Métis trading family into the traditional Saugeen territory.

About the same time Piché was joined by other similar Métis trading families comprised of third and fourth generation members of existing Great Lakes trading networks. Also arriving were trading families from the Northwest who after the NWC/HBC merger in 1821 entered Lake Huron either as HBC employees or former NWC traders trading on their own account.

From these distinct groups emerged a distinctive Métis community rooted along the shoreline of eastern Lake Huron. For almost three decades prior to settlement of the Saugeen territory, the Historic Saugeen Métis traded in a south-north axis along the shoreline from above Sarnia to Lake Huron's North Shore.

Present-day Historic Saugeen Métis community members are descendants of the historic Métis who have lived in, cared for and relied on the shared traditional Saugeen territory since the time of Piché. Some Historic Saugeen Métis Council (2015) and community members descend from the Piché Wampum carrier, Marguerite Lange Gonneville, and other Métis families of that era.

The HSM are concerned with ensuring the safe operation of the Bruce nuclear site and minimizing any impacts on the waters and lands that support their asserted Aboriginal rights. The HSM continue their subsistence fisheries and land-based harvesting practices and assert Aboriginal rights over the lands and waters surrounding the Bruce nuclear site. The HSM indicate that these lands and waters "provide vital support for our Métis culture and way of life, as well as the economy, health and social relationships in the HSM community and it is their obligation to ensure a sustainable environment for current and future Métis Families claiming s. 35 Aboriginal rights in the traditional Métis Saugeen Territory. The HSM indicate that they rely on the lands that include the Bruce site and surround area to harvest deer and other mammals, water and land fowl, and plants. According to the HSM, many community members reside within a few kilometres of site or in Southampton (35 km away from the site) *and HSM ancestors are buried within a very short distance of the site. The HSM acknowledges that Bruce "continues to provide countless opportunities for employment, high-skilled jobs for local Métis" and that "nuclear generation is the safest, cleanest, most reliable source of energy available"* [R-23].

1.3.3 Concerns Raised

Bruce Power continues to engage with SON, MNO and HSM and make progress on all commitments made at the 2018 licence renewal. Regular meetings are held with the SON, MNO, and HSM to discuss key concerns, regulatory items, and other items of interest.. This continued dialogue results in improved understanding and opportunities for feedback and collaboration. This allows Bruce Power to incorporate any feedback and modify planned work as needed and provides opportunities for collaboration. Over the last 5 years, topics of focus have included thermal effluent, fish impingement and entrainment (I&E), environmental monitoring and assessment, I&E and thermal mitigation measures, and dietary surveys.

Bruce Power continues to seek further understanding on traditional land use, way of life and traditional knowledge via dialogue and publicly available information. This section outlines some of the issues and interests that have been discussed. Bruce Power remains committed to open and transparent dialogue with SON, MNO and HSM and look forward to continuing to grow and strengthen the relationship, as well as furthering our understanding of their way of life and rights.

1.3.3.1 Saugeen Ojibway Nation

Indigenous traditional land use is an important part of SON's way of life. This includes the use of lands for harvesting fish, wildlife and terrestrial plant species for foods, spiritual purposes, medicines, arts and crafts. SON describes its traditional territory as the waters and fisheries that surround their traditional lands. They also stated during the 2015 Commission Public Hearing Oral Presentation in relation to the "Bruce Power Inc. Application to renew the Power Reactor Operating Licence for the Bruce A and B Nuclear Generating Stations" that [R-21]:

"The relationship with traditional lands, waters and resources is profound, ongoing and an essential part of their identity and culture as well as the economy of our people that sustains us to this day"

SON have emphasized that their specific relationship to the fisheries of Lake Huron and Georgian Bay is of vital importance to their cultural and economic health as First Nations. Historically, Lake Whitefish have been one of Lake Huron's most commercially valuable fish and they continue to be important to First Nations and other fisheries around Lake Huron. Additionally, SON has expressed the following interests related to the Bruce Power site:

- The potential health and safety implications for the natural environment, specifically the health of plants and animals;
- Potential effects on animal species, migratory patterns, and the threat of species extinction;

- Lake Huron water quality and level of contaminants in fish;
- Effects on the food chain and on all parts of the environment;
- Effects of future lake water levels and climate change; and,
- The effects on future generations of Indigenous people because of the potential for damage to traditional lands and their way of life [R-20].

1.3.3.2 Métis Nation of Ontario

Indigenous traditional land use is an important part of the MNO's way of life. This includes the use of lands for harvesting fish, wildlife and terrestrial plant species for foods, spiritual purposes, medicines, arts and crafts.

The MNO defines harvesting as *"the taking, catching or gathering for reasonable personal use in Ontario of renewable resources by MNO citizens. Such harvesting includes plants, fish, wildlife and firewood, taken for heating, food, and medicinal, social or ceremonial purposes and includes donations, gifts and exchange with Indigenous persons. For greater certainty such Métis harvesting is for reasonable personal use only and does not include harvesting for commercial purposes"* [R-24].

Additionally, the MNO have expressed the following interests related to the Bruce Power site:

- Impacts on Métis rights and interests including hunting, trapping, harvesting and other traditional practices;
- DFO Authorization Process;
- Impacts of operations on white tailed deer and muskrat;
- Facility safety;
- The adequacy of previous studies for the Bruce A Refurbishment in assessing impacts on Métis fishing, hunting and trapping activities as valued ecosystem components;
- Impacts to fish species and/or fish habitat from changes in water flow and circulation and increased lake temperature, including impacts to Yellow Perch and Smallmouth Bass;
- Potential radiological contamination of fish, wild food, and medicinal terrestrial plants consumed by and/or sacred to the Métis; and
- The need for radiation testing or monitoring of Métis people as a distinct group, given their regular consumption of wild foods, animals and fish.

1.3.3.3 Historic Saugeen Métis

Traditional land uses and way of life is an important part of HSM culture and history.

"The most fundamental right Métis have is to their identity as Aboriginal people and their continuing use of the land – whether it be for hunting, fishing, trapping, gathering food and medicines or for any of their traditional pursuits" [R-23].

Additionally, the HSM have expressed the following interests related to the Bruce Power site:

- The need to ensure the safe transportation, storage, and processing of nuclear waste with minimal impact on the water and lands that support the HSM's asserted Aboriginal rights;
- The potential impacts on water, fish, and associated harvesting activities from malfunctions, accidents or malevolent acts at the nuclear waste management site;
- Ability to continue traditional harvesting practices, rights and interests;
- A clear, timely and effective process for communication, exchange of key information, and meaningful input and consultation during the licence period;
- The need to involve the HSM in monitoring and other decisions relating to the management of nuclear waste facilities on the Bruce site, including environmental management programs and mitigation measures;
- Employment, training and economic opportunities; and
- Cumulative effects on harvesting activities.

1.3.4 Commitments to Indigenous Communities

Bruce Power and Indigenous Communities routinely engage on at least a quarterly basis and during these meetings key environmental and regulatory items and issues are discussed. If environmental and regulatory items require more technical discussions then Bruce Power and Indigenous Communities meet outside of routine meetings.

1.3.4.1 ECA Thermal Flexibility Communication

Lake Huron hydrodynamics have been monitored year round in the vicinity of the Bruce Power Site since pre-operational studies in the 1970s, through post operational studies and several Environmental Assessments. These years of studies have confirmed that thermal effluent results in low to no risk to the natural environment. The Ministry of Environment, Conservation and Parks (MECP) has provided Bruce Power with a temporary amendment through 2023 to the Bruce A Environmental Compliance Approval (ECA) (See Appendix I, Section 9.2). This allows operational flexibility with respect to effluent temperatures in the summer months. Bruce Power is committed to routine communication with SON, MNO and HSM with respect to this flexibility which includes updates on the execution of the thermal monitoring, email notification if the flexibility is invoked and sharing of daily average intake and discharge temperatures on a monthly basis during the ECA window (July, August and September). This information has been shared as per these conditions.

1.3.4.2 Impingement and Entrainment Monitoring Plan

Fish presence and abundance has been monitored throughout the year in the vicinity of the Bruce Power Site since pre-operational studies in the 1970s, through post operational studies and several Environmental Assessments. These years of studies have confirmed that Operations result in low to no population level risk to fish. Bruce Power is required to complete impingement and entrainment monitoring as part of the conditions of the Fisheries Act Authorization [R-25]. An entrainment monitoring pilot project is planned for the spring of 2023 and is needed to determine entrainment monitoring methodology. A final Impingement and Entrainment Monitoring Plan is to be provided to DFO for review and approval by March 31st, 2024. Indigenous communities will be engaged during the finalization of the plan. The finalized and approved entrainment monitoring will, at a minimum, be undertaken over a 12-month period in 2025 at Bruce A and Bruce B and will include entrainment monitoring a minimum of twice per week. Bruce Power will review the fish density results of the entrainment monitoring and complete a statistical analysis by October 31st, 2025 to determine if there is a significant difference from the 2013 and 2014 entrainment results. Should the 2025 entrainment monitoring show significantly higher fish densities than the data in 2013 or 2014, an additional year of entrainment monitoring will take place in 2026. The entrainment monitoring results will be reported to DFO by June 1st, 2026, and 2027 if applicable. The entrainment results will be reviewed with DFO to determine which dataset is most appropriate to use to estimate entrainment losses and the actual annual and cumulative entrainment losses at Bruce Power from 2019-2028 will be adjusted accordingly.

1.3.4.3 Identification of Potential Fisheries Offset Measures

As part of the conditions with Bruce Power's Fisheries Act Authorization [R-25] section 4.2.3 states:

- 4.2 Scale and description of offsetting measures: offsetting measures shall be carried out in accordance with the measures set out in the Proponent's offsetting plan in the Bruce Power Application and subsequent discussions that occurred with DFO and Indigenous communities and nations including:
- 4.2.3 Bruce Power shall engage with each Indigenous nation and community to develop an offsetting plan focused on fish and fish habitat in Lake Huron watershed. A minimum of three cost-effective offsetting plans shall be developed and submitted to DFO for review and approval by December 31, 2023 and shall form part of the offsetting plan outlined in this authorization.

Bruce Power received its official authorization on December 17, 2019 and has been actively discussing offset measures with since this time.

No projects have been formally proposed to Bruce Power by the Saugeen Ojibway Nation (SON). This remains an open agenda item for discussion at our regular meetings. Bruce Power looks forward to continuing engagement with the SON to develop an offsetting project that is important to their community when one is identified.

Although a project with the Métis Nation of Ontario (MNO) has not yet been formalized, discussions and an in-person meeting occurred in 2021 in order to define an offsetting project to take place on Bothwell's Creek in Leith, ON. The MNO have identified this as important fishing ground and have expressed desire to maintain/improve its fishery. At this time, Bruce Power and the MNO are working with Trout Unlimited Canada to define a project scope and it is hoped that an offsetting project plan can be shared with the DFO in 2022.

Bruce Power and the Historic Saugeen Métis (HSM) have developed an offsetting project to remove invasive *Phragmites australis* from the Fishing Islands. This project plan was approved by DFO in 2021 and an amended *Fisheries Act* Authorization was issued to Bruce Power. As per the Authorization, an annual report documenting the work completed in 2021 was prepared by Bruce Power and the HSM and was submitted to DFO in March 2022 [R-26].

1.3.4.4 Climate Change

Bruce Power is engaging with SON, MNO and HSM to support climate change research that is relevant to each community. A general overview of this research is provided here, with community-specific results provided in Sections 1.3.4.5, 1.3.4.6 and 1.3.4.7. In 2018, Bruce Power announced its intent to carry out a Climate Change study in partnership with the Council of the Great Lakes Region (CGLR) from 2019-2021. The study provided insight into the following issues:

- The state of climate change science in the Great Lakes Region;
- The impact of a changing climate on various ecosystems and sectors in the Great Lakes, including the region's aquatic environment, fisheries and Bruce Power's operations;
- The knowledge and decision-making systems companies and communities need to better manage changing risks as a result of climate change; and
- The role that Bruce Power and other sectors might play in tackling climate change on a local and regional level, and how companies can adjust their corporate sustainability strategies to limit their impact.

In the fall of 2018, Bruce Power and CGLR hosted two workshops one within Kincardine and one in Toronto to solicit feedback and start to gather baseline knowledge of what were main areas of concern for the communities, as well as what was already bring done to ensure that resources were being used efficiently. Following this workshop, a literature review was completed in collaboration with researchers from the University of Toronto verifying existing bodies of knowledge Bruce Power was using as well as expanding other area on a regional level. Following this review the areas of focus were narrowed down to impacts of Climate Change related to land based issues for Indigenous Communities, Agriculture and Municipalities. In the fall of 2019, the study saw the departure of the University of Toronto team and the entrance of the Climate Risk Institute (CRI) to carry out the next phase of this work, which included assessing climate change impacts, risks, and opportunities with respect to three Areas of Focus (Coniferous and Mixed Forests; Great Lakes; and Alvars and Cliffs) in the countries of Grey, Bruce And Huron. Work in each Area of Focus involved:

- Developing a climate change risk registry;
- Establishing focus, scope and approach for risk and opportunity assessments;
- Conducting Area of Focus assessments; and
- Producing Area of Focus and basin-wide climate change risk and opportunity information products.

A draft risk assessment summary, titled “Climate Risk Assessment for Indigenous Communities in Grey, Bruce And Huron Counties” was completed by CRI and distributed to the SON, MNO and HSM communities in Q4 of 2021 for their review. Follow up engagement sessions were then held virtually with each of the communities to gather insight on social, cultural, and economic consequences associated with each risk scenario for the Coniferous and Mixed Forests; Great Lakes; and Alvars and Cliffs habitats. Insights from the engagement sessions were then integrated into the final information products by CRI, which include:

- A Risk Registry Summary Report titled “Climate Change Risk Assessment for Indigenous Communities in Grey, Bruce And Huron Counties - Habitat Climate Change Risk Assessment Summary” [R-27].
- A Climate Change Risk Assessment Scenario Narrative Report for each of the communities – SON, MNO, and HSM [R-28]–[R-30].
- An online Story Map outlining climate trends, impacts and opportunities for each of the habitats within traditional lands and territories for each of the communities [R-31]–[R-33].

CGLR, CRI and Bruce Power held virtual engagement sessions in February 2022 with SON, MNO and HSM to present on the final reports and story maps, and to gather feedback from the communities on how they would like to use the information products going forward, so that additional support can be provided accordingly.

The climate change impacts to habitat in Bruce, Grey and Huron Country that will impact the traditional practices of Indigenous Communities are listed in Table 1 [R-27]. The implications of these changes for each Community are described in Sections 1.3.4.5, 1.3.4.6 and 1.3.4.7 below.

Table 1 Habitat Risk Assessment Summary [R-27]

Assessment	Habitat Component	Climate Driver	Risk: Current (1981-2010)	Risk: Future (2050 at RCP 8.5)
Coniferous and Mixed Forests	Deciduous trees	Increasing air temperatures (summer/annual)	Low	Moderate
		Increasing air temperature (winter)	High	High
		Moisture deficit and drought conditions	Low	High
	Coniferous trees	Increasing air temperatures (summer/annual)	High	Very High
		Increasing air temperature (winter)	High	Very High
		Moisture deficit and drought conditions	Low	High
	All trees species	Extreme wind events	High	Very High
		Wildfire	High	Very High
Great Lakes Aquatic Habitats	Cold-water fish species	Increasing water temperature	Low	Very High
	Cool-water fish species	Increasing water temperature	Low	Moderate
	Warm-water fish species	Increasing water temperature	Low	Low
	Native fish species	Extreme high water levels	Moderate	High
		Extreme low water levels	Low	High
		Declining ice cover and duration	Moderate	High
		Drought conditions	Very Low	Moderate
		Increase in extreme precipitation events	Moderate	High
Alvars and Cliffs	Lichens	Drought conditions	Unknown	Unknown
		Increasing annual temperature	Moderate	Very High
	Vascular Plants	Wildfire	High	High
		Increasing annual temperature	High	Very High
		Drought conditions	Unknown	Unknown
	Non vascular plants	Extreme heat	High	Very high
		Moisture deficit	Unknown	Unknown

1.3.4.5 Saugeen Ojibway Nation

As part of the 2018 licence renewal hearings, several ERA-related commitments were made to SON. These commitments included:

- A joint environmental monitoring and stewardship program
- An alternative mitigation measures assessment

Although not directly related to the ERA, results from additional commitments made during licence renewal are presented in this ERA:

- Preparation of an updated thermal monitoring plan and an updated impingement and entrainment monitoring plan
- Identification of potential fisheries offset measures
- Assessment of the potential impact of climate change in the Great Lakes region

Progress on Commitments

Bruce Power continues to regularly engage SON on items of interest and has taken several steps since 2018 to support the further monitoring and assessment of these issues, including funding the SON Coastal Waters Monitoring Program, expanding thermal monitoring, conducting dietary surveys, funding a climate change study, and assessing alternative mitigation measures for thermal and I&E.

Coastal Waters Environmental Monitoring Program

In the fall of 2018, Bruce Power and SON started more detailed discussions and planning related to an environmental monitoring and stewardship program, now called the Coastal Waters Environmental Monitoring Program (CWMP). This program was jointly developed between Bruce Power and SON and aims to enhance the existing body of knowledge being compiled through Bruce Power's routine Environmental Monitoring. The program has extensive focus on the nearshore areas of Lake Huron as these are immensely important for sustaining life for both human and non-human beings. Most fish species in Lake Huron use nearshore areas for at least one part of their life history for feeding, rearing or nursery needs. The program also aims to build a comprehensive inventory of data (i.e., fish, vegetation, water quality and temperature) for use in consultation and SON decision making and processes regarding new and ongoing projects. The program itself extends beyond the existing monitoring boundary of Bruce Power's site.

The CWMP methodology was finalized in March of 2019 and the first field season started in May of 2019. Although some of the scope had to be modified for 2020 due to Covid-19 the 2020 field season was also able to be carried out. A third field season was completed in 2021. This program is run by three community members of SON through the Environment Office, the results are shared annually with Bruce Power and are incorporated into the

Environmental Risk Assessment, as well as other Environmental Monitoring Processes, including the Fisheries Act Authorization. Bruce Power was the founding funder of this program; however, is open to and encourages the participation of other proponents as deemed appropriate by SON. The continuation and possible expansion of this program will improve baseline understanding of Lake Huron and Georgian Bay, including knowledge of the existing fish community, water temperature, water quality, wetland habitat and SON ecological knowledge. This will enhance SON knowledge of the current conditions and health of coastal habitats and wildlife (especially fish) across the Territory and will allow differences between sites and over time, including climate-related changes, to be monitored [R-34]. This improved understanding of the aquatic environment will benefit all users. Bruce Power remains committed to the continuation of this program.

Information shared with Bruce Power from the CWMP program has been integrated throughout the 2022 ERA. Monitoring of nearshore fish communities has been integrated into the site description (Appendix A [R-35]). Thermal monitoring data has been used as part of the thermal risk assessment dataset (Appendix I [R-35]). Water quality data is incorporated into the conventional ecological risk assessment (Appendix C and E [R-35]). Incorporation of the CWMP monitoring data has enhanced understanding of the spatial extent of the environmental risk assessment, which has confirmed low to no risk to human and ecological receptors.

An alternative mitigation measures assessment

As part of the renewed Power Reactor Operating Licence, Section 9.1 of the Licence Condition Handbook [R-36] outlines the requirement for the Assessment of Feasible Mitigation Measures (AFMM). Bruce Power was required to conduct and submit an AFMM for thermal effluent and impingement and entrainment (I&E) by December 31, 2019. This date was extended to March 31, 2020 based on mutual agreement between SON, CNSC and Bruce Power to allow adequate inclusion of Indigenous Values into the assessment [R-37].

The AFMM provides information on potential mitigation measures with the overall objectives of this report being to:

- Provide background information on existing mitigation technologies implemented for the Bruce Site;
- Provide an overview of available impingement and entrainment and thermal mitigation technologies;
- Evaluate the feasibility of mitigation measures for impingement and entrainment and thermal mitigation technologies for the Bruce Site; and,
- Engage with Indigenous Communities throughout and consider Indigenous Values in the overall qualitative evaluation process.

Through 2019, SON and Bruce Power had twenty meetings to discuss and ensure SON's values and the concerns, expressed over a number of years of consultation, were reflected in this analysis. Bruce Power and SON hosted two community workshops as well as invited participation in diet and mitigation surveys which 36 community members participated in [R-38][R-39].

The SON Environment Office engaged in more focused discussions with Community Members, including specific groups of Community Members (e.g., commercial fishers) to understand the specific questions, concerns, and knowledge that SON Members have regarding Bruce Power. Bruce Power submitted its AFMM analysis on March 31, 2020. Three feasible mitigation measures were identified for potential implementation if the risks related to I & E and thermal effluent increased. These included the use of variable speed drives to modify the withdrawal of cooling water, a chain rope barrier at the Bruce A velocity cap and acoustic and/or light deterrents at Bruce A and B [R-40].

SON has communicated four questions related to the AFMM to the CNSC, including a request to understand knowledge gaps related to applicability of the three identified feasible mitigation measures [R-41]. These questions include a request for further understanding of:

1. Knowledge gaps, risks and benefits and anticipated reduction in I & E and thermal discharge for each measure.

2. CNSC triggers to require Bruce Power to implement the feasible mitigation measures.

3. Operational or safety barriers to implementation of the feasible mitigation measures.

4. Opportunities for Bruce Power to implement the feasible mitigation measures.

In response to these questions and in response to CNSC comments received on the AFMM report [R-41], updates to the risk assessment for I & E and thermal effluent in Sections 6.3 and 6.4 include an assessment of the need for mitigation measures and an update on any progress to mitigation measure implementation, if applicable.

Assessment of the potential impact of climate change in the Great Lakes region

The Climate Risk Institute prepared a climate change risk scenario narrative [R-28] was prepared for SON and the information was presented as an online story map [R-31] for communication to community members.

Coniferous and Mixed Forests

Forest habitat and the products it provides are culturally and economically significant for members of SON. Forests provide opportunities for hunting (deer and birds), mushroom foraging, and harvesting of tree products including cedar bark for cultural rituals, ash branches for basket weaving, maple syrup, birch bark for art and medicinal uses and coniferous tree branches for wreath and garland making in the wintertime. The spread of invasive species such as emerald ash borer is one of the growing concerns due to its impacts on traditionally harvested ash branches. Increasing temperature and drought conditions impacting coniferous trees have implications for traditional harvest of cedar, spruce and fir branches as well as for maple syrup production that is dependent on sub-zero temperatures in the spring shoulder season. Increased wind speeds and the number of tornadoes and windstorms resulting in tree damage could limit access to forest for traditional activities [R-28].

The impacts of climate change on forest connectivity are an important issue for SON, both from the aboriginal and treaty rights perspective as well as due to impacts it has on culturally and economically significant species such as black bear and deer. The impact of Lyme disease has raised health concerns due to continued tick range expansion in SON's traditional territory and impacted the usage of forest and therefore cultural and economic activities [R-28].

Great Lakes

Saugeen Ojibway Nation operates one of the largest Indigenous commercial fisheries in the Great Lakes Basin, on the waters of Lake Huron and Georgian Bay. The fishery and the fish species (such as Lake Whitefish) are an integral part of their way of life, economy, culture and overall well-being. There are numerous stressors (such as invasive species, contaminants, and shoreline development) on the health of the Territory's aquatic habitats and associated species, which will be exacerbated by climate change. Changes in climate will result in individual and cumulative impacts on natural habitats, presenting risks to the community including limitations on traditional activities and practices (hunting, fishing, foraging), health risks associated with changes to water quality, source water protection, shoreline erosion and damages, and economic losses from impacted livelihoods due to declines in fish harvest [R-28].

Alvars and Cliffs

Many of the alvars on the Bruce Peninsula are located within or near areas of cultural significance of the people of the Saugeen Ojibway Nation, whose traditional territory includes the entire Bruce Peninsula, and much of southwestern Ontario from Goderich to Collingwood, as well as the adjacent waters and lakebed of Lake Huron and Georgian Bay. SON maintains an interest in protecting alvar habitats from a general stewardship perspective. Due the globally imperiled nature of the many rare alvar species, there is cultural and social interest in protecting and preserving the habitat for future generations. Members of SON also utilize the area for recreational and social activities such as hiking, which is another important reason for their protection. Tourism was highlighted as a cause for concern due to the degradation and overburdening of infrastructure that can occur when there are large numbers of visitors [R-28].

A major threat faced by alvars as a result of increasing temperatures is the loss of key lichen and vascular species and the habitat fragmentation that follows. Due to SON's vested interest in preserving the habitat and the unique species, this hazard presents a barrier to their social and cultural stewardship role. For instance, Pennyroyal and Calamint were identified as species of interest due to the cultural and traditional values they represent for SON members. These species are part of the tradition of establishing and maintaining a connection with the land and the bounties it provides. The loss of these species as a result of increasing temperatures will have consequences on these community practices that have been occurring for generations [R-28].

1.3.4.6 Métis Nation of Ontario

As part of the 2018 licence renewal hearings, several ERA-related commitments were made to the MNO. These commitments included:

- An MNO monitoring program to ensure that MNO Valued Components (VCs) are being monitored and assessed
- An MNO-specific diet survey to assess site impacts on citizen's health
- An MNO Emergency and Communication Plan

Although not directly related to the ERA, results from additional commitments made during licence renewal are presented in this ERA:

- Preparation of an updated thermal monitoring plan and an updated impingement and entrainment monitoring plan
- Identification of potential fisheries offset measures
- Assessment of the potential impact of climate change in the Great Lakes region

Progress on Commitments

Bruce Power continues to regularly engage MNO on items of interest and has taken several steps since 2018 to support the further monitoring and assessment of these issues, including developing and executing a diet survey, funding a climate change study, and assessing alternative mitigation measures for thermal and I&E.

Prior to license renewal in 2018, Bruce Power and MNO agreed to co-develop the following:

1. **MNO Monitoring Program:** Bruce Power and the MNO agreed to expand upon Bruce Power's current monitoring programs to ensure that MNO identified VCs are being appropriately monitored, assessed, and incorporated into future ERAs.
2. **MNO-Specific Diet Survey:** Bruce Power and the MNO agreed to co-design a diet survey to further assess any impacts of the Project on MNO Citizens' health.
3. **MNO Emergency Communications and Management Plan:** Bruce Power and MNO agreed to develop a notification protocol for emergency communications [R-42].

Bruce Power and the MNO discussed a number of proposed preliminary tasks to implement these recommendations and agreed to the preliminary plan set out in the MNO's CNSC Submission (CMD 18-H4.57 [R-24]), as set out below.

In August of 2019, Bruce Power received an updated version of the VC Monitoring in a report entitled *Métis Nation of Ontario, Region 7 Valued Components Monitoring Report 2019*

Results Update [R-43]. As in the 2017 Report [R-42] the Métis specific Valued Components remain:

- Métis Lands, Resources and Water; and
- Métis Nationhood

These VC Components were broken down into indicators. Following the receipt of this report, Bruce Power, OPG, MNO and CNSC held a meeting in October of 2019 to go through the results and create a plan on how to address the VC Components and indicators. In June of 2020, the decision by OPG to not move the DGR forward came, and a recalibration of recommendations related to the VC Monitoring was required as the survey heavily focused on the DGR, and less on the operation of the Bruce Power site.

As part of the Environmental Monitoring commitment, Bruce Power and MNO focused on the creation and delivery of the Diet Survey (explained in more detail below). In February of 2021 Bruce Power, MNO and CNSC were able to collectively meet and go through the recommendations made in the 2019 Report and the disposition of the environment-related recommendations is described in Table 2 [R-44]. Bruce Power remains committed to discussing enhanced Environmental Monitoring with MNO as they deem necessary. At this time, Bruce Power understands that additional actions are not required under the area of Environmental Monitoring beyond what is currently being achieved via the diet survey and the inclusion of MNO VC species within the ERA analysis. MNO continues to promote a consolidated use of resources and avoidance of duplication when it comes to Environmental Monitoring of the Bruce Power site.

Table 2 Response to Environment-Related Recommendations from 2019 Valued Components Report [R-43]

Recommendation	Details	Bruce Power Response
Additional Monitoring	OPG and Bruce Power should work with the MNO to identify specific causes for reduction in use to rule out project related factors Additional monitoring is required for all identified indicators to ensure trends are correct	Bruce Power is willing to review the list of indicators gathered from the survey participants and review in conjunction with the existing elements being monitored. Over the course of 2019 Bruce Power and the MNO worked on the refinement of a Diet Survey, which focused on the lifestyle of MNO Region 7 citizens. The Diet Survey was completed by MNO Region 7 citizens in 2021, results compiled and shared back with MNO in 2021. Results were used to further refine the hunter/fish scenario in the environmental risk assessment, initiated at the request of MNO during licence renewal discussions.
Métis citizens knowledge transfer	OPG and Bruce Power should invest in MNO capacity to support MNO in encouraging Métis citizen's knowledge transfer activities, including providing assurance for a safe and sustainable environment for Métis Citizens to continue knowledge transfer activities.	Bruce Power is willing to further discuss this recommendation, gain more details around what this may involve and if that can be achieved within the existing capacity and support it is currently providing via the relationship agreement.

Work leading up to the 2021 response began prior to the 2018 Licence Renewal. In the April 2018 meeting, the MNP firm proposed potential activities and timelines to Bruce Power and MNO to consider for achieving the three commitments. These items and updates are provided below in charts specific to each commitment (Table 3) [R-44].

Table 3 Co-Development of the MNO Monitoring Program

MNO AMP tasks	Desired Outcome	Activity	Timeline
Understand existing CNSC IEMP, Bruce Power Environmental Monitoring Program	Avoid overlapping monitoring activities and define where gaps exist between MNO areas of interest and current monitoring programs	• Defined current state of proponent and regulator monitoring • A working session held between CNSC, BP and MNO	Fall to winter 2018
Review and evaluate MNO VCs and areas of concern to focus the MNO AMP	Ensure all identified impacts to MNO VCs and areas of interest have a corresponding monitoring plan to continue to understand the project effects	• MNO completed a workshop with MNO Harvesters to refine key areas for consideration	Fall to winter 2018
Create an implementation plan for monitoring/oversight of areas of interests (as identified above)	Ensuring a robust monitoring program is followed to understand effects to MNO VCs and areas of interest	• Annual VC Citizen survey completed in 2017 and 2019to support aspects of MNO VCs • Identified that training and capacity needs for MNO to implement new biophysical monitoring or participate in existing monitoring was not required at this time	2019-2021
Develop/identify program to train environmental monitors or create oversight role for MNO	Provide confidence to MNO Citizens that the monitoring results are accurate and/or have MNO oversight	• MNO was to identify hiring need • Bruce Power was to provide required training and/or capacity for training • MNO and Bruce Power agreed that this is not required at this time	2019-2021
Identify adaptive management measures should predictions and mitigation measures prove to be incorrect or unanticipated effects occur	Ensure the MNO AMP is a living and robust program which provides efficient response to emergent situations	• Bruce Power hosted regular/annual follow up meetings with MNO representatives • Bruce Power and MNO discussed options for emergent situations (e.g. education sessions/tours in response to perception issues)	Continuous – Regular meetings from 2019 to 2021.

An MNO-specific diet survey to assess site impacts on citizen's health

In the 2017 ERA and recent annual dose calculations, a "Hunter/Fisherman" receptor was considered in order to represent Indigenous populations that may consume greater quantities of local fish and wild game. However, since specific surveys had not been performed, intake rates were based on results of the First Nations Food, Nutrition, and Environmental Study (FNFES) [R-45] for Indigenous groups in Ontario, and the fraction of locally obtained food was conservatively assumed to be equal to the highest value of the other groups considered in the 2016 Site Specific Survey (the Subsistence Farm Resident) [R-46]. During the 2018 Licence Hearing Process, the following activities were proposed by the MNP firm to Bruce Power and MNO to ensure that the Diet Survey commitment would be achieved, shown in Table 4.

Table 4 MNO Specific Diet Survey

MNO AMP tasks	Desired Outcome	Activity	Timeline
Co-designing MNO-specific survey/study to understand any Project impacts on MNO Citizens' health	To ensure that a MNO-specific survey contains appropriate plant and animal species as well as accounts for unique Métis attributes (e.g. parts of animals consumed, preparation of traditional foods/medicines, etc. seasons)	• Bruce Power to host working sessions with MNO representatives to revise existing Bruce Power human health/diet survey • The MNO to draft survey, Bruce Power to review and provide feedback • Bruce Power to provide training/software for the MNO to conduct survey and analyze data	Fall to winter 2018 – Complete co-design occurred over 2019 and was delivered virtually during 2020. Originally intended to be delivered in April of 2020; however, delays occurred due to Covid-19 and eventually a date in November was picked by MNO. The survey remained open online until February 2021.
Complete MNO-specific data gathering	Ensure appropriate selection of participants and delivery of survey in a manner appropriate to the MNO	• The MNO to identify participants and outreach protocol • The MNO to conduct in-person surveys or outreach to MNO participants to complete online surveys	Complete – MNO provided Bruce Power with an online option, a broad Councillor meeting was held on Nov 1. 2020 and the survey went live from November 23 2020 through to February 28, 2021.
Analyze survey results	Ensure survey results are communicated as well as incorporated and assessed in the next ERA	• The MNO to analyze survey results • The MNO to provide results to BP • The MNO to present results to Citizens • Bruce Power to analyze a subset of the survey data (scope to be agreed to with the MNO) • Bruce Power to incorporate and assess MNO-specific survey results in next ERA filing	Complete - results integrated into the ERA as well as the Annual Environmental Protection Program.

In 2020, additional surveys of MNO Citizens were conducted. Based on the results of these surveys as well as additional surveys with SON and HSM, the Hunter/Fisher Resident (BHF) receptor was updated in order to refine the assumptions used in the ERA and ensure that they are representative of the relevant aspects of Indigenous lifestyles in the area. Bruce Power remains committed to revisiting the Diet Survey on a frequency agreed upon with MNO.

An MNO Emergency and Communication Plan

During the 2018 license renewal process, Bruce Power committed to developing an emergency and communication plan with the MNO as shown in Table 5. Following dialogue with the MNO, on February 12, 2020 Bruce Power provided the MNO a written emergency communication plan [R-47].

Table 5 MNO Emergency Communications and Management Plan

MNO AMP tasks	Desired Outcome	Activity	Timeline
Develop a notification protocol for emergency	To ensure that MNO representatives and Citizens receive information around any emergency or unplanned event in a timely manner	• Bruce Power and MNO to host working session to identify appropriate contacts at MNO • Bruce Power to present current process to the MNO representatives • The MNO to identify communication protocol for information distribution to MNO Citizens • The MNO and Bruce Power to identify type of information that should be provided to MNO - The MNO and Bruce Power to define what constitutes “emergency” to each party • The MNO to provide information at community meetings	At regular MNO-Bruce Power meeting. Community meeting to coincide with ongoing VC workshops – Completed February 2020.

An alternative mitigation measures assessment

MNO was invited to participate in the alternative mitigation measures assessment and this topic was discussed at meetings between Bruce Power and MNO. No additional technical meetings were requested by MNO to discuss the mitigation assessment. During the quarterly meeting in October 2019, 5 senators representing the MNO community participated in the mitigation measures survey. This input was integrated into the Assessment of Feasible Mitigation Measures (AFMM) report [R-40].

Assessment of the potential impact of climate change in the Great Lakes region

The Climate Risk Institute prepared a climate change risk scenario narrative [R-29] was prepared for MNO and the information was presented as an online story map [R-32] for communication to community members.

Coniferous and Mixed Forests

Members of Métis Nation of Ontario have traditionally used forests for food harvesting including hunting, mushroom (e.g., morels and puffballs) and fiddlehead gathering as well as berry picking. Importantly, forests also serve as gathering space where members of the community often interact and share their traditions and ways of life with younger generations. Increases in populations of certain species (e.g., white-tailed deer) present an opportunity for MNO members; however, habitat fragmentation and its impacts on wildlife and plant species is a growing concern due to changes in traditional harvests and food security implications [R-29].

Great Lakes

Members of Métis Nation of Ontario rely on Lake Huron and Georgian Bay habitats for traditional harvesting, recreational activities, and cultural practices. Members of Métis communities have observed changes in fish populations in recent years, with select fish populations (such as speckled trout) completely disappearing from their traditional harvest areas. The communities rely on fish harvests as a key food source, with the risk of food scarcity increasing if native fish species continue to decline in the area. Community members also noted their concern for future generations and the challenges with traditional harvests and other important cultural practices, as aquatic habitat conditions in the region continue to change [R-29].

Alvars and Cliffs

It was evident from discussions with representatives from Métis Nation of Ontario that ecosystem health and preservation are important to the community. MNO maintain an interest in protecting all habitats, including alvars, from a stewardship perspective and recognize the importance of preserving all habitats for future generations [R-29].

1.3.4.7 Historic Saugeen Métis

Bruce Power remains committed to ongoing engagement and collaboration with HSM on all regulatory and environmental matters. Although not directly related to the ERA, results from additional commitments made during licence renewal are presented in this ERA:

- Preparation of an updated thermal monitoring plan and an updated impingement and entrainment monitoring plan
- Identification of potential fisheries offset measures
- Assessment of the potential impact of climate change in the Great Lakes region

<u>Progress on Commitments</u>

Bruce Power continues to regularly engage HSM on items of interest and has taken several steps since 2018 to support the further monitoring and assessment of these issues, including developing a fisheries offset project, investigating local ecological restoration, funding a climate change study, and assessing alternative mitigation measures for thermal and I&E

An alternative mitigation measures assessment

The HSM was invited to participate in the alternative mitigation measures assessment and this was discussed at technical and quarterly meetings between Bruce Power and the HSM. HSM requested 4 additional technical meetings over the course of 2019 to focus on more detailed engagement related to the mitigation assessment, in addition to quarterly meetings. During these technical meetings, HSM provided Bruce Power with their values as it relates to the assessment. These values are included throughout the assessment in areas which are applicable.

Assessment of the potential impact of climate change in the Great Lakes region

The Climate Risk Institute prepared a climate change risk scenario narrative [R-30] was prepared for HSM and the information was presented as an online story map [R-33] for communication to community members.

Coniferous and Mixed Forests

Forests provide multiple hunting and harvesting opportunities to members of the HSM community, with impacts of the changing climate affecting a number of important species and traditional activities. Some of the highest sugar levels in sugar maple range have been observed on the Bruce Peninsula and maple sugar production has always been an important activity and source of revenue for members of the community. Changes in weather patterns during the shoulder seasons, particularly spring, result in reduced maple syrup/sugar harvests and lower income available for the Historic Saugeen Métis. Hot and dry conditions during the summer months result in the wilting of plants such as wild ginger and leeks, while berries and mushrooms are not producing as much as they used to. Lack of harsh winters necessary to curb the spread of invasive species (e.g., emerald ash borer) and diseases (e.g., beech bark disease) has resulted in impacts to traditional practices including the harvesting of ash branches and ash basket weaving. Increasing prevalence of parasites in deer and small game (e.g., rabbits) inhibit traditionally important organ meat consumption. Variability of winter weather has adverse impacts on hunting, with occasional extreme cold temperatures affecting animal movements and causing declines in food sources and numbers of deer, turkey and other game species. Increasing prevalence of ticks, including ones carrying Lyme disease has serious implications for hunting and human health [R-30].

Great Lakes

Lake Huron and surrounding aquatic habitats are located within the traditional harvesting territory of the Historic Saugeen Métis (HSM). The Lake Huron habitat and its associated species, support several traditional activities and practices, including hunting, trapping, fishing, harvesting and medicinal uses. Additionally, the lake plays an important spiritual role for the community. Impacts and changes to the local fishery have been observed by community Elders, noting changes to native fish populations and declining harvests. For instance,

warmer water temperatures and reduced ice cover, have raised concerns surrounding the health of native cold-water fish species, such as lake whitefish. The community has observed changes to Lake Whitefish abundance, as they are being pushed away from the shoreline into deeper waters to meet their thermal preferences and spawning needs. Other species that rely on the habitat, such as waterfowl and wild rice, both food sources for the community, have also been impacted by fluctuating water levels, declining ice cover and warming water temperatures.
Members of the community noted that existing stressors on the habitat, including invasive species, run-off pollution, contamination and shoreline development, have exacerbated climate change impacts on the habitat and ultimately, their community's well-being [R-30].

Alvars and Cliffs

Alvars and cliffs provide numerous social and cultural benefits to members of the HSM community. These habitats contain plant life that have medicinal value and are traditionally used by the community. Alvars also house ancient biomes that have been part of the community for generations making them an important habitat to conserve. There is also a spiritual element to these habitats since they are a cultural landscape that plays an important role in maintaining the memory and story of place [R-30].

Severe ice storms combined with hot and dry summers have affected rare and culturally important species, including Wallaroo fern, Creeping juniper and Barberry. The latter two species are sacred trees and important food and fibre plants that help maintain genetic diversity in the habitat. Several lichen species found on alvars are also edible and used for dyeing fabric, which is an important cultural practice for HSM community members. The Massassauga rattlesnake is an important species that makes the alvar habitat its home and is known spiritually as the protector of plant life. Alvars provide appropriate gestation sites that help maintain this species' population which makes preserving this habitat very crucial for the HSM community. Changes in winter snow and ice cover along with freeze and thaw cycles have been observed to adversely affect the species [R-30].

Seasonal cycles of flooding and drought important for alvars have seen disruptions in recent years. Alvars close to coastal areas (e.g., at St Jean's point) have been exposed to fluctuating water levels and destroyed by waves, a trend that has been amplified significantly over the last decade leading to vegetation loss and "an empty parking lot" look of the alvar. Alvar and cliff habitats are also under threat from increased visitor numbers in national and provincial parks. Climate change has increased the tourism season length with higher numbers of people travelling to the area in late fall and early winter compared to previous years causing additional stress to the habitat. Several parks are more accessible and less protected than national parks and are therefore more exposed and at risk. The upper Bruce peninsula is protected but covers only about 30% of the land while other areas remain exposed. There are areas that have been worn to a shine due to a high number of tourists and in some cases, visitors have defaced certain rocks and lifeforms by carving out symbols and messages. Tourists tend to pull off and uproot non-vascular plants such as mosses during recreational activities such as rock climbing and bouldering which has weakened the integrity of the habitat [R-30].

1.4 Organization of Report

Given the length of the ERA, background information included in the site description and in-depth methodology was moved to the Appendices [R-35]. The remainder of this report is structured consistent with most of the major headings provided in Annex A of CSA Standard N288.6-12 [R-14]:

- Section 2.0, Human Health Risk Assessment for Chemicals: Discusses the methods and assumptions used in the HHRA for chemicals, anticipated effects of MCR activities, and provides the results of the assessment.
- Section 3.0, Human Health Risk Assessment for Radiological Contaminants: Discusses the methods and assumptions used in the HHRA for radionuclides, anticipated effects of MCR activities, and provides the results of the assessment.
- Section 4.0, Ecological Risk Assessment for Chemicals: Discusses the methods and assumptions used in the EcoRA for chemicals, anticipated effects of MCR activities, and provides the results of the assessment.
- Section 5.0, Ecological Risk Assessment for Radiological Contaminants: Discusses the methods and assumptions used in the EcoRA for radionuclides, anticipated effects of MCR activities, and provides the results of the assessment.
- Section 6.0, Risk Assessment for Physical Stressors: Discusses the methods and assumptions used in the risk assessment for physical stressors (e.g., noise, thermal effluent), anticipated effects of MCR activities, and provides the results of the assessment.
- Section 7.0, Conclusions and Recommendations: Provides the findings of the HHRA and EcoRA, and discusses potential recommendations for monitoring.
- Section 8.0, References.

Long content sections not directly relevant to an overall understanding of the results of the Environmental Risk Assessment are located in the ERA Appendices [R-35], and include:

- Appendix A: Site Description
- Appendix B: ERA Methodology
- Appendix C: Identification of Chemicals of Potential Concern
- Appendix D: Predictive Environment Risk Assessment
- Appendix E: Environmental Quality Data Tables for Chemicals and Tier 1 Chemical Screening

- Appendix F: Ecological Risk Assessment for Chemicals – Exposure and Risk Tables
- Appendix G: Toxicological Evaluation of Chemicals with Site-Specific Discharge Limits
- Appendix H: Evaluation of Point of Impingement Limits
- Appendix I: Thermal Risk Assessment
- Appendix J: Release Rates from the Bruce Power Site
- Appendix K: Triple Joint Frequency Files
- Appendix L: Exposure Point Concentrations for the HHRA
- Appendix M: Radiation Dose to Humans
- Appendix N: Radiation Dose to Non-Human Biota
- Appendix O: Tritium in Water
- Appendix P: 2017 ERA Concordance Table

1.5 Environmental Protection and Monitoring Programs

Power Reactor Operating Licence (PROL) Bruce Nuclear Generating Stations A and B 18:02/2028 [R-48] and the associated Licence Condition Handbook [R-49], has Section 3.3 Reporting Requirements that require Bruce Power to notify and report in accordance with CNSC regulatory document REGDOC-3.1.1, version 2 [R-50]. Environmental Protection is one safety control area which covers programs that identify, control, and monitor all releases of radiological, non-radiological and hazardous substances, and monitors the effects on the environment from the operation of facilities or as the result of licensed activities.

An environmental protection report is submitted annually to the Canadian Nuclear Safety Commission (CNSC) and contains information as required by REGDOC-3.1.1, version 2 section 3.5 [R-50] posted publicly at Publications – Bruce Power.

Bruce Power complies with Federal Regulations, programs, and standards which protect human health and the environment under the Nuclear Safety and Control Act [R-51]. The key elements are listed below:

- The General Nuclear Safety and Control Regulations [R-52] require every licensee to take all reasonable precautions to protect the environment and to control release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity.
- The Class 1 Nuclear Facilities Regulations [R-53] set out environmental protection requirements that must be met.

- The Radiation Protection Regulations [R-54] prescribe radiation dose limits for the general public of 1 mSv (1000 µSv) per calendar year.

- PROL 18.02/2028, Nuclear Reactor Operating Licence Bruce Nuclear Generating Stations A and B [R-48].

The CNSC, when considering relicensing, has an obligation through the Nuclear Safety and Control Act [R-51] to consider whether an applicant will make adequate provision for the protection of the environment and the health and safety of people as outlined in REGDOC 2.9.1 Environmental Protection Policies, Programs and Procedures [R-55]. As a result, the CSA N288 standards are implemented through requirements set out in the License Condition Handbook (LCH) [R-49].

REGDOC-2.9.1 [R-55] outlines the requirements needed for an environmental protection program consistent with the environmental management system standard, ISO 14001, Environmental Management System. Bruce Power's BP-PROG-00.02, Environmental Management [R-56] implements this environmental protection program.

The CSA N288 standards are part of a series of guidelines and standards on environmental management of nuclear facilities. Bruce Power will continue to strive to be industry best and implement newer versions of the CSA N288 series of environmental standards as they become available.

Bruce Power has implemented the following CSA standards that are relevant to the CNSC's regulatory framework for environmental compliance:

- CSA N288.1-14 (Update 3), Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities [R-57];

- CSA N288.4-10, Environmental Monitoring Program at Class I nuclear facilities and uranium mines and mills [R-58];

- CSA N288.5-11, Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills [R-59];

- CSA N288.6-12, Environmental Risk Assessments at Class I nuclear facilities and uranium mines and mills [R-60];

- CSA N288.7-15, Groundwater Protection Programs at Class I nuclear facilities and uranium mines and mills [R-61]; and

- CSA N288.8-17, Establishing and implementing action levels for releases to the environment from nuclear facilities [R-62].

Bruce Power is working towards implementing, N288.1-20, Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities [R-63].

Bruce Power is following the guidance provided in CSA N288.9-18, Guideline for design of fish impingement and entrainment programs at nuclear facilities [R-64] to enhance the fish impingement and entrainment programs and CSA N288.3.4-13, Performance testing of nuclear air-cleaning systems at nuclear facilities [R-65].

Over the past 20 years Bruce Power has gained a significant amount of experience in the restart and refurbishment of its CANDU reactors. The applicable Bruce Power environmental management programs are outlined in the section following, along with how they may evolve through MCR and continued station operations. Overall, potential environmental effects of future activities are anticipated to be similar to those associated with the existing operations, as outlined in the PERA. Therefore, existing environmental monitoring will be retained as required to confirm predictions and be reported through the annual EMP findings.

An overview of each of the components of environmental monitoring is provided in this section.

1.5.1 Environmental Management System

Bruce Power Environmental Management oversees the planning, implementation and operation of activities, with a focus on minimizing the potential adverse impact of Bruce Power operations on the natural environment. This includes ensuring the Bruce Power Environmental Safety Program conforms to International Organization for Standardization (ISO) 14001 standard for EMS [R-66]. As part of the EMS, environmental compliance obligation applicable to the activities at Bruce Power; documented in BP-PROG-00.02, Environmental Management [R-67]. Compliance obligations include commitments to regulators and contractual agreements with OPG and voluntary commitments to interested parties.

1.5.1.1 Environment & Sustainability Policy

The Environment & Sustainability Policy establishes guiding principles for environmental management and environmental expectations for employees and those working on behalf of Bruce Power. The Environment & Sustainability Policy reflects the commitment of Bruce Power to protect the environment.

You can count on Bruce Power to:

- Ingrain a healthy nuclear safety culture which promotes nuclear safety, radiological safety, industrial safety and environmental safety and sustainability;

- Commit to excellence by meeting or exceeding all relevant legal and voluntary requirements to which Bruce Power subscribes;

- Understand our environmental impact and verify environmental protection through monitoring the environment, collaborating with industry and the community, and driving related strategic research and innovation;
- Focus on continuous improvement by adopting applicable industry best practices and requirements of ISO 14001;
- Ensure our business decisions support the application and practice of sustainability principles by protecting, conserving, and restoring our resources through energy conservation, reducing water consumption, supporting waste diversion, and considering product life cycle in our Supply Chain;
- Hold ourselves accountable to prevent pollution through robust management of emissions, effluents and waste, as well as implementation of spill mitigation measures;
- Promote environmental stewardship and awareness at work, in the community, and across Ontario;
- Uphold the trust of the community through open and transparent communication with partners, Indigenous communities, and stakeholders on environmental interests;
- Play a leading role in keeping the air clean and fighting climate change; supporting emissions reductions strategies to achieve a Net Zero Canada by 2050; adopting ambitious net reduction strategies for Bruce Power to achieve Net Zero (GHG); and
- Support partners, communities and organizations to drive innovations and projects to offset and sequester carbon in a real and tangible way.

1.5.1.2 ISO 14001

ISO 14001:2015 was released by the International Organization for Standardization on September 15, 2015. Bruce Power's ISO 14001 certification meets the requirements of the PROL, and Bruce Power is currently registered to ISO 14001:2015. ISO 14001:2015 focuses on the EMS being integrated throughout business processes to aid in the organization's knowledge and understanding of external and internal issues, stakeholders needs and expectations, and risks and opportunities impacting the organization.

These major themes are in the areas of leadership and commitment of management, identification of risks/opportunities related to environmental aspects affecting interested parties, protecting the environment beyond prevention of pollution, continual improvement of environmental performance, adoption of a lifecycle approach when determining environmental aspects, and internal/external communications. Bruce Power was successful in achieving full implementation of ISO 14001 and was registered to the 2015 version of the standard in 2017 and has maintained certification to date.

1.5.2 Spills Management

The Spills Management program outlines the steps and procedures necessary to satisfies the requirements of Ontario Regulation 224/07 [R-68], Spill Prevention and Contingency Plans (SPCP); Ontario Regulation 675/98 [R-69], Classification and Exemption of Spills and Reporting of Discharges; and Part X: Spills of the Environmental Protection Act (EPA) [R-70]. This ensures consistency is achieved across the Site, and that environmental impacts from spills remain ALARA.

The regulations above set out requirements to define your facilities spill risks and plan for the mitigation of these risks. In addition, they establish the requirements for external reporting. These regulations have a very low threshold for reporting externally to the Ministry of Environment, Conservation and Parks (MECP) and therefore, a reportable spill is most often not a significant spill with the potential for negative effects to the environment.

Significant spills occurring between 2017 and 2022 are discussed below in Sections 1.5.2.1, 1.5.2.2 and 1.5.2.3. Significant spills are defined as a spill that had or could have had a negative effect on the natural environment based on the chemical hazard, size of release and location of the release (i.e., a water way) and had or could have had a significant impact on or off site that required some level of remediation beyond the normal absorbents/spill material used in cleanup.

Finally, the Groundwater monitoring program is informed by historic spill events on site. In addition to areas that might be at risk for a spill event occurring monitoring wells are also installed in areas that had historic events that may be at risk for contaminant migration. These impacted lands or “contaminated lands” are tracked and monitored further through ground water monitoring program as well as soil, sediment and surface water monitoring as required. Areas impacted by historic spills that are relevant to the 2022 ERA are discussed in Appendix A: Site Description [R-35].

1.5.2.1 Bruce A

<u>Unit 1 Transformer Spill- July 2018</u>

On July 25, 2018 at Bruce A, a failure of the Unit 1 Main Output Transformer (blue phase) resulted in a spill of 12,843L of mineral oil [R-71]. The balance of the full transformer volume remained in the transformer and was subsequently drained as part of maintenance activities. Of the 12,843L released, it is estimated that 7,500L was contained within the engineered SorbWeb® Plus secondary containment system, designed to contain oil spills. The balance of the oil released was recovered into vacuum trucks, barrels, and absorbent materials. Emergency Protective Services personnel first on the scene assessed that approximately 150 L of mineral oil reached the pavement beyond SorbWeb® Plus, a small volume of which entered yard drainage. Samples and visual observations did not indicate that oil reached Lake Huron.

As evidenced by the calculated losses and recovered mineral oil, a minimal amount of oil reached the natural environment and there has been no evidence that any oil reached the lake. Therefore, it was assessed that the oil spill did not have an adverse impact on Lake Huron or the natural environment. Annual groundwater monitoring has not identified oil in any of the Bruce A groundwater wells that has been attributed to this spill. Additionally, there was not any contact with potential ecological or human receptors as a result of this spill. In 2019, the impacted sections of the SorbWeb® Plus were replaced.

1.5.2.2 Bruce B

Unit 8 Transformer Spill- December 2018

On December 6, 2018, a failure of TSS8, a transformer outside the Unit 8 building at the Bruce B generating station, resulted in a release of approximately 97,000 litres of Voltesso 35 (a petroleum-based, non-PCB containing type of mineral oil) into the U8 Secondary Oil Containment (SOC) structure (Sorbweb®) [R-72]. The fire-deluge system was subsequently activated to suppress the fire, followed by fire suppression efforts made by Emergency Response Team personnel discharging water from the station's firewater supply and applying Fireade 2000, a firefighting agent.

Slight mineral oil sheen was observed in the station's intake channel as well as at the Construction North yard drainage discharge point at the shore of Lake Huron. Once this was identified, booms were installed to contain and prevent the mineral oil sheen from entering the lake, and later, an underflow weir dam was established at this discharge point to prevent sheen from reaching the shoreline. Bruce Power worked with vendors (ECRC, GFL) to wash the walls of the forebay and skim oil off the surface of the forebay.

Bruce Power crews deployed booms to contain and absorb the mineral oil sheen on site, and our Environment team continued to monitor to ensure no sheen traversed barriers into the lake. We expect that the majority of the oil was collected and contained by the SorbWeb® Plus. It has been conservatively estimated that less than 100 litres of mineral oil was released to Lake Huron via the yard drainage as a result of this spill.

The Bruce B outfall was consistently monitored and no release of oil was observed via this pathway. This was confirmed by 3rd party vendor ECRC daily observation logs.

Boat, drone, and shoreline observations demonstrated no significant impacts to Lake Huron. On two occasions within twenty four hours of the event, slight visible sheen was observed north of the Bruce B outfall and near the Construction North drainage ditch, as well as during boating rounds on Lake Huron. There have been no sheen observations of substantial size/ intensity that could reasonably be remediated. Samples collected during the boating rounds, including within visible sheen areas analyzed by Kinectrics, have been at or below Kinectrics' detection limit of 0.02 ppm oil in water.

On December 12, 2018, as part of annual lake monitoring, Bruce Power vendors collected 5 lake samples to the north and south of Bruce Power from boats. Samples were analyzed for Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) and F1-F4 Hydrocarbons. All results were less than Reportable Detection Limit (RDL).

Bruce Power Operators collected samples from manhole MH28 (just upstream of yard drainage outlet at south end of powerhouse), MH8 (just upstream of yard drainage outlet at north end of powerhouse), upstream of the weir dam (downstream of MH8 on the north side), and downstream of the weir dam and analyzed them for visual oil. Over 50 samples were taken, with the sampling regime concentrated around December 7th and 8th, 2018 until such time as there was minimal concern of any oil sheen traversing the weir dam barrier to the lake. Generally, a gradual improvement (decrease in visible) oil sheen was noted at MH28, MH8, and upstream of the weir dam. Sampling of the weir dam discharge continued until the yard drainage flushing was completed (see below) and sample results for solvent extractables were consistently below MDL.

In 2018, clean-up included: vacuuming spilled material from catch basins and manholes; power washing and using hydrovac trucks to clean the intake channel and impacted roadways; cleaning out the catch basins and yard drainage; and monitoring the underflow weir dam at the Construction North drainage ditch and Manhole 8, removing sheen as required. In 2019, remediation work continued, including: excavating oil contaminated soil underneath the Bruce B Administrative Building, completing flushing of the yard drainage system, and replacing impacted sections of the SorbWeb® Plus. Annual groundwater monitoring has not identified oil in any of the Bruce B groundwater wells that has been attributed to this spill.

There was no significant contact with potential ecological or human receptors as a result of this spill. As a result of this event, additional personnel from Emergency Protective Services can operate the deluge system to reduce the flow of water once the event is controlled. This will reduce the potential for contaminants to reach ecological and human receptors during any future events.

1.5.2.3 Centre of Site

<u>Hydro One Transformer Spill- May 2017</u>

On May 15, 2017 Bruce Power received notification that a leak was discovered on-site in the Hydro One Switchyard on a Hydro One tanker storing used transformer oil. An estimated 18,000 L of mineral insulating oil leaked out over a two week time period. The oil release made its way into the gravel within the switchyard and to the ditch adjacent to the switchyard.

Bruce Power's Emergency and Protective Services were dispatched upon notification and they arrived on the scene to assist with mitigation measures. Hydro One staff had constructed a weir dam to stop the flow and Bruce Power Emergency and Protective Services constructed sand berms and put down absorbent booms in the ditches upstream of the lake to contain the affected area. Bruce Power staff also walked down the ditch and shoreline. No indication of oil was visible in the lake. The leak was stopped and the booms and berms were effective in containing the leak.

Bruce Power collected samples on May 15, 2017 from the two ditches on Bruce Power leased lands, just prior to entering the lake, as well as, a culvert in close vicinity to the switchyard. Sample analysis for oil and grease showed <1.0 mg/kg for the ditches prior to entering the lake and 28.5 mg/kg at the culvert in close proximity to the switchyard.

Groundwater monitoring has continued in the vicinity of the spill since 2018. In 2021, no free-phase product or other evidence of non-aqueous phase liquids were encountered on the surface of the water table within the monitoring wells and recovery wells, with the exception of petroleum sheen observed on DBW006 in June 2021. More detail on the proceeding summary can be found in the 2021 Semi-Annual Groundwater Monitoring, Well Abandonment and Well Installation Activities Bruce A Transformer Station Tiverton, Ontario report [R-73]. Routine site inspections are no longer required, as there is sufficient data to support delineation of the subsurface impacts.

There was no significant contact with potential ecological or human receptors as a result of this spill.

Hydro One T4 Transformer Spill – October 2020

On October 25th, 2020, Hydro One field staff received a low level alarm on their T4 transformer conservator tank adjacent to Douglas Point (B01). When they responded to the alarms they found a drain valve open and leaking into the gravel substrate surrounding the transformers in the switch yard. The valve was then closed terminating the spill. On Monday morning (October 26th, 2020), Hydro One determined that there was a larger release than originally anticipated, and further investigation revealed a loss of approximately 2,000L of Voltesso 35 mineral oil with 5ppm of PCBs. Oil drained towards the ditch north of the transformer and travelled along the ditch to the northern edge of the switch yard ‘Holding Pond Ditch’.

The remedial excavation was advanced on-Site in the north-central portion of the transformer spill (TS) adjacent to Transformer T4, off-Site immediately north of Transformer T4, and along the Containment Berm and Holding Pond Ditch, located off-Site to the north and northwest of Transformer T4, respectively. Between October 26th and October 31st, 2020, Hydro One’s spill response contractor, Accuworx Inc. (Accuworx) advanced a remedial excavation on-Site at the Douglas Point TS in the area immediately adjacent to, and downgradient of transformer T4. The remedial excavation was extended off-Site to the northern edge of the Containment Berm, and along the Containment Berm and Holding Pond Ditch. Accuworx advanced supplemental on-Site and off-Site excavations to remove residual impacts identified in soil on November 16 and 25, 2020, respectively.

- A total of approximately 153,000 litres of electrical insulating oil (EIO)-impacted surface water was pumped into Frac tanks and was transported for off-Site disposal.

- A total of approximately 107 yards of soil slurry (mixed potable water and soil) was hydro-excavated from around Transformer T4 and was transported to a drying pad at the Bruce A TS for subsequent stockpile screening and sampling before being transported off-Site for disposal.

- An estimated 660 tons of soil was excavated and loaded directly into rock trucks and transported to a drying pad at the Bruce A TS for subsequent stockpile sampling and screening before being transported off-Site for disposal.

Review of the confirmatory soil sample analytical results indicates that all confirmatory soil samples collected from the final excavation limits and submitted for petroleum hydrocarbon compounds (PHCs) fractions F2-F4 and polychlorinated biphenyls (PCB) analysis were either below the laboratory method detection limits (MDLs) or were detected at a concentration below the MECP Table 6 SCS. All PHC fractions F2-F4 and PCB-impacted soil was removed during the remedial excavation activities. Although only 1,232 litres out of 2,000 litres was calculated as being recovered, there is a notable margin of error resulting from the conservative estimated volume released as well as the unknown volume of EIO recovered within absorbent pads and booms. Based on post remediation soil and groundwater results and observations, accessible EIO was remediated.

There was no significant contact with potential ecological or human receptors as a result of this spill.

1.5.3 Effluent Monitoring

Emissions and effluent monitoring performed by Bruce Power is in accordance with CSA N288.5-11 Effluent Monitoring programs at Class 1 Nuclear facilities and uranium mines and mills [R-16]. The emissions and effluent monitoring program demonstrates:

- Compliance with authorized release limits;
- Effectiveness of effluent control;
- Provision of data to assist in refining modeling; and
- Meeting stakeholder commitments.

The release of hazardous substances is regulated by both the MECP and ECCC through various acts and regulations, as well as federally by the CNSC.

Results of Bruce Power's emissions and effluent monitoring are reported annually to the CNSC in the Environmental Protection Report. The annual Environmental Protection Report is made available through Bruce Power's website, and submitted to the CNSC in accordance with the Bruce A and Bruce B PROL and CNSC REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants [R-36][R-74]. The Environmental Protection Report summarizes the annual releases and environmental data collected during the year, their interpretations, and the estimates of radiation doses to the public.

Emissions and effluent monitoring is a risk-informed activity to quantify or estimate the radiological and hazardous substances being released into the environment. Emissions and effluent are currently monitored through existing monitoring as outlined in the following sections.

1.5.3.1 Radiological Emissions

Radiological emissions and effluent from Bruce A Nuclear Generating Station, Bruce B Nuclear Generating Station, the Central Maintenance Facility (CMF) and the Central Storage Facility (CSF) are monitored in accordance with CSA N288.5-11 Effluent Monitoring programs at Class 1 Nuclear facilities and uranium mines and mills [R-16].

The OPG WWMF also monitors emissions in accordance with N-STD-OP-0031 Monitoring of Nuclear and Hazardous Substances in Effluents. CNL Douglas Point monitors for emissions in accordance with 22-00960-SWS-001, Douglas Point Waste Facility Storage with Surveillance Plan.

The Radiation Protection Regulations prescribe radiation dose limits for the general public of 1 mSv (1,000 μSv) per calendar year [R-17]. To facilitate the control and limitation of radiological releases to air and water below the annual public dose limit, Derived Release Limits (DRLs) are determined, and approved by the CNSC, following the guidance in CSA N288.1 Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities.

A revised Power Reactor Operating Licence (PROL) for Bruce A and Bruce B was received in 2018 from the CNSC [R-36]. This PROL includes “Transition” DRLs and Environmental Action Levels, as well as “New” DRLs and Environmental Action Levels. The Transition DRLs and Environmental Action Levels were replaced by the New DRLs and Environmental Action Levels on December 31, 2021.

The DRLs were revised based on:

- The most current meteorological conditions;
- Limiting radionuclides;
- Representative persons; and
- Results from the site specific survey and assumptions.

Furthermore, Bruce Power has established Environmental Action Levels in accordance with CSA N288.8, Establishing and implementing action levels to control releases to the environment from nuclear facilities [R-75]. These Environmental Action Levels were calculated based historical emissions and effluent data and represent the upper range of normal releases that is expected to be seen once every five years. Exceedance of an Environmental Action Level requires notification of the CNSC and could indicate a loss of control of part of Bruce Power’s environmental program and the need for specific actions to be taken.

1.5.3.2 Conventional (Non-Radiological) Emissions

Bruce Power monitors the effluent emission streams for a variety of conventional parameters including hazardous substances. This monitoring is performed to meet the regulatory obligations of several Federal and Provincial regulatory agencies, including the CNSC. The results for these monitoring events are submitted to the lead environmental agencies at various times throughout the year. The conventional monitoring program operated by Bruce Power is described in internal procedures based on the N288 series.

Effluent sampling and monitoring is conducted in compliance with limits set forth in the following:

- Ontario Regulation 215/95: Effluent Monitoring and Effluent Limits - Electrical Power Generation Sector [R-76] – this was revoked on July 1st, 2021 and now is enforced via ECA notices (outlined below).
- Ontario Regulation 419/05: Air Pollution - Local Air Quality) [R-77], the Environmental Protection Act (R.S.O. 1990, c. E. 19) [R-55]
- Ontario Water Resources Act (R.S.O. 1990, c.O.40) [R-78]
- ECAs issued by the Ministry of the Environment Conservation and Parks (MECP) [R-79] [R-79] [R-80][R-81] including Notice 1 for each [R-82] [R-83] [R-84]
- Permits to Take Water (PTTW) [R-85]–[R-87] issued by MECP and with Internal Administrative Levels - New Permits were acquired in May 2021 [R-88] [R-89] [R-90].
- Ontario Regulation 390/18: Greenhouse Gas Emissions: Quantification, Reporting and Verification [R-91]
- Federal Halocarbon Regulations, 2003, SOR 2003-289 [R-92]
- Notice to Report: Under the authority of Section 46 of the Canadian Environmental Protection Act (CEPA), operators of facilities that meet the criteria specified in the annual notice with respect to reporting of greenhouse gases (GHGs), published in the *Canada Gazette*, are required to report facility GHG emissions to Environment and Climate Change Canada by the annual June 1st reporting deadline [R-93].
- Notice to Report: Under the authority of the Canadian Environmental Protection Act, 1999 (CEPA 1999), owners or operators of facilities that meet published reporting requirements are required to report to the NPRI [R-94]
- Ontario Regulation 463/10: Ozone Depleting Substances and other Halocarbons [R-95]
- Ozone-Depleting Substances and Halocarbon Alternatives Regulations (SOR/2016-137) [R-96]

1.5.4 Environmental Monitoring

Bruce Power's Environmental Protection Program is built upon an integrated monitoring approach that strives to understand environmental impact, verify environmental protection, and continuously improve by driving strategic research and innovation through collaborations with industry and community. Environmental safety and responsibility are woven into all aspects of the company's nuclear safety culture, and Bruce Power commits to meet or exceed all relevant legal and voluntary environmental requirements. The company holds itself accountable to prevent pollution through strong management of emissions, effluents, and waste, and it implements robust spill mitigation measures in order to provide effective containment and control of contaminants.

To demonstrate environmental protection Bruce Power performs extensive monitoring and modelling of radiological and conventional contaminants in the Earth's Critical Zone [R-97]. The Critical Zone is comprised of the permeable zones near the Earth's surface where living organisms, air, water, soil, sediment and groundwater interact (Figure 1).

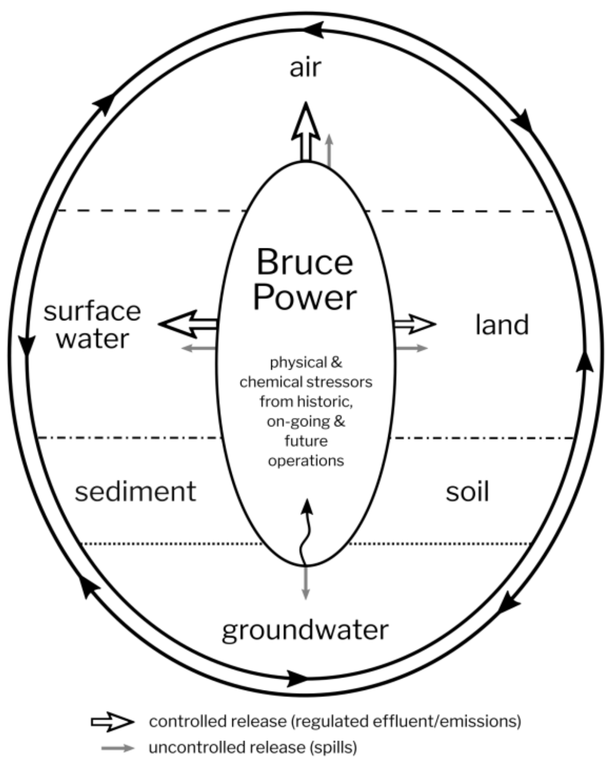

Figure 1 Bruce Power has multiple layers of protection in place to minimize emissions and effluents released during facility operations. The Environmental Protection Program monitors and models physical and chemical stressors released to the environment and continuously assesses their risk and impact

Air emissions and water/land effluents are controlled and regulated releases that occur in a manner that minimizes environmental impact. Bruce Power's radiological and conventional environmental monitoring programs are designed to continuously verify that environmental protection is being maintained and that these releases have a minimal impact on the surroundings. The programs are based on CSA N288.4-10 and N288.7-15 [R-58] [R-61], CNSC REGDOC-2.9.1 [R-55], reporting requirements in CNSC REGDOC-3.1.1 [R-50] and the framework laid out in internal procedures.

The key goal of the environmental protection program is to:

- Ensure that physical stressors and radiological and conventional contaminants released through controlled pathways or spills do not cause undue risk to living organisms.

This is achieved by fulfilling several program objectives:

- Assess the level of risk to human health and safety, and potential biological effects that may arise from operation of the facility.
- Demonstrate compliance with limits on the concentration/activity of radiological and conventional contaminants and intensity of physical stressors in the environment and/or their effect on the environment.
- Ensure that groundwater end-uses are protected by implementing a groundwater protection program, control releases that have the potential to impact groundwater and have a groundwater monitoring program in place.
- Independently check the effectiveness of emission and effluent controls and provide public assurance of the efficacy of these measures.
- Obtain concentrations of radioactivity in environmental media, calculate radiation exposure doses to representative persons, and meet the applicable requirements of REGDOC 3.1.1: Reporting Requirements for Nuclear Power Plants [R-50].
- Provide data to verify predictions, refine models, and/or reduce uncertainty in predictions as required for the Environmental Risk Assessment (ERA) [R-98], and incorporate any recommendations into the program design; and,
- Demonstrate due diligence and meet stakeholder commitments.

1.5.4.1 Radiological Environmental Monitoring

Bruce Power has well-established radiological environmental monitoring programs that focus on the local area around the facility, including neighboring communities and Lake Huron. Together, the results build an overall understanding of the risk to human health and impact on the environment. The programs are based on CSA N288.4-10 and N288.7-15 [R-99] [R-100] , CNSC REGDOC-2.9.1 [R-101] and CNSC REGDOC-3.1.1 [R-102]. The key goal of the environmental protection program is to ensure that physical stressors and radiological and conventional contaminants released through controlled pathways or spills do not cause undue risk to living organisms. Bruce Site Radiological Environmental Monitoring.

The radiological environmental monitoring (REM) program establishes a database of radiological activity measured in the environment near Bruce Power and determines the contribution of overall radiation dose to members of the public as a consequence of the radiological releases from normal operations on Site. The REM data implicitly reflects the influence of releases from all Bruce Power licensed facilities (i.e., Bruce A, Bruce B, CMF and CSF) as well as facilities within or adjacent to the Bruce Power site boundary that are owned by other parties. This includes the OPG WWMF (owned and operated by OPG), the Douglas Point Waste Facility (owned by CNL), and KI North (owned by Kinectrics).

The REM program involves the annual collection and analysis of environmental media for radionuclides specific to nuclear power generation. Background levels due to naturally occurring sources are subtracted from the totals in order to elucidate the impact specific to Bruce Power operations. Bruce Power relies on the OPG Health Physics Laboratory in Whitby, Ontario for provincial background radiation levels measured in a variety of environmental media collected at locations outside the influence of Bruce Power.

The design of the REM program is based on risk and is informed by a radionuclide and exposure pathways analysis. The following environmental media are collected and analyzed as part of the annual REM program: air, precipitation, drinking water, lake and stream water, groundwater, animal products (e.g. milk, eggs, honey, animal meat), agricultural products (e.g., fruits, vegetables, farm crops, animal feed), soil and sand, fish and sediment. The radionuclides that are measured include tritiated water (HTO), carbon-14 (C-14), iodine-131 (I-131), beta and gamma emitting radionuclides.

For the Bruce Power REM program, monitoring locations for aquatic media such as lake water, fish and sediment are downstream of the site, at locations where radionuclides are expected to accumulate. For air sampling, monitors are situated at varying distances from Bruce Power, at locations covering all landward wind directions. For terrestrial foodstuffs (e.g., milk, meat, fruit, vegetables, grains, eggs, honey), sampling is performed at nearby areas or at local farms and residences, as applicable. Monitoring locations are based on practical considerations, including the availability of samples and participation of local residents and farmers. Wild animals are sampled only when available (e.g., subject to on-site vehicle collisions or samples provided by local hunters). Milk is monitored from five local dairy farms through an agreement with the Dairy Farmers of Ontario.

1.5.4.2 Conventional Environmental Monitoring

This program monitors for conventional contaminants, physical stressors, potential biological effects, and pathways for both human and non-human biota. Non-radiological chemical stressors from historic and current operations are monitored (with future effects predicted using models as needed) in local surface waters, sediments, soil, and/or air using an activity-centered, risk-based approach. Effects on wildlife from physical stressors are documented using numerous Biological Effects Monitoring (BEM) approaches.

Chemical stressors that have the *potential* for environmental impact are referred as Chemicals of Potential Concern (COPCs). COPCs are routinely monitored at Bruce Power, and they are chosen based on known controlled releases from the facility. Controlled emissions/effluents are regulated and are described in Bruce Power's Conventional Effluent Monitoring Program (see Section 1.5.3). A second pathway to the environment is through an uncontrolled release (i.e., spill). If a spill was to occur and a contaminant reached the environment, the location and frequency of COPC monitoring may change on a case-by-case basis, as dictated by remediation activities and/or follow-up monitoring.

Routine monitoring for conventional COPCs occurs in surface waters (annually) and sediments (every 5 years) because they have the highest probability of impact from facility operations such as station effluents, storm water discharges, and Centre of Site operations (e.g., sewage treatment and discharges). Soil has a low probability of being impacted by chemical stressors at Bruce Power, primarily because COPCs are not discharged directly to soil under normal operations. This has been repeatedly demonstrated in past Environmental Risk Assessments [R-98]. Sediments, soils, and surface waters were sampled in 2021 to inform this ERA.

The impact of air emissions on the surrounding environment is assessed annually in the Conventional Environmental Monitoring Program and in recurring ERAs which have demonstrated that these impacts are very low [R-98]. The transport of COPCs through the air to surface water (and potentially sediment, soil or groundwater) occurs via deposition, runoff and percolation processes. Transport through air is short-lived and there is minimal interaction between COPCs and potential receptors.

1.5.4.3 CNSC Independent Environmental Monitoring Program

The CNSC has implemented its Independent Environmental Monitoring Program (IEMP) to verify that the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to, the CNSC's ongoing compliance verification program. The IEMP involves taking samples from publicly accessible areas around the facilities and measuring and analyzing the amount of radioactive and hazardous substances in those samples. CNSC staff collects the samples and send them to the CNSC's state-of-the-art laboratory for testing and analysis. The most recent IEMP in the area outside of the Bruce Power Site perimeter was sampled in 2019 [R-103].

The 2019 IEMP sampling plan for the Bruce Power Site focused on nuclear and hazardous contaminants. This differs from IEMP sampling plans in 2013, 2015 and 2016 which focused only on nuclear contaminants. A site-specific sampling plan was developed based on Bruce Power's approved environmental monitoring program and the CNSC's regulatory experience with the site. The Métis Nation of Ontario (MNO), Saugeen Ojibway Nation (SON) and Historic Saugeen Métis (HSM) also collaborated with the CNSC by providing valuable information about locations and species of interest for sampling, and by participating in the collection of samples. It is a priority for the CNSC to ensure that IEMP sampling reflects traditional Indigenous land use, values and knowledge, where possible, so that IEMP results are meaningful to the communities.

In all years, samples were collected in publicly accessible areas outside the Bruce Power site perimeter and included samples of air, water, soil, sediment, vegetation and food, such as meat and produce from local farms.

In 2019, the radioactivity measured in air, water, sediment, soil and vegetation samples, as well as in samples of meat, fish, milk and produce was below guidelines and CNSC screening levels. These results are similar to the findings in 2013, 2015 and 2016. CNSC screening levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv/year. No health impacts are expected at this dose level.

The levels of hazardous (non-radiological) contaminants measured in water and sediment were below applicable guidelines. All samples were within the range of Bruce Power's data based on previous environmental risk assessments, and below the toxicity data available, indicating that potential effects to the environment are low.

1.5.5 Groundwater Protection

REGDOC-2.9.1 [R-7], sets out the CNSCs regulatory requirements and expectations for programs related to environmental protection. It states that nuclear licensees shall implement a groundwater protection program in a graded approach, appropriate to their circumstances, to:

- Prevent or minimize releases of nuclear or hazardous substances to groundwater,
- Prevent or minimize the effects of physical stressors on groundwater end uses,
- Confirm that adequate measures are in place to stop, contain, control, and monitor any releases and physical stressors that can occur under normal operation.

The CNSC has mandated that this shall be implemented, thereby confirming need in addition to the requirements on environmental protection in accordance with conditions within the operating license of the Bruce A and B generating stations.

Bruce Power has established a Groundwater Protection Program in alignment with CSA N288.7-15 [R-100], Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills. Compliance with the Standard will allow facilities to demonstrate that they will not pose an unreasonable risk to the environment or the health and safety of humans and non-human biota from groundwater. The N288.7 Standard provides requirements and guidance on the elements of a Groundwater Protection Program (GWPP) and detailed guidance on developing Groundwater Monitoring Programs (GWMPs) as components of a GWPP.

Several groundwater investigations at the Site have included installing shallow and deep monitoring wells that have been used in various capacities to better understand and characterize the Site's hydrogeological characteristics and in some instances to assess for presence and or absence of constituents of interest associated with various sites. A series of nested wells at Bruce A and Bruce B (referred to as the Radiological Environmental Monitoring Program or REMP wells) are primarily used for radiological monitoring. Select other wells have been installed on an as-required basis to respond to and investigate known subsurface issues and as part of the proactive groundwater monitoring program implemented by Bruce Power. There are 16 legacy areas within the Site that are being monitored as part of the annual monitoring program. Additionally, the Bruce B Unit 7 and Unit 8 Standby Generators and fuel supply systems, and Bruce B Emergency Power Generator and fuel supply systems are being monitored as part of on-going fuel oil spill remediation activities. In December 2021 the onsite soil management area had six monitoring wells installed to address the need for a monitoring program there.

1.5.6 Excess Soil Management

Bruce Power's current soil monitoring program includes the management of dry and liquid soil (slurry) on-site following best practices described in Ontario Regulation 406/19 Excess Soils Regulation (O. Reg. 406/19) [R-104] and the Rules for Soil Management and Excess Soil Quality Standards [R-105]. Management of soil resources in an environmentally responsible way is integral to building and maintaining environmental protection.

The Center of Site Soil Management Area (SMA) is located in the eastern area of Bruce Power-leased lands, between Siding Road and the Hydro One transmission line corridor that runs from Bruce A. The SMA contains a large bermed area for temporary staging and dewatering of soil slurries (wet or liquid soils that would fail a 'slump test') and another area designated for management of dry soil resources. All Bruce Power construction projects are expected to characterize soil quality within the project boundaries prior to starting excavation and relocation of material to the SMA. This helps ensure that soils can be reused in the future and that potential contamination from historical spills is not spread across the site. Depending on analytical results, soil is temporarily stored at the SMA for future beneficial reuse on site, managed on site for long-term storage, or removed from site and managed at an offsite disposal facility.

1.6 Cumulative Effects Assessment

The operation of Bruce Power facilities has the potential to act cumulatively with the effects of past, present and reasonably foreseeable projects and activities. The potential for cumulative effects has been considered in previous environmental assessments (e.g., [R-4][R-5]) for activities on the Site.

The Site also contains several facilities that are not owned and operated by Bruce Power, namely OPG's WWMF, CNL Douglas Point and Hydro One transmission infrastructure (see Figure 2). The potential for cumulative effects between the Bruce Power operations and these facilities is discussed below.

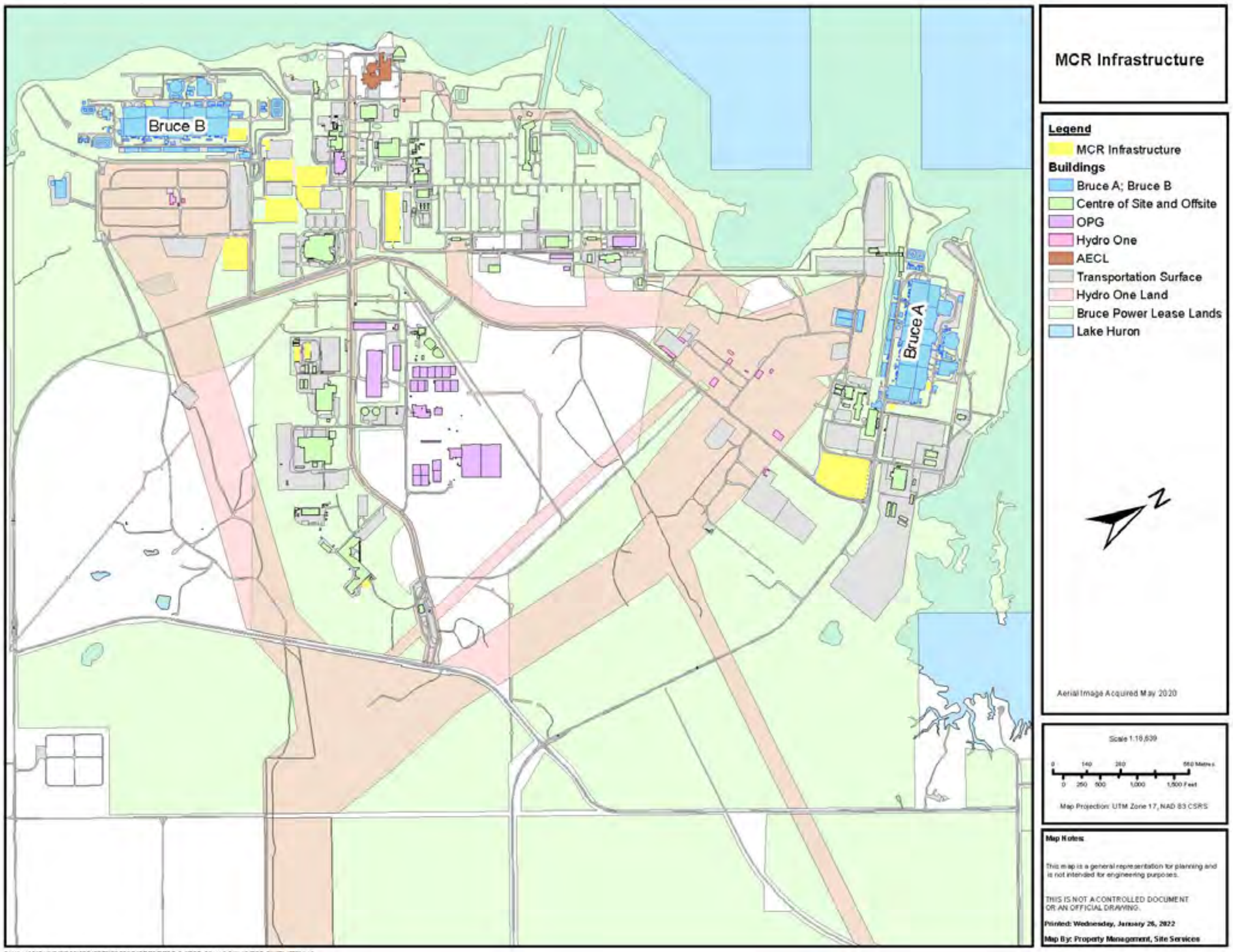

Figure 2 Site Layout showing Bruce Power leased lands (green) and lands retained or leased to other site tenants.

1.6.1 OPG's Western Waste Management Facility

The WWMF is owned and operated by OPG and located on-site, defined by the parcel of land designated for the management of OPG's radioactive waste and licensed for such use by the CNSC. The objectives of the WWMF are to provide safe material handling (receipt, transfers and retrieval), treatment, and storage of radioactive materials produced at nuclear generating stations and other facilities currently or previously operated by OPG, or its predecessor Ontario Hydro. This facility also provides safe storage of Bruce Power's used fuel in Dry Storage Containers (DSC) until it can be transported to an alternative long term used fuel storage or disposal facility (i.e., Adaptive Phased Management, which is the mandate of the Nuclear Waste Management Organization [NWMO]). The used fuel dry storage area is a security-protected area located northeast of the L&ILW storage area, and consists of DSC processing and storage buildings.

The L&ILW storage area consists of various structures such as the Amenities Building, Waste Volume Reduction Building, Transportation Package Maintenance Building, above ground low-level and intermediate-level waste storage buildings, quadricells, in ground containers, trenches, and tile holes. These structures are primarily used for storage and processing of the L&ILW from OPG's Pickering and Darlington Nuclear Generating Stations as well as Bruce Power operations.

The cumulative influence of these facilities is included and assessed within the ERA and PEA implicitly given that it is not possible to isolate any potential effects due to these facilities when reviewing monitored data for the Site as a whole.

1.6.2 Canadian Nuclear Laboratories Douglas Point

The Douglas Point Waste Management Facility (DPWMF) is owned by Canadian Nuclear Laboratories (CNL) and is located on the Site. The facility consists of a permanently shut down, partially decommissioned prototype 200 megawatt CANDU® reactor and associated structures and ancillaries. This facility is presently in the long term "Storage with Surveillance" phase of a decommissioning program.

The cumulative influence of emissions from CNL Douglas Point are included and assessed within the ERA and PERA implicitly given that it is not possible to isolate any potential effects from this facility when reviewing monitored data for the Site as a whole.

1.6.3 Hydro One

Hydro One owns and operates a number of assets within Site. These include, but are not limited to, office and workshops for maintenance, switchyards at Bruce A and Bruce B, switching stations and transformer stations. Cumulative effects from the construction and operation of Hydro One facilities are included implicitly in the ERA and PERA for the Site as the whole.

1.6.4 Future Standards and Regulations

It is anticipated that new standards and regulations will be introduced during the current licensing period that may affect the execution of activities.

The MECP is in the process of reviewing Bruce Power's ECA Limited Operational Flexibility application. The requirements for application of the approved ECA and any new guidance documents will be reviewed as the approval, standards and regulations are finalized.

Regulatory document REGDOC-2.9.2, *Controlling Releases to the Environment*, is under development and will apply to Bruce Power once published. It sets out the CNSC's requirements and guidance for controlling releases to the environment, through:

- Applying the concept of best available technology and techniques, economically achievable (BATEA);
- Establishing and implementing licensed release limits and action levels for releases to the environment;
- Commissioning a treatment system and confirming performance; and,
- Implementing adaptive management where required [R-106].

1.7 Environmental Risk Assessment

CSA N288.6 Environmental risk assessment at Class I nuclear facilities and uranium mines and mills [R-14], addresses the design, implementation and management of the ERA, including HHRA and EcoRA. The ERA is a systematic process used to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors, including the magnitude and extent of the potential effects associated with a facility. The outcome of the ERA is a series of risk-based recommendations.

The 2022 ERA Report provides an update to earlier ERAs submitted to the CNSC in 2015 and 2017. The report has not identified any risks that were not previously known. Key areas of interest remain to be thermal effluent and impacts and impingement and entrainment of fish. Bruce Power received feedback from CNSC that the 2015 and 2017 submissions met the compliance requirement of CSA N288.6. The 2022 update to the ERA incorporates current environmental monitoring information, addresses feedback from the CNSC and updates risk calculations. The ERA will also be used as one of the tools to improve the development, definition, and implementation of various environment program areas across the company.

CSA Standard N288.6 [R-14] requires that the ERA be reviewed periodically, recommending a five year cycle, or more frequently if major facility changes are proposed. In addition, REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants* [R-74] requires that an updated ERA for the Site is submitted to the CNSC within five years of the date of the previous submission or when requested to do so by the CNSC.

According to N288.6 [R-14] , the review process should include consideration of the following:

- Changes that have occurred in site ecology or surrounding land use;
- Changes to the physical facility or facility processes that have the potential to change the nature of facility effluent(s) and resulting risks to receptors;
- New environmental monitoring data collected since the last ERA update;
- New or previously unrecognized environmental issues that have been revealed by the EMP;
- Scientific advances that require a change to ERA approaches or parameters; and
- Changes in regulatory requirements pertinent to the ERA.

The overall iterative nature of the ERA will capture any substantial change in the facility or in an activity that could alter the potential interaction with the environment. The process requires that the ERA reflect the changes in the effluent, environmental monitoring and groundwater monitoring programs such that the environmental risks are assessed and mitigated.

1.8 Predictive Environmental Risk Assessment

CSA N288.6 also provides provision for use of an ERA in a predictive context [R-14]. A predictive ERA is generally applicable to a new facility or process, and attempts to estimate the effects of a contaminant or stressor on an existing environment prior to release into the environment. Given the ongoing nature of Life Extension and Major Component Replacements for Units 3 to 8 and the start of Lu-177 production, an update of the 2017 PERA is integrated into the 2022 ERA.

To support any licensing decision under the NSCA, the Canadian Nuclear Safety Commission (CNSC) must make a determination regarding the protection of the environment and health and safety of persons. Since MCR activities (e.g., fuel channel assembly and calandria tube replacement [i.e., retube], Primary Heat Transport [PHT] feeder replacement, steam generator (replacement) are not identified in the Regulation Designating Physical Activities, the Impact Assessment Act (2019) [R-107] does not apply. Therefore, a predictive environmental effects assessment and safety review, both conducted under the provisions of the NSCA, is completed. The CNSC has outlined expectations for environmental assessments (EAs) under the NSCA in Regulatory Document (REGDOC) 2.9.1 Environmental Protection: Environmental Principles, Assessments and Protection Measures [R-7]. This section documents the Predictive Environmental Risk Assessment (PERA) for future site activities, including MCR activities.

Bruce Power is implementing the Life-Extension Program, which includes the Major Component Replacement (MCR) Program, to support the Ontario Long Term Energy Plan and assist the Province of Ontario in meeting its future electricity demand by extending the operating life of Bruce A Units 3 and 4 and Bruce B Units 5 to 8 through replacement of each unit's life-limited critical components. The MCR is anticipated to add approximately 30 to 35 years of reactor life for each unit, thereby providing cost-effective electricity to ratepayers through this timeframe. An amended Bruce Power Refurbishment Implementation Agreement took economic effect on January 1, 2016, allowing Bruce Power to initiate the Life-Extension Program, which includes preparations for MCR Project for Units 3 to 8.

Additionally, Bruce Power is planning to begin the production of Lutetium-177 (Lu-177), a medical isotope, in 2022. Lu-177 is used for targeted cancer therapy and is produced by the irradiation of Ytterbium-176 (Yb-176). Accordingly, the predicted ERA impacts of Lu-177 production have been incorporated into the PERA.

1.8.1 Predictive Effects Assessment Objectives and Scope

The PERA is being conducted to demonstrate consideration of the environment and the health of persons during future site activities, including MCR activities. The specific goals of this PERA are:

- To identify changes from the current operations to those during future site activities, including MCR activities, and assess which changes result in potentially greater environmental emissions or effects;
- To evaluate the risk to human and ecological receptors based on the bounding scenarios (see below);
- To identify the specific objectives for the Environmental Monitoring Program (EMP); and
- To support the As Low As Reasonably Achievable (ALARA) principal at site and the progressive safety culture that not only applies to worker safety, but also the protection of the public and the environment.

The PERA is designed to focus on those pathways which may introduce new or modified effects to the environment, as well as focusing on those interactions most likely to cause an adverse environmental risk. Where Life-Extension activities or Lu-177 production result in potential environmental emissions that are the same or less than current operational conditions, the current operational conditions are considered to be bounding and detailed evaluation is not considered warranted as effects are evaluated in the ERA. Where Life-Extension activities or Lu-177 production result in potential environmental emissions that are greater than the current operational conditions, potential worst case (i.e., bounding) scenarios are developed. In general, bounding scenarios reflect an "upper bounding" case to provide a conservative assessment of effects from future site activities.

The overall approach for predicting and assessing effects of future site activities is based on REGDOC 2.9.1 and CSA N288.6-12 [R-7][R-14]. Although CSA N288.6-12 allows for the provision of ERAs that predict effects into the future, it does not provide specific guidance on predictive effects assessments. Therefore modifications to the ERA approach to complete a PERA are discussed further in Appendix D. The PERA evaluates potential effects of releases from the facility on the human and ecological environment, as well as physical stressors. As indicated in CSA N288.6-12, the PERA does not address acute or high level exposures resulting from accidents, future potential spills or unplanned emissions. The PERA does not include the operations or projects occurring on lands within the Bruce Power site that are not part of the Bruce Power lease agreement.

1.8.2 Regulatory Context

As a condition of the operating licence PROL-18.01/2028, the CNSC must be informed of any plan to refurbish or replace a major component of the nuclear facilities. Bruce Power has notified the CNSC of their intention to extend the operating lives of Bruce A Units 3 and 4 and Bruce B Units 5 through 8, including the replacement of major components. Implementing the Life-Extension Program, including MCR, required a licensing decision and amendment to the current operating licence.

The PERA has been prepared following the guidance of CSA N288.6-12 and demonstrates consideration of environmental protection during future site activities, including Lu-177 production and MCR activities for Unit 6, Unit 3 and Unit 4. It provides sufficient information to the CNSC to support their preparation of an EA under the NSCA as indicated in REGDOC-2.9.1 [R-7]. The information provided is as per the known status of projects as of June 1, 2021. This PERA incorporates information about future predicted activities at the Bruce Power site from June 1, 2021 to June 1, 2026 and includes predicted activities related to the production of Lu-177 and planned Life Extension activities, including the completion of the Unit 6 MCR and the commencement of the Unit 3 and Unit 4 MCRs. Predictions related to the first portion of the Unit 3 and Unit 4 MCRs have been adjusted for findings and lessons learned during the first portion of the Unit 6 MCR. Environmental and effluent monitoring outcomes of the first portion of the Unit 6 MCR have been incorporated directly into the ERA, although a brief summary of changes from the predictions in the 2017 ERA is presented in the PERA.

1.8.3 Uncertainty

The PERA forecasts effects associated with future site activities, including MCR activities, occurring from June 1, 2021 to June 1, 2026. The greatest certainty exists with regard to the activities planned for the immediate future (e.g., the next five years), although MCR activities will be occurring on-site through to 2033. This report reflects MCR planning as of June 1, 2021. Bounding assumptions have been made in the assessment to capture the range of potential future effects where there is uncertainty in the approach for executing MCR activities. There may be efficiencies in approaches, procedures and methods for carrying out MCR activities that are discovered as MCR activities take place sequentially on units. Bruce Power will review assumptions as part of ongoing licence renewal and environmental activities to reflect lessons learned and environmental monitoring data obtained during this interval, thereby continually reducing uncertainty in the effects predictions.

1.8.4 Site Characterization

The characterization of the Site includes descriptions of both the existing conditions (i.e., the baseline natural environment and existing Bruce Power operations), as well as description of future Lu-177 production, Life-Extension and MCR activities.

1.8.4.1 Existing Site Conditions and Operations

The existing environment, facilities and operations are described in Appendix A: Site Description. Additional Appendices include quantitative releases from the facilities and operations in both liquid and gaseous effluents [R-35]. The ERA HHRA and EcoRA are used as a point of comparison for future activities, including Life-Extension and MCR activities, to determine if the existing ERA bounds future activities.

The PERA uses the same defined spatial boundaries and ecological and human receptors as used in the ERA. Where applicable, the baseline values identified in the ERA are referenced in the identification of potential interactions and are combined or compared as appropriate with the estimated predicted changes resulting from future site activities, including Life-Extension and MCR activities, to evaluate risk. The baseline values are combined with the estimated predicted changes resulting from the proposed future site activities, including Life-Extension and MCR activities, to obtain the total environmental condition for the predictive effects assessment.

The outcomes of activities predicted to have an increased environmental impact in the 2017 PERA [R-12], along with any other new activities that have occurred on site in the last 5 years are described in Appendix D: Predictive Environmental Risk Assessment. A summary of the preliminary screening for future site activities in relevant media is included in the relevant ERA section. Full details of the preliminary screening are available in Appendix D: Predictive Risk Assessment [R-35].

1.8.4.2 Future Site Activities

The Life-Extension Program, which includes MCR of Units 3 to 8, was initiated on January 1, 2016 following signing of the amended, long-term agreement with the IESO. The description of future site activities, including MCR activities, forms the basis for the effects assessment. Future routine site operations, planned outages, and routine asset management activities are described, with a focus on how these may be different from existing site conditions and operations. For MCR, each Bruce Power system, structure and facility is described as to how they may change during each of the MCR activities (e.g., Reactor Retube and Feeder Replacement). For example, this may be through either increased activity or decreased activity. Additionally, Bruce Power intends to begin production of Lu-177, a medical isotope, in 2022.

Only normal operations are described. The PERA does not consider accident scenarios or unplanned operations (i.e., spills or leaks), consistent with CSA N288.6-12 [R-14]. The consideration of future site activities assumes MCR activities may be occurring on two units concurrently (e.g., Unit 6 and Unit 3 are both currently scheduled to be undergoing MCR activities during 2023), and also assumes planned outages may be occurring at the same time as the MCR activities and routine site operations. For the Life-Extension Program, the schedule has been optimized to allow for MCR unit overlap as shown in Figure 3. It is assumed that MCR activities will take place with increasing efficiency as the program is carried out. The anticipated MCR schedule by unit is shown on Figure 4.

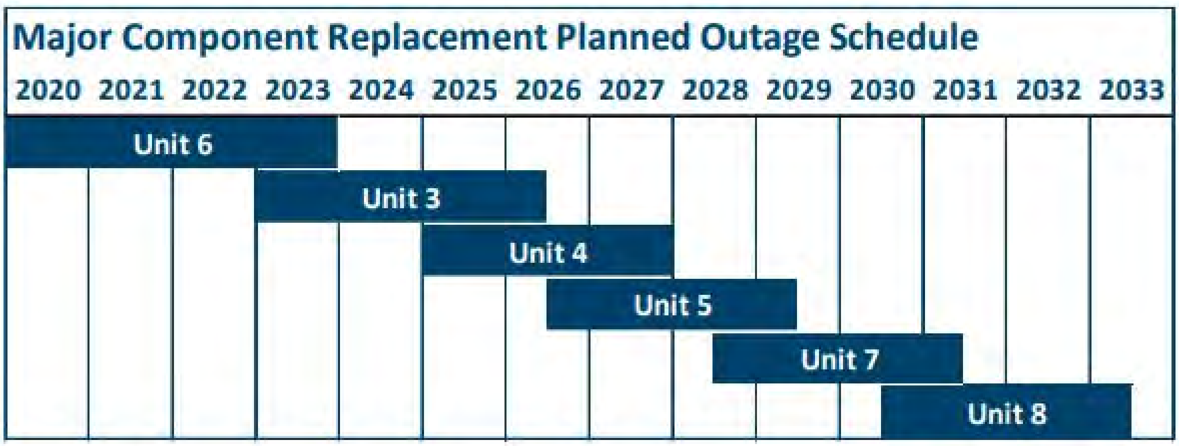

Figure 3 Major Component Replacement Schedule by Unit

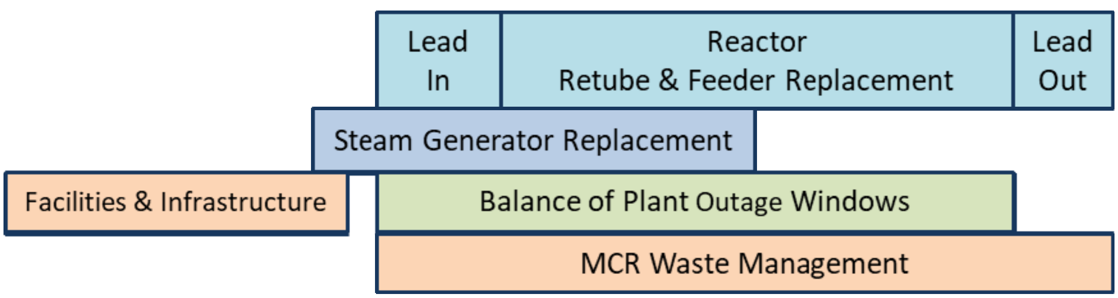

Figure 4 Sequence for Major Component Activities in Units 3 to 8

The Bruce Power Life-Extension program is responsible for implementing and executing the refurbishment of Units 3 through 8 by carrying out focused major component replacements on a range of nuclear and non-nuclear systems. The MCR program commenced with Unit 6 in 2020 and will end with Unit 8 in 2033. Installation of Life-Extension infrastructure common to all units and for Bruce B is complete. Infrastructure installation specific to Unit 3 and 4 MCR continues and is described in detail in Appendix D [R-35].

For each of Units 3 to 8, MCR involves the following primary activities and these are described in detail for Unit 3 and Unit 4 and for Unit 6 where the activity has not yet been completed, in Appendix D [R-35]. Future site activities will involve the Life-Extension program including MCR activities, and waste handling and waste management activities.

Life-Extension:

- Station system and component lay-ups and preventative maintenance work. This will be executed and the system condition monitored to ensure asset preservation over the MCR unit outage duration;
- Asset management and sustained capital projects such as transformers, pumps, and;
- Outage work, including planned and maintenance outages, station containment outages, and vacuum building outages.

MCR:

- Facilities and Infrastructure: Installation of facilities to support MCR activities at Bruce B is complete. These include an Administrative Building, Storage Buildings, Training Facilities, Material Handling Building and an Auxiliary Guardhouse. For the MCRs on Units 3 and 4, installation of an Auxiliary Guardhouse and a Material Handling Building will be completed in 2021 and 2022. These will support all future MCRs. Each MCR will have the following primary activities:
    - Lead In: This activity prepares the reactor and work area for reactor retube and feeder replacement activities. This has been completed for MCR6. Lead In activities include the following main tasks:
        - Reactor Shutdown and De-fuel: Removal of all fuel bundles using existing fuel handling equipment.
        - Vault Preparation: Installation of bulkheads in the unit undergoing MCR to isolate it from the other operating units and to create a safe working environment for reactor activities to take place.
        - Reactor Drain and Dry: Primary Heat Transport (PHT) and moderator drain and dry activities.
    - Reactor Retube and Feeder Replacement: This activity is a key objective of the MCR and will focus on the removal of feeders, pressure tubes, calandria tubes and the re-installation of new components. This activity is in progress for MCR6.
    - Steam Generator Replacement: This activity will include the removal, replacement and reconnection of eight steam generators for each unit undergoing MCR. This activity is in progress for MCR6.
    - Balance of Plant Work: This activity includes primary heat transport, electrical, safety systems, conventional systems, and cooling water system life-extension work. This activity is in progress for MCR6.

    - Lead Out: This activity will involve safe returning of the unit to its operational state and commissioning of the unit.

- Waste Handling and Waste Management: This ongoing activity encompasses the handling and management of non-radiological and radiological waste generated by future site activities, including MCR activities. Once MCR is complete, redundant facilities established for project activities will be removed.

A more detailed discussion of planned and occurring MCR activities is available in Appendix D [R-35].

1.8.5 Predictive Risk Assessment Outcomes (2016-2021)

Outcomes of Life Extension activities completed between June 2016 and June 2021 listed in the 2017 predictive risk assessment are described under each section and any measurable changes from routine operations are described. Additional activities and outcomes that represent a change from the 2017 predictive risk assessment are also included. A summary of these outcomes is presented in each chapter of the ERA and the full details are available in Appendix D [R-35].

In future ERAs, activities described as complete in this ERA will be integrated into routine effluent and environmental monitoring activities on the Bruce Power site and will no longer be discussed in the predictive risk assessment section.

1.8.6 Predictive Risk Assessment Methodology (2021-2026)

Future site works and activities may interact with the environment. These, along with professional judgement and knowledge of the Site, provide the basis for the identification of predicted environmental effects. The risk of change to the PERA's findings as a result of changes to assumptions regarding specific methods for carrying out future site activities is minimized by the general use of an “upper bounding” case to provide a conservative assessment of effects. During future site activities, all modifications, processes and activities will be conducted by trained staff and applicable procedures and regulations will be adhered to.

1.8.7 Preliminary Screening

The preliminary screening includes evaluation of potential interactions of future site activities, including Lu-177 production, Life-Extension and MCR activities, with the environment to identify those receptors, exposure pathways and Contaminants of Potential Concern (COPC) that may warrant further assessment. A summary of the preliminary screening is presented in each chapter of the ERA and the full details are available in Appendix D [R-35].

1.8.8 Quantitative Risk Assessment (if required)

Where a pathway or receptor is not bound by current operational conditions and the predicted change to a COPC and/or physical stressor cannot be screened using accepted guidelines, then the pathway and/or receptors are described in the conceptual site model and evaluated further in the quantitative predictive risk assessment, if required. No quantitative predictive risk assessments were required in the 2022 PERA.

1.8.9 Environmental Protection and Monitoring

The environmental protection and monitoring program for the Site is summarized in Section 1.5. Additional information is provided in this section relevant to the PERA.

Over the past 15 years, Bruce Power has gained a significant amount of experience in the restart and refurbishment of its CANDU reactors. These lessons learned will be reviewed and applied as MCR activities progress. The applicable Bruce Power environmental management programs are outlined in the section following, along with how they may evolve through MCR and continued station operations. Overall, potential environmental effects of future activities are anticipated to be similar to those associated with the existing operations. Therefore, the existing environmental monitoring programs will be retained as required to confirm predictions and be reported through the annual EMP findings.

To support the objectives of MCR, an Environmental team was made up of in-house Environmental Technical Officers assigned to focus solely on environmental protection during execution of project deliverables. This team was started in 2015 and provides environmental governance and oversight of the project through stakeholder involvement in design reviews and work packages, completion of Environmental Impact Worksheets (EIW), Environmental Management Plans (EMPs), procedural adherence, and walkdowns. EIWs and EMPs are Bruce Power's Environmental Management System tools to capture the environmental evaluation and outline environmental requirements necessary to ensure the work is carried out in an environmentally protective manner, mitigate risk, and ensure the evolutions remain in compliance with regulatory requirements. The EIWs and EMPs will be updated as needed as the program continues and will be used for ongoing monitoring during project execution.

1.8.10 Recommended Modifications to Monitoring

Recommendations for monitoring or risk management may be made based on the results of the PERA. Per CSA N288.4 [R-15] and CSA N288.5 [R-16], the results of the PERA will inform the Bruce Power Environmental Monitoring Program (EMP) and emission/effluent monitoring programs.

The existing environmental monitoring programs described in Sections 1.5 are anticipated to continue through the current licensing period. The assessment conducted as part of the PERA (see Appendix D: Predictive Risk Assessment [R-35]) has confirmed there are no substantial changes to the environmental monitoring program recommended at this time.

1.9 QA/QC Requirements

The ERA makes extensive use of environmental monitoring data. Specific Quality Assurance/Quality Control (QA/QC) procedures undertaken during the collection of this information are outlined in the 2021 Environmental Protection Report [R-108]. Additional QA/QC procedures were used for the preparation of thermal monitoring data in the thermal risk assessment. These procedures are detailed in Appendix I [R-35].

Throughout the planning and preparation of the ERA, all work was internally reviewed and verified. Reviews included verification of data and calculations, as well as review of report content.

2.0 HUMAN HEALTH RISK ASSESSMENT FOR CHEMICALS

The HHRA component of the ERA assessed the potential health risks to people who could potentially come into contact with environmental media (i.e., soil, surface water or air) and local food and water sources that may be affected by historical and ongoing activities at the Site. This section focusses on potential risks to human health due to non-radiological chemicals.

2.1 Problem Formulation

The purpose of the problem formulation stage is to scope the assessment by identifying the environmental issues of concern, and identifying the receptors, exposure pathways and COPCs for which further quantitative analysis is warranted from those that can be eliminated from further consideration. Once this analysis is complete, the results from the problem formulation stage are summarized in a conceptual site model (CSM), which illustrates how receptors can potentially come into contact with identified COPCs in relevant environmental media that have been affected by historical and ongoing activities at the Site.

2.1.1 Receptor Selection

The Site description is provided in Appendix A. The only people expected to be present on-site for extended periods of time are those that are classified as Nuclear Energy Workers (NEWs), as well other on-site workers. The health and safety of on-site workers is strictly regulated and monitored, and there are a number of health and safety programs/protocols in place for the Site that applies to NEWs. Additionally, as described in CSA Standard N288.6-12 [R-14], assessment of on-site workers is not typically incorporated into risk assessments under the Standard. Strict compliance with all applicable occupational health and safety protocols was assumed and as a result, on-site workers were not assessed in the HHRA.

The human receptors to be assessed in the non-radiological HHRA were selected based upon the known current and likely future uses of the Site and its surrounding area as described in the Site Specific Survey [R-109]. This selection process is summarized in the previous SLRA [R-10] and below.

2.1.1.1 Receptor Selection Process

The human receptors remain unchanged from the 2017 ERA report, with the exception of the exclusion of visitors to the Indigenous Spirit Site located on OPG retained lands [R-12]. The selection process followed is described in the Site Specific Survey [R-109] and includes public involvement and consultation. Based upon the known land uses both on the Site and in the area, potential human receptors were identified as described below.

2.1.1.2 Receptor Descriptions

A brief description of the activities and basic characteristics of each human receptor considered for assessment in the non-radiological HHRA is provided below.

1. Members of Indigenous Communities

   The nearest Indigenous communities are Chippewa's of Saugeen First Nation Reserve No. 29 and Chippewa's of Nawash Unceded First Nation Cape Crocker Reserve No. 27 [R-10]. Members of the Métis Nation and the HSM may also reside in the area around the Site. There is also an Indigenous Spirit Site on the portion of the site retained by OPG [R-110] that may be visited occasionally by members of Indigenous communities. Because the Spirit Site is located on OPG retained lands, visitors to this site are not assessed in the 2022 HHRA.

2. Local Residents

   Local residents include people who live at the nearest homes, including farms and cottages if they are used year-round. Residents include non-farm residents, farm residents, subsistence farm residents, and dairy farm residents. Potential pathways of exposure considered in the HHRA include inhalation of ambient air (represented by air concentrations predicted at the Site property boundary), consumption of drinking water (represented by shallow residential wells or treated water from local municipal supplies), and direct contact with surface water (represented by off-shore surface water at Lake Huron including off the Bruce A and Bruce B discharges).

3. Seasonal Users

   The HHRA evaluated seasonal cottagers and campers at nearby parks. There are several provincial parks located along the shores of Lake Huron, including Inverhuron Provincial Park that borders the Site to the south. Potential pathways of exposure considered for seasonal users include inhalation of ambient air (represented by predicted ambient air concentrations at the Site property boundary), consumption of drinking water (represented by shallow residential wells or treated water from local municipal supplies), and direct contact with surface water (represented by off-shore surface water at Lake Huron including off the Bruce A and Bruce B discharges), while swimming in recreational areas along Lake Huron.

4. Bruce Eco-Industrial Centre (BEC) Workers

   This receptor group includes people who work at the Bruce Eco-Industrial Park and are nearby off-site workers. As described in the previous SLRA [R-10], exposure by these receptors is bounded by the other receptors listed above and therefore was not considered further in the non-radiological HHRA.

2.1.2 Identification of Chemicals of Potential Concern

2.1.2.1 Screening of Chemicals in Bruce A and Bruce B Discharges

As described in Section 3.4 of Appendix C, no COPCs were identified for surface water discharges from the Bruce A and Bruce B facilities; therefore, potential exposure to COPCs in Bruce A and Bruce B discharges has not been retained for further assessment in the HHRA.

2.1.2.2 Screening of Chemicals in Air

As described in Section 3.4 of Appendix C, no COPCs were identified for airborne emissions from the Bruce A and Bruce B facilities; therefore, potential exposure to COPCs in air has not been retained for further assessment in the HHRA.

2.1.2.3 Screening of Chemicals in Soil

As described in Section 3.4 of Appendix C, no off site soil sampling was completed. Therefore, potential exposure to COPCs in soil has not been retained for further assessment in the HHRA.

2.1.2.4 Screening of Chemicals in Groundwater

On-site groundwater is not used as a potable water source for on-site workers assessed in this HHRA. Given that there is no complete exposure pathway by which human receptors may come into contact with on-site groundwater, this environmental medium was not retained for further assessment in the HHRA.

Potential off-site migration of on-site groundwater was considered when evaluating the off-site shallow residential drinking water wells, which is described in Section 2.1.2.7 below.

2.1.2.5 Screening of Chemicals in Surface Water

Public access to the Site is restricted; therefore, human receptors were not considered to come into contact with surface water in the small streams and waterbodies within the facility footprint (i.e., Stream C). However, people access Lake Huron at various locations along the shoreline and these were considered further in the secondary screening. As described in Section 3.4 of Appendix C, no COPCs were identified in surface water in relation to recreational use by humans (i.e., incidental ingestion and dermal contact with surface water while swimming). The noted exceedances of the preliminary screening standards were not considered further in the HHRA as maximum observed concentrations did not exceed their Canadian Drinking Water Guidelines (note that in many cases the preliminary screening standards were based upon the protection of freshwater aquatic life rather than human health). As a result, surface water was not considered further in the HHRA.

2.1.2.6 Screening of Chemicals in Sediment

As described in Section 2.1.2.5 above for surface water, site access is restricted, and no recreational use is permitted within the Site's fenceline. As a result, sediment exposure on-site is an incomplete pathway. The beach areas along the shoreline are comprised of coarse, sandy substrate that is not expected to have the necessary binding sites that permit adsorption of chemicals released from the Site. Therefore, given that there is no complete exposure pathway by which human receptors may come into contact with COPCs in sediment, this environmental medium was not retained for further assessment in the HHRA.

2.1.2.7 Screening of Chemicals in Drinking Water

As described in Section 3.4 of Appendix C and in the 2017 ERA [R-12], no COPCs were identified in the off-site shallow residential drinking wells and the local drinking water treatment plants. The noted exceedances of the preliminary screening standards are associated with the water treatment process and/or are not attributed to the operations at the Bruce Power facilities. As a result, drinking water was not considered further in the HHRA.

2.1.3 Selection of Exposure Pathways

Based on the information presented in Sections 2.1.1 and 2.1.2 above, there are no COPCs identified in any applicable environmental media. As a result, risks to human health are negligible as a result of chemicals.

2.1.4 Human Health Conceptual Site Model

The pathways by which human receptors may come into contact with COPCs in the various environmental media are illustrated in a CSM. The CSM for off-site human receptors around the Site is provided in Figure 5. All of the potential exposure pathways for each of the human receptors identified in the problem formulation have been included on the CSM. Given that there were no COPCs identified in Bruce A and Bruce B discharges, air, soil, surface water, groundwater, sediment, and drinking water, all exposure pathways associated with these environmental media are shown as incomplete (i.e., a dotted line). The exposure pathways are considered incomplete because there are no COPCs identified from any source with the potential to encounter a human receptor at levels above the human health-based screening guidelines. Complete pathways, if present, would be identified by solid lines and represent a potential exposure to a COPC at levels above the human health-based screening guidelines.

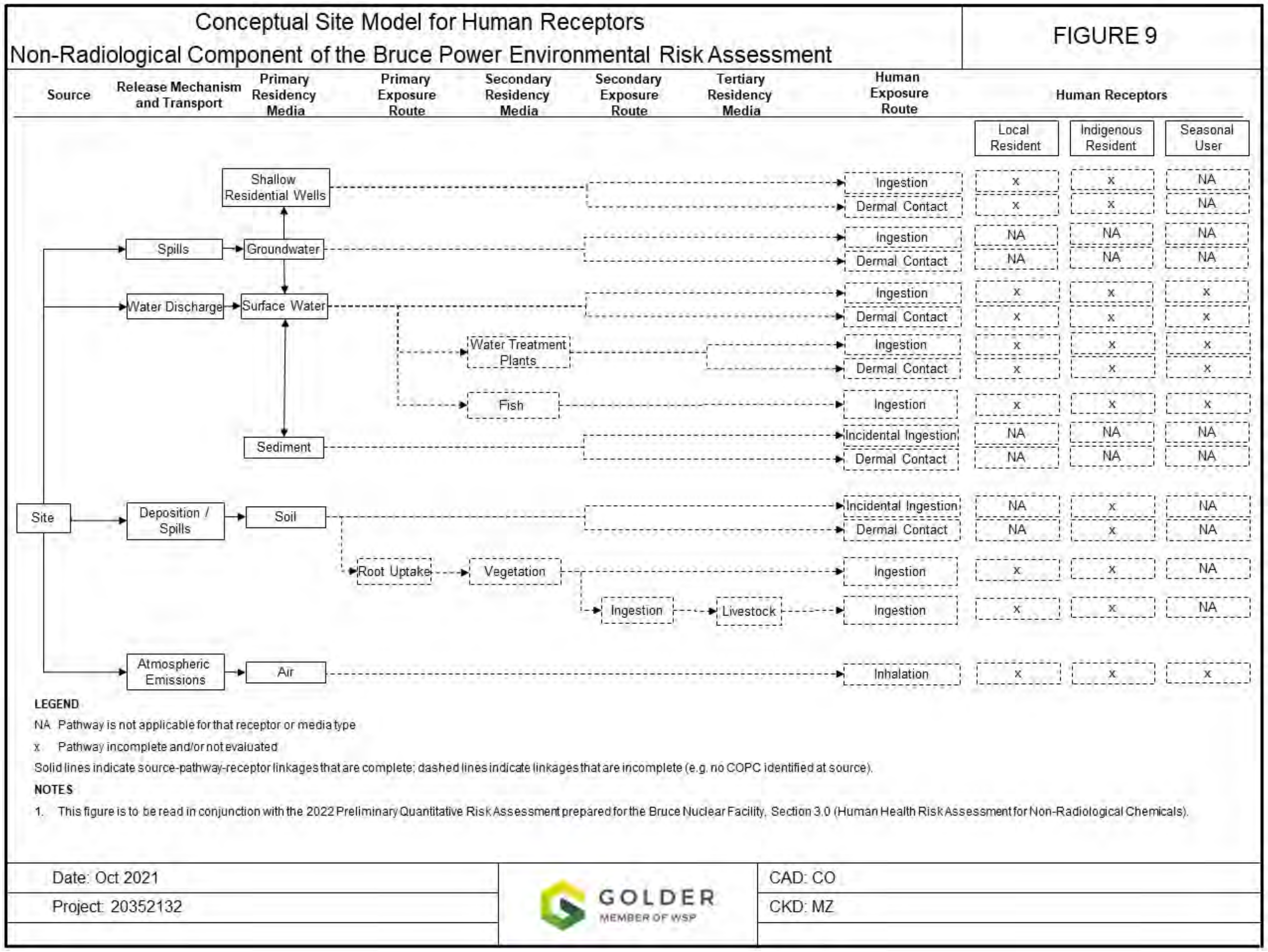

Figure 5 Conceptual Site Model for Human Receptors

2.2 Exposure Assessment

The exposure assessment typically describes: (1) all relevant human receptors, including the characteristics of those receptors; (2) all potential pathways by which human receptors could be exposed to the COPCs and justification of those pathways which are complete and incomplete; (3) the exposure estimates for each complete exposure pathway, which are typically represented by maximum observed concentrations for each COPC, or determined by calculating the representative 95% Upper Confidence Limit of the Mean (UCLM) for each COPC. Given that COPCs were below screening levels set to be protective of human health, further exposure assessment is not required.

2.2.1 Toxicity Assessment

The toxicity assessment provides the basis for assessing what is an acceptable exposure and what level of exposure may adversely affect human health. This involves identification of the potentially harmful effects of chemicals, and determination of the dose that a receptor can be exposed to without experiencing adverse effects. This value is called the toxicity reference value (TRV) and is expressed as mg of a chemical per kg of body weight per day (mg/kg-day). Given that COPCs were below screening levels set to be protective of human health, further toxicity assessment is not required.

2.2.2 Risk Characterization

In the risk characterization step, information from the exposure and toxicity assessments are combined to determine if a potential health risk exists. Risks may be estimated qualitatively based on scientific judgment or quantitatively by comparing the estimated daily intake to the selected TRV. Given that COPCs were below screening levels set to be protective of human health, further estimation of risk (qualitative or quantitative) is not required.

2.3 Predictive Human Health Risk Assessment for Chemicals

Environmental outcomes of completed activities predicted to have increases in environmental interactions in the 2017 predictive risk assessment are reported in Appendix D [R-35], Section 4.3. Preliminary screening of interactions for future planned site activities, including Lu-177 production and MCR are reported in Appendix D [R-35], Section 4.4.

Activities assessed under the 2017 PERA [R-12] and completed to date have not demonstrated a negative environmental impact on conventional air quality or the human environment. No adverse outcomes impacting conventional air emission or waterborne effluent have occurred to date resulting from new activities occurring on site. In the absence of substantial changes to air emissions or waterborne effluent resulting from MCR activities, there has been no substantial change in environmental monitoring results. With these stable environmental monitoring results, there has been no change to the overall outcome of the HHRA resulting from new activities occurring on site between 2016 and 2021.

Current operational conditions have been shown to be bounding of predicted changes for conventional air and surface water quality as a result of future activities at site. As such, changes predicted in these environmental components are not considered as potentially affecting human receptors.

2.3.1 Conclusion

The outcomes of Life Extension and MCR activities on site have not shown a measurable human health impact to date. For additional new activities, including Life Extension, MCR and Lu-177 production, current operational conditions are demonstrated to be bounding of future activities. The updated ERAs continue to be bounding of the proposed activities. The non-radiological HHRA evaluated the potential for health risks for members of the public, and the potential for health risks due to non-radiological chemicals were shown to be negligible considering normal operations at the Site.

2.4 Overall Conclusions of the Human Health Risk Assessment

The human health risk assessment for chemicals identified no unreasonable risk for people using the lands around the Site for recreational or residential/agricultural uses.

3.0 HUMAN HEALTH RISK ASSESSMENT FOR RADIOLOGICAL CONTAMINANTS

The Human Health Risk Assessment (HHRA) for radiological contaminants assessed the potential health risks to people who could come into contact with environmental media (i.e., soil, water or air) and local food sources that may be contaminated by radioactive material released as a result of historical and ongoing activities at the Site.

3.1 Problem Formulation

The purpose of the problem formulation stage is to scope the assessment by identifying the radionuclides of concern, exposure pathways and receptors for the assessment of the radiological risk to members of the public. Once this analysis is complete, the results from the problem formulation stage are summarized in a conceptual site model (CSM), which illustrates how receptors can potentially be exposed to radiation emitted from radionuclides in relevant environmental media that have been affected by historical and ongoing activities at the Site.

As described in the SLRA [R-10], all radionuclides released from operations on the Site were carried forward for quantitative assessment due to public concern regarding radiation and radioactive material.

3.1.1 Receptor Selection

The Bruce Power Site Specific Survey Report documents information regarding land usage, population distribution, meteorology, hydrology, water sources, water uses and food sources [R-109]. The following categories of representative persons were identified in the Site Specific Survey Report, based on distinct lifestyle and proximity to the Site:

- Non-farm resident (BR);
- Farm resident (BF);
- Subsistence farm resident[1] (BSF);
- Dairy farm resident (BDF);
- Hunter/Fisher resident (BHF); and
- Bruce Eco-Industrial park worker (BEC).

The subsistence farm resident is defined as an individual for whom over half of their diet is self-produced. Therefore, this group is representative of Mennonite/Amish farmers and other residents who depend predominantly on locally-grown foodstuff.

[1] Previously referred to as Mennonite farm residents in Bruce Power Environment Programs documentation.

The hunter/fisher resident is defined as an individual who catches and consumes wild game and fish in significantly greater quantities than other residents. In this context, the hunter/fisher resident is representative of Indigenous populations. Bruce Power has conducted surveys of the Saugeen Ojibway Nation (SON), Historic Saugeen Métis (HSM) and Métis Nation of Ontario (MNO) from 2019 – 2021. These surveys collected information on the lifestyles of local Indigenous groups, including dietary information, sources of food and water, and the use of wild flora for medicinal and ceremonial purposes. The data from these surveys has been used to establish intake rates and local intake fractions of fish, wild game, and other foodstuffs to ensure that the assessment is representative of the characteristics of Indigenous residents living near Site.

For the purposes of the HHRA, the representative persons as identified in the Site Specific Survey [R-109] are the human receptors. There are a total of 19 representative persons each comprised of an adult (16 to 70 years old), child (6 to 15 years old), and infant (0 to 5 years old) [R-111] except for the Bruce Eco-Industrial park worker, who is assumed to be an adult. All representative persons are located within 15 km from the Site, with the exception of the hunter/fisher resident, who is located approximately 20 km north of the site. The list of representative persons is consistent with the previous environmental risk assessment for the Site. The 2021 Site Specific Survey Report provided additional insight into the dietary intake rates of local Indigenous populations which is reflected in the updated characteristics of the hunter/fisher group [R-109].

Additional description of the human receptors is available in Appendix B: ERA Methodology [R-35]. A map of receptor locations is provided below in Figure 6.

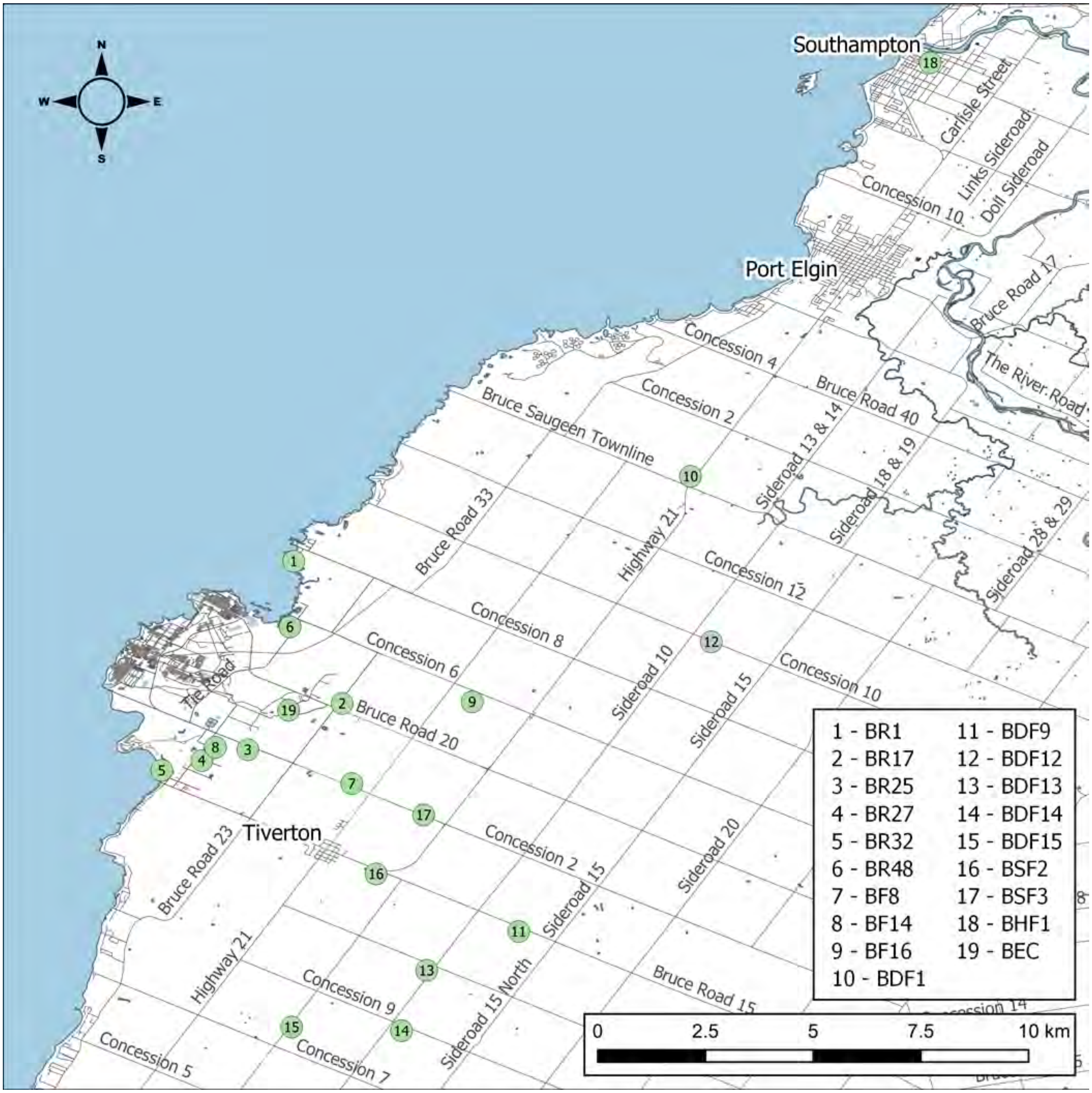

Figure 6 Human Receptor Locations

3.1.2 Selection of Radiological Contaminants

In order to establish average and upper range exposure concentration data, this assessment examines the airborne and waterborne effluents from all facilities on the Site, from 2016 to 2020 inclusive. Therefore, the average exposure assessment is based on the average annual release from the Site of each radionuclide category; the upper range exposure assessment is based on the maximum annual release from the Site of each radionuclide category.

The radiological contaminants released from the Site include those from the following facilities:

- Bruce A Nuclear Generating Station;
- Bruce B Nuclear Generating Station;
- Central Maintenance Facility (CMF);
- OPG Western Waste Management Facility (WWMF);
- CNL (formerly AECL) Douglas Point Waste Management Facility (DPWMF); and
- Kinectrics North Facility.

Additionally, the Central Storage Facility (CSF) began operations in December 2020. While this facility monitors and reports tritium and particulate emissions, emission rates are negligible relative to overall Site emissions. Emissions from the CSF are not explicitly considered in this ERA, but given that CSF emissions are a small fraction of overall site emissions, there is no impact on the radiological HHRA results.

The values shown in Figure 7 and Figure 8, represent the summation of airborne and waterborne releases from Bruce A, Bruce B, CMLF, WWMF, DPWMF and Kinectrics North [R-112]–[R-116]. Appendix J [R-35] contains the quantitative data from which the following figures are developed. All activities are reported in becquerels (Bq), with the exception of noble gases which are reported in Bq-MeV.

The airborne release categories presented in the figures below, and that are used throughout the radiological risk assessment, are the ones reported by Bruce Power in their annual Environmental Monitoring Reports [R-112]–[R-116]. The airborne radionuclide groups are reported as follows:

- Tritium oxide as water vapour (HTO);
- Noble gases;
- Carbon-14;
- Mixed fission product iodines;
- Gross alpha particulates; and
- Gross beta/gamma particulates.

The waterborne radionuclide groups are reported as follows:

- Tritium oxide as irradiated water (HTO);
- Carbon-14;
- Gross alpha; and
- Gross beta/gamma.

Radioiodines released to the atmosphere are assumed to be in the form of mixed fission products, I(mfp), consisting of I-131 along with short-lived radioiodines I-132 to I-135 present in a ratio associated with a state of equilibrium. The dose calculation process conservatively assumes that all iodine is I-131 for longer duration pathways (i.e., anything related to sediment or soil partitioning, or bio-uptake), but for shorter duration pathways (i.e., air inhalation or immersion) the full release is equivalent to I(mfp).

The gross beta/gamma emitters, cobalt-60 and cesium-134, have been measured to be below detection limits in environmental media outside the Site boundary, including soil, sediment, fish, and deer. Cesium-137 has been measured above detection limits, but concentrations in soil outside the Site boundary have been indistinguishable from measurements at background locations. Cobalt-60 is conservatively selected to represent gross beta/gamma in airborne emissions and waterborne effluents since it has the highest external dose coefficient and therefore leads to the highest (most conservative) dose among gamma-emitters routinely emitted from Site operations. Concentrations of cobalt-60 in most environmental media, where it has been either less than detection limits or not directly measured, are conservatively determined using the IMPACT modeling software.

Releases of alpha emitters are conservatively assumed to consist solely of neptunium-237 for airborne emissions, and plutonium-239 for waterborne effluents. These radionuclides are not directly detected, but are selected because they have the most restrictive DRLs of alpha emitting radionuclides for airborne emissions and waterborne effluents, respectively. Since alpha emitters in environmental media are not analyzed as part of environmental monitoring, the transport of alpha emitters through the environment and in the food chain is modelled in this ERA using the IMPACT software. Therefore, the selection of radionuclides with the most restrictive DRLs as representative radionuclides will result in the most conservative estimate of risk due to alpha emitters.

It is noted that in previous years, effluent and emissions monitoring results that were less than the limit of detection were conservatively assumed to be equal to the limit of detection. As of 2016, results below detection limits are considered to be indistinguishable from background and are not included in effluent release totals. This has resulted in decreases in reported emissions of iodine, gross beta/gamma, and most significantly gross alpha. An analysis of uncensored alpha measurement data has confirmed that the previous approach was overly conservative and that the exclusion of results below detection from effluent and emissions totals is justified (Appendix J [R-35]).

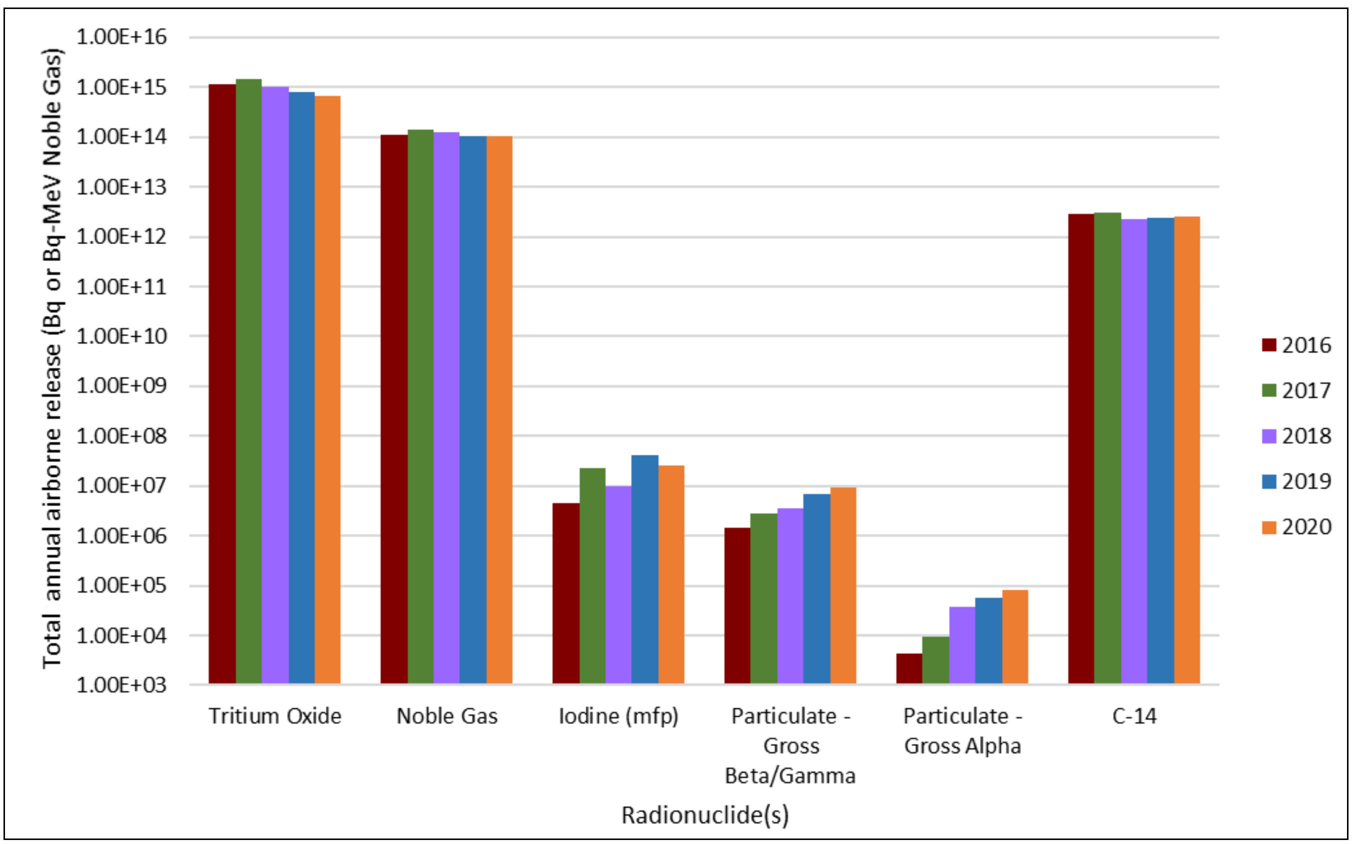

Figure 7 Total Airborne Releases from All Facilities on the Site (2016-2020)

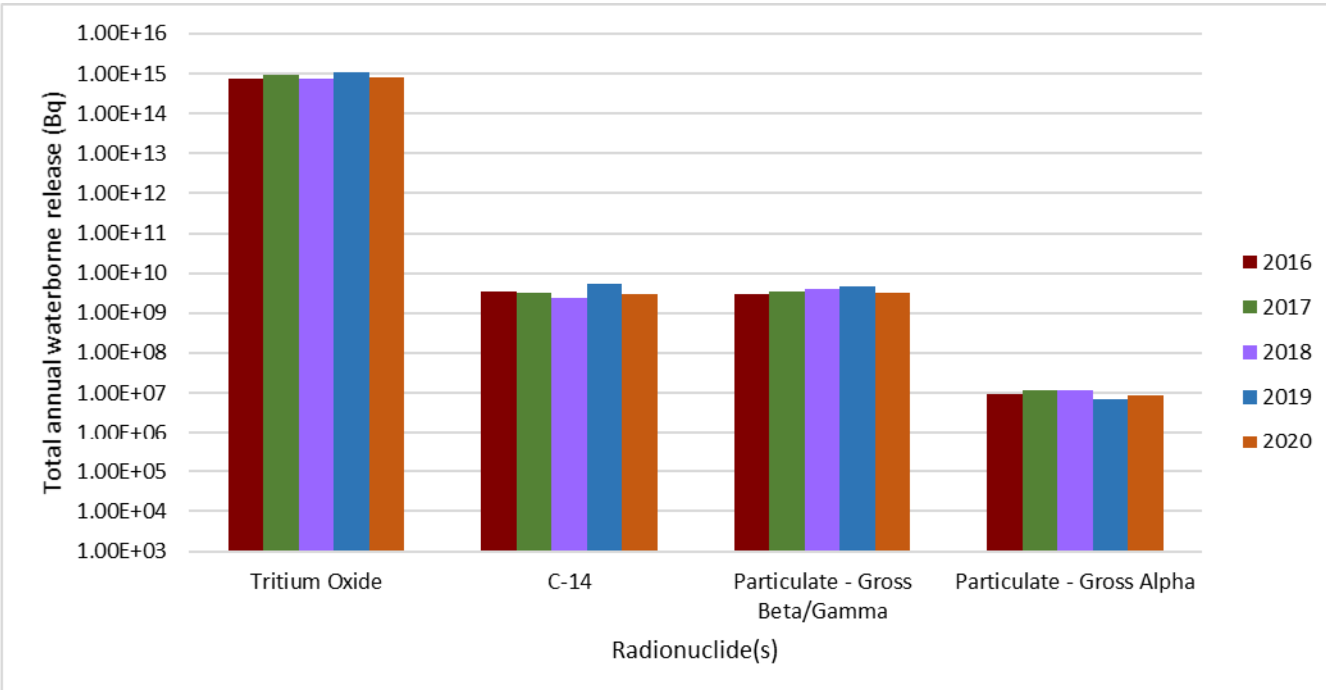

Figure 8 Total Waterborne Releases from All Facilities on the Site (2016-2020)

3.1.3 Selection of Exposure Pathways

IMPACT was used to model and calculate the radiation dose to humans for each radionuclide as a result of the following exposure pathways:

- Air inhalation;
- Air immersion;
- Water ingestion;
- Water immersion;
- Soil ingestion (incidental);
- Soil external (ground shine);
- Terrestrial animal ingestion;
- Terrestrial plant ingestion;
- Aquatic animal ingestion;
- Aquatic plant ingestion;
- Sediment ingestion (incidental); and,
- Sediment external.

3.1.4 Human Health Conceptual Model

The transport of radioactive material through various environmental media and food chains is illustrated in the conceptual model shown in Figure 9, which is adapted from CSA Standard N288.1 [R-111].

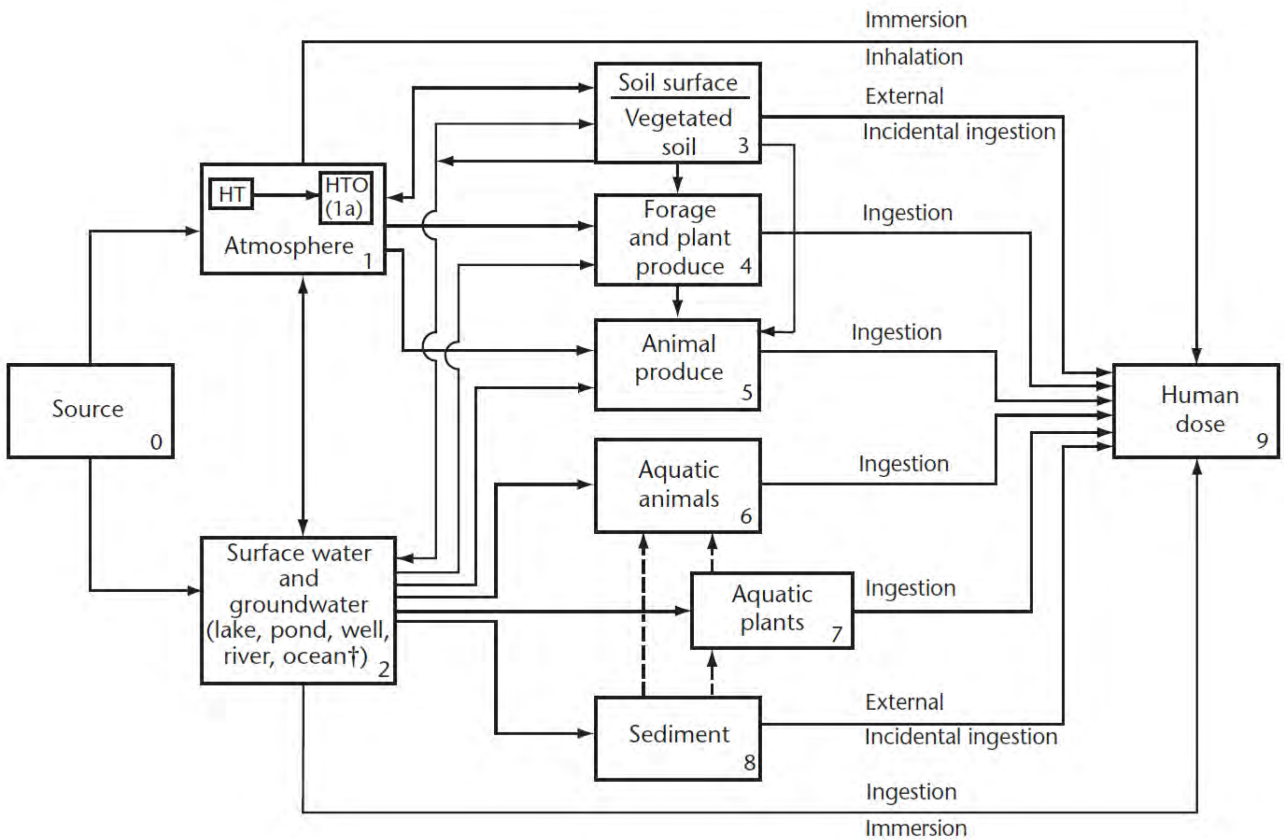

Figure 9 Human Health Conceptual Model

The Integrated Model for the Probabilistic Assessment of Contamination Transport (IMPACT) was used to model and calculate the radiation dose to each human receptor. The model is described in Appendix B: ERA Methodology [R-35].

Meteorological inputs and characteristics of airborne emissions and waterborne effluents are located in Appendix B: ERA Methodology [R-35].

3.2 Exposure Assessment

A full quantitative exposure assessment was carried out for each receptor (i.e., representative person) at the locations identified at the Problem Formulation stage. Full details of the exposure assessment are presented in Appendix B: ERA Methodology [R-35].

3.2.1 Receptor Characteristics and Exposure Scenarios

The Site Specific Survey Report documents water usage and dietary intake information for the residents within 10 km of the Site. The results of the site specific survey define the following local intake fractions for each receptor category:

- Fraction of locally obtained water (municipal/private well/community well) used for drinking, bathing, gardening and sanitation;
- Fraction of locally grown fruits and vegetables consumed;
- Fraction of locally raised livestock/eggs/milk/deer consumed; and
- Fraction of locally caught fish consumed.

These fractions were entered into the IMPACT model; they are listed in Appendix C of the 2021 Site Specific Survey Report for the Bruce Power Site [R-109].

Based on the results of the Site Specific Survey, the amount of wild meat consumed by local residents is approximately 18 times more than average Canadian diets. Therefore, the terrestrial animal intake rates for infants, children and adults were increased to account for increased consumption of wild meat for the non-farm, farm, subsistence farm, and dairy farm receptors. The specific intake rates are provided in the Site Specific Survey Report for the Bruce Power Site [R-109].

As discussed in Appendix B [R-35], fish and wild game intake rates for the generic hunter/fisher receptor were based on the Site Specific Survey Report [R-109]. The characteristics of the hunter/fisher receptor have been updated with information obtained from surveys of local Indigenous groups in order to ensure that the assessment is representative of the Indigenous residents living near Site. The surveys have demonstrated that intake rates of wild game may be up to 24.3 times higher than the average Canadian diet, while intake rates of fish and shellfish may be up to 1.35 times higher. For the updated hunter/fish receptor the bounding local intake fraction results from these recent surveys were used.

All other receptor characteristics, including but not limited to the following, were derived from CSA Standard N288.1 [R-111]:

- Human ingestion rates for terrestrial plants, aquatic animals, and water (95th percentile);
- Inhalation rates for air (95th percentile);
- Outdoor occupancy factor;
- Exposure fractions (e.g., outdoor air, soil, lake sediment);
- All wildlife (terrestrial and aquatic) input and exposure fractions; and
- Physical and hydrological characteristics of wells and bodies of water.

As per CSA Standard N288.1, the water intake rate for infants is assumed to be zero, as total liquid intake is accounted for as fresh cow's milk consumption [R-111].

Radionuclide-Specific Factors

All radionuclide-specific factors are based on CSA Standard N288.1 and the COG DRL Guidance [R-111][R-60]. These include environmental transport factors (e.g., distribution coefficients, bioconcentration factors and transfer factors), dose coefficients and shielding factors.

The selection of representative radionuclides is discussed in Section 3.1.2.

3.2.2 Exposure Point Concentrations

The objective of the HHRA is to determine the dose to human receptors as a result of being exposed to both average and upper-range concentrations of radioactive material in the environment. As recommended in CSA N288.6-12, upper-range values are used for a PQRA, while average values are more suitable for a DQRA. The exposure point concentrations were calculated following the general methodology used for the annual Bruce Power Environmental Monitoring Reports. The following steps were taken to determine the exposure point concentrations (i.e., dictator concentrations in IMPACT) at each receptor location:

1. Radiological data for environmental media surrounding the Site from Bruce Power's Environmental Monitoring was collected for the years 2016 to 2020 inclusive.
2. Radiological data for environmental media in provincial background/Bruce Power far-field (control) locations was collected for the years 2016 to 2020 inclusive.
3. Background concentrations were subtracted from measured concentrations surrounding the site and were converted as necessary to appropriate units for the dictator sources in IMPACT [R-117][R-118] (see Appendix L [R-35]).

4. For each combination of receptor location, environmental medium and radionuclide:

    a) The average concentration is calculated as the average of the annual average background-subtracted concentrations over the five years.

    b) The upper-range concentration is the maximum annual average background-subtracted concentration over the five years.

The outputs for each of the steps, including the exposure point concentrations for each receptor, are tabulated in Appendix L [R-35].

Bruce Power Radiological Environmental Monitoring has been designed to meet the requirements of Canadian Standards Association (CSA) N288.4, Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills [R-15]. The design of REM is based on environmental risk, and includes a pathways analysis in order to develop and justify the selection of:

- Significant radionuclides and pathways.
- Environmental media for specific radionuclides to be monitored.
- Appropriate locations for monitoring.
- Appropriate monitoring frequencies and sensitivities of analysis.

Methods for dealing with values less than the limits of detection were applied according to Appendix D of N288.4-10 [R-15]. Where environmental monitoring data is less than the associated limit of detection (Ld) or critical level (Lc), those values were taken as reported. For example, in the calculation of local or background averages where some measured values were reported as less than Lc or Ld, the uncensored analytical results were used in the calculation of the average. In previous years' dose calculations, values <Ld or <Lc were assumed to be half of the respective limit for background samples, and equivalent to the limit for local samples. This change in procedure, initiated for the 2018 dose calculations, is intended to achieve consistency in reporting of REM data and also to achieve consistency with other procedures where those data are also used. The implications of this change to the reported doses are very minor. In most cases, the resulting doses are slightly more conservative (i.e., higher) in following the new approach. In some cases where uncensored data is not available, the critical level is used as an upper bound on the applicable environmental media concentration.

For the years 2016 to 2020, the majority of the following samples were reported as having concentrations less than the applicable L_d or Method Detection Limit (MDL) for both the area surrounding the Site and background locations:

- Deep well water (tritium);
- Soil (Cesium-134 and Cobalt-60);
- Milk (Iodine-131);
- Deer (Cesium-134, Cobalt-60);
- Sediment (Cesium-134 and Cobalt-60); and
- Fish (Cesium-134 and Cobalt-60).

For the majority of measurements surrounding the Site that were reported as less than L_d, exposure point concentrations were not specified in the IMPACT model. This allows the model to calculate concentrations based on site emissions and generally conservative environmental transfer factors.

Soil

It is noted that while cesium-137 was measured above detection limits in soil, samples from the vicinity of the site had comparable concentrations to far-field background locations. As shown below in Figure 10, there is variability in measured concentrations of cesium-137 in the vicinity of the Site, as well as in background locations, which includes Amberley (approximately 30 km from the Site) and provincial locations (Cobourg, Goderich and Lakefield). Provincial data, as of 2017, is only collected every five years. The average concentration of cesium in soil was only above background in 2016, with an average background-subtracted value of 0.681 Bq/kg-dw. However, the five-year average of the samples near site is 2.0 Bq/kg-dw while the five-year average for the background values is 4.8 Bq/kg-dw. Based on these data and as shown in Figure 10, it is not possible to definitively conclude that there is a detectable amount of cesium-137 in soil at receptor locations that is solely attributable to emissions released from the Site. Therefore exposure point concentrations of cesium-137 in soil were not specified, allowing the value to be conservatively calculated by the IMPACT model.

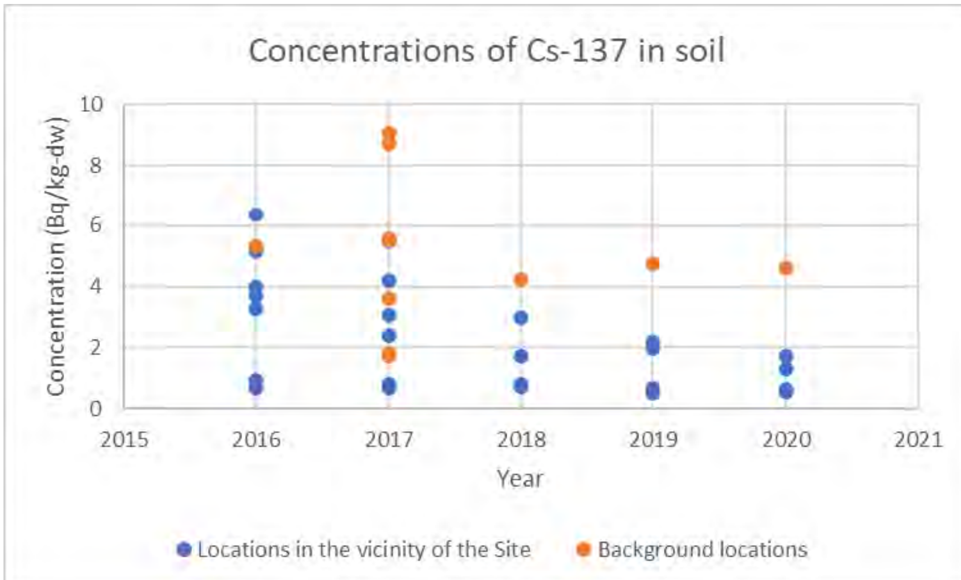

Figure 10 Concentration of Cesium 137 in Soil Sampled Near the Site and at Background Locations

<u>Fish and Deer</u>

Cesium-137 has been measured above detection limits in fish and deer. No background measurements of cesium-137 in deer are available. As listed above, concentrations of cobalt-60 and cesium-134 have been measured to be below detection limits for both fish and deer, and therefore beta/gamma emitter concentrations in fish and deer were not specified in the IMPACT model. Where cobalt-60 and cesium-134 concentrations are below detection, the value in the model is conservatively set to be the critical level. The background level (subtracted value) of cesium-137 in deer is conservatively assumed to be zero.

<u>Sediment</u>

Cesium-137 in sediment has been measured above detection limits and background levels, therefore the measured values are used to dictate sediment concentrations in the model. Cobalt-60 and cesium-134 have been measured to be below detection limits in sediment. In order to avoid double counting of environmentally monitored and modelled gamma emitters in sediment (i.e., measured cesium-137 concentration, in addition to modelled cobalt-60 representing gross beta/gamma particulate emissions), cesium-134 and cobalt-60 concentrations are dictated in the model based on the recorded critical level concentration. This is a conservative assumption since the actual concentration of cobalt-60 and cesium-134 in sediment is between zero and the critical level.

General Methodology

Wherever background measurements (i.e., measurements of radionuclide concentrations in environmental media taken from provincial or far-field (control) locations) were reported as less than MDL, they were conservatively assumed to be equal to zero. As well, when background corrected values were calculated to be negative, they were omitted.

Utilizing the approach described above, exposure point concentrations are either conservatively estimated by the model based on emissions data, or the most conservative background-subtracted measured concentrations are specified for environmental media. The degree of uncertainty associated with these assumptions and its effect on the exposure results is discussed in Section 3.2.4.

As indicated in Table 6, three approaches were used to correlate measurements from Environmental Monitoring to the exposure point concentrations. Each of these approaches is described in the following paragraphs. For all other media-radionuclide combinations, for those radionuclides selected as contaminants for the ERA (Section 3.1.2), IMPACT was used to conservatively model environmental transport and determine exposure point concentrations.

Since the hunter/fisher receptor is located approximately 20 km from the Site, which is outside the boundary of Environmental Monitoring, IMPACT was used to entirely model environmental transport of radionuclides in the majority of environmental media. For radionuclides in air, concentrations were specified based on the nearest measurement location (monitoring location B8 at Port Elgin), using measured values for tritium oxide (HTO). For other airborne radionuclides, concentrations were calculated using the dilution factor approach described below.

Approach 1: Measurement at Closest Monitoring Location to Receptor

Air monitoring stations surrounding the Bruce Power site measure tritium and carbon-14. Additionally, fruits and vegetables are sampled at specific monitoring locations in the vicinity of the Site. For each receptor location, radionuclide concentrations in these environmental media are selected based on the measured values at the closest monitoring location. In some cases where multiple monitoring locations exist nearby, the maximum of the nearby values is used.

Approach 2: Average Measurement for the Area Surrounding the Site

This approach is based on the assumption that the radionuclide concentration in an environmental medium that a specific receptor is exposed to is equal to the average concentration measurement for the entire area surrounding the Site. This simplified approach was used for the following environmental media:

1. Private well water, since the private wells sampled for tritium concentrations are not at the same locations as the human receptors chosen for this assessment;

2. Lake water and sediment, since there is no specific data regarding the amount of time residents or aquatic animals spend at each shoreline location; and

3. Specific foodstuffs that either have fewer sampling locations or lower sampling frequency. These include milk, eggs, deer, fish, grains, and honey.

Approach 3: Concentration Based on the Empirical Atmospheric Dilution Factor for HTO

Air monitoring stations surrounding the Site measure airborne concentrations of tritium and carbon-14. For the remaining airborne contaminants (i.e., radioiodines, radioactive particulates and noble gases), concentrations at each receptor location were calculated based on the empirical atmospheric dilution factor for HTO (i.e., ratio of measured airborne concentration of HTO at a monitoring location to the activity of HTO released from the Site).

As an example, the concentration of iodine-131 at the B5 monitoring station is calculated as follows:

$$C_{I-131,B5} = Q_{I-131} \times \frac{C_{HTO,B5}}{Q_{HTO}}$$

Where:

$Q_{I-131,B5}$	is the total activity of iodine-131 released to the atmosphere from the Site (Bq)
$C_{HTO,B5}$	is the measured airborne concentration of HTO at monitoring station B5 (Bq/m^3)
Q_{HTO}	is the total activity of HTO released to the atmosphere from the Site (Bq)

The calculated values at each monitoring station are then used to represent airborne concentrations at the closest receptors, as described above. The approach assumes that the atmospheric dispersion of radioactive particulates and noble gases is identical to that of tritium.

Specific environmental monitoring data used in the HHRA can be found in Appendix B: ERA Methodology [R-35].

Table 6 Use of Environmental Monitoring Data in the HHRA

Medium	Radionuclide	Measured Units [a]	Use of Environmental Monitoring Data for Exposure Point Concentrations
Air	Tritium	Bq/m^3	Measurement at nearby monitoring location.
Air	Carbon-14	Bq/kg-C	
Air	Particulate	Bq/m^3	Calculated concentration based on HTO atmospheric dilution factor at nearby monitoring location.
Air	Noble Gas	Gamma Bq-MeV/m^3	
Air	Iodine	Bq/m^3	
Fruit	Tritium	Bq/L	Measurement at nearby monitoring location.
Fruit	Carbon-14	Bq/kg-C	
Vegetables	Tritium	Bq/L	
Vegetables	Carbon-14	Bq/kg-C	
Well water - shallow	Tritium	Bq/L	
Well water – deep[b]	Tritium	Bq/L	Average measurement for the area surrounding the Site.
Lake[c]	Tritium	Bq/L	
Sediment	Cesium-137	Bq/kg-dw	
Sediment	Cesium-134	Bq/kg-dw	
Sediment	Cobalt-60	Bq/kg-dw	
Fish	Tritium	Bq/L	
Fish	Carbon-14	Bq/kg-C	
Fish	Cesium-137	Bq/kg-dw	
Fish	Cesium-134	Bq/kg-dw	
Fish	Cobalt-60	Bq/kg-dw	
Milk	Tritium	Bq/L	
Milk	Carbon-14	Bq/kg-C	
Eggs	Carbon-14	Bq/kg-C	
Deer	Tritium	Bq/L	
Deer	Carbon-14	Bq/kg-C	
Deer	Cesium-137	Bq/kg-dw	
Deer	Cesium-134	Bq/kg-dw	
Deer	Cobalt-60	Bq/kg-dw	
Grain	Tritium	Bq/kg-fw	
Grain	Carbon-14	Bq/kg-C	
Honey	Tritium	Bq/kg-fw	

Table 6 Use of Environmental Monitoring Data in the HHRA

Medium	Radionuclide	Measured Units [a]	Use of Environmental Monitoring Data for Exposure Point Concentrations
Honey	Carbon-14	Bq/kg-C	

Notes:
a) dw – dry weight; fw – fresh weight.
b) For deep well water, tritium concentrations of samples from 2016-2020 have been less than the limit of detection, therefore all concentrations have been assumed to be equal to the limit of detection.
c) For tritium in lake water, the maximum of Baie du Doré, Inverhuron, and Scott Point samples is used.

3.2.3 Exposure Equations and Exposure Doses

The equations for human exposure to radiation are provided in CSA Standard N288.1 [R-117] and are fully implemented in the IMPACT software.

The IMPACT results were tabulated and a summary of the doses to each human receptor (i.e. representative persons including specific age category) resulting from average and upper range annual concentrations over a five-year period (2016-2020) is shown in Table 7. The doses to adults, children and infants are depicted separately in Figure 11, Figure 12 and Figure 13 respectively. A breakdown of the radiation dose by radionuclide and for the most exposed individuals, by exposure pathway, is provided in Appendix M: Radiation Dose to Humans [R-35].

The receptor with the highest radiation dose is an adult subsistence farmer at BSF3, who is located near the intersection of Highway 21 and Concession Road 4. The range of calculated annual doses for the adult has an average value of 2.52 μSv/year and an upper range value of 3.28 μSv/year.

The farm receptor with the highest radiation dose is an adult at BF14, who is located at the eastern border of Inverhuron Provincial Park. The range of calculated annual doses for the adult has an average value of 1.87 μSv/year and an upper range value of 2.58 μSv/year.

The dairy farm receptor with the highest radiation dose is an adult at BDF12, located approximately 13 km east of Bruce A. The range of calculated annual doses for the adult has an average value of 1.71 μSv/year and an upper range value of 2.23 μSv/year.

The range of calculated annual doses for the BEC worker has an average value of 0.11 μSv/year and an upper range value of 0.14 μSv/year.

The residential receptor with the highest radiation dose is an adult at BR48. The range of calculated annual doses for this receptor has an average value of 1.56 μSv/year and an upper range value of 2.13 μSv/year.

The adult has the highest calculated dose among the hunter/fisher representative group. The range of calculated annual doses for this receptor has an average value of 1.77 µSv/year and an upper range value of 3.74 µSv/year.

Table 7 Dose to Receptors

Location	Age	Average Case (mSv/year)	Upper-range (mSv/year)
BDF1	Adult	1.56E-03	2.08E-03
	Child	1.54E-03	2.08E-03
	Infant	1.54E-03	2.13E-03
BDF12	Adult	1.71E-03	2.23E-03
	Child	1.67E-03	2.17E-03
	Infant	1.70E-03	2.18E-03
BDF13	Adult	1.48E-03	1.92E-03
	Child	1.43E-03	1.81E-03
	Infant	1.49E-03	1.83E-03
BDF14	Adult	1.39E-03	1.87E-03
	Child	1.36E-03	1.78E-03
	Infant	1.44E-03	1.82E-03
BDF15	Adult	1.34E-03	1.83E-03
	Child	1.26E-03	1.70E-03
	Infant	1.21E-03	1.65E-03
BDF9	Adult	1.38E-03	1.87E-03
	Child	1.34E-03	1.78E-03
	Infant	1.40E-03	1.82E-03
BEC	Adult	1.06E-04	1.39E-04
BF14	Adult	1.87E-03	2.58E-03
	Child	1.69E-03	2.29E-03
	Infant	1.49E-03	2.00E-03
BF16	Adult	1.53E-03	2.01E-03
	Child	1.37E-03	1.80E-03
	Infant	1.21E-03	1.57E-03
BF8	Adult	1.20E-03	1.59E-03
	Child	1.06E-03	1.37E-03
	Infant	9.52E-04	1.20E-03
BSF2	Adult	2.24E-03	3.01E-03
	Child	2.11E-03	2.80E-03
	Infant	2.03E-03	2.65E-03
BSF3	Adult	2.52E-03	3.28E-03
	Child	2.34E-03	2.99E-03

Table 7 Dose to Receptors

Location	Age	Average Case (mSv/year)	Upper-range (mSv/year)
	Infant	2.21E-03	2.79E-03
BR1	Adult	1.45E-03	2.54E-03
	Child	1.37E-03	2.18E-03
	Infant	1.21E-03	1.66E-03
BR17	Adult	1.10E-03	1.45E-03
	Child	1.07E-03	1.40E-03
	Infant	1.01E-03	1.29E-03
BR25	Adult	1.41E-03	1.85E-03
	Child	1.36E-03	1.75E-03
	Infant	1.26E-03	1.61E-03
BR27	Adult	1.47E-03	1.91E-03
	Child	1.41E-03	1.82E-03
	Infant	1.30E-03	1.67E-03
BR32	Adult	1.46E-03	1.94E-03
	Child	1.40E-03	1.83E-03
	Infant	1.29E-03	1.68E-03
BR48	Adult	1.56E-03	2.13E-03
	Child	1.56E-03	2.11E-03
	Infant	1.46E-03	1.95E-03
BHF1	Adult	1.73E-03	3.57E-03
	Child	1.62E-03	3.47E-03
	Infant	1.54E-03	3.56E-03

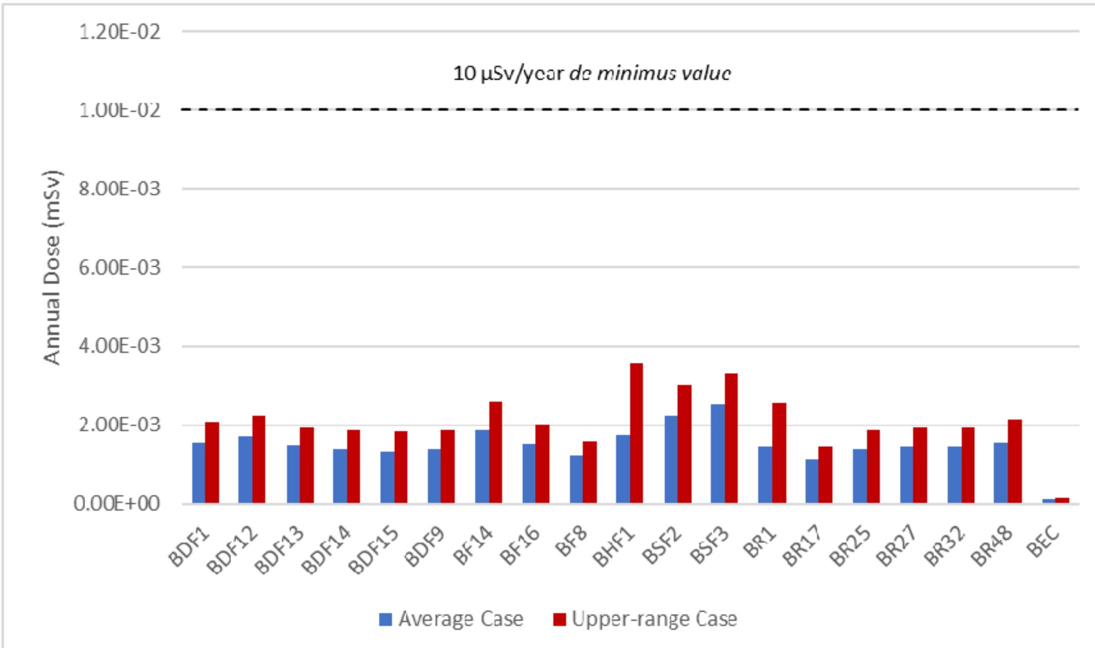

Figure 11 Average Versus Upper Range Dose for Adults

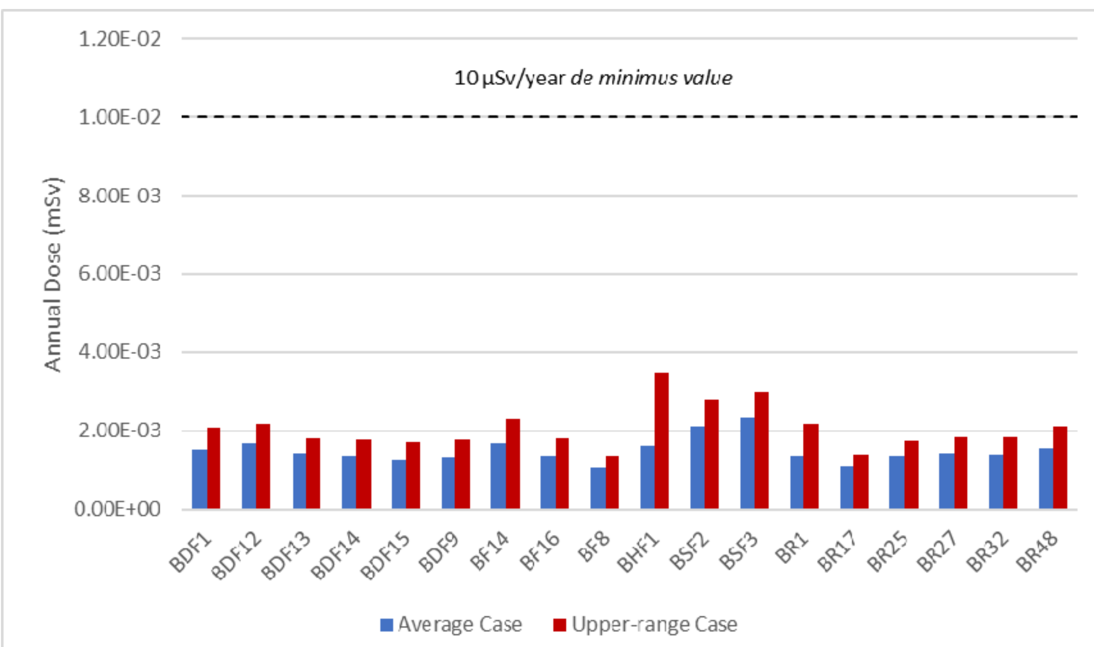

Figure 12 Average Versus Upper Range Dose for Children

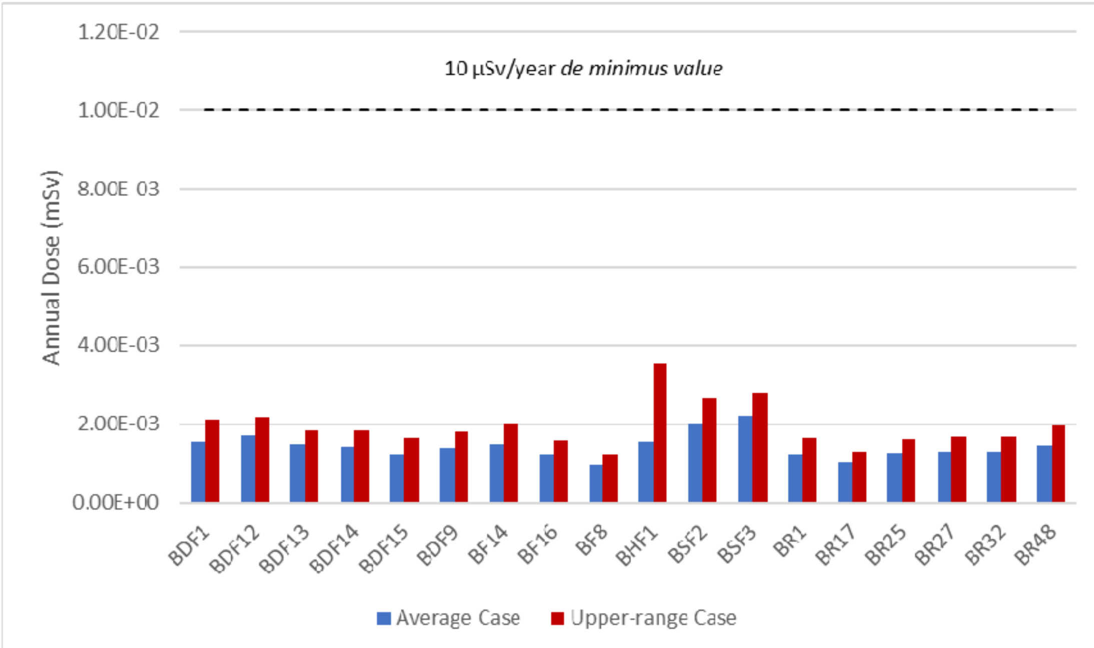

Figure 13 Average Versus Upper Range Dose for Infants

3.2.4 Uncertainties and Assumptions in the Exposure Assessment

The following are the predominant sources of uncertainty in the radiological exposure assessment for human health:

1. The use of effluent and environmental data reported as less than a detection limit (L_d);
2. The assumption that Site survey data and generic exposure factors apply to all receptors considered in this assessment;
3. The use of average, non location-specific radionuclide concentrations for the majority of environmental media;
4. The use of the IMPACT model to determine concentrations that are not measured (resulting in conservative over-estimates);
5. The use of a single radionuclide (e.g., cobalt-60) to represent a group of radionuclides (e.g., airborne radioactive particulates) (resulting in conservative over-estimates).

Some of the measurement values are reported at the detection limit (L_d), which is also sometimes referred to as the minimum detection limit (MDL). Methods for dealing with values less than the limits of detection were applied according to Appendix D of N288.4-10 [R-15]. This creates an initial uncertainty in the use of the measured data, i.e., the true measured value is between zero and the L_d value in a particular sample. In the calculation of exposure and dose, the most conservative assumption is to assume that the concentration is equal to the L_d value. As discussed in Section 3.2.2, uncensored data below the detection limit is now used where possible where data is below detection limits. However, in some cases the critical level is conservatively used as an upper bound on contaminant concentration.

Site specific survey data [R-109] was used as a basis for all receptors of a particular type (resident, farmer, dairy farmer, subsistence farmer and hunter/fisher). Residents of the same type are modeled as having common local intake fractions. All other exposure factors (e.g., dietary intake rates) are assumed to be common among all receptors. This creates some uncertainty in the analysis, as the individual receptors are not being modeled exactly as they are in reality. However, all exposure factors are deemed to be conservative based on CSA Standard N288.1 guidance and local site survey data. Therefore, the resultant exposure and radiation doses will likely be a conservative assessment for a given receptor. For the hunter/fisher receptor, which is representative of Indigenous groups near Site, intake rates for wild game and fish were previously assumed to be 95th percentile results from the First Nations Food, Nutrition, and Environmental Study (FNFNES). Surveys undertaken by Bruce Power from 2019 – 2021 have demonstrated that the FNFNES results were over conservative, and have provided specific intake rates and local intake fractions of fish, wild game, and other foodstuffs. Incorporating these site-specific (local) results reduces uncertainty and ensures that the assessment is representative of the characteristics of Indigenous residents in the area surrounding Site.

Every receptor location does not have associated measured values for all of the environmental media used in the IMPACT model (i.e., the concentration of radionuclides in air, soil, water, sediment, livestock, produce, etc.). When environmental media surrounding the Site have fewer sampling locations or lower sampling frequency (e.g., foodstuffs), an average concentration for the entire area is calculated and used for each receptor location, which can result in increased uncertainty for receptor locations further away from the measured location.

In the cases where measurements are not taken as part of the Environmental Monitoring (e.g., alpha emitters, concentrations in foodstuff for the hunter/fisher), or measurements in environmental media are either below detection limits or indistinguishable from background (e.g., cesium-137 in soil), IMPACT is relied upon to model the environmental transport of radionuclides from the release points at the Site to each receptor location. Based on a review of the ratio of modeled versus measured concentration of tritium in the air, the IMPACT model generally overestimates the concentrations at receptor locations by approximately a factor of two, and is generally conservative.

For the hunter/fisher receptor, there is uncertainty associated with the location that wild game and fish are caught. In order to conservatively manage this uncertainty, the concentrations of radionuclides in fish are based on average values from the most bounding location (Baie du Doré), and the concentrations in wild game are based on average concentrations in deer tissue from samples collected on or near the Bruce site.

Radioactive particulates in airborne and waterborne releases from the site are reported as gross beta/gamma and gross alpha. In this assessment, specific radionuclides are used to conservatively represent each category of particulates. For example, cobalt-60 is used to represent all beta/gamma emitters for modelling purposes. As discussed in Section 3.1.2, cobalt-60 is selected because it has greater dose conversion coefficients for external exposure than other expected contaminants. The assumption that the entire activity of beta/gamma is solely comprised of cobalt-60 overestimates the radiation dose, particularly via external exposure pathways due to its relatively high energy gamma emission. This represents conservative management of uncertainties associated with gross beta/gamma and alpha particulate releases.

3.3 Toxicity Assessment

3.3.1 Radiation Dose Limits and Targets

For the radiological toxicity assessment, the CNSC effective dose limit for a member of the public (1 mSv/y) was used as the limit below which exposure is considered to have no meaningful health effects [R-17].

3.3.2 Uncertainties and Assumptions in the Toxicity Assessment

The 1 mSv/y annual dose threshold for meaningful health effects is a well-established regulatory dose limit and therefore uncertainties in the toxicity assessment are not considered.

3.4 Risk Characterization

3.4.1 Discussion of Radiation Effects

3.4.1.1 Estimated Health Risks for Radionuclides

As shown in Section 3.2.3 the highest upper-range annual radiation dose is approximately 3.74 µSv/y, or 0.0037 mSv/y (Adult at BHF1). Therefore, all doses are less than the 10 µSv/y *de minimis* value, the dose below which the effects to humans are considered to be negligible or insignificant [R-119].

Furthermore, the radiation doses are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.

3.4.1.2 Effects Monitoring Evidence

As concluded in the preceding section, the calculated hazard quotient of less than 0.01 confirms that there is no radiological risk or adverse effect to members of the public surrounding the Site, as well as to the hunter/fisher receptor, representing local Indigenous people located further from Site. To date, there has been no data or information regarding the health of local residents to suggest that there is any correlation between the low levels of radioactivity in the environment and adverse health effects.

3.4.1.3 Likelihood of Effects

With a hazard quotient of less than 0.01, it is extremely unlikely that adverse health effects will be measurable at the population level.

3.4.2 Uncertainties and Assumptions in the Risk Characterization

It is very likely that the conservative methods of addressing the many uncertainties associated with the exposure assessment (see Section 3.2.4) have resulted in an overestimation of the radiation dose to humans. The primary sources of uncertainty are the concentration values that are reported as less than a detection limit, the use of modeled data for radionuclides that are not analyzed in environmental samples, and the conservative selection of representative radionuclides for gross beta/gamma and alpha contaminants.

This overestimation still results in a hazard quotient that is less than 0.01 and is therefore inconsequential to the final risk characterization that there is no radiological risk to human health.

3.4.3 Cumulative Effects in the Human Health Risk Assessment

The radiological HHRA has considered emissions from all site facilities, including new facilities and those not operated by Bruce Power (e.g., Kinectrics North). As discussed in Section 3.2.1, the new Central Storage Facility is not explicitly included; however it has a negligible contribution to emissions. Furthermore, the majority of the calculated dose in the radiological HHRA is based on REM program measurements, which implicitly consider all potential contaminant sources. Therefore, the existing radiological HHRA considers cumulative effects of all operational facilities in the vicinity of Bruce Power.

3.4.4 Conclusion

The radiation doses to members of the public residing in the area surrounding the Site are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., concentrations reported as less than a detection limit) addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.

3.5 Predictive Human Health Risk Assessment for Radiological Contaminants

Environmental outcomes of completed activities predicted to have increases in environmental interactions in the 2017 predictive risk assessment are reported in Appendix D [R-35], Section 4.3. Preliminary Screening of interactions for future planned site activities, including Lu-177 production and MCR are reported in Appendix D [R-35], Section 4.4. No impacts are expected from future Site systems, structures or activities on the radiological emissions that would impact human receptors.

No adverse outcomes impacting radiological air emission or waterborne effluent have occurred to date resulting from new activities occurring on site and covered by the 2017 PERA predictions. In the absence of substantial changes to air emissions or waterborne effluent resulting from Life Extension and Major Component Replacement (MCR) activities, there has been no substantial change in environmental monitoring results. With these stable environmental monitoring results, there has been no change to the overall outcome of the HHRA resulting from any new (non-routine) activities occurring on site between 2016 and 2021.

The historical radiological releases from 2012 – 2016 considered in the previous ERA [R-12] were predicted to bound MCR, and the resulting radiation doses to human receptors were anticipated to remain negligible. The results of the present radiological HHRA demonstrate that the doses to human receptors have remained negligible from 2016 to 2020, with maximum calculated doses continuing to be well below the 10 µSv *de minimis* value, and less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y).

The potential interactions with increasing radiological environmental effects between future site activities, including Life Extension, MCR and Lu-177 production, and radiological air quality, surface water quality and the overall human environment are summarized in Appendix D, Section 4.5.2.2 [R-35].

There are no foreseeable additions in or around the Site that would result in substantial changes to radiological emissions or effluent greater than what has historically been released. No change in overall emissions or effluent is anticipated from Life Extension or MCR activities.

Bruce Power plans to begin the production of Lutetium-177 (Lu-177), a medical isotope, in 2022. A full description of this activity is available in Appendix D, Section 4.2 [R-35]. Negligible emissions are expected during commissioning and normal operation of the Lu-177 Isotope Production System (IPS). While the Lu-177 IPS is being commissioned, as well as during its operation, radiological releases will be closely monitored through activity readings in the stack. During the commissioning and a short time after production begins, the particulate filters will be analyzed for beta/gamma emitters Lu-177, Yb-175 and Yb-177, which could be produced in the very unlikely event of a target capsule failure (i.e. breakage). Due to the nature of the decay products associated with the production of Lu-177, particles will either decay to negligible activity or be caught by High Efficiency Particulate Air (HEPA) filters, resulting in negligible emissions. Air ingress in the IPS could lead to activation of Argon-41 (a noble gas) or Carbon-14, which will be detected as part of normal compliance monitoring already in place. Any increase in activity will be detected in the exhaust monitoring system and be included in weekly effluent reporting and be reported to the CNSC via regular quarterly reports. These potential and likely negligible gaseous emissions are predicted to generate no additional risk.

No effects on human receptors are expected from radiological releases associated with Life-Extension, MCR, Vacuum Building Outage/Station Containment Outage (VBO/SBOs) or Lu-177 production.

3.5.1 Conclusion

Site radiological air emissions and waterborne effluents are controlled and maintained below compliance levels, which are protective of human and non-human biota in the surrounding environment. Monitoring of emissions and effluents at the Site are conducted in accordance with CSA N288.5 [R-16]. Derived Release Limits (DRLs) and Environmental Action Levels (EALs) have been developed by Bruce Power to ensure releases to the environment will not exceed the annual regulatory public dose limit of 1 mSv/y.

Historical radiological releases associated with outage and maintenance activities are predicted to continue to be bounding of MCR based on the nature of MCR activities. Lu-177 production is not expected to have an effect on emissions.

There is no anticipated change in normal emission levels related to Lu-177 production. No substantial changes in radiological air quality or surface water quality are expected as a result of Life Extension or MCR activities. As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities.

Given that radiological emissions and effluents are expected to remain stable during the future activities on site, including Life Extension, MCR and Lu-177 production, no substantial changes are expected to environmental monitoring results and subsequently to the dose to public during these activities and no corresponding changes to the findings of the HHRA are expected.

3.6 Overall Conclusion of the Radiological Human Health Assessment

The baseline radiation doses to members of the public residing in the area surrounding the Site as calculated based on current operational conditions are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., concentrations reported as less than a detection limit) addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.

As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is shown to be bounding of the proposed activities. Therefore, there is no radiological risk to human health for members of the public resulting from anticipated future activities.

4.0 ECOLOGICAL RISK ASSESSMENT FOR CHEMICALS

The Ecological Risk Assessment (EcoRA) component of the Updated ERA prepared for the Site assessed the potential risks to terrestrial and aquatic ecological receptors that could come into contact with environmental media (i.e., soil, shallow groundwater, surface water and sediment). This section focuses on potential risks to terrestrial and aquatic receptors due to non-radiological chemicals with supporting details provided in the following appendices:

- Appendix A: Site Description
- Appendix B: Supplementary ERA Methodology
- Appendix C: Identification of Chemicals of Potential Concern
- Appendix E: Environmental Quality Data Tables For Chemicals And Tier 1 Chemical Screening
- Appendix F: Ecological Risk Assessment For Chemicals – Exposure And Risk Tables

The approach followed in this EcoRA for chemicals used acceptable ecological risk assessment methods referred to in CSA Standard N288.6-12 [R-14] including those described by the Canadian Council of Ministers of the Environment (CCME) [R-120]. In brief, the EcoRA follows a multi-media approach as described in clause 7.2.5.4.2 of CSA Standard N288.6-12 [R-14], in which COPCs that exceeded their respective screening benchmark in one environmental medium were retained for assessment in all environmental media for which that COPC is greater than its method detection limit (to ensure that exposure from all environmental sources is quantified). Using this approach, contribution to exposure from all potential sources is assessed. Considering representative exposure assumptions, potential risks were assessed with respect to endpoints such as survival, growth, and reproduction.

4.1 Overview

This section outlines the general methodology applied for the EcoRA, with supplementary details provided in Appendix B.

Section 4.2 to Section 4.4 presents the results related to each specific environmental media from the COPCs identified in Appendix C.

4.1.1 Problem Formulation

4.1.1.1 Identification of Chemicals of Potential Concern

The purpose of the identification of chemicals of potential concern was to focus the EcoRA on substances that may be associated with a potential health risk. Through comparison with highly conservative health-based screening guidelines, COPCs were identified and comprise the substances that were examined further in the risk assessment. Chemicals present at concentrations less than health-based guidelines were considered to be associated with a negligible health risk and therefore were not evaluated further in the risk assessment.

The preliminary screening identified COPCs by comparing measured concentrations of chemicals to their respective site-specific limits established in the regulatory permits for the Site (i.e., as cited in the Effluent Monitoring and Effluent Limits (EMEL), ECA or Emission Summary and Dispersion Modelling (ESDM) reports). These regulatory permits apply to Bruce A and Bruce B discharges to surface water and to atmospheric emissions. Where site specific limits were not available (i.e., for soil, groundwater, surface water, sediment and drinking water), the more stringent of the provincial and federal standards were used for preliminary screening purposes. The preliminary criteria are generally considered protective of both human and ecological health.

For COPCs with concentrations greater than the preliminary benchmarks, a secondary screening was conducted for the EcoRA to identify the chemicals that need to be quantitatively assessed for each applicable for each ecological receptor group considered in the EcoRA: i) plants and soil organisms; ii) terrestrial wildlife; iii) semi-aquatic wildlife; iv) aquatic communities, including fish, plants, plankton and benthic invertebrates. This secondary screening was completed against the most stringent ecological component values/guidelines provided by the available federal and provincial (i.e., Ontario) environmental guidelines. The ecological component values/guidelines were developed for each environmental media to protect ecological receptor groups from a specific pathway. Screening against these secondary benchmarks ensures that the risk assessment focuses on only those receptors and exposure pathways that have the potential for unacceptable risk at a given site.

A summary of the identification of chemicals of potential concern screening results for each media is presented below. Detailed descriptions of the methodology and results of the identification of chemicals of potential concern are available in Appendix C.

The identification of COPCs was completed on an area basis, representative of a number of engineered site facilities considered to provide potential terrestrial ecological habitat or to be adjacent to terrestrial ecological habitat. Aquatic habitat provided in Stream C, the permanent on-site drainage features (Former Sewage Lagoon (FSL), B16 Pond, B31 Pond and Eastern Drainage Ditch (EDD)), and along the shoreline and nearshore environment of Lake Huron was also evaluated. Site descriptions for all areas assessed are in Appendix A. The habitat within each area, and the potential receptors considered to be potentially exposed to COPCs at each area is summarized in Table 18 in Appendix A. The assessed areas for the EcoRA are presented below in Figure 14.

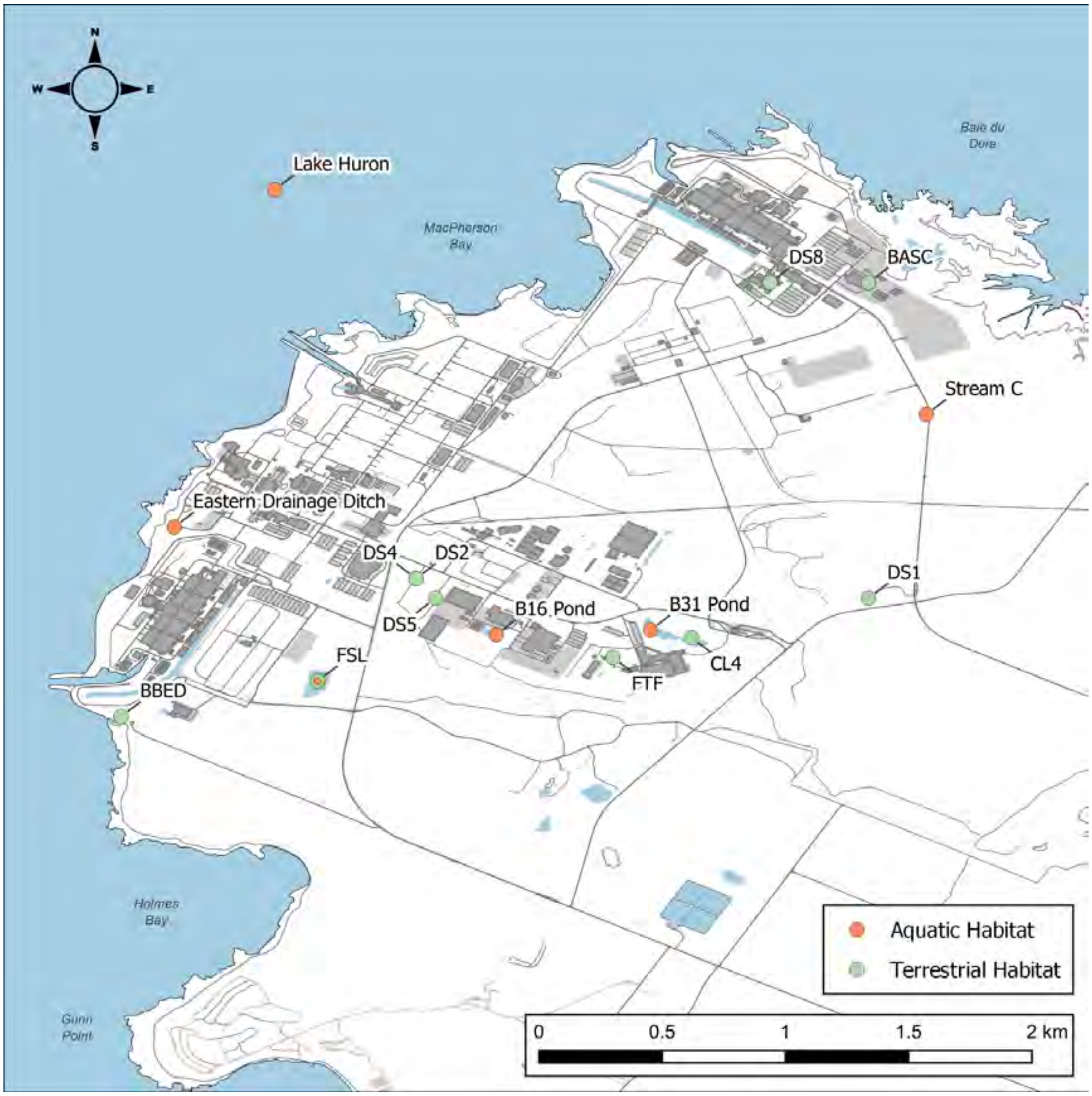

Figure 14 Areas Assessed in the EcoRA

<u>Bruce A and Bruce B Discharges</u>

As described in Section 3.4.1 of Appendix C, no COPCs were identified for surface water discharges from the Bruce A and Bruce B facilities; therefore, potential exposure from Bruce A and Bruce B discharges has not been retained for further assessment in the EcoRA.

<u>Air</u>

As described in Section 3.4.2 of Appendix C, no COPCs were identified for air; therefore, potential exposure from air discharges has not been retained for further assessment in the EcoRA.

Soil

As described in Section 3.4.3 of Appendix C, COPC screening was carried out for all on-site areas that contained terrestrial ecological habitat or were adjacent to ecological habitat including Bruce A Storage Compound (BASC), Bruce B Empty Drum Laydown Area (BBED), Construction Landfill #4 (CL4), Fire Training Facility (FTF), FSL, Distribution Station #1 (DS1), DS2/DS4/DS5, DS8, and general soil sampling locations (BPS/SS). These areas are described in detail in Section 1.3.1 of Appendix A.

COPCs identified in soil based on comparison to the preliminary benchmarks were further screened against secondary benchmarks protective of terrestrial receptors. COPCs were identified following secondary screening within BASC, CL4, FTF, FSL, DS1, DS2/4/5 and BPS/SS. Soil COPCs within each of these areas were further evaluated for potential risks to terrestrial plants, soil invertebrates, mammals, birds, amphibians, and reptiles. The list of soil COPCs evaluated in the risk assessment is presented in Section 4.2.1.

Groundwater

As described in Section 3.4.4 of Appendix C, the groundwater table is shallow (i.e., <1.5 mbgs) at the BASC and FSL. As such, groundwater was considered with respect to potential root uptake by terrestrial plants in these areas only.

COPCs identified in groundwater based on comparison to the selected preliminary benchmarks were further screened against secondary benchmarks protective of terrestrial plants. No COPCs were identified for groundwater; therefore, potential shallow root uptake has not been retained for further assessment in the EcoRA.

Sediment

As described in Section 3.4.6 of Appendix C, COPC screening was carried out for Lake Huron and all on-site areas that contained permanent aquatic habitat including Stream C, B31 Pond, Former Sewage Lagoon (FSL), B16 Pond and the Eastern Drainage Ditch (EDD). These areas are described in detail in Section 1.8.1 of Appendix A.

COPCs identified in sediment based on comparison to the preliminary benchmarks were further screened against secondary benchmarks protective of aquatic receptors from direct contact and terrestrial wildlife from soil and food ingestion (applied as a surrogate for sediment ingestion). COPCs were identified following secondary screening within FSL, B31 Pond and EDD. No COPCs for sediment were identified at the B16 pond or within Lake Huron. Sediment COPCs within each of these areas were further evaluated for potential risks to aquatic communities (plants, invertebrates, and fish) and semi-aquatic wildlife (mammals, birds, reptiles, and amphibians). The list of sediment COPCs evaluated in the risk assessment is presented in Section 4.3.1.

Surface Water

As described in Section 3.4.5 of Appendix C, COPC screening was carried out for Lake Huron and all on-site areas that contained aquatic ecological habitat including Stream C, B31 Pond, Former Sewage Lagoon (FSL), B16 Pond and the Eastern Drainage Ditch (EDD). These areas are described in detail in Section 1.8.1 of Appendix A.

COPCs identified in surface water based on comparison to the preliminary benchmarks were further screened against secondary benchmarks protective of aquatic receptors. COPCs were identified following secondary screening within Lake Huron, B16 Pond and EDD. Surface water COPCs within each of these areas were further evaluated for potential risks to aquatic communities (plants, invertebrates, and fish). The list of surface water COPCs evaluated in the risk assessment is presented in Section 4.4.1.

Drinking Water

There is no complete exposure pathway for ecological receptors with respect to drinking water and as such, drinking water was not considered further in the EcoRA.

4.1.1.2 Receptor (Valued Ecosystem Component) Selection

A functioning ecosystem involves interaction of multiple species and each species responds differently to COPCs and/or physical stressors. Because it is not possible to directly assess the risk for each individual species, the ecosystem was divided into components or receptor groups (e.g., plants, invertebrates, birds, mammals, amphibians, reptiles, and fish). For birds, mammals, amphibians, reptiles, and fish, a limited number of species were selected to be representative of various feeding guilds within the receptor group (e.g., herbivores, insectivores, piscivores and carnivores). For plants and invertebrates, individual species were not selected but rather these receptors were defined at the community level (e.g., terrestrial plants, soil invertebrates, aquatic plants, phytoplankton, zooplankton, and benthic invertebrates).

Species and habitats observed on the Site are summarized in Appendix A Section 1.6 to 1.8. Inventories of the wildlife (herpetofauna, birds and mammals) and fish that have been documented on the Site are updated through further studies and surveys completed between 2016 and 2020 [R-121]–[R-123] in Appendix A Section 1.6 to 1.8.

Valued Ecosystem Components (VECs) are defined as components of the ecosystem that are likely to be exposed to contaminants and are the most sensitive to potential exposures from contaminants. VECs are representative of major plant and animal groups from terrestrial and aquatic habitats, including a holistic representation of all trophic (i.e., food chain) levels. VECs were identified based on previous environmental studies and surveys conducted for the Site [R-121]–[R-123]. VECs were selected by technical specialists with input from regulatory agencies, local Indigenous communities, and community stakeholders for the 2017 EcoRA. VECs were considered in the selection of receptors for the 2022 EcoRA. In some cases, the identified VECs would be difficult to assess or were not reflective of receptors associated with the highest exposures (and thus potential risks) reported on the Site. In these cases, the identified VECs were represented by ecologically similar species with better known exposure factors and potentially higher exposures in the EcoRA.

Omnivorous mammals and birds were not selected for assessment. Evaluation of risks to other mammals and birds that feed almost exclusively on plants, invertebrates or small mammals is considered protective of omnivorous animals whose diets are comprised of smaller portions of each of these food items. Larger mammals (e.g., white-tailed deer) are typically less sensitive to chemicals than smaller mammals because of lower metabolic rates which minimize exposure. Furthermore, the larger home range of larger mammals minimizes the time spent on the Site compared to smaller species and thus minimizes exposure. Assessment of smaller mammals is generally considered to be a conservative representation of the exposure and risk to larger mammals that have been documented on the Site. However, white-tailed deer were included in the non-radiological assessment for consistency with the radiological assessment and based on stakeholder interest.

Special consideration is to be given to Species at Risk (SAR) in order to protect and conserve rare flora and fauna. In Ontario, two different legislations apply to SAR, the provincial *Endangered Species Act* (ESA) [R-124] and the federal *Species at Risk Act* [R-125]. Screening for SAR on and around the Site was updated in 2022 [R-126], which identified two arthropod species, nine plant species, sixteen bird species, four bat species, and six reptile species of conservation status that had a moderate to high potential of occurring on-site. The SAR assessment completed in 2022 is summarized in Appendix A: Section 1.9. Aquatic receptors of conservation status include one fish species designated as “special concern”. In Table 8 to Table 10 describing receptors, the identification of “None” in the column “Surrogate for Species at Risk” indicates that that selected receptor is not representing any species identified as Vulnerable, Threatened or Endangered.

Specific SAR were not identified as receptors for the EcoRA given the paucity of exposure-related data for these species. Therefore, the approach used was to identify generic receptors of the same feeding guild as the SAR with exposure assumptions that would be protective of the SAR, such as a smaller body weight or foraging range.

All potential SAR were assessed in the EcoRA with surrogate species of the same feeding guild, with the exception of:

- Species whose primary diet consists of aerial insects which would result in negligible exposures to COPCs. These species include the eastern small-footed myotis *(Myotis leibii),* little brown myotis *(Myotis lucifugus),* northern myotis *(Myotis septentrionalis),* tri-coloured bat *(Perimyotis subflavus),* bank swallow *(Riparia riparia),* barn swallow *(Hirundo rustica)* and chimney swift *(Chaetura pelagica)*.

- Aerial invertebrate species: Monarch *(Danaus plexippus) and* Yellow-banded bumble bee *(Bombus terricola).* These species are primarily exposed through ingestion of plants that may have bioaccumulated COPCs in soil rather than direct soil contact. There is a lack of toxicological data and receptor characteristics to evaluate exposures for aerial invertebrates, and the assessment of soil invertebrates is considered protective of these species.

The selected VECs are also considered protective of all culturally significant species identified in Appendix A: Section 1.6.3, 1.7.4 and Section 1.8.7.

The terrestrial and aquatic receptors selected for the EcoRA are provided in Table 8 to Table 10. Detailed descriptions of each selected receptor are available in Section 2.3.1.1, Appendix B.

Terrestrial Receptors

Selected terrestrial receptors are listed in Table 8 below, along with the justification for their selection.

Table 8 Terrestrial Receptors and Justification for Selection

Terrestrial Receptor	Justification for Selection	Surrogate for Species at Risk*	Surrogate for Culturally Significant Species
Terrestrial Plants	• High potential for exposure to chemicals because of root contact with soils. • Primary producers play a critical role in the terrestrial environment. • Food source for wildlife. • Representative of species at risk such as butternut.	• American ginseng *(Panax quinquefolius)* • Butternut *(Juglans cinerea)* • Dwarf Lake Iris *(Iris lacustris)* • Gattinger's agalinis *(Agalinis gattingeri)* • Hill's pondweed *(Potamogeton hillii)* • Houghton's goldenrod *(Solidago houghtonii)* • Lakeside daisy *(Tetraneuris herbacea)* • Pitcher's thistle *(Cirsium pitcher).* • Tuberous Indian-plantain *(Arnoglossum plantagineum)*	• Over 100 plant species identified in Section 1.6.3 in Appendix A.
Soil Invertebrates	• Closely associated with soil as they both live and feed within soil. • Play a vital role in soil fertility. • Food source for wildlife.	• None	• None
Mammals			
Meadow Vole *(Microtus pennsylvanicus)*	• Herbivorous small mammal. • Inhabits grassy fields, marshes, and bogs. • Documented on (within the perimeter fence) and around the Site. • High potential for exposure to chemicals due to feeding habits (consumes plants in large amounts relative to body weight). • Plays a key role in the food web (component of the diet of larger mammals and birds of prey). • Life history information is readily available.	• None	• Rabbit *(Leporidae)* • Racoon *(P. lotor)* • Black Squirrel (*Sciurus)* • Groundhog (*Marmota monax*) • Weasel (*Mustela*) • Hares (*Lepus*)
Northern Short-tailed	• Small insectivorous or vermivorous mammal.	• None	• Skunk *(Mephitidae)*

Table 8 Terrestrial Receptors and Justification for Selection

Terrestrial Receptor	**Justification for Selection**	**Surrogate for Species at Risk***	**Surrogate for Culturally Significant Species**
Shrew (*Blarina brevicauda*)	• Inhabits forest, wetlands, and grasslands. • Caught in small mammal traps on the Site. • High rate of food consumption relative to body weight which increases potential exposure to chemicals. • Plays a key role in the food web (component of the diet of larger mammals and birds of prey). • Life history information is readily available.		
White-tailed Deer (*Odocoileus virginianus*)	• Herbivorous large mammal. • Inhabits forests, open brush, mixed farmland, cedar swamps and swamp edges. • Most common mammal species observed on and around the Site. • Life history information is readily available.	• None	• Black bear *(Ursus americanus)*
Red Fox (*Vulpes vulpes*)	• Carnivorous mammal. • Feeds mainly on small mammals and birds. • Occur in many habitats but prefer a mixture of forest and open habitat. • Documented on the Site. • Plays a key role in the food web (carnivore). • Indicator of exposures to chemicals that may bioaccumulate/biomagnify in the terrestrial food web. • Life history information is readily available.	• None	• Fox *(Canidae)*
Birds			
Mourning Dove (*Zenaida macroura*)	• Herbivorous bird that consumes 99% seeds in its diet. • Most common in open woodlands and forest edges near grasslands and fields.	• Red-headed woodpecker *(Melanerpes erythrocephalus)*	• Canada Goose *(Branta canadensis)* • Pigeon *(Columbidae)*

Table 8 Terrestrial Receptors and Justification for Selection

Terrestrial Receptor	Justification for Selection	Surrogate for Species at Risk*	Surrogate for Culturally Significant Species
	• Documented on the Site. • Life history information readily available. Representative of other herbivorous birds documented on the Site, including the wild turkey and omnivorous species with conservation status		• Grouse (*Phasianinae*)
American Woodcock (*Scolopax minor*)	• Vermivorous bird. • 50 to 90% of diet is earthworms so potential for high exposure to soil contaminants. • Lives in moist early successional woodlots near open fields or forest clearings, abandoned fields, edges of streams and ponds. Documented on the Site. • Representative of other vermivores/insectivores documented on the Site, including species with conservation status (other species will likely be less exposed because of feeding habits).	• Bobolink (*Dolichonyx oryzivorus*) • Eastern meadowlark *(Sturnella magna)* • Eastern whip-poor-will (*Antrostomus vociferus*) • Canada warbler *(Cardellina canadensis)* • Eastern wood-pewee *(Contopus virens)* • Grasshopper sparrow *(Ammodramus savannarum)* • Wood thrush *(Hylocichla mustelina)*	• Buffleheads *(Bucephala albeola)* • Wild turkey *(Meleagris gallopavo)*
Short-eared Owl (*Asio flammeus*)	• Considered representative of all birds that eat small mammals, including species with conservation status • Plays a key role in the food web (top predator). • Indicator of exposures of chemicals that may bioaccumulate/biomagnify in the terrestrial food chain. • The short-eared owl was used as a representative species in the risk assessment because it has readily available receptor characteristics. • Documented in Baie du Doré. • Indicator of exposures of chemicals that may	• Common nighthawk *(Chordeiles minor)* • Peregrine falcon (*Falco peregrinus*)	• Gulls (*Laridae*)

Table 8 Terrestrial Receptors and Justification for Selection

Terrestrial Receptor	Justification for Selection	Surrogate for Species at Risk*	Surrogate for Culturally Significant Species
	bioaccumulate/biomagnify in the terrestrial food chain.		
Reptiles and Amphibians			
Common Gartersnake *(Thamnophis sirtalis)*	• Reptile that consumes amphibians, earthworms, small mammals and birds and fish. • Juveniles primarily eat earthworms and this life stage is assessed for the terrestrial component. • Habitat ranges from forests, fields and prairies and is often found near water in moist forests and meadows, vegetated riparian zones of creeks, rivers, lakes and marshes. • Most documented snake species on and/or around the Site.	• Potential terrestrial snakes on-site with conservation status	• Snake *(Serpentes)*
Wood Frog *(Lithobates sylvatica)*	• Amphibian that consumes terrestrial insects, and considered representative of all adult frogs • Found in a variety of habitats, including forests, fields, muskegs, marshes, wet meadows, moist woodlands and brush.	• None	• Leopard Frog *(Lithobates)* • Bull Frog *(Lithobates catesbeianus)*

*None indicates that the selected terrestrial receptor is not a surrogate for a Vulnerable, Threatened or Endangered species.

Semi-Aquatic Wildlife

Semi-aquatic wildlife were also considered with respect to incidental ingestion of sediment while foraging in aquatic environments, and uptake models were used to estimate tissue concentrations in aquatic plants, invertebrates, and fish. All semi-aquatic wildlife receptors, listed in Table 9, were also considered to be exposed to chemicals in surface water via ingestion as a drinking water source.

Table 9 Semi-Aquatic Receptors and Justification for Selection

Semi-Aquatic Receptor	Justification for Selection	Surrogate for Species at Risk?*	Surrogate for Culturally Significant Species?
Mammals			
Muskrat (*Ondatra ziebethicus*)	• Eats aquatic plants with cattails being one of the most important plant foods. • Inhabit freshwater creeks, streams, lakes, marshes and ponds. Use ditches and wetland features on the Site that support dense stands of cattail species. • Consumes about 1/3 of its weight every day which increases potential exposure to chemicals. • Life history information is readily available. • Representative of other aquatic herbivores documented on the Site, including the beaver.	• None	• Beaver *(Castoridae)*
American Mink (*Neovison vison*)	• Carnivorous mammal that eats fish as part of its diet. • Uses aquatic habitats such as streams, lakes, and marshes. • Indicator of exposures to chemicals that may bioaccumulate/biomagnify in the aquatic food web. • Documented on the Site. • Life history information readily available.	• None	• Otter *(Lutrinae)* • Fisher (*Pekania pennanti*)
Birds			
Green-winged Teal (*Anas carolinensis*)	• Small duck that feeds mainly on aquatic plants. • Documented in Baie du Doré.	• None	• Canada goose *(Branta canadensis)* • Mallard *(Anas platyrhynchos)* • Wood duck *(Aix sponsa)* • Pidgeon *(Columba livia domestica)*
Spotted Sandpiper *(Actitis macularia)*	• Feeds mainly on benthic invertebrates so potential for high exposure to chemicals in sediment. • Documented on-site	• None	• Bufflehead *(Bucephala albeola)*

Table 9 Semi-Aquatic Receptors and Justification for Selection

Semi-Aquatic Receptor	Justification for Selection	Surrogate for Species at Risk?*	Surrogate for Culturally Significant Species?
Belted Kingfisher (*Megaceryle alcyon*)	• Piscivorous bird. • Documented on the Lake Huron shoreline. • Higher food ingestion rate than other piscivores documented on the Site (including the bald eagle which has conservation status) so potential for higher exposure to chemicals	• Bald eagle *(Haliaeetus leucocephalus)* • Horned grebe *(Podiceps auratus)* • Least bittern *(Ixobrychus exilis)*	• Merganser *(Mergus merganser)* • Black duck *(Anas rubripes)* • Redhead duck *(Aythya americana)*
Reptiles			
Snapping Turtle (*Chelydra serpentina*)	• Considered representative of all reptiles (snakes and turtles) that consume aquatic insects, including species with conservation status. • Prefer shallow waters with a soft bottom substrate and some submergent and emergent vegetation. • Documented on and around the Site.	• Potential turtles on-site with conservation status	• Turtle *(Testudines)*
Northern Water Snake (*Nerodia sipedon*)	• Piscivorous reptile. • Utilize many different aquatic habitats such as rivers, streams, sloughs, lakes, ponds, bogs, and marshes. • Documented on and around the Site.	• Potential aquatic snakes on-site with conservation status	• Snake *(Serpentes)*

*None indicates that the selected semi-aquatic receptor is not a surrogate for a Vulnerable, Threatened or Endangered species.

<u>Aquatic Receptors</u>

With respect to aquatic VECs identified, some VECs were identified with respect to their sensitivity to potential effects to COPCs (e.g., they play a certain role in the food web). Other VECs were identified with respect to their sensitivity to physical stressors such as thermal effects (e.g., cold water species). The selected aquatic receptors and the justifications for their selection are provided in Table 10 below.

Table 10 Aquatic Receptors and Justification for Selection

Aquatic Receptor	Justification for Selection	Surrogate for Species at Risk*	Surrogate for Culturally Significant Species
Aquatic Plants	• Provide habitat (i.e., food, shelter, and spawning areas) to many animals, both aquatic and terrestrial. • Present in sheltered areas along the Lake Huron shoreline, including Baie du Doré, the Bruce A and Bruce B discharge channels and in Stream C, B16 pond, B31 pond and EDD. • Sago pondweed used as an indicator species for the Site in the past.	• None	• Arrowhead (*Sagittaria latifolia*) • Cattail (*Typha angustifolia &* • *Typha latifolia*) • Watercress (*Rorippa nasturtium-aquaticum*) • Water lily (*Nymphaea leibergii*) • Water smartweed (*Polygonum amphibium*)
Zooplankton	• Important food source for other aquatic life, including fish. • *Ceriodaphnia dubia* and *Daphnia magna* are common test organisms in laboratory toxicity testing for a number of reasons, including their broad distribution in freshwater systems, their importance in the aquatic food chain, their sensitivity to a wide range of chemicals and their relatively short life cycles that allows for chronic toxicity testing. • Large toxicological database for species such as *C. dubia* and *D. magna.*	• None	• None
Benthic Invertebrates	• Play a vital role in nutrient cycling and breakdown of detritus in the aquatic environment. • Documented in Stream C, Lake Huron, and permanent drainage features. • Important food source for fish, birds, and amphibians. • Both live and feed in sediments so potential for exposure is maximized. • Relatively sessile animals so potential for exposure is maximized. • Can be sensitive to contamination. • Includes crayfish (*Fallicambarus fodiens*) which has been documented in inland watercourses and wet meadows within the site area and in Baie du Doré. This species has been	• None	• None

Table 10 Aquatic Receptors and Justification for Selection

Aquatic Receptor	Justification for Selection	Surrogate for Species at Risk*	Surrogate for Culturally Significant Species
	documented as uncommon but not rare by the Ontario Ministry of Natural Resource's Natural Heritage Information Centre.		
Amphibians (embryonic and larval life stages)	• Exposure to contaminants through direct contact with contaminated water is considered a major pathway for the aquatic embryonic and larval life stages. • In general, embryo and larval stages appear to be more susceptible to contaminants than the adult stage. • Most water quality guidelines, including those provided by CCME, appear to provide adequate protection of amphibians [R-127].	• None	• Bullfrog *(Lithobates catesbeianus)*
Fish	• Serve as prey species for other wildlife, provide recreational value to anglers, and are culturally significant to Indigenous communities • Fish have been documented in Lake Huron, Stream C, and all permanent drainage features • Evaluation in EcoRA focused on direct contact with surface water, the major exposure pathway for fish species at the Site • Evaluated based on the protection of important fish populations at the Site, as well as the Species of Special Concern, Deepwater Sculpin in Lake Huron.	• None	• Lake Whitefish *(Coregonus clupeaformis)* • Lake Sturgeon *(Acipenser fulvescens)* • Whitefish *(Salmonidae)* • Cisco *(Coregoninae)* • Cyprind sp. (Cyprinoidea) • Northern Pike *(Esox lucius)* • Walleye *(S. vitreus)* • Salmon Sp. *(Salmoninae)* • Rainbow Trout *(Oncorhynchus mykiss)* • Brook Trout *(Salvelinus fontinalis)* • Yellow Perch *(Perca flavescens)* • Cisco *(Coregonus artedi)* • Muskellunge *(Esox masquinongy)* • Bass *(Perciformes)* • Lake Trout *(Salvelinus namaycush)* • Lake Herring *(Coregonus artedi)* • Burbot *(Lota lota)*

Table 10 Aquatic Receptors and Justification for Selection

Aquatic Receptor	Justification for Selection	Surrogate for Species at Risk*	Surrogate for Culturally Significant Species
			• Bullhead *(Ameiurus melas)* • Channel Catfish *(Ictalurus punctatus)* • Smallmouth Bass *(Micropterus dolomieu)* • Largemouth Bass *(Micropterus salmoides)* • Brown Trout *(Salmo trutta)* • White Sucker *(Catostomus commersonii)* • Carp *(Cyprinus carpio)* • Smelt *(Osmeridae)* • Chub *(Squalius cephalus)*

*None indicates that the selected aquatic receptor is not a surrogate for a Vulnerable, Threatened or Endangered species.

4.1.1.3 Assessment and Measurement Endpoints

Assessment endpoints are narrative statements that describe the environmental values to be protected but rarely can they be measured directly. Measurement endpoints are the studies, tests or models that can be performed that serve as a proxy for the assessment endpoints and are the means by which the risk assessor will achieve the assessment endpoint.

With the exception of SAR listed as endangered, threatened or vulnerable, which are assessed at the individual level, the assessment endpoints for the ecological receptors are defined at the population or community level. Species at risk are assessed at the individual level because impairment of individuals could imperil populations. For the purposes of this assessment, “population” and “community” are as defined in the CSA Standard N288.6-12 [R-14].

“A population is defined in this Clause as an assemblage of organisms of a single species that inhabit an area sufficiently small that they are able to interbreed freely”.

“A community is defined in this Clause as an assemblage of organisms of multiple species that exist and interact with one another in a particular area. In practice, the area is usually large enough to encompass populations.”

The assessment and measurement endpoints used in the EcoRA are provided in the media specific sections (Section 4.2 to Section 4.4).

4.1.1.4 Exposure Pathway Selection

The general approach to the selection of ecological exposure pathways for wildlife is described below. For terrestrial and aquatic communities (i.e., plants, invertebrates, fish) exposure pathways evaluated in ecological risk assessment focus on direct contact with the contaminated media. Specific pathways considered for each media are listed in the media-specific sections (Section 4.2 to Section 4.4).

Exposure Pathways for Mammals and Birds

The potential for mammals and birds to be exposed to COPCs at the Site was evaluated based on the 2020 CCME *Guidance on Ecological Risk Assessment* [R-120].

Wildlife may be exposed to contamination via oral, dermal contact and inhalation routes. Oral exposure could occur through the consumption of contaminated food, water, or soil/sediment, while dermal exposure could occur via direct absorption through the skin. Inhalation exposure could occur when volatile compounds or fine particulates are respired into the lungs. Therefore, the total exposure that a receptor could potentially experience is the sum of exposure from all three pathways (i.e., $E_{oral} + E_{dermal} + E_{inhalation} = E_{total}$).

Generally, dermal exposure is assumed to be negligible for birds and mammals on most contaminated sites because skin absorption of most contaminants is minimized or reduced due to the presence of feathers and fur. As the COPCs identified in the Site generally adhere to soil/sediment particles, dermal exposure is expected to be negligible in comparison with the oral route. As well, the lack of relevant dermal toxicity data does not permit a reliable estimation of dermal exposure to wildlife.

Receptors were not considered to be exposed to volatiles in air. The CCME has noted that inhalation is likely to be a minor route of exposure for ecological receptors and thus will contribute little to potential risks to the receptors. As well, toxicological benchmarks or TRVs for exposure by inhalation have not been developed for ecological receptors.

Soil particles containing COPCs (by either adsorption or absorption) can also potentially be inhaled by wildlife. However, inhalation of impacted particulates by wildlife cannot be adequately assessed because there is limited toxicity data related to inhalation exposure for wildlife. As well, respirable particles (i.e., greater than 5 µm) are most likely ingested as a result of mucocilliary clearance rather than being inhaled [R-128]. At equal exposure concentrations, it has been determined that inhalation of contaminants associated with dust particles is expected to contribute less than 0.1% of total risk compared to oral exposure to wildlife [R-129]. As such, inhalation exposure is expected to be minimal, if not negligible, in comparison to the oral route of exposure.

Therefore, for this quantitative evaluation, it was assumed that the majority of the COPC exposure experienced by wildlife is from the oral (ingestion) exposure pathway (i.e., $E_{oral} \cong E_{total}$). These exposure pathways evaluated in the EcoRA are commensurate with the risks present.

As wildlife move across the Site, oral exposure is considered to primarily occur from multiple sources, such as ingestion of plant (or prey) and ingestion of contaminated soil (or sediment). Soil/sediment ingestion was hypothesized to be incidental for wildlife species. For grazing herbivores (such as the meadow vole and white-tailed deer), incidental ingestion of soil may occur via consumption of soil deposited on foliage or adhered to roots, along with direct ingestion of vegetation. For ground insectivores (such as the short-tailed shrew), exposure may occur via consumption of soil adhered to earthworms, as well as soil in the gastrointestinal tracts of earthworms. It should be noted that wildlife were considered to be exposed to COPCs in surface soil via ingestion of plants and prey items that have accumulated these COPCs in their tissues from the soil. Given that site-specific tissue residues are not available for the Site, chemical uptake models were used to estimate the transfer of COPCs from soil into plants and soil organisms, as well as uptake to small mammals and birds that may serve as prey for omnivorous and carnivorous wildlife.

Semi-aquatic birds and mammals were also considered with respect to incidental ingestion of sediment while foraging in aquatic environments, and uptake models were used to estimate tissue concentrations in aquatic plants, invertebrates, and fish. All wildlife receptors were also considered to be exposed to chemicals in surface water via ingestion as a drinking water source.

Exposure Pathways for Reptiles and Amphibians

Exposure pathways for reptiles and amphibians include those that were identified for mammals and birds above. However, dermal contact exposure with environmental media is likely to be more important for these receptors than mammals and birds due to the lack of fur or feathers. Some amphibians bury themselves in soil to stay moist during dry seasons or hibernate in the soil during winter. Amphibians also absorb much of the water in the soil as a way to remain hydrated in the terrestrial environment; however, there is insufficient knowledge and tools available to evaluate dermal exposures [R-127].

Evaluating exposure from surface water consumption is also challenging for amphibians and reptiles. There are no water ingestion rates that have been identified for these species. The water balance of amphibians is complex as they absorb water through their skin and extract water from their food. They rely on skin rehydration and are not known to consume water [R-130].

It is noted that consideration of the aquatic life stages of amphibians has been included in the assessment of exposure and risk to aquatic life, including the use of a fish model for sensitive life stages (i.e., eggs and larvae) that are aquatic. Therefore, evaluation of the aquatic life stages of amphibians will be protective of surface water exposures to terrestrial life stages.

Therefore, for this quantitative evaluation, it was assumed that the majority of the COPC exposure experienced by adult reptiles and amphibians is from the oral (soil and food ingestion) exposure pathway (i.e., $E_{oral} = E_{total}$).

4.1.1.5 Ecological Conceptual Site Models

The results of the receptor (VEC) identification, chemical screening and exposure pathway screening are summarized in a conceptual site model (CSM), which graphically illustrates the source of the COPCs, the release mechanisms, environmental transport and residency media, and exposure route for each ecological receptor.

Ecological receptors may be exposed to COPCs through direct and indirect pathways. Direct pathways are those in which the receptor comes into direct contact with the source of the COPCs (e.g., sediment, soil, and surface water root uptake or ingestion) as shown in Figure 15 and Figure 16). Indirect exposure pathways are those in which the exposure results from secondary residency media (e.g., ingestion of vegetation and/or prey, which is represented by invertebrates and small mammals) as shown in Figure 15 and Figure 16.

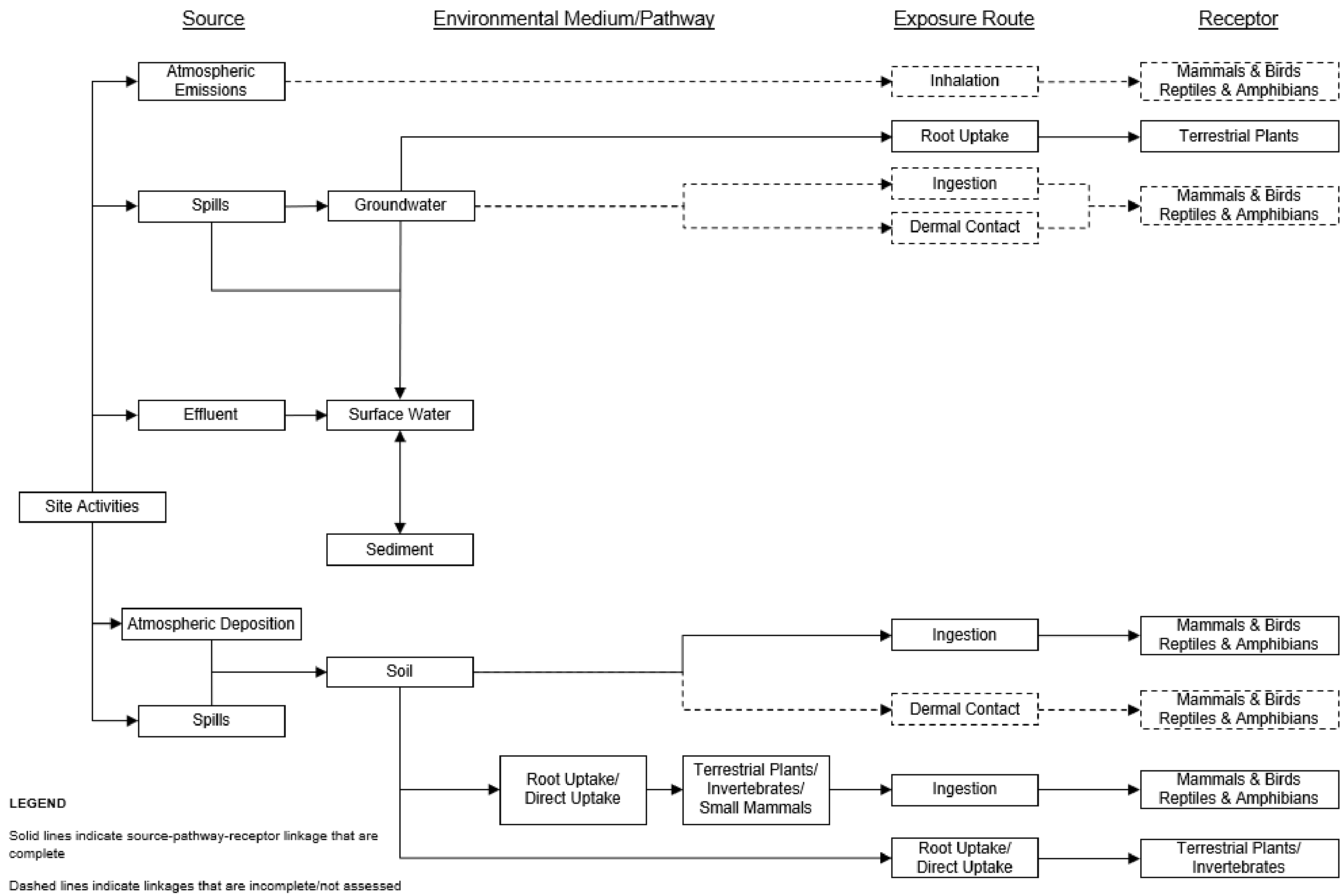

Figure 15 Conceptual Site Model for Terrestrial Ecological Receptors from Soil and Groundwater Exposures

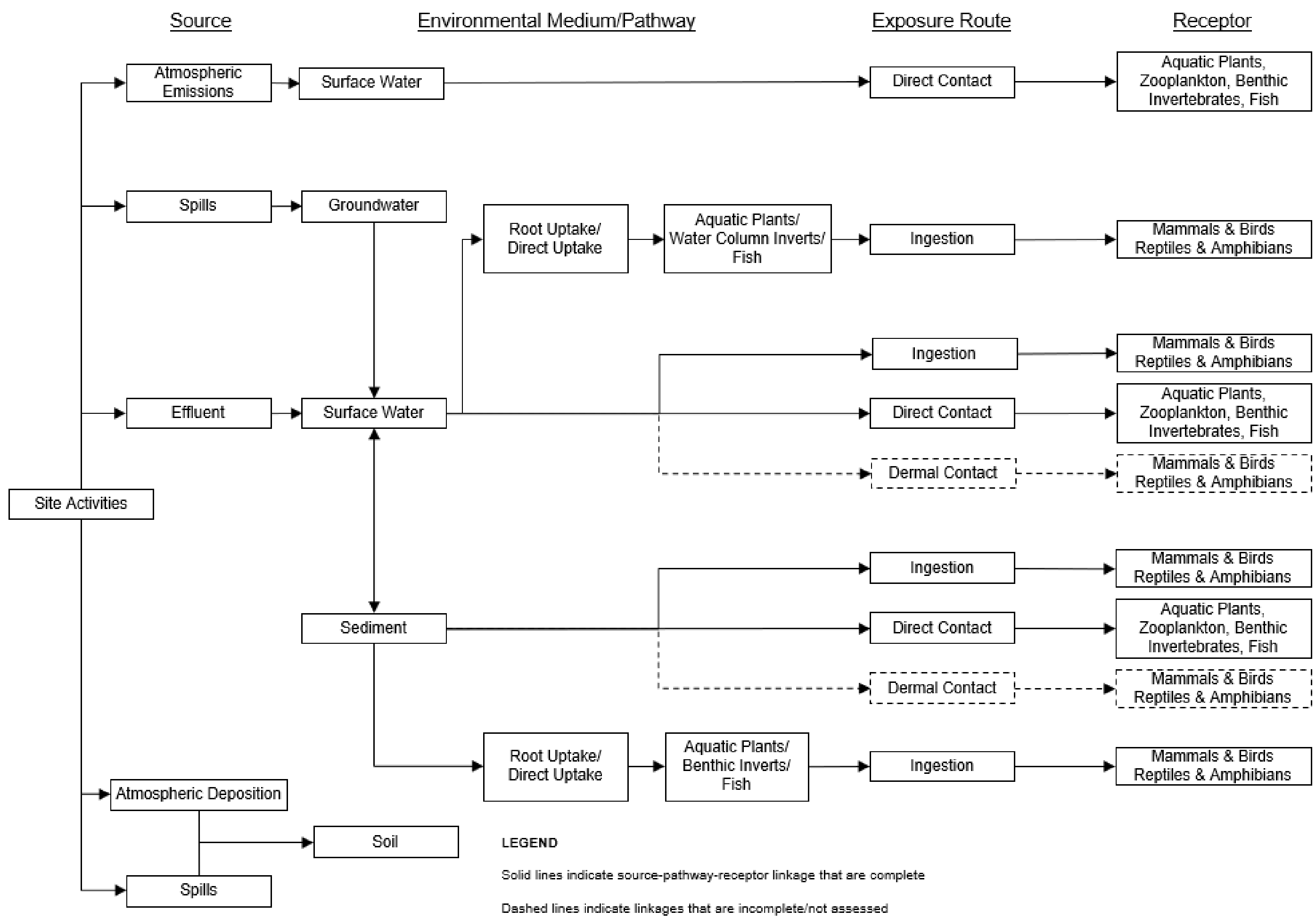

Figure 16 Conceptual Site Model for Aquatic and Semi-Aquatic Ecological Receptors from Sediment and Surface Water Exposures

4.1.2 Exposure Assessment

An exposure assessment is conducted for each COPC identified in the problem formulation.

For wildlife, exposure is typically estimated as a daily dose. The daily dose is determined by assessing the concentration of a COPC in each exposure pathway (e.g., food, water), based on documented rates of food and water ingestion. The daily dose is the total concentration of the COPCs to which the receptor is exposed from all of the relevant pathways. This value is calculated as an Estimated Daily Intake (EDI) and is typically expressed as milligrams (mg) of a chemical per kilogram (kg) of body weight per day (mg/kg-day). The EDI is calculated from site-specific concentrations of COPCs in soil, surface water, sediment and food, the amount of time a receptor spends on the site, and receptor-specific characteristics such as body weight, ingestion rate and dietary preference.

For plants, soil invertebrates and aquatic life, exposure is estimated by the concentration of the COPC in media (e.g., soil, water, and sediment) to which the receptor is primarily exposed to be consistent with the methods used to derive toxicological benchmarks for these media. These methods to estimate exposure to ecological receptors are consistent with the CCME guidance [R-131][R-132] referred to in CSA Standard 288.6-12 [R-14].

The key components of the exposure assessment for the EcoRA included the following:

- The estimation of the amount of time that ecological receptors might be expected to be present at the Site (probability of exposure) (for wildlife only);
- A description of the receptor-specific exposure parameters used in the assessment including body weights and rates of ingestion of soil/sediment, surface water and food (receptor characterization) (for wildlife only);
- The estimation of the exposure concentrations in each environmental medium, i.e., concentrations of COPCs in soil, sediment, and surface water (exposure point concentrations);
- A description of the uptake equations and factors used to estimate COPC concentrations in dietary items (chemical-specific factors) (for wildlife only);
- The estimation of the amount of COPCs that wildlife might be exposed to through incidental ingestion of soil or sediment, ingestion of surface water and ingestion of food (exposure equations). This is calculated as a dose in terms of mg/kg-day for chemicals (exposure doses); and
- A description of the uncertainties for each of the components listed above.

4.1.2.1 Probability of Exposure

Probability of exposure is often considered in exposure assessment, particularly for migratory species, species with home ranges that far exceed the size of the site or impacted area, or species that only spend certain life stages or a portion of their lifetime on the site.

Probability of exposure was not quantitatively incorporated into the exposure assessment. In order to fulfill the objective of informing whether risk management may be recommended, the EcoRA was carried out considering that each receptor spends 100% of its time at a particular area on-site, which is a reasonable and conservative assumption given that the Site is 932 ha in size and a single receptor would not be expected to use the entire Site as habitat.

Details regarding the home range, seasonality of wildlife, and the size, habitat and potential receptors present in the areas considered during the EcoRA are available in Section 2.3.2.1 of Appendix B.

This information, while not incorporated into the quantitative estimates of exposure (and risk), was considered when describing the uncertainties in the risk estimates given that this approach has the potential of overestimating exposure. That is, if potential risks were identified, consideration of the home ranges or seasonality of the affected receptors were considered when concluding whether an area may be posing potential risks to ecological health.

4.1.2.2 Receptor Characterization

Receptor characterization involves quantifying the factors that govern exposure, namely body weight, food ingestion rate, and water ingestion rate, as these factors together with chemical concentrations govern a wildlife receptor's exposure dose.

Receptor characteristics are not required for the assessment of exposure for terrestrial plants, soil invertebrates, and aquatic life, because these receptors are considered to be in direct contact with soil, sediment, or surface water. In general, toxicological benchmarks for these receptors are provided in terms of a soil, sediment or surface water concentration based on toxicity studies evaluating direct contact exposures

Receptor characterization for the selected wildlife receptors is provided in Section 2.3.2.2 of Appendix B.

4.1.2.3 Exposure Point Concentrations

As described in CSA Standard 288.6-12 [R-14], maximum and average (or 95th percentile) concentrations of COPCs in each environmental medium were assessed for each receptor and for each assessed area. The use of maximum concentrations in the exposure assessment is considered to be a conservative approach as most COPCs were identified in isolated locations and it has been assumed that receptors will be exposed to this maximum concentration across their entire home range.

For COPCs with sample concentrations below the detection limit, N288.4-10 Annex D [R-15] was considered when deriving an exposure point concentration (EPC). If less than 50% of the data set for a COPC contained non-detected concentrations, then an average was calculated assuming a normal distribution. If more than 50% of the data set for a COPC contained non-detected concentrations, then the 95th percentile was applied as the EPC. The full detection limit was applied for statistical interpretations of the data as a conservative measure. Exposure point concentrations are further discussed in each media specific section (Section 4.2 to 4.4).

4.1.2.4 Chemical-Specific Factors

Given that site-specific measured concentrations of chemicals in dietary items are not available, uptake equations determined in laboratory studies were used to estimate chemical uptake into dietary items consumed by wildlife (e.g., uptake of chemicals in soil into terrestrial plants). These equations are considered to provide reasonable estimates of tissue concentrations to use in the EcoRA.

The uptake equations used in the EcoRA were obtained from various literature sources including the U.S. EPA Eco-SSL guidance [R-129]. The uptake equations applied in the EcoRA are further discussed in each media specific section (Section 4.2 to 4.4).

4.1.2.5 Exposure Equations and Exposure Doses

The approach followed in this EcoRA involved calculating exposure doses for wildlife using acceptable ecological risk assessment methods referred to in CSA Standard N288.6-12 [R-14], including those described by the CCME [R-120]. Additionally, consideration of a multi-media approach was used as described in clause 7.2.5.4.2 of CSA Standard N288.6-12 [R-14], in which COPCs that exceeded their respective screening benchmark in one environmental medium were retained for assessment in all environmental media for which that COPC exceeds its method detection limit. Using this approach, contribution to exposure from all potential sources is assessed. This applied to the evaluation of semi-aquatic wildlife, where exposures from both surface water and sediment were evaluated. Terrestrial wildlife exposure to surface water was considered negligible (as discussed in Section 4.4.3).

Specific equations used to estimate exposure doses are described in Section 2.3.2.3 of Appendix B. The exposure doses are further discussed in each media specific section (Section 4.2 to 4.4).

Exposure equations are not required for terrestrial plants, soil invertebrates, and aquatic life because exposure estimates for these receptors are represented by the EPC measured in the environmental media they are exposed to.

4.1.3 Toxicity and Effects Assessment

Effects assessment (or toxicity assessment) involves identification of the potentially toxic effects of a chemical and determination of the amount to which an organism can be exposed without experiencing measurable adverse health effects. The concentration of a chemical that does not result in significant adverse health effects is defined as the toxicity reference value (TRV) when expressed as a daily exposure dose (i.e., for mammals and birds) or toxicological benchmark when expressed as a soil, sediment, or surface water concentration (i.e., for terrestrial plants and invertebrates, and aquatic life).

4.1.3.1 Toxicity Reference Values and Toxicological Benchmarks

Toxicological benchmarks and TRVs that are not associated with adverse effects were identified. However, the definition of what is defined as a significant adverse health effect for each receptor depends upon its assessment endpoint target: community success, population success, or individual success (as discussed in Section 4.2.5.2). VEC representing species with conservation status have a higher level of protection (i.e., to protect individual success rather than population success).

The toxicological benchmarks and TRVs applied in the ERA are presented for each media in Section 2.3.5.4, Section 2.3.6.4 and Section 2.3.7.3 of Appendix B.

4.1.4 Risk Characterization

In the risk characterization step, information from the exposure and toxicity assessments are combined to determine if a potential risk exists. Risks may be estimated qualitatively based on scientific judgment or quantitatively by comparing the estimated exposures to the TRVs/toxicological benchmarks identified in the effects (toxicity) assessment. A quantitative approach was employed where possible in the EcoRA.

Throughout all steps of the EcoRA, conservative assumptions were used where there was uncertainty in a given parameter or exposure scenario. That is, a precautionary approach was employed such that risks would be overestimated rather than underestimated. As a result, where risks are determined to be negligible, there is a high degree of confidence that no adverse effects would be expected. Where potential risks are estimated, further investigation may be warranted to confirm the presence of risks.

4.1.4.1 Risk Estimation

Risk characterization is the final step in the risk assessment process, during which the exposure and effects assessments are integrated. The approaches to risk characterization for wildlife, terrestrial plants and soil invertebrates, and aquatic life are described in Section 2.3.4 of Appendix B. Hazard quotients for each VEC and assessed area are summarized under each media-specific section (Section 4.2 to 4.4).

An HQ of less than 1 indicates that the current level of exposure presents no unreasonable risk to the health of the receptor. An HQ of greater than 1 indicates that the level of exposure is greater than the level at which a potential for adverse effects has been identified in laboratory toxicity studies. This does not mean that an adverse effect is present at the Site, but merely that there is a potential for adverse effect. For the locations where the HQ is above 1, further characterization by more analysis or the collection of additional site-specific data may be required to refine the HQ estimates and reduce the uncertainty around potential risks.

4.1.4.2 Site-Specific Target Levels

For COPCs with HQs above 1 that were retained for further assessment, a site-specific target level (SSTL) was established to guide future assessments. The SSTL represents the concentration within the contaminant media that would result in an HQ of 1; therefore, all concentrations measured below the SSTL are considered to present no unreasonable risk. If the derived SSTL resulted in a value that was less than the Ontario MECP Table 1 standard, then the Ontario MECP Table 1 value was used as the SSTL to avoid having SSTLs below background levels.

4.1.5 Uncertainties and Assumptions in EcoRA

In risk assessment, uncertainty is defined as having two components: variability and true uncertainty.

Variability accounts for the natural or inherent variation in natural systems. Calculations relating to variability include descriptive statistics such as standard deviation or standard error of the mean. Measurement errors occur with any technique used. Such measurement errors can be presented in terms of precision and accuracy. The true mean and standard deviation of a statistical population are descriptions of that population. Increasing the number of samples used to estimate the mean and other descriptive statistics, improves the ability to estimate those parameters (i.e., reduces sampling error).

Other forms of uncertainty relate to model error. Model errors occur as a result of simplifying assumptions, as well as from imperfect knowledge (i.e., things that we do not know or that are inherently unknowable). Use of “uncertainty factors” or “safety factors” reflects the precautionary principle (i.e., drive TRVs or toxicological benchmarks to lower numbers; drive exposure estimates to higher numbers). For example, No Observed Adverse Effect Levels (NOAELs) are often derived using uncertainty factors from a Lowest Observed Adverse Effect Level (LOAEL), or are based upon the doses used in the key study (i.e., the true NOAEL may actually be substantially higher); these limitations often result in overly conservative TRVs. Generally, increasing the numbers of valid and relevant toxicity tests can narrow the uncertainty of TRVs and toxicological benchmarks and thus diminish the use of safety factors. Similarly, valid and relevant field studies can be used to refine exposure estimates (such as measuring the COPC concentration in dietary items of wildlife) that more accurately reflect site-specific conditions.

The specific uncertainties around the HQs greater than 1 that were calculated for the ecological receptors are discussed further in the media-specific sections below.

4.2 Soil

4.2.1 Identification of Chemicals of Potential Concern

Soil sampling was completed for all on-site areas that contained terrestrial ecological habitat or were adjacent to ecological habitat including BASC, BBED, CL4, FTF, FSL, DS1, DS2/DS4/DS5, DS8 and BPS/SS. The soil sampling is described in detail in Appendix C Section 3.4.3.

4.2.1.1 Preliminary Screening

COPCs were identified in Table 11 following Preliminary screening against the most stringent provincial and federal soil criteria (discussed in detail in Appendix C Section 3.4.3).

Table 11 Summary of COPCs Retained in EcoRA Following Preliminary Screening

Assessed Area	Soil COPCs
BASC	Antimony Boron (HWS) Chromium VI Zinc Benzene Xylene PHC F2 PHC F3 PHC F4
BBED	None
CL4	Cadmium Copper Silver Molybdenum Uranium 4-Bromophenyl Phenyl Ether Di-n-butyl Phthalate Benzene Acenaphthene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Dibenzo(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene Naphthalene Phenanthrene
FTF	TPH Light (C10-24) Benzyl butyl phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Hexachlorobenzene Nitrobenzene Diphenylamines (total) 2,3,4,5-Tetrachlorophenol Phenol

Table 11 Summary of COPCs Retained in EcoRA Following Preliminary Screening

Assessed Area	Soil COPCs
	2-methylphenol Isophorone Acetone Benzene Chloroform Ethylbenzene Methyl ethyl ketone Purgeable Hydrocarbons (C5-C10) Toluene Xylene Acenaphthene Acenaphthylene Anthracene Benzo(a)anthracene Dibenzo(a,h)anthracene Fluorene Naphthalene Phenanthrene
FSL (Land)	Molybdenum Silver Uranium PHC F2
DS1	TPH Light (C10-C24) Total PCBs
DS#2/4/5	TPH Light (C10-C24) Xylenes
DS#8	TPH Light (C10-C24)
BPS / SS	Boron (HWS) Cadmium Lead Selenium Strontium Uranium PHC F1 PHC F2 PHC F3 PHC F4 Acetone

4.2.1.2 Secondary Screening

Based on the secondary screening provided in Appendix C Section 3.5.1, several parameters in soil listed in Table 12 were retained as COPCs in the 2022 ERA for evaluation of terrestrial plants and soil invertebrates and semi-aquatic wildlife (i.e., birds, mammals, amphibians, and reptiles).

Table 12 Summary of COPCs Retained in EcoRA Following Secondary Screening

Receptor Group and Exposure Pathway	Assessed Area	Soil COPCs
Terrestrial Plants and Soil Organisms Direct Contact	BASC	Boron (HWS) Chromium VI Zinc PHC F3
	BBED	None
	CL4	Copper Zinc Acenaphthene Benzo(a)anthracene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene 4-Bromophenyl Phenyl Ether Di-n-butyl Phthalate
	FTF	TPH Light (C10-24) PHC F3 Purgeable Hydrocarbons (C5-C10) Acenaphthene Acenaphthylene Benzo(a)anthracene Dibenzo(a,h)anthracene Acetone Benzyl butyl phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Hexachlorobenzene Nitrobenzene Diphenylamines (total) 2,3,4,5-Tetrachlorophenol 2-methylphenol Isophorone
	FSL	None
	DS1	TPH Light (C10-24)

Table 12 Summary of COPCs Retained in EcoRA Following Secondary Screening

Receptor Group and Exposure Pathway	**Assessed Area**	**Soil COPCs**
	DS#2/4/5	None
	DS#8	None
	BPS/SS	Boron (HWS) Selenium Strontium Acetone PHC F2 PHC F3
Terrestrial Wildlife (Mammals, Birds, Amphibians and Reptiles) Soil and Food Ingestion	BASC	Zinc
	BBED	None
	CL4	Cadmium Silver Zinc Benzo(a)pyrene Benzo(g,h,i)perylene Dibenzo(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene 4-Bromophenyl Phenyl Ether Di-n-butyl Phthalate
	FTF	Acenaphthylene Dibenzo(a,h)anthracene Benzyl butyl phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Hexachlorobenzene Nitrobenzene Diphenylamines (total) 2,3,4,5-Tetrachlorophenol 2-methylphenol Isophorone
	FSL	Silver
	DS1	None
	DS#2/4/5	None
	DS#8	None

Table 12 Summary of COPCs Retained in EcoRA Following Secondary Screening

Receptor Group and Exposure Pathway	Assessed Area	Soil COPCs
	BPS/SS	Lead Selenium Strontium

4.2.2 Problem Formulation

The EcoRA quantitatively evaluated potential risks from the following receptors and soil exposure pathways:

- Direct contact with soil by plants and soil organisms
- Incidental ingestion of soil and ingestion of prey that accumulate COPCs from soil by terrestrial wildlife

The following describes the approach employed for assessing soil exposures.

4.2.2.1 Assessment and Measurement Endpoints

VECs representing SAR potentially exposed to COPCs through soil were assessed at the individual level, all other VECs were assessed at the population level (for higher tropic wildlife) or community level (for plants and invertebrates).

The measurement endpoint for terrestrial plants and soil organisms is comparison of soil concentrations to literature-derived toxicological benchmarks without deleterious effects on survival, growth, development, or reproduction.

For wildlife, the measurement endpoint is comparison of modeled dietary doses to literature-derived toxicity reference values (TRVs) without deleterious effects on survival, growth, development, or reproduction. Concentrations and doses less than literature-derived values are considered to pose negligible risks to terrestrial plants, soil organisms, mammals, and birds.

Uptake models were used to estimate tissue concentrations in plants and soil organisms when assessing exposures via ingestion of COPCs in food items. Environmental fate and transport considerations for metals and organics in soil are discussed in Appendix B, Section 2.3.5.1.

The assessment and measurement endpoints considered in the terrestrial EcoRA are summarized in Table 13 below.

Table 13 Assessment and Measurement Endpoints for Terrestrial Ecological Receptors for Chemicals

Receptor	Assessment Endpoint			Measurement Endpoint
	Population Success	**Community Success**	**Individual Success**	
Terrestrial Plants			✓ [1]	Comparison of soil concentrations to literature-derived toxicological benchmarks without deleterious effects on survival, growth, development, or reproduction.
Soil Invertebrates		✓		
Mammals				
Meadow Vole	✓			Comparison of modelled dietary doses to literature-derived TRVs without deleterious effects on survival, growth, development, or reproduction.
Northern Short-tailed Shrew	✓			
White-tailed Deer	✓			
Red Fox	✓			
Birds				
Mourning Dove			✓ [2]	Comparison of modelled dietary doses to literature-derived TRVs without deleterious effects on survival, growth, development, or reproduction.
American Woodcock			✓ [2]	
Short-eared Owl			✓ [2]	
Reptiles and Amphibians				
Common Gartersnake			✓ [3]	Comparison of modelled dietary doses to literature-derived TRVs without deleterious effects on survival, growth, development, or reproduction.
Wood Frog	✓			

Notes:
(1) Nine species of plants with conservation status identified as having moderate to high potential on the Site.
(2) Ten species of terrestrial birds with conservation status identified on and around the Site.
(3) Considered representative of all reptiles with conservation status identified as having moderate to high potential on the Site.

4.2.3 Exposure Assessment

4.2.3.1 Exposure Pathways for Soil

Table 14 describes the potential exposure pathways for soil and rationale for their inclusion/exclusion in the EcoRA.

Table 14 Exposure Pathways Evaluated for Soil

Pathway	**Evaluated**	**Rationale**
Inhalation of Soil Dust – Wildlife	×	The COPCs identified for the study area (e.g., metals) can sorb to dust and be inhaled by wildlife. However, exposure via this pathway is expected to be negligible in comparison to exposure from direct soil ingestion [R-129]. As such, inhalation of soil dust was not evaluated in the EcoRA.
Ingestion of Soil – Wildlife	✓	Wildlife species consume small amounts of soil during foraging, preening, and grooming. Therefore, this exposure pathway was evaluated in the EcoRA. Receptors assumed to consume soil include the following: • Meadow vole; • Northern short-tailed shrew; • White-tailed deer; • Red fox; • Mourning dove; • American woodcock; • Common Gartersnake • Wood Frog
Dermal Contact with Soil – Mammals and Birds	×	Although wildlife may be exposed by directly contacting soil, mammals and birds are unlikely to receive significant doses through this route relative to other routes, such as direct ingestion of soil, plants and prey, due to the presence of fur and feathers [R-129][R-133]. Therefore, dermal contact with soil was not evaluated in the EcoRA.
Dermal Contact with Soil – Amphibians and Reptiles	×	Soil can be an important exposure medium for adult amphibians because some bury themselves in soil to stay moist during dry seasons or hibernate in the soil during winter. Amphibians also absorb much of the water in the soil as a way to remain hydrated in the terrestrial environment; thus, dermal uptake of dissolved contaminants from soil pore water is a significant exposure pathway. However, there is a lack of published toxicity data for evaluating such exposures.
Ingestion of Terrestrial Plants – Wildlife	✓	Soil COPCs may be taken up into plants that are food sources for wildlife. Consumption of plants could expose herbivorous and omnivorous wildlife to COPCs. Site-specific tissue residue data for terrestrial plants were not available; therefore, tissue residues were modeled using uptake models and/or factors from the literature. The use of literature-based uptake factors does not account for site-specific conditions and has a high degree of uncertainty that may overestimate or underestimate exposure from this pathway. This exposure pathway was evaluated for herbivorous and omnivorous wildlife receptors including the following: • Meadow vole; • Northern short-tailed shrew; • White-tailed deer; • Red fox; • Mourning dove; and,

Table 14 Exposure Pathways Evaluated for Soil

Pathway	Evaluated	Rationale
		• American woodcock.
Ingestion of Soil Invertebrates – Wildlife	✓	Soil COPCs may be taken up into soil invertebrates that are food sources for wildlife. Site-specific tissue residue data for terrestrial invertebrates were not available; therefore, tissue residues were modeled using uptake models and/or factors from the literature. The use of literature-based uptake factors does not account for site-specific conditions and has a high degree of uncertainty that may overestimate or underestimate exposure from this pathway. Receptors considered to ingest soil invertebrates included the following: • Meadow vole; • Northern short-tailed shrew; • Red fox; • American woodcock; • Common gartersnake; and, • Wood frog.
Ingestion of Prey – Wildlife	✓	Carnivorous and omnivorous animals have the potential to be exposed to COPCs via ingestion of prey. The available models to calculate potential COPC concentrations in prey may underestimate or overestimate potential COPC tissue concentrations. Receptors considered to ingest prey included the following: • Northern short-tailed shrew; • Red fox; • Short-eared owl; and, • Common gartersnake.
Direct Contact with Soil – Terrestrial Plants and Soil Invertebrates	✓	Terrestrial plants and soil invertebrates reside within the soil matrix and as a result, are directly exposed to COPCs in soil.
Notes: × = exposure pathway is not evaluated in the EcoRA. ✓ = exposure pathway is evaluated in the EcoRA.		

4.2.3.2 Areas Assessed

Each of the areas considered in the EcoRA, the habitat within each area, and the potential receptors considered to become exposed to COPCs at each area are presented in Table 15.

Table 15 Areas Assessed for Soil COPCs

Area	Potential Receptors	Further Evaluated in EcoRA?
Bruce A Storage Compound (BASC) - 17 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants (both soil and shallow groundwater contact) and invertebrates	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.
Bruce B Empty Drum Laydown Area (BBED) - 1.4 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.	No, COPCs were not identified in soil following preliminary screening.
Construction Landfill #4 (CL4) - 3.8 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.
Fire Training Facility (FTF) - 2.8 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.
Former Sewage (Commissioning Waste) Lagoon (FSL) - 7 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants (both soil and shallow groundwater contact) and invertebrates.	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.

Table 15 Areas Assessed for Soil COPCs

Area	Potential Receptors	Further Evaluated in EcoRA?
Distribution Station #1 (DS1) - 0.068 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.
Distribution Station #2/4/5 (DS2/DS4/DS5) - 0.05 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.
Distribution Station #8 (DS8) - 0.21 ha	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates	No, COPCs were not identified in soil following preliminary screening
General surface soil samples (BPS/SS sampling serious)	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates	Yes, COPCs were identified in soil following secondary screening for soil invertebrates and terrestrial plants, mammals, birds, amphibians and reptiles.

4.2.3.3 Exposure Point Concentrations

Within each assessed area, the maximum and average concentrations (or 95th percentiles where the data set contained more than 50% undetected concentrations) of each COPC from all sampled locations and sampling dates since 2000 were used as the Exposure Point Concentration (EPC) in soil.

For BPS/SS locations, only the maximum soil concentrations of COPCs were considered as an EPC given that the sampling was widely dispersed across different habitats.

As discussed in Section 4.2.2.1, the soil EPC represents the exposure estimates for plants and soil organisms from direct contact with soil. For exposure to terrestrial wildlife, the soil EPCs were used to estimate the exposure doses from incidental ingestion of soil and ingestion of prey that have bioaccumulated COPCs from soil.

The EPCs for soil COPCs used to assess exposures to terrestrial plants, soil invertebrates are provided in Table 16; and terrestrial wildlife are provided in Table 17.

Table 16 Exposure Point Concentrations for Soil for Terrestrial Plants and Soil Invertebrates

COPC	Soil Concentration (mg/kg)		
	Maximum	Average[1]	95th Percentile[1]
BASC			
Boron (HWS)	6.3	0.92	-
Chromium VI	1	-	1
Zinc	520	86	-
PHC F3	340	91	-
BBED			
None	-	-	-
CL4			
Copper	120	49	-
Zinc	350	113	-
Acenaphthene	0.48	-	0.48
Benzo(a)anthracene	2.6	-	2.1
Benzo(b)fluoranthene	5	-	5
Dibenzo(a,h)anthracene	0.79	-	0.79
Indeno(1,2,3-cd)pyrene	1.7	-	1.4
4-Bromophenyl Phenyl Ether	0.01	0.006	-
Di-n-butyl Phthalate	0.11	0.043	-
FTF			
TPH Light (C10-24)	9676	534	-
Purgeable Hydrocarbons (C5-C10)	222	-	84
Acenaphthene	0.41	-	0.03
Acenaphthylene	0.71	-	0.4
Benzo(a)anthracene	2.1	-	0.26
Dibenzo(a,h)anthracene	0.22	-	0.10
Acetone	1.8	-	1.1
Benzyl butyl phthalate	0.1		0.04
Di-n-butyl Phthalate	0.06	-	0.05
Di-n-octyl Phthalate	0.02	-	0.005
Hexachlorobenzene	2.4	-	0.9
Nitrobenzene	4.5	-	0.7
Diphenylamines (total)	1.5	-	0.7

Table 16 Exposure Point Concentrations for Soil for Terrestrial Plants and Soil Invertebrates

COPC	Soil Concentration (mg/kg)		
	Maximum	**Average[1]**	**95th Percentile[1]**
2,3,4,5-Tetrachlorophenol	32	-	5.1
2-methylphenol	16	-	4.5
Isophorone	0.13	-	0.05
FSL			
None	-	-	-
DS1			
TPH Light (C10-24)	384	-	267
DS2/DS4/DS5			
None	-	-	-
BPS / SS			
Boron (HWS)	6.6	NA [2]	NA [2]
Selenium	2.8	NA [2]	NA [2]
PHC F2	500	NA [2]	NA [2]
PHC F3	1500	NA [2]	NA[2]
Acetone	1.1	NA[2]	NA[2]

Notes:

[1] If the data set for a COPC has less than 50% undetected concentrations, the average is applied as the EPC, otherwise the 95th percentile is used.

[2] Statistical assessments of concentrations not applicable for BPS / SS locations as they are widely dispersed and represent different ecological habitats

Table 17 Exposure Point Concentrations for Soil for Terrestrial Wildlife

COPC	Soil Concentration (mg/kg)		
	Maximum	Average [1]	95th Percentile [1]
BASC			
Zinc	520	86	-
BBED			
None	-	-	-
CL4			
Cadmium	6.5	0.55	-
Silver	2.6	-	1.8
Zinc	350	113	-
Benzo(a)pyrene	2.4	-	1.9
Benzo(g,h,i)perylene	1.7	-	1.4
Dibenzo(a,h) anthracene	0.79	-	0.79
Fluoranthene	4.4	-	3.52
Indeno(1,2,3-cd)pyrene	1.7	-	1.36
4-Bromophenyl Phenyl Ether	0.01	0.006	-
Di-n-butyl Phthalate	0.11	0.043	-
FTF			
Acenaphthylene	0.71	-	0.4
Dibenzo(a,h)anthracene	0.22	-	0.10
Benzyl butyl phthalate	0.1	-	0.04
Di-n-butyl Phthalate	0.06	-	0.05
Di-n-octyl Phthalate	0.02	-	0.005
Hexachlorobenzene	2.4	-	0.9
Nitrobenzene	4.5	-	0.7
Diphenylamines (total)	1.5	-	0.7
2,3,4,5-Tetrachlorophenol	32	-	5.1
2-Methylphenol	16	-	4.5
Isophorone	0.13	-	0.05
FSL			
Silver	1.4	-	<0.7
DS1			
None	-	-	-
DS2/DS4/DS5			
None	-	-	-
DS8			
None	-	-	-

Table 17 Exposure Point Concentrations for Soil for Terrestrial Wildlife

COPC	Soil Concentration (mg/kg)		
	Maximum	Average [1]	95th Percentile [1]
BPS / SS			
Lead	130	NA[2]	NA[2]
Selenium	2.8	NA[2]	NA[2]

Notes:

[1] If the data set for a COPC has less than 50% undetected concentrations, the average is applied as the EPC, otherwise the 95th percentile is used.

[2] Statistical assessments of concentrations not applicable for BPS / SS locations as they are widely dispersed and represent different ecological habitats

4.2.3.4 Modelled Concentrations in Dietary Items

As discussed in Section 4.2.2.1, chemical uptake of COPCs from soil into dietary items (terrestrial plants, soil invertebrates, small mammals) consumed by wildlife was modelled using update equations. The modelled concentrations in dietary items are presented in Appendix B, Section 2.3.5.2.

4.2.3.5 Exposure Doses for Terrestrial Wildlife

As discussed in Section 4.2.2.1, exposure doses to terrestrial wildlife from soil COPCs were estimated using receptor characteristics for each VEC and food-chain modelling. The exposure doses for terrestrial wildlife are presented in Appendix F, Section 6.2.

4.2.4 Toxicity and Effects Assessment

4.2.4.1 Toxicological Benchmarks for Terrestrial Plants and Soil invertebrates

The toxicological benchmarks used in the assessment of terrestrial plants and soil invertebrates from soil are presented in Appendix B, Section 2.3.5.3.

4.2.4.2 TRVs for Terrestrial Wildlife

The TRVs used in the assessment of terrestrial wildlife from soil are presented in Appendix B, Section 2.3.5.4. The NOAEL was selected for the evaluation of birds and reptiles to ensure protection of SAR identified on-site. For assessment of those receptors that were not used as surrogates for species at risk (mammals), the LOAEL was used.

4.2.5 Risk Characterization

4.2.5.1 Terrestrial Plants and Soil Invertebrates

The estimated HQs for terrestrial plants and soil invertebrates for soil COPCs are shown in Appendix F, Section 6.2.1. A summary of the estimated HQs that were greater than 1 are shown in Table 18, followed by further discussion about if the COPC is retained for further assessment.

Table 18 Estimated Hazard Quotients > 1 for Terrestrial Plants and Soil Invertebrates from Soil

COPC	**Hazard Quotient > 1?**		**Chemical retained for further assessment?**	**SSTL (mg/kg)**
	Maximum	**Average/ 95^{th} Percentile** [1]		
BASC				
Boron (HWS)	**4.2**	0.6	No; estimated HQs are less than 1 using average soil concentrations.	2
Zinc	**4.3**	0.7		290
PHC F3	**1.1**	0.3		300
BBED				
No COPCs identified				
Construction Landfill #4				
Copper	**1.7**	0.7	No; estimated HQs are less than 1 using average soil concentrations.	91
Zinc	**2.9**	0.9		290
Fire Training Facility				
Total Petroleum Hydrocarbons (TPH) Light	**65**	**3.6**	**Yes, HQs> 1 based on average concentration** *Further work should characterize the current PHC concentrations around historically contaminated areas within surface soil to affirm potential risks.*	150
Nitrobenzene	**2.0**	0.3	No; estimated HQs are less than 1 using 95^{th} percentile soil concentrations.	2.2
Purgeable Hydrocarbons (C5-C10)	**1.1**	0.4	No; estimated HQs are less than 1 using 95^{th} percentile soil concentrations.	210
Former Sewage Lagoon				
No COPCs identified				

Table 18 Estimated Hazard Quotients > 1 for Terrestrial Plants and Soil Invertebrates from Soil

COPC	Hazard Quotient > 1?		Chemical retained for further assessment?	SSTL (mg/kg)
	Maximum	Average/ 95th Percentile [1]		
DS1				
TPH Light	**2.6**	**1.8**	**Yes, HQs> 1 based on 95th percentile soil concentration** *Further work should characterize the current PHC concentrations around historically contaminated areas within surface soil to affirm potential risks.*	150
Distribution Station #2/4/5				
No COPCs identified				
Distribution Station #8				
No COPCs identified				
BPS / SS				
Boron (HWS)	**4.4**	NA	**Yes, HQs> 1 based on maximum soil concentration** *Further work should delineate the extent of metal impacts in surface soil around BPS-04-07 to affirm potential risks because this was the only locations that exceeded the SSTL.*	2
Selenium	**5.4**	NA		1.5
Petroleum Hydrocarbons (PHC) F2	**3.3**	NA	**Yes, HQs> 1 based on maximum soil concentration** *Further work should delineate the extent of PHC impacts in surface soil around BPS-04-07 and BPS-01-07 to affirm potential risks because these were the only locations that exceeded the SSTL.*	150
PHC F3	**5.0**	NA		300

Notes:

SSTL – Concentration of COPC in soil resulting in no unreasonable risk (see Section 4.1.4.2)

NA – Not applicable; statistical assessment of soil concentrations was not completed for BPS / SS sampling locations as they are widely dispersed and represent different habitats.

[1] If the data set for a COPC has less than 50% undetected concentrations, the average is applied as the EPC, otherwise the 95th percentile is used.

Risks for all COPCs at BASC and CL4 where HQs could be calculated were acceptable when considering average concentrations (where more than 50% of concentrations are detected) or 95th percentile concentrations (where less than 50% of concentrations are detected). There were COPCs at CL4 and FTF where toxicological benchmarks were not available and it was not possible to calculate HQs and fully characterize the associated risk. COPCs where toxicological benchmarks were not available are discussed below. Overall, while there may be some localized effects to terrestrial vegetation and soil invertebrates, the soil concentrations are not expected to adversely affect plant and soil invertebrate communities in these areas. Section 4.2.5.3 provides further discussion regarding the likelihood of effects. It is noted that no visible localized impacts to vegetation have been observed during field surveys at BASC and CL4.

Risks were not reduced to HQs less than 1 for terrestrial plants and soil invertebrates when considering:

- Average concentrations of TPH Light at FTF.
- 95th percentile concentrations of TPH Light at DS1.
- Maximum concentrations (applied due to large spatial distribution of the general soil sampling sites and the limited data set at each site) of boron (HWS), selenium at BPS-04 and PHC F2 and PHC F3 at BPS-07 and BPS-01.

Further rationale as to if these COPCs should be retained for further assessment is discussed below.

<u>TPH Light at FTF</u>

At FTF, 15 out of 27 sampled locations collected within the top 1.5 m had TPH Light concentrations greater than the toxicological benchmarks. However, all of the sampled locations with elevated TPH Light concentrations were collected in 2000. Given that TPH Light fractions have likely decreased overtime as a result of natural attenuation from leaching, volatilization and biodegradation, further work should characterize the current PHC concentrations around historically contaminated areas within the surface soil to affirm potential risks. Samples collected in 2016 and 2021 had PHC concentrations less than the preliminary benchmarks, but none of these samples were collected where maximum TPH Light concentrations were measured historically. No visible localized impacts to vegetation have been noted during field surveys at FTF, although the soil in the area was disturbed during the execution of improvements to the FTF in 2013-2014 (see Appendix A, Section 1.3.1.3). The sample locations at FTF with concentrations of TPH Light greater than the SSTL of 150 mg/kg are outlined in Figure 17 below.

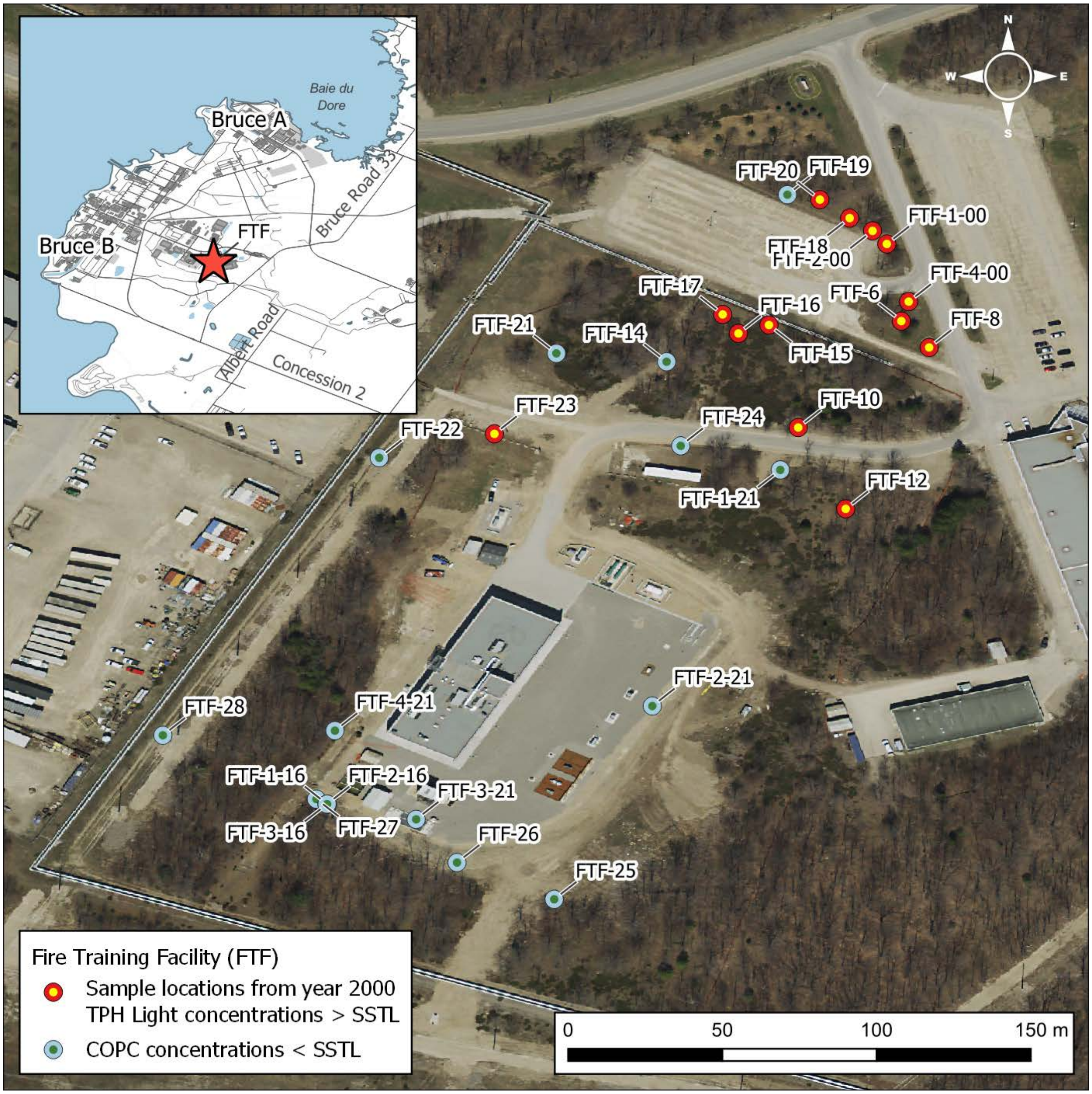

Figure 17 Sample Locations at FTF Greater than SSTL for TPH Light for the Protection of Plants and Soil Invertebrates

TPH Light at DS1

At DS1, 2 out of 17 sampled locations collected within the top 1.5 m had TPH Light concentrations greater than the toxicological benchmarks. However, all of the sampled locations with elevated TPH Light concentrations were collected in 2000. Further work should characterize the current PHC concentrations around historically contaminated areas within the surface soil to affirm potential risks given natural attenuation processes. Samples collected in

2016 had PHC concentrations less than the preliminary benchmarks, but none of these samples were collected where maximum TPH Light concentrations were measured historically. No visible localized impacts to vegetation have been noted during field surveys at DS1. The sample locations at DS1 with concentrations of TPH Light greater than the SSTL of 150 mg/kg are outlined in Figure 18 below.

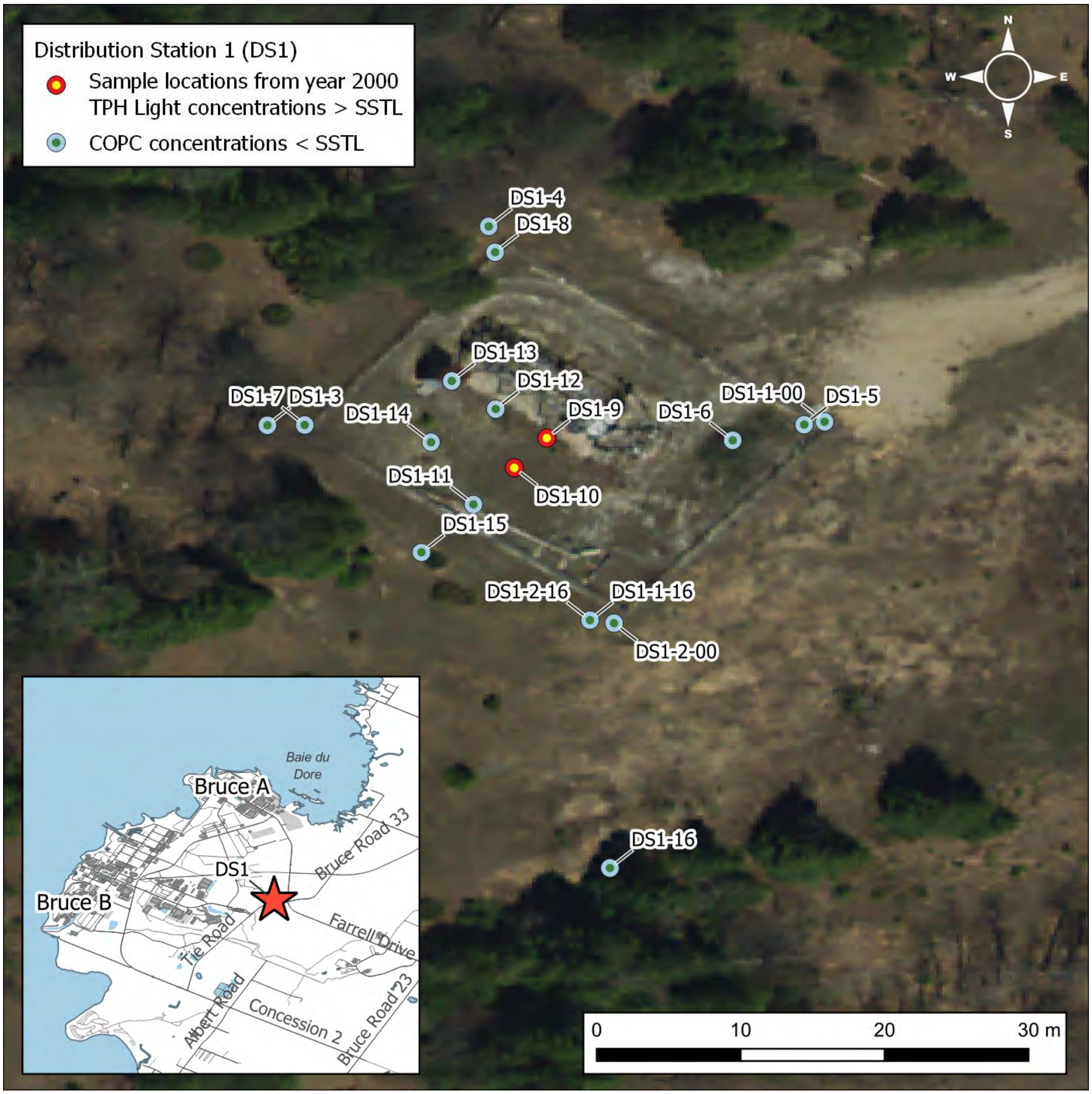

Figure 18 Sample Location at DS1 Greater than the SSTL for TPH Light for the Protection of Plants and Soil Invertebrates

Boron (HWS), Selenium, PHCs at BPS/SS

BPS/SS locations had HQs greater than 1 based on maximum concentrations of boron (HWS), selenium, PHC F2 and PHC F3 in soil, shown in Figure 19. A statistical assessment of soil concentrations was not completed for BPS/SS sampling locations as they are widely dispersed and represent different habitats. Further work should characterize the extent of impacts around the following BPS / SS sampling locations with concentrations greater than the SSTL to affirm potential risks (2 mg/kg for boron (HWS), 1.5 mg/kg for selenium, 150 mg/kg for PHC F2 and 300 mg/kg for PHC F3):

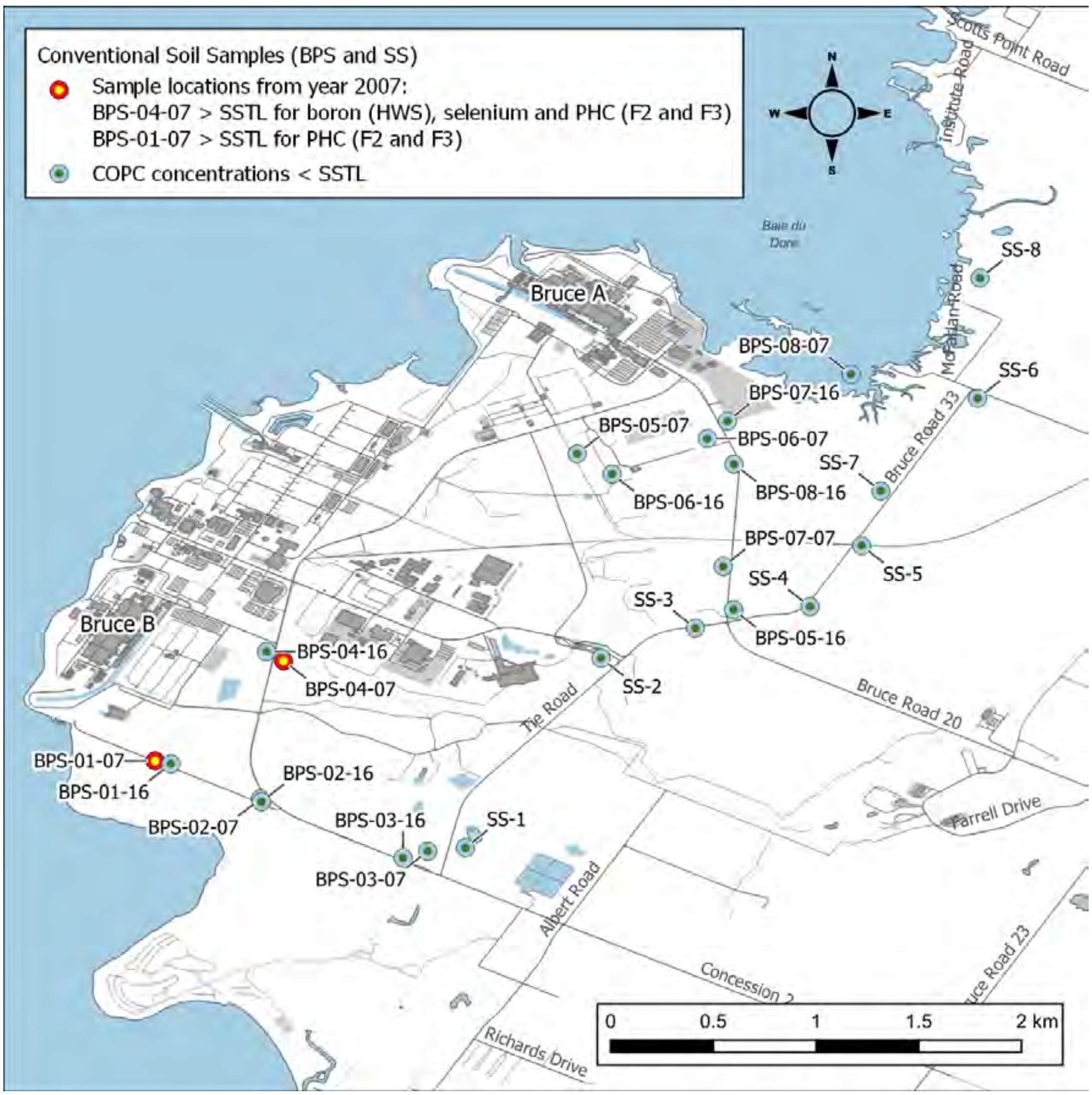

Figure 19 Sample Locations across BPS/SS Greater than the SSTL for Boron (HWS), Selenium and PHCs for the Protection of Plants and Soil Invertebrates

4.2.5.2 Terrestrial mammals, Birds, Amphibians and Reptiles

The estimated HQs for terrestrial mammals and birds due to soil COPCs are provided in Appendix F, Section 6.2.2. A summary of the estimated HQs that were greater than 1 are shown Table 19 below, followed by further discussion about if the COPC is retained for further assessment.

Table 19 Estimated Hazard Quotients > 1 for Terrestrial Wildlife from Soil

COPC	VEC	Hazard Quotient > 1?		Chemical retained for further assessment?	SSTL (mg/kg)
		Maximum	Average / 95th Percentile [1]		
Construction Landfill #4 (CL4)					
Cadmium	Northern Short-Tailed Shrew	**2.3**	0.3	No; estimated HQs are less than 1 using average soil concentrations.	2.3
	American Woodcock	**2**	**1.7**	No; elevated cadmium concentration at BASC is located in one sample location at depths greater than 90 cm. Cadmium exposure to ecological receptors is considered minimal.	1.2
	Wood Frog	**4.2**	0.6	No; estimated HQs are less than 1 using average soil concentrations.	1.2
Zinc	Northern Short-Tailed Shrew	**1.7**	**1.2**	**Yes, HQs>1.** *Further work should characterize the extent of zinc impacts around the CL4 sampling site collected in 2016 to affirm potential risks because this was the only location that exceeded the SSTL.*	290
	Mourning Dove	**1.6**	0.85		
	American Woodcock	**6.3**	**4.3**		
	Wood Frog	**2.1**	**1.4**		
Total High Molecular Weight (HMW) PAHs	American Woodcock	**9.9**	**8.2**	**Yes, HQs> 1.** *Further work should characterize the extent of impacts around CL4-9 collected in 2000 to affirm potential risks because this was the only location that exceeded the SSTL.*	0.67
	Wood Frog	**3.3**	**2.7**		2.0

Table 19 Estimated Hazard Quotients > 1 for Terrestrial Wildlife from Soil

COPC	VEC	Hazard Quotient > 1?		Chemical retained for further assessment?	SSTL (mg/kg)
		Maximum	Average / 95th Percentile [1]		
BASC					
Zinc	Northern Short-Tailed Shrew	**2.0**	**1.1**	No; elevated zinc concentrations at BASC are located within gravel parking areas and roads that do not provide ecological habitat. Impacts are delineated adjacent to ecological habitat surrounding BASC. Zinc exposures to ecological receptors are considered minimal.	290
	Mourning Dove	**2.1**	0.7		
	American Woodcock	**7.1**	**3.9**		
	Wood Frog	**2.4**	**1.3**		
BPS / SS					
Lead	Northern Short-Tailed Shrew	**2.3**	NA	**Yes, HQs> 1 when considering maximum soil concentration.** *Further work should characterize the extent of lead impacts around SS6 to affirm potential risks as this was the only location that exceeded the SSTL.*	120
	Mourning Dove	**3.3**	NA		
	American Woodcock	**18**	NA		
	Wood Frog	**6.0**	NA		
Selenium	Meadow Vole	**2.5**	NA	**Yes, HQs> 1 when considering maximum soil concentration.** *Further work should characterize the extent of selenium impacts around BPS-04-07 to affirm potential risks as this was the only location that exceeded the SSTL.*	1.5
	Northern Short-Tailed Shrew	**5.2**	NA		
	Mourning Dove	**4.7**	NA		
	American Woodcock	**5.2**	NA		
	Wood Frog	**1.6**	NA		

Notes:

SSTL – Concentration of COPC in soil resulting in no unreasonable risk (see Section 4.1.4.2)

NA – Not applicable; statistical assessment of soil concentrations was not completed for BPS / SS sampling locations as they are widely dispersed and represent different habitats.

[1] If the data set for a COPC has less than 50% undetected concentrations, the average is applied as the EPC, otherwise the 95th percentile is used.

Considering area-wide 95th percentile concentrations (for less than 50% detected concentrations across the data set) or average soil concentrations (for more than 50% detected concentrations across the data set), HQs greater than 1 remain for:

- The American Woodcock from cadmium at CL4
- Northern Short-Tailed, Mourning Dove, American Woodcock and Wood Frog from zinc at CL4
- The American Woodcock and the Wood Frog from PAHs at CL4
- The Northern Short-Tailed, Mourning Dove, American Woodcock and Wood Frog from zinc at BASC

Further rationale as to if these COPCs should be retained for further assessment is discussed below:

<u>Cadmium at CL4</u>

For cadmium exposures at CL4, the HQ was 1.7 for the American Woodcock in consideration of the average concentration. However, only one sample location out of 12 assessed locations had cadmium concentrations above the MECP Table 1 standards representative of soil background levels (6.5 mg/kg vs. 1.2 mg/kg). The elevated concentration was found at a depth of 90 cm; with concentrations measured below method detection limits at 23 and 46 cm. The American Woodcock's diet consists of at least 90% earthworms. Studies have shown that most earthworms are found within surficial soil layers (no more than 30 cm deep) where the majority of humus and decomposed plant matter is found; and therefore, 30 cm is considered a default depth for evaluating exposures to soil invertebrates [R-134]. Therefore, potential ecological exposures to cadmium at CL4 are considered negligible and follow-up monitoring is not recommended.

<u>Zinc at CL4</u>

For zinc exposures at CL4, HQs ranged from 1.2 to 4.3 for the Northern Short-Tailed Shrew, Wood Frog and American Woodcock in consideration of the average concentration. Only one sample location (CL4) analyzed in 2016 had zinc concentrations above the MECP Table 1 standards representative of soil background levels (350 mg/kg vs. 290 mg/kg). However, the next closest sample location was over 50 m from CL4 (2016). Further work should characterize the extent of impacts around CL4 (2016) to affirm potential risks. The sample locations at CL4 with zinc concentrations greater than the SSTL of 290 mg/kg are outlined in Figure 20 below.

PAHs at CL4

For PAH exposures at CL4, HQs ranged from 2.7 to 8.2 for the Wood Frog and the American Woodcock in consideration of the 95th percentile concentration. Only one (CL4-9) of five sample locations analyzed in 2000 had elevated PAH concentrations at CL4. However, the next closest sample location analyzed for PAHs was over 50 m from CL4-9. Further work should characterize the extent of impacts around CL4-9 to affirm potential risks. The sample locations at CL4 with concentrations of PAHs greater than the SSTL are outlined in Figure 20 below.

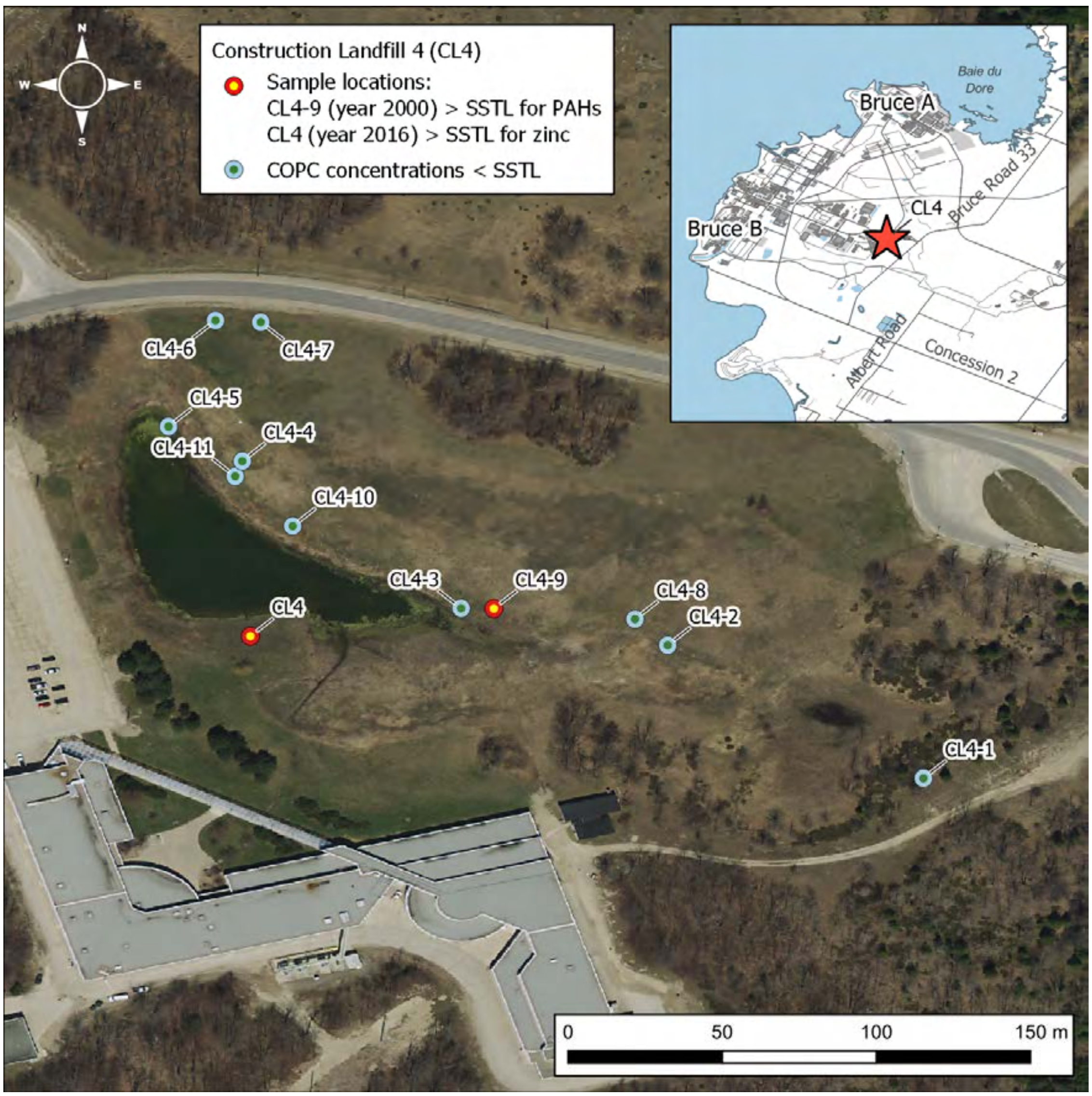

Figure 20 Sample Locations at CL4 Greater Than the SSTL for Zinc and PAHs for the Protection of Terrestrial Wildlife

Zinc at BASC

For zinc exposures at BASC, HQs ranged from 1.1 to 3.9 for Northern Short-Tailed Shrew, Wood Frog and American Woodcock in consideration of the average concentration. However, only two sample locations out of 22 assessed locations had zinc concentrations above the SSTL (measured at 490 and 520 mg/kg vs. 290 mg/kg). As shown below in Figure 21, these elevated zinc concentrations are located within graveled parking areas or roads that do not support ecological habitat; and all locations collected at BASC adjacent to ecological habitat had zinc concentrations below the MECP background levels. Therefore, exposure to ecological receptors from elevated zinc concentrations is considered minimal at BASC and follow-up monitoring is not recommended.

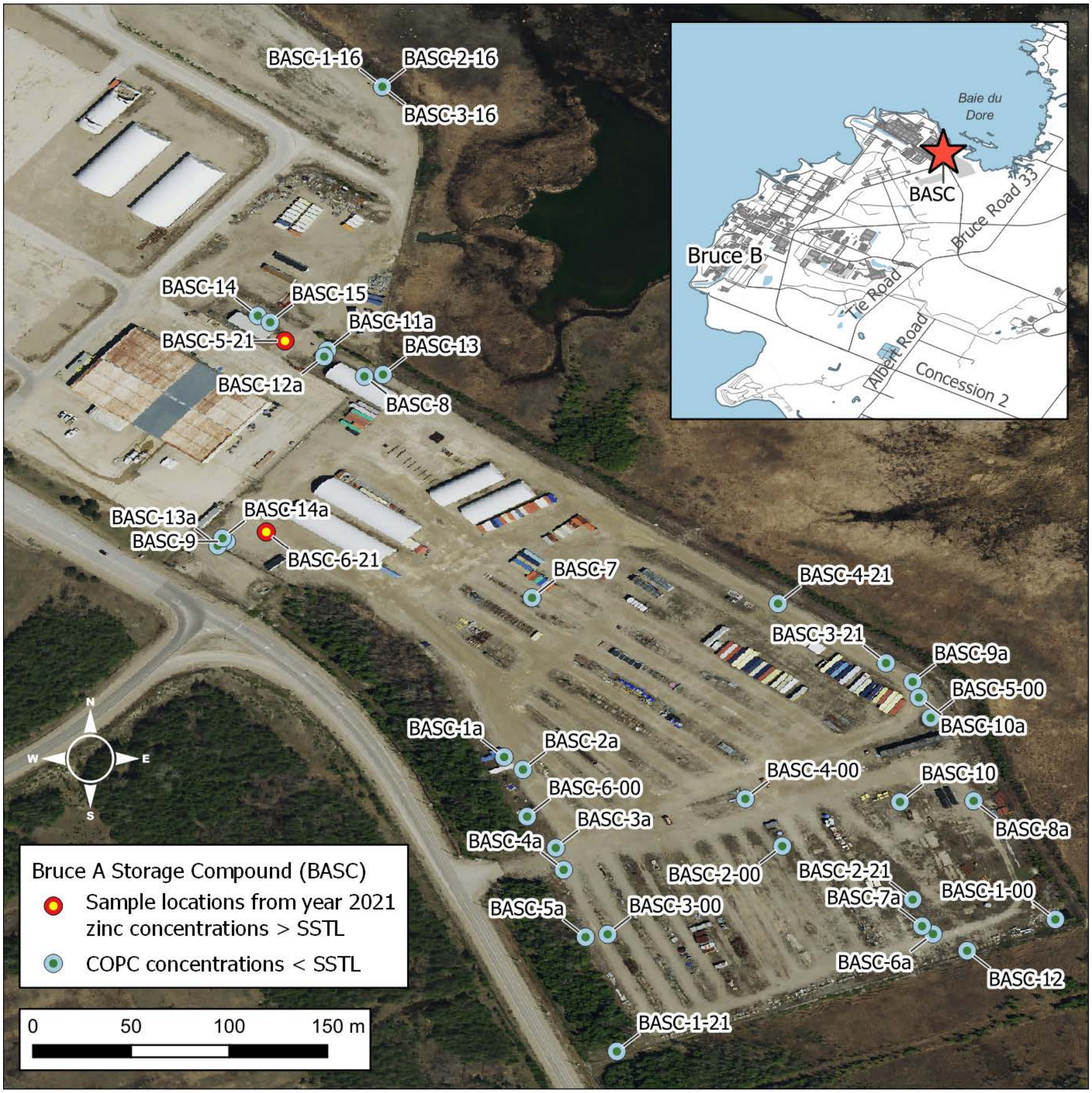

Figure 21 Sample Locations at BASC Greater Than the SSTL for Zinc for the Protection of Terrestrial Wildlife

<u>Selenium and Lead at General Surface Soil Sampling Locations (BPS/SS)</u>

BPS/SS locations had HQs greater than 1 based on maximum concentrations of selenium and lead in soil. A statistical assessment of soil concentrations was not completed for BPS/SS sampling locations as they are widely dispersed and represent different habitats, see Figure 22 below. Further work should characterize the extent of impacts around the BPS-04-07 (sampling location with HQs greater than 1 for selenium) and SS6 (sampling location with HQs greater than 1 for lead) to affirm potential risks.

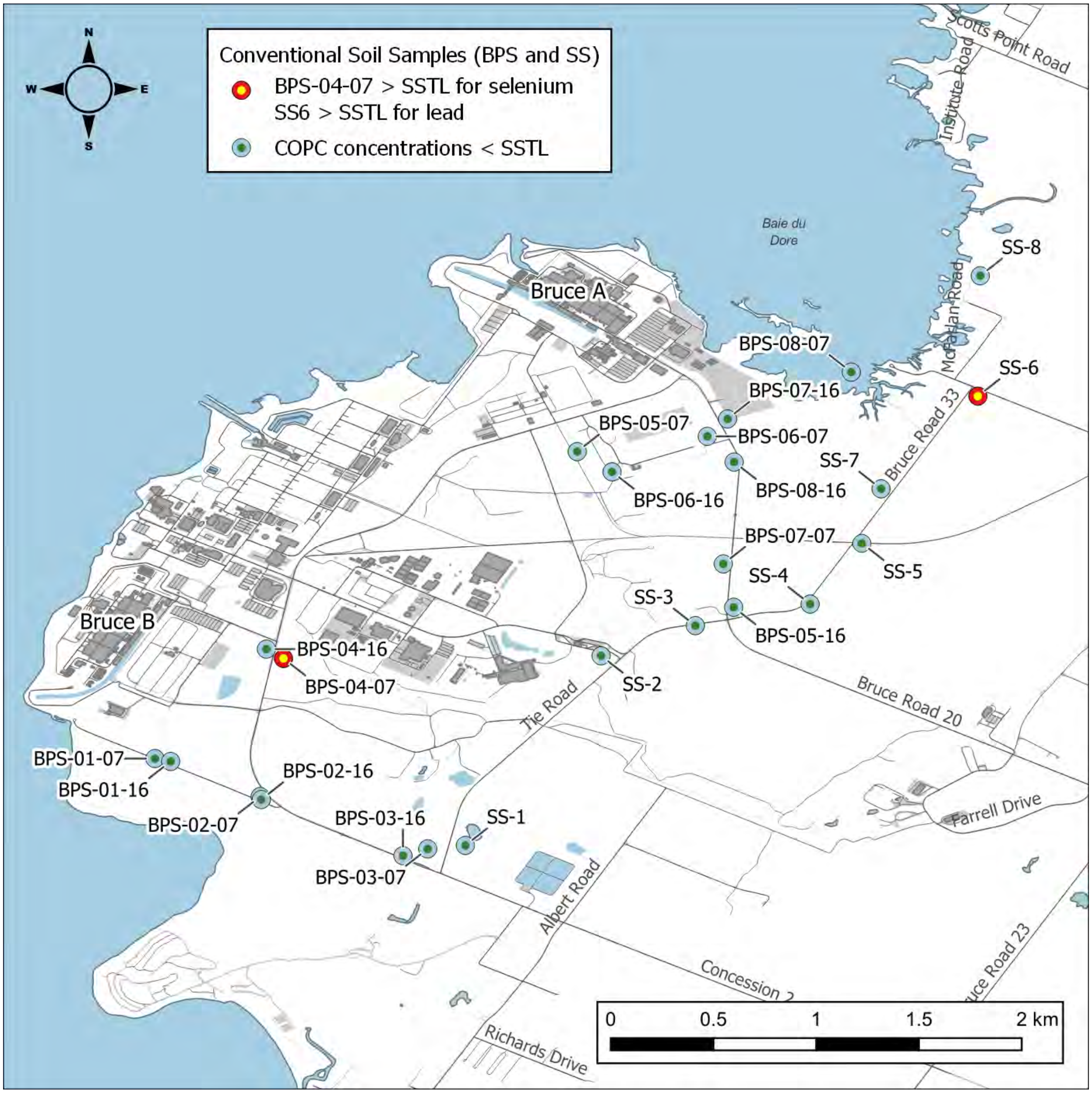

Figure 22 Sample Locations at BPS/SS Greater than the SSTL for Selenium and Lead for the Protection of Terrestrial Wildlife

These HQs were calculated considering that the receptor would spend 100% of its most sensitive life stage on the assessed area and that the receptor will experience toxic effects once exposed to concentrations above the selected TRVs. Section 4.2.5.3 provides further discussion regarding the likelihood of effects and Sections 4.1.5 and 4.2.6 provide further discussion around the uncertainties of these assumptions.

4.2.5.3 Likelihood of Effects

The proportion of the Site with HQs greater than 1 in consideration of average or 95th percentile soil concentrations included CL4 and FTF. These areas comprise of 6.6 ha across the Site that is 932 ha. While the HQs predict potential impacts to terrestrial plants at these locations, these have not been observed incidentally. Additionally, it is unlikely that any localized impacts to plants will affect terrestrial wildlife as there are other nearby areas that provide more suitable habitat for populations to succeed.

4.2.6 Uncertainties and Assumptions

Uncertainties within this EcoRA, like many, are often addressed by making conservative assumptions to ensure that receptors are adequately protected. Table 20 examines the assumptions in each aspect of the EcoRA for soil, comments on the level of uncertainty that should be assigned to the findings, and identifies areas where future work may be used to reduce uncertainties.

Table 20 Summary of Assumptions and Uncertainties for Evaluation of Soil COPCs

Assumptions	Uncertainties	Under- or Over- Estimate Risk	Rationale
Exposure Assessment			
Exposure Point Concentrations	High	Over-estimate	The average and 95th percentile were applied as an EPC, where possible. This provides a more realistic exposure estimate than maximum measured concentrations of COPCs as plants and invertebrates are protected at the community level, and mammals and birds are mobile. These EPCs are driven by soil concentrations targeting contaminated areas and it is conservatively assumed that the VECs will forage within the contaminated areas. Additional sampling to better understand contaminant distribution and delineate impacts can reduce this uncertainty. EPCs for TPH Light at FTF and DS1 were driven by data collected in 2000, and no recent sampling has been completed to confirm current concentrations. Additionally, when calculating average/95th percentile concentrations, where reported concentrations were less than the method detection limits, the full detection limit was used in the calculation. This is a conservative approach and the EPCs are likely biased high.
Frequency of Exposure	High	Over-estimate	Frequency of exposure was not quantitatively evaluated in the exposure assessment for wildlife. Although seasonality and home range are factors that may affect a receptor's likely exposure, the EcoRA was carried out assuming that the receptor could be exposed to the affected area throughout their lifetime. Excluding frequency of exposure has the greatest potential of overestimating risks to receptors with large home ranges (e.g., red fox, mourning dove) and those that are migratory and would only be present on-site for a short period (e.g., mourning dove and American woodcock).
Habitat Quality	High	Over-estimate	The habitat quality at the majority of the assessed sites is expected to be lower than assumed in this EcoRA as they are found within or adjacent to industrial operations. Wildlife receptors are mobile and forage in many areas, and are more likely to be drawn to natural habitats surrounding the site than they are to linger at the impacted part of the site.

Table 20 Summary of Assumptions and Uncertainties for Evaluation of Soil COPCs

Assumptions	Uncertainties	Under- or Over- Estimate Risk	Rationale
Literature-Based Chemical-Specific Factors	High	Over-estimate	Given that site specific concentrations of chemicals in dietary items were not available, uptake equations from the literature were used. However, these equations are based upon using relatively bioavailable forms of metals and as such, would be expected to overestimate uptake into dietary items when obtained from areas where impacts would be aged and weathered and more tightly adsorbed to environmental media. As a result, the concentrations estimated in dietary items are likely overestimated.
Bioavailability	High	Over-estimate	Exposure estimates for wildlife were not adjusted for bioavailability because TRVs were expressed as the administered dose (i.e., amount taken into the body), rather than the absorbed dose (i.e., amount absorbed and retained in the body). This is a conservative approach given that the administered dose is often in a more bioavailable form than that found in the environment. The soils at the Site are likely weathered, and therefore, the bioavailability and toxicity of the chemicals are likely less than that for amended soils used to derive the TRVs.
Toxicity and Effect Assessment			
Literature-based Toxicological Benchmarks and TRVs	High	Over-estimate	Toxicological benchmarks and TRVs are generally developed from laboratory studies that use species that are not identical to the receptors identified for a site. Species differ in the absorption, metabolism, distribution and excretion of chemicals and the resulting toxicity may differ. For example, Wildlife TRVs are often based upon studies carried out on laboratory animals such as rats and mice, and again there are uncertainties in extrapolating effects for laboratory animals to wildlife. The dosing methods used in key studies using laboratory animals tend to use spiked food with a bioavailable form of the substance (i.e., often as a soluble salt in the case of metals). Similarly, toxicity studies evaluating direct contact effects to plants and soil invertebrates also use readily bioavailable forms within freshly spiked soils.
TRVs for Herpetofauna	High	Under- or over-estimate	Toxicity data for herpetofauna were not available for use in this assessment. Therefore, avian toxicity data were used as a surrogate for risk estimation. There is uncertainty regarding the relative sensitivity of herptiles and birds to the COPCs. If birds are substantially more or less sensitive than reptiles and amphibians, then risk would be over or underestimated, respectively.

Table 20 Summary of Assumptions and Uncertainties for Evaluation of Soil COPCs

Assumptions	Uncertainties	Under- or Over- Estimate Risk	Rationale
TRVs based on NOAEL	Moderate	Over-estimate	For bird and herpetofauna VECs, risks were estimated using NOAEL-based TRVs that tend to overestimate risks and often apply uncertainty factors. The NOAEL was applied for the protection of potential bird and reptile SAR at the site. Potential risks to bird VECs that were surrogated to SAR were identified at CL4 and BPS / SS locations and there is potential for avian SAR at these sites based on habitat. Therefore, the use of the NOAEL was considered appropriate for assessing potential risk from soil.

Table 20 Summary of Assumptions and Uncertainties for Evaluation of Soil COPCs

Assumptions	Uncertainties	Under- or Over- Estimate Risk	Rationale
Lack of TRVs/ Toxicological Benchmarks	High	Over-estimate	TRVs and/or toxicity benchmarks were not available for the following COPCs: • Isophorone • Acetone • Benzyl Butyl Phthalate • 4-Bromophenyl Phenyl Ether • Diphenylamines (total) • 2-Methylphenol • 2,3,4,5-Tetrachlorophenol • Strontium A review should be completed for the next EcoRA to determine if published TRV's and/or toxicity benchmarks for these COPCs become available. At FTF, these COPCs are co-located with the maximum concentrations of PAHs and TPH Light at FTF-12 collected in 2000. At CL4, 4-Bromophenyl Phenyl Ether and Di-n-butyl Phthalate were identified as COPCs and they were co-located with the maximum concentrations of PAHs at CLF-9 collected in 2000. Strontium was only analyzed in 2007 as part of the BPS sampling program. The strontium concentration exceeded the preliminary benchmark in 2 out of 8 sampled locations (BPS-01-07/BPS-02-07). The maximum concentration was only 1.4 times the MECP Table 1 SCS. Characterizing the current concentration of these parameters to confirm if they remain COPCs may also reduce uncertainty.

4.3 Sediment

4.3.1 Identification of Chemicals of Potential Concern

Sediment sampling was completed within areas considered to contain aquatic habitat: Lake Huron, Stream C, Eastern Drainage Ditch (EDD), B31 Pond, FSL and B16 Pond, as described in Section 3.4.6 of Appendix C. Samples collected since 2016 were further considered in the EcoRA.

4.3.1.1 Preliminary Screening

The COPCs in Table 21 were identified following preliminary screening against the most stringent provincial and federal sediment criteria (discussed in detail in Appendix C). These COPCs were further screened against Tier 2 criteria protective of aquatic communities and semi-aquatic wildlife.

Table 21 Summary of COPCs Retained in Sediment following Preliminary Screening

Assessed Area	Sediment COPCs
Lake Huron	None
Stream C	None
EDD	Cadmium Copper Nickel Selenium Vanadium Zinc Toluene PHC F3
B16 Pond	None
B31 Pond	Copper Nickel Selenium Zinc
FSL (Pond)	Cadmium Chromium Chromium (III) Copper Lead Mercury Nickel Zinc PHC F3 PHC F4

4.3.1.2 Secondary Screening

Based on the secondary screening provided in Section 3.5.3 of Appendix C, several parameters in sediment were retained as COPCs in the Updated ERA for evaluation of aquatic communities (i.e., benthic invertebrates) and semi-aquatic wildlife (i.e., birds, mammals, amphibians, and reptiles). The COPCs shown in Table 22 were also evaluated for surface water exposures to ensure a total dose from all environmental sources was quantified for semi-aquatic wildlife (see Section 4.4).

Table 22 Summary of COPCs Retained in Sediment Following Secondary Screening

Receptor Group and Exposure Pathway	Assessed Area	Sediment COPCs
Aquatic Communities Direct Contact	Lake Huron	None
	Stream C	None
	EDD	Selenium Vanadium Zinc Toluene PHC F3
	B16 Pond	None
	B31 Pond	Copper Selenium Zinc
	FSL	Copper Mercury PHC F3 PHC F4
Semi-Aquatic Wildlife (Mammals, Birds, Amphibians and Reptiles) Sediment, Surface Water and Food Ingestion	Lake Huron	None
	Stream C	None
	EDD	Vanadium Zinc
	B16 Pond	None
	B31 Pond	Zinc
	FSL	Cadmium Lead

4.3.2 Problem Formulation

The EcoRA quantitatively evaluated potential risks from the following receptors and sediment exposure pathways:

- Direct contact with sediment by benthic invertebrates
- Incidental ingestion of sediment and ingestion of prey that accumulate COPCs from sediment by semi- aquatic wildlife

The approach for assessing these sediment exposures is described below.

4.3.2.1 Assessment and Measurement Endpoints

VECs representing SAR potentially exposed to COPCs through sediment were assessed at the individual level, all other VECs were assessed at the population level (for higher tropic wildlife) or community level (benthic invertebrates).

The measurement endpoint for aquatic receptors is comparison of sediment concentrations to literature-derived toxicological benchmarks without deleterious effects on survival, growth, development, or reproduction. Survival, growth, and reproduction endpoints are generally considered to be closely linked to population success which is why they are considered in the development of toxicological benchmarks. Concentrations less than literature-derived values are considered to pose negligible risks to aquatic receptors.

For semi-aquatic wildlife, the measurement endpoint is comparison of modeled dietary doses to literature-derived toxicity reference values (TRVs) without deleterious effects on survival, growth, development, or reproduction. Concentrations and doses less than literature-derived values are considered to pose negligible risks to terrestrial plants, soil organisms, mammals, and birds.

Uptake models were used to estimate tissue concentrations in aquatic plants, invertebrates and fish when assessing exposures via ingestion of COPCs in food items bioaccumulated from sediment. Environmental fate and transport considerations for metals in sediment are available in Appendix B, Section 2.3.6.1.

The assessment and measurement endpoints considered in the EcoRA are summarized in Table 23 below.

Table 23 Assessment and Measurement Endpoints for Ecological Receptors for Chemicals in Sediment

Receptor	Assessment Endpoint			Measurement Endpoint
	Population Success	Community Success	Individual Success	
Semi-Aquatic Wildlife				
Muskrat	✓			Comparison of modelled dietary doses to literature-derived TRVs without deleterious effects on survival, growth, development, or reproduction.
Green winged Teal	✓			
Spotted Sandpiper	✓			
Belted Kingfisher			✓ (1)	
Snapping Turtle			✓ (2)	
Northern Water Snake			✓ (3)	
Aquatic Life				
Benthic Invertebrates		✓		Comparison of sediment concentrations to literature-derived toxicological benchmarks without deleterious effects on survival, growth, development, or reproduction.

Notes:
(1) Surrogated to piscivorous birds with conservation status, including the bald eagle, horned grebe and least bitter
(2) Surrogated to potential turtles on-site with conservation status
(3) Surrogated to potential reptiles on-site with conservation status

4.3.3 Exposure Assessment

4.3.3.1 Exposure Pathways for Sediment

Table 24 describes the potential exposure pathways for sediment and rationale for their inclusion/exclusion in the EcoRA.

Table 24 Exposure Pathway Analysis for Sediment

Pathway	Evaluated	Rationale
Ingestion of Sediment – Semi-Aquatic Wildlife	✓	Wildlife species that feed from the aquatic environment may consume small amounts of sediment during feeding. Therefore, this exposure pathway was evaluated in the EcoRA for wildlife that feed from the aquatic environment including the following: • Muskrat; • Green-winged teal; • Spotted sandpiper; and, • Snapping Turtle
Dermal Contact with Sediment – Semi-Aquatic Wildlife	×	Exposure via dermal contact with sediment is considered insignificant relative to exposure via incidental sediment ingestion [R-135]. Therefore, this exposure pathway was not evaluated in the EcoRA.
Ingestion of Aquatic Plants – Semi-Aquatic Wildlife	✓	Sediment COPCs may be taken into aquatic plants that are food sources for wildlife. Consumption of aquatic plants could expose herbivorous and omnivorous wildlife to COPCs. Site-specific tissue residue data for aquatic plants were not available; therefore, tissue residues were modeled using uptake models and/or factors from the literature. The use of literature-based uptake factors does not account for site-specific conditions and has a high degree of uncertainty that may overestimate or underestimate exposure from this pathway. This exposure pathway was evaluated for herbivorous and omnivorous wildlife receptors including the following: • Muskrat; • Green-winged teal; and, • Snapping Turtle
Ingestion of Benthic Invertebrates – Semi-Aquatic Wildlife	✓	Benthic invertebrates may take up COPCs from sediment and some wildlife species may be exposed to COPCs by eating benthic invertebrates. Site-specific tissue residue data for benthic invertebrates were not available; therefore, tissue residues were modeled using uptake models and/or factors from the literature. The use of literature-based uptake factors that do not account for site-specific conditions has a high degree of uncertainty that may overestimate or underestimate exposure from this pathway. Receptors considered to ingest benthic invertebrates included the following: • Green-winged teal; and, • Belted kingfisher.
Direct Contact with Sediment – Aquatic Receptors	✓	Exposure via direct contact with sediment was evaluated for benthic invertebrates.
Notes: × = Exposure pathway is not evaluated in the EcoRA. ✓ = Exposure pathway is evaluated in the EcoRA.		

4.3.3.2 Areas Assessed

Each of the areas considered in the EcoRA, the habitat within each area, and the potential receptors considered to become exposed to COPCs at each area are presented in Table 25 below.

Table 25 Areas Assessed for Sediment COPCs

Area	**Potential Receptors**	**Further Evaluated in EcoRA?**
Stream C	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Benthic invertebrates	No, COPCs were not identified in sediment following preliminary screening
Lake Huron shoreline	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Benthic invertebrates	No, COPCs were not identified in sediment following preliminary screening
FSL	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Benthic invertebrates	Yes, COPCs were identified in sediment following secondary screening
B16 Pond	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Benthic invertebrates	No, COPCs were not identified in sediment following preliminary screening
B31 Pond (at CL4)	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Benthic invertebrates	Yes, COPCs were identified in sediment following secondary screening
Distal Eastern Drainage Ditch	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Benthic invertebrates	Yes, COPCs were identified in sediment following secondary screening

4.3.3.3 Exposure Point Concentrations

Within each assessed area, the maximum concentrations of each COPC from all of the sampled locations and sampling dates since 2016 were used as the EPCs in sediment. The maximum sediment concentration was applied because there was not enough sample data to derive descriptive statistics. The EPCs for sediment COPCs used to assess exposures to aquatic communities and semi-aquatic wildlife are provided in Table 26 and Table 27 below.

Table 26 Exposure Point Concentrations for Sediment for Aquatic Life (mg/kg)

COPC	Maximum Concentration
Lake Huron	
None	-
Stream C	
None	-
FSL	
Copper	210
Mercury	0.61
B16 Pond	
None	-
B31 Pond	
Copper	150
Selenium	1
Zinc	360
PHC F3	1100
PHC F4	230
Eastern Drainage Ditch	
Selenium	1.1
Vanadium	100
Zinc	390
Toluene	0.26
PHC F3	500

Table 27 Exposure Point Concentrations for Sediment for Semi-Aquatic Wildlife (mg/kg)

COPC	Maximum Concentration
Lake Huron	
None	
Stream C	
None	
FSL	
Cadmium	2
Lead	50
B16 Pond	
None	
B31 Pond	
Zinc	360
Eastern Drainage Ditch	
Vanadium	100
Zinc	390

4.3.3.4 Modelled Concentrations in Dietary Items

As discussed in Section 4.1.2.4, chemical uptake of COPCs from sediment into dietary items (aquatic plants and benthic invertebrates) consumed by wildlife was modelled using update equations. The uptake equations and modelled concentrations are presented in Appendix B, Section 2.3.6.2.

4.3.3.5 Exposure Doses for Semi-Aquatic Wildlife

As discussed in Section 4.1.2.5, exposure doses to semi-aquatic wildlife from sediment COPCs were estimated using receptor characteristics for each VEC and food-chain modelling. The exposure doses are presented in Appendix F, Section 6.4.2.

4.3.4 Toxicity and Effects Assessment

4.3.4.1 Toxicological Benchmarks for Benthic Invertebrates

The toxicological benchmarks used in the chemical assessment for sediment are presented in Appendix B, Section 2.3.6.3 for evaluation of benthic invertebrates.

4.3.4.2 TRVs for Semi-Aquatic Wildlife

The TRVs used in the chemical assessment for sediment are presented in Appendix B, Section 2.3.6.4 for the evaluation of semi-aquatic wildlife. The NOAEL was selected for the evaluation of birds and reptiles to ensure protection of SAR identified on-site. For assessment of those receptors that were not used as surrogates for species at risk (mammals), the LOAEL was used.

4.3.5 Risk Characterization

4.3.5.1 Benthic Invertebrates

The estimated HQs for benthic invertebrates due to sediment COPCs within each assessed area is provided in Appendix F Section 6.4.1. The HQs greater than 1 are summarized in Table 28 below, followed by rationale as to if the chemical is retained for further assessment:

Table 28 Hazard Quotients > 1 for Benthic Invertebrates from Sediment

COPC	Max HQ	Chemical retained for further assessment?	SSTL (mg/kg)
FSL			
Copper	**1.1**	No; risks considered negligible	197
Mercury	**1.2**		0.49
PHC F3	**10**	**Yes;** further sampling should be completed to delineate potential risks; Total Organic Carbon (TOC) should be assessed to derive a site-specific toxicological benchmark	112
PHC F4	**1.2**	No; risks considered negligible	192
B31 POND			
Zinc	**1.1**	No; risks considered negligible	315
EDD			
Zinc	**1.2**	No; risks considered negligible	315
PHC F3	**4.5**	**Yes;** further sampling should be completed to delineate potential risks; TOC should be assessed to derive a site-specific toxicological benchmark.	112

Notes:
Bold indicates HQ>1
SSTL – Concentration of COPC in soil resulting in no unreasonable risk (see Section 4.1.4.2)

Metals at FSL, B31 Pond and EDD

The HQs for metals at FSL, B31 Pond and EDD ranged from 1.1 to 1.2 based on maximum sediment concentrations. Overall, the risks are negligible in consideration of the conservative exposure assumptions, including the use of maximum measured concentrations and the assumption that the measured concentrations are 100% bioavailable to benthos.

PHCs

The HQs for PHC F3 within the EDD and FSL ranged from 4.5 to 10 based on maximum measured sediment concentrations; however, the toxicological benchmark applied is considered to be conservative as it is based on surface water screening thresholds and an equilibrium partitioning model to estimate an equivalent sediment concentration [R-136]. The equilibrium partitioning model considers the level of total organic carbon (TOC) within sediment, where a default of 0.01 was applied in absence of site-specific data. If the TOC within the drainage features is higher than 0.01, this would result in a higher toxicological benchmark for PHCs. Additional sampling of PHCs and TOC should be completed to validate the overall risks within FSL and EDD.

4.3.5.2 Semi-Aquatic Wildlife

The estimated HQs for semi-aquatic wildlife due to sediment COPCs within each assessed area is provided in Appendix F, Section 6.4.2. The HQs greater than 1 are summarized in Table 29 below, followed by rationale if the chemical/VEC is retained for further assessment.

Table 29 Hazard Quotients > 1 for Semi-Aquatic Life from Sediment

COPC	Max HQ NOAEL	Max HQ LOAEL	Chemical / VEC retained for further assessment?	SSTL
FSL				
Lead				
Green Winged Teal	**1.3**	0.6	No; not surrogated to a SAR and HQs less than 1 in consideration of LOAEL	79
Spotted Sandpiper	**2.4**	**1.2**	No; not surrogated to a SAR and HQs close to 1 in consideration of LOAEL. FSL habitat does not support sandpiper (or other semi-aquatic birds that consume benthic species).	41
Belted Kingfisher	**1.6**	0.8	No; FSL does not provide suitable habitat for surrogated SAR (Horned Grebe or Least Bittern or Bald Eagle) and HQs less than 1 in consideration of LOAEL	64
EDD				
Vanadium				
Green-winged Teal	**19**	**9.3**	**Yes; HQs greater than 1 in consideration of LOAEL.** *Further work should delineate extent of impacts and measure COPC concentration in benthos.*	11
Spotted Sandpiper	**37**	**18**		6
Belted Kingfisher	**23**	**11**		9
Snapping Turtle	**2.2**	0.9	No; EDD does not provide suitable habitat for turtle SAR and HQs less than 1 in consideration of LOAEL	112

Notes:
Bold indicates HQ>1
SSTL – Concentration of COPC in soil resulting in no unreasonable risk (see Section 4.1.4.2)

Considering maximum sediment concentrations and the NOAEL as a TRV for semi-aquatic birds and reptiles, HQs greater than 1 were predicted for:

- Green-winged Teal, Spotted Sandpiper and Belted Kingfisher for lead at FSL
- Green-winged Teal, Spotted Sandpiper, Belted Kingfisher and Snapping Turtle for vanadium at FSL

Further rationale as to if these COPCs should be retained for further assessment is discussed below:

Lead at FSL

Elevated risks (HQs > 1) were estimated for the Green-winged Teal, Spotted Sandpiper and Belted Kingfisher at FSL based on the NOAEL as a TRV; however, FSL does not support any semi-aquatic bird SAR and therefore estimating risks from sediment exposures based on LOAELs is acceptable according to N288.6-12, Clause 7.4.3.1 [R-14]. The HQs are less than 1 in consideration of the LOAEL as a TRV for the Green-winged Teal and Belted Kingfisher, and close to 1 for the Spotted Sandpiper. It is noted though that FSL habitat does not support sandpipers or other semi-aquatic birds that consume benthic species. Therefore, sediment COPCs present minimal risk to the health of semi-aquatic wildlife populations.

Vanadium at EDD

Elevated risks (HQs > 1) were estimated for the Green-winged Teal, Spotted Sandpiper, Belted Kingfisher, and Snapping Turtle at EDD based on the NOAEL as a TRV; however, EDD does not support any semi-aquatic bird or reptile SAR and therefore estimating risks based on LOAELs from sediment exposures is acceptable. The HQs are less than 1 in consideration of the LOAEL as a TRV for Snapping Turtle, but range from 9.3 to 11 for the Green-winged Teal, Spotted Sandpiper, Belted Kingfisher.

The risks at EDD were driven by benthic invertebrate consumption, where it was conservatively assumed that the vanadium concentration in benthos was equal to the vanadium concentration measured in sediment as a chemical specific uptake factor could not be identified in the literature. A screening assessment for vanadium completed under the Canadian Environmental Protection Act (CEPA) concluded that there are several lines of evidence to suggest that the bioaccumulation potential of vanadium in natural ecosystems is low: 1) moderate to low (1.6–333) Bioconcentration Factors (BCFs) and Bioaccumulation Factors (BAFs) obtained from six studies conducted at steady state; 2) a Biota Sediment Accumulation Factor (BSAF)-sediment and a BSAF-soil well below 1; and 3) two field surveys indicating the absence of biomagnification of vanadium in natural food webs [R-137]. As such, vanadium did not meet the criteria for bioaccumulation potential (BCF or BAF ≥ 5000) as set out in the Persistence and Bioaccumulation Regulations of CEPA 1999 [R-137]. The current risk estimates are therefore overestimated and the actual risk posed by vanadium in the EDD is lower.

Additional sampling should be completed to validate the overall risks from sediment within the EDD, including sampling of benthic invertebrate tissue to confirm the extent of COPC bioconcentration.

These HQs were calculated considering that the receptor would spend 100% of its most sensitive life stage on the assessed area and that the receptor will experience toxic effects once exposed to concentrations above the selected TRVs. Section 4.3.5.3 provides further discussion regarding the likelihood of effects and Section 4.3.6 provides further discussion around the uncertainties of these assumptions.

4.3.5.3 Likelihood of Effects

The proportion of the Site with HQs greater than 1 in sediment was limited to the B31 Pond and the distal end of the EDD. While there may be some impacts to sessile aquatic plants and invertebrates at these locations, it is unlikely that impacts to wildlife would occur given that there are other nearby areas that provide more suitable habitat for populations to succeed. No observable impacts have been noted during field walk downs but extensive surveys to confirm impacts have not been completed.

4.3.6 Uncertainties and Assumptions

Uncertainties within this EcoRA, like many, are often addressed by making conservative assumptions to ensure that receptors are adequately protected in the absence of site-specific information. Table 30 examines the assumptions in each aspect of the EcoRA for sediment, comments on the level of uncertainty that should be assigned to the findings, and identifies areas where future work may be used to reduce uncertainties.

Table 30 Summary of Assumptions and Uncertainties in the EcoRA for Sediment

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Exposure Assessment			
Exposure Point Concentrations	High	Under- or Over-estimate	The maximum concentration in sediment was applied as the EPC given the limited data set, where only one sediment sample was generally evaluated for each permeant drainage feature. Additional sampling to better understand contaminant distribution and delineate impacts can reduce this uncertainty.
Frequency of Exposure	High	Over-estimate	Frequency of exposure was not quantitatively evaluated in the exposure assessment for wildlife. Although seasonality and home range are factors that may affect a receptor's likely exposure, the EcoRA was carried out assuming that the receptor could be exposed to the affected area throughout their lifetime. Excluding frequency of exposure would tend to overestimate the risk to receptors with large home ranges (e.g., green-winged teal and snapping turtle) and those that are migratory and would only be present on-site for a short period (e.g., spotted sandpiper).

Table 30 Summary of Assumptions and Uncertainties in the EcoRA for Sediment

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Habitat Quality	High	Over-estimate	The habitat quality at the majority of the assessed sites is expected to realistically be lower than assumed in this EcoRA as the habitat exists within or adjacent to industrial operations. Wildlife receptors are mobile and forage in many areas, and are more likely to be drawn to natural habitats surrounding the site than they are to linger at the impacted part of the site.
Literature-Based Chemical-Specific Factors	High	Over-estimate	Given that site specific concentrations of chemicals in dietary items were not available, uptake equations from the literature were used. However, these equations are based upon using relatively bioavailable forms of metals and as such, would be expected to overestimate uptake into dietary items when obtained from areas where impacts would be aged and weathered and more tightly adsorbed to environmental media. As a result, the concentrations estimated in dietary items are likely overestimated. This is particularly true for vanadium, where it was assumed that the concentration in food items was equal to the concentration in sediment because a chemical specific factor could not be identified.
Bioavailability	High	Over-estimate	Exposure estimates for wildlife were not adjusted for bioavailability because TRVs were expressed as the administered dose (i.e., amount taken into the body), rather than the absorbed dose (i.e., amount absorbed and retained in the body). This is a conservative approach given that the administered dose is often in a more bioavailable form than that found in the environment. The sediments at the Site are likely weathered, and therefore, the bioavailability and toxicity of the chemicals are likely less than that for soils where the chemical was recently added in experimental studies used to derive the TRVs.
Toxicity and Effect Assessment			

Table 30 Summary of Assumptions and Uncertainties in the EcoRA for Sediment

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Literature-Based TRVs	High	Over-estimate	TRVs are generally developed from laboratory studies that use species not identical to the receptors identified for a site. Species differ in the absorption, metabolism, distribution and excretion of chemicals and the resulting toxicity may differ. For example, wildlife TRVs are often based upon studies carried out on laboratory animals such as rats and mice, and again there are uncertainties in extrapolating effects for laboratory animals to wildlife. The dosing methods used in key studies using laboratory animals tend to use spiked food with a bioavailable form of the substance (i.e., often as a soluble salt in the case of metals).
TRVs for Herpetofauna	High	Under- or Over-estimate	Toxicity data for herpetofauna were not available for use in this assessment. Therefore, avian toxicity data were used as a surrogate for risk estimation. There is uncertainty regarding the relative sensitivity of herptiles and birds to the COPCs. If birds are substantially more or less sensitive than reptiles and amphibians, then risk would be over or underestimated, respectively.
Toxicological Benchmark for PHCs	High	Over-estimate	The toxicological benchmark for PHCs in sediment is conservative as it is based on surface water screening thresholds and an equilibrium partitioning model to estimate an equivalent sediment concentration [R-136]. The equilibrium partitioning model considers the level of total organic carbon (TOC) within sediment, with a default of 0.01 was applied in absence of site-specific data. The TOC within the drainage ditches is likely higher than 0.01, which would result in a higher toxicological benchmark for PHCs.
TRVs based on NOAEL	Moderate	Over-estimate	For bird and herpetofauna VECs, risks were estimated using NOAEL-based TRVs that tend to overestimate risks and often apply uncertainty factors. The NOAEL was applied for the protection of potential SAR. Potential risks to VECs surrogated to SAR (Horned Grebe or Least Bittern or Bald Eagle) were identified at FSL and EDD; however, the habitat in these areas does not support these avian SAR. To reduce uncertainty, TRVs based on LOAEL were also considered.

4.4 Surface Water

4.4.1 Identification of Chemicals of Potential Concern

Surface water sampling was completed at the following areas as they are considered to contain aquatic habitat: Lake Huron, Stream C, B31 Pond, FSL, B16 Pond, as described in Appendix C, Section 3.4.5. Samples collected since 2016 were further considered in the EcoRA.

4.4.1.1 Preliminary Screening

The COPCs in Table 31 were identified following Preliminary screening against the most stringent provincial and federal surface water criteria (discussed in detail in Appendix C). These COPCs were further screened against secondary criteria protective of aquatic communities.

Table 31 Summary of COPCs Retained for Further Assessment Following Preliminary Screening

Assessed Area	Surface Water COPCs
Lake Huron	Ammonia Zinc
Stream C	None
EDD	Aluminum Iron Vanadium Zinc
B16 Pond	Iron
B31 Pond	Aluminum Copper Iron
FSL (Pond)	Copper Zinc pH

4.4.1.2 Secondary Screening

Based on the Tier 2 screening provided in Appendix C Section 3.5.4, several parameters in surface water were retained as COPCs in the 2022 EcoRA for evaluation of aquatic communities (i.e., plants, invertebrates, and fish) and semi-aquatic wildlife (mammals, birds, amphibians, and reptiles). These COPCs are listed in Table 32. Total exposure from sediment and surface water was considered for semi-aquatic wildlife. COPCs for semi-aquatic wildlife were identified based on sediment screening, as sediment exposures are considered the dominant exposure pathway.

Table 32 Summary of COPCs Retained for Further Assessment Following Secondary Screening

Receptor Group and Exposure Pathway	Assessed Area	Surface Water COPCs
Aquatic Communities Direct Contact	Lake Huron	Ammonia Zinc
	Stream C	None
	EDD	Aluminum Iron Vanadium Zinc
	B16 Pond	Iron
	B31 Pond	Aluminum Copper Iron
	FSL	Copper Zinc pH
Semi-Aquatic Wildlife (Mammals, Birds, Amphibians and Reptiles) Sediment, Surface Water and Food Ingestion	Lake Huron	None
	Stream C	None
	EDD	Vanadium Zinc
	B16 Pond	None
	B31 Pond	Zinc
	FSL	Cadmium Lead

4.4.2 Problem Formulation

The EcoRA quantitatively evaluated potential risks from the following receptors and surface water exposure pathways:

- Direct contact with surface water by aquatic communities
- Ingestion of surface water by semi- aquatic wildlife
- Ingestion of fish that bioaccumulate COPCs from surface water and ingestion by semi- aquatic wildlife

The approach for assessing these surface water exposures is described below.

4.4.2.1 Assessment and Measurement Endpoints

VECs representing SAR potentially exposed to COPCs through surface water were assessed at the individual level, all other VECs were assessed at the population level (for higher tropic wildlife) or community level (for plants, invertebrates, and fish).

The measurement endpoint for aquatic receptors is comparison of surface water concentrations to literature-derived toxicological benchmarks without deleterious effects on survival, growth, development, or reproduction. Survival, growth, and reproduction endpoints are generally considered to be closely linked to population success which is why they are considered in the development of toxicological benchmarks. Concentrations less than literature-derived values are considered to pose negligible risks to aquatic receptors.

All wildlife receptors were considered to be exposed to chemicals in surface water via ingestion as a drinking water source.

For semi-aquatic wildlife, the measurement endpoint is comparison of modeled dietary doses to literature-derived toxicity reference values (TRVs) without deleterious effects on survival, growth, development, or reproduction. Concentrations and doses less than literature-derived values are considered to pose negligible risks to terrestrial plants, soil organisms, mammals, and birds.

Uptake models were used to estimate tissue concentrations in fish when assessing exposures via ingestion of COPCs in food items bioaccumulated from surface water. Environmental fate and transport considerations for metals in surface water are available in Appendix B, Section 2.3.7.1. Table 33 provides assessment and measurement endpoints for ecological receptors.

Table 33 Assessment and Measurement Endpoints for Ecological Receptors for Chemicals in Surface Water

Receptor	Assessment Endpoint			Measurement Endpoint
	Population Success	Community Success	Individual Success	
Semi-Aquatic Life				
Muskrat	✓			Comparison of modelled dietary doses to literature-derived TRVs without deleterious effects on survival, growth, development, or reproduction.
Green winged Teal	✓			
Spotted Sandpiper	✓			
Belted Kingfisher			✓ (1)	
Snapping Turtle			✓ (2)	
Northern Watersnake			✓ (3)	
Aquatic Life				
Aquatic Plants		✓		Comparison of surface water concentrations to literature-derived toxicological benchmarks without deleterious effects on survival, growth, development, or reproduction.
Zooplankton		✓		
Fish	✓			

Notes:
(1) Surrogated to piscivorous birds with conservation status, including the bald eagle, horned grebe and least bitter
(2) Surrogated to potential turtles on-site with conservation status
(3) Surrogated to potential reptiles on-site with conservation status

4.4.3 Exposure Assessment

Table 34 describes the potential exposure pathways for surface water and rationale for their inclusion/exclusion in the EcoRA.

Table 34 Exposure Pathway Analysis for Surface Water

Pathway	Evaluated	Rationale
Ingestion of Surface Water – Mammals and Birds	✓	Wildlife species may consume surface water. Water ingestion by terrestrial mammals and birds was not assessed quantitatively in the EcoRA. Water ingestion is considered to be a negligible pathway in terms of its contribution to overall exposure, particularly given that wildlife can meet their daily water requirements with the water content in their diet [R-138]. Water ingestion was quantitatively assessed for the semi-aquatic mammals and birds (given that these receptors can be also exposed to COPCs in water via food), as listed below: • Muskrat; • Green-winged teal; • Spotted sandpiper; and • Belted kingfisher.
Dermal Contact with Surface Water – Mammals and Birds	×	Although wildlife may be exposed by directly contacting surface water, mammals and birds likely do not receive significant doses through this route relative to other routes, such as direct ingestion of water [R-131] due to the presence of fur and feathers. Therefore, dermal contact with surface water was not evaluated in the EcoRA.
Ingestion/ Dermal Contact with Surface Water – Amphibians and Reptiles	×	Evaluating exposure from surface water consumption is challenging for amphibians and reptiles. There are no water ingestion rates that have been identified for these species. The water balance of amphibians is complex as they absorb water through their skin and extract water from their food. They rely on skin rehydration and are not known to consume water [R-139]. There is insufficient toxicological information and exposure models to evaluate these exposures.
Ingestion of Fish – Wildlife	✓	Piscivorous wildlife has the potential to be exposed to COPCs via ingestion of fish that have accumulated chemicals from surface water. Site-specific tissue residue data for fish were not available; therefore, tissue residues were modeled using uptake models and/or factors from the literature. The use of literature-based uptake factors does not account for site-specific conditions and has a high degree of uncertainty that may underestimate or overestimate exposure from this pathway. Receptors that were considered with respect to ingestion of fish included the following: • Mink; • Belted Kingfisher; • Snapping Turtle; and, • Northern Watersnake
Direct Contact with Surface Water	✓	Exposure via direct contact with surface water was evaluated for aquatic plants, zooplankton, benthic invertebrates, and fish. Evaluation of these receptors was assumed to be protective of the larval / juvenile amphibians that spend the majority of this life stage in water.

Table 34 Exposure Pathway Analysis for Surface Water

Pathway	Evaluated	Rationale
Notes: × = Exposure pathway is not evaluated in the EcoRA. ✓ = Exposure pathway is evaluated in the EcoRA.		

4.4.3.1 Areas Assessed

Each of the areas considered in the EcoRA, the habitat within each area, and the potential receptors considered to become exposed to COPCs at each area are presented in Table 35 below.

Table 35 Areas Assessed for Surface Water COPCs

Area	Potential Receptors	Further Evaluated in EcoRA?
Stream C – 2.2 km	• Semi-aquatic reptiles (snapping turtle and northern water snake) • Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher).	No, COPCs were not identified in sediment following Preliminary screening; therefore, cumulative exposure from surface water not further evaluated as it is considered a minor exposure pathway relative to sediment.
	• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.	Yes, COPCs were identified in surface water following secondary screening
Lake Huron shoreline and nearshore environment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake)	No, COPCs were not identified in sediment following Tier 1 screening; therefore, cumulative exposure from surface water not further evaluated as it is considered a minor exposure pathway relative to sediment.
	• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.	Yes, COPCs were identified in surface water following secondary screening
FSL	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake)	Yes, COPCs were identified in sediment following secondary screening; therefore, cumulative exposure from surface water further evaluated
	• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.	Yes, COPCs were identified in surface water following secondary screening

Table 35 Areas Assessed for Surface Water COPCs

Area	Potential Receptors	Further Evaluated in EcoRA?
B16 Pond	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake)	Yes, COPCs were identified in sediment following secondary screening; therefore, cumulative exposure from surface water further evaluated
	• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.	Yes, COPCs were identified in surface water following secondary screening
B31 Pond (at CL4)	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake)	Yes, COPCs were identified in sediment following secondary screening; therefore, cumulative exposure from surface water further evaluated
	• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.	Yes, COPCs were identified in surface water following secondary screening
Distal Eastern Drainage Ditch	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake)	Yes, COPCs were identified in sediment following secondary screening; therefore, cumulative exposure from surface water further evaluated
	• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.	Yes, COPCs were identified in surface water following secondary screening

4.4.3.2 Exposure Point Concentrations

Within each assessed area, the maximum and average concentrations of each COPC from all of the sampled locations and sampling dates since 2016 were used as the EPC in surface water. Average concentrations could not be calculated for the permanent drainage features due to insufficient number of samples (less than three). The EPCs for surface water are provided below in Table 36 for aquatic communities and in Table 37 for semi-aquatic wildlife.

Table 36 Exposure Point Concentrations for Surface Water for Aquatic Life (µg/L)

COPC	Maximum Concentration	Average / 95th Percentile Concentration [1]
Lake Huron		
Ammonia	300	11
Zinc	130	21
Stream C		
None	-	-
FSL		
Copper	2.8	NC
Zinc	8.7	NC
pH	9.5	NC
B16 Pond		
Iron	370	NC
B31 Pond		
Aluminum	210	NC
Copper	4.8	NC
Iron	310	NC
Eastern Drainage Ditch		
Aluminum	775	229
Iron	1310	387
Vanadium	20.5	10.6
Zinc	10.6	20

Notes:
NC – not calculated as there were less than three samples for assessed area
[1] If the data set for a COPC has less than 50% undetected concentrations, the average is applied as the EPC, otherwise the 95th percentile is used.

Table 37 Exposure Point Concentrations for Surface Water for Semi-Aquatic Wildlife (µg/L)

COPC	Maximum Concentration
Lake Huron	
None	-
Stream C	
None	-
FSL	
Cadmium	0.09
Lead	0.5
B16 Pond	
None	-
B31 Pond	
Zinc	12.0
Eastern Drainage Ditch	
Vanadium	20.5
Zinc	16.0

4.4.3.3 Modelled Concentrations in Dietary Items

As discussed in Section 4.1.2.4, chemical uptake of COPCs from surface water into fish consumed by wildlife was modelled using update equations. The uptake equations and modelled concentrations are presented in Appendix B, Section 2.3.7.2.

4.4.3.4 Exposure Doses for Semi-Aquatic Wildlife

As discussed in Section 4.1.2.5, exposure doses to semi-aquatic wildlife from surface water COPCs were estimated using receptor characteristics for each VEC and food-chain modelling. The exposure doses are presented in Appendix F, Section 6.5.2.

4.4.4 Toxicity and Effects Assessment

4.4.4.1 Aquatic Receptors

The toxicological benchmarks used in the chemical assessment of surface water for the protection of aquatic life are presented in Appendix B, Section 2.3.7.3.

4.4.4.2 Semi-Aquatic Wildlife

The TRVs used in the chemical assessment for surface water are presented in Appendix B, Section 2.3.7.4. The NOAEL was selected for the evaluation of birds and reptiles to ensure protection of SAR identified on-site. The LOAEL was selected for mammals as they are not surrogated to SAR.

4.4.5 Risk Characterization

4.4.5.1 Aquatic Communities

The estimated HQs for aquatic communities due to surface water COPCs within each assessed area is provided in Appendix F, Section 6.5.1. The HQs greater than 1 are summarized in Table 38 below.

Table 38 Hazard Quotients for Aquatic Life from Surface Water

COPC	Max HQ	Average / 95th Percentile HQ [1]	Chemical retained for further assessment?	SSTL
Lake Huron				
Ammonia	**19**	0.7	No; HQs<1 based on average concentration.	16
Zinc	**10**	**1.6**	**Yes; HQs>1 based on the 95th percentile concentration.** Additional sampling events required to affirm potential risks. Analysis of Dissolved Organic Carbon (DOC) required to derive site-specific toxicological benchmark for zinc.	13
FSL				
Copper	**1.4**	NC	**Yes; HQs>1 based on maximum concentration.** Additional sampling events required to affirm potential risks. Analysis of DOC required to derive site-specific toxicological benchmark for zinc.	2
Zinc	**3.5**	NC		2.5
B31 Pond				
Copper	**2.4**	NC	**Yes; HQs>1 based on maximum concentration.** Additional sampling events required to affirm potential risks.	2
Eastern Drainage Ditch				
Aluminum	**1.8**	0.5	No; HQs<1 based on average concentration.	426
Iron	**2.2**	0.6		604
Zinc	**1.3**	0.8		26

Notes:
NC – Not calculated, # of samples less than 3.
Bold indicates HQ>1
[1] If the data set for a COPC has less than 50% undetected concentrations, the average is applied as the EPC, otherwise the 95th percentile is used.
SSTL – Concentration of COPC in soil resulting in no unreasonable risk (see Section 4.1.4.2)

Ammonia in Lake Huron

The HQ for ammonia was less than 1 using average concentrations within Lake Huron over the past five years. Average concentrations are most representative of the typical conditions that aquatic communities are exposed to and the potential for long-term, chronic effects.

There is potential for acute effects when ammonia is present at higher concentrations for short durations. The mean 48-hr and 96-hr LC50 values reported for freshwater invertebrates and fish ranged from 1.1 to 22.8 mg/L for invertebrates and from 0.56 to 2.37 mg/L for fish species [R-140]. The maximum measured concentration of ammonia (0.3 mg/L) is below these thresholds; therefore, there is no concern for acute effects from short-term elevated concentrations of ammonia in Lake Huron.

Zinc in Lake Huron

The HQ was greater than 1 based on the 95th percentile concentration of zinc over the past five years within Lake Huron. Because >50% of the measurements were below the detection limit, the 95th percentile is used because it is a better representation of the chronic concentrations aquatic communities may be exposed to and the potential for long-term effects.

The elevated zinc levels in Lake Huron were only measured during the last surface water sampling event (i.e., during June-2021). Zinc was not detected during previous sampling events. The reason for this anomaly is unknown, but it is noted that pH was also elevated during this event. Routine surface water monitoring should be completed to confirm if the elevated zinc concentrations are an anomaly or the result of facility operations.

Also, the toxicological benchmark for zinc is based on pH, hardness, and dissolved organic carbon (DOC). DOC was not measured within Lake Huron; therefore, a conservative value of 1 mg/L was assumed. Future sampling should measure the DOC concentrations within Lake Huron associated with each sampling event.

Metals at FSL and B31 Pond

Copper and zinc concentrations within FSL, and copper concentrations within B31 Pond resulted in HQs greater than 1 (1.4 to 3.5), suggesting potential risks to aquatic life from exposure to these COPC in surface water. However, these results are based on only one sampling event and FSL was the only area with two sampling locations analyzed. Also, DOC was not measured within the drainage features; therefore, a conservative value of 1 mg/L was assumed to derive the toxicological benchmarks. Routine surface water monitoring should be completed to validate the overall risks within the drainage features.

Metals at EDD

The HQ for aluminum, iron and zinc was less than 1 using average concentrations within the EDD over the past five years. Average concentrations are most representative of the typical conditions that aquatic communities are exposed to and the potential for long-term, chronic effects. Further, elevated concentrations were driven by one monitoring event in Feb 2017; where the concentration of aluminum, iron and zinc in subsequent monitoring events were below the SSTLs.

pH at FSL

The pH level within FSL exceeded the acceptable range that is protective of toxic effects to aquatic biota (9.5 vs. 9). According to the US EPA [R-141], a high pH within an aquatic environment is defined as exceeding a pH of 9 for prolonged periods or with high frequency. Short-term exposures of fish to high pH (~9.5) are rarely lethal to most fish species. However, prolonged exposure to pH between 9.5 and 10 can damage outer surfaces such as gills, eyes, and skin [R-141]. The pH levels were only measured once at FSL during the summer. Higher photosynthesis activity during this time may have increased pH levels. Routine surface water monitoring should be completed to confirm the frequency of high pH at FSL and the seasonal variability.

4.4.5.2 Semi-Aquatic Wildlife

The estimated HQs for semi-aquatic wildlife due to surface water COPCs within each assessed area is provided in Appendix F, Section 6.5.2. All the HQs were less than 1; therefore, risks to wildlife from surface water exposures (including direct ingestion of surface water and ingestion of fish that bioaccumulate COPCs from surface water) are considered to pose no unreasonable risk.

4.4.6 Uncertainties and Assumptions

Uncertainties within this EcoRA are addressed by making conservative assumptions to ensure that receptors are adequately protected in the absence of site-specific information. The following, Table 39, examines the assumptions in each aspect of the EcoRA for surface water, comments on the level of uncertainty that should be assigned to findings, and identifies areas where future work may be used to reduce uncertainties. The uncertainties are focused on the characterization of risk to aquatic receptors, as no unreasonable risk was identified for semi-aquatic wildlife from surface water exposures based on the conservative assumptions applied in the EcoRA.

Table 39 Summary of Assumptions and Uncertainties for Surface Water COPCs

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Exposure Assessment			
Exposure Point Concentrations	High	Under- or Over-estimate	The maximum concentration in surface water was applied as the EPC for the permanent drainage features given the limited data set, where only one surface water sample was generally evaluated for each area. Routine surface water monitoring to better understand seasonal variability will reduce uncertainty.

Table 39 Summary of Assumptions and Uncertainties for Surface Water COPCs

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Bioavailability	High	Over-estimate	Aquatic toxicity is highly dependent on the physio-chemical properties of the water body that affect the amount of bioavailable species (e.g., free metal ions or un-ionized ammonia). As a result, several toxicological benchmarks derived by the CCME are based on pH, temperature, hardness and/or DOC. DOC was not measured during surface water sampling events, and should be included as part of the routine analysis.
Toxicity and Effect Assessment			
Literature-based Toxicological Benchmarks	Moderate	Over-estimate	Toxicological benchmarks are generally developed from laboratory studies that use species that are not identical to the receptors identified for a site. Species differ in the absorption, metabolism, distribution and excretion of chemicals and the resulting toxicity may differ. Further, toxicity studies evaluating direct contact effects to fish, aquatic plants or zooplankton tend to use readily bioavailable forms. Although site-specific toxicological benchmarks were calculated for ammonia, aluminum, copper and zinc based on physio-chemical properties of the water body.
Evaluation of Herpetofauna	High	Under- or Over-estimate	There is insufficient toxicological information and exposure models to evaluate surface water consumption and direct contact for amphibians and reptiles. The water balance of amphibians is complex as they absorb water through their skin and extract water from their food. Exposure via direct contact with surface water was evaluated for aquatic plants, zooplankton, benthic invertebrates, and fish. Evaluation of these receptors was assumed to be protective of the larval / juvenile amphibians that spend the majority of this life stage in water and are the most sensitive life stage. Toxicity data for herpetofauna were not available for use in this assessment. Therefore, avian toxicity data were used as a surrogate for risk estimation. There is uncertainty regarding the relative sensitivity of herptiles and birds to the COPCs. If birds are substantially more or less sensitive than reptiles and amphibians, then risk would be over or underestimated, respectively.

4.4.7 Cumulative Risks from Sediment and Surface Water by Semi-Aquatic Wildlife

It was assumed that a receptor would be exposed to the maximum concentrations of each COPC in all environmental media to which it may be exposed. This assumption applied to the evaluation of semi-aquatic wildlife, given that these receptors may be exposed to COPCs in both surface water and sediment. Surface water exposures to terrestrial wildlife were considered negligible (as discussed in Section 4.4.3).

The exposure and risk estimates from surface water and sediment exposures to semi-aquatic wildlife are presented in Appendix F, Sections 6.4.2 and 6.5.2. The cumulative risks did not result in additional COPCs with HQs greater than 1. For COPCs with HQs>1 from sediment exposure pathways, the incorporation of risk from surface water exposures did not impact the final risk estimate.

4.5 Predictive Ecological Risk Assessment

4.5.1 Conventional Surface Water

No changes attributable to MCR have been quantified in conventional surface water quality (See Appendix D, Section 4.5.5.1 [R-35]). All future activities (see Appendix D, Section 4.6.3.1 [R-35]) are anticipated to have a negligible effect on surface water quality as all effluent discharges are maintained within compliance limits.

4.5.2 Groundwater

The only MCR activities that were identified as potentially resulting in a measurable change in groundwater were the Bruce A and Bruce B Parking Lot Expansion (Appendix D, Section 4.6.4 [R-35]). The runoff from the expanded parking lots could affect groundwater quality, as there will be a greater paved area being treated with salt during winter conditions. The groundwater monitoring program will continue to monitor groundwater across site. Where the potential exists for exposure of ecological receptors to contaminants, sampling of relevant nearby environmental media will be completed to determine the extent of exposure, if any. These sampling results will be included in subsequent ERAs.

4.5.3 Geology, Sediment and Soil

No interactions related to radiological impacts to geology, sediment and soil were identified in the 2017 PERA or in findings from environmental monitoring programs from 2016-2021 (Appendix D, Section 4.5.7 and 4.6.5 [R-35]). During MCR direct effects to soil will be limited to the Site; the majority of the areas to be impacted has already been disturbed and to a great extent had already been graveled. Further, as material handling procedures and protocols in place for the Site will encompass MCR activities, the potential indirect interactions with soil quality from proposed excavation activities are limited. No future activities were found to have a likely measurable change on soil quality.

4.5.4 Conclusion

No adverse impacts to conventional surface water, groundwater, geology, soil and sediment are expected as part of the production of Lu-177, and Life Extension activities, including MCR at Units 6, 3 and 4.

4.6 Overall Conclusions of the Ecological Risk Assessment

The overall conclusions of the EcoRA are summarized for each assessed area and environmental media in Table 40 below.

Table 40 Summary of EcoRA Conclusions and Recommendations

Area	Media Assessed	Conclusions	Recommendations
TERRESTRIAL			
Bruce A Storage Compound (BASC) - 17 ha	Soil	No unreasonable risk to terrestrial plants, soil invertebrates and wildlife.	None
	Groundwater	No unreasonable risk to terrestrial plants.	None
Bruce B Empty Drum Laydown Area (BBED) - 1.4 ha	Soil	No unreasonable risk to terrestrial plants, soil invertebrates and wildlife.	None
Construction Landfill #4 (CL4) - 3.8 ha	Soil	No unreasonable risk to terrestrial plants and soil invertebrates. HQs> 1 for terrestrial wildlife from zinc and HMW PAHs.	Further work should characterize the extent of zinc impacts around CL4 collected in 2016 and PAH impacts around CL4-9 collected in 2000 to affirm potential risks because these were the only locations that exceeded the SSTL. Further work should characterize the current acid base extractable concentrations at CLF-9 collected in 2000 to confirm if they remain COPCs in absence of risk-based criteria.
Fire Training Facility (FTF) – 2.8 ha	Soil	HQs> 1 for plants and soil invertebrates from TPH Light. No unreasonable risk to terrestrial wildlife.	Further work should characterize the current PHC concentrations around historically contaminated areas within surface soil to affirm potential risks. Further work should characterize the current acetone and acid base

Table 40 Summary of EcoRA Conclusions and Recommendations

Area	Media Assessed	Conclusions	Recommendations
			extractable concentrations at FTF-12 collected in 2000 to confirm if they remain COPCs in absence of risk-based criteria.
Former Sewage (Commissioning Waste) Lagoon (FSL) – 7 ha	Soil	No unreasonable risk to terrestrial plants, soil invertebrates and wildlife.	None
	Groundwater	No unreasonable risk to terrestrial plants.	None
Distribution Station #1 (DS1) – 0.068 ha	Soil	HQs> 1 for plants and soil invertebrates from TPH Light. No unreasonable risk to terrestrial wildlife.	Further work should characterize the current PHC concentrations around historically contaminated areas within surface soil to affirm potential risks.
	Groundwater	No unreasonable risk to terrestrial plants.	None
Distribution Station #2/4/5 (DS2/DS4/DS5) – 0.05 ha	Soil	No unreasonable risk to terrestrial plants, soil invertebrates and wildlife.	None
Distribution Station #8 (DS8) – 0.21 ha	Soil	No unreasonable risk to terrestrial plants, soil invertebrates and wildlife.	None
General Surface Soil Samples (BPS and SS series)	Soil	HQs> 1 for plans and soil invertebrates from boron (HWS), selenium and PHC F2/F3. HQs>1 for terrestrial wildlife from lead and selenium.	Further work should delineate the extent of metal impacts in surface soil around BPS-04-07/SS6 and the extent of PHC impacts around BPS-07-07/BPS-01-07 to affirm potential risks because these were the only locations that exceeded the SSTL. Further work should delineate strontium impacts around BPS-01-07/BPS-02-07 to confirm if strontium remains a COPC in absence of risk based criteria.

Table 40 Summary of EcoRA Conclusions and Recommendations

Area	Media Assessed	Conclusions	Recommendations
PERMANENT WATER COURSE			
Stream C – 2.2 km	Sediment	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None
	Surface Water	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None
Lake Huron shoreline and nearshore habitat	Sediment	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None
	Surface Water	HQ>1 for aquatic communities from zinc. No unreasonable risk to semi-aquatic wildlife.	Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program. Analysis of DOC required to derive site-specific toxicological benchmark for zinc.
PERMANENT DRAINAGE FEATURE			
FSL (1 ha)	Sediment	HQ>1 for aquatic communities from PHC F3. No unreasonable risk to semi-aquatic wildlife.	Further work should delineate PHC impacts; total organic carbon should be assessed to derive a site-specific toxicological benchmark.
	Surface Water	HQ>1 for aquatic communities from copper and zinc. No unreasonable risk to semi-aquatic wildlife.	Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program. Analysis of dissolved organic carbon required to derive site-specific toxicological benchmark for zinc.
B16 Pond (0.3 ha)	Sediment	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None
	Surface Water	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None

Table 40 Summary of EcoRA Conclusions and Recommendations

Area	Media Assessed	Conclusions	Recommendations
B31 Pond (at CL4) (0.4 ha)	Sediment	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None
	Surface Water	HQ>1 for aquatic communities from copper. No unreasonable risk to semi-aquatic wildlife.	Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program.
Distal Eastern Drainage Ditch (0.09 ha)	Sediment	HQ>1 for aquatic communities from PHC F3. HQ>1 for insectivorous, semi-aquatic wildlife from vanadium.	Further work should delineate PHC impacts; total organic carbon should be assessed to derive a site-specific toxicological benchmark. Further work should delineate vanadium impacts and measure COPC concentration in benthos.
	Surface Water	No unreasonable risk to aquatic communities and semi-aquatic wildlife.	None

No adverse impacts are expected as part of the production of Lu-177, and Life Extension activities, including MCRs on Units 6, 3 and 4.

5.0 ECOLOGICAL RISK ASSESSMENT FOR RADIOLOGICAL CONTAMINANTS

The Ecological Risk Assessment (EcoRA) for radiological contaminants assessed the potential health risks to ecological receptors potentially exposed to environmental media (i.e., soil, air, sediment or water) that may be contaminated by radioactive material released as a result of historical and ongoing activities at the Site.

5.1 Problem Formulation

The purpose of the problem formulation stage is to scope the assessment by identifying the radionuclides of concern, exposure pathways and receptors for the assessment of the radiological risk to ecological receptors. Once this analysis is complete, the results from the problem formulation stage are summarized in a conceptual site model (CSM), which illustrates how receptors can potentially be exposed to radiation emitted from radionuclides in relevant environmental media that have been affected by historical and ongoing activities at the Site.

5.1.1 Receptor (Valued Ecosystem Component) Selection

5.1.1.1 Receptor Selection Process

The ecological receptors chosen for the EcoRA and the process and rationale for their selection are described in the EcoRA for non-radiological contaminants (see Section 3.6). Representative receptors were chosen for the radiological assessment based on the selection of the exposure model as described in the following paragraphs.

The selection of the radiological exposure model and associated parameters for the EcoRA is primarily based on the source of two parameters: exposure factors (e.g., bioaccumulation factors and transfer factors) and dose coefficients. As recommended in CSA Standard N288.6, the following sources were used to determine exposure factors [R-14]:

1. CSA Standard N288.1 [R-117]; or

2. ERICA Tool – Ecological Risk from Ionizing Contaminants: Assessment and Management [R-142].

Further, the ERICA Tool was used for dose coefficients [R-142].

The ERICA Tool extracts data from several databases for the purpose of estimating radionuclide concentrations in environmental media, and activity concentrations in and dose rates to non-human biota. The ERICA Tool was most recently updated to v2.0 in July 2021 [R-143]. Parameters published in the ERICA Tool are used whenever possible.

The fundamental basis of the EcoRA receptor selection is the use of reference organisms, which is consistent with the recommendations of the International Commission on Radiological Protection (ICRP) [R-142][R-144]. As defined in the ERICA Tool as well as the Framework for Assessment of Environmental Impact (FASSET) project, a reference organism is:

"A series of entities that provide a basis for the estimation of radiation dose rate to a range of organisms which are typical, or representative, of a contaminated environment. These estimates, in turn, would provide a basis for assessing the likelihood and degree of radiation effects." [R-142]

The intent of the generic use of reference organisms in the radiological EcoRA is to apply exposure parameters (e.g., concentration ratios and dose coefficients) that are assumed to generally apply to a given set of biota. If the resulting Hazard Quotient (HQ) is close to or greater than 1, a more detailed examination of the specific organisms and their exposure parameters would be required in a radiological DQRA; otherwise the use of reference organisms is deemed appropriate in concluding that there is no radiological risk to the respective set of biota.

Representative reference organisms selected for the radiological EcoRA are shown in Figure 23 and Table 41. These are discussed further for terrestrial and aquatic biota in Section 5.1.5 and 5.1.6, respectively. The entirety of the radiological assessment for non-human biota was carried out for the reference organisms; consistent with ICRP guidance [R-144], it was assumed that the results pertaining to exposure and risk equally apply to all receptors represented by the reference organism.

5.1.1.2 Receptor Descriptions

The reference organisms for the purpose of the radiological assessment are provided in Section Figure 23 and Table 41.

As shown in Figure 23, a single location was chosen for all terrestrial biota and two locations were chosen for all aquatic biota. Consistent with CSA N288.6 guidance, the locations were chosen based on the location of the maximum measured radionuclide concentrations – on-site or off-site (see discussion in Sections 5.1.5 and 5.1.6). If the resulting Hazard Quotient (HQ) is close to or greater than 1, a more detailed examination of other locations would be required in a radiological DQRA; otherwise the use of locations with maximum measured radionuclide concentrations is deemed appropriate in concluding that there is no radiological risk to the respective representative biota. Further discussion supporting the selection of the bounding terrestrial and aquatic biota locations is provided in Appendix N.

The environmental monitoring data considered in the assessment include measurements of:

- Carbon-14 in air from 14 locations throughout the Site;
- Gamma emitters in soil from 15 locations on or near the Site;
- HTO, carbon-14 and gamma emitters in deer tissue from samples collected due to animal-vehicle collisions at the Site;
- HTO in lake water from 3 locations near the Site (Inverhuron, Baie du Dore, and Scott Point);
- HTO, Organically Bound Tritium (OBT), carbon-14, and gamma emitters from benthic and pelagic fish sampled at Baie du Doré;
- Gamma emitters in sediment from three locations within Baie du Doré;
- HTO concentrations in water from the Former Sewage Lagoon on-site; and
- Gamma emitters in sediment from the Former Sewage Lagoon.

The majority of these data are regularly collected as part of the Radiological Environmental Monitoring program, and data from 2016-2020 has been considered. Measurements of gamma emitters in soil on-site were performed in 2019. Measurements of HTO in water and gamma emitters in sediment from the Former Sewage Lagoon include additional sampling conducted in 2021.

Bruce Power's radiological environmental monitoring complies with CSA N288.4 [R-15] and is based on environmental risk. An analysis has been performed to determine the radionuclides and exposure pathways that have the most significant contributions to radiation dose. Terrestrial biota located on Site is considered based on monitoring throughout the Site, including locations where radioactivity in air is expected to be greatest. Aquatic biota are considered based on measurement of radioactivity in on-site water bodies and nearby locations where radioactivity in surface water from Site operations is expected to be greatest and there is sedimentation of radionuclides. Based on the results of the pathways analysis, the radionuclide groups contributing most significantly to total biota dose have been considered for on-site radiological environmental monitoring.

Figure 23 Ecological Receptor Locations

5.1.2 Assessment and Measurement Endpoints

Assessment endpoints are narrative statements that describe the environmental values to be protected but rarely can they be measured directly. The assessment endpoint in this EcoRA is the protection of non-human biota from adverse effects on survival, growth, or reproduction, due to radiological contaminants.

Measurement endpoints are the studies, tests or models that can be performed that serve as a proxy for the assessment endpoints and are the means by which the risk assessor will achieve the assessment endpoint. The absorbed radiation dose rate to non-human biota will be used as the measurement endpoint to determine the radiological risk. Decision criteria will be based on established radiation dose benchmarks published by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and other organizations (see Section 5.3).

5.1.3 Selection of Radiological Contaminants

A full description of the quantitative data used in the EcoRA is available in Appendix N [R-35]. Among the beta/gamma-emitting radionuclides of cobalt-60, cesium-134 and cesium-137, only cesium-137 has been measured above detection limits in on-site soil, and sediment and fish samples in and around the Site. As a result, cesium-137 was chosen as the sole beta/gamma-emitting radionuclide for the EcoRA.

The representative radionuclides for gross alpha radionuclides were selected based on the limiting (lowest) Derived Release Limit (DRL) calculations for both Bruce A and Bruce B [R-145][R-146]. A literature review of alpha dosimetry in non-human biota was conducted in order to validate the selection of specific representative alpha radionuclides for the EcoRA [R-147]. It was determined that Concentration Ratios (CR) among potential representative alpha radionuclides vary significantly for different radionuclide-biota pairs. Other parameters (e.g., dose coefficients) are less variable, and are represented by the selection of neptunium-237 and plutonium-239 as representative alpha radionuclides. Therefore, the calculation approach was modified such that the greatest CR value among all potential alpha radionuclides was used for evaluating alpha dose to each species. This represents conservative management of uncertainty associated with the selection of representative alpha-emitting radionuclides.

5.1.4 Selection of Exposure Pathways

The radiation dose to non-human biota is categorized in two types of exposure pathways: external exposure from air or water immersion and internal exposure from ingestion of contaminants. Where applicable, internal exposure is calculated based on the concentrations measured in biota tissue sampled and analyzed as part of the environmental monitoring program. For all other biota, internal exposure pathways are examined inherently with the use of Concentration Ratios (CRs), which correlate the radionuclide concentrations in environmental media to the concentrations in the tissue.

5.1.5 Terrestrial Problem Formulation

5.1.5.1 Terrestrial Receptor (Valued Ecosystem Component) Selection

Representative terrestrial reference organisms for the radiological EcoRA are shown in Table 41. As specified in the ERICA Tool, the biota were represented by generic reference organisms, using dose coefficients and concentration ratios [R-143]. Deer were chosen as representative receptors for large mammals since there is environmental monitoring data (i.e., radionuclide concentration in tissue) over the past five years.

Table 41 Representative EcoRA Terrestrial Receptors

Representative Radiological EcoRA Receptor(s)
Tree Grasses and Herbs
Soil invertebrates
Large mammal (deer) Small mammal
Bird
Amphibian

For the purpose of the assessment, all terrestrial biota are assumed to reside on the Site, specifically north of Bruce A, where the highest on-site concentrations of carbon-14 in air are measured (excluding those locations in the immediate vicinity of the WWMF). The only exception is large mammal (deer), for which the exposure assessment is based on opportunistic samples of deer collected near the Site.

5.1.5.2 Selection of Terrestrial Exposure Pathways and Conceptual Model

The external exposure pathways for terrestrial biota include:

- Air immersion (exposure from gaseous radionuclides in the air, primarily noble gases); and
- Ground shine (exposure from radioactive particulate on the ground, primarily gamma emitters such as cesium-137).

The predominant internal exposure pathway for terrestrial biota is their respective food chains, or water uptake for plants.

Figure 24 delineates the exposure pathways used for terrestrial biota in the EcoRA for radiological contaminants.

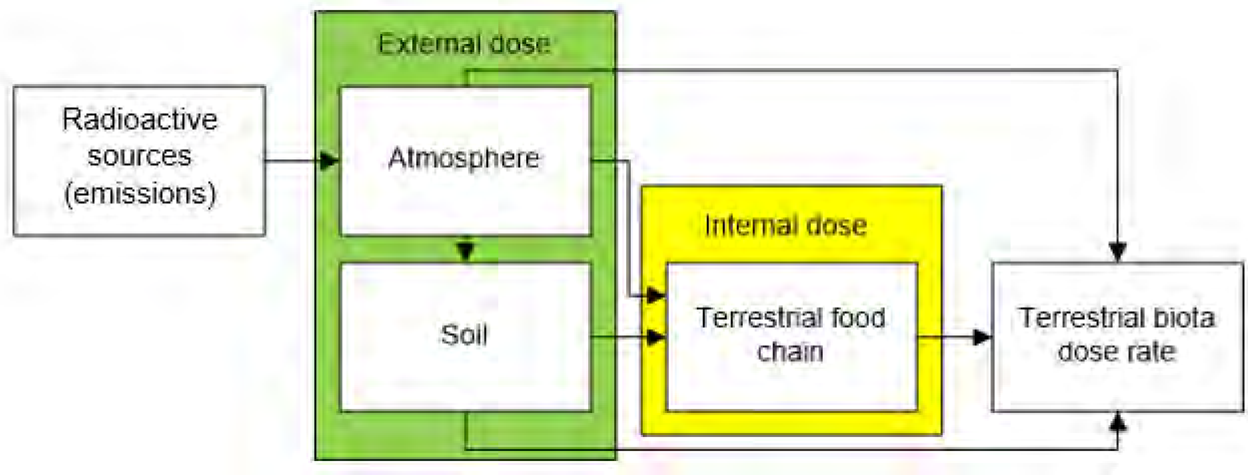

Figure 24 Radiological Exposure Pathways for Terrestrial Biota

5.1.5.3 Selection of Terrestrial Radiological Contaminants

The radionuclides selected for the assessment of exposure to terrestrial biota were:

- Tritium (H-3);
- Carbon-14;
- Cesium-137 (representing gross beta/gamma radionuclides);
- Plutonium-239 (representing gross alpha radionuclides);
- Iodine-131; and
- Noble gases.

Dose to terrestrial biota from iodine is based on modelled concentrations in soil. For these longer-duration pathways associated with soil partitioning and bio-uptake, the contribution of short-lived radioiodines (i.e. I-132 to I-135) is assumed to be negligible, and transfer parameters and dose coefficients are based on I-131.

A representative "noble gas" radionuclide was used to simulate airborne concentrations of noble gases at the terrestrial EcoRA site. The terrestrial dose to biota calculation uses the bounding noble gas Dose Coefficient (DC) among Argon-41, Krypton-85, Krypton-88, Xenon-131m and Xenon-133 for each receptor to provide a conservative estimate of the dose from noble gases.

5.1.6 Aquatic Problem Formulation

5.1.6.1 Aquatic Receptor (Valued Ecosystem Component Selection)

Representative aquatic reference organisms for the radiological EcoRA are shown in Table 42. These were selected based on the receptors considered in the non-radiological EcoRA (Section 4.1.1.2). Pelagic fish and benthic fish were chosen as representative receptors since there is environmental monitoring data (i.e., radionuclide concentration in tissue) over the past five years. The remaining biota was represented by generic reference organisms, using dose coefficients and concentration ratios as specified in the ERICA Tool. The “Freshwater Plant” receptor represents aquatic plants. The “Pelagic Invertebrate” receptor represents small aquatic invertebrates in the water column, e.g., Zooplankton. The “Benthic Invertebrate” receptor is representative of bottom-dwelling invertebrates and aquatic insect larvae. Benthic and Pelagic fish represent “bottom-dwelling” fish and those that inhabit the water column, respectively. An aquatic mammal receptor was included to represent terrestrial mammals which are exposed to the aquatic environment (i.e., muskrat and water shrew). An aquatic bird receptor was included to represent terrestrial birds which are exposed to the aquatic environment (i.e., ducks and waterfowl).

Table 42 Representative Freshwater EcoRA Aquatic Receptors

Representative Radiological EcoRA Receptor(s)
Plants
Pelagic invertebrates
Benthic invertebrates
Pelagic fish
Benthic fish
Mammal
Bird

Aquatic biota is assumed to reside in Baie du Doré or the Former Sewage Lagoon. Baie du Doré is the off-site location where the highest concentrations of tritium and gamma-emitting radionuclides are measured. Although pelagic fish do not consistently reside in Baie du Doré, benthic and pelagic fish are assumed to reside in Baie du Doré for the purpose of dose calculation to ensure the most conservative possible outcomes are presented.

In the previous ERA, it was recommended that radionuclides in the South Railway Ditch be measured and compared to Stream C, to ensure that the aquatic assessment considers the on-site location that is bounding in terms of radioactivity in aquatic species. Additional monitoring has been undertaken of on-site waterbodies as part of REM, and with sampling of Stream C, South Railway Ditch, the B31 Pond, B16 Stormwater Pond, and Former Sewage

Lagoon undertaken in 2020 and 2021. The measurements of radioactivity in these waterbodies are presented in Appendix N: Radiation Dose to Non-Human Biota [R-35].

The onsite waterbody FSL is selected as an additional aquatic receptor location because it has higher tritium concentrations than Baie du Doré, and has been identified as fish habitat. Sampling data have shown that the FSL has tritium concentrations that are bounding of all on-site waterbodies, including Stream C, South Railway Ditch, the B31 Pond, and B16 Stormwater Pond.

5.1.6.2 Selection of Aquatic Exposure Pathways and Conceptual Model

The external exposure pathways for aquatic biota include:

- Water immersion (primarily gamma emitters such as cesium-137); and
- Sediment external (exposure from radioactive particulate in sediment, primarily gamma emitters such as cesium-137).

The predominant internal exposure pathway for aquatic biota is their respective food chains, or water uptake.

Figure 25 delineates the exposure pathways used for aquatic biota in the EcoRA for radiological contaminants.

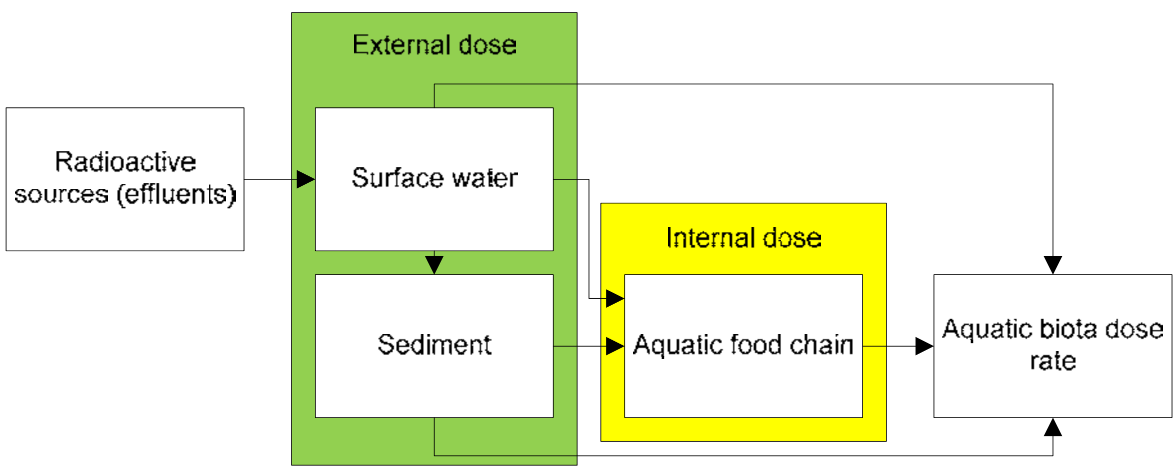

Figure 25 Radiological Exposure Pathways for Aquatic Biota

5.1.6.3 Selection of Aquatic Radiological Contaminants

The radionuclides selected for the assessment of exposure to aquatic biota were:

- Tritiated water (HTO);
- Organically Bound Tritium (OBT);
- Carbon-14;
- Cesium-137 (representing gross beta/gamma radionuclides); and
- Plutonium-239 and Neptunium-237[2] (representing gross alpha radionuclides).

5.2 Exposure Assessment

Exposure assessment for wildlife is the process of estimating the degree to which a wildlife receptor could be exposed to a radionuclide as a result of its foraging behaviour, feeding habits and habitat. Exposure assessment for aquatic life is the identification of radionuclide concentrations to which the aquatic receptor is considered to be directly exposed.

The key components of the exposure assessment for reference organisms included the following:

1. Empirically-derived Concentration Ratios (CRs) that correlate the activity concentration in environmental media to biota tissue and hence dictate the level of internal exposure;
2. Empirically-derived distribution coefficients that correlate the activity concentration between environmental media (e.g., between surface water and sediment);
3. Dose Coefficients (DC) that correlate the dose rate to the concentration in tissue (for internal exposure) or environmental media (for external exposure); and
4. Occupancy Factors (OF) that represent the amount of time the biota is exposed to the contaminated environment.

Each of these parameters is examined in the following sections. They are the basis for a simplistic yet comprehensive method to calculate the dose rate to non-human biota in μGy/h.

[2] As discussed in Section 6.1.3, Np-237 and Pu-239 are the representative radionuclides for airborne and waterborne alpha emissions, respectively. As the FSL is an on-site waterbody with no connection to waterborne releases, it is assumed all alpha-emitting radionuclides come from the airborne representative radionuclide Np-237 rather than Pu-239.

5.2.1 Probability of Exposure

For relatively immobile ecological receptors (e.g., plants and invertebrates), it was assumed that biota were exposed to the maximum radionuclide concentrations in air, soil, water or sediment 100% of the time. The same assumption regarding residency was used for more mobile receptors (e.g., mammals, birds, amphibians and fish). This is a very conservative assumption given the migratory nature of these species and that their home range size is much larger than the spatial area where the maximum radionuclide concentrations are observed. Species that may be exposed to both the terrestrial or aquatic environment (e.g., mammals and birds) have been included in both the aquatic and terrestrial assessments. This approach represents 100% exposure to the aquatic or terrestrial locations with the maximum radionuclide concentrations, and is bounding of any potential exposure for these mobile receptors.

5.2.2 Receptor Characterization

The specific diets of the reference organisms selected for the EcoRA have been inherently accounted for with the use of Concentration Ratios (CRs) published in CSA Standard N288.1 and the ERICA Tool [R-117][R-143], which are described in the following section. Therefore, the CRs implicitly include ingestion rates for food, water, soil and sediment.

CRs are empirically derived from an extensive review of publications containing data that correlates environmental media concentrations to tissue concentrations. Where such data was not available for reference organism-radionuclide combinations, the ERICA Tool employs the following approaches [R-143]:

- Use an available CR value for an organism of similar taxonomy within that ecosystem for the radionuclide under assessment;
- Use an available CR value for a similar reference organism;
- Use CR values recommended in previous reviews or derive them from previously published reviews; and
- Use specific activity models for H-3 and carbon-14.

The effects to radiation emitted from radionuclides within and external to the reference organisms are quantified by the dose coefficients, which are included in the ERICA Tool.

5.2.3 Radionuclide-Specific Factors

The FASSET and ERICA projects have collected a database of whole organism CRs to relate the concentration of radioactivity in environmental media to the concentration of radioactivity found in the tissue of biota [R-143][R-148]. Knowing the concentration in the air, soil, water and sediment, allows the concentration in the biota tissue to be estimated.

For most radionuclides in the terrestrial environment, the CR is defined as:

$$CR_{soil} = \frac{\text{Activity concentration in biota whole organism } \left(\frac{\text{Bq}}{\text{kg}} \text{ fresh weight}\right)}{\text{Activity concentration in soil } \left(\frac{\text{Bq}}{\text{kg}} \text{ dry weight}\right)}$$

For atmospheric emissions of H-3 and carbon-14, the CR is estimated as follows:

$$CR_{air} = \frac{\text{Activity concentration in biota whole organism } \left(\frac{\text{Bq}}{\text{kg}} \text{ fresh weight}\right)}{\text{Activity concentration in air } \left(\frac{\text{Bq}}{\text{m}^3}\right)}$$

For aquatic ecosystems, the CR is calculated as:

$$CR_{water} = \frac{\text{Activity concentration in biota whole organism } \left(\frac{\text{Bq}}{\text{kg}} \text{ fresh weight}\right)}{\text{Activity concentration in water } \left(\frac{\text{Bq}}{\text{L}}\right)}$$

The concentration in sediment is often required to determine external exposure rates to aquatic organisms that spend the majority of their time in or near the sediment surface, such as bottom-feeders (i.e., benthic fish). The solid-liquid distribution coefficient (K_d) can be used to relate water and sediment concentrations:

$$K_d = \frac{\text{Activity concentration in sediment} \left(\frac{\text{Bq}}{\text{kg}}\right)}{\text{Activity concentration in water } \left(\frac{\text{Bq}}{\text{L}}\right)}$$

5.2.4 Exposure Point Concentrations

Additional sampling of gamma emitters in on-site soils was conducted in 2019 (Appendix N). Excluding cesium-137 and naturally occurring radionuclides, all radionuclides were below detection. The concentrations of cesium-137 in soil were comparable to results from 2016 soil sampling, as presented in the 2017 ERA. The average cesium-137 concentration on-site was 6.01 Bq/kg-dw, as compared to 5.67 Bq/kg-dw in 2016. For context, the average background value of Cs-137 was 5.38 Bq/kg-dw, based on soil measurements at Cobourg, Goderich and Lakefield in 2017. The maximum value on-site was approximately 30.92 Bq/kg-dw in 2019, as compared to 20.1 Bq/kg-dw in 2016. While the maximum value in 2019 is higher, the 2019 sampling campaign included different soil monitoring locations selected to represent the highest potential for radionuclide concentration from airborne deposition, therefore some variability is expected.

For each radionuclide considered in the EcoRA, the radiation dose was calculated for both aquatic and terrestrial biota following the guidance provided in CSA Standard N288.6-12 [R-14]. Values below the limits of detection were dealt with according to the suggested methodology in N288.4, Appendix D [R-15] and are discussed in detail in Section 3.2.2. For the internal dose to aquatic and terrestrial biota, CRs were used to correlate the tissue concentration to the concentration in air, water, sediment or soil. All CRs, dose coefficients, and occupancy factors were obtained from the tables provided in the ERICA Tool [R-143].

As discussed in Section 5.1.3, alpha dose calculations utilize the bounding CR among all potential alpha radionuclides, in order to conservatively manage uncertainty associated with representative radionuclide selection.

The equations for calculating exposure point concentrations and radiation dose to biota are provided in Section 1.4 of the ERA Appendix B: ERA Methodology [R-35].

5.2.5 Exposure Doses

Using the equation and parameters described in the preceding section and the ERA Appendices [R-35], the calculated internal, external and total dose rates to terrestrial and aquatic biota are shown in Section 5.2.6 and 5.2.7. The detailed calculations of the dose rate for all non-human biota are provided in Appendix N: Radiation Dose to Non-Human Biota [R-35].

5.2.6 Terrestrial Exposure Doses

The calculated internal, external and total dose rates to terrestrial biota are shown in Table 43 and Figure 26. The benchmark value of 2.4 mGy/d for terrestrial biota is provided for context (see Section 5.3). The dose rate for all terrestrial species except large mammals is approximately equivalent (2.0E-03 mGy/d) and is comparable to the 2017 ERA [R-12]. It is evident that the measurements of radioactivity in tissue for deer resulted in a significantly lower calculated internal dose for large mammals compared to the internal doses of all other terrestrial biota, which were based on modelled concentrations. The dose rate to large mammals (1.79E-04 mGy/d), is 10 times less than any other terrestrial species considered in this assessment.

Table 43 Calculated Internal, External and Total Terrestrial Dose Rates

Ecological Receptor	Internal Dose Rate (mGy/d)	External Dose Rate (mGy/d)	Total Dose Rate (mGy/d)
Terrestrial Biota			
Large Mammal (deer)	5.01E-05	1.28E-04	1.79E-04
Small Mammal	2.05E-03	2.79E-04	2.33E-03
Amphibian	1.79E-03	2.85E-04	2.08E-03
Bird	1.81E-03	1.91E-04	2.01E-03
Tree	1.78E-03	5.52E-05	1.83E-03
Grasses and Herbs	1.80E-03	6.90E-05	1.87E-03
Soil Invertebrate	1.65E-03	1.85E-04	1.84E-03

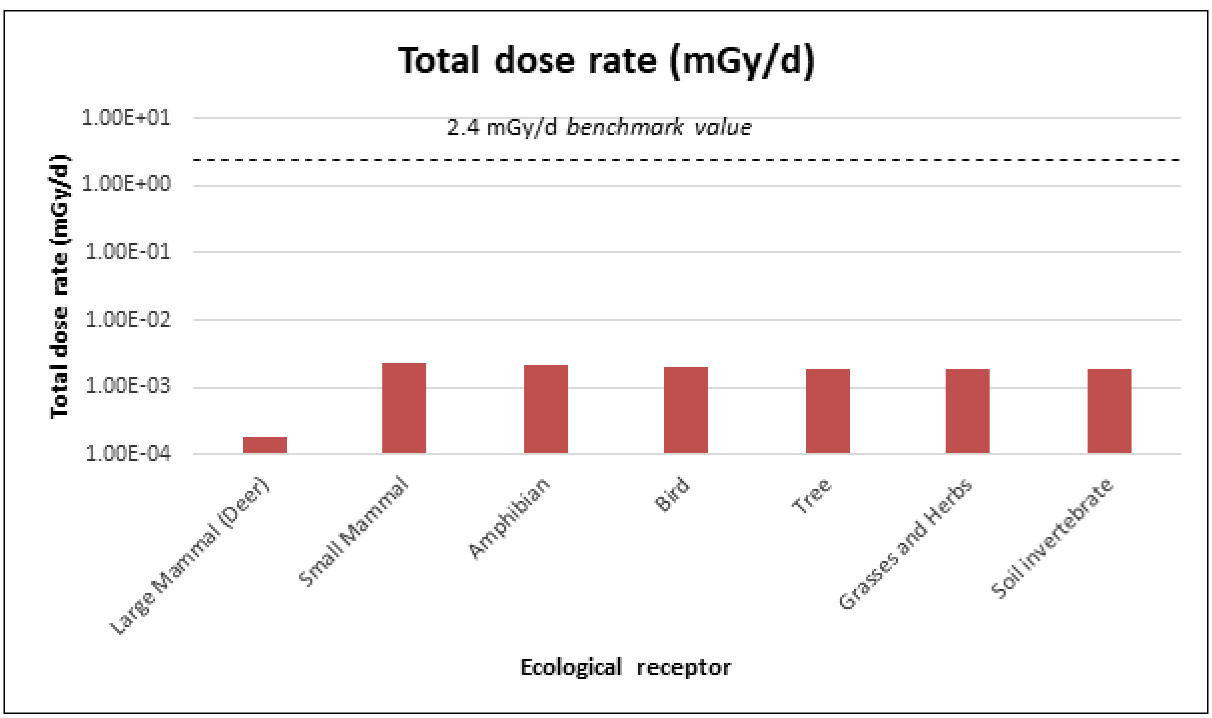

Figure 26 Total Dose to Terrestrial Ecological Receptors

5.2.7 Aquatic Exposure Doses

The calculated internal, external and total dose rates to terrestrial biota are shown in Table 44, Figure 27 and Figure 28. Doses to aquatic biota in the Former Sewage Lagoon are shown to be higher than in Baie du Doré. This is primarily due to higher measured concentrations of tritium in water and cesium-137 in sediment, and modelled concentrations of carbon-14 from atmospheric deposition. The FSL is an on-site waterbody located close to Bruce B, and radionuclide concentrations are expected to be impacted by airborne emissions from the facilities.

The benchmark value of 9.6 mGy/d for aquatic biota is provided for context (see Section 5.3). The aquatic receptor with the highest total radiation dose rate is the benthic invertebrate receptor at the Former Sewage Lagoon. The total dose rate for the benthic invertebrate is approximately 2E-03 mGy/d. The total radiation dose rates to aquatic biota in Baie du Doré ranges from 7E-06 to 2E-04 mGy/d. These are comparable to the 2017 ERA where doses in Baie du Doré ranged from 1E-06 to 4E-05 mGy/d, and remain far below benchmarks [R-12]. Doses are lowest where tissue concentrations are available as opposed to where modelled concentrations are used.

Doses to aquatic biota in the Former Sewage Lagoon are shown to be higher than in Baie du Doré. This is primarily due to higher measured concentrations of tritium in water and cesium-137 in sediment, and modelled concentrations of carbon-14 from atmospheric deposition. The FSL is an on-site waterbody located close to Bruce B, and radionuclide concentrations are expected to be impacted by airborne emissions from the facilities.

Table 44 Calculated Internal, External and Total Aquatic Dose Rates

Ecological Receptor	Internal Dose Rate (mGy/d)	External Dose Rate (mGy/d)	Total Dose Rate (mGy/d)
Aquatic Biota (Baie du Doré)			
Aquatic Bird	1.21E-04	5.78E-10	1.21E-04
Benthic Fish	1.00E-05	4.91E-06	1.49E-05
Pelagic Fish	6.89E-06	5.89E-10	6.89E-06
Aquatic Mammal	1.26E-04	5.29E-10	1.26E-04
Pelagic Invertebrate	1.94E-04	1.13E-09	1.94E-04
Benthic Invertebrate	1.96E-04	1.29E-05	2.09E-04
Freshwater Plant	2.68E-05	6.53E-07	2.75E-05
Aquatic Biota (FSL)			
Aquatic Bird	5.57E-04	5.31E-08	5.57E-04

Table 44 Calculated Internal, External and Total Aquatic Dose Rates

Ecological Receptor	Internal Dose Rate (mGy/d)	External Dose Rate (mGy/d)	Total Dose Rate (mGy/d)
Benthic Fish	6.14E-04	4.51E-04	1.07E-03
Pelagic Fish	6.12E-04	5.41E-08	6.12E-04
Aquatic Mammal	6.58E-04	4.86E-08	6.58E-04
Pelagic Invertebrate	5.82E-04	7.68E-08	5.82E-04
Benthic Invertebrate	6.24E-04	1.19E-03	1.81E-03
Freshwater Plant	1.51E-04	5.95E-05	2.10E-04

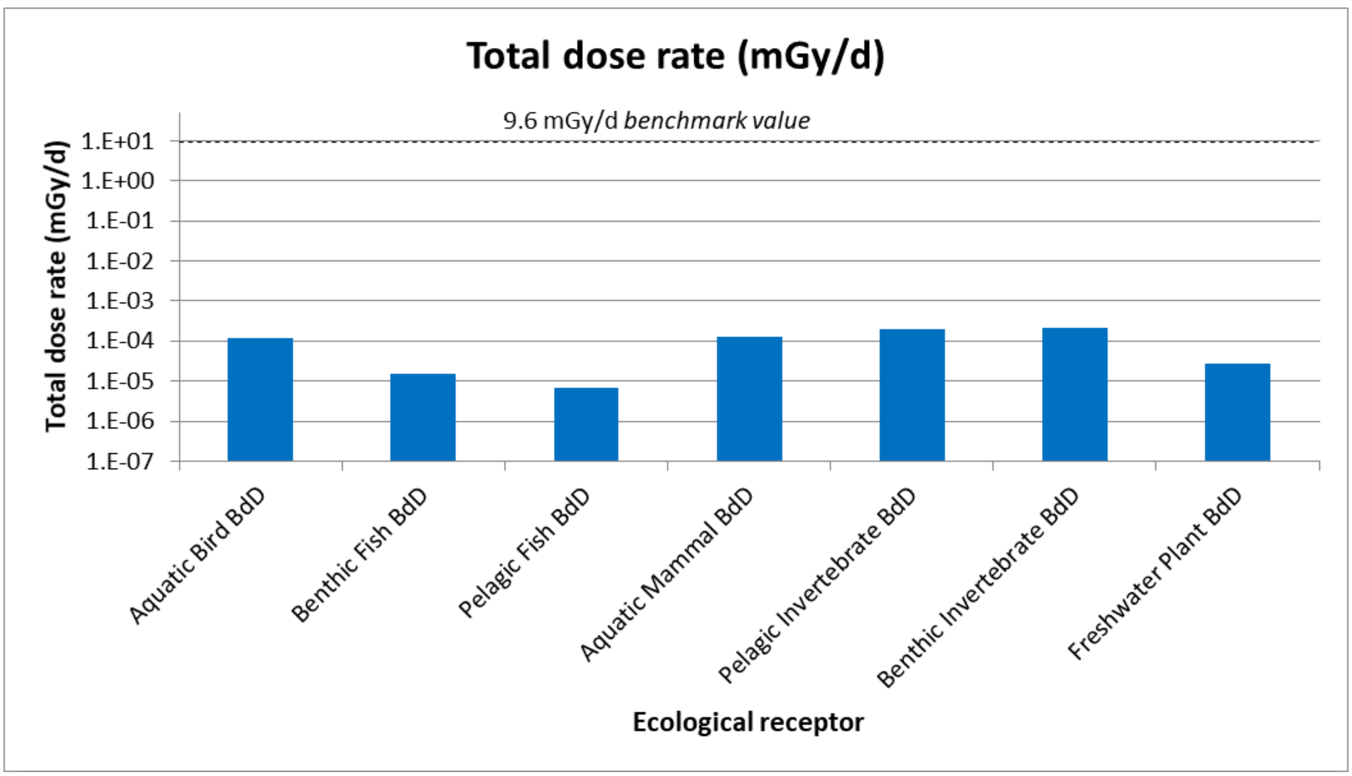

Figure 27 Total Dose to Aquatic Ecological Receptors - Baie du Doré (BdD)

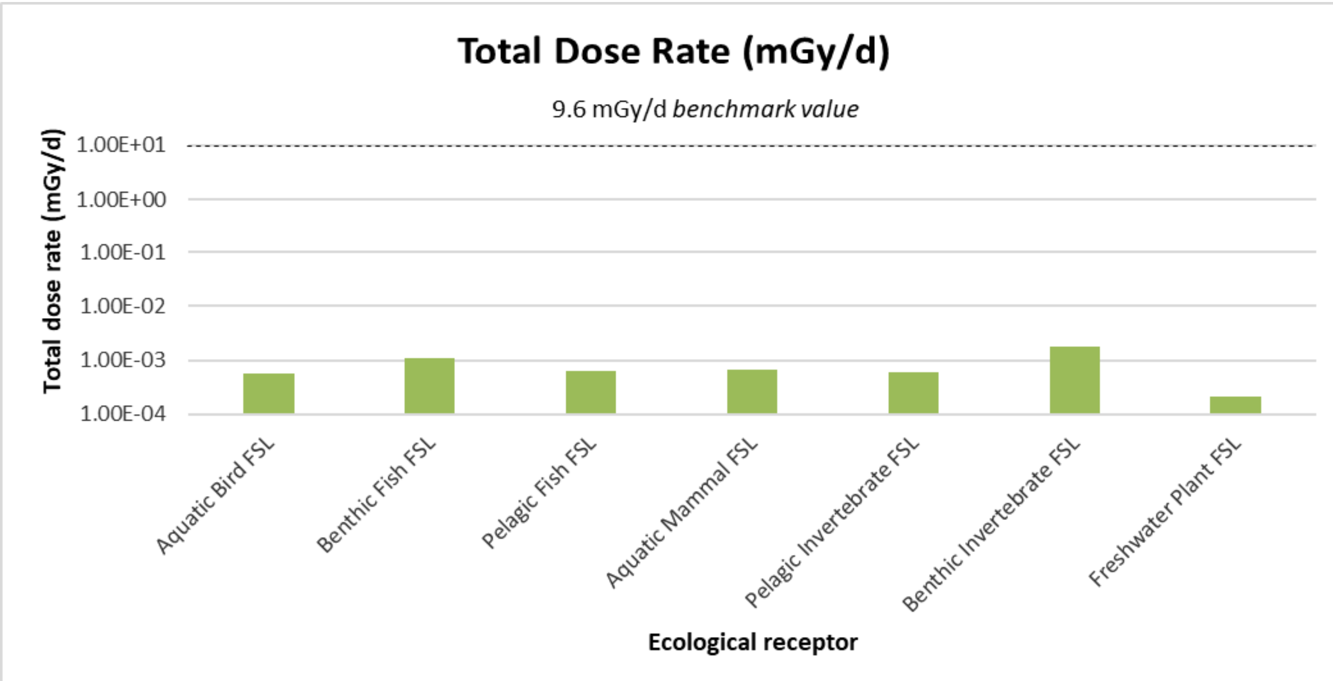

Figure 28 Total Dose to Aquatic Ecological Receptors – Former Sewage Lagoon (FSL)

5.2.8 Uncertainties and Assumptions in the Exposure Assessment

The following are the predominant sources of uncertainty in the radiological exposure assessment for ecological receptors:

1. The use of effluent and environmental data reported as less than a detection limit (Ld);
2. The use of generic CRs for reference organisms to quantify the uptake of radionuclides through the food chain;
3. The use of the IMPACT model to determine concentrations that are not measured (resulting in conservative over-estimates); and
4. The use of 100% occupancy factors for biota with no available measurements of tissue concentrations (resulting in conservative over-estimates).

Effluent and environmental data reported as less than a detection limit is a source of uncertainty in the radiological ERA. As discussed in Section 3.2.4 for the HHRA, methods for dealing with values less than the limits of detection were applied according to Annex D of N288.4-10 [R-99]. Uncensored data below the detection limit is now used where possible, rather than assuming data is equal to the detection limit.

This assessment makes use of CRs to relate the concentration of radionuclides present in the environment to the concentration of radionuclides present in biota tissue, for the purposes of calculating internal dose. Consistent with the recommendations of CSA N288.6, CSA Standard N288.1 and the ERICA Tool were used as the source of CRs given that site-specific CRs are not available [R-117][R-117][R-143]. The use of generic CRs, albeit for representative species, provides an approximate relationship between environmental and tissue concentrations, but does not consider any special food-chain relationships that may exist on the Site.

Aside from the radioactivity in deer tissue, measurements of Carbon-14 in air and Cesium-137 in soil were incorporated into the exposure assessment for terrestrial biota. Modelling or calculations of all other radionuclide concentrations were used in the dose rate calculations, which generally results in a more conservative assessment.

For the assessment of exposure to aquatic biota in the Former Sewage Lagoon, only measurements of tritium in water and Cesium-137 in sediment were available. Therefore, concentrations of Carbon-14 and Plutonium-239 in water were calculated based on atmospheric emissions. While modelled values are expected to be conservative, this represents a significant source of uncertainty.

All terrestrial and aquatic biota were assumed to be exposed to the maximum radionuclide concentrations found on or near the Site, for the entire year – unless measurements of radioactivity in tissue were incorporated (e.g., deer and fish). This is extremely conservative, given the migratory nature of these species and that their home range size is much larger than the spatial area where the maximum radionuclide concentrations are observed. The conservatism of this approach is evidenced by the dose rate to fish in Baie du Doré and deer killed in the vicinity of the site, for which measured tissue concentrations are used, resulting in significantly lower tissue concentrations than those conservatively estimated based on CRs and constant exposure to maximum concentrations. This extreme conservatism in the exposure assessment forms a bounding risk assessment; the risk to biota further away from the Site is assumed to be much less than that calculated in this assessment.

Additionally, measurements of radionuclides in coyote and beaver killed at the site in 2019 and 2020 respectively are available. Since only one sample of each was available, these were not used in dose calculations, but results are compared to modelling to demonstrate that the modelling approach is conservative. Measurements of tritium and carbon-14 were between 3 and 8 times lower in measured beaver tissue than in the FSL aquatic mammal calculation. Measured concentrations of tritium and carbon-14 in coyote tissue were between 3 and ~50 times lower than modelled values in small mammals. This further demonstrates the conservatism of the modelling approach using concentration ratios and assuming 100% occupancy in the most bounding locations.

Birds may be exposed to higher concentrations of radionuclides if they are located in very close proximity to the exhaust stacks. There is a mitigation program to control the gull population on site. During inspections of the rooftops and other nesting areas near exhaust stacks, there has been no evidence of other species nesting in these areas. Other locally nesting species, such as eagles and peregrine falcons, would not allow for a thriving gull colony so close by. Based on the information collected on site, impacts to other bird species, including high profile species, are not expected. There are no known Species at Risk on Site which utilize areas near exhaust stacks. Therefore, it is unlikely that birds would be exposed to radionuclides exceeding the current conservative assumptions, which are based on exposure to the maximum measured radionuclide concentrations on Site, for the entire year.

There is some uncertainty related to the exposure assessment for large mammals and fish, where measured tissue concentrations were incorporated, however calculated dose rates considering these uncertainties would remain far below benchmarks. It is unknown whether or not the exposure duration (i.e., time spent in the near field) and resulting radionuclide concentrations in tissue for sampled deer and fish are truly bounding of all similar biota on or near the Site. Accounting for this uncertainty may result in higher doses to large mammals and fish, but doses would be comparable to those calculated for other biota where no tissue concentrations are available and conservative CRs have been used, and calculated dose rates still remain far below benchmark values.

Where measured tissue concentrations were used in the assessment, there is uncertainty associated with the assumption that measured concentrations in flesh are representative of biota whole body concentration. The flesh concentrations used in the assessment are HTO and Carbon-14 in deer, and HTO, Carbon-14, and Cesium-137 in fish. HTO and Carbon-14 concentrations per kg of animal product are calculated based on dry weight fraction, water equivalent fraction of combustion water, and stable carbon concentrations respectively [R-111]. Based on the specific activity models used for tritium and Carbon-14, and the relative concentrations of water and carbon in flesh versus other biota tissues (e.g., bone), these calculated flesh concentrations of tritium and Carbon-14 are assumed to conservatively represent whole body concentrations. According to International Atomic Energy Agency (IAEA) TRS 479 [R-149], the fish muscle to whole organism conversion factor for Cesium-137 is 1.00, therefore Cesium-137 fish flesh concentrations are expected to be comparable to whole body concentrations.

5.3 Effects Assessment

As recommended in CSA N288.6 [R-14], the reference benchmarks for the radiological effects assessment are based on UNSCEAR guidance [R-150] (emphasis added):

- *Chronic dose rates of less than **100 µGy/h** to the most highly exposed individuals would be unlikely to have significant effects on most terrestrial communities; and that*

- *Maximum dose rates of **400 µGy/h** to any individual in aquatic populations of organisms would be unlikely to have any detrimental effect at the population level.*

These dose rates correspond to 2.4 mGy/d and 9.6 mGy/d for terrestrial and aquatic biota respectively.

5.3.1 Uncertainties and Assumptions in the Effects Assessment

The radiological benchmarks provided in the preceding section are based on effects to non-human biota correlating to the following endpoints: morbidity, mortality or reproduction. Since the specific dose rate associated with each effect can vary by an order of magnitude, there is a large degree of uncertainty in the radiological benchmarks [R-14]. The benchmarks chosen for this assessment and recommended by UNSCEAR are at the lower bounds of the range of potential dose rates that may lead to adverse effects to non-human biota, and are therefore deemed to be conservative.

Table 45 provides additional radiological benchmarks listed in CSA Standard N288.6-12 [R-14]. While the differences from the UNSCEAR guidelines highlight the uncertainty in the benchmarks, the values are generally consistent with the exception of the Environment Canada/Health Canada (EC/HC) proposed benchmark for fish (0.5 mGy/d), which is approximately 20 times lower. This benchmark will be carried through to the risk characterization step for fish.

Table 45 Other Radiological Benchmarks

Organization	Biota	Dose rate (mGy/d)
ACRP	All	3
EC/HC	Invertebrates	5.4
	Fish	0.5
	All others	2.7

Notes:
ACRP – Advisory Committee on Radiation Protection [R-151]
EC/HC – Environment Canada/Health Canada [R-152]

One of the aspects of uncertainty in the effects assessment is the sensitivity to radiation at early life stages. While it is generally acknowledged that species have a greater radio-sensitivity during early life stages [R-14], current radiological benchmarks for non-human biota do not explicitly account for this [R-150]. In the exposure assessment, a benthic invertebrate representative receptor was also represents the exposure of pelagic fish larva and insects.

5.4 Risk Characterization

5.4.1 Risk Estimation

Risk characterization is the final step in the risk assessment process, during which the exposure and effects assessments are integrated. The process of risk characterization conducted in this EcoRA reflects the conservative approach used to generate risk estimates. Table 46 shows the calculated hazard quotient (HQ) for each ecological receptor, which is the ratio of the predicted exposure to the applicable radiological benchmark. As stated in the previous section, the EC/HC radiological benchmarks for fish are considerably lower than those recommended by UNSCEAR and are therefore included in Table 46 for comparison. Given the small values for the hazard quotient results, the percent of the applicable benchmark represented by the calculated total dose rate is presented for further context.

As discussed in CSA N288.6 [R-14], exceeding the UNSCEAR radiation dose benchmarks would indicate a potential for adverse effects and a need for further detailed assessment. Since all hazard quotients are less than 1% of the benchmark value, it has been assessed that there is no unreasonable radiological risk to non-human biota resulting from normal operations on the Site.

Table 46 Hazard quotients for Non-human Biota

Ecological receptor	Total dose rate (mGy/d)	Benchmark (mGy/d)	Hazard Quotient	Percent of Benchmark (%)
Terrestrial Biota				
Large Mammal (deer)	1.79E-04	2.4	7.46E-05	0.01%
Small mammal	2.33E-03	2.4	9.71E-04	0.10%
Amphibian	2.08E-03	2.4	8.67E-04	0.09%
Bird	2.01E-03	2.4	8.38E-04	0.08%
Tree	1.83E-03	2.4	7.63E-04	0.08%
Grasses and Herbs	1.87E-03	2.4	7.79E-04	0.08%
Soil Invertebrate	1.84E-03	2.4	7.67E-04	0.08%
Aquatic Biota (Baie du Doré)				
Aquatic Bird	1.21E-04	9.6	1.26E-05	0.001%
Benthic Fish	1.49E-05	9.6 0.5	2.98E-05	0.0002%
Pelagic Fish	6.89E-06	9.6 0.5	1.38E-05	0.00007%
Aquatic Mammal	1.26E-04	9.6	1.31E-05	0.001%
Pelagic Invertebrate	1.94E-04	9.6	2.02E-05	0.002%
Benthic Invertebrate	2.09E-04	9.6	2.18E-05	0.002%
Freshwater Plant	2.75E-05	9.6	2.86E-06	0.0003%
Aquatic Biota (Former Sewage Lagoon)				
Aquatic Bird	5.57E-04	9.6	5.80E-05	0.006%

Table 46 Hazard quotients for Non-human Biota

Ecological receptor	Total dose rate (mGy/d)	Benchmark (mGy/d)	Hazard Quotient	Percent of Benchmark (%)
Benthic Fish	1.07E-03	9.6 0.5	2.14E-03	0.01%
Pelagic Fish	6.12E-04	9.6 0.5	1.22E-03	0.006%
Aquatic Mammal	6.58E-04	9.6	6.85E-05	0.007%
Pelagic Invertebrate	5.82E-04	9.6	6.06E-05	0.006%
Benthic Invertebrate	1.81E-03	9.6	1.89E-04	0.02%
Freshwater Plant	2.10E-04	9.6	2.19E-05	0.002%

A more detailed examination of the contribution from each exposure pathway to the total dose rate is provided in Appendix N of [R-35]. The primary intent of this examination is to inform the Environmental Monitoring Program for program development as appropriate.

5.4.2 Effects Monitoring Evidence

As concluded in the preceding section, the calculated hazard quotient of less than 0.01 suggests that there is no radiological risk or adverse effect to non-human biota surrounding the Site. To date, there has been no data or information regarding the health of local biota to suggest that there is any correlation between the low levels of radioactivity in the environment and adverse health effects.

It is not expected that radiation effects on biota are measurable when doses are well below the levels that are represented by the UNSCEAR benchmarks.

5.4.3 Likelihood of Effects

With a hazard quotient of less than 0.01, it is extremely unlikely that adverse health effects will be measurable at the population level.

5.4.4 Uncertainties and Assumptions in the Risk Characterization

This overestimation based on conservative assumptions still results in a hazard quotient that is less than 0.01 and is therefore inconsequential to the final risk characterization, i.e., there is no radiological risk to non-human biota. Given that the risks to non-human biota are negligible, further refinement of the dose calculations is not considered to be warranted. Specifically, for all biota excluding deer and fish in Baie du Doré, no tissue measurements were available and the exposure assessments based on conservative modelling remained far below benchmarks, therefore there is no justification for additional sampling of these biota tissue. Cumulative Effects in the Ecological Risk Assessment

The radiological EcoRA has considered emissions from all site facilities, including new facilities and those not operated by Bruce Power (e.g., Kinectrics North). As discussed in Appendix J: Release Rates from the Bruce Power Site of [R-35], the new Central Storage Facility is not explicitly included, however it has a negligible contribution to emissions. Furthermore, a significant portion of the calculated dose in the radiological EcoRA is based on measurements in on-site environmental media rather than modelling based on emissions, therefore all potential contaminant sources are implicitly considered. Therefore, the existing 2022 radiological EcoRA considers cumulative effects of all operational facilities at the Bruce Power site. It is noted that locations in the immediate vicinity of the WWMF are excluded from the Bruce Power radiological EcoRA, and are assessed by the 2021 WWMF ERA [R-153].

5.4.5 Conclusions

The radiation dose rates to non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value [R-150]. With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., occupancy factors and ingestion parameters) addressed in a conservative manner, there is no radiological risk to non-human biota resulting from normal operations on the Site.

5.5 Predictive Radiological Ecological Risk Assessment

Activities assessed under the 2017 PERA and completed to date have not demonstrated a negative environmental impact on air quality, soil, sediment, and surface water. No adverse outcomes impacting radiological air emissions or waterborne effluent have occurred to date resulting from new activities occurring on site. In the absence of substantial changes to air emissions or waterborne effluent resulting from MCR activities, there has been no substantial change in environmental monitoring results. With these stable environmental monitoring results, there has been no change to the overall outcome of the EcoRA resulting from new activities occurring on site between 2016 and 2021.

The predicted interactions with increasing environmental effects between air quality, surface water, sediment, soil, terrestrial and aquatic receptors and future site activities, including MCR activities, are summarized in Appendix D: Predictive Environmental Risk Assessment [R-35]. There was no predicted increase in radiological environmental impacts as a result of planned Life Extension, MCR or Lu-177 production activities.

Activities that involve opening systems are predicted to interact with the environment by resulting in an increase in the airborne contaminants directed to active ventilation. Those activities that could result in a measurable change are:

- Primary Heat Transport (PHT) Drain and Dry;
- Moderator Drain and Dry; and
- Roof Opening Installation and Closure.

Based on experience with Unit 6 MCR activities to date, there has been no change in radiological air emissions during the PHT Drain and Dry, Moderator Drain and Dry or the Roof Opening Installation. The closure of the Roof Opening has not occurred yet for Unit 6 but is not anticipated to generate radiological air emissions. As a result of this recent experience, future Life Extension and MCR activities of this nature on additional units are not expected to contribute to additional radiological air emissions.

All MCR activities that contribute to waterborne effluents are considered within normal plant operation, including maintenance activities. Waterborne effluents are routed through ALW, and although effluents may fluctuate dependent on the activity occurring at the time, every discharge is analyzed and must meet pre-release criteria prior to discharge. This ensures that all effluents remain well below regulatory limits.

While the Isotope Production System (IPS) is being commissioned, as well as during its operation, releases will be closely monitored through activity readings in the stack. During the commissioning and a short time after production begins, the particulate filters will be analyzed for Lu-177, Yb-175 and Yb-177. Any increase in activity will be detected in the stack monitor and the environmental impact of these increases will be included in weekly effluent reporting. Due to the nature of the decay products associated with the production of Lu-177, particles will either decay to negligible activity or be caught by HEPA filters. Air ingress in the Isotope Production System could lead to activation of Ar-41, a noble gas, and Carbon-14 which will be detected and included in the weekly gaseous effluent reporting. These additional gaseous effluents generate no additional risk due to the negligible potential emissions.

Operation of the Lu-177 Isotope Production System is expected to have a negligible impact on radiological releases to the environment and therefore changes to air, surface water, sediment and soil quality is not anticipated. The Lu-177 Isotope Production System is completely dry and there is no potential for a leak or spill of radiological material that could affect the environment. Changes to airborne releases are expected to be negligible during normal operation. Consequently, no changes to the dose rates to terrestrial or aquatic ecological receptors are anticipated for the Lu-177 Isotope Production System.

There are no foreseeable additions in or around the Site that would result in emissions or effluents of radioactive material greater than what is currently being released. This includes the ongoing Life Extension work, including MCR, and Bruce Power’s plans to begin the production of Lu-177 in 2022.

5.5.1 Conclusion

There has been no substantial increase in radiological airborne emissions or waterborne effluent as a result of the Life-Extension activities carried out through to June 1, 2021. As a result, no significant change in radionuclides in air, surface water, sediment or soil is anticipated as a result of Life-Extension and MCR activities or Lu-177 production. With no significant changes to radionuclides in air, surface water, sediment or soil, there is no expected change in the results of the EcoRA for radiological contaminants as a result of planned activities occurring on site.

As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities. Lu-177 production is not expected to change dose rates to terrestrial or aquatic receptors. The radiation dose rates to terrestrial non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value for terrestrial non-human biota of 2.4 mGy/d. The radiation dose rates to aquatic non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value for aquatic biota of 9.6 mGy/d.

No significant changes to radiation doses to aquatic or terrestrial receptors are anticipated as the result of Life-Extension and MCR activities. Since there are negligible potential emissions from the Lu-177 production, no new exposure pathways exist. As such, no measurable changes to the dose to non-human biota are expected from these predicted site activities.

5.6 Overall Conclusions of the Ecological Risk Assessment for Radiological Contaminants

The radiation doses to non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value. With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., occupancy factors and ingestion parameters) addressed in a conservative manner, there is no radiological risk to non-human biota resulting from normal operations on the Site.

As the current operational conditions are demonstrated to be bounding of future activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities. Therefore, there is no radiological risk to non-human biota resulting from anticipated future activities.

6.0 RISK ASSESSMENT FOR PHYSICAL STRESSORS

The CSA Standard N288.6-12 [R-14] indicates that physical stressors may be assessed if they may affect human or ecological receptors. The physical stressors identified in the problem formulation include the following:

- Noise;
- Physical effects from cooling water discharge;
- Thermal effects;
- Fish entrainment and impingement;
- Habitat alteration;

All of these physical stressors were retained for further assessment in the ERA.

6.1 Noise

Noise was the only physical stressor identified for human health in the SLRA [R-10], and no changes to the operations that may warrant the assessment of other physical stressors were identified. The SLRA included an assessment of noise citing the previous EAs and acoustic audits completed for the Site. For ecological receptors, no benchmarks are available from federal or provincial regulatory agencies, including the U.S. EPA, and the scientific literature focusses on behavioural adaptations to elevated noise levels (e.g., avoidance) rather than health effects.

6.1.1 Human Health

Noise investigations conducted annually between 2015 and 2020 demonstrated that the sound levels at the concerned receptors (Lake Street) complied with the quantitative limits stipulated by the MECP. There was no direct correlation between the noise logs provided by the residents at Lake Street and operational events at Bruce Power. The study revealed that changing meteorological conditions influence the propagation of sound from the stations (i.e., Bruce Power is slightly audible during periods of low background noise).

A Noise Control Investigation for the four rooftop deaerator vents at Bruce B was conducted using sound level measurements and source measurements collected during the 2015 and 2016 Noise Monitoring Programs [R-154]. The sound power emission measurements collected from each of the four deaerator vents at Bruce B in 2015 were input to an acoustical model of the Bruce Power site and surrounding area to determine predicted sound levels at locations within the surrounding community which are shown on Figure 5. With a worst-case predicted sound level of 33 decibels A (dBA) at Lake Street, the facility is well below the applicable criteria.

In order to mitigate the sound level exceedances, a project was initiated in 2018 to install silencers on the four deaerator vents at Bruce B affording a minimum of 30 dBA of attenuation. A silencer was installed on the Unit 8 deaerator vent in October 2018. A sound level measurement was collected from the Unit 8 deaerator vent following the installation of the vent silencer and compared to measurements collected in 2015. The sound level measurement confirmed that an overall reduction of 31dBA was achieved relative to the unsilenced vent (4 by-pass valves open), exceeding the noise reduction target of 30dBA. In addition, the sound from the Unit 8 deaerator vent is no longer tonal (high frequency hum/whistle).

Remaining silencers were installed throughout 2019, on the Unit 7 deaerator vent in March; the Unit 6 deaerator vent in May; and the Unit 5 deaerator vent in October. A two-week noise monitoring campaign was completed in August 2019 to assess the change in sound levels following the installation of Unit 6, Unit 7 and Unit 8 deaerator vent silencers [R-155]. Unit 5 was in outage at the time of the campaign. Results indicated that the sounds of nature and resident activities were dominant at Lake Street and within Inverhuron Provincial Park. The distinct tone that was audible from all four deaerator vents prior to installation of the silencers was completely inaudible with Unit 5 shutdown, which is an indication of the effectiveness of the silencers.

A Noise Investigation was conducted for a one-week period in July 2020 [R-156]. During the investigation, natural sounds were typically dominant. Bruce Power was faintly audible when background sound was lower. During periods where the contribution of background sound was at a minimum, the sound levels at Lake Street and within Inverhuron Provincial Park were as low as 22 to 24 dBA, which is well within the applicable MECP criterion of 40 dBA.

Figure 29 Noise Monitoring Locations

Noise as a physical stressor for human receptors was excluded after noise monitoring found that noise levels attributable to the facility in 2015/2016, 2017, 2019 and 2020 complied with the applicable MOECC night-time noise limit of 40 dBA [Night-time Exclusion Limit for Class 3 Areas (Rural)] [R-157] at nearby residences.

6.1.2 Ecological Receptors

There are no noise benchmarks available from federal or provincial regulatory agencies, including the US EPA, that are protective of health effects to ecological receptors.

The scientific literature focuses on behavioural adaptations to elevated noise levels (e.g., avoidance) rather than health effects. The Government of Canada's recommendations to reduce risks to migratory birds indicates that consideration of increased setbacks from the nests of migratory birds with significant sources of disturbance, including noise exceeding 10dB above ambient noise levels and noise greater than about 50dB [R-158]. The measured noise levels in dBA described in 6.1.1 are below the level of significant disturbance.

Due to the lack of benchmarks, noise effects on wildlife are not quantitatively assessed in the ERA.

6.2 Physical Effects of Cooling Water Discharges

6.2.1 Problem Formulation

Physical Displacement

The discharge channels, which return the cooling water and other effluent discharges (e.g., service water supply) to the lake, were designed to dissipate the effluent as it enters the lake to minimize impact on flow patterns. The discharge channels for Bruce A and Bruce B consist of thin deposits of sand and organics (silt) in depositional areas underlain by bedrock substrate and are lined with armourstone [R-12]. Due to the shape and orientation of these discharge channels, the Bruce A and Bruce B discharges act as surface jet plumes, altering lake-bottom current velocities in both discharge channels [R-159]. The Bruce A and B discharge channels were designed to dissipate the jet momentum of both discharges to minimize flow alterations within the lake, thereby limiting hydrodynamic effects on fish and fish habitat. Flow velocities in Bruce A and Bruce B discharge channels decrease with depth and distance from the shoreline.

Discharge Channel Velocities

The average velocity within the Bruce A discharge channel ranges from approximately 2.4 m/s near the water surface to approximately 0.8 m/s along the discharge channel bed [R-160] but decreases to below 0.1 m/s above ambient speeds within 390 m to 460 m from the point of discharge at the lake surface and to below 0.1 m/s above ambient speeds within 380 m to 440 m at the lake bed (depending on operational flow, lake levels and average ambient lake current speeds [R-161]).

The average velocity in the Bruce B discharge channel ranges from approximately 1.8 m/s to approximately 2.4 m/s [R-162] but decreases to below 0.1 m/s above ambient speeds within 480 and 750 m at lake surface and to 0.1 m/s above ambient speeds within 250 m to 410 m at the lake bed (depending on operational flow, lake levels and average ambient lake current speeds, [R-161]).

The discharge jets enter the lake at the end of the discharge channels at one to two orders of magnitude above the ambient current speed, however jet momentum and current speed is significantly reduced through mixing with ambient lake water [R-159], owing to the design of the discharge channels and longshore currents within the lake.

Discharge Temperatures

The Bruce A and Bruce B CCW discharge locations have thermal limits to limit fish habitat alteration and effects to fish habitat utilization and behaviour. These limits are fully described in Section 6.3 and Appendix I [R-35].

Interaction with Local Currents

The spatial extent of altered flows caused by the effluent is confined to the areas around the CCW intakes and discharges (i.e., the effect is localized). Based on recent modelling work [R-161], the area of hydraulic influence associated with the Bruce A discharge (i.e., defined as velocities that are ≥ 5 cm/s greater than ambient currents) varies between 12 and 19 ha at the lake surface and between 10 and 14 ha at the lake bed (depending on operational flow, lake levels and average ambient lake current speeds, [R-161]). Meanwhile, the same study concludes that the area of hydraulic influence associated with the Bruce B discharge (i.e., defined as velocities that are ≥ 5 cm/s greater than ambient currents) varies between 18 and 50 ha at the lake surface and between 7 and 18 ha at the lake bed (depending on operational flow, lake levels and average ambient lake current speeds, [R-161]). An earlier study suggested that the discharge jets affect ambient currents to a distance of 300 m and 800 m from shore, which aligns with the area of hydraulic influence [R-162][R-163].

The nearshore currents typically move parallel to the shoreline (north or northeast direction) and rarely offshore (west) [R-12]. The discharge jets from Bruce A and Bruce B are more affected by environmental conditions (lake levels and ambient current speed) than Bruce Power operations (i.e., the number of operational units running in each nuclear generating station) seeing as the number of pumps required to maintain discharge temperatures limits are activated according to the amount of heat production. Increasing Lake Huron water levels were found to dissipate the energy associated with the discharge jet more quickly (i.e., over shorter distances) due to increased water depths [R-161]. Increasing ambient current speeds were also found to reduce the difference in magnitude between ambient currents and the discharge jet. In contrast, increased operations (i.e., the number of operational units) over time did not significantly increase the velocity fields associated with the discharge jet [R-161].

6.2.2 Exposure and Effects Assessment

The physical impact of the discharge cooling water has the potential to impact components of the local ecosystem, including aquatic plants, zooplankton, benthic invertebrates and fish [R-12]. The physical stress from the discharge cooling water may have varying effects on different species and taxa. The potential impacts of the discharge cooling water on the local ecosystem are discussed in detail below.

6.2.2.1 Aquatic Plants

Macrophytes

Macrophytes can be classified as emergent, submergent, and floating aquatic vegetation. Macrophytes grow in sheltered areas along the Lake Huron shoreline including in the Bruce A and Bruce B discharge channels [R-12]. In the Bruce A and B discharge channels, submerged macrophytes occur in sheltered areas with low flow velocity; emergent vegetation is limited.

The dominant macrophyte in the Bruce A discharge channel is Elodea sp., and in the Bruce B discharge channel it is Myriophyllum and Potamogeton species [R-12]. These macrophytesare resilient and tolerant to temperature fluctuations and increased flow velocities [R-164]–[R-167]. A number of Potamogeton sp., such as *Potamogeton alpinus*, *Potamogeton malaianus*, and *Potamogeton perfoliatus*, are tolerant to temperature fluctuations and can develop thermotolerance acclimation [R-164][R-165], and can morphologically adapt to water velocity changes [R-168]. Elodea sp. (e.g., *Elodea canadensis*) can withstand turbulent water velocities [R-166] and Myriophyllum sp. (e.g., *Myriophyllum spicatum*) have a high temperature optimum for photosynthesis [R-167]. Overall, increases in water temperature, as a result of thermal plumes, have been shown to increase macrophyte growth in temperate lakes and can cause localized changes to species composition [R-169][R-170].

Periphyton

Periphyton, known as attached algae, grow on submerged substrates (e.g., rocks, woody debris, and macrophytes) in aquatic ecosystems. They are found in a complex matrix of algae, bacteria, fungi, and detritus embedded in an abiotic matrix secreted by the algae and bacteria [R-171]. Periphyton can be the base of the food web depending on the characteristics of the waterbody. They also possess many attributes that make them effective tools in water quality monitoring, i.e., short life cycles generally resulting in rapid responses to environmental change, and ability of different species to adapt differently to a range of ecological conditions with different tolerances to change. Periphyton can be used to assess the potential presence of environmental stressors (e.g., thermal stress, metals contamination, and nutrient enrichment).

Historical studies in the vicinity of Bruce Power found that limited amounts of periphyton (attached algae) were present along the shoreline or nearshore areas in the Bruce A and B discharge channels, potentially owing to low nutrient concentrations, cool water temperatures and exposure to high energy environments (e.g., wave action, scouring), typical of Lake Huron [R-122]. A 2007/2008 study that evaluated nuisance algal (i.e., periphyton turf, *Chara*, and *Cladophora*) growth along the southeastern shore of Lake Huron found that nuisance algae growth increased by 79% compared to studies conducted in 1977 [R-172].

Excessive growth of nuisance algae has the potential to occur within the vicinity of the discharge channels, and thermal plumes have been shown to increase periphyton growth [R-173]. However, the effects of the Bruce Power thermal discharge on periphyton growth have been limited in the immediate vicinity of Bruce Power, likely owing to low nutrient concentrations and high flow velocities resulting in scouring [R-122].

6.2.2.2 Plankton

Plankton is a general term referring to small, usually microscopic organisms that live suspended in the water. For the purposes of this review, plankton is sub-divided into two different groups: phytoplankton and zooplankton. Many things can influence plankton community abundance, biomass, and composition. Key factors influencing plankton communities are light, temperature, nutrients, toxic substances and grazing.

Phytoplankton

The term *phytoplankton* refers to the algal component of the plankton community, ranging in size between 2 and 20 micrometres (μm) [R-174]. Phytoplankton are free-floating photosynthesizing algae and cyanobacteria, which can fix large amounts of carbon; they form the base of the food web for aquatic animals [R-171]. Phytoplankton sampling is carried out to keep a broad ecological record of the algal population and is carried out to understand biomass, abundance, taxonomic richness, and community composition [R-175]. Understanding changes in the phytoplankton community is important, as excess limiting nutrients and increases in light and temperature can encourage the growth of certain phytoplankton groups, such as cyanobacteria, which may produce harmful toxins, while increases or decreases in other substances can also cause changes in the phytoplankton community by inhibiting or enhancing growth of certain phytoplankton groups [R-171].

Previous studies have shown that the density and diversity of phytoplankton in Lake Huron has been low as a result of the low nutrient concentrations [R-122].

The Environmental Climate Change Canada (ECCC) Guidance Document: *Environmental Effects Assessment of Freshwater Thermal Discharge* (2019) states that at water temperatures of 20°C or less an increase in water temperature leads to an increase in algal productivity but large temperature increases (i.e., >5.6°C) lead to a decrease in productivity [R-173]. Overall, the effects of the thermal plume are not typically lethal to phytoplankton and even if mortality does occur, it would not have a long-term effect on phytoplankton populations due to high phytoplankton reproductive rates [R-173].

Thermal plumes have the potential to increase phytoplankton growth in the discharge channels [R-173]. However, the effects of the thermal discharge on phytoplankton in the vicinity of Bruce Power are likely small, due to low nutrient concentrations, high flow velocities resulting in scouring, and the overall hydraulic forces in the discharge channels [R-159].

Zooplankton

Zooplankton are the free-floating animal constituent of the plankton and consists of small crustaceans and rotifers. Zooplankton communities can be useful indicators of environmental change because they respond rapidly to changes in nutrients or other substances. There are thousands of species of zooplankton, each with unique environmental optima and tolerances;

therefore, species assemblages can be effectively used to infer changes in the aquatic environment [R-171] and, zooplankton are the primary consumers in aquatic food webs. Fish and other aquatic biota depend on plankton for energy and nutrients; therefore, changes in the plankton community can serve as an early warning system for higher trophic levels such as larval Smallmouth Bass (*Micropterus dolomieu*), Brook Trout (*Salvelinus fontinalis*), Spottail Shiners (*Notropis hudsonius*) and juvenile White Suckers (*Catostomus commersonii*) [R-176]–[R-179].

Previous studies have reported reductions in zooplankton abundance and changes in community structure in Lake Huron since the 2000s, noting reductions in nutrient loading (as a result of water quality management policies) and high filtering capacity of some invasive species (i.e., zebra mussels) as potential causes [R-3][R-180]. Recent studies have indicated some stability in the Lake Huron zooplankton community; however, low nutrient concentrations and invasive species continue to impact the community [R-3].

General thermal plume impacts on zooplankton can include lower egg production at 35°C, increased growth over 27°C, and variable thermal tolerance with time [R-173]. Although short-term temperature fluctuations from a thermal plume typically have a minimal effect on zooplankton because of their high reproductive rates, prolonged or repeated warming events can be lethal and change zooplankton community composition and abundance [R-173]. Water temperatures in the Bruce A and Bruce B discharge channels exceeded 27°C approximately 12% of the year within the past five years (i.e., 2016 to 2020). The daily difference between intake and effluent temperatures is capped at 11.1°C and 11.0°C at Bruce A and Bruce B, respectively [R-181]. Therefore, the zooplankton community in the vicinity of Bruce Power is unlikely to be impacted by the thermal discharge.

There is the potential for increased flow velocity resulting from the discharge jet in Bruce A and Bruce B discharge channels to displace zooplankton. However, flow velocities in the Bruce A and Bruce B discharge channels above ambient conditions are localized and the nearshore currents typically parallel the shoreline [R-12]. Therefore, although the Bruce A and Bruce B discharges have the potential to displace zooplankton offshore for a limited distance and duration, the flow velocities are much lower outside of the channel (<10 cm/s within <500 m from the point of discharge) and currents will likely transport the zooplankton parallel to the shoreline once in the lake [R-12]. Within the lake, the zooplankton would be subject to natural lake conditions, including alongshore circulation moving in a counter clockwise direction [R-12]. The effect of zooplankton displacement is limited to the flow velocity fields surrounding the discharges, which are relatively small in spatial extent compared to rest of Lake Huron.

Evans et al (1986) also showed that zooplankton mortalities resulting from passing through the CCW intake and thermal plumes were less than 3% and if mortalities did occur, the community would recover quickly as a result of recolonization from nearby lake populations [R-12][R-180][R-182]. Therefore, the thermal plume in the Bruce A and Bruce B discharges is not expected to affect zooplankton abundance or alter community composition.

The effect of zooplankton displacement is limited to the flow velocity fields surrounding the discharges, which are relatively small in spatial extent compared to rest of Lake Huron.

6.2.2.3 Benthic Invertebrates

Freshwater benthic invertebrates include organisms such as insect larvae, crustaceans, worms, leeches, snails, and clams that live on the bottoms of lakes and streams. Benthic invertebrates live on the surface of sediments or burrow into sediments, although some species are closely associated with aquatic plants [R-183]. Benthic invertebrate communities often consist of thousands of organisms per square metre, and are an integral part of aquatic ecosystems, as primary food source for fish and as secondary producers [R-184].

Benthic invertebrates are frequently sampled to monitor the environmental quality of lakes and rivers, because they are sensitive to a large variety of disturbances, present in nearly all waterbodies, and have relatively long lifecycles and small home ranges [R-183]. The presence and abundance of specific invertebrates in the benthic community present at a location serve as indicators of aquatic ecosystem health, and can be used to evaluate anthropogenic effects on the ecosystem [R-184]. Benthic invertebrate communities often display a wide range of tolerance to contaminants, exposure conditions, and habitat types [R-185]. As a result, benthic invertebrate community monitoring can provide valuable information regarding the state of an aquatic ecosystem, as well as information on the food resources available for fish.

Temperature can strongly influence reproduction and growth rates of benthic invertebrates [R-171] as well timing of emergence [R-185], and can impose constraints on metabolic rates and primary production rates [R-186]. Changes in thermal conditions has the potential to alter species composition, and negatively affect the abundance and richness of the taxa present [R-186]. Benthic invertebrates show a range in tolerances and optimal thermal ranges, where the upper limit for most species is between 30ºC to 40ºC, with the exception of the most sensitive taxa [R-186]. Additionally, thermal effects on the benthic invertebrate community have resulted in increases in macrophyte associated taxa (such as gastropods and ostracods), increase or decrease of EPT (Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)) taxa, depression of sensitive taxa, decreased diversity of Chironomidae species, favouring taxa with larger body sizes and/or increased presence of thermally tolerant taxa, such as Procladius, Tanypus, and Chironomus, Physidae, Hydracarina, and Oligochaeta, particularly Tubificinae [R-173].

The benthic invertebrate communities in the discharge channels were comprised mostly by Oligochaeta (Naididae), Amphipoda, Chironomidae and Ephemeroptera. Amphipoda and Chironomidae were the dominant groups in nearshore areas in Bruce A and Bruce B discharge channels, respectively, and Oligochaeta was the dominant taxa in the deeper areas within the Bruce A and Bruce B channels. Benthic invertebrates are not present in exposed bedrock substrate within the discharge channels [R-122] and generally cannot inhabit exposed bedrock. Within the sandy depositional areas of the discharge channels, benthic invertebrate abundance and diversity is limited as is generally the case for sandy substrates. Wave action and ice scour likely influence the benthic invertebrate distribution in the discharge channels. Zebra/quagga mussels (Dreissena sp.) are present in the discharge channels but tend to be limited to the areas protected from wave action and ice scour [R-122].

Previous benthic invertebrate studies have shown that the benthic invertebrate communities in the vicinity of the Bruce Power nuclear generating stations are reduced in both density and diversity relative to Lake Huron, reflecting the aversion by certain taxa to the naturally hostile wave-washed and bedrock habitat along the shoreline near the discharge locations. Where the thermal plume enters Lake Huron along the shoreline, rock substrates were colonized by both sensitive groups (i.e., Ephemeroptera and Trichoptera, and more tolerant groups [i.e., Chironomidae, Oligochaeta, Isopoda, and some zebra/quagga mussels]) [R-12]. Sensitive species such as Ephemeroptera and Trichoptera are attracted to coarser substrates and increased flow velocity. Oligochaeta (specifically Tubificida) and Chironomidae dominate the benthic invertebrate community in the vicinity of the Bruce A and Bruce B discharge thermal plume, as these are relatively tolerant groups to both wave action, and changes in temperature [R-187].

The ECCC Guidance Document: Environmental Effects Assessment of Freshwater Thermal Discharge (2019) states that water temperatures above ambient but below 32°C can have the potential to affect benthic invertebrate life history processes, such as incubation period, hatching success of eggs, dormancy, growth and maturation, and emergence. Water temperatures above ambient and above 32°C can alter benthic invertebrate community composition (i.e., species assemblage). Historical studies on thermal plumes have shown that in water temperatures above 32°C, the benthic invertebrate community structure and composition is typically changed [R-173]; however, these changes are often small, and tend to be localized [R-188]. Historical studies comparing benthic invertebrate diversity found that diversity tended to be lower in thermal plume compared to ambient temperatures [R-189][R-190]. Community composition in the warmest areas of thermal discharges is typically dominated by tubificid Oligochaetes (Tubificida) and Chironomidae, and Amphipod density was found to greatly increase in water more than 4°C warmer than ambient temperatures [R-170][R-191]. In waters 35°C or greater, Chironomid species were found to be virtually eliminated [R-192].

According to thermal tolerance values compiled by the ECCC (2019), most tubificid Oligochaetes have a thermal tolerance (i.e., the temperature resulting in 50% morality of the test animals) of 32°C or higher, with a few species tolerating 25°C at 50% mortality [R-173]. Most species of the Amphipoda family Gammaridae have an upper lethal temperature limit greater than 29.5°C, and most isopods have upper lethal temperature limits greater than 30°C [R-173]. Chironomids were generally found to tolerate temperatures exceeding 30°C to a maximum of 35°C, with only a few species with a thermal tolerance (i.e., the temperature resulting in 50% morality of the test animals) of 29-30°C [R-173].

Generally, the benthic invertebrate taxa present in the discharge channels can tolerate water temperatures less than 30°C without high mortality. Short term, localized effects to benthic invertebrate life processes may occur in the discharge channels as a result of the thermal plume. However, temperatures rarely exceed 32°C (Table 47) in the discharge channels, the threshold where noticeable changes to the community may occur [R-173]. The maximum discharge temperature recorded between 2016 and 2020 was 33.4°C, at Bruce A in 2018.

Table 47 Number of Days where Daily Hourly Maximum Temperature Exceeds 32°C in the Bruce A (BA) and Bruce B (BB) Discharge Channels, 2016-2020

Month	2016		2017		2018		2019		2020	
	BA	BB	BA	BB	BA	BB	BA	BB	BA	BB
July	--	--	--	--	--	--	--	--	4	--
August	2	5	--	--	5	2	3	--	8	--
September	1	--	--	--	2	--	--	--	9	--

6.2.2.4 Fish

The Bruce Power thermal plume has the potential to interact with fish that are found in the vicinity of the discharge. The potential impacts to fish from the thermal plume are summarized below and include physical displacement of larvae, impacts to aquatic habitat, including Smallmouth Bass nesting habitat and changes to dissolved gases. Thermal effects and potential cold shock are discussed in Section 6.3 and in Appendix I.

Larvae and Small-Bodied Fish

Most fish are able to detect changes in flow above ambient conditions and will likely avoid the discharge area. However, because fish eggs and larvae are not motile, there is potential for increased flow velocity resulting from the discharge jet in Bruce A and Bruce B discharge channels to displace fish eggs and larvae to less favourable habitat (e.g., areas with less cover, available food), increasing the potential for larval predation in the open lake [R-193][R-194]. This effect is especially relevant to species that are nearshore lake spawners such as Alewife (*Alosa pseudoharengus*), Rainbow Smelt (*Osmerus mordax*), Emerald Shiner (*Notropis atherinoides*), Lake Herring (*Coregonus artedi*) and small-bodied adult fish [R-195]. Of these species, Alewife are known to spawn in the discharge, but potential spawning habitat is presumed to be widespread along the Lake Huron shoreline [R-180].

A study looking at fish species presence along the shoreline of Lake Huron was completed in 2019 [R-196]. For the nearshore area close to Bruce Power and the Bruce A and Bruce B discharge jets, there was no evidence that the jet was displacing small-bodied fish. The area of Baie du Doré was given a Wetland Fish Index (WFI) rating of Very Good. The WFI is used across the Great Lakes to assess the relative health of nearshore habitats, based on the fish species presence and absence, and abundance. A WFI rating of Very Good indicates that endemic species were captured along the nearshore area in abundance, and is not indicative of any impacts occurring to nearshore habitat use by small-bodied fish as a result of the discharge jet.

Historic studies showed that drift of Alewife larvae was highly dependent on wind, where constant high wind (i.e., N to NE winds of 10-20km/hr) resulted in a longshore drift up to 1 km offshore and light or variable wind had a minimal effect on the longshore drift near the discharge [R-197]. The nearshore currents in the discharge channels typically move parallel to the shoreline and rarely offshore [R-198]. Therefore, although the Bruce A and Bruce B discharges have the potential to displace fish eggs and larvae offshore for a limited distance and duration, they are likely to be transported parallel to the shoreline. Here the eggs and larvae would be subject to natural lake conditions, including alongshore circulation moving in a counter clockwise direction [R-12]. In addition, currents are weaker in the spring relative to other seasons [R-198], reducing the potential for displacement of eggs/larvae of spring-spawning fish species.

Fall spawners, specifically Lake Whitefish, were found in low density near the discharges [R-199] relative to other areas in Lake Huron, as evidenced through gillnet surveys of adult whitefish and egg surveys [R-199][R-200]. In addition, there are no shoals within the hydraulic zone of the discharges utilized for high-density fish spawning, limiting the number of fish eggs and larvae that have the potential to be displaced.

Smallmouth Bass are known to consistently nest in the Bruce A and Bruce B discharge channels. The adults lay eggs in late spring in nests made on sand/gravel substrates and the male remains nearby for several weeks to rear the young through to fry dispersal. During this time, this young life stage is continually exposed to the flow and temperature conditions of the CCW discharges. Physical displacement of Smallmouth Bass eggs, yolk-sac larvae and risen fry from the Bruce A and Bruce B discharge channels is not observed as these life stages have been observed and are located in sheltered areas tight to bottom. For the green fry stage that have dispersed from the nest there is no evidence to suggest that there are secondary effects caused by physical displacement due to the flows from cooling water discharges. Smallmouth Bass benefit from the increase in available spawning habitat due to the discharge channels themselves, and beneficial effects of the thermal plume on Smallmouth Bass growth, survival, and changes in spawning and development [R-180][R-181]. Monitoring has shown successful Smallmouth Bass nesting in the Bruce A and Bruce B discharge channels from 2009 to 2020 (see Appendix A, Section 1.8.6), including fry achieving stages 6-8 (risen fry to green fry). Given the consistent presence of successful Smallmouth Bass nests in both discharge channels over 11 years of monitoring, the site fidelity of males to generally within 140m of the previous year’s nests [R-201] and a maximum known age of about 15 years [R-202], there is likely several generations that have returned to spawn in the Bruce A and B discharge channels.

There is potential for increased flow velocity resulting from the discharge jet in Bruce A and Bruce B discharge channels to physically displace larval Deepwater Sculpin. However, as discussed in previous sections, phytoplankton and zooplankton would also be displaced in the discharge channels, likely in nearshore currents that parallel the shore. Therefore, although the Bruce A and Bruce B discharges have the potential to displace larval Deepwater Sculpin offshore for a limited distance and duration, larval food sources would be similarly displaced, thus the effect on this species would be negligible.

<u>Impacts to Fish Habitat – Lake Whitefish</u>

Potential Lake Whitefish spawning habitat is present in the nearshore areas (e.g., shoals) of Lake Huron around Bruce Power and extends North of Bruce Power to Tobermory, and Lake Whitefish in spawning condition have been found in these areas [R-199]. However, the presence and abundance of larval Lake Whitefish have been minimal and infrequent at sampling sites near Bruce Power [R-199]. This lack of spawning evidence near Bruce Power suggests adult spawning Lake Whitefish found near the site are members of a larger population which spawn beyond the extent of the Bruce Power operations receiving environment [R-199].

Research carried out by the University of Regina and University of Guelph confirmed that spawning-condition Lake Whitefish near Bruce Power are not a distinct genetic or ecological group, and are part of a larger genetic and ecological population spanning the Main Basin of Lake Huron [R-199]. This lack of a distinct spawning population and lack of presence of spawning fish on local shoals indicates that any potential effects of the Bruce Power discharge to Lake Whitefish spawning habitat are offset by abundant alternative habitat along the coast, with ongoing production of Lake Whitefish populations beyond the extent of Bruce Power.

Impacts to Fish Habitat – Smallmouth Bass

Smallmouth Bass are known to consistently nest in the Bruce A and Bruce B discharge channels. The adults lay eggs in late spring in nests made on sand/gravel substrates and the male remains nearby for several weeks to rear the young through to fry dispersal. During this time, this young life stage is continually exposed to the flow and temperature conditions of the discharges. Other fish species using this habitat are generally able to swim in and out of the area and are not continually exposed to these conditions.

To identify the effect of the discharges on Smallmouth Bass nesting, Smallmouth Bass nesting surveys were completed on an annual basis. Nesting surveys have been conducted since 2009 in the Bruce A discharge channel, Bruce B discharge channel, and Baie du Doré (starting in 2010), and were also conducted in the past (1970s and 1980s; [R-113]). The Smallmouth Bass nesting surveys consist of an assessment of nesting locations and recording of nest success and larval dispersal. Surveys began in spring with the pairing of adults, and nests are monitored regularly to observe the development of eggs through to the green fry stage. The eggs hatch in 1-2 weeks and stay tight to bottom in the protection of the guarding male. After another 1-2 weeks of development, the green fry begin to rise and disperse into the water column. Water temperature and lake water level data are also summarized as part of the nesting surveys.

The numbers of nests in Baie du Doré and in the Bruce A and Bruce B discharge channels continue to have high inter-annual variability [R-181]. However, throughout the years, Smallmouth Bass consistently use the Bruce A and B discharge channels for spawning and occupy similar habitat in all three sampling areas, likely with the selection of a given nest location determined by substrate type, water depth and shelter from prevailing winds and wave action. From 2009 to 2020, the majority of the nests recorded in the Bruce A discharge channel were located in the lower velocity and higher shelter areas near the docking facilities of the north eastern section of the Bruce A discharge channel. In the Bruce B discharge channel, nests are typically spread between the north and south sides of the groyne, and also near the dock structure on the northern side of the discharge channel.

While survival and latent effects on fry past the green fry stage cannot be monitored, there are two indicators that gauge the potential of further effects occurring. The first is that the results of the annual number of nests and the success of those nests (indicated by the presence of risen fry) have not shown a decline over the years of monitoring. If survival or other latent effects were occurring, this would be expected to manifest in a decline in abundance in future years. Secondly, the creel survey results do not show any indication of a weak year class which would indicate poor recruitment. Data is available since 2009 (start of recent creel surveys) which provide a relative estimate of year class proportion back to 2001. Creel aging results show that year classes from 2001 to 2010 (age 6 in 2016 creel, approaching the size for harvest) do not show any declines in overall recruitment [R-203].

It was concluded that increased surface water elevation and water temperature were not significant predictors of total counts of nests or counts of successful nests [R-181]. All analyses suggest no measurable adverse effect of Bruce Power operations on Smallmouth Bass nesting activity or success; however, Smallmouth Bass nesting will continue to be monitoring on an annual basis within the Bruce Power discharge channels.

Total Dissolved Gas Supersaturation

Total Dissolved Gas (TDG) supersaturation in water can be caused by a variety of natural and anthropogenic phenomena [R-204]. TDG supersaturation occurs when the partial pressures of atmospheric gases in solution exceed their respective partial pressures in the atmosphere. Under these conditions, gases may accumulate in fish tissues resulting in Gas Bubble Trauma (GBT). GBT is analogous to the “bends” experienced by SCUBA divers, and can range from mild to fatal depending on the level of TDG, fish species, life cycle stage, water depth, condition of the fish, and temperature of the water [R-205].

GBT can occur when discharge configurations do not allow for rapid mixing of the thermal discharge with receiving waters, and organisms reside in the supersaturated effluent for long periods of time. Heated water discharges become supersaturated as the gas saturated intake water increases in temperature and the resulting effluent becomes supersaturated as the solubility of the gases decrease with increased temperature, resulting in an increase in the partial pressures of the gases. In general, an increase in temperature of 1°C causes an increase in Total Gas Pressure of approximately 2%. Rapid thermal rises of as little as 3 to 5°C can cause GBT [R-204]. The effects of GBT can be reversible if deeper water is available or if movement to an area with lower TDG is possible [R-206].

TDG measured in the Bruce A and B channels during the nesting surveys ranged from 103 to 128% in 2013. As there is maximum depth available as fish refuge, the results indicated a low potential for GBT to occur in the discharge channels [R-207]. To investigate the occurrence of GBT in Smallmouth Bass residing in the discharge channels at Bruce A and Bruce B, surveys were performed in 2014 and 2015. Adults were examined in 2014 and 2015 and larvae/fry in 2015 [R-112].

At Bruce A, no external evidence of GBT was found in any of the adult Smallmouth Bass in 2014 (10 individuals) or 2015 (16 individuals). Additionally, no internal evidence of GBT was found in the Smallmouth Bass fry (15 individuals from 3 nests) captured in 2015.

At Bruce B, external evidence of minor GBT (<5% of fin covered with bubbles) was observed in two of the eight adult Smallmouth Bass captured in 2014. Tissue-level pathological analysis of pectoral fins from the two fish exhibiting signs of GBT did not confirm evidence of

GBT, suggesting the gas bubbles dissipated prior to examination. No evidence of external GBT was found in the adults captured in 2015 (14 individuals). Of the three nests where Smallmouth Bass fry were collected from Bruce B in 2015, only one nest showed potential internal signs of GBT in three of the five individuals collected. This same nest was determined successful during the 2015 Smallmouth Bass nesting survey (fry had risen and dispersed). There is no evidence to suggest that GBT had an effect on the success or health of the fry located at this nest [R-207].

CCME guidelines consider 103% to 110% saturation to be protective of aquatic life, depending on water depth (CCME 2014 with updates). Given the TDG values measured in the discharge channels, and the maximum depths available as refuge for the fish, there is low potential for GBT to result in health-related effects in the Bruce A and B discharge channels. Examination of both adult and fry Smallmouth Bass has provided no evidence of significant GBT affecting the health and reproductive success of Smallmouth Bass in the discharge channels. In addition, the Smallmouth Bass nesting surveys (from 2009 to 2020) have demonstrated nesting success in both Bruce A and Bruce B discharge channels. Given this, there is no indication of any significant adverse effects to the Smallmouth Bass population from GBT [R-207].

CCME guidelines consider 103% to 110% saturation to be protective of aquatic life, depending on water depth [R-208]. Given the TDG values measured in the discharge channels, and the maximum depths available as refuge for the fish, there is low potential for GBT to result in health-related effects in the Bruce A and B discharge channels. Examination of both adult and fry Smallmouth Bass has provided no evidence of significant GBT affecting the health and reproductive success of Smallmouth Bass in the discharge channels. In addition, the Smallmouth Bass nesting surveys (from 2009 to 2017) have demonstrated nesting success in both Bruce A and Bruce B discharge channels. Given this, there is no indication of any significant adverse effects to the Smallmouth Bass population from GBT [R-207].

6.2.3 Risk Characterization

This risk assessment on the physical effects of the cooling water discharges has demonstrated no unreasonable risk to aquatic receptors. Based on extensive literature reviews and field studies of the shoreline areas where the discharge cooling water interacts with the local environment, there has not been any evidence of impacts to aquatic plants, plankton, benthic invertebrates, or fish and fish habitat.

No further studies evaluating the impacts of the discharge cooling water on the local ecosystem are proposed. Bruce Power will continue to monitor the local ecosystem in the vicinity of the Bruce Power site.

6.3 Thermal Effects

6.3.1 Problem Formulation

The Bruce A and Bruce B discharge channels return cooling water and service supply water to Lake Huron. The temperature of the discharge waters emitted from Bruce A and Bruce B are monitored year-round, and the discharge points have ECA thermal limits in order to limit habitat alteration and negative effects to fish habitat and behaviour (see Appendix I, Section 9.2 for full details).

Mitigation of potential thermal impacts was a prime consideration in the initial site location of Bruce Power. The site is located in a region of Lake Huron where the bathymetry drops off rapidly, and the current move quickly, limiting the thermal impact of operations and the use of the area by spawning fish. Section 6.3.2 summarizes the assessment of feasible mitigation measures for thermal effects.

The effects of thermal effluent discharge on aquatic plants, plankton and benthic invertebrates are discussed in Section 6.2 because studies of these effects consider physical displacement and temperature effects together. Section 6.2 also considers the effects of the thermal plume on the physical displacement of larval and small-bodied fish. This section of the report considers the effects of thermal effluent on all life stages of selected VEC fish species that occur in the area impacted by thermal effluent from the Bruce Power site.

6.3.1.1 Thermal Monitoring

Bruce Power deployed temperature loggers throughout the water column in the spring, summer and fall (surface to bottom) and in the winter (lake bottom only) at thermal monitoring sites near Bruce Power. Severe weather and ice coverage in the winter prevented deployment of loggers at surface or within the water column. Data collected from April 1, 2016 to March 31st, 2021 were used for the 2022 ERA. For the assessment of Lake and Round Whitefish embryos only, data from April 1, 2021 to May 31, 2021 was included to enable full assessment of five incubation seasons. An Acoustic Doppler Current Profiler (ADCP) deployed at 20 m depth off of Gunn Point (south of Bruce B) monitored year-round water currents (speed and direction) throughout the water column. Available data from thermal loggers deployed in support of the bass nesting program were also used, as well as thermal monitoring data collected from the Coastal Waters Monitoring Program (CWMP) conducted by SON. See Appendix I, Section 9.3.1 and 9.4.2 [R-35] for full details regarding thermal monitoring included in the risk assessment.

6.3.1.2 Thermal Modelling

A third-party contractor, Golder Associates Ltd., has completed thermal modelling of the thermal effluent from the Bruce Power site using a lake-wide model. Temperatures at bottom and at 1m below the surface were modelled with and without the effects of Bruce Power operations from April 1, 2016 to March 31, 2021. Full detailed of the use of thermal modelling to delineate the Local Study Area, determine reference sites, incorporate spatial assessment into the chronic HQ calculations and determine the final risk characterization are available in Appendix I, Section 9.3.3 and 9.4.3 [R-35].

6.3.1.3 Local Area Selection

Thermal effects on all life stages occurring in the nearshore are considered in this section. The local area assessed for the purpose of thermal impacts on fish is defined by the extent of the thermal plume. In the absence of defined habitat- or population- based boundaries for a local study area for the purpose of thermal effects assessment, the maximum extent of the thermal plume was used to define the local study area. In order to ensure that the assessment captured the entire potential thermal output from Bruce Power, a single Local Study Area (LSA) was delineated as the 95th percentile of the 1°C isopleth of the modelled difference between operational and non-operational conditions at the surface and bottom from April 1, 2016 to March 31, 2021. See Appendix I, Section 9.3.4 and 9.4.1 [R-35] for full details regarding local area selection for the risk assessment.

6.3.1.4 Reference Site Selection

Each individual site and depth combination within the LSA was independently matched to a Primary and Secondary Reference site and depth outside the LSA, based only on statistical criteria to obtain the most similar temperature profiles under non-operational conditions. See Appendix I, Section 9.3.4.1 and 9.4.3.3 [R-35] for full details regarding reference site selection for the risk assessment.

6.3.1.5 VEC Selection

A selection of fish species were used for each of the cold, cool and warm water guilds based on use in the 2017 ERA, known presence in the local area, physiology and environmental preferences, discussion with regulators (CNSC/ECCC) and First Nations and Métis communities, and stakeholder interest including recreational and commercial fisheries [R-12]. These included Lake Whitefish, Round Whitefish, Deepwater Sculpin, Chinook Salmon, Rainbow Trout, Lake Trout, Emerald Shiner, Gizzard Shad, Smallmouth Bass, Walleye, White Sucker, Yellow Perch, Brown Bullhead, Channel Catfish, Common Carp, Freshwater Drum and White Bass. VEC species selected included the Species of Special Concern, Deepwater Sculpin. The VEC species selected also cover the breadth of species identified as culturally important to SON, MNO and HSM (see Appendix A, Section 1.8.7).

The biology of each of the 17 fish species was examined to determine the timing and length of each life stage and the potential for presence in the nearshore area close to the Bruce Power site. Species and life stages not anticipated to be in the nearshore environment were eliminated from further assessment. Location within the water column was also considered, with benthic species assessed against lake bottom temperatures only and pelagic species assessed against temperatures throughout the water column (see Appendix I Section 9.3.2 for full details).

The egg stages of cold water species with long overwinter incubation periods on the lake bottom were subject to some depth and location restrictions in the thermal risk assessment (see Appendix I Section 9.3.2.1 for full details).. Lake Trout eggs were assessed at depths of greater than 12m only. Lake and Round Whitefish were assessed at depths between 2m and 10m and excluded Baie du Doré.

6.3.2 Mitigation Measures Assessment

The Bruce Nuclear Generating Stations have been operating safely for over 40 years. The design of the stations carefully considered interactions with Lake Huron and measures were taken to minimize interactions that remain industry best practice for fish protection from I&E. The Ontario Hydro Research Division did extensive work to improve on the design as Pickering, Bruce And Darlington were built. These design improvements can be seen at both Bruce A and B with the use of deepwater offshore intakes with velocity caps, and with the addition of the chain-rope barrier and the rock groyne nozzle at Bruce B. As part of commitments made to the SON in the 2018 license renewal, Bruce Power completed an assessment of potential future mitigation measures in 2020 [R-40].

Monitoring and assessment of I&E and thermal effluents over time (in prior EAs [R-1]–[R-5], ERAs [R-10][R-98] and in Sections 6.3.5 , 6.4.4 and Appendix I) continues to verify no unreasonable risk to the natural environment as a result of these physical stressors. Extensive monitoring to verify these conclusions, coupled with comprehensive assessments that utilize best practices to characterize risk, have resulted in the conclusion that further mitigation is not warranted at this time. This conclusion is substantiated by the measured fish loss (non-significant) and lack of change in the predicted temperature differential from operations. Continued monitoring and assessment will occur as per the established regulatory framework. This iterative assessment will also include ongoing Indigenous engagement and working to embed Indigenous values as was done throughout the mitigation measures assessment report.

Surveys, workshops and technical discussions were held with Indigenous Communities to understand their overlay of considerations. Reviews and feedback on a draft version of this report were provided by regulators, independent experts and peer reviewers and comments were incorporated into this report. The feedback was valuable, much appreciated, and the process was an effective way to share information for integration into a comprehensive report.

This assessment of feasible mitigation measures for reduction of I&E and thermal effluents included the review of many technologies in terms of their application to the Bruce Site. Based on the feasibility review of technologies, the most feasible options for reduction of I&E and thermal effluent are provided in Table 48. At the present time, Bruce Power is exploring the use of intake water flow flexibility (i.e., variable speed drives) at the conceptual engineering plan phase. Bruce Power will also continue to remain up to on current research related to the effects of sound and light on fish species relevant to the LSA.

Table 48 Summary of feasible technologies

Reduction	Mitigation Option	Comments
I&E	Variable Speed Drives	For reducing entrainment
	Velocity Cap Modifications (i.e., light or sound deterrents)	For reducing impingement
Thermal	Variable Speed Drives	For flexibility in use (i.e., reduce cooling water intake during times of ↑ I&E and increase cooling water intake during times of ↑ temperatures)

The environment is dynamic and risks and potential consequences can change. A re-evaluation of risks and basis for decision will continue in the future through existing regulatory processes. Full details of the assessment of potential future mitigation measures are available in the report [R-40].

6.3.3 Exposure Assessment

6.3.3.1 Thermal Monitoring Data Analysis

Initial data analysis of the thermal monitoring data consisted of selecting temperature data within individual loggers by depth for the calculation of chronic and acute Hazard Quotients (HQs). For example, a thermal monitoring location with loggers at depths of 10m, 5m, and 1m recording hourly temperature values would have three separate daily maximum, rolling weekly maximum and rolling weekly average temperatures per day (one for each depth), for a total of nine temperature values for each day (three for each depth). Daily maximum temperatures were used for acute HQ calculations. Rolling weekly average and rolling weekly maximum temperatures were used to calculate chronic HQs for warm, cool and cold water guilds, respectively. Full details of the thermal monitoring data analysis are available in Appendix I Section 9.3.1.4.

6.3.4 Toxicity and Effects Assessment

6.3.4.1 Thermal Benchmarks

There are a variety of thermal criteria reported in the literature for each fish species and life stage. These benchmarks consist of acute and chronic temperature limitations, are derived from lab and field based studies, and include lethal and sub-lethal endpoints. There is a large variation in how the temperatures were determined and the availability of thermal data varies for each species. A literature review was completed and benchmarks were selected, with a preference for benchmarks that aggregated multiple studies and, where this was not available, with consideration for the results with the most similar acclimation temperature. This process resulted in a hierarchical approach for benchmark selection, described below. For cold water species without available benchmarks, modelled benchmarks were used. Full details of the thermal benchmark selection are available in Appendix I, Section 9.3.6.1.

Under the hierarchical approach, thermal benchmarks complied from multiple sources are used as the first choice, followed by benchmarks derived by a single study, chosen based on the most similar acclimation temperature if multiple studies are available, and finally, by modelled or calculated benchmarks. The use of this approach ensures that each thermal benchmark selected utilizes the available scientific evidence to the fullest extent practicable.

6.3.4.2 HQ Calculations

Chronic HQs were calculated, where benchmarks were available, for each species and life stage for each month using the 7-day rolling daily average (or maximum, for cold water guild species) temperature divided by the selected Maximum Weekly Average Temperature (MWAT) thermal benchmark.

Acute HQs were calculated for each species at the embryonic stage for each month using the daily maximum hourly temperature divided by the selected acute benchmarks.

For Lake and Round Whitefish, a more complex approach was used to assess thermal risk. This included a temperature-dependent egg incubation start date and the application of a hatch timing model for Lake Whitefish to determine the length of the egg incubation period. Hatch advance was assessed for Lake Whitefish eggs. For Round Whitefish eggs, specific temperature benchmarks and a spatial assessment were applied to the first 30 days of incubation (i.e., Block 1) to ensure that the risk assessment was protective of this cold water species. For consistency with the 2017 ERA, a delta 3°C benchmark was assessed for Lake and Round Whitefish eggs between selected reference sites and sites within the LSA along with the new modelled thermal benchmarks. Full details of the HQ calculations are available in Appendix I Section 9.3.6.

All HQs above 1.0, or exceedances of alternative thresholds (i.e., spatial extent over 10% of the LSA), were retained for further assessment.

6.3.4.3 Characterization of Significant Thermal Exceedances

All HQs greater than 1.0 were further assessed in terms of significance. HQs were assessed as non-significant exceedances and excluded from further assessment based on the following criteria:

1. Short Duration: HQ>1.0 lasted for 10% or less of the calendar month.
2. Reference Site HQ: Exceedance (HQ>1.0) at Primary or Secondary reference site on the same calendar date.
3. Small spatial extent (chronic benchmarks only): Thermal model operational temperature modelling by calendar month indicated that the spatial extent of temperatures generating the HQ>1.0 was less than or equal to 10% of the LSA.

All HQs that did not meet one of the above criteria were retained for further risk characterization as significant thermal exceedances. Exceedance of the Lake or Round

Whitefish temperature, hatch advance or spatial extent criteria were considered equivalent to a significant HQ exceedance and were retained for further assessment.

6.3.5 Risk Characterization

Using existing thermal research literature, the potential impact of the significant HQ exceedances was described in terms of:

1. Size - Percent of the LSA affected by the significant thermal exceedance:
    a) 0-10% of the LSA: No Unreasonable Risk
    b) 10.1%-25% of the LSA: Low Risk
    c) >25% of the LSA: Moderate Risk
2. Extent - Frequency of the exceedances over the thermal risk assessment period based on number of years where significant thermal exceedances occurred:
    a) 1 year: No Unreasonable Risk
    b) 2-5 years: Low-Moderate Risk
3. Biological relevance: species life stage mobility, research regarding tolerance of short-term thermal exceedances, acclimation temperature used in determining the benchmark.
4. Ecological relevance: population size, availability of nearby equivalent habitat, knowledge of local populations, SAR status.

A detailed discussed of the risk characterization for each species and life stage and rationale for each category is provided in Appendix I Section 9.5 [R-35].

The final thermal risk assessment characterization is present Table 49. The final risk characterization included consideration of 1) quantitative criteria of the spatial extent of the thermal exceedance within the LSA and the number of year where the exceedance occurred and 2) qualitative consideration of the mobility of the life stage, the ecological context for the species and the biological significance of the exceedance. Full details of all HQ values, significant HQ exceedances and the final quantitative and qualitative aspects of the risk characterization by species and life stage are available in Appendix I Section 9.5 [R-35].

Table 49 Final Thermal Risk Assessment Characterization

Guild	No Unreasonable Risk		Low Risk	
	Species	Life Stage	Species	Life Stage
Cold	Chinook Salmon Lake Trout Round Whitefish	Larvae Larvae, Growth Larvae	Chinook Salmon Rainbow Trout Lake Trout Lake Whitefish Round Whitefish Deepwater Sculpin	Growth Growth Egg Egg, Larvae, Growth Egg Larvae
Cool	Emerald Shiner Gizzard Shad Smallmouth Bass White Sucker Yellow Perch	Egg, Larvae, Growth Egg, Larvae Egg, Larvae, Growth Larvae, Growth Eggs, Larvae	Gizzard Shad Smallmouth Bass Walleye Yellow Perch	Growth Parent Egg, Larvae, Growth Growth
Warm	Brown Bullhead Channel Catfish Freshwater Drum White Bass	Egg, Larvae, Growth Egg, Growth, Parent Egg, Growth Egg, Larvae, Growth	Brown Bullhead	Egg, Parent

In response to the low risk posed by thermal effluent to several fish species, Bruce Power will continue to execute thermal monitoring through logger deployments and conduct thermal modelling to characterize the risk posed by thermal effluent in the LSA.

Thermal logger deployments at depths over 10m will be discontinued during the winter period starting in the fall of 2022. Deployments at 3m, 5m and 10m depths will continue. Bluetooth technology for data loggers is being trialed to help improve retrieval of temperature loggers at shallow depths (≤10m). Deep locations (>10m) are difficult to retrieve in the spring, resulting in more field days and additional exposure of field personnel to health and safety concerns as a result of searching for and pulling these deep locations from the lake bottom.

Over the winter period, the TRA considers only Lake Whitefish and Round Whitefish eggs at depths of 4-10m and Lake Trout eggs at depths of over 12m. For Lake Trout eggs, the only species and life stage assessed over the winter period at depths greater than 10m, thermal exceedances occur equitably at both reference and LSA sites early in the incubation period (see Appendix I, Section 9.5.1.3); therefore, deployment and retrieval of temperature loggers over the winter period at depths greater than 10m is not contributing to the assessment of thermal effects.

The LSA Remapping Tool generates daily temperatures for 8,815 nodes at the surface and 8,815 nodes at the bottom over the entire TRA period. Daily average and daily maximum temperatures from the LSA Remapping Tool can be used in the same manner as measured temperature values in the TRA process. For the 2022 TRA, the tool was used to increase the spatial assessment of the extent of thermal exceedances for Lake Whitefish eggs, Round

Whitefish eggs and Lake Trout eggs. In the 2027 TRA, temperatures used for HQ calculations for Lake Trout eggs will be generated using the LSA Remapping Tool. Temperatures used for HQ calculations for Lake and Round Whitefish eggs will also be completed using the LSA Remapping Tool and available measured data.

6.3.5.1 Uncertainties and Assumptions in the Assessment of Thermal Effects

The following section documents a number of individual uncertainties that could affect the thermal risk assessment. Despite these individual uncertainties, the combination of methods employed to evaluate thermal risk to fish considerably limits the effect of these individual uncertainties on the conclusions drawn from the overall thermal risk assessment.

Thermal Benchmarks

There is uncertainty associated with the thermal benchmarks used in the assessment. The effect of this uncertainty may result in an over- or under-estimate of the potential thermal impacts to fish. Thermal benchmarks are often derived from laboratory studies where fish may be abruptly moved from one water temperature to another or have a rate of increase of water temperature that is not similar to natural rates of increase. Benchmarks are associated with acclimation temperatures and although efforts were taken to select the temperature most similar to lake temperatures at the time of year during the presence of that life stage, acclimation temperatures were often not reflective of natural conditions. Acclimation temperature strongly influences thermal benchmark test results and has been included with the benchmark when available. If multiple benchmarks with different acclimation temperatures were available, the benchmark with the acclimation temperature closest to seasonal reference site temperatures was selected. Research has found that acclimation temperature differences can cause the CTM to vary up to 10°C within a species, particularly for warmwater species. Seasonal and diel variation in temperature toxicity results can be as much as approximately 2°C [R-173]. Uncertainty is reduced with the hierarchical approach used to select optimal thermal benchmarks in this assessment (see Appendix I, Section 9.3.6.1 [R-35]).

Thermal Monitoring

Field conditions on Lake Huron generate inhospitable conditions for the thermal monitoring program that affects the retrieval rate of thermal loggers. Under extreme lake conditions, poor logger retrieval reduces data availability and contributes to uncertainty in the thermal risk assessment results. To help offset this unavoidable variability in data availability, the assessment includes five years of data and all available thermal monitoring sites, including loggers from the thermal monitoring program and the Coastal Waters Monitoring Program.

As field technology continues to evolve, improvements will be made to the thermal monitoring program that may result in higher success of data collection in the shallower locations such as the use of Bluetooth communication for data retrieval in shallow water.

Temperature loggers in future ERAs will continue to be positioned practicably to capture the greatest temperature variation possible while still ensuring safe and sufficient retrieval potential.

Thermal Modelling

The HHT model provides the best available model for predicting water temperatures at the Bruce Power site [R-198]. The statistical comparison of model benchmarks to literature benchmarks indicates that the HHT model provides performance that is equal to, or better than, the results typically presented in literature and that this model can adequately represent current and temperature conditions in the area of Bruce Power. The HHT model is a sophisticated prediction tool which provides temperature and current predictions in the range of published values and is therefore, well suited for evaluating meteorological and operational thermal effects in the vicinity of the Bruce Power facility. Specific assumptions and limitations of the HHT MIKE3 model are covered in Appendix I Section 9.7.2 [R-35].

The LSA risk characterization carried out with the LSA Remapping Tool was used to determine the spatial extent of significant thermal exceedances in the Thermal Risk Assessment (TRA). The LSA Remapping Tool used HHT model outputs corrected using thermal monitoring temperatures to generate a daily average and daily maximum temperature at 8,815 surface and bottom nodes across the LSA for each date included in the thermal risk assessment. These monitoring data-corrected HHT modelling outputs were used for the entire thermal risk assessment period.

LSA, Extent of LSA, Reference Site Selection and Thermal Benchmarks

Although the uses of the MIKE3 HHT model outputs provide a significant enhancement to the thermal risk assessment, particularly in the area of risk characterization, each of these outputs has some sources of uncertainty that are covered in detail in Appendix I Section 9.7. The uncertainties in thermal benchmarks, thermal monitoring and thermal modelling contribute to the uncertainty in the overall thermal risk assessment.

Climate Change

Although water temperatures increases under operational and non-operational climate scenarios are expected to be similar in magnitude, these increases will present challenges to the ERA assessment in the area of thermal risk assessment.

The current thermal risk assessment includes temperature data from April 1, 2016 to March 31, 2021 and covers any temperature changes measured near the Bruce Power site over the 5 years of this risk assessment (see Appendix I Section 9.5.4 [R-35]). As a result, the short-term effects of climate change are covered in the current thermal risk assessment. There is significant uncertainty related to the long term acclimation of fish species to gradual increases in lake temperatures. As lake temperatures increase, further thermal benchmark research will become more important to evaluate changes in thermal benchmarks that will occur as fish species and life stage acclimate to higher lake temperatures. This will ensure that thermal benchmarks used in the thermal risk assessment will be more reflective of the actual thermal tolerances of fish species near Bruce Power. Fish living in Lake Huron at the present time may in fact, have very different acclimation temperatures and thermal tolerances compared to the fish used to conduct thermal benchmark research, particularly research conducted several decades ago. Additionally, further exploration of the utility of modelled thermal benchmarks would be a useful addition to laboratory and field thermal benchmark research as thermal benchmarks evolve with climate change [R-209]. The use of Bayesian modelling techniques may allow thermal benchmark research to be updated using a selection of fish species in an experimental setting and further adjustment of the thermal benchmarks for the remaining species to occur through modelling work [R-210].

Summary

The layered approach used for the thermal risk assessment uses both measured and modelled thermal data to complete a holistic assessment of the risk posed by thermal effluent from the Bruce Power site. This approach ensures that the risks to all selected VEC species and life stages present in the LSA are fully assessed to the extent possible and uses defined criteria along with biological and ecological context to determine the overall thermal risk characterization. This comprehensive approach reduces the uncertainties associated with reliance solely on measured or modelled data.

6.3.6 Conclusion

The TRA assessed a low risk to several mainly cold and cool water species and life stages located in the Local Study Area (listed in Table 49). Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected. Thermal monitoring and modelling will continue in the LSA year-round in response to the low level of risk due to thermal effluent. Deployment of winter loggers will be reduced to include only sites at 5m and 10m depths. The approach to thermal risk assessment over the winter months will shift to using daily average and daily maximum data generated by the LSA Remapping Tool (i.e., modelled data corrected for measured data) to calculate HQs across the LSA using the same methodology as for the measured data.

6.4 Fish Entrainment and Impingement

6.4.1 Problem Formulation

Bruce Power operations do not destroy fish habitat, but some adults, juveniles and eggs are drawn into the stations with the lake cooling water CCW system. When adult fish and larger juveniles are drawn into the forebay from the lake and become trapped against the 3/8″ mesh intake screens in the pump houses, this fish loss is called impingement. Organisms small enough to fit through the intake screens (i.e., eggs and small juveniles) travel through the cooling system and are pumped back out to the lake. This fish loss is called entrainment. The magnitude of fish losses from impingement and entrainment depends on the volume and velocity of water withdrawn at the intake.

Water is drawn into Bruce A and Bruce B from Lake Huron through deep water intake structures equipped with velocity caps designed to minimize currents and fish impingement.

Water passes into the forebay via a tunnel that runs underneath the lake bed. Intake water passes through bar racks and travelling screens to remove large and small debris, respectively. Water passes through the condenser and is discharged to Lake Huron via the CCW duct and discharge channel (Figure 30). This process is the same for Bruce A and Bruce B and they have separate intake structures and discharge channels. A general overview of water intake and discharge parameters for each intake is given in Table 50 [R-180][R-211]. Water withdrawal for each station is greater than 5.5 m^3/s, which is the definition of a large intake under the *Fisheries Act*, and thus an evaluation of the effect on the fishery is required [R-212].

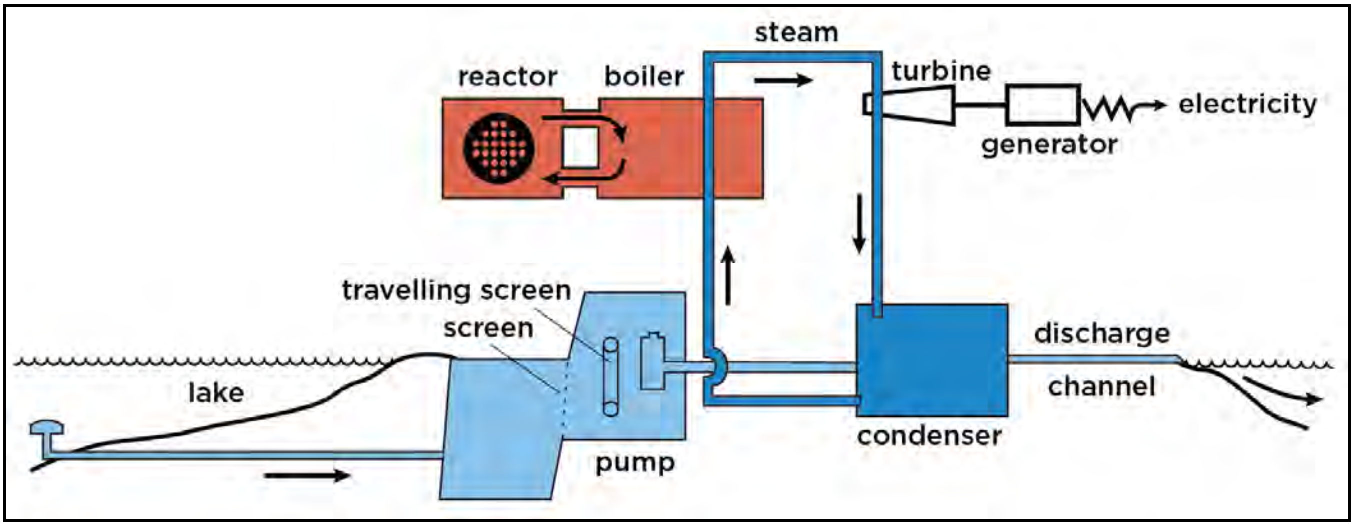

Figure 30 Overview of the once-through cooling system, modified from [R-213]

Table 50 Water intake and discharge parameters

Station	Deepwater Intake		Intake Flow and Velocity	
	Water Depth (m)	Distance offshore (m)	Max Design (m^3/s)	Velocity at cap (m/s)
Bruce A	11	550	175	0.15 to 0.27
Bruce B	14	830	193	0.15 to 0.24
COS	15	820	0.75	~0.0001

COS: Center of Site

6.4.2 Exposure Assessment

The Bruce site was built on the Douglas Point headland, a ~920 ha land mass that projects out into Lake Huron. The site has three deep-water intake structures located in a high-energy zone of Lake Huron; one at Bruce A, Bruce B and Centre of Site (COS), respectively. Situating the facility on the headland allowing the intake structures to reach deep, offshore waters is an effective avoidance strategy that reduces impingement and entrainment because the diversity and abundance of fish in the offshore is lower than in the nearshore environment.

All three water intakes were built to industry standard following best practices: each has a velocity cap and is located several hundred meters offshore [R-214]. The velocity cap is the primary mitigation measure for impingement because it reduces the hydraulic zone of influence (HZI) by directing water flow into a horizontal plane, which is something that fish are able to detect and avoid Figure 31. Without the velocity cap, water would also be drawn in a vertical plane and this would result in greater fish impingement. Velocity caps alone have been found to provide 50-90% reductions in fish impingement [R-215]. The average flow rates at the periphery of the cap are ~0.17 m/s (range 0.15 to 0.27 m/s): these low approach velocities allow many fish species and life stages to avoid impingement.

The Bruce A and Bruce B deep-water intakes have a maximum design flowrate of 175 m^3/s and 193 m^3/s, respectively (Table 50) [R-180]. Actual flows are lower than the designed flowrate because there are practical limitations in CCW pump efficiency and maintenance outages have pumps shut down periodically. The COS water intake is a low-volume intake that supplies the on-site firewater system and the Bruce Eco-Industrial Centre. The withdrawal rate at the COS intake is very low (28 cm/hr) and no fish impingement occurs. As a result, the COS intake is not considered further for impingement and entrainment losses.

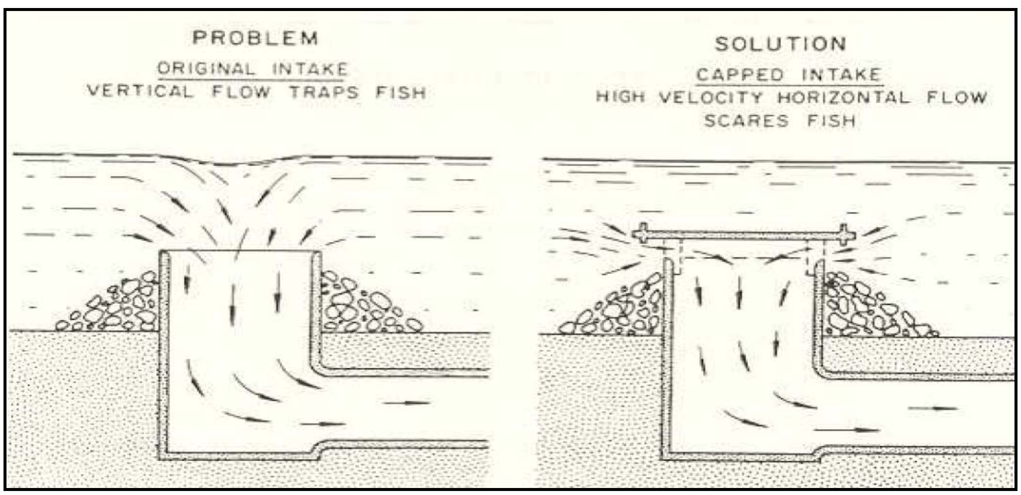

Figure 31 A diagram of water intakes with and without velocity caps [R-216]. The cross-sectional area of the caps at Bruce A and Bruce B are much larger than shown in this illustration. This causes the water velocity at the edge of the concrete cap to be much slower than the velocity within the intake tunnel.

In addition to its velocity cap, the Bruce B intake is equipped with a chain-net barrier that acts as a passive deterrent to reduce impingement. Bruce A is not equipped with a chain-net barrier because its velocity cap is unable to support the additional weight. Several other measures designed to mitigate impingement and entrainment have been investigated across the industry (e.g., lights, sounds, and large-scale design changes), however none have been implemented at Bruce Power to-date because there is insufficient justification to do so. Either the efficacy of the technology is insufficient, or their implementation was not justified given the low quantity of fish that are impinged and entrained at Bruce Power. An updated mitigation measures report was prepared in 2020 and submitted to regulators and Indigenous communities [R-40][R-41]. The conclusions of the report are described in Section 6.3.2.

Although habitat around the velocity cap structures is not affected by the withdrawal of water for CCW cooling, some entrainment and impingement of fish does occur. The HZI is the area surrounding the intake structure where entrainment can occur because the current speed can exceed the critical swimming speed of larval fish Figure 32. Hydrodynamic modeling simulations were carried out to quantify the HZI for larval fish measuring 5-30 mm in length, and to understand the physical extent to which intake-generated currents would exceed the critical swimming speeds of these larvae (0.063-0.244 m/s, respectively) [R-217]. Using actual flow rates for 2013 and 2014 (~90% of the maximum design flow) and a Continuity equation, the maximum intake-generated current speeds at Bruce A and Bruce B were estimated to be ~0.15 m/s and ~0.18 m/s, respectively, based on modeling estimates. These velocities are very similar to the values indicated on the velocity cap design drawings [R-218]. Currents near the velocity cap are strongest at its edge (~0.15 m/s), and they decrease radially outward to a point where there is no difference between the intake current and the natural current of Lake Huron.

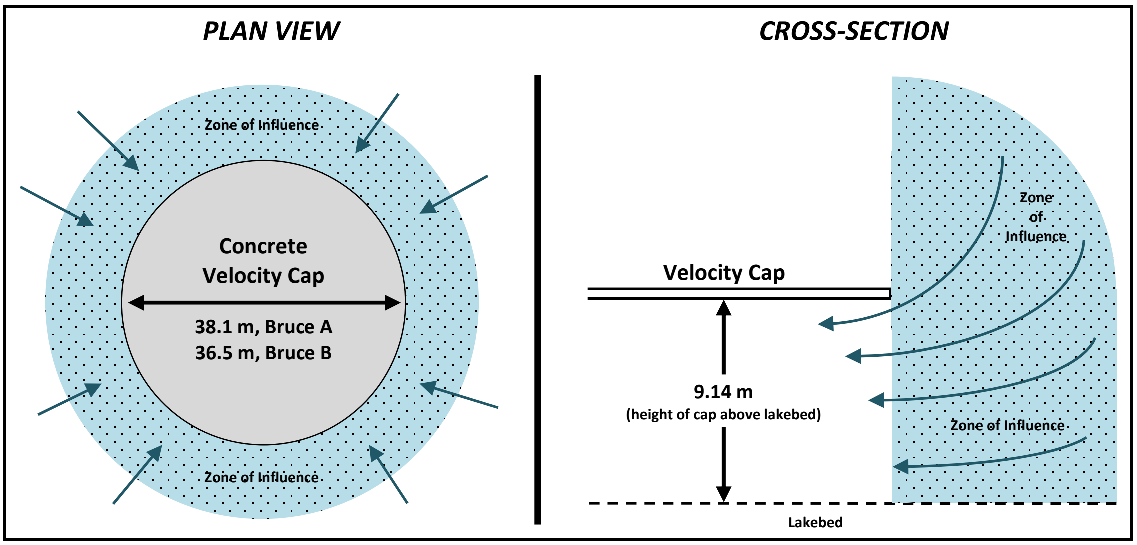

Figure 32 Hydraulic Zone of Influence (HZI) (blue speckled area) around the velocity cap at Bruce A and Bruce B

Currents were also modeled when lake conditions were not calm using ambient lake currents measured 1.5 km southwest of the Bruce A intake (median velocity ≈ 0.1 m/s) [R-217]. Figure 33 helps visualize the concept of up- and down-drift at the water intake caps when lake conditions are not calm.

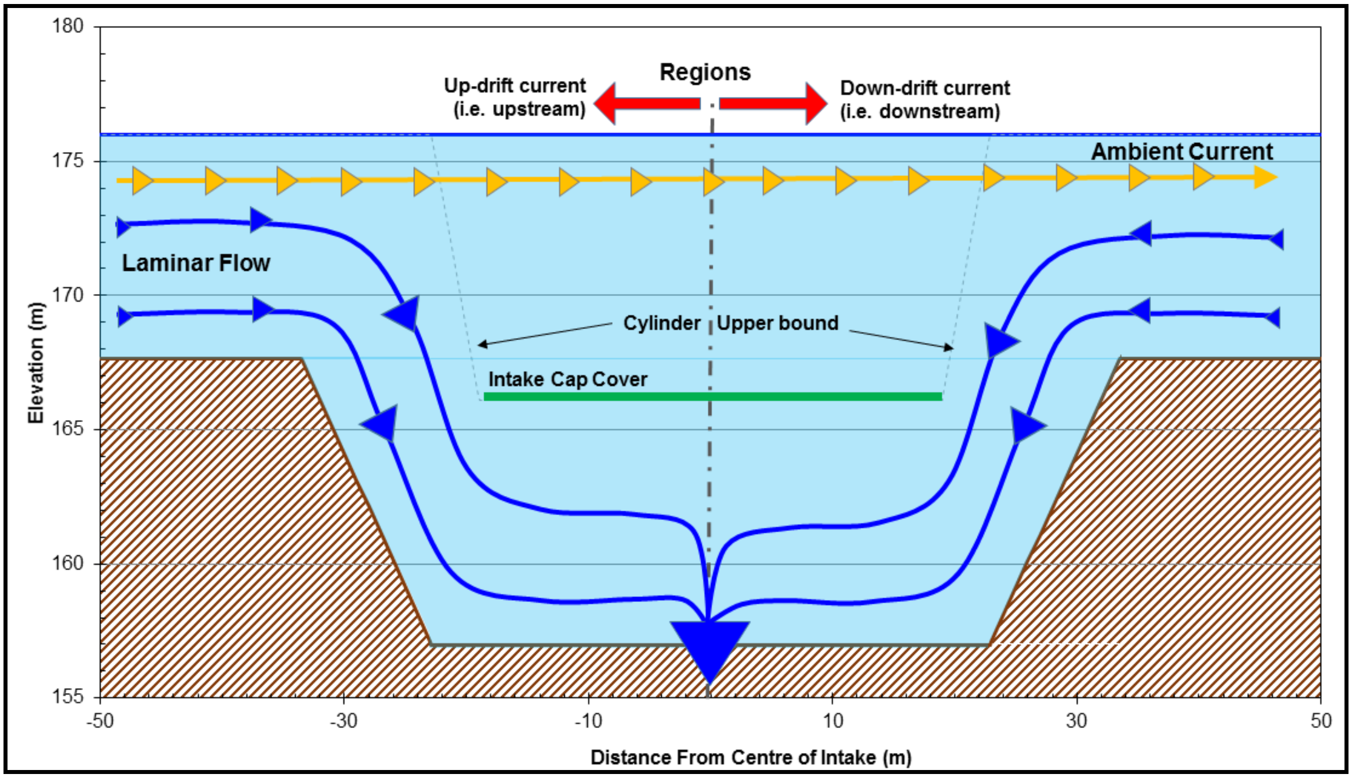

Figure 33 A simplified flow path to illustrate the effects of ambient currents at the intake [R-217]

When natural currents are present, the HZI deviates away from a toroidal shape and resembles a pyriform ellipsoid (similar to the shape of an egg) [R-217]. The current speed at the up-drift side is greater than at the down-drift side, and the HZI for 5 mm larvae extends outward for >100 m (Figure 34). When natural currents are present, the HZI at the down-drift side is contracted and small (Figure 34).

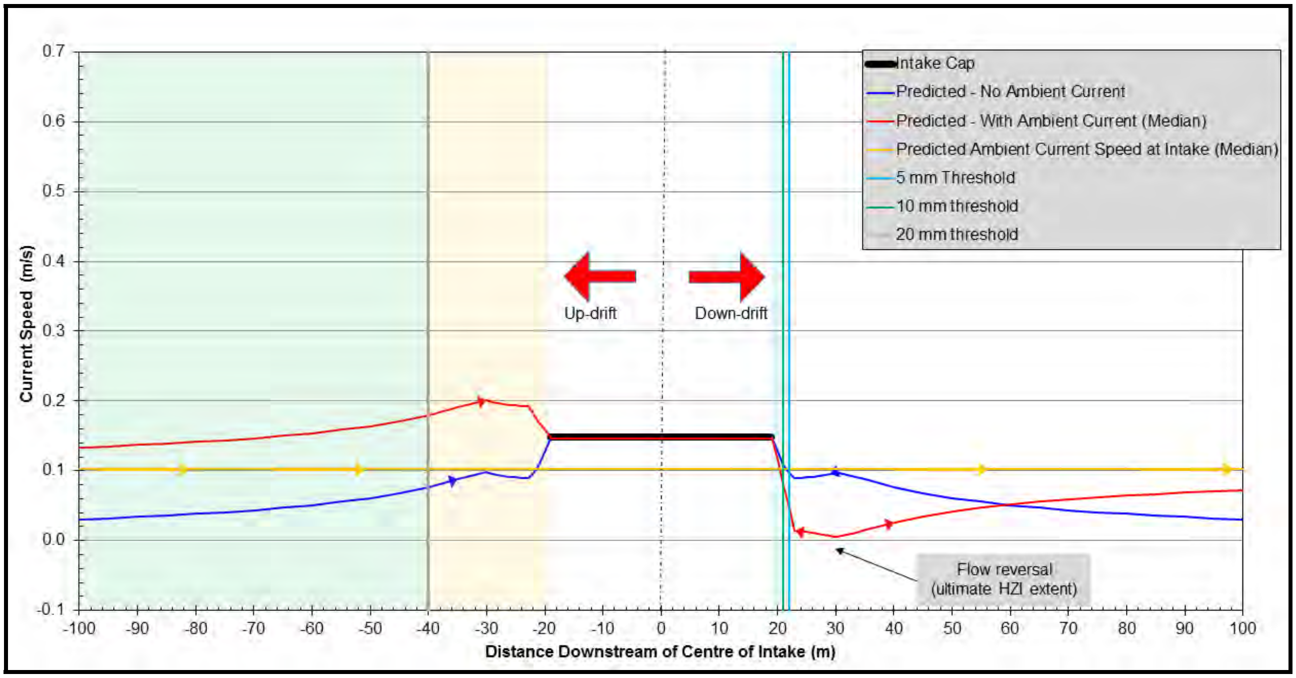

Figure 34 When ambient currents are present (yellow line) the total current speeds up-drift of the velocity cap are greater than down-drift of the intake (red line), resulting in a larger hydraulic zone of influence (shaded areas) on the up-drift side [R-217].

The geographic extent effect is confined to the areas of influence around the intakes and discharges (i.e., the effect is localized). The Hydraulic Zone of Influence (HZI) is 0.4 to 0.8 hectares, compared to 6 million hectares of the main basin of Lake Huron (<0.00001%).

6.4.3 Effects Assessment

Fish impingement monitoring at Bruce A and Bruce B is completed daily in each operating unit to account for all losses from impingement. Entrainment monitoring was last conducted at Bruce A in 2013 and 2014 in preparation for Bruce Power's *Fisheries Act* Authorization (FAA) application. In 2013, there were 41 day samplings and 41 night samplings. In 2014, there were 40 day samplings and 39 night samplings. Entrainment sampling occurred in the Bruce A forebay using plankton nets. Organisms were identified wherever possible, enumerated, and annual entrainment losses were calculated using a Bayesian model that accounted for actual intake flows through the station. Entrainment at Bruce B was extrapolated using the Bruce A monitoring data by assuming the Bruce B entrainment density was equal to the levels observed at Bruce B and by using the measured annual flows for Bruce B. This likely overestimated the actual entrainment at Bruce B because this station has a deeper water intake compared to Bruce A and fish egg/larvae density is lower in the deeper off-shore waters. Entrainment monitoring at Bruce A and Bruce B will occur again in 2025 as a condition of Bruce Power's *Fisheries Act* Authorization.

Impingement and entrainment losses (Figure 35) are summarized annually (expressed in kg/yr) following a Habitat Productivity Index (HPI) approach [R-219] modified from methods first developed by Bob Randall and Charles Minns, two former Fisheries and Oceans Canada (DFO) fisheries scientists [R-220]. This method was carefully developed in collaboration with DFO and CNSC, and is advantageous because the HPI approach normalizes impingement and entrainment losses of all fish species and all ages and can be used to directly compare fish gains acquired through offsetting measures.

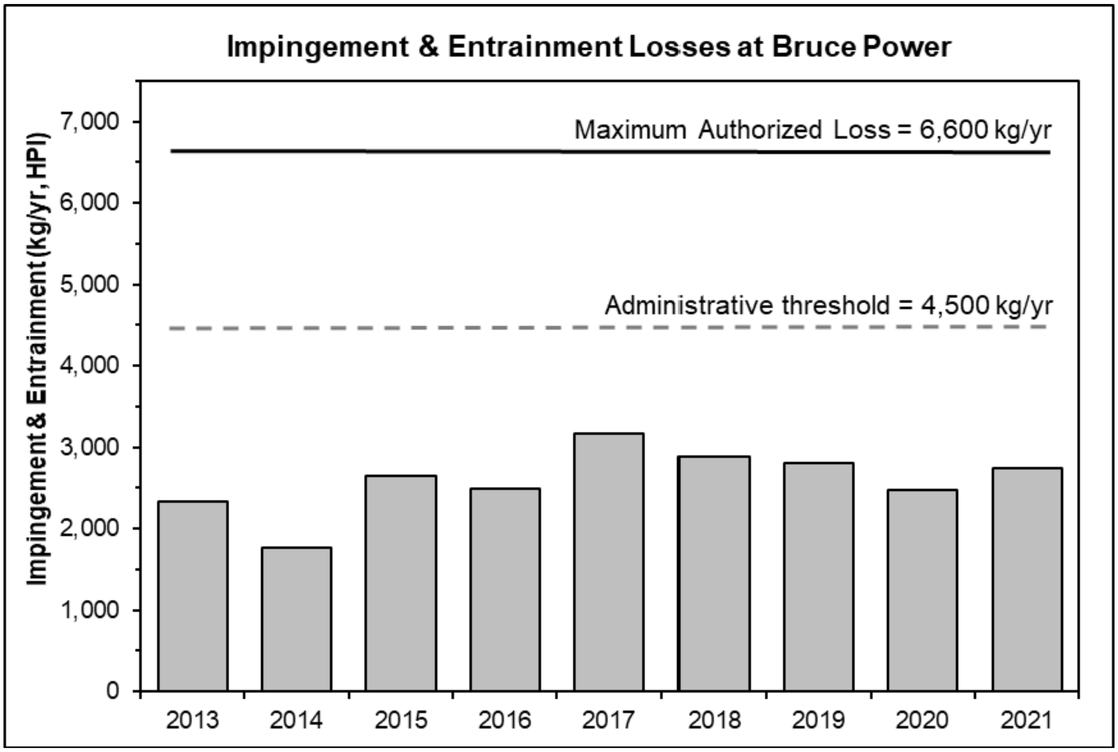

Figure 35 Fish impingement and entrainment losses at Bruce Power (kg/yr)

Impingement fish counts for 2015-2021 are summarized by species in Table 51 and the proportion of fish impinged over that time period is shown in Figure 37.

Table 51 Fish Impingement counts at Bruce A and Bruce B (2015-2021)

Species	2015	2016	2017	2018	2019	2020	2021
Alewife	225	65	273	57	293	611	27
Brown Trout	10	8	16	11	12	12	13
Bullhead	0	0	1	2	3	1	10
Burbot	211	252	410	202	207	234	411
Carp	19	20	49	45	47	13	105

Table 51 Fish Impingement counts at Bruce A and Bruce B (2015-2021)

Species	2015	2016	2017	2018	2019	2020	2021
Channel Catfish	64	15	27	41	47	24	110
Chinook Salmon	35	9	10	20	8	22	35
Coho Salmon	22	7	13	9	9	28	37
Freshwater Drum	40	20	39	22	16	4	12
Gizzard Shad	567	603	9559	5051	4540	1264	1202
Lake Trout	93	63	84	110	49	133	109
Lake Whitefish	77	69	98	60	35	42	27
Pike	0	0	0	0	0	3	0
Rainbow Smelt	401	1129	1300	2352	974	210	120
Rainbow Trout	16	22	33	22	26	58	41
Rock Bass	2	19	41	15	3	1	10
Round Goby	1838	2768	3623	2147	2018	3632	221
Round Whitefish	12	4	3	1	0	1	5
Shiners	266	19	260	1382	105	142	1488
Smallmouth Bass	20	15	14	36	16	6	22
Suckers	603	695	756	621	359	1252	1398
Walleye	120	27	119	189	133	50	111
White Bass	0	0	0	0	2	101	
White Perch	0	26	123	24	1	22	16
Yellow Perch	2369	1857	2727	158	43	69	426

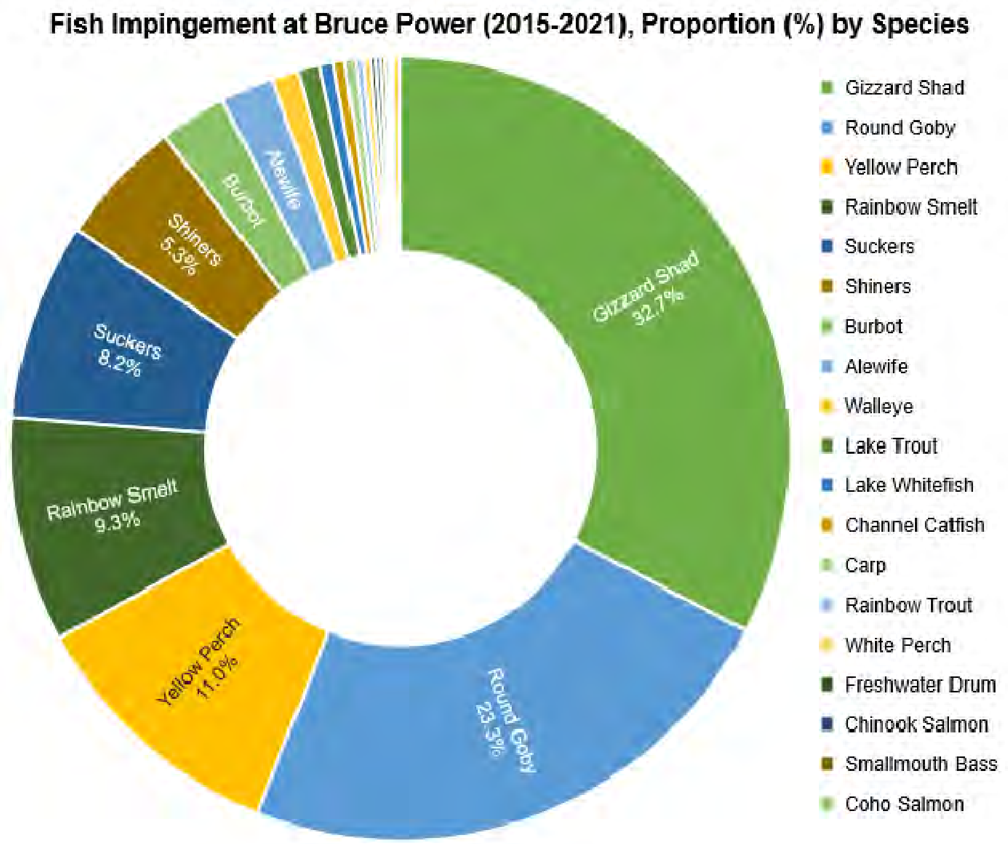

Figure 36 The proportion of fish impinged at Bruce Power, by species (2015-2021).

No benchmarks for fish impingement or entrainment are available from federal or provincial authorities that can be used to assess the environmental risk. Effects thresholds are dependent on sufficient knowledge of the population including natural variability. Bruce Power obtained a *Fisheries Act* Authorization (FAA) in 2019 from Fisheries and Oceans Canada (DFO) [R-25] that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting to counterbalance fish losses. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time. The FAA was granted to Bruce Power in 2019 by the Canadian Federal Government under DFO's authority and mandate to protect fish and fish habitat. Annual reports are submitted to DFO in March each year demonstrating compliance to conditions of the FAA which will be reviewed for renewal prior to the end of 2028.

The Authorization permits a maximum annual loss of 6,600 kg of fish per year as calculated using a Habitat Productivity Index (HPI)[R-219][R-220]. The Authorization establishes an administrative threshold of 4,500 kg of fish per year (expressed as HPI), and if fish losses exceed this value in any year then Bruce Power is to engage with the DFO for discussion. Should fish losses exceed 4,500 kg/yr in 2 years of a 5-yr period, then Bruce Power is to engage the DFO in discussions to determine potential follow-up requirements/conditions. The FAA includes conditions for any aquatic species at risk listed as *Threatened or Endangered* on Schedule 1 under the *Species at Risk Act*.

6.4.4 Risk Characterization

The environmental risk from impingement and entrainment at Bruce Power is minimized to the greatest extent possible by situating the site on the Douglas Point Headland and placing the bottom-water intakes in deep, offshore waters. This employs the key *Fisheries Act* Authorization application principal of *avoidance*. Mitigation technologies are implemented at all Bruce Power water intakes through the use of the velocity cap structures, which is the proven, industry-best standard for reducing impingement. Additionally, Bruce B is fitted with a chain-rope curtain to dissuade schooling fish from being impinged. This employs the key principal of *mitigation*. Finally, any residual harm (i.e., fish losses from impingement and entrainment) is offset using approved compensation projects outlined in Bruce Power's FAA. This employs the key principal of *offsetting*. Together, these key principals, combined with the successful offsetting measures that are in action today, result in no net loss of fish in the Lake Huron watershed.

Bruce Power's key offsetting measure is the Truax Dam Removal Project. The Truax Dam, located on the Saugeen River in the town of Walkerton, ON, was partially removed in August 2019 after it stood for >100 years, acting as a complete barrier to most community fish and a major barrier to Salmonids, despite the presence of a fishway. Extensive monitoring of fish biomass and habitat up- and downstream of the dam began in 2018 and has continued annually since that time. Twenty-two biomass monitoring sites, including 4 control sites, were established in the Saugeen River and upstream tributaries of Otter Creek, Meux Creek, South Saugeen River, Beatty Saugeen River, and the Styx River. A before-after-control-impact (BACI) study is used to compare changes in biomass and fish production that occurred after the dam was removed. To-date, there is a clear and statistically-significant increase in biomass in the Saugeen River upstream of the former Truax Dam location. The magnitude of this change, expressed using the Habitat Productivity Index (HPI), is 1,523 kg/year (Table 52). This is the current value of the offset, 2 years post-dam removal, and the offset is expected to increase with time as biomass and fish production increase in the upstream tributaries. Additional gains in fish production in the upstream tributaries are expected to take a few years to be fully realized.

Table 52 Cumulative fish losses and offsets during the Authorization period (2019-2028). All values are shown in kilograms, calculated using the Habitat Productivity Index (HPI) methodology

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Impingement & Entrainment	-2,806	-2,472	-2,739	-	-	-	-	-	-	-	-8,017
Truax Dam Removal Project	N/A	+1,523	+1,523	-	-	-	-	-	-	-	+3,046
Lake Trout Stocking	+3,077	+3,077	N/A								+6,154
Coastal Waters Monitoring Program	+281	+247	+274	-	-	-	-	-	-	-	+802
Indigenous Nation & Community Projects	N/A	N/A	N/A	-	-	-	-	-	-	-	-
Total	+552	+2,375	-942	-	-	-	-	-	-	-	+1,985

The numbers of individuals are scaled to actual flow for entrainment. A Habitat Productivity Index (HPI) is used to calculate the total impingement and entrainment losses at Bruce Power (Figure 35), with losses ranging from 2,474kg (2014) to 3,171kg (2017) annually.

Additional offsetting was completed in 2019 and 2020, in conjunction with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry, with the stocking of Lake Trout in Georgian Bay. Cumulatively, this added 6,154 kg of fish productivity over 2 years.

Bruce Power's support of the SON Coastal Waters Monitoring Program (CWMP) is considered a complimentary offsetting measure, and is valued at 10% of the annual impingement and entrainment losses. Since the Authorization was issued, Bruce Power's support of the CWMP represents a total offset of 802 kg (Table 52).

Overall, given the 2019-2021 cumulative fish losses (from impingement and entrainment) and gains (from all offsetting measures), there exists a net positive gain in fish production equal to 1,985 kg (Table 52) meaning the residual environmental risk from impingement and entrainment is fully compensated.

6.4.4.1 Characterization of Impingement and Entrainment Losses

Additional analysis of impingement and entrainment was completed in preparation for this ERA by comparing annual fish losses, expressed as HPI, to the following:

- Commercial fisheries data from the Ontario Commercial Fisheries Association (OCFA);
- Commercial fishery data from management zone-1 based on Ontario Ministry of Natural Resources and Forests (MNRF) data;
- Sport fishing data from creel survey data;
- Smallmouth Bass nesting data, and;
- HPI values of other Great Lakes.

The details on each data set are provided in Table 53.

Table 53 Datasets used for comparison to impingement and entrainment (I&E) losses

Data Sources	Sampling Years	Spatial Extent	Species Targeted
Commercial fishery data from the Ontario Commercial Fisheries Association (OCFA)	Annually, 2013-2021	Information currently unavailable.	Information currently unavailable
Commercial fishery data from Ontario Ministry of Natural Resources and Forestry (MNRF)	Annually, 2013-2021	Management Zone-1.	• Lake Whitefish (*Coregonus clupeaformis)* with bycatch of; ○ Channel Catfish (*Ictalurus punctatus*) ○ Cisco (*Coregonus artedi*) ○ Deepwater Chub (may include Bloater (*Coregonus hoyi*) ○ Deepwater Cisco (*Coregonus johannae*) • Lake Trout (*Salvelinus namaycush*) • Northern Pike (*Esox lucius*) • Walleye (*Sander vitreus*)

Table 53 Datasets used for comparison to impingement and entrainment (I&E) losses

Data Sources	**Sampling Years**	**Spatial Extent**	**Species Targeted**
Creel survey data	Annually, 2013-2017	Inverhuron Provincial Park and Baie du Doré boat launches.	• Atlantic Salmon (*Salmo salar*) • Brown Trout (*Salmo trutta*) • Chinook Salmon (*Oncorhynchus tshawytscha*) • Coho Salmon (*Oncorhynchus kisutch*) • Freshwater Drum (*Aplodinotus grunniens*) • Lake Trout • Northern Pike • Pink Salmon (*Oncorhynchus gorbuscha*) • Rainbow Trout (*Oncorhynchus mykiss*) • Smallmouth Bass (*Micropterus dolomieu*) • Walleye • Yellow Perch (*Perca flavescens*)
Chantry Chinook Classic Fish Derby data	Annually, 2013-2019	Lake Huron on the west side of the Bruce Peninsula in the area bounded by the Nine Mile River to the south, the Lyal Island Lighthouse to the north and International Border to the west, and on the east side of the Bruce Peninsula in the area bounded by Dyer's Bay to the north, Wiarton to the south, and extending approximately 10 km laterally offshore to the east.	• Salmonids, including: ○ Brown Trout ○ Chinook Salmon ○ Coho Salmon ○ Lake Trout ○ Rainbow Trout ○ Pink Salmon ○ Atlantic Salmon

Table 53 Datasets used for comparison to impingement and entrainment (I&E) losses

Data Sources	Sampling Years	Spatial Extent	Species Targeted
Smallmouth Bass nesting data	Annually, 2013-2020	Bruce A and Bruce B discharge channels, and Baie du Doré.	Non-intrusive observations of Smallmouth Bass nesting
HPI values of other great lakes [R-220]	1994	Lake Ontario and Lake Erie at six different locations: Inner Long Point Bay in Lake Erie, and Presq'ile in Lake Ontario (coastal wetlands); Port Dover and Port Colbourne in Lake Erie and Port Dalhousie and Bronte Harbour in Lake Ontario (harbours); and exposed shorelines to either side of the harbors in each lake.	All fish captured by electrofishing along the shoreline, excluding off-shore species: • Alewife (*Alosa pseudoharengus*) • Rainbow Smelt (*Osmerus mordax*) • Salmonids.

Commercial Fishery Data

In comparison to HPI values, commercial fishery data provided by OCFA and MNRF are simply the total weight of captured fish per species [R-221]. In addition to the differences in calculation and interpretation of the summary statistics, the entrainment portion of the HPI values uses the biomass of age-1 fish, which differs from the population of fish included in the commercial fishery harvests and summaries in that these are weight-at-age caught and therefore not equitable to age-1. Moreover, commercial catch data are a combination of targeted species (e.g., Lake Whitefish) and bycatch species (e.g., Channel Catfish). Therefore, the interpretation of comparisons of I&E losses to commercial fishery data differs between species. Although I&E losses and commercial fishery harvests are not directly comparable, MNRF and OCFA fishery data are provided herein as further context to the I&E loss.

For the seven individual species present in the commercial catch data, Channel Catfish, Cisco, Lake Trout, Northern Pike, Round Whitefish, White Bass, and Yellow Perch, I&E loss values ranged from 0 kg (Northern Pike in 2013-2019, Round Whitefish in 2019 and 2020, and White Bass in 2015-2018) to 429 kg (Cisco in 2013, 2015, 2016, 2019, and 2020, when no Cisco were impinged and the worst-case entrainment values were applied;Table 54).

Impingement biomass ranged from 0 kg (for Cisco in 2013-2016 and 2019-2020, Northern Pike in 2013-2019, and White Bass in 2015-2018) to 292 kg (for Lake Trout in 2015). In comparison, for species that appeared in the OCFA harvest data, annual harvests ranged from 1 kg (Round Whitefish in 2016 and 2020) to 243,352 kg (for Yellow Perch in 2014). Commercial harvests as reported by MNRF data ranged from 2 kg (for Channel Catfish in 2013) to 37,725 kg (for Lake Trout in 2016).

Comparison of impingement biomass to commercial fishery harvests for individual species indicated that impingement values amount to a small fraction of commercial fishery harvests. For example, Lake Trout impinged biomass ranged from 36 kg (in 2014) to 292 kg (in 2015), and amounted to a maximum of 0.18% and 1.4% of reported OCFA and MNRF commercial harvests, respectively. Similarly, Yellow Perch impinged biomass ranged from 4 kg (in 2019) and 195 kg (in 2015), and amounted to a maximum of 0.17% and 22.5% of reported OCFA and MNRF commercial harvests, respectively (note that Yellow Perch harvest as reported by MNRF is bycatch only and harvest values are low compared to OCFA harvests, leading to higher percentages of impinged biomass in relation to MNRF commercial harvests).

Table 54 Commercial fishery catches and I&E losses of Channel Catfish, Northern Pike, Round Whitefish, and White Bass.

Species	Year	Commercial fishery harvest (kg)		I&E losses	
		OCFA	MNRF	Impinged biomass (kg)	I&E HPI (kg)
Channel Catfish	2013	596	2	27	8
	2014	106	16	81	23
	2015	38	90	159	27
	2016	38	0	24	5
	2017	299	--	57	10
	2018	753	--	58	12
	2019	47	7	67	14
	2020	66	21	29	6
Cisco	2013	--	65	0	429
	2014	--	822	0	119
	2015	--	240	0	429
	2016	--	534	0	429
	2019	--	866	0	429
	2020	--	60	0	429
Lake Trout	2013	153,888	29,165	48	13
	2014	147,674	21,737	36	10
	2015	164,708	21,088	292	46
	2016	125,920	37,725	131	24
	2017	150,371	20,351	172	31
	2018	170,152	18,682	166	34
	2019	126,243	26,472	84	16
	2020	109,869	11,054	154	34

Table 54 Commercial fishery catches and I&E losses of Channel Catfish, Northern Pike, Round Whitefish, and White Bass.

Species	Year	Commercial fishery harvest (kg)		I&E losses	
		OCFA	MNRF	Impinged biomass (kg)	I&E HPI (kg)
Northern Pike	2013	91	8	0	0
	2014	115	115	0	0
	2015	180	0	0	0
	2016	241	180	0	0
	2017	173	--	0	0
	2018	344	--	0	0
	2019	189	84	0	0
	2020	531	0	12	2
Round Whitefish	2013	355	--	13	4
	2014	15	--	3	1
	2015	16	--	9	2
	2016	1	--	2	1
	2017	46	--	2	1
	2018	9	--	1	0.2
	2019	5	--	0	0
	2020	1	--	2	0
White Bass	2013	2644	--	2	1
	2014	440	--	1	1
	2015	521	--	0	0
	2016	382	--	0	0
	2017	938	--	0	0
	2018	1080	--	0	0
	2019	326	--	1	0.3
	2020	66	--	5	3

Table 54 Commercial fishery catches and I&E losses of Channel Catfish, Northern Pike, Round Whitefish, and White Bass.

Species	Year	Commercial fishery harvest (kg)		I&E losses	
		OCFA	MNRF	Impinged biomass (kg)	I&E HPI (kg)
Yellow Perch	2013	220,344	1,355	53	155
	2014	243,352	828	33	39
	2015	117,841	1,403	195	250
	2016	116,779	3,052	89	180
	2017	145,949	778	175	240
	2018	136,722	886	16	119
	2019	141,572	38	4	109
	2020	110,768	369	7	112

Sport Fishing Data

I&E losses are expressed as HPI values. In comparison, creel data, which record sport fishing activity, report fishing harvests in counts of individual fish. Therefore, the HPI values and creel data are not directly comparable without alternative modeling of I&E data to provide the same metric for comparisons. While comparisons of I&E loss as HPI to sport fishing losses are not straightforward in interpretation, sport fishing data recorded in two separate programs are provided here for context. The creel surveys, conducted at Inverhuron Provincial Park and Baie du Doré boat launches suggested that fishers generally targeted Chinook Salmon, Lake Trout, Smallmouth Bass, and Walleye (Table 55). Of the salmonids recorded during the Chantry Chinook Classic Fish Derby, the most commonly captured fish were Chinook Salmon and Lake Trout, followed by Rainbow Trout (Table 56). Of the species recorded during the creel surveys and the Chantry Chinook Classic Fish Derby, Atlantic Salmon and Pink Salmon were never recorded as entrained or impinged (however note that unidentified salmonids were recorded during I&E sampling in 2013).

Table 55 Results of creel surveys by sampling year (2013-2017)

	Species	**2013**	**2014**	**2015**	**2016**	**2017**
Fish counts	Atlantic Salmon	--	2	1	--	1
	Brown Trout	3	1	--	1	1
	Chinook Salmon	25	27	5	19	12
	Coho Salmon	2	27	8	4	1
	Freshwater Drum	3	--	1	--	--
	Lake Trout	2	34	21	15	9
	Pike	--	--	--	1	1
	Pink Salmon	1	43	--	7	4
	Rainbow Trout	12	16	10	4	19
	Smallmouth Bass	108	63	102	46	62
	Walleye	40	21	30	21	46
	Yellow Perch	--	2	--	--	6
	All Species	**196**	**236**	**178**	**118**	**162**
Weight (kg)	Atlantic Salmon	--	2.8	1.9	--	1.8
	Brown Trout	13	4.5	--	0.9	4.1
	Chinook Salmon	70.7	76.8	7.5	22.6	3.9
	Coho Salmon	6.4	76.8	12.7	9	1.8
	Freshwater Drum	3	--	4.6	--	--
	Lake Trout	2.7	65.5	38.7	38.9	22
	Pike	--	--	--	1	0.9
	Pink Salmon	0.8	27.9	--	4.1	4.6
	Rainbow Trout	33.3	41.2	27.2	8.8	49.1
	Smallmouth Bass	76.3	63.4	63.6	28.3	46.5
	Walleye	88.9	38.7	62.1	49.3	93
	Yellow Perch	--	0.3	--	--	0.9
	All Species	**295**	**397.7**	**218.1**	**171**	**264.6**

Table 56 Chantry Chinook Classic Fish Derby total catch data from all weigh-in stations (2013-2019)

	Species	2013	2014	2015	2016	2017	2018	2019
Fish count	Atlantic Salmon	1	4	4	5	10	15	2
	Brown Trout	9	9	4	4	3	5	5
	Chinook Salmon	575	711	465	311	449	793	699
	Coho Salmon	35	165	41	20	27	91	27
	Lake Trout	141	453	621	508	467	606	298
	Pink Salmon	--	3	--	2	2	--	1
	Rainbow Trout	145	374	146	159	182	113	140
	All Species	**905**	**1,715**	**1,277**	**1,009**	**1,140**	**1,623**	**1,172**
Weight (kg)	Atlantic Salmon	3	13	7	19	40	89	8
	Brown Trout	33	34	10	45	20	35	31
	Chinook Salmon	2,330	2,571	1,602	2,840	3,549	6,862	6,649
	Coho Salmon	83	349	90	120	126	449	131
	Lake Trout	471	1,366	1,757	3,364	3,399	4,341	2,352
	Pink Salmon	--	6	--	8	6	--	3
	Rainbow Trout	385	985	376	834	1,038	693	860
	Total	**3,301**	**5,311**	**3,836**	**7,230**	**8,177**	**12,468**	**10,034**

Smallmouth Bass Survey and Sport Harvest Data

Smallmouth Bass I&E losses in 2013-2020 only included impingement because Smallmouth Bass were not entrained during the 2013-2014 entrainment surveys ([R-222]). The losses were provided as counts of fish, which can be directly compared to data derived from creel and nesting surveys for Smallmouth Bass. The Smallmouth Bass nesting survey data are presented in detail in the 2020 Smallmouth Bass nesting survey report [R-181] and are summarized in Section 2.8.6 of the Site Description in [R-35].

Overall, the number of Smallmouth Bass impinged at Bruce A and Bruce B ranged from 14% to 67% of the number of harvested Smallmouth Bass, as recorded by the creel surveys (in 2017 and 2014, respectively;Table 57). This comparison could only be made for 2013-2017 sampling years, when both datasets were available

Nesting data were summarized as counts of active and successful nests in Bruce A, Bruce B, and Baie du Doré, to provide reference for the creel data, which were collected at Inverhuron Provincial Park and Baie du Doré boat launches [R-203]. Note that a single active or successful nest at the end of the nesting surveys indicates the continuous presence of a single male Smallmouth Bass, since once a male abandons a nest, it is not claimed by another male [R-223]. A single nest may also be considered as the indication of presence of two adult Smallmouth Bass (at least in the spawning period for each nest; [R-223]). However, only a portion of all adult males and females spawn at a given year [R-223]; that is, the number of nests, multiplied by two, is only a fraction of the adult Smallmouth Bass present in the area. In addition, the area sampled for Smallmouth Bass nesting only accounts for a fraction of available nesting habitat in the area, and therefore, nest counts reported here are only a small portion of all nesting activity in the area.

When compared to the number of adult Smallmouth Bass that were nesting in each year (calculated as twice the number of successful and active nests), the number of impinged fish ranged from 3% in 2020 to 52% in 2013 (Table 57). Annual impingement was less than 10% of the nesting bass numbers in six of the eight sampling years, with the exception of 2013 and 2014. This comparison is made only with the number of nesting adults in the three sampled areas, since only a fraction of the adults present in the area engage in nesting activity [R-223], and only a fraction of the overall available habitat is sampled during nesting surveys. That is, the results of proportion impinged presented here are very conservative, since the number of adult Smallmouth Bass in the vicinity of Bruce Power is considerably larger than numbers based on the available nesting surveys (see Appendix A, Section 1.8.6 and Section 6.2.2.4 above).

Table 57 Annual counts of impinged Smallmouth Bass, harvested Smallmouth Bass as part of the sport fishery, and number of nests that were still successful or active at the end of the sampling period

Year		Counts	
	Impinged	Harvested (creel surveys)	Successful or active nests (Bruce A, Bruce B, and Baie du Doré)
2013	60	171	58
2014	65	97	144
2015	20	122	132
2016	15	49	99
2017	14	97	164
2018	36	No data collected	185
2019	16		217
2020	6		103

<u>Commercial Fishery Zone 1 HPI Values</u>

A comparison between I&E loss values, expressed as HPI, was performed to the annual habitat productivity index (HPI) of the Commercial Fishery Management Zone-1 (CFM Zone-1). For this comparison, the HPI values reported for Lake Erie and Lake Ontario (as kg/ha/yr; [R-220]) were applied to the spatial extent of CFM Zone-1, to calculate annual HPI values (kg/yr). HPI values are not available for Lake Huron, however Great Lake values are available for Lakes Erie and Ontario. Using the values collected in the other Great Lakes and applying it to Lake Huron is an exercise that allows for a direct comparison of I&E losses to whole fish community production estimates in Lake Huron.

The Lake Erie and Lake Ontario HPI values were calculated for three habitat types (nearshore habitat, wetlands, and port areas) based on measurements obtained through a series of electrofishing surveys performed at several locations [R-220]. The results were presented as average HPI values (transformed as $\log_{10}(x+1)$) for each habitat type, with an associated standard error (Table 58). The HPI values for Lake Erie and Lake Ontario were digitized from Figure 5 in [R-220] using the GetData Graph Digitizer v. 2.26 software, and are presented in Table 58. The Lake Erie and Lake Ontario HPI values provided in [R-220] do not include offshore species such as Alewife, Rainbow Smelt, and salmonines [R-220], which are species that are impinged and entrained at Bruce Power. Therefore, these species were removed from the I&E losses used in this comparison.

An aerial estimate of the nearshore, wetland, and port habitats within the CFM Zone-1 was required in order to use the HPI values for Lake Erie and Lake Ontario published in [R-220]. These habitat areas were delineated using Geographic Information System (GIS), where habitats shallower than 10 m were defined as “nearshore”, and lacustrine (coastal) wetlands were used as the “wetland” habitat. Shoreline and island data were extracted from Land Information Ontario waterbody and shoreline feature classes [R-224]. Wetland spatial data were based on the Great Lakes Coastal Wetland Monitoring Plan [R-225]. The CFM Zone-1 was digitized from the Lake Huron Commercial Fishing Summary for 2011 by the Ontario Ministry of Natural Resources [R-226]. Bathymetry data used for the 10 m depth contour was taken from the National Oceanic and Atmospheric Administration (NOAA) National Geophysical Data Center. The port habitats areas were visually located from aerial imagery.

Based on GIS datasets, a 273 ha portion of the lacustrine wetlands in the Coastal Wetland Monitoring Plan dataset overlapped with the “nearshore” habitat. Of this potential nearshore habitat, 22.4 ha was within Baie du Doré. The overlapping areas were assigned to the wetland habitat class in order to reflect that these areas are ecologically different from open, low-vegetation nearshore areas, and to reflect the recent Phragmites removal efforts undertaken in Baie du Doré. The area values associated with each habitat type were 232 ha for port areas, 83,647 ha for nearshore habitat, and 760 ha for wetland habitat (Table 60).

Following the calculation of the HPI associated with CFM Zone-1, the estimated I&E loss was expressed as proportion (%) of the CFM Zone-1 HPI. When interpreting the results, it is important to note that only the nearshore portion (depths of 0-10 m) of Lake Huron was used to calculate habitat productivity, and this only represents 7.4% of the total CFM Zone-1 area in Lake Huron. In other words, this is a very conservative comparison because Bruce Power’s I&E losses are being compared here to a fraction of the actual CFM Zone-1 area.

Table 58 Log-transformed Habitat Productivity Index (HPI) values calculated by Randall and Minns (2002) [R-220] for Lake Erie and Lake Ontario

Lake	Habitat	$\log_{10}$(HPI + 1 [kg/hectare/year])	
		Mean	95% Confidence Interval
Erie	Port	1.751	1.664 – 1.838
	Nearshore	0.370	0.176 – 0.564
	Wetland	1.608	1.511 – 1.705
Ontario	Port	1.658	1.484 – 1.832
	Nearshore	0.899	0.648 – 1.151
	Wetland	1.544	1.418 – 1.670

The HPI estimated for CFM Zone-1 was smallest in port areas, reflecting the limited spatial extent of this habitat, and estimated at 10.3 ton/year to 12.9 ton/year, depending if the Lake Erie or Lake Ontario HPI value was used (Table 59). The wetland HPI in CFM Zone-1 was estimated to be 25.8 ton/year to 30.0 ton/year, depending on the source of the HPI values. The calculated HPI for nearshore habitat was highest, reflecting the large spatial extent of the habitat, and estimated to be 112.5 ton/year to 580.0 ton/year, depending if the Lake Erie or Lake Ontario HPI value was used (Table 59).

Impingement and entrainment losses at Bruce Power from 2013 to 2020 represents approximately 0.5-0.9% of the CFM Zone-1 nearshore productivity based on Lake Ontario HPI values, or approximately 2.1-3.7% of the nearshore productivity based on Lake Erie HPI values (Figure 37). The variability associated with the estimates was considerably higher for Lake Erie when compared to Lake Ontario, reflecting the higher uncertainty associated with Lake Erie nearshore HPI estimates (Table 58).

Table 59 Estimated annual Habitat Productivity Index (HPI; as kg/year) in the Lake Huron commercial fishery management Zone-1 of Lake Huron, based on Lake Erie and Lake Ontario HPI values calculated by Randall and Minns (2002) [R-220]

Source of HPI Values	Habitat	Habitat Area in Zone-1 of Lake Huron (hectares)	Estimated HPI (kg/year) for Lake Huron Zone-1	
			Mean	95% Confidence Interval
Lake Erie	Port	232	12,861	10,481 – 15,770
	Nearshore	83,647	112,525	41,938 – 222,785
	Wetland	760	30,031	23,878 – 37,720
Lake Ontario	Port	232	10,330	6,838 – 15,547
	Nearshore	83,647	579,979	288,011 – 1,101,312
	Wetland	760	25,835	19,143 – 34,777

Estimates of I&E losses as a proportion of CFM Zone-1 HPI provided here have inherent uncertainty owing to the fact that the comparison uses HPI values derived for Lake Erie and Lake Ontario, whereas Lake Huron is generally less productive than Lake Erie and Lake Ontario [R-227]. Of note, whole-lake primary production for Lake Erie and Lake Ontario indicated that Lake Erie is twice as productive as Lake Ontario [R-227], however, HPI values of fish reported for the two lakes are similar for both port and wetland habitats, and only differ in nearshore habitats, with Lake Erie having the lower productivity values (Table 58). If differences in whole-lake primary production translate to similar differences in nearshore HPI, it is likely that actual nearshore fishery productivity in Lake Huron is lower than that previously described for Lake Erie and Lake Ontario. Although the effect of this uncertainty cannot be quantified at this time, the exclusion of offshore areas from the estimates of habitat productivity of Zone-1 is assumed to provide a conservative calculation of the proportional I&E loss.

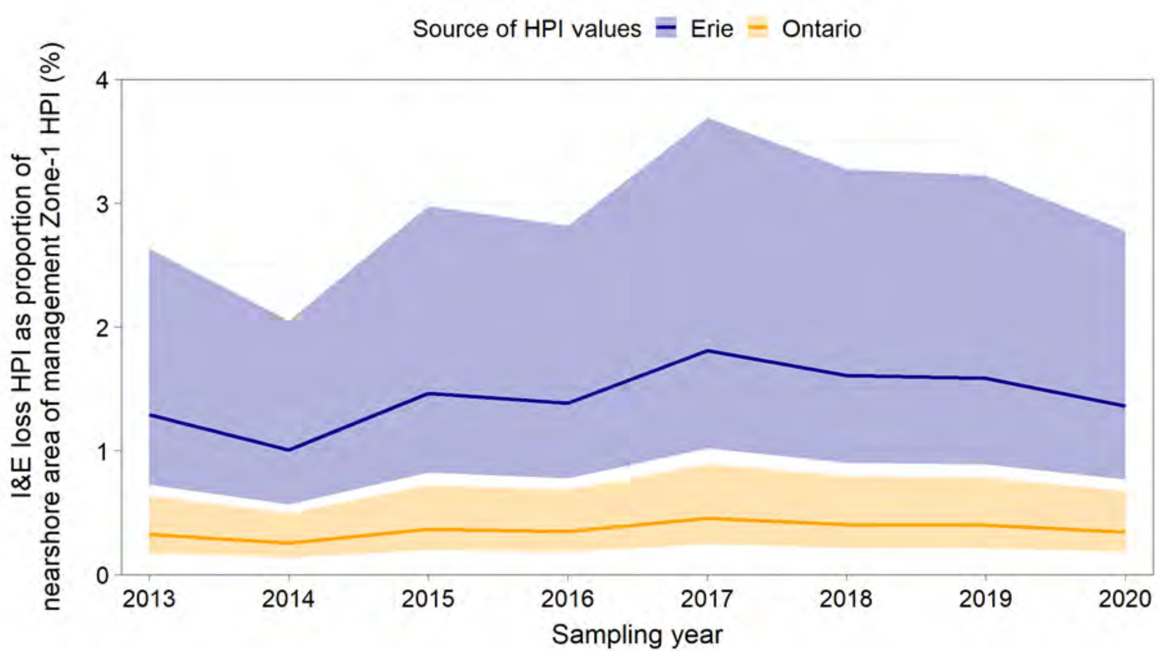

Figure 37 Annual I&E loss, expressed as proportion (%) of the annual HPI of the commercial fishery management area 4-4 Commercial Fishery Management Area Zone-1; ribbons represent 95% confidence intervals

<u>Species at Risk</u>

As Deepwater Sculpin are federally-listed species of *Special Concern*, a smaller scale threshold and/or monitoring endpoint would be appropriate as compared to those used to evaluate potential effects to other populations, although evaluation at the individual level is not required because this species is not *Vulnerable*, *Threatened* or *Endangered*. It is recognized that adults and juveniles, being generally benthic, live well outside the HZI of the intakes. Further, the HZI is approximately 0.4 to 0.8 ha, compared to the area of Lake Huron (6 million hectares). Therefore, the HZI represents less than 0.00001% of the area available within the lake. None of the identified threats to Deepwater Sculpin are related to population loss through impingement and entrainment. Fisheries and Oceans Canada lists the primary threat to the population as invasive species and disease, including the arrival of the alewife that feed on larvae. A review of recent literature involving Deepwater Sculpin is available in Appendix A Section 1.8.9 [R-35].

Deepwater Sculpin generally only enter the HZI and become vulnerable to entrainment or impingement during a portion of the larval phase. Larval Deepwater Sculpin are expected to remain in a pelagic phase for between 40 and 60 days as they grow from 8mm to 20-25mm in length [R-228]–[R-230]. The 8mm larvae have little to no yolk sac remaining when captured during larval tows [R-228]. This suggests that the movement to pelagic habitat might be driven by the need for a higher density of plankton in the early larval stages that is only available during the early spring on the nearshore side of the thermal bar (i.e., surface temperatures >4°C, generally near 6°C).

It is not possible to determine a scientifically-valid population-level effect threshold, although thresholds of 10 to 25% have been used in other such studies [R-231]–[R-233]. The impact of entrainment is well below any potential proposed threshold of similar magnitude. Recently, the Bruce A entrainment mortality was compared to natural mortality and fishing mortality for Deepwater Sculpin through a life cycle simulation (i.e., compared to lake-wide trawling data). The number of age-2 equivalent lost to entrainment at Bruce A accounted for <0.01% (95% upper credibility limit 0.01%) and 0.07% (95% upper credibility limit 0.73%) of the total Lake Huron age-2 population in 2013 and 2014, respectively. This represents an estimated 18 and 859 individual age-2 fish in 2013 and 2014 and is not significant when compared to natural sources of mortality for Deepwater Sculpin (one juvenile and no adults were impinged or entrained during 2013 and 2014). Natural survival of Deepwater Sculpin larvae from the pelagic to benthic stages is estimated to be 0.1-0.4% (Geffen and Nash 1992 in [R-229]).

Larval mortality as a result of entrainment had no significant impact on the final size of the reproductive population in Lake Huron (14 larval entrained in 2013 and 163 larvae and 1 juvenile in 2014). There was no significant change in the population due to added mortality from entertainment throughout the lifecycle for the median entrainment estimate. Entrainment monitoring was also conducted in 2004 (two Bruce A units were operating) and twelve larval fish and no eggs were collected. Entrained fish larvae included Alewife, Ninespine Stickleback (*Pungitius pungitius*), Rainbow Smelt, and Yellow Perch. In 2014, under high observed entrainment rates, median estimate of reduction in age-2 abundance of Deepwater Sculpin was 2.9% for an initial larval population of 38 million and 0.4% for an initial larval population size of 313 million larvae.[R-11]

Given the limited impact of impingement and entrainment on the mortality of age-2 Deepwater Sculpin in Lake Huron, no significant adverse effect on the species is anticipated due to entrainment.

6.4.4.1 Uncertainties and Assumptions in the Risk Characterization

The quantification of impingement and entrainment losses has several source of uncertainty including life history parameters (i.e., growth curves, weight-at-length, natural mortality rates and fishing mortality rates), entrainment monitoring methods, fish identification and flow estimates. The uncertainty in the quantification of impingement and entrainment estimates has been reduced to the extent possible by using local Great Lakes data when available for life history parameters and by conducting sensitivity analyses on the impact of chosen life history parameters. A detailed discussion of uncertainty components is provided in the *Fisheries Act Authorization* Application [R-222].

6.5 Habitat Alteration

6.5.1 Problem Formulation

Habitat mapping was updated in 2017 as part of environmental monitoring. The habitat mapping did not show substantive increase in the footprint of Site facilities, and therefore no additional habitat loss was noted in the 2017 ERA.

Since 2017, a total of 7.2 hectares of land have been cleared as part of the installation of MCR infrastructure, including the B31 simulator and additional parking lots at Bruce A and Bruce B. As part of the ESG program, Bruce Power has contributed towards the preservation of 61.6 hectares of high quality habitat during this same time period. Details of Bruce Power Land Clearing Offsets are available in Appendix D, Section 4.5.8 [R-35]. No changes to aquatic habitat have occurred on site since 2017.

6.5.2 Exposure and Effects Assessment

The 7.2 hectare alteration of sub-optimal fragmented terrestrial habitat on the Bruce Power site is equivalent of 0.8% of the total 932 hectares available on the site. The alternation of sub-optimal habitat has been adequately offset through the preservation of high quality habitat in other locations (see Appendix D, Section 4.5.8 [R-35]).

6.5.3 Habitat Alteration Benchmarks

Habitat alteration is considered to represent a significant change in local habitat availability if losses of greater than 10% are recorded. There is some support in the literature for a loss of 10% as the threshold of measurability at a local scale, such as the Local Study Area [R-233][R-234].

6.5.4 Risk Characterization

Habitat loss on site is well below the 10% threshold for no unreasonable risk. As such, habitat alteration on the Bruce Power site poses no unreasonable risk to terrestrial receptors. No alteration of aquatic habitat has occurred.

6.6 Vehicle-Wildlife Interactions and Bird Strikes

Vehicle-wildlife interactions and bird strikes are routinely monitoring on the Bruce Power site and reported annually in the Environmental Protection Reports [R-108][R-113]–[R-116]. Monitoring results are used to support on-site initiatives to minimize the risk of vehicle-wildlife interactions and bird strikes. Examples of these initiatives include new road signage, communications to staff to be aware of wildlife movement during peak migration and modifications to building windows. Population level data to quantitatively assess the impact of these physical stressors is not available.

6.6.1 Vehicle-Wildlife Interactions

The level of mortality observed in and around Bruce Power is consistent with the level observed across the province of Ontario. Ontario reports approximately 14,000 large herbivore (mainly deer) collisions annually on provincial roads and highways [R-235] but the real number of wildlife vehicle collisions is likely much higher, with 24,000 collisions with vertebrates recorded on a 31km stretch of the Thousand Islands Parkway in Eastern Ontario over only 5 months in 2008 [R-236]. With approximately 190,000km of roads in Ontario [R-237], this represents 0.07 large herbivore collisions per kilometer of road and 774 vertebrate collisions per kilometer of road. From 2017 to 2021, Bruce Power surveys found a total of 3 deer collisions and 392 vertebrate collisions over approximately 35km of roads surveyed for vehicle wildlife collisions [R-108]. This results in an annual average of 0.017 large herbivore collisions per kilometer of road and 2.24 vertebrate collisions per kilometer of road, well below reported data for public roads in Ontario. There is no differential mortality occurring due to these stressors related to the operation of the Bruce Power site compared to other industrial and residential locations across Ontario.

6.6.2 Bird Strikes

Prior to 2017, Bruce Power had not collected information on bird strikes. Surveys commenced in the late spring of 2017 as part of environmental monitoring. Two buildings at which heightened collision risk had been identified were selected for regular monitoring (Buildings B10 and B31). Building B10 is a five-story glass building. Building B31 is a one-story building with surrounding glass windows. A third building (B16) was added at the start of the 2020 monitoring year. B16 is split building with one story in the front section and two stories in the back, it is mostly brick with several glass window in the front office section. All bird strike survey buildings are located near diverse woodlot communities. Four years of bird building collision monitoring has resulted in only eight recorded bird carcasses between the three monitored buildings. The monitoring year of 2017 resulted in the highest numbers of birds recorded with a total of 5 birds for the season, 2018 yielded only one bird carcass, 2019 had a total of two bird carcasses and finally no birds were recorded in 2020. The eight recorded species are forest associates, which may reflect the presence of woodlots in proximity to the buildings. There is no unreasonable risk to the local bird populations related to bird strikes on site buildings. Bird strike monitoring will be discontinued unless a significant change to bird strikes is incidentally noted in the future.

6.7 Predictive Environmental Risk Assessment

6.7.1 Noise

Activities assessed under the 2017 PERA [R-12] and completed to date have not demonstrated a negative environmental impact on noise levels (Appendix D, Section 4.5.3 and 4.6.1 [R-35]).

Current operational conditions have been shown to be bounding of predicted changes for noise as a result of future activities at site. As such, changes predicted in these environmental components are not considered as potentially affecting human receptors. Noise exposure for ecological receptors was not assessed due to lack of benchmarks.

6.7.2 Terrestrial Environment (Species and Habitat)

The small area impacted by wildlife habitat changes, tree removal, and soil management was documented in Environmental Management Plans and Environmental Impact Worksheets and walkdowns were performed to ensure compliance. No significant adverse effects noted to date (Appendix D, Section 4.5.9 and 4.6.6 [R-35]).

Investing in the protection of off-site, environmentally sensitive land helps to compensate for clearing of land that was required for new parking lots and facilities [R-238]. In 2018, Bruce Power contributed to the expansion of the Bruce Trail Conservancy by preserving 142 acres of irreplaceable Niagara Escarpment landscape.

As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities.

6.7.2.1 Vehicle-Wildlife Interactions and Bird Strikes

The initialization of the Life-Extension program and MCR coincided with a period of remote work for many Bruce Power workers due to the COVID-19 pandemic. As a result, it is not possible to assess the impact of the increased activity on-site as this was offset by the reduction in overall on-site workers. The effect of the increased on-site workforce on wildlife-vehicle collisions will be assessed in the 2027 ERA. The additional buildings constructed to support Life-Extension and MCR at Bruce A and Bruce B have included control measures to deter nesting of birds, including gulls. The additional buildings do not have features that make them high risk for bird strikes (i.e., expansive glass [R-239]) thus bird strike monitoring will not be completed at these new buildings, unless a need for such monitoring is identified.

As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities.

6.7.3 Aquatic Environment (Species and Habitat)

Given that there are no anticipated impacts to surface water arising from MCR, no impacts to aquatic environments are anticipated (Appendix D, Section 4.5.9 and 4.6.7 [R-35]).

Thermal Effects

Current operational conditions are considered be bounding of predicted changes, as a result of future activities at site for thermal effects. Except for the expected reduction in discharge temperature from units undergoing refurbishment, no significant changes to measured temperatures have occurred and no additional thermal effects are anticipated. Comparisons of pre and post restart of Units 1 and 2 during follow-up monitoring [R-11] did not demonstrate any measurable effect and therefore shorter duration changes during unit outages, including MCR, are not expected to generate measurable effects. No additional thermal effects are expected from planned Life-Extension activities or Lu-177 production and current operations are considered bounding of future operations at this time. No significant increases to measured temperatures have occurred and no additional thermal effects are anticipated.

Fish Entrainment and Impingement

Current operational conditions are considered to be bounding of predicted changes, as a result of future activities at site for fish entrainment and impingement.

Physical Effects of Cooling Water

No increase in cooling water discharge will occur as a result of the Life-Extension program. Update with changes related to CCW refurbishment, power recover plan. No increase in cooling water discharge is expected from planned Life-Extension activities and current full operations are considered bounding of future operations at this time. No increase in cooling water discharge has occurred or is anticipated as a result of Life-Extension activities.

6.7.4 Conclusion

There are no unreasonable risks due physical stressors resulting from planned Life-Extension activities or Lu-177 production.

6.8 Overall Conclusion of the Risk Assessment for Physical Stressors

Bruce Power has completed a comprehensive quantitative thermal risk assessment with substantial methodological improvements over past thermal risk assessments. These improvements have included the full incorporation of thermal modelling data, modelled thermal benchmarks for cold water fish species and assessment of all species and life stages present in the nearshore area. A low risk to some cold and cool water species and life stage located in the Local Study Area (listed in Table 61) was assessed during the thermal risk assessment process. Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected.

Monitoring and assessment of I&E and thermal effluents over time (in prior EAs and ERAs) continues to verify no unreasonable risk to the natural environment as a result of these physical stressors. Extensive monitoring to verify these conclusions, coupled with comprehensive assessments that utilize best practices to characterize risk, have resulted in the conclusion that further mitigation is not warranted at this time. This conclusion is substantiated by the measured fish loss (non-significant) and lack of change in the predicted temperature differential from operations. This assessment of feasible mitigation measures for reduction of I&E and thermal effluents identified the most feasible options for reduction of I&E and thermal effluent as Variable Speed Drives (VSDs) and velocity cap modifications (i.e., light or sound deterrents).

No benchmarks for fish impingement or entrainment are available from federal or provincial authorities that can be used to assess the environmental risk. Effects thresholds are dependent on sufficient knowledge of the population including natural variability. Bruce Power obtained a Fisheries Act Authorization (FAA) from Fisheries and Oceans Canada (DFO) in 2019 [R-25] that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time.

The assessment of the physical effects of the noise, cooling water discharge and habitat alteration has shown no unreasonable risk to human or ecological receptors. Additionally, there are no unreasonable risks due physical stressors resulting from planned Life-Extension activities or Lu-177 production.

7.0 CONCLUSIONS AND RECOMMENDATIONS

As described in Section 1.5, Bruce Power has a robust environmental management program, which takes into consideration results of the existing EMP and the ERA. Federal and provincial regulations, the CSA N288 series of standards, and the site-specific EMS ensure that:

- The risks associated with releases to the environment are continually assessed and mitigated;
- Releases are controlled and monitored; and
- The environment is monitored.

One of the core objectives of the ERA is to provide a risk-based rationale for Environmental Monitoring, specifically the locations, frequency and data analysis associated with environmental sampling.

7.1 Indigenous Engagement

7.1.1 Conclusions

Based on the review of the past Bruce Power-specific concerns raised by Indigenous communities, all technical considerations within the construct of the CSA N288.6 framework have been dispositioned and those related to the ERA have been highlighted within the text. Bruce Power is committed to ongoing engagement, consultation and communication with the SON, HSM and MNO in accordance with Bruce Power's Indigenous Relations Policy, Protocol, and Relationship Agreements with the communities and regulatory requirements.

7.1.2 Recommendations

Bruce Power will continue to engage with SON, MNO and HSM to support climate change research that is relevant to each community.

Bruce Power will continue to support the Coastal Waters Environmental Monitoring Program (CWMP). This program was jointly developed between Bruce Power and SON and aims to enhance the existing body of knowledge being compiled through Bruce Power's routine Environmental Monitoring.

As a follow-up to the submission of the Assessment of Feasible Mitigation Measures report [R-41], updates to the risk assessment for I & E and thermal effluent will continue to include an assessment of the need for mitigation measures and an update on any progress to mitigation measure implementation, if applicable.

Bruce Power is required to complete entrainment monitoring and offset projects as part of the conditions of the *Fisheries Act* Authorization [R-25] and will continue to engage with SON, MNO and HSM to communicate the results of the entrainment monitoring and to select and complete these offset projects.

7.2 Conventional Risk Assessment

7.2.1 Conclusions

The non-radiological human health risk assessment evaluated the potential for health risks for members of the public residing in the area surrounding the Site, including recreational users. The potential for health risks due to non-radiological chemicals and physical stressors were negligible considering normal operations at the Site.

The conventional EcoRA identified potential risks to terrestrial ecological receptors at Construction Landfill #4, Fire Training Facility, Distribution Station #1 and at five general soil sampling sites, to semi-aquatic receptors at Eastern Drainage Ditch and to aquatic receptors in Lake Huron, FSL, B31 Pond and Eastern Drainage Ditch (see Table 60). The conservative nature of the methodology used to assess risks due to conventional contaminants in the EcoRA results in the identification of areas of potential risk but does not necessarily indicate a current risk to receptors. Additional follow-up monitoring is required to refine the risk assessment.

Table 60
Summary of EcoRA Conclusions and Recommendations

Area	Media Assessed	Conclusions	Recommendations
TERRESTRIAL			
Construction Landfill #4 (CL4) - 3.8 ha	Soil	HQs> 1 for terrestrial wildlife from zinc and HMW PAHs.	• Further work should characterize the extent of zinc impacts around CL4 collected in 2016 and PAH impacts around CL4-9 collected in 2000 to affirm potential risks because these were the only locations that exceeded the SSTL. • Further work should characterize the current acid base extractable concentrations at CLF-9 collected in 2000 to confirm if they remain COPCs in absence of risk-based criteria.
Fire Training Facility (FTF) – 2.8 ha	Soil	HQs> 1 for plants and soil invertebrates from TPH Light.	• Further work should characterize the current PHC concentrations around historically contaminated areas within surface soil to affirm potential risks. • Further work should characterize the current acetone and acid base extractable concentrations at FTF-12 collected in 2000 to confirm if they remain COPCs in absence of risk-based criteria.

Table 60
Summary of EcoRA Conclusions and Recommendations

Area	Media Assessed	Conclusions	Recommendations
Distribution Station #1 (DS1) – 0.068 ha	Soil	HQs> 1 for plants and soil invertebrates from TPH Light.	• Further work should characterize the current PHC concentrations around historically contaminated areas within surface soil to affirm potential risks.
General Surface Soil Samples (BPS and SS series)	Soil	HQs> 1 for plans and soil invertebrates from boron (HWS), selenium and PHC F2/F3. HQs>1 for terrestrial wildlife from lead and selenium.	• Further work should delineate the extent of metal impacts in surface soil around BPS-04-07/SS6 and the extent of PHC impacts around BPS-07-07/BPS-01-07 to affirm potential risks because these were the only locations that exceeded the SSTL. • Further work should delineate strontium impacts around BPS-01-07/BPS-02-07 to confirm if strontium remains a COPC in absence of risk based criteria.
PERMANENT WATER COURSE			
Lake Huron shoreline and nearshore habitat	Surface Water	HQ>1 for aquatic communities from zinc.	• Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program. Analysis of DOC required to derive site-specific toxicological benchmark for zinc.
PERMANENT DRAINAGE FEATURE			
FSL (1 ha)	Sediment	HQ>1 for aquatic communities from PHC F3.	• Further work should delineate PHC impacts; total organic carbon should be assessed to derive a site-specific toxicological benchmark.
	Surface Water	HQ>1 for aquatic communities from copper and zinc.	• Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program. Analysis of dissolved organic carbon required to derive site-specific toxicological benchmark for zinc.
B31 Pond (at CL4) (0.4 ha)	Surface Water	HQ>1 for aquatic communities from copper.	• Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program.
Distal Eastern Drainage Ditch (0.09 ha)	Sediment	HQ>1 for aquatic communities from PHC F3. HQ>1 for insectivorous, semi-aquatic wildlife from vanadium.	• Further work should delineate PHC impacts; total organic carbon should be assessed to derive a site-specific toxicological benchmark. • Further work should delineate vanadium impacts and measure COPC concentration in benthos.

7.2.2 Recommendations

The conventional HHRA demonstrated no unreasonable risk to human receptors and no additional recommendations are required.

For the conventional EcoRA, Bruce Power will complete follow-up monitoring as recommended in Table 60 to refine the assessment of risk in the 2027 ERA. Results of follow-up monitoring will be reported annually in the Environmental Protection Reports and compared to the SSTLs calculated in the 2022 ERA.

Based on the results of the 2022 conventional EcoRA and the lack of ongoing industrial activity at the following locations, soil sampling will be discontinued at the Bruce A Storage Compound (BASC), the Bruce B Empty Drum Laydown Area (BBED), Former Sewage Lagoon (FSL) and at Distribution Stations #2/4/5/8. Sediment and surface water monitoring at the B16 pond will be discontinued. Groundwater monitoring at the shallow (<1.5m) wells at FSL and BASC will be discontinued given the lack of COPCs. The need for additional monitoring will be determined by the Groundwater Protection Program in alignment with CSA N288.7-15 [R-100].

7.3 Radiological Risk Assessment

7.3.1 Conclusions

The radiation doses to members of the public residing in the area surrounding the Site are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., concentrations reported as less than a detection limit) addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.

The radiation dose rates to non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value. With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., occupancy factors and ingestion parameters) addressed in a conservative manner, there is no radiological risk to non-human biota resulting from normal operations on the Site.

In addition to assessing the overall risk to humans and non-human biota, this report examined the specific contributions of each radionuclide and exposure pathway to the total radiation dose. This analysis of relative risk provides information for the design of Environmental Monitoring.

7.3.2 Recommendations

The following sections present recommendations based on the relative risks determined in the Radiological HHRA and the EcoRA respectively.

Effluent and environmental data reported as less than a detection limit is a source of uncertainty in the radiological ERA. As noted in Section 3.2.3, uncensored data below the detection limit is now recorded and used where possible for environmental monitoring data. In some cases, the critical level is conservatively used as an upper bound of contaminant concentration. For effluent/emissions monitoring data, Bruce Power is in the process of completing the required work to report uncensored data and critical level information for all radiological analyses. This uncensored data and critical level information will then be used in routine reporting. The use of uncensored data and critical level information for effluent and emissions data will represent a refinement of the ERA dose calculations. However, the most of the HHRA dose calculations are based on measurements in environmental media and are not dependent on effluent/emissions data. As a result, increasing the accuracy of reported emissions will have a small effect on reported doses and on the outcomes of the radiological HHRA and EcoRA.

From the EcoRA, additional measurements of radionuclides in on-site waterbodies have confirmed that the Former Sewage Lagoon is the bounding exposure location. Doses to non-human biota remain far below benchmark values, therefore additional refinement of dose calculations is not required. Continued monitoring of radionuclides in water and sediment at the Former Sewage Lagoon is recommended. This may include characterization of C-14 in surface water to refine concentrations that were calculated based on modelling.

7.4 Physical Stressor Assessment

7.4.1 Thermal Effects

Bruce Power has completed a comprehensive quantitative thermal risk assessment (TRA) with substantial methodological improvements over past thermal risk assessments. These improvements have included the full incorporation of thermal modelling data, modelled thermal benchmarks for cold water fish species and assessment of all species and life stages present in the nearshore area. The TRA assessed a low risk to several mainly cold and cool water species and life stages located in the Local Study Area (listed in Table 61). Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected.

Table 61 Final Thermal Risk Assessment Characterization

Guild	No Unreasonable Risk		Low Risk	
	Species	**Life Stage**	**Species**	**Life Stage**
Cold	Chinook Salmon Lake Trout Round Whitefish	Larvae Larvae, Growth Larvae	Chinook Salmon Rainbow Trout Lake Trout Lake Whitefish Round Whitefish Deepwater Sculpin	Growth Growth Egg Egg, Larvae, Growth Egg Larvae
Cool	Emerald Shiner Gizzard Shad Smallmouth Bass White Sucker Yellow Perch	Egg, Larvae, Growth Egg, Larvae Egg, Larvae, Growth Larvae, Growth Eggs, Larvae	Gizzard Shad Smallmouth Bass Walleye Yellow Perch	Growth Parent Egg, Larvae, Growth Growth
Warm	Brown Bullhead Channel Catfish Freshwater Drum White Bass	Egg, Larvae, Growth Egg, Growth, Parent Egg, Growth Egg, Larvae, Growth	Brown Bullhead	Egg, Parent

7.4.2 Impingement and Entrainment

No benchmarks for fish impingement or entrainment are available from federal or provincial authorities that can be used to assess the environmental risk. Effects thresholds are dependent on sufficient knowledge of the population including natural variability. Bruce Power obtained a Fisheries Act Authorization (FAA) from Fisheries and Oceans Canada (DFO) in 2019 [R-25] that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time.

7.4.3 Mitigation Measures Assessment

Monitoring and assessment of I&E and thermal effluents over time (in prior EAs and ERAs) continues to verify no unreasonable risk to the natural environment as a result of these physical stressors. Extensive monitoring to verify these conclusions, coupled with comprehensive assessments that utilize best practices to characterize risk, have resulted in the conclusion that further mitigation is not warranted at this time. This conclusion is substantiated by the measured fish loss (non-significant) and lack of change in the predicted temperature differential from operations. This assessment of feasible mitigation measures for reduction of I&E and thermal effluents identified the most feasible options for reduction of I&E and thermal effluent as Variable Speed Drives (VSDs) and velocity cap modifications (i.e., light or sound deterrents).

7.4.4 Other Physical Stressors

The assessment of the physical effects of the noise, cooling water discharge and habitat alteration has shown no unreasonable risk to human or ecological receptors.

7.4.5 Recommendations

With respect to physical stressors, based on the risk assessment, no recommendations related to environmental monitoring are required given that the existing programs are adequate for identifying potential changes in the environment. Bruce Power will continue to monitor the local ecosystem in the vicinity of the Bruce Power site.

7.4.5.1 Impingement and Entrainment

Monitoring for impingement will continue. Bruce Power will also complete entrainment monitoring and offset projects as part of the conditions of the Fisheries Act Authorization [R-25].

7.4.5.2 Thermal Effects

In response to the low risk posed by thermal effluent to several fish species, Bruce Power will continue to execute year-round thermal monitoring through logger deployments and thermal modelling work to monitor the risk posed by thermal effluent in the LSA.

Thermal logger deployments at depths over 10m will be discontinued during the winter period starting in the fall of 2022. Deployments at 3m, 5m and 10m depths will continue. Bluetooth technology for data loggers is being trialed to help improve retrieval of temperature loggers at shallow depths (≤10m). Deep locations (>10m) are difficult to retrieve in the spring, resulting in more field days and additional exposure of field personnel to health and safety concerns as a result of searching for and pulling these deep locations from the lake bottom.

Over the winter period, the TRA considers only Lake Whitefish and Round Whitefish eggs at depths of 4-10m and Lake Trout eggs at depths of over 12m. For Lake Trout eggs, the only species and life stage assessed over the winter period at depths greater than 10m, thermal exceedances occur equitably at both reference and LSA sites early in the incubation period (see Appendix I, Section 9.5.1.3); therefore, deployment and retrieval of temperature loggers over the winter period at depths greater than 10m is not contributing to the assessment of thermal effects.

The LSA Remapping Tool generates daily temperatures for 8,815 nodes at the surface and 8,815 nodes at the bottom over the entire TRA period. Daily average and daily maximum temperatures from the LSA Remapping Tool can be used in the same manner as measured temperature values in the TRA process. For the 2022 TRA, the tool was used to increase the spatial assessment of the extent of thermal exceedances for Lake Whitefish eggs, Round Whitefish eggs and Lake Trout eggs. In the 2027 TRA, temperatures used for HQ calculations for Lake Trout eggs will be generated using the LSA Remapping Tool. Temperatures used for

HQ calculations for Lake and Round Whitefish eggs will also be completed using the LSA Remapping Tool and available measured data.

7.4.5.3 Mitigation Measures Assessment

Continued monitoring and assessment of impingement and entrainment and thermal effects will occur as per the established regulatory framework. This iterative assessment will also include ongoing Indigenous engagement and working to embed Indigenous values as was done throughout the mitigation measures assessment report. A re-evaluation of risks and basis for decisions surrounding mitigation measure will be reported in subsequent ERAs.

Bruce Power will provide an update on the progress of the use of intake water flow flexibility (i.e., variable speed drives) engineering work and on current research related to the effects of sound and light on fish species relevant to the LSA in the 2027 ERA.

7.5 Predictive Effects Assessment

7.5.1 Conclusions

Over the past 20 years Bruce Power has gained a significant amount of experience in the restart and refurbishment of its CANDU reactors. Overall, as outlined in Appendix D [R-35] of this report, potential environmental effects of future effects are anticipated to be similar to those associated with the existing operations. Therefore, the existing environmental monitoring programs will be retained as required to confirm predictions and be reported through the annual EMP findings. During MCR activities, Bruce Power's environmental management programs will be maintained.

The future site activities including Lu-177 production, Life Extension and MCR activities were evaluated for potential interactions with the environment. The preliminary assessment screened these interactions to assess whether the current operational conditions were bounding. Where this was not considered to be the case, a predicted bounding condition was developed and screened against accepted values for the protection of human health and the environment. In all cases, the current conditions were considered bounding or the predicted conditions were screened as being acceptable.

The environmental effects and interactions that were discussed in this report will be continually evaluated throughout the MCR planning stages through involvement of the Environment Department as a stakeholder in the design process and planning of MCR activities. Environmental Management Plans will be implemented and executed as required for certain MCR activities.

All activities at the Bruce Power site, including MCR activities, will continue to be executed in a manner that ensures continual protection of human health and the environment, in accordance with applicable operating licences, codes and standards.

7.5.2 Recommendations

Although no significant impact on the environment is expected from Lu-177 production, Bruce Power will collect data to verify and confirm that changes in atmospheric emissions are negligible. During commissioning of the IPS and for a limited period thereafter, the particulate filters from the stack monitor will be analyzed for the presence of Yb-175, Yb-177 and Lu-177 in the gaseous effluents. Bruce Power will review the additional monitoring data to validate the assumptions presented in the PERA.

With the successful execution of a large portion of the higher risk Life Extension and MCR activities for Unit 6, including the draining of systems and the removal of components, no substantial changes to baseline radiological and conventional emissions and effluents are expected to occur during Life Extension and MCR. As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities. The need to evaluate for monitoring related to Gas Bubble Trauma at the completion of the Life Extension Program will be carried to the 2027 ERA. No specific recommendations are required.

7.6 Conclusions

The ERA demonstrates that the operation of the Bruce Nuclear Facility has not resulted in adverse effects on human health of nearby residents or visitors or on non-human biota as a result of exposure to physical stressors or to radiological or chemical substances.

The baseline radiation doses to members of the public residing in the area surrounding the Site as calculated based on current operational conditions are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). There is no radiological risk to human health for members of the public resulting from normal operations on the Site. The human health risk assessment for chemicals identified no unreasonable risk for people using the land around the Site for recreational or residential/agricultural uses.

The radiation doses to non-human biota residing on or near the Site are less than 1% of the applicable UNSCEAR benchmark value. There is no radiological risk to non-human biota resulting from normal operations on the Site. The conventional EcoRA identified potential risks to terrestrial ecological receptors at Construction Landfill #4, Fire Training Facility, Distribution Station #1 and at five general soil sampling sites, to semi-aquatic receptors at Eastern Drainage Ditch and to aquatic receptors in Lake Huron, FSL, B31 Pond and Eastern Drainage Ditch. Additional follow-up monitoring will be completed to refine these potential risks.

For thermal effluent, a low risk to some mainly cold and cool water species and life stages located in the Local Study Area was assessed during the thermal risk assessment process. Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected. For impingement and entrainment, Bruce Power has obtained a Fisheries Act Authorization (FAA) from Fisheries and Oceans Canada (DFO) that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time. For other physical stressors, the assessment of the physical effects of noise, cooling water discharge and habitat alteration has shown no unreasonable risk to human or ecological receptors.

As the current operational conditions are demonstrated to be bounding of future activities, the 2022 ERA is, therefore, shown to be bounding of proposed future activities. Therefore, there is no additional radiological or non-radiological risk to human or non-human biota resulting from anticipated future activities.

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APPENDICES FOR BRUCE POWER 2022 ENVIRONMENTAL QUANTITATIVE RISK ASSESSMENT

B-REP-03443-00025

Rev 000

June 2022

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APPENDICES FOR BRUCE POWER 2022 ENVIRONMENTAL QUANTITATIVE RISK ASSESSMENT			

ABSTRACT OF PRESENT REVISION:

Initial Issue

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1.0 APPENDIX A: SITE DESCRIPTION

The Site is located on the east shore of Lake Huron approximately 18 km north of Kincardine and 17 km southwest of Port Elgin (Figure 1). The Site occupies an area of 932 hectares (2,300 acres) within the Municipality of Kincardine, County of Bruce, Ontario. The Site is surrounded by a security fence and site access is restricted and monitored 24 hours per day by security personnel.

The Site is currently being leased by Bruce Power, but also encompasses lands occupied by OPG, CNL Douglas Point and Hydro One. This update to the ERA includes only lands leased by Bruce Power and does not consider environmental impacts due to activities occurring on non-Bruce Power leased lands (Figure 2).

Land use in the immediate vicinity of the Site is primarily agricultural, recreational and rural residential. Surrounding the Site is a mixture of rural agricultural land, former gravel pits, fragmented woodlands, streams and wetlands. Recreational land use includes Inverhuron Park and cottages in the hamlet of Inverhuron (south of the Site) and Baie du Doré/Scott Point area (north of the Site). The Bruce Power Site lies within traditional Indigenous territory.

Figure 1 Site Location

1.1 Engineered Site Facilities

The Bruce Nuclear Facility is comprised of the Bruce A Generating Station and the Bruce B Generating Station. Bruce A is located on the northeast corner of the Bruce Nuclear Facility, while Bruce B is located on the southwest corner of the Bruce Nuclear Facility (Figure 2). The Bruce A and Bruce B facilities are each licensed by the CNSC as a Class I Nuclear Facility under the *Nuclear Safety and Control Act*. A list of engineered site facilities and their general locations is provided in Table 1.

The four Bruce A CANDU pressurized heavy water nuclear reactors[1] were brought into service by Ontario Hydro in 1977 (Units 1 and 2), 1978 (Unit 3) and 1979 (Unit 4). The four Bruce B CANDU pressurized heavy water nuclear reactors (Units 5 through 8) were similarly brought into service in 1984 (Unit 6), 1985 (Unit 5) 1986 (Unit 7) and 1987 (Unit 8).

In the late 1990s, Ontario Hydro, the then owner of the stations, made a business decision to temporarily lay-up the Bruce A units in order to concentrate resources on other reactors in Ontario Hydro's fleet. The four Bruce A reactors were subsequently taken out of service in 1995 (Unit 2), 1997 (Unit 1), and 1998 (Unit 3 and Unit 4). Bruce B continued in service.

In 2001, Bruce Power took over operation of Bruce A and Bruce B from OPG, which is Ontario Hydro's successor, through a long-term leasing arrangement. At that time, all four units of Bruce A were in a laid-up state. Following an environmental assessment in 2002, Bruce Power subsequently returned Bruce A Units 3 and 4 to service in 2004 and 2003, respectively. The extent of the Bruce Power leased lands and habitat classification is presented in Figure 3.

In 2005, Bruce Power entered into the Bruce Power Refurbishment Implementation Agreement to enable the restart of Bruce Units 1 and 2, to return the site to its full operating capacity of eight units. As of the fall of 2012, all eight CANDU units have been fully operational.

In 2006, Bruce Power was granted approval to extend the life of Bruce A Units 1 and 2 after completing an EA, which concluded that the extension of life activities, and continued operation caused no significant adverse effects. It was recommended that continual evaluation for minor adverse effects be completed. This recommendation is encompassed by the Bruce A Refurbishment for Life Extension Environmental Assessment Follow-up Monitoring Program (EA FUP [R-1]).

In 2015, Bruce Power and the Independent Electricity System Operator (IESO) entered into an amended, long-term agreement to secure 6,400 MW of electricity from the Site, through a multi-year Life-Extension Program. The Life Extension also includes Major Component Replacement, which began for Unit 6 in 2020 and extends the life of Units 3-8 over a period of 16 years, allowing Bruce Power's units to operate safely through to 2064.

[1]Canada Deuterium Uranium (CANDU) Pressurized Heavy Water Reactors (PHWR) designed by Atomic Energy of Canada Limited and Ontario Hydro.

Each of the generating stations contains intake and outflow channels to collect cooling water for circulation through the generating stations followed by discharge into Lake Huron. Most of the water that is withdrawn passes once through the Condenser Cooling Water (CCW) system, and the remainder is used for service water to maintain pressure and provide water for small components. Water is drawn from Lake Huron through a deep water intake equipped with a velocity cap to minimize currents and fish impingement for intake locations, note that not to scale and lines are illustrative). Water passes to the forebay via a tunnel that runs underneath the lake bed and is equipped with a velocity cap that is partly recessed into the lake bed. From the forebay, intake water passes through bar screens and travelling screens to remove large and small debris, respectively. Water passes through the condenser and is discharged to Lake Huron via the CCW duct and discharge channel. This process is the same for Bruce A and Bruce B which have separate intake structures. At Bruce A, the reinforced CCW duct extends from Unit 4 in the east to the outfall structure, at the start of the discharge channel into Lake Huron. Similarly, at Bruce B, the reinforced CCW discharge duct extends from Unit 8 in the northeast to the outfall structure, at the start of the discharge channel into Lake Huron. Both discharge channels are bounded by concrete and rock groynes.

Several support facilities are located on the Bruce Nuclear Facility and operated and maintained by Bruce Power such as a Central Maintenance Facility (CMF), Central Storage Facility (CSF), garages, warehouses, workshops, a sewage processing plant and various administrative buildings (collectively known as Centre of Site).

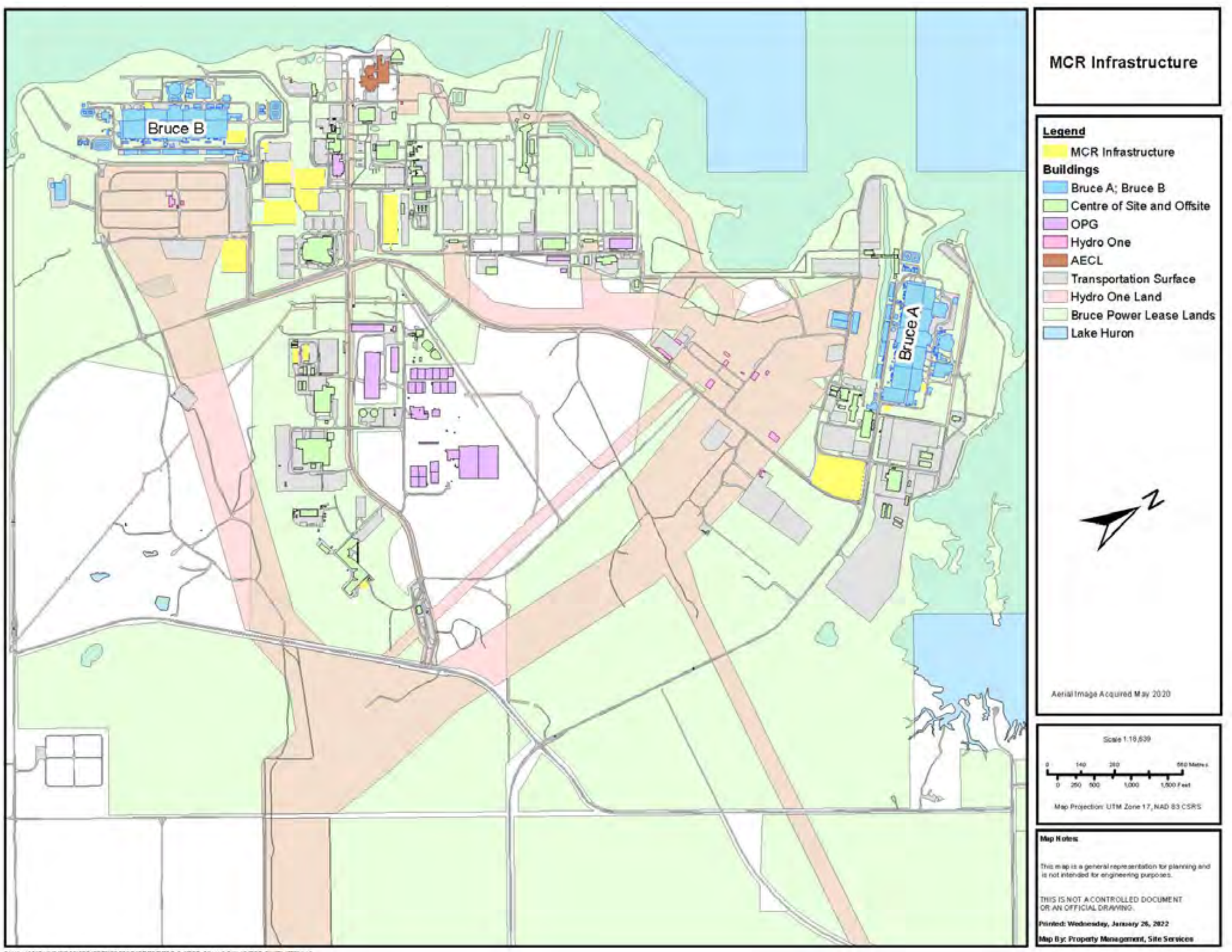

Figure 2 Bruce Power Site Layout. OPG retained lands are shown as white areas.

Table 1 Engineered Site Facilities at the Bruce Nuclear Facility

Bruce A	Bruce B	Center of Site
• Bruce A Nuclear Generating Station (B03) • Technical Building (B06) • Restart Warehouse (B07) • Sandblasting Shop • Water Treatment Building H • Bruce A Switchyard	• Bruce B Nuclear Generating Station (B05) • Water De-Mineralization Plant (B42) • Bruce B Switchyard • Bruce B Administration Building	• Douglas Point (CNL, B01) • Technical Mock-up Building (TMB) (B29) • Condensate Plant (B13) • Operations Building “A” (OBA) (B22) • Phase 1 (Security) (B11) • Phase III (OPG, B21) • Support Centre (B10) • Bruce Steam Plant (BSP) (B41) • Sewage Plant (B18) • Western Waste Management Facility (OPG, B15) • Western Used Fuel Dry Storage Facility (OPG, B20) • Supply Chain (B16) • Central Maintenance and Facility (CMF) (B12) • EPS Training Facility (B38) • Bruce Learning Centre (B31) • Main Entry Building (B34) and security checkpoints • Central Storage Facility (B44) • MCR Warehouses (B16) • Project Offices (B33) • North Warehouse (B07)
Note: In addition to the above, there are also additional engineered site facilities owned/operated by OPG, CNL and Hydro One on site.		

The Site also contains several facilities that are not owned and operated by Bruce Power. The Site was originally owned and operated by Ontario Hydro (now OPG). In 2001, Bruce Power took over operation of the Site from OPG, through a long-term lease arrangement. OPG retains portions of the Site and operates a number of facilities within these OPG retained lands, most notably the WWMF. OPG-retained lands are shown on Figure 2.

1.1.1 Western Waste Management Facility

The WWMF is owned and operated by OPG and is located on OPG retained lands within the boundary of the Site. Developed in stages since 1974 to accommodate wastes produced during reactor operation and maintenance, the waste management facility receives and manages shipments of low and intermediate level radioactive waste from the Bruce, Pickering and Darlington nuclear power stations. Beginning in 2003, used fuel from the Bruce Power stations has also been stored at the Used Fuel Dry Storage Facility, located adjacent to the WWMF. While OPG was not explicitly involved in the assessment, the influence of the WWMF is implicitly included in the assessment given that it is not possible to isolate any potential effects due to the WWMF from the Site as a whole. Furthermore, an ERA has been completed for the WWMF by OPG [R-2], and is referenced where applicable in this report.

1.1.2 Douglas Point

The Douglas Point reactor, owned by Canadian Nuclear Laboratories (CNL), is also located within the boundaries of the Site (Figure 2). Douglas Point, which operated between 1966 and 1984, was the prototype commercial-scale CANDU nuclear power plant. With full operation commencing in 1968, the Douglas Point Generating Station supplied 220 MW to the Ontario grid over the next 16 years.

Eventually a decision was made to shut down Douglas Point rather than undertake the refurbishment of the pressure tubes that was required for continued operation. While the Douglas Point facility structures remain in place today, the reactor has been permanently shut down since 1984. Used fuel from the reactor is stored in dry storage modules at the facility. Decommissioning of the Douglas Point Facility is progressing with a 2070 timeline for completion. The decommissioning plans for the coming years include the dismantling of non-nuclear buildings and nuclear support buildings. The reactor and its building are anticipated to be decommissioned after 2030.

1.1.3 Bruce Heavy Water Plant

The former Bruce Heavy Water Plant lands are located within the Site. The Bruce Heavy Water Plant was in continuous operation from April 1973 until March 1998, producing reactor grade heavy water for use in OPG's and other CANDU reactors. Plant A was operated from 1973 to 1984. Plant B was operated from 1979 to 1997.

In 2003, the federal Minister of the Environment made a decision to allow the decommissioning project to proceed through the licensing process. Following a public hearing in February 2004, OPG was granted a ten-year licence to carry out decommissioning of the facility. In 2015, following completion of decommissioning, these lands were subsequently leased to Bruce Power.

1.1.4 Hydro One

Hydro One owns and operates a number of assets within Site. In addition to these assets, Hydro One owns transmission corridors and distribution lines that run from on-site facilities to off-site [R-3]. As stated previously, these assets are not part of the 2022 ERA.

1.1.5 Kinectrics North

Kinectrics' KI North Facility is located in Tiverton, Ontario, approximately 3 km from the Bruce Site. The site has an approximate footprint of 16.66 hectares and houses one building with an approximate footprint of 3440 m^2. The facility functions as a radioactive workspace to decontaminate and refurbish large nuclear reactor tools and equipment used during reactor maintenance outages [R-4].

1.2 Description of the Natural and Physical Environment

The natural and physical environment of the Site has been the subject of numerous previous environmental investigations. These investigations have described the geology, hydrogeology, hydrology, vegetation communities, aquatic communities, human land use, and population density that are listed in CSA Standard N288.6-12 [R-5] requirements. The key findings from these investigations are summarized in the following subsections.

In general, the Site is situated at the northern end of the Douglas Point Promontory, a feature of comparatively low relief rising approximately 13 to 15 m above the mean surface elevation of Lake Huron to elevations of approximately 185 to 190 metres above sea level (masl). This promontory juts 2.5 to 3.0 km into the lake over a length of 5 km extending from Baie du Doré southward to Inverhuron Bay. Bedrock outcrops exist along the Lake Huron shoreline between Inverhuron Bay and Baie du Doré where it has been exposed by shoreline erosion. Inland, the dominant physiographic feature is the Algonquin Bluff, a ridge approximately 30 m high formed from shoreline erosion by post-glacial Lake Algonquin. The terrain above and inland from the Algonquin Bluff consists of comparatively flat clay plains with a network of streams that drain westward to Lake Huron. The glacial Lake Nipissing shoreline is marked by the less prominent Nipissing Bluff situated below the Algonquin Bluff. Areas of wetland including cedar swamp also occur below the Algonquin Bluff and in other poorly drained forested areas. The Baie du Doré Provincially Significant Wetland (PSW) is located on the shore of Lake Huron, adjacent to the northern Site boundary.

The Site and its surroundings have features of natural, physical and cultural significance. These include the Lake Huron shoreline, Lake Huron commercial, recreational and traditional fisheries, and the Baie du Doré PSW. Two provincial parks (Inverhuron and MacGregor Point) and two conservation areas (Brucedale and Saugeen Bluffs) are within close proximity to the Site.

1.2.1 Study Area

The spatial and temporal boundaries of the assessment are described below.

1.2.2 Spatial Boundaries

Figure 3 illustrates the spatial boundaries considered in the 2022 ERA. The Site is defined herein as the lands within the fenced perimeter of the Site, including the 914 m exclusion zones of Bruce A and Bruce B; a portion of Inverhuron Provincial Park (immediately southwest of the Site); the lands of the Baie du Doré wetland (as mapped by the Ontario Ministry of Natural Resources and Forestry [MNRF]); and the land to the east of the Bruce Power Facility to Tie Road. Note that the Site encompasses lands currently occupied by OPG and CNL Douglas Point. Previous investigations have included the collection of surface water samples at several points locations along the shoreline of the nearshore Lake Huron (i.e., as far south as Kincardine and as far north as Southampton) environment and therefore the assessment includes the adjacent waters of Lake Huron. These locations were also considered to be within the spatial boundaries of the assessment.

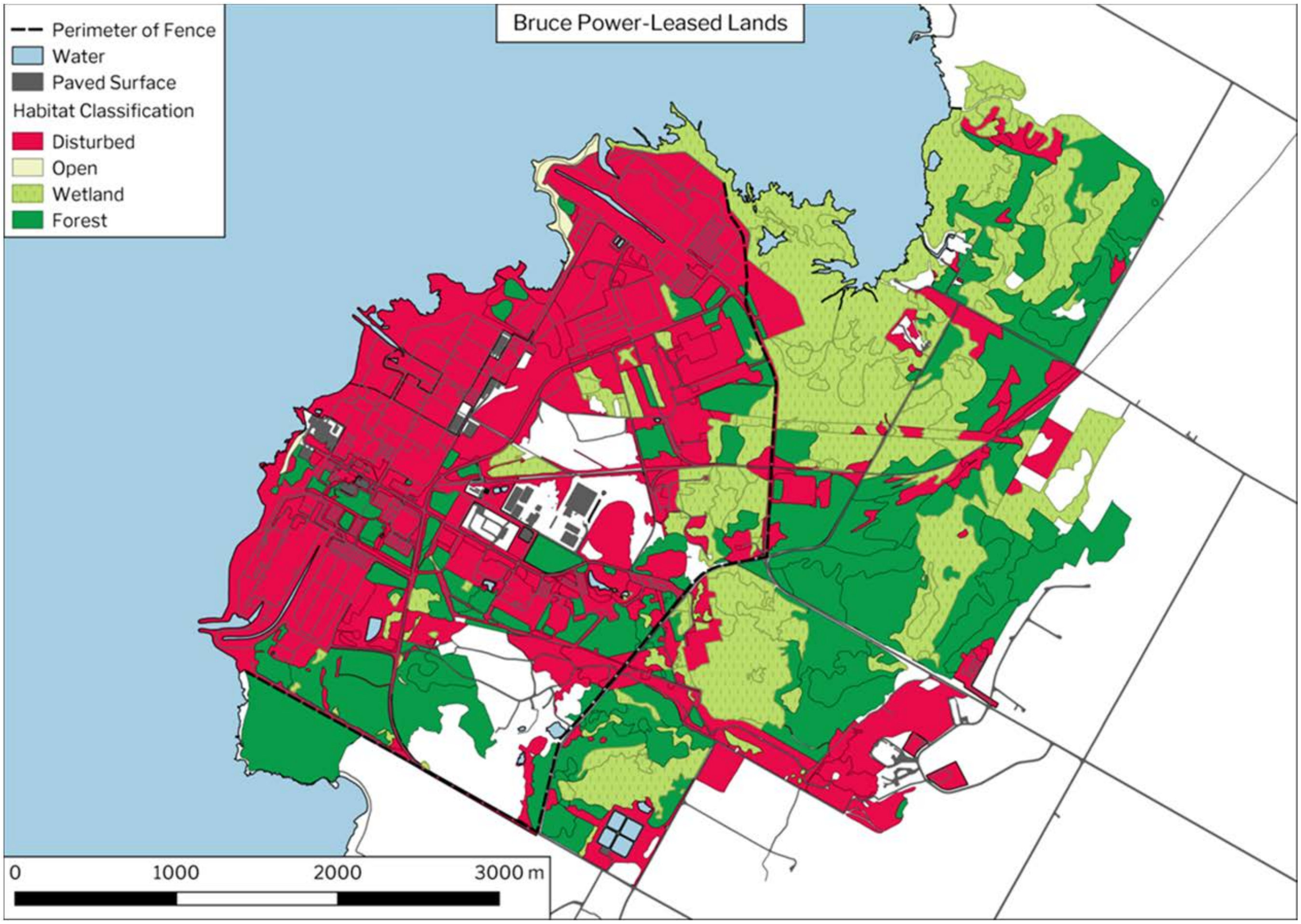

Figure 3 Bruce Power Leased Lands and Habitat Classification. White areas on site are OPG retained lands.

1.2.3 Temporal Boundaries

Where possible, the 2022 ERA is supported by environmental quality data for chemicals, radionuclides, and physical stressors that has been collected within the past five years (i.e., 2016 to 2020/2021, inclusive). For most environmental media, recent data were available. However, if data from the past five years were not available for a given environmental medium or location, older data were used to fill data gaps. Therefore, facility operations that were active as of the time of data collection are considered in the 2022 ERA.

1.2.4 Areas of Environmental Significance

Baie du Dore, which is along the north portion of the Site and study area (that includes lands within 1 km of the Site), as well as Scott Point which is in the northeast portion of the study area, is mapped on Schedule C (Constraints) of the County of Bruce Official Plan [R-6]. Based on the County Official Plan, designated areas where development must be controlled include cold and warm water streams, Areas of Natural Significance (ANS), local and provincially significant wetlands, as shown on Schedule C. Development is required to be set back from all watercourses and PSW, and the County is in a position to influence the nature of development occurring within and adjacent to ANS.

The lakeshore area of Lake Huron along the southern portion of the study area, as well as the unevaluated wetlands and significant woodlands in the southeast portion of the Site and study area, are mapped on Schedule B (Natural Heritage System) of the Municipality of Kincardine (the Municipality) Official Plan [R-7]. Development and site alternation shall not be permitted in all fish habitat, significant wetlands and woodlands, and ANS.

1.3 Areas of Previous Environmental Investigation

Previous environmental investigations carried out on the Site property were largely focused around the engineered site facilities listed in Table 2, which informed a number of the historic soil sampling investigations (and subsequent updates).

As a result, much of the available on-site environmental quality data have been collected from these engineered site facilities that are active industrial areas. Given that the ecological component of the 2022 ERA focused on on-site exposures, it is reasonable to exclude those areas that are in active industrial use and those areas on OPG retained lands. These industrial areas were not assessed further in the 2022 ERA given the lack of ecological habitat and/or lack of complete exposure pathways. Many of these active industrial areas either contain buildings or at least are paved and therefore do not represent ecological habitat.

However, there were two areas that are classified as “active industrial” that were included in the assessment: the Bruce A Storage Compound (BASC) and Distribution Station #8 (DS8). These areas can be described as having a gravel cover with grasses and shrubs, which may be used occasionally by some ecological receptors. These areas were also adjacent to lands that represent suitable ecological habitat. For those reasons, it was considered reasonable to assess these locations in the EcoRA.

Table 2
Areas of Previous Environmental Investigation at the Bruce Nuclear Facility, with historical numbering from the 2000 Phase II Environmental Site Assessment [R-8] included for consistency

Bruce A	Bruce B	Center of Site
• Bruce A Construction Maintenance Yard (BACM Site #8) • Bruce A Storage Compound (BASC Site #5) • Bruce A Scrap Metal Yard (BASM Site #6) • Bruce A Standby Generators (BASG Site #9) • Bruce A Transformer Area (BATR Site #49) • Distribution Station #8 (DS8 Site #57) • Former PCB (Polychlorinated Biphenyls) Storage Building (PSB Site #7) • Paint and Sandblast Shop (PSS Site #51)	• Bruce B Construction Laydown Area (BBCL Site #17) • Bruce B Empty Drum Laydown Area (BBED Site #58) • Bruce B Emergency Generators (BBEG Site #47) • Bruce B Standby Generators (BBSG Site #46) • Bruce B Transformer Area (BBTR Site #50) • Bruce B PCB storage building (Site #18)	• *Bunker C Oil Tanks & Ignition Oil Day Tanks (BCO Site #13)* • *Bunker C Oil Tanks & Ignition Oil Day Tanks – Acid Wash Pond (BCO-AWP Site #13A)* • Bunker C Oil AST (Aboveground Storage Tank) & Oil Delivery System (BCOA-ODS Site #12) • Bruce Nuclear Standby Generators (BNSG Site #36) • Bruce Stores Storage Compound (BSSC Site #30) • *Construction Landfill #4 (CL4 Site #33)* • Distribution Station #1 (DS1 Site #57) • Distribution Station #2 (DS2 Site #57) • Distribution Station #4 (DS4 Site #57) • Distribution Station #5 (DS5 Site #57) • Former Large Bore Pipe Shops (FPS Site #23) • Former Sewage (Commissioning Waste) Lagoon (FSL Site #21) • Fire Training Facility (FTF Site #32) • *Former Spent Solvent Treatment Facility (SSTF Site #48)* • Waste Chemical Transfer Facility (WCTF Site #28) • *Western Waste Management Facility (WWMF)*
Note: Engineered site facilities owned/operated by OPG shown in *italics*.		

1.3.1 Areas Included in the Assessment

Areas encompassing active or historical industrial operations on the Site which have been retained for further assessment in the 2022 ERA (Figure 4) are described below. Currently, Bruce Power performs groundwater monitoring annually at selected locations across the Site focusing on areas requiring long term monitoring.

In addition to specific assessment of the areas described below, routine soil monitoring data has been collected during the period from 2000 to the present. Given the low turnover of soil as a media and the lack of new sources of conventional contamination at areas located away from industrial activity on site, soil data from 2000 to the present has been included for completeness. This included several isolated soil sampling locations (SS/BPS sites - Figure 44) across the Site located further from the industrial activities and likely providing habitat for terrestrial receptors. Given extensive past construction efforts at the Bruce Power site, no area can be considered completely undisturbed natural habitat.

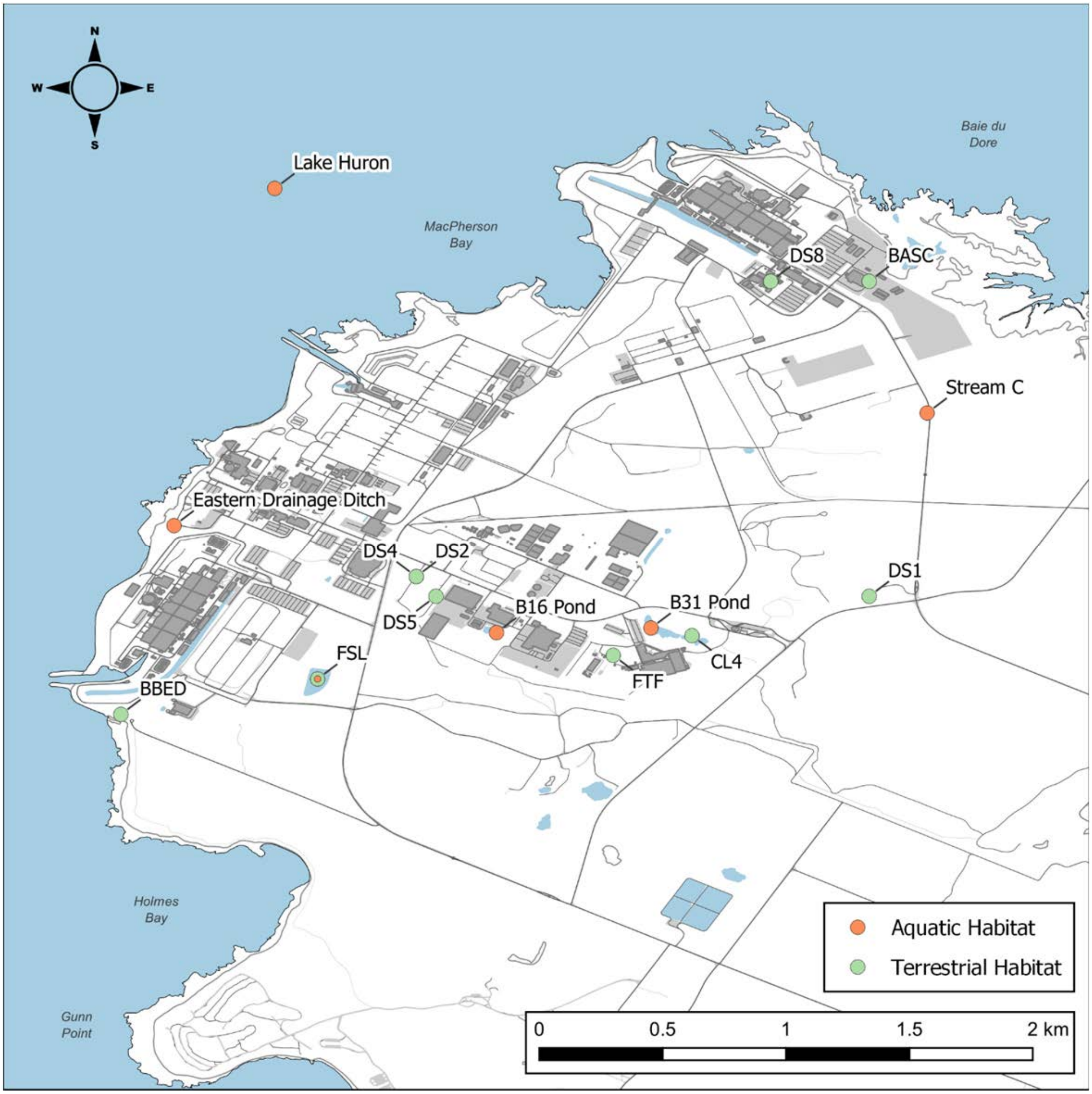

Figure 4 Areas Included in the Assessment, including Lake Huron, Stream C, Bruce A Storage Compound (BASC), Construction Landfill 4 (CL4), B31 and B16 Ponds, Eastern Drainage Ditch (EDD), Fire Training Facility (FTF), Former Sewage Lagoon (FSL), Bruce B Empty Drum (BBED) Laydown Area and Distribution Stations (DS1-DS8)

1.3.1.1 Bruce A Engineered Site Facilities

Bruce A Storage Compound (BASC Site #5)

The Bruce A Storage Compound (BASC) is located east of the Bruce 1-4 Generating Station in proximity to Lake Huron. The site is approximately 670 m by 260 m, with an area of 17 hectare. The site has a large warehouse structure, parking lots, and a few small shed-like structures onsite. The majority of the site consists of an outdoor storage yard that is fenced and locked outside of normal operating hours. The outdoor storage area has been used for a variety of materials, including cables, salt, scrap metal and wood, since the 1970’s. Two areas north of the large warehouse were used for storage and dispensing of various chemicals. The chemicals were known to have included solvents, paint thinners, and boiler cleaning related chemicals.

The BASC site consists of sand and gravel or gravely sand fill present to a general depth of 1.5 mbgs. Clayey silt fill is present at most locations to a general depth of 2 to 3 mbgs. Clayey silt and/or silt (native) at seven locations, below depths of 2 to 3 mbgs and extending until termination of the borehole.

During the monitoring event completed on October 8, 2019, the groundwater elevations were measured between 177.54 and 178.41 masl. Monitoring wells BASC-22 and BASC-23 had water levels (piezometric surface) at or above ground surface and were therefore considered to be under confined or semiconfined (aquifer) condition. The water levels at both BASC-22 and BASC-23 were 0.16 and 0.42 m above ground surface respectively during the monitoring event indicating they were under positive hydrostatic pressure at both locations. This may be attributed to the installation of the monitoring wells within a deep native till layer. The regional hydrogeology is defined in section 2.5.4 and generally flows towards Lake Huron. From the 2019 monitoring event, the inferred groundwater flow direction was found to be northwest. This site is relatively flat, and the site groundwater may be influenced by site features such as topography and the large amount of gravel surface cover. There are currently 4 groundwater monitoring wells located at the BASC with groundwater elevations ranging from 177.410 masl to 178.448 measured most recently on September 28, 2020.

Groundwater sampling occurred in 2016 for radionuclides and in 2017 for anions and nutrients, dissolved metals, VOC’s, PAH’s, PHC’s and radionuclides. All results met the applicable MECP Site Condition Standards. Radionuclide results were compared against the Ontario Drinking Water Standards (ODWS) [R-9] although the groundwater is not considered to be directly applicable to the Safe Drinking Water Act. All groundwater results were well below the ODWS. Based on these results, groundwater sampling was not completed at this site in 2018, 2019 and 2020 however water levels were taken in order to infer groundwater flow direction.

Soil monitoring was completed in 2016 and 2021 at the BASC. Sampling took place for pH, metals, PCB’s, PHC’s phenols and VOC’s at three locations on October 26, 2016. Minor metals exceedances were observed when compared against MECP Table 1 SCS and the CCME Soil Quality Guidelines [R-10][R-11]. Soil sampling was also completed for radionuclide analysis for Cs-134, Cs-137, Co-60 and K-40 in order to compare against previous results from 2009. The soil criteria used to determine the presence of radioactive (gamma) contamination are obtained from the National Council on Radiation Protection and Measurements (NCRP), 1999 [R-12]. All results were well below the criteria. Results from 2021 are described in Section 1.11. Soil sampling is not completed at the BASC on a regular frequency.

Based on the ecological land classifications previously completed for the Site [R-13], the BASC is classified as industrial in active use (Figure 9). The BASC is maintained free of most vegetation except grass and weeds [R-8].

Due to the potential ecological habitat it provides and the suitable habitat to which it is adjacent, the BASC was retained for assessment in the EcoRA. Soils were retained for birds and small terrestrial mammals that are considered to be able to access the Site, as these receptors may make occasional use of the area for foraging. Terrestrial plants and invertebrates were therefore evaluated. Groundwater was retained for the potential discharge of groundwater to Baie du Doré, and due to the shallow groundwater conditions at the BASC, for direct contact with terrestrial plants.

1.3.1.2 Bruce B Engineered Site Facilities

Bruce B Empty Drum Laydown Area (BBED Site #58)

The Bruce B Empty Drum Laydown Area (BBED) is located between the south bank of the Bruce B intake forebay and the shoreline of Lake Huron and has an area of 1.4 hectares. The BBED was cleared in 1977, and was used during the construction of Bruce B for the storage of construction materials, drums, trailers and potentially tanks [R-8]. The storage of drums occurred on approximately 20% of the BBED, on the east end [R-8]. Construction activities ceased in the late 1980s, and the drums were removed around 1989 [R-8]. This site currently has no activity and as a result of the previous assessment was not considered for long term groundwater monitoring.

Test pitting showed that the majority of the BBED consisted of gravel or stone with some weeds and grass at surface. The underlying materials at the east end of the sampled area within the BBED were primarily rock fill with granular fill, and the west end of the sampled area the underlying materials were primarily silty clay with lenses of sand [R-8].

No groundwater was observed within the test pits to 1.5 mbgs [R-8]. Groundwater wells have not been installed on the BBED, therefore no groundwater depths or flow information is currently available. Regardless, groundwater flow on the BBED is inferred from regional groundwater flow within the general area and is inferred to flow westerly towards Lake Huron.

Groundwater sampling has not been conducted at the BBED site. Previous investigations at this site concluded that no significant contamination was found and no further studies were required. Based on these findings, there is no regular sampling completed at the BBED.

Soil sampling for conventional parameters was last conducted at the BBED site during ESA activities in 2000. More recently, sampling was completed in 2019 in the general BBED area for radionuclides Cs-134, Cs-137, Co-60 and K-40. The soil criteria used to determine the presence of radioactive (gamma) contamination are obtained from the NCRP, 1999 [R-12]. All results were well below the criteria. Soil sampling is not completed at the BBED on a regular frequency.

Based on the ecological land classifications previously completed for the Site [R-13], the BBED is classified as industrial barren (Figure 9).

The BBED provides relatively unattractive habitat due to a lack of surface cover and the proximity of forested areas to the south, but ecological receptors could potentially utilize the BBED as corridor to Lake Huron and as a result the BBED was retained for assessment in the EcoRA. Potential ecological receptors assessed in the EcoRA included mammals, birds, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs on the Site. Groundwater sampling has not occurred on the BBED; therefore groundwater within the BBED could not be assessed with respect to potential root uptake by terrestrial plants or for potential discharge of groundwater to surface water. Potential groundwater discharge into Lake Huron will be assessed based on its surface water quality data.

Bruce B Standby Generators - North Site (Site #46)

The Bruce B Standby Generator Site (BBSG, Site #46) consists of two separate units: BBSG South, at the southern end of the Bruce B Powerhouse and BBSG North, at the northern end of the Bruce B Powerhouse. At the northern site, there are storage and maintenance facilities to the east and west, and the Bruce B Powerhouse building is located to the south. On the northern side, there is a strip of vacant land, then a ditch leading to Lake Huron. Both sites have a pair of generator units, and adjacent are two vertical above ground fuel storage tanks with secondary spill containment around each tank. In December 2012, a #2 fuel oil line leak was discovered near the north site. Initial response to this event damaged BBSG-13 and this well is no longer available for use. As a result of this underground line leak, oil sheen was discovered on the shore of the Lake as well as the Eastern Drainage ditch to the north of the BBSG site. Emergency response was implemented and the line was isolated. Corrective actions were put in place and a long term remedial action plan was rolled out. Fifty five monitoring wells currently exist at the BBSG North site of which 30 have been installed in the overburden, 20 installed in the bedrock and 5 installed in the bedrock/overburden interface.

During the subsurface investigation and related activities in September 2013 and February 2014, the soil profile and subsurface stratigraphy encountered in the boreholes generally consisted of a coarse-grained surficial fill layer, extending to bedrock at most locations; this is consistent with the previous drilling investigations for the BBSG Site. The fill material is generally categorized as gravel to silty sand to sandy silt fill, while fragments of shale are encountered closer to the inferred bedrock contact, at depths ranging from 1.52 to 4.88 metres below ground surface (mbgs). The bedrock profile and stratigraphy encountered in the boreholes during the subsurface investigation activities consisted of dolomitic limestone, dolostone, and shale interbeds. The bedrock surface elevations ranged from 175.1 to 178.9 metres above sea level (masl). The dolomitic limestone rock unit was brownish-grey in colour, medium-strength, and generally, the upper 0.1 to 0.3 m of rock showed signs of weathering and moderate fractures. The additional drilling work completed in December 2020 further supports the existing interpretation of the local geology. Generally silty sand fill was noted in the two boreholes on the west side of the EDD, with increasing trace gravel at depth with dolomitic bedrock encountered between 1.78 mbgs (BBSG-69BR) and 1.98 mbgs (BBSG-68BR). The three boreholes to the east of the EDD noted light brown silty sand, sand or sandy silt fill with trace gravel to bedrock which was encountered between 1.25 mbgs and 1.80 mbgs [R-14].

The groundwater in the overburden and shallow bedrock beneath the BBSG is interpreted as flowing in a north-northwestern direction toward the lake, and in a northeastern direction toward the EDD. The groundwater flow directions were generally consistent throughout 2020. These inferred groundwater flow directions are consistent with 2019 and historical observations. Based on the data collected after the operation of the mobile P&T system and up to the end of 2020, the water table in general is close to the interface of overburden and bedrock, with some variations due to the variable thickness of overburden at the Site. The shallow groundwater in the overburden and bedrock is under unconfined conditions and is influenced by recharge from precipitation and snow melt. In 2020, the depth to the water table ranged from 1.25 to 3.08 metres below ground surface (mbgs). Backfilling and land reclamation operations during the construction of Bruce B have significantly altered the original site topography, and the shallow subsurface stratigraphy. The shallow overburden material may have been buried beneath fill material of variable thickness and composition. Construction materials, consisting of compact sands and gravel, may have been used as bedding materials for utilities and foundations, and for backfilling around station structures. The groundwater flow at the BBSG Site may be affected by local subsurface structures, such as the surrounding building foundations and underground services and conduits. In addition, the granular backfill material surrounding the structures and utility corridors may represent preferential pathways for groundwater flow and contaminant migration, while some of the Site structures constructed deep into the subsurface (such as piping, conduits, foundations, and the like) may serve as flow barriers that restrict or redirect groundwater flow [R-14].

Between 2013 and 2018, free phase product recovery activities occurred. Overall, there has been a general decrease or decline in the PHC concentrations detected in the groundwater away from the source area except for the wells located near the Eastern Drainage Ditch. Currently, the north site is undergoing a long term monitored natural attenuation program which consists of sampling up to 25 monitoring wells quarterly for 2019 and 2020 and semi-annually from 2021-2023 [R-14].

The 2020 Monitored Natural Attenuation (MNA) program involved the quarterly collection of groundwater samples for COPCs and Natural Attenuation (NA) indicator parameters from the selected monitoring well network to monitor temporal trends and to observe the effects of Natural Attenuation (NA) in groundwater. In 2020, due to COVID-19 restrictions and limitations, only three of the four (Q2-Q4) proposed quarterly monitoring events were conducted. The monitoring results from this MNA program are continuing to be evaluated to determine whether any additional remedial action is warranted or required and to refine the MNA program for beyond 2020 [R-14].

The COPCs include PHC fractions F1 through F4 and BTEX. Natural Attenuation parameters include nitrate/nitrite, sulphate/sulphide/hydrogen sulphide (H2S), total and dissolved iron, dissolved manganese, alkalinity, and methane. Field parameters recorded for NA evaluation included dissolved oxygen (DO) and oxidation reduction potential (ORP). Groundwater data from the monitoring events are compared to applicable Table 8 SCS [R-10][R-14].

At the BBSG, the EDD was identified as the primary location of ecological receptors that could be impacted by the COPCs in the subsurface in the site Northeast plume. The extent of the Liquid Non-Aqueous Phase Liquids (LNAPL) and dissolved plume is within approximately 20 m of the EDD; however no sheen or detected concentrations of PHCs were observed or measured in the EDD during any of the quarterly events in 2020 based on existing surface water sampling locations. Previously, dissolved concentrations and some sheen have been noted in the past in the EDD. This may suggest that the mass of mobile LNAPL has been reduced sufficiently that there is little to no potential for migration of LNAPL to the EDD and that natural attenuation may be sufficient to limit discharge of the dissolved plume into the EDD [R-14].

The results of the 2020 MNA Program have indicated that NA at the BBSG continues to be active and potentially significant [R-14]. The LNAPL extents have not expanded following the cessation of active pumping in the fall of 2018 and the maximum thickness measured in any well at the BBSG was 1.5 cm. The areal extents of the dissolved plumes have not expanded since 2018 based on the current monitoring network and in most instances been reduced. However, an additional year of monitoring is required to confirm the status of the plume. Biological activity appears to be present and significant at the Sites as noted by:

- Increased alkalinity in the centre of the plume;
- Increased dissolved iron and manganese within the plume;
- Decreased sulphate in the core of the plume;
- High concentrations of methane within the dissolved plume with the most likely source of carbon from the PHCs as an energy source for methanogenesis; and
- Reduction-oxidation (redox) observations suggest that the groundwater conditions may be suitable for either aerobic or anaerobic bacteria to actively degrade the COPCs by using the carbon in the PHCs as an energy source for reducing activity and methanogenesis. There is continuing evidence of reducing activity within the plume footprints.

To date approximately, 1,065 litres (L) of free-phase product have been recovered at the BBSG Site. Of these, approximately 1,014.5 L were recovered via the P&T system, and the remaining was recovered through manual bailing. Generally, free-phase product recovery via the P&T system declined between 2013 and 2018 and based on the recovery rate change over time, the LNAPL recoverability across the site has been reduced approximately 97 percent, compared to the initial LNAPL recoverability. Limited LNAPL recovery in 2019 (< 1 L), similar to 2018 (2.5 L), indicated LNAPL is likely at or near residual saturation and there is no significant recoverable or mobile LNAPL remaining onsite. The 2020 monitoring did not detect LNAPL in any sufficient thickness to justify manual recovery [R-14].

Soil sampling occurred in the general area of the BBSG North site in 2016 and 2020 (during installation of additional monitoring wells near the EDD). On October 28, 2016 soils were sampled for metals, BTEX, VOC's and radionuclides. No exceedances were observed when compared against MECP Table 2 and 8 SCS or the NCRP, 1999 soil quality criteria for radionuclides [R-15].

Following the decommissioning of the P&T system at BBSG, surface water monitoring and sampling was proposed to monitor the potential effects of groundwater to surface water discharge. The surface water samples were analyzed for the primary COPCs of interest: PHC F1-F4 and BTEX with the results used to assess the presence of potential petroleum impacts. Historically, intermittent observations of sheen were reported from 2013 to 2018 in the EDD northeast of the Site, likely caused by the fluctuations in the water table. Sheen was last reported on the surface of the EDD between May 9 and May 24, 2018. Sheen is not necessarily indicative of mobile LNAPL; rather, during historical releases, LNAPL may have migrated into the soils adjacent to the surface water. Based on the amount and intermittent nature of the sheen observations, the LNAPL in the soils adjacent to the EDD is most likely residual caused by the fluctuation of the water table and no longer likely to migrate. This LNAPL cannot be effectively removed hydraulically, that is, through pumping. Sheen was not observed in the EDD during any of the quarterly inspections conducted in 2020. The surface water analytical results were compared Ontario PWQO [R-16]. All surface water samples collected met the PWQOs for the parameters analyzed and all results were reported as less than the laboratory method detection limits [R-14].

Based on thermoimagery results, there are limited groundwater to surface water interactions due to the constructed nature of the EDD [R-17]. One of two identified groundwater to surface water interaction locations is located adjacent to the BBSG site [R-17]. As a result of this potential groundwater to surface water interaction near the location of the historic spill, the distal end of the EDD has been retained for assessment in the EcoRA as aquatic habitat given the observed presence of fish and use by terrestrial and riparian receptors (e.g., turtles, frogs, waterfowl, herons, and beavers).

<u>Bruce B Emergency Generators (Site #47)</u>

The BBEG is located south end of the Bruce B generating station with the Bruce B intake forebay to the south, the Bruce B standby generator and transformer area to the east and north, and Lake Huron to the west. The oil storage portion of the BBEG is paved or graveled, and is enclosed with a fence [R-8]. There are some small patches of grass and weeds. In May 2011, a diesel fuel leak (#2 Fuel Oil release) to the subsurface was discovered at the BBEG Site. This leak was subsequently confirmed to have been released from below grade piping north of the BBEG Site, also referred to as Site #47. Emergency response was implemented and the line was isolated. Corrective actions were put in place and a long term remedial action plan was rolled out. Thirty six monitoring wells currently exist at the BBEG site in the overburden [R-14].

Since May 2011, Bruce Power has conducted several subsurface investigations and remedial activities, to assess and characterize the subsurface impacts associated with the fuel oil leaks that occurred in May 2011, to evaluate the potential remedial measures, and to implement remedial activities including monitoring and manual bailing and recovery of free-phase product. In September 2015, Bruce Power installed a mobile P&T system to recover free-phase product and impacted groundwater near the source, in an effort to control the migration of groundwater contamination. Between September 2015 and November 2018, the mobile P&T system typically operated during spring to fall of each year, followed by a shutdown period during the winter, with the intent to monitor the potential "rebound" of free-phase product and associated groundwater contamination. In October 2018, an in-depth evaluation of the P&T system was conducted and concluded further operation of the P&T system at the BBEG Site was no longer efficient nor beneficial to control, contain, or recover free-phase product, or to remediate dissolved-phase PHCs. As part of this evaluation, various remedial options available as broadly defined by Interstate Technology and Regulatory Council (ITRC) (2018) were assessed and based on the site conditions including available data and site constraints, three potentially viable remedial scenarios were considered. Bruce Power elected to implement, an MNA program. In 2019 the first year of MNA monitoring was completed [R-14].

The BBEG site is adjacent to Lake Huron which is situated approximately 150 m to the Site north. Immediately to the south is the cooling water discharge channel for the Bruce B units, which discharges into Lake Huron. During subsurface investigations and related activities from 2011 to 2015, the soil profile and subsurface stratigraphy encountered in the boreholes generally consisted of a sand and gravel surficial fill layer, with silt extending to bedrock at most locations. The fill material can be generally categorized as gravel to silty sand to sandy silt fill, while fragments of shale are encountered closer to the inferred bedrock contact, at depths ranging from 3.35 to 9.31 mbgs. The bedrock profile and subsurface stratigraphy encountered in the boreholes during the subsurface investigation activities consisted of dolomitic limestone, dolostone, and shale interbeds [R-14].

Groundwater in the shallow aquifer beneath the BBEG has generally been shown to flow radially from the hillslope area adjacent the Site northeast corner of the Emergency Water Pumphouse (BBEG-12) towards the station cooling discharge channel and westward and northward towards Lake Huron. Groundwater flow at the BBEG, as observed in quarterly snapshots in 2020, was not consistent with past interpretations and may reflect increasing influence by Lake Huron water levels. Lake levels in 2020 have been observed to continue to increase. In past monitoring years, seasonal water level fluctuations have at times been noted to disrupt the inferred groundwater flow directions showing a low Site eastward gradient. In 2020, this Site eastward gradient was apparent during Q2, Q3 and Q4. Previous observations have found flow has been generally to the north and to the south; thereby identifying the Site North and South plume fronts. In Q2 and Q3 2020, flow was primarily towards the centre of the Site and to the east-southeast towards the Powerhouse. However, in Q4 the flow pattern resembled that from Q4 2019 with flow again to the north towards the Lake in the north portion of the Site but still with a consistent component of flow to the east-southeast towards the Powerhouse. Groundwater flow towards the cooling channel from the south area was not observed in 2020 based on the interpreted flow paths and groundwater elevations. This potential connection between the Like Huron water levels and the shallow groundwater at the BBEG Site was more apparent in 2020 than it was in 2019, with several more wells showing water table elevations below Lake levels, suggesting that as the Lake levels rise, the flow towards Site east may become increasingly dominant if the lowest elevation influence the gradients and flow direction has potentially shifted from the Lake to the foundation drains (~176.5 masl) or other subsurface features at the Bruce B Powerhouse.

The results of the 2020 MNA Program have indicated that natural attenuation at the BBEG appears to be active and potentially significant. The areal extent of the dissolved plumes have not expanded since the cessation of active pumping and treating in October 2018 based on the current monitoring network. Biological activity appears to be present and significant at the Sites as noted by:

- Increased alkalinity in the centre of the plume.
- Decreased sulphate in the core of the plume. Increased dissolved iron and manganese in impacted or previously impacted areas of the plume.
- High concentrations of methane within the dissolved plume with the most likely source of carbon from the PHCs as an energy source for methanogenesis.
- Redox conditions suggest that the groundwater conditions are suitable for anaerobic bacteria to actively degrade the COPCs by using the carbon in the PHCs as an energy source for reducing activity and methanogenesis. Note that there is evidence of reducing activity within the plume footprint.

A review of the 2020 data with respect to favourable conditions for NA revealed that the most suitable conditions and strongest indication of biological activity correspond to the centre of the PHC plumes in wells where residual LNAPL is or has been present [R-14].

The primary COCs include PHC fractions F1 through F4, BTEX; and NA parameters: nitrate/nitrite, sulphate/sulphide/hydrogen sulphide, total and dissolved iron, dissolved manganese, alkalinity, and methane. Key field parameters recorded for NA include DO and ORP. Groundwater data from the monitoring events are compared to applicable MECP Table 8 SCS. No Table 8 SCS exist for the NA parameters as these are not considered contaminants but rather indicators of biological activity through NA and a therefore evaluated only spatially and temporally with respect to the dissolved plume of COPCs [R-14].

To date, approximately, 63.5 L of free-phase product have been recovered at the BBEG Site. Of these, approximately 52 L were recovered by the mobile P&T system, and the remaining 11.5 L were recovered through manual bailing. In 2019, < 25 mL were recovered manually from BBEG-33 and in 2020 no free product was manually recovered as there was insufficient thickness in any of the wells that previously contained LNAPL. Of the 36 wells that have been monitored at the BBEG Site since 2012, up to twelve contained measurable free product, primarily between 2013 and 2014. The LNAPL footprint as determined by the monitoring well network has decreased significantly from 2014 to 2020, which is likely a combined result of the remedial activities (manual bailing and the operation of the mobile P&T system) and MNA.

Based on the recovery rate change over time and the limited recovery in 2018 and 2019, the LNAPL recoverability across the BBEG Site indicates LNAPL is likely at or near residual saturation and there is no significant recoverable or mobile LNAPL remaining onsite. Overall, the observed LNAPL results suggest the LNAPL at the Site is not presently migrating and is decreasing, although fluctuations in the water table have caused intermittent reappearances of LNAPL. The overall decrease of the LNAPL extent is considered a combined result of the remedial activities (groundwater remediation) to date (such as manual recovery and operation of the mobile P&T system) and natural attenuation occurring in the subsurface [R-14].

Soil sampling occurred in the general area of the BBEG site in 2016. On October 28, 2016 soils were sampled for pH, metals, PCB's, BTEX, phenols, VOC's and radionuclides. No exceedances were observed when compared against MECP Table 2 and 8 SCS or the NCRP, 1999 soil quality criteria for radionuclides [R-10][R-12][R-15]. Due to the lack of available ecological habitat in the surrounding area, soil at the BBEG was not retained for assessment in the EcoRA.

Surface water sampling was not completed at the BBEG site due to safety concerns associated with accessing the CCW discharge channel. Additionally, given the large flows and high mixing occurring in and near the discharge channel, it is not anticipated that COPCs from this site would be found in measurable quantities if sampling was possible due to the immediate dilution in the CCW discharge channel. This will be captured in the overall assessment of Lake Huron as aquatic habitat.

1.3.1.3 Center of Site Engineered Site Facilities

Construction Landfill #4 (CL4 Site #33)

The former construction landfill #4 (CL4, Site #33) is located near the eastern edge of the Bruce Power site, between the central guardhouse and the Bruce Stores storage compound. It is approximately 3.8 hectares in size. The site was used for construction and excavation wastes from the Douglas Point Nuclear Generating Station, the Bruce Heavy Water Plant (BHWP), Bruce 1-4 and Bruce 5-8 construction. The landfill is located in a former gravel pit and a liner was not reported to have been installed. The B31 Pond, an ornamental pond constructed for stormwater management purposes, is located in part of the original site. CL4 itself is on land currently occupied by OPG, however, the B31 (formerly Ornamental) Pond is on Bruce Power leased lands. As a result, assessment of CL4 will be limited to the B31 Pond and a small sliver of land between the B31 Pond and the former CL4 site.

The site generally consists of sand and gravel fill, from 0.1 metres to a maximum depth of 6.4 metres below ground surface (mbgs), containing miscellaneous waste fragments such as glass, rubber, concrete and wire. Clay sand fill, from 1.8 to 3.8 mbgs was found at monitoring well CL4-16. Silty sand till (native) was found from 2.3 metres to the termination depth of the borehole at 4.4 mbgs. Sand and gravel fill materials were observed at all borehole and monitoring well locations.

Groundwater was generally encountered at depths ranging from 5.16 to 7.50 mbgs. Inferred groundwater elevations and contours could not be prepared based on available information however the groundwater is expected to flow southward towards the ornamental pond. The regional hydrogeology is defined in section 2.5.4 and generally flows towards Lake Huron. There are currently 4 groundwater monitoring wells located at the CL4.

Based on the ecological land classifications previously completed for the Site [R-13], the CL4 is classified as cultural grassland with an open water body (Figure 9). The base of the CL4 is in a gravelly area, and most of the surrounding land is partially cleared, with regrowth of shrubs and trees [R-8]. It is recognized there is the potential for construction and excavation wastes to have impacted groundwater and the adjacent wetlands.

Groundwater sampling occurred at the CL4 site in 2016, 2018 and 2019 for dissolved metals, VOC's and radionuclides. Groundwater sampling occurred in 2017 for dissolved metals, anions and nutrients, VOC's, PHC's, PAH's and radionuclides. Groundwater sampling did not occur in 2020 as there were no obvious signs of contamination, impacts or reasons for concern, however water levels were taken.

Soil monitoring was completed in 2016 and 2021 at CL4. Sampling took place for pH, metals, PHC's phenols and VOC's at three locations on November 7, 2016. Minor metals exceedances were observed when compared against MECP Table 1 SCS and the CCME Soil Quality Guidelines. Soil sampling was also completed for radionuclide analysis for Cs-134, Cs-137, Co-60 and K-40. The soil criteria used to determine the presence of radioactive (gamma) contamination are obtained from the NCRP, 1999 [R-12]. All results were well below the criteria. Results from 2021 are described in Section 1.11. Soils are not sampled at CL4 on a regular frequency.

Due to the available ecological habitat it provides, the Bruce Power leased portion of the CL4 was retained for assessment in the EcoRA, which included the assessment of mammals, birds, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs on the Site. The depth of groundwater has been consistently greater than 1 mbgs, and therefore has not been retained for potential root uptake by terrestrial plants. Surface water and sediment has been collected within the B31 Pond and will be used to assess aquatic, semi-aquatic and terrestrial receptors. The B31 Pond is a permanent stormwater drainage feature but not considered permanent aquatic fish habitat as it is an isolated, man-made water feature and is likely to freeze to bottom during cold winters.

Fire Training Facility (FTF Site #32)

The Fire Training Facility (FTF, Site #32) has operated since 1977 and is located west of the Bruce Learning Centre and east of the Central Maintenance Facility. Historically, the FTF had a number of fire displays spread over an area of approximately 120m by 85m. Active construction at this site occurred in 2013 and 2014 resulting in an updated FTF with new displays completed in 2015. The water used to extinguish the fires is collected in oil/water separators located in the southwest and northeast corners of the area. The primary concern for FTF is the potential for PHC contamination. Previous investigations concluded that there was impacted soil and groundwater due to the failure of systems, structures and components (SSC) related to the older facility. The current facility uses liquid propane and Tekflame as fuel in mock firefighting exercises. Mineral oil is also used to create smoke during these exercises.

The wastewater is directed to a clay-lined bio-swale planted with a wetlands seed mix, along the east side of the yard, closed at the north end to convey drainage to the Wastewater Treatment system. The Wastewater Treatment system has a design capacity of 12,000m^3 / day consisting of a rectangular primary gravity fed oil/grit separator tank with a grit chamber, inlet weir to a floating/settling chamber with surface baffles and skimmers, a quiet settling basin with inclined plate separators, flow equalization and valved or emergency overflow to a pumping chamber. A pumphouse conveys effluent from the pumping chamber to a secondary treatment tank. The secondary treatment tank discharges to a rip rap covered concrete slab in a clay-lined bio-swale on the west side of the training field. All outdoor props have drains and direct piping to convey the effluent to the Wastewater Treatment system or indirectly through the bio-swale along the east side. The bio-swale along the west side of the facility has two stone pile check dams and a final timber check dam with a V-cut key, to convey effluent from Oil Separation Tank #1, south to a rip rap protected culvert which connects with the area storm water drainage ditch system discharging to Lake Huron.

The FTF is regulated under Environmental Compliance Approval (ECA) 9809-9KXLEB to use propane fuel or fuel specifically formulated for fire training with an aromatic hydrocarbon content not to exceed 0.25 percent by volume. Samples are taken (monthly) at the V-cut overflow from the timber check dam in the west bio-swale and must be in accordance with prescribed limits.

The site generally consists of sand or sand and gravel fill, with varying silt content from ground surface to 2 metres below ground surface (mbgs), native sand and gravel (likely till) from 2 mbgs to the termination depth of the boreholes (typically 5 mbgs) and native sandy silt till, encountered at 5 or 6 mbgs extended to the termination depth of the monitoring wells (typically 9 mbgs). In general, the boreholes encountered fill materials at ground surface underlain by sand and gravel which was, in turn, underlain by layers of glacial till. Beneath the glacial till, bedrock consisting of limestone and dolostone was encountered at depth.

Groundwater was encountered during drilling at depths of 3.8 to 7.5 mbgs. Groundwater levels should be expected to fluctuate seasonally and in response to significant precipitation events. During the monitoring event completed on September 28, 2020, the groundwater elevations were measured between 187.35 and 189.93 masl. The regional hydrogeology is defined in section 2.5.4 and generally flows towards Lake Huron. Based on the groundwater data collected during the September 2020 monitoring event, the groundwater is inferred to flow in a generally western direction. Based on this year and previous years' information and the encountered subsurface stratigraphy, two separate water zones are inferred to be present at the site: a shallower, possibly perched aquifer is within the fill/ sand and gravel layers, and the water table within the native sandy silt till layer. The sand and gravel groundwater zone appears to be limited to the northeastern corner of the site, near the former oil/water separator, and has been considered "perched water." There are currently 30 groundwater monitoring wells located at the FTF.

Based on depth to the water table at this location, groundwater has been screened out of the ERA as explained below. From 2016 to 2020 groundwater was typically sampled for VOC's, PAH's, PHC's and radionuclides with more extensive sampling completed in 2017 for anions and nutrients and dissolved metals. Parameters are selected based on site activities with respect to potential contaminants of concern. As noted above, there have been historical events leading to groundwater contamination at this site. Exceedances of Table 2 SCS were observed for PAH's, PHC's and VOC's. Results from groundwater monitoring confirm that this contamination is not migrating to receptors and is decreasing as expected. Annual groundwater monitoring will continue to confirm this decreasing trend.

Soil monitoring was completed in 2016 and 2021 at the FTF. Sampling took place for metals, PCB's, PHC's phenols, VOC's and PFAS at three locations on October 26, 2016. No exceedances were observed when compared against MECP Table 1 SCS or federal soil quality guidelines for PFAS [R-10][R-18]. Soil sampling was also completed for radionuclide analysis for Cs-134, Cs-137, Co-60 and K-40 in order to compare against previous results from 2009. The soil criteria used to determine the presence of radioactive (gamma) contamination are obtained from the NCRP, 1999 [R-12]. All results were well below the criteria. Results from 2021 are described in Section 1.11. Soils are not sampled at the FTF on a regular frequency.

Based on the ecological land classifications previously completed for the Site [R-13], the FTF is classified as industrial barren in active use, with areas of cultural thicket and forest (Figure 9).

Due to the available ecological habitat in the surrounding area, the FTF was retained for assessment in the EcoRA which included the assessment of mammals, birds, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs on the Site. Historical soil samples from 2000 were only retained where the area continued to offer ecological habitat. Shallow soil sample locations that were paved over or otherwise rendered inaccessible during the FTF improvements have been eliminated from the 2022 ERA. Groundwater has not been retained for the FTF as the depth of groundwater has been consistently greater than 1.5 mbgs, and therefore has not been retained for assessment of root uptake by terrestrial plants. Potential discharges of groundwater to a surface water body are not considered as a potential pathway for the FTF, as the closest water feature (the B31 Pond on CL4) is inferred to be hydraulically upgradient of the FTF.

<u>Former Sewage (Commissioning Waste) Lagoon (FSL Site #21)</u>

The Former Sewage Lagoons (FSL, Site #21) were constructed around 1970, in the form of two large holding cells. There is evidence that they were used initially for sewage from the Bruce Heavy Water Plant (BHWP). Later, at least one of the cells may have received commissioning wastes from Bruce 1-4 and/or Bruce 5-8. They were also known as the Bruce Retention Lagoons. The northern cell and the western half of the southern cell were filled in during construction of Bruce 5-8, around 1977.

The site is located between the Interconnecting Road and Bruce 5-8 Switchyard and south of the main Bruce 5-8 entrance. It is nearly circular in shape, with a diameter of approximately 300m and an area of 7 hectares. Three quarters of the original complex has been filled in, apparently with material excavated from the Bruce 5-8 area. The remaining section of the lagoon is wedge shaped and full of water. It is not known if any active piping systems are still connected to it (inlet or outlet), but it is not in use.

The site generally consists of silt fill with varying amounts of sand from ground surface to a depth of 3 mbgs at the perimeter of the site and less than 2 mbgs in the middle of the site. There is silty clay fill from 2 to 3 mbgs in the middle of the site and dolomitic limestone (bedrock) at 3 mbgs to the termination depth of the monitoring wells or boreholes to a maximum of 4 mbgs.

During the monitoring event completed on September 23, 2019, the shallow groundwater elevations at the site ranged between 182.40 and 183.22 masl. The groundwater appears to generally flow in a northern direction.

From 2016 to 2020 groundwater was typically sampled for dissolved metals and radionuclides with more extensive sampling completed in 2017 for anions and nutrients, VOC's, PHC's, and PAH's. Parameters are selected based on historical site activities with respect to potential contaminants of concern. All results met the applicable MECP Table 2 SCS with the exception of a minor metals exceedance in 2017 [R-10]. Follow up monitoring has shown that this has decreased to below the applicable standard and is no longer an exceedance. Based on groundwater conditions observed over the last number of years, sampling frequency has been reduced to every five years.

Soil monitoring was completed in 2016 at the FSL. Sampling took place for pH, metals, phenols and VOC's at two locations on October 26, 2016. A minor metals exceedance was observed when compared against MECP Table 1 SCS and the CCME Soil Quality Guidelines [R-10][R-11]. Soil sampling was also completed for radionuclide analysis for Cs-134, Cs-137, Co-60 and K-40. The soil criteria used to determine the presence of radioactive (gamma) contamination are obtained from the NCRP, 1999 [R-12]. All results were well below the criteria. Soils are not sampled at FSL on a regular frequency. Surface water and sediment sampling were completed for radiological and conventional contaminants in 2020 and 2021 and are assessed in this ERA.

Based on the ecological land classifications previously completed for the Site [R-13], the FSL is classified as cultural meadow, with swamp, marsh and forested areas (Figure 9).

Due to the available ecological habitat it provides, the FSL was retained for assessment in the EcoRA, which included the assessment of mammals, birds, amphibians, reptiles, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs. Groundwater has been measured at depths less than 1 mbgs, and therefore has been retained for root uptake by terrestrial plants. Potential discharges of groundwater to a surface water body are not considered as a potential pathway for the FSL, as the remaining standing water on the FSL is clay lined [R-8], and the monitoring wells on the FSL are located hydraulically upgradient. For most of the year (i.e., the summer, fall and winter), standing water at the FSL is unlikely to be used as a drinking water source by most terrestrial and semi-aquatic birds and mammals given that there is more suitable and more attractive habitat elsewhere around the Site (e.g., Baie du Doré, Inverhuron Park and multiple bays along Lake Huron within the area). Given that standing water within the FSL, some birds may potentially use the FSL as temporary landing area. Therefore ingestion of surface water by birds that may land on the standing water was assessed in the EcoRA. Incidental ingestion of sediment was not evaluated further given that the standing water on the FSL is not considered to provide food to birds that may land on the water surface. The FSL is a man-made feature, however, based on the known presence of fish receptors, as well as periodic use by terrestrial and riparian receptors (e.g., turtles, frogs, waterfowl, herons, and beavers), it cannot be ruled out as a functioning ecosystem that could support aquatic life. The most recent environmental monitoring (i.e., wildlife camera) have identified that aquatic receptors have been previously introduced to the FSL either opportunistically or inadvertently.

Distribution Station 1 (DS1 Site #57)

Distribution Station 1 (DS1) is located on the eastern portion of the Site, west of the north entrance security guardhouse. The facility formerly supplied electricity to the guardhouse, and currently has one transformer and associated overhead electrical transmission lines [R-19]. DS1 is entirely fenced and locked when authorized personnel are not present [R-19]. Reportedly in 1973, several thousand litres of insulating oil (total petroleum hydrocarbon [TPH] and possible PCBs) was released to the environment following an act of vandalism where the drain valve of the transformer was opened [R-19]. The transformer had exploded after running dry, and was subsequently replaced by the current on-site transformer [R-19].

This location is monitored directly as part of the comprehensive groundwater monitoring at Site. From a study consisting of field sampling and analysis at 16 sampling locations in order to represent soil conditions near the transformer fenceline, and the potential migration in either direction (4 locations at the outside and 4 at the inside corner of the transformer station, along with 7 locations near the transformer base and a background sample on the south side of the study site) was completed in 2000 (Phase I environmental site assessment [R-8]).
No contamination by arsenic was found, localized PCB contamination was found near the west side of the transformer at concentrations up to 0.38 ppm only in the upper layer (i.e., to about 0.5 m depth) [R-8], but was not considered to be significant given that the land is classified as “culturally barren” (Figure 9) and not in use. Elevated concentrations of TPH were found in the upper soil layers associated with the historical spill, west of the transformer and had not reached the fenceline in 2000. Low concentrations of benzene and toluene were detected in groundwater grab samples [R-8]. Groundwater is not used in this area and insulating oil is considered to have a low toxicity. Limited groundwater sampling and the installation of permanent monitoring points were installed adjacent to the site and have been sampled annually for several years. Sampling conducted in 2016 showed no values of concern compared to Provincial and Federal standards [R-20]. Currently, DS1 Site #57 groundwater sampling has been reduced from an annual frequency to once every 5 years since there are no values of concern and this remains part of the groundwater monitoring program.

The stratigraphy of the DS1 generally consists of gravel or topsoil fill from ground surface to a depth of approximately 0.15 mbgs, followed by silty sand fill to approximately 2.5 mbgs [R-19]. Native gravelly sand or silty sand with gravel deposits were present at several locations to a maximum depth of 2.9 mbgs, and native clayey silt till/clay with trace silt was encountered at the south end of the site up to 5.7 mbgs (termination depth of the borehole) [R-19].

During the most recent monitoring event on September 28, 2020 groundwater levels were measured from 184.433 masl to 184.661 masl with an inferred groundwater flow direction to the northeast. The regional hydrogeology is defined in section 2.5.4 and generally flows towards Lake Huron.

From 2016 to 2020 groundwater monitoring has occurred at the DS1 site with sampling completed in 2016 for PHC's, PCB's and radionuclides and in 2017 for anions and nutrients, dissolved metals, VOC's, PHC's, PCB's, PAH's and radionuclides. Sampling was not completed from 2018 to 2020 since there have been no exceedances for the last number of years and the lack of activity and potential for adverse impacts at this site.

Soil sampling was conducted at the DS1 site in 2016. On October 27, 2016 samples were taken for pH, metals, PCB's, PHC's, phenols, radionuclides and VOC's. No exceedance were observed when compared against MECP Table 1 SCS and the CCME Soil Quality Guidelines or the NCRP, 1999 soil quality criteria for radionuclides [R-10]–[R-12][R-20].

Based on the ecological land classifications previously completed for the Site [R-13], the DS1 is classified as cultural barren adjacent to a swamp to the west and across the interior road, to cultural meadow and cultural woodland to the east within the Site's fenceline (Figure 9).

Due to the available ecological habitat in the surrounding area, the DS1 was retained for assessment in the EcoRA, which included the assessment of mammals, birds, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs on the Site. Groundwater has been measured at depths greater than 1.5 mbgs, and therefore has not been retained for assessment of root uptake by terrestrial plants. The low-lying area at DS1, west of Stream C, is a temporary, shallow wetland that is likely present early in the season but dry by the end of the summer.

Distribution Stations 2/4/5 (Site #57)

Distribution Stations 2, 4 and 5 (DS2, DS4, DS5) are located to the west of the Bruce Central Stores laydown area, and have an area of 0.05 hectares. There is no active industrial use on the DS2, DS4 and DS5 area, and there is a perimeter fence that encloses the three distribution stations [R-8]. The ground surface is graveled, and patches of weeds, small trees and shrubs have grown between the distribution stations [R-8]. A previous investigation was carried out at these sites through a Phase 2, Part 1 Environmental Site Assessment in 2000. Issues and concerns at the sites were related to oil staining at the base of the transformer, indicating historic leaks of mineral insulating oil (TPH and possible PCB). Arsenic was also identified as a potential concern in the graveled area. At DS2, DS4 and DS5, soil samples were taken and analyzed for TPH (C10-C24 and C25-50), PCB's and arsenic. Soil results for were all below MOE guidelines. No PCB's, TPH or arsenic were detected in any groundwater sample. These results showed that there was no residual contamination from historic leaks and that there was no residual contamination from the use of arsenic trioxide herbicides. No contamination was found and no further studies were required [R-8].

The stratigraphy in the enclosure around the distribution stations consists of coarse gravel at surface, followed by variable silty sands and gravel with large stones [R-8]. Regional groundwater flow within the area is inferred towards Lake Huron.

Further groundwater sampling has not been conducted at the DS2, DS4 and DS5 sites. As noted above, previous investigations at this site concluded that no significant contamination was found and no further studies were required. Based on these findings, there is no regular groundwater sampling completed at the DS2, DS4 and DS5 sites.

Soil sampling is not carried out at the DS2, DS4 and DS5 sites based on results and conclusions from previous investigations.

Based on the ecological land classifications previously completed for the Site [R-13], the DS2, DS4 and DS5 sites are classified as industrial barren in close proximity to forested areas to the south and west (Figure 9).

Due to the available ecological habitat in the surrounding area, DS2, DS4 and DS5 were retained for assessment in the EcoRA, which included the assessment of mammals, birds, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs on the Site. Groundwater has not been retained for DS2, DS4 and DS5 as groundwater quality within each distribution station was determined to be free of contamination in the 2000 Phase II Environmental Site Assessment [R-8].

Distribution Station 8 (DS8 Site #57)

Distribution Station 8 (DS8) is located to the south of the Bruce A generating station. In previous environmental investigations, DS8 was divided into two areas, as the DS8 formerly contained a transformer located along the north edge of a road, and several pole-mounted transformers located approximately 90 m to the north. Between the former transformer and the former pole-mounted transformers there is a woodlot that has an approximate area of 0.21 hectares.

The stratigraphy within DS8 consists of some grass and organic matter in the upper layer of granular fill which consists of variable fine sands and gravel, with patches of clayey sand that was interpreted as sand underneath [R-8]. Groundwater wells have not been installed on DS8, therefore no groundwater depths or flow information is currently available. Regional groundwater flow within the area is inferred towards Lake Huron.

Groundwater sampling was completed as part of previous Environmental Site Assessment (ESA) work carried out in 2000 [R-8]. Samples were submitted for analysis of TPH, PCB's and arsenic. All samples met the applicable guidelines. Groundwater sampling has not been conducted recently at the DS8 site. Previous investigations at this site concluded that no significant contamination was found and no further studies were required. Based on these findings, there is no regular sampling completed at the DS8.

Soil sampling was also completed as part of the previous ESA work with seven sampling locations selected for analysis of TPH, PCB's and arsenic. All samples met the applicable criteria. Soil sampling has not been conducted since this sampling occurred as previous investigations concluded that there is no environmental concern associated with this site which was decommissioned prior to the sampling events.

Based on the ELC previously completed for the Site [R-13][R-21], DS8 is classified as active industrial adjacent to forested areas to the south and east (Figure 9).

Due to the available ecological habitat it provides, DS8 was retained for assessment in the EcoRA, which included the assessment of mammals, birds, terrestrial plants and soil invertebrates. Soils were retained for the 0 to 1.5 mbgs depth, as ecological receptors are not anticipated to come into direct contact with soils greater than 1.5 mbgs on the Site. Groundwater has not been retained for the DS8 as groundwater quality within was determined to be free of contamination in the 2000 Phase II Environmental Site Assessment [R-8].

1.3.2 Areas Excluded from Further Assessment

The areas in Table 3 have been excluded from further assessment in the 2022 ERA given that these areas are either active industrial use areas, located on OPG retained lands, or are classified as industrial barren and are not located adjacent to ecological habitat (please refer to the list for definitions of these acronyms).

Table 3 Areas of Previous Environmental Assessment at the Bruce Nuclear Facility not included in the 2022 ERA, with historical numbering from the 2000 Phase II Environmental Site Assessment [R-8] included for consistency

- BACM (Site #8)
- PSB (Site #7)
- PSS (Site #51)
- BASM (Site #5)
- BATR (Site #49)
- BASG (Site #9)
- BBCL (Site #17)
- BBTR (Site #50)
- BBSG South Site (Site #46)
- TC68 Bruce B PCB storage building (Site #18)
- CSF
- CMF
- BHWP
- BCO (Site #13)
- BCO-AWP (Site #13A)
- SSTF (Site #48)
- WCTF (Site #28)
- BSSC (Site #30)
- FPS (Site #23)
- WWMF (formerly known as Waste Volume Reduction Facility, WVRF not included in Phase II Site Assessment)
- Construction Landfill #1 (CL1 Site #1)
- Construction Landfill #2 (CL2 Site #2)
- Construction Landfill #3 (CL3 Site #44)
- Former Clariflocculator Sludge Lagoon (CSL Site #45)

Rationale for the exclusion of the areas listed above is provided below.

Bruce A Engineered Site Facilities

- **Bruce A Construction Maintenance Yard (BACM Site #8):** The BACM is classified as industrial barren and was excluded from assessment in the EcoRA due to its location within the Bruce A facilities, and a lack of suitable habitat both within the BACM and adjacent to this area. The Bruce A generating station is located to the south, and the paint and sandblast shop are located to the east. A forested area and Lake Huron is located to the north and west of the BACM, but are separated from the BACM by a fence. The BACM is located within a man-modified environment and is maintained free of most vegetation except grass and weeds [R-8].

- **Former PCB Storage Building (PSB Site #7):** The PSB is classified as industrial barren and was excluded from assessment in the EcoRA due to its location within the Bruce A facilities, and a lack of suitable habitat. The PSB is a building located within the fenced area of the BACM. The Bruce A generating station is located to the south, and the paint and sandblast shop are located to the east. A forested area and Lake Huron is located to the north and west of the BACM, but are separated from the BACM by a fence. Like the BACM, the PSB is located within a man-modified environment and is maintained free of most vegetation except grass and weeds [R-8].

- **Paint and Sandblast Shop (PSS Site #51):** The PSS is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce A facilities, active land use status and lack of suitable habitat. The Bruce A generating station is located to the southwest of the PSS, and the BACM is located to the west. Vacant land is located to the north and east of the PSS, followed by Lake Huron which is separated from the Site by a fence. The ground surface in the PSS is generally paved or graveled, and is maintained free of vegetation [R-8].

- **Bruce A Scrap Metal Yard (BASM Site #5):** The BASM is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce A facilities, active land use status and lack of suitable habitat. The Bruce A generating station is located to the west and south of the BASM and is surrounded by mainly vacant land including the BACM to the north, and a parking lot to the east.

- **Bruce A Transformer Area (BATR Site #49):** The BATR is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce A facilities, active land use status and lack of suitable habitat. The BATR is located at the southwest side of the Bruce A main station building that houses Units 1 to 4 [R-19]. It is also close to DS8 and the former construction camp and parking lot to the east. The BATR is predominantly covered by concrete, asphalt or graveled surfaces, with no vegetation [R-8]. The transformers were built during the period when PCBs were in use, since commissioning they have been drained and re-filled and the entire BATR have been reconstructed with an engineered spill containment structure. This location is monitored directly as part of the comprehensive groundwater monitoring at Site.

- **Bruce A Standby Generators (BASG Site #9):** The BASG is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce A facilities, active land use status and lack of suitable habitat. The BASG is located at the north end of the Bruce A generating station within the protected area [R-19]. The Bruce A intake forebay is located to the south of the BASG, and the outlet channel is located to the north. The BASG is predominantly covered by gravel or asphalt [R-19]. This location is monitored directly as part of the comprehensive groundwater monitoring at Site.

Bruce B Engineered Site Facilities

- **Bruce B Construction Laydown Area (BBCL Site #17):** The BBCL is classified as industrial barren and was excluded from assessment in the EcoRA due to its location within the Bruce B facilities, and a lack of suitable habitat in its vicinity. The Bruce B generating station is located to the south/southeast, Lake Huron is located to the northwest and an area of undeveloped land is located to the northwest. Lake Huron is separated from the BBCL by a fence. Terrestrial ecological receptors on the Site are considered more likely to utilize the habitat found in the forested undeveloped area to the northeast of the BBCL.

- **Bruce B Transformer Area (BBTR Site #50):** The BBTR is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce B facilities, active land use status and lack of suitable habitat. The BBTR is located at the south side of the Bruce B main station building that houses Units 5 to 8 [R-19] and is approximately 1.7 hectares in area. The BBTR has the water treatment plant to the west, the Bruce B switching station to the south, and the neutralizing transformers to the east. The BBTR is covered by graveled surfaces [R-8]. In April 2005, the Unit 6 Main Output Transporter exploded; material was excavated from the south and east of the transformer area. Monitoring indicated the mineral oil may have migrated elsewhere. It is possible that the mineral oil accumulated under the service road to the south and its migration partially or fully impeded due to the presence of the low pressure service water pipe. A similar event occurred in 2018 with the Unit 8 System Service Transformer (see Section 1.5.2.2 of [R-22]). Much of the mineral oil was contained within the engineered subsurface containment structure however, due to firefighting activities some diluted mineral oil overflowed this structure and travelled over asphalt into the intake channel as well as being deposited into the storm water system. Emergency response efforts recovered a significant quantity of this diluted mineral oil however some of this product was discharged to Lake Huron. This location is monitored directly as part of the comprehensive groundwater monitoring at Site.

- **Bruce B Standby Generators (BBSG Site #46) – South Site:** The BBSG consists of two separate units, one at the south end of the Bruce B generating station, and the other at the north end [R-19]. The BBSG South Site area is classified as active industrial and was excluded from assessment in the EcoRA due to their location within the Bruce B facilities, active land use status and lack of suitable habitat. The Bruce B intake forebay is located to the east of the southern unit of the BBSG, and the outlet channel is located to the southwest. This location is monitored directly as part of the comprehensive groundwater monitoring at Site.

- **Bruce B PCB Storage Facility (TC68 Site #18):** Building TC68 served as a PCB Waste Storage facility from 1986 until 2002 at which time Bruce Power decontaminated and decommissioned the TC68 PCB Waste Storage Facility in accordance with Director's Instructions issued by the MOECC at that time.

Center of Site Engineered Site Facilities

- **Central Storage Facility (CSF):** The CSF is classified as active industrial (Figure 9), and was excluded from assessment in the EcoRA due to its location within the ancillary facilities, active land use status, and lack of suitable habitat. The CSF site was constructed at the former location of the Bunker C Oil AST site (BCOA, Site #12). Construction of the new Central Storage Facility commenced in 2018 and was complete in 2020. It is expected that the CSF will temporarily store contaminated tools and equipment that arises from the Major Component Replacement (MCR) project. Current groundwater monitoring at the CSF site includes tritium and other radionuclides based on activities related to the facility. The entire site is surrounded by a fence as it is a protected area.

- **Central Maintenance Facility (CMF):** The CMF is classified as active industrial, and was excluded from assessment in the EcoRA due to its location within the ancillary facilities, active land use status, and lack of suitable habitat. The CMF, or Building B12, was an operating facility managed by Bruce Power for the purposes managing radiologically contaminated laundry and maintenance of Bruce A, Bruce B and Centre of Site vehicles and mobile equipment. The CMF yard consists of a fenced property of about 7 hectares (ha) that includes a Mechanical Laydown Yard, a Transport & Work Equipment (T & WE) Yard, a Container Laydown area, an area for vehicle washing and fuelling and a Temporary Emergency Response Facility. The CMF fueling system is directly adjacent the vehicle wash building. It consists of three single-walled (6.35-mm [1/4"] steel plate) underground storage tanks (USTs), and a fuelling island with three pumps. The fueling island area is paved with concrete; approximately 3 m either side of the pumps and ties in at-grade with the asphalt paving of the main CMF yard area. Six groundwater monitoring wells were recently installed at the CMF to confirm annually the absence of impacts related to the continued operation of the fueling equipment and the UST's.

- **Former Bruce Heavy Water Plant (BHWP):** The BHWP is classified as active industrial, and was excluded from assessment in the EcoRA due to its location within the ancillary facilities, active land use status, and lack of suitable habitat. The former BHWP site is located east of the Bunker C Oil Site, along the shore of Lake Huron. The former BHWP Site operated between the mid-1970s and the late 1990s and was decommissioned in 2006. During 2019, soil from various locations within Centre of Site have been placed in open area (approximately 23,000 m^2) of the BHWP lands located just north of the BHWP Forebay and east of the Lake Huron shoreline adjacent to the former BHWP lagoons. The BHWP site is known to have 34 monitoring wells including wells along the perimeter of the site fence adjacent to Lake Huron. Previous PHC impacts are known to have been observed in a former oil storage area. There are no current activities taking place on this large area of land. Groundwater monitoring takes place annually at select wells to confirm that previous impacts related to past activities are not adversely impacting the environment.

- **Bunker C Oil Tanks & Ignition Oil Day Tanks (BCO Site #13):** The BCO is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the ancillary facilities, active land use status, and lack of suitable habitat. The BCO is surrounded by the BHWP and the Douglas Point nuclear generating station, and the acid wash pond is located to the southwest. The surrounding area is either paved or graveled and is generally maintained free of vegetation [R-8]. This location is monitored directly as part of the comprehensive groundwater monitoring at Site, the primary concern was the potential for fuel oil contamination around the aboveground storage tank, valves and pipelines. Previously visible oil staining was observed on soils within the former containment dyke. The Phase 1 ESA noted there was concern about the corrosion of fuel oil tanks and pipelines. Today, all tanks have been removed from this location.

- **Bunker C Oil Tanks & Ignition Oil Day Tanks – Acid Wash Pond (BCO-AWP Site #13A):** The BCO-AWP is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the ancillary facilities, active land use status, and lack of suitable habitat. The BCO-AWP is surrounded by the Bruce Heavy Water Plant to the southeast, the Douglas Point nuclear generating station to the north and the BCO to the northwest. A small grassed area is located to the south/southeast of the BCO-AWP, but it is not considered an ecological corridor or suitable habitat for terrestrial mammals and birds given that the area is surrounded by active operations. This area was once used to retain liquids generated during the washing of air preheaters and during acid cleaning of Bruce Steam Plant boilers. This location is monitored directly as part of the comprehensive groundwater monitoring at Site. The pond was neutralized and after settling of solids, the liquid was sampled and analyzed to ensure it met environmental limits before being discharged to Lake Huron. The pond has now been removed and the area has been regraded.

- **Former Spent Solvent Treatment Facility (SSTF Site #48):** The SSTF is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce ancillary facilities, active land use status and a lack of suitable habitat. The SSTF consists of a processing building, and a storage tank farm with secondary spill containment dykes and drainage sumps, and the railroad right-of-way and the railway ditch runs along the north of the SSTF [R-8]. The SSTF is on land currently occupied by OPG and is no longer operated and plans are underway to decommission. The area surrounding the ditch is primarily grassed, and according to the 2001 Bioinventory survey [R-23], the portion of the ditch in the vicinity of the SSTF is not considered verified aquatic habitat. Terrestrial receptors are considered more likely to utilize the habitat found in the forested area to the north of the SSTF.

- **Waste Chemical Transfer Facility (WCTF Site #28):** The WCTF is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce ancillary facilities, active land use status and lack of suitable habitat. The WCTF area is fenced with controlled access. The immediate area around the WCTF is all part of the Central Stores, Sewage Processing and radioactive waste management facility (WWMF) area [R-8]. The WCTF area is maintained free of vegetation, and outside of the building the ground surface is either paved or graveled [R-8]. The railway ditch is located to the north, but no groundwater, sediment, or surface water data is available from the WCTF to assess potential impacts on the railway ditch.

- **Bruce Stores Storage Compound (BSSC Site #30):** The BSSC is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce ancillary facilities, active land use status and lack of suitable habitat. The Central Stores Warehouse is located to the south, and the WCTF is located to the north. Active industrial use is located to the east and west of the BSSC, followed by forested areas.

- **Former Large Bore Pipe Shop (FPS Site #23):** The FPS is classified as active industrial and was excluded from assessment in the EcoRA due to its location within the Bruce ancillary facilities, active land use status and lack of suitable habitat. The surrounding land is mostly vacant lands and roads, and outside of the FPS facility the surface is either paved or graveled [R-8].

- **Construction Landfill #1 (CL1 Site #1):** Former Construction Landfill #1 (CL1) is located towards the east of center portion of the Site to the southeast of the WWMF with an area of 7.5 hectares [R-8]. CL1 is on land currently retained by OPG and is excluded from the 2022 ERA. Based on the ecological land classifications previously completed for the Site [R-13], the CL1 is classified as cultural meadow (Figure 10). The base of the CL1 is within a substantial lowland and wetland area, with low regrowth tree cover [R-8]. No specific records are available for CL1, but it was believed to have been used for the disposal of construction and excavation waste from the construction of the Douglas Point generating station in the 1950s and may have also received construction waste materials from the construction of BHWP, Bruce A and Bruce B prior to the closure of the landfill by 1990 [R-8]. When CL1 was closed, it was given a top cover of granular and aggregate materials and is partially vegetated with grasses, weeds and shrubs [R-8]. It is unknown if further environmental assessment study was completed as a result of the Phase 2, Part 1. This site did not meet criteria for further investigation as part of a Phase 2, Part 2 study [R-8]. Groundwater wells have not been installed on CL1, therefore no groundwater depths or flow information is currently available. Regardless, groundwater flow on CL1 has been inferred from regional groundwater flow within the general area and is inferred towards Lake Huron.

- **Construction Landfill #2 (CL2 Site #2):** Former Construction Landfill #2 (CL2) is located towards the east of the center portion of the Site to the southeast of CL1 with an area of 3.5 hectares [R-8]. CL2 is on land currently retained by OPG and is excluded from the 2022 ERA. Based on the ecological land classifications previously completed for the Site [R-13], the CL2 is classified as cultural barren (Figure 10). The base of the CL2 is within a substantial lowland and wetland area, with low regrowth tree cover [R-8]. A low lying area at the base of CL2 provides an isolated, temporary, shallow wetland (20 m by 20 m), standing water is assumed to be present seasonally; however, as current standing water is not present by the end of the summer, no aquatic habitat is present within CL2. No specific records are available for CL2, but it was believed to have been used for the disposal of construction and excavation waste from the construction of the Douglas Point generating station in the 1950s and may have also received construction waste materials from the construction of Bruce Heavy Water Plant, Bruce A and Bruce B prior to the closure of the landfill by 1990 [R-8]. When CL2 was closed, it was given a top cover of granular and aggregate materials and is partially vegetated with grasses, weeds and shrubs [R-8]. No further investigation has been recommended for this site. [R-8] Groundwater wells have not been installed on CL2, therefore no groundwater depths or flow information is currently available. Regardless, groundwater flow on CL2 is inferred from regional groundwater flow within the general area and is inferred towards Lake Huron.

- **Construction Landfill #3 (CL3 Site #44):** Former Construction Landfill #3 (CL3) is located towards the southeastern portion of the Site with an area of 5 hectares [R-15]. CL3 is on land currently retained by OPG and is excluded from the 2022 ERA. Based on the ecological land classifications previously completed for the Site [R-13], the CL3 is classified as industrial barren (Figure 10). The base of the CL3 is in a gravelly area, and most of the surrounding land is partially cleared, with regrowth of shrubs and trees [R-8]. CL3 is on land currently retained by OPG and is excluded from the 2022 ERA. It has been reported as having been used primarily for the disposal of construction and excavation waste for the construction of Bruce B prior to the closure of the landfill by 1990 [R-8]. When CL3 was closed, it was given a top cover of granular and aggregate materials and is partially vegetated with grasses, weeds and shrubs [R-8]. A Phase 2 investigation was separately carried out (2000) for this landfill and concluded that the contamination plume emanating from the landfill downgradient of the site under investigation in this program is contained within the Contamination Attenuation Zone. [R-8] Groundwater wells have not been installed on CL3, therefore no groundwater depths or flow information is currently available. Regardless, groundwater flow on CL3 is inferred from regional groundwater flow within the general area and is inferred towards Lake Huron.

- **Former Clariflocculator Sludge Lagoon (CSL Site #45):** The Former Clariflocculator Sludge Lagoon (CSL) is located towards the southeastern portion of the Site and has an area of 0.6 hectares. CSL is on lands currently occupied by OPG and is excluded from the 2022 ERA. There are no specific records for the CSL, but it is believed to have been in use from the late 1970s to the mid-1980s, and received sludge from the water treatment plants at the Bruce Heavy Water Plant and from the former Steam Plant chemical waste pond [R-8]. The CSL is monitored by OPG as part of their active landfill monitoring. Stratigraphy for the bottom of the CSL consists of a layer of sand with some organic matter, overlying clay [R-8] Neither soil nor groundwater data are available for the CSL; only surface water and sediment samples have been collected. Additionally, groundwater wells have not been installed in the vicinity of the CSL, therefore no groundwater depths or flow information is currently available. Regional groundwater flow within the area is inferred towards Lake Huron. For most of the year (i.e., the summer, fall and winter), like the FSL, the CSL is unlikely to be used as a drinking water source by most terrestrial and semi aquatic birds and mammals given that there is more suitable and more attractive habitat elsewhere around the Site (e.g., Baie du Doré, Inverhuron Park and multiple bays along Lake Huron within the area). However, given that the CSL is likely to be one of the first water features in the area to thaw in the early spring, some birds may potentially use the CSL as temporary landing area. Therefore ingestion of surface water by birds that may land on the standing water was assessed in the EcoRA. Incidental ingestion of sediment was not evaluated further given that the CSL is not considered to provide food to birds that may land on the water surface. The CSL is a man-made feature and is not considered to be a natural, functioning ecosystem that would support aquatic life (see Section 2.2.6). There is the potential for aquatic receptors to be introduced to the CSL either opportunistically or accidentally, but due to the historical industrial use of this sludge lagoon, it was not assessed further with respect to aquatic life. The CSL is on land currently retained by OPG and is excluded from the 2022 ERA.

1.4 Meteorology

Southern Ontario has a humid continental climate, and harsh weather is not uncommon in the region. Climate represents the long-term expected values for parameters such as temperature, precipitation and winds. The climate of an area can be described by the long term average (e.g., 30 years) and the historic average climate has been calculated for the region for the period of 1971 to 2000 [R-24]. The historic annual average daily temperature, total precipitation, and average wind speed and direction at Wiarton Airport were 6.1°C, 1,041.3 mm, and 13.5 km/hour predominantly from the south, respectively. Recent meteorological data used in the ERA is summarized in the following subsections.

1.4.1 Wind

Wind data for the Site are obtained from two meteorological towers (50 m on-site tower and 10 m off-site tower on Part Lot 1, Concession 5, and Bruce Township – see Figure 5) installed in 1990. The towers have been situated to ensure that meteorological measurements are representative of atmospheric conditions relevant to emissions conveyed inland. The on-site tower measures wind speed and direction at the 10 m and 50 m elevation. The off-site tower measures wind speed and direction at the 10 m elevation. Consideration of this wind data in the 2022 ERA is discussed in Section 6.1.4 [R-25].

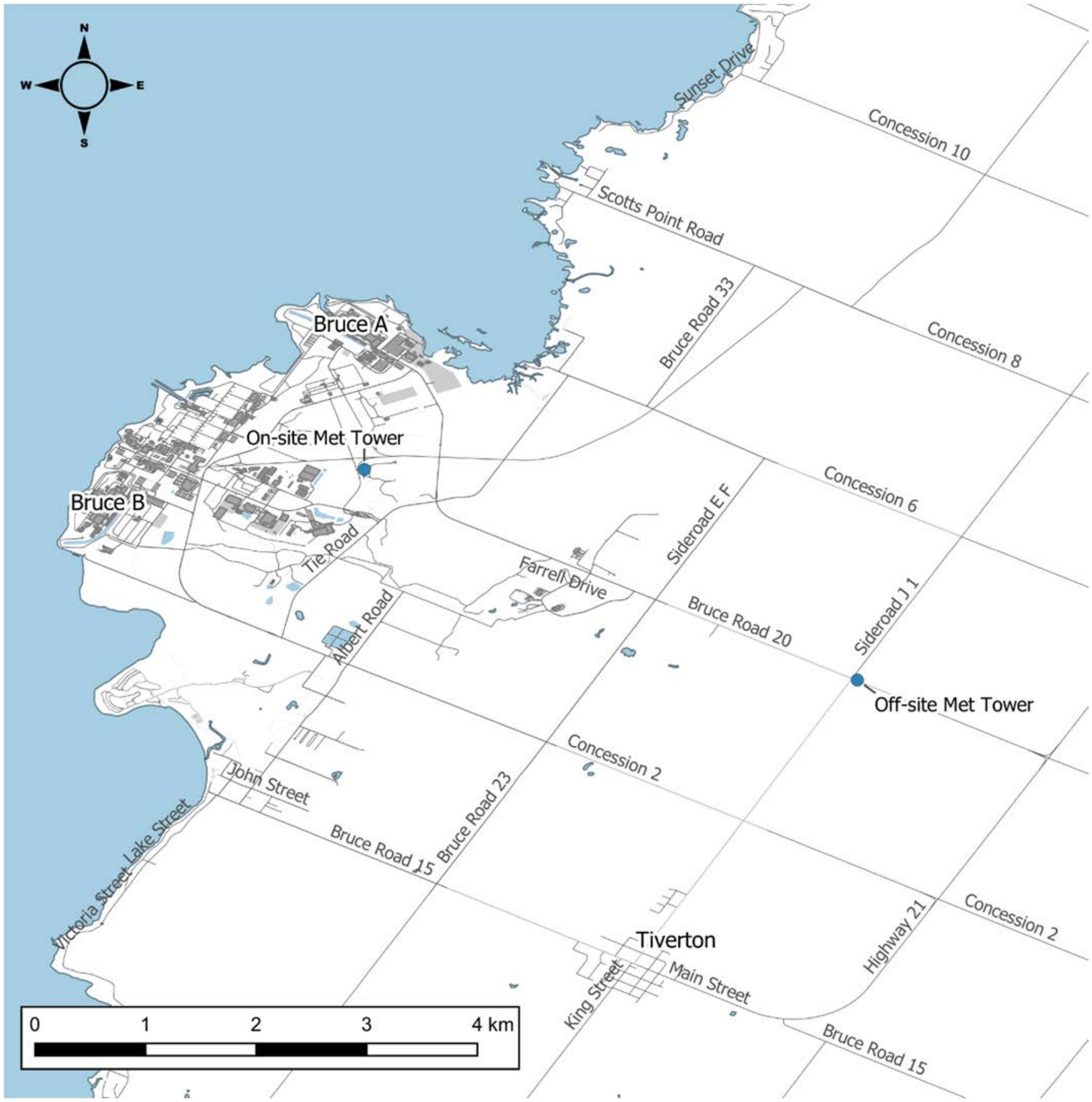

Figure 5 Meteorological Tower Locations

Since 2017, there have been recurring technical issues regarding on-site meteorological data recording. Therefore, the five-year dataset from 2011-2016 (excluding 2014) were used to represent the wind conditions for the Bruce Power site for both the average and upper-range exposure assessments. Data from 2014 and 2017 to 2019 cannot be used due to the technical issues. The 2011-2016 meteorological data was processed in Triple Joint Frequency (TJF) format that contains the annual frequency of specific wind conditions based on wind speed, direction and Pasquill stability. The TJF data is provided in Appendix K and the corresponding wind rose is shown in Figure 6.

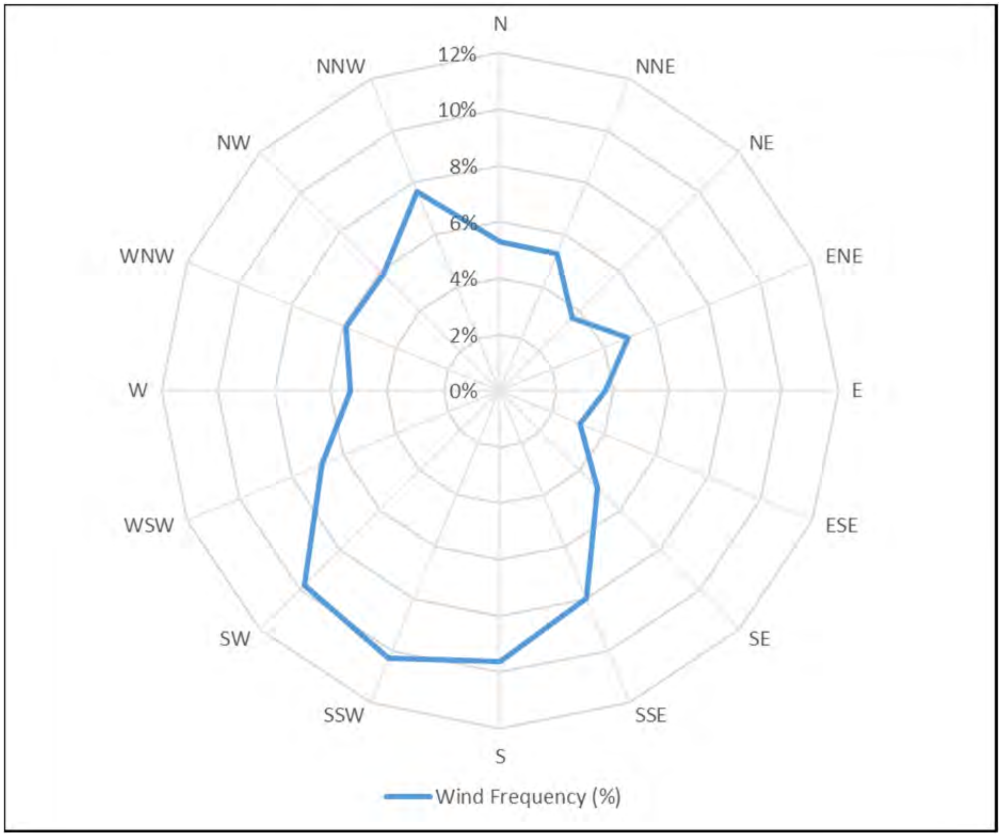

Figure 6 Wind Rose Diagram Based on Surrogate Data (2011-2016) (50 m On-site Tower at 10 m Height)

1.4.2 Temperature

Air temperature data is collected from the on-site meteorological tower at the 10 m elevation. The hourly average monthly temperatures, including maximum and minimum values averaged over the ten-year period between 2007 and 2016, are shown in Table 4.

Table 4 Atmospheric Temperature Data from Onsite Meteorological Tower (2007–2016)

Month	Hourly Temperature Max. (°C)	Hourly Temperature Min. (°C)	Monthly Temperature Mean (°C)
January	17.3	-20.3	-4.0
February	10.9	-26.7	-5.0
March	25.1	-18.6	0.7
April	28.4	-7.7	5.9
May	31.1	-0.3	12.5
June	31.0	3.1	16.6
July	34.1	8.3	20.4
August	31.2	8.9	20.2
September	31.9	3.2	17.0
October	27.1	-1.7	10.4
November	20.8	-11.0	5.6
December	16.1	-14.3	-0.9
Year	34.1	-26.7	8.3

Since there is a gap in temperature data for 2017-2020, consideration has been given to utilizing air temperature data collected by Environment Canada at weather stations within the vicinity of the Site.[R-26] The hourly temperature maximum, minimum and monthly temperature mean for the weather stations at Wiarton and Kincardine between 2016 and 2020 are shown in Table 5.

It should be noted that the Kincardine and Wiarton stations may not closely represent the near-shore temperature conditions of the Bruce Power site.

Compared to the 2007-2016 on-site data presented in Table 4, the total daily temperature maximum, minimum and total monthly temperature mean recorded for Kincardine and Wiarton is not significantly different. Differences between the on-site meteorological tower (Table 4) and Environmental Canada stations (Table 5) range from ±0.1°C (total daily temperature maximum) to ±4.2°C (total daily temperature minimum).

Table 5 Atmospheric temperature for Kincardine and Wiarton, Environment Canada Stations (2016-2020)

	Kincardine			Wiarton		
Month	**Daily Temperature Max (°C)**	**Daily Temperature Min (°C)**	**Monthly Temperature Mean (°C)**	**Daily Temperature Max (°C)**	**Daily Temperature Min (°C)**	**Monthly Temperature Mean (°C)**
January	11.5	-17.5	-3.8	16.1	-26.5	-5.0
February	17.0	-22.5	-1.6	14.4	-26.6	-4.2
March	17.5	-14.5	0.6	16.6	-26.2	-1.4
April	23.0	-10.0	5.2	27.2	-14.0	3.6
May	33.0	-3.0	11.4	30.8	-5.0	10.9
June	33.0	4.0	17.6	31.7	2.4	15.8
July	34.0	8.5	21.7	34.2	7.2	19.9
August	33.0	10.0	21.4	32.6	4.8	19.0
September	32.5	2.0	18.2	30.7	-0.1	15.5
October	26.5	-1.0	11.1	27.0	-6.0	9.4
November	20.5	-11.0	4.1	23.6	-13.1	2.9
December	13.0	-15.0	-1.2	13.1	-26.9	-2.4
Year	34.0	-22.5	8.7	34.2	-26.9	7.0

1.4.3 Precipitation

As the meteorological stations at the Site do not record precipitation, data available for Wiarton (approximately 55 km northeast of the Site) were used. Precipitation data are collected by Environment Canada at weather stations within the vicinity of the Site. The maximum precipitation of 1390.4 mm was in 2013 [R-26]. Total annual precipitation data for the weather station at Wiarton are shown in Table 6.

Table 6 Precipitation Data for Wiarton Environment Canada Station (2010 – 2020)

Year	Total Rainfall (mm)	Total Snowfall (cm)	Total Precipitation (mm)
2010	705.3	242.6	912.3
2011	1029.9	313.4	1281.9
2012	755.8	286.9	985.8
2013	954.0	500.0	1390.4
2014	818.3	359.8	1135.0
2015	705.4	272.9	961.0
2016	669.6	476.9	1099.0
2017	917.7	376.8	1240.2
2018	507.0	401.8	882.3
2019	823.6	405.7	1192.3
2020	864.8	291.1	1206.2

1.5 Geology

1.5.1 Regional Overburden and Bedrock Geology

Based on a review of published geological mapping and available background information, the overburden at the Bruce Power site consists of Elma Till, which has a sandy silt to silt matrix, with clayey silt at the southern area. Other areas of the site (to the east) have exposed bedrock at select locations. A thin seam of glaciolacustrine deposits (sand and gravel mixtures) is present along the shoreline, north from Kincardine to Inverhuron Provincial Park. Sections of these deposits are referred to as the Huron fringe, which extends from Sarnia to Tobermory. The overburden surrounding the site (to the east) is characterized as St. Joseph Till (silt to silty clay), with pockets of glaciolacustrine deposits (silt and clay). The topography at the Bruce Power facility is generally smooth. The ground elevation rises approximately 20 m from the Lake Huron shoreline to the eastern property boundary. The former lake shoreline is present now as a bluff on the other side of the eastern property boundary. The ground surface within the Bruce Power facility is generally flat, due to construction grading activities within the site. The overburden increases in thickness from less than 3 m near the shoreline to approximately 27 m in depth at the eastern property boundary. Several stratigraphic units are present within the subsurface; they vary in thickness and are laterally discontinuous [R-27].

The bedrock at the Bruce Power facility is composed of Paleozoic limestone, dolostone, and shale of the Detroit River Group, or Onondaga Formation. The bedrock is exposed at ground surface at certain locations or is covered by a thin layer of overburden at others. The Onondaga Formation extends in a southeastern direction and is underlain by the Bois Blanc and Oriskany Formations (sandstone, dolostone, and limestone). The bedrock rises from beneath Lake Huron to an elevation over 184 metres above sea level (masl), approximately 500 to 800 m from the shore. This area is a local high point of bedrock elevation [R-27].

1.5.2 Site Overburden Geology

The overburden geology of the Site comprises variable thicknesses of sand and gravel (0 to 10 m) overlying a silt till sequence which has been divided into a “weathered till unit” and an underlying “un-weathered till unit”. Near the Lake Huron shoreline, there is less than 3 m of overburden in the vicinity of the Bruce B generating station, former Bruce Heavy Water Plant (BHWP), and parts of the Bruce A generating station prior to their construction [R-28]. These areas were graded with engineered fill to enable construction.

The generalized overburden stratigraphic sequence may be presented as follows:

- Surficial Sand and Gravel Unit;
- Upper Weathered Silt Till Unit;
- Upper Unweathered Silt Till Unit;
- Middle Sand / Layered Till Unit (vicinity of WWMF); and
- Lower Unweathered Silt Till Unit.

In the nearshore areas along the Lake Huron shoreline, wave scouring has removed much of the overburden and left a residual lag of boulders [R-28].

1.5.3 Site Bedrock Geology

The bedrock underlying the surficial deposits at the Site consists of Middle Devonian age, buff dolostone interbedded with dark grey bituminous limestone of the Amherstburg Formation [R-28]. The bedrock surface under the Site dips northeastward at approximately one percent, which likely reflects the influence of glacial erosion of the bedrock surface. By comparison, the bedding structure of the bedrock sequence (Amherstburg – Bois Blanc Formation contact) beneath the Site dips gently westward to southwestward at approximately one percent, based on structural contours [R-28].

1.5.4 Hydrogeology

In general, overburden groundwater flow is toward Lake Huron, with the exception of radial inward flows at the Bruce A and Bruce B generating stations induced by foundation drains [R-28]. Groundwater flow across the Site is shown on Figure 7 and Figure 8 for overburden and shallow bedrock, respectively.

There appears to be a groundwater divide in the water table within the overburden, between the former BHWP and the WWMF. Northwest of this divide, shallow groundwater flows towards Lake Huron; southeast of the divide, shallow groundwater flows towards the WWMF area. The divide appears to be related to the presence of the Middle Sand Aquifer underlying the vicinity of the WWMF. There also appears to be a groundwater divide within the WWMF area, with a component of groundwater flow to the north and a component of groundwater flow to the south. The Middle Sand Aquifer in some areas is directly connected to the underlying shallow bedrock and appears to act as a conduit for vertical migration of infiltrating groundwater in the vicinity of the WWMF.

The shallow bedrock groundwater flow appeared to be similar to that observed for the overburden, wherein there appears to be a groundwater divide between the former BHWP and the WWMF. Northwest of this divide, shallow groundwater flows towards Lake Huron; southeast of the divide, shallow groundwater flows towards the WWMF area.

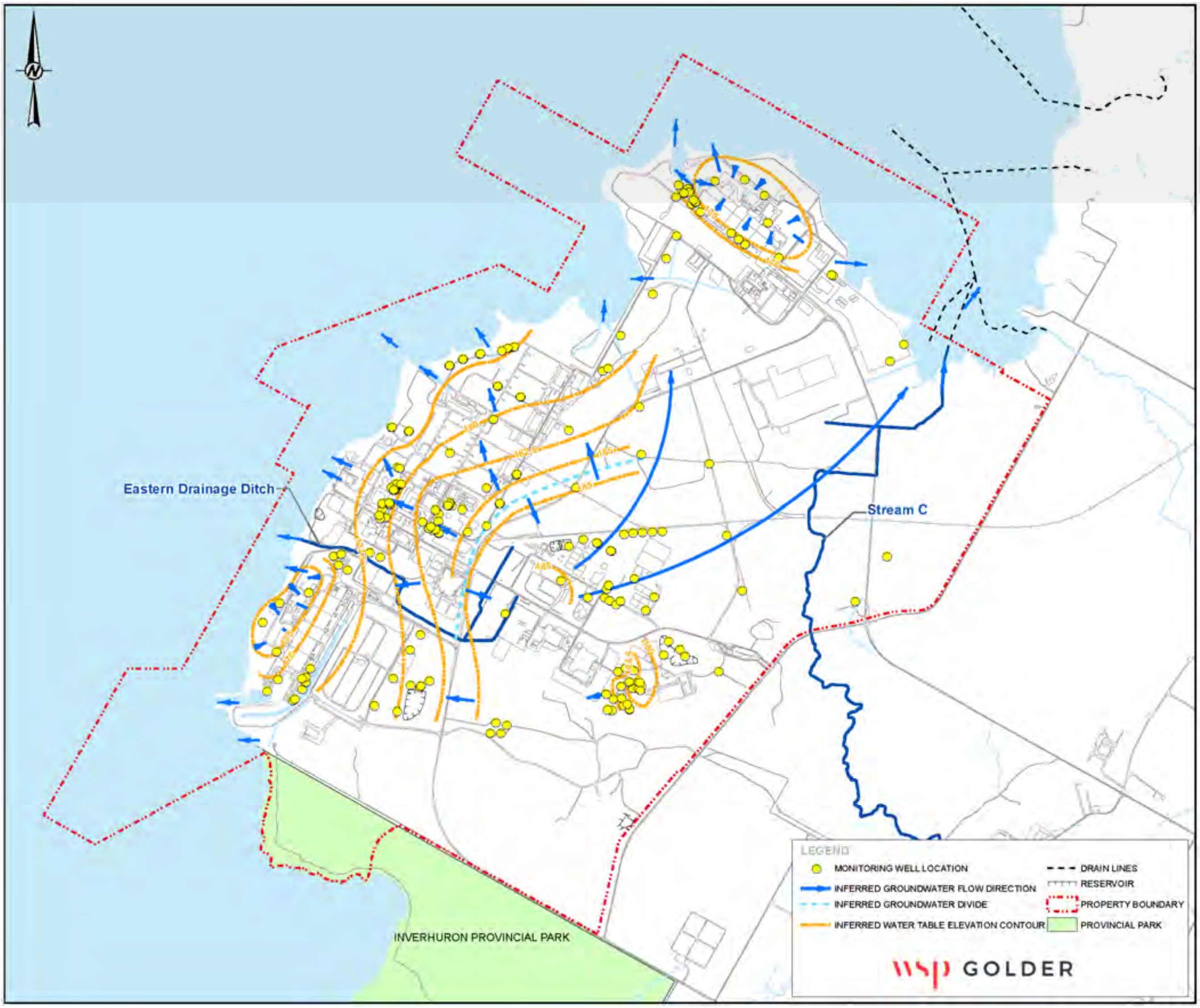

Figure 7 Groundwater Flow Direction for Overburden

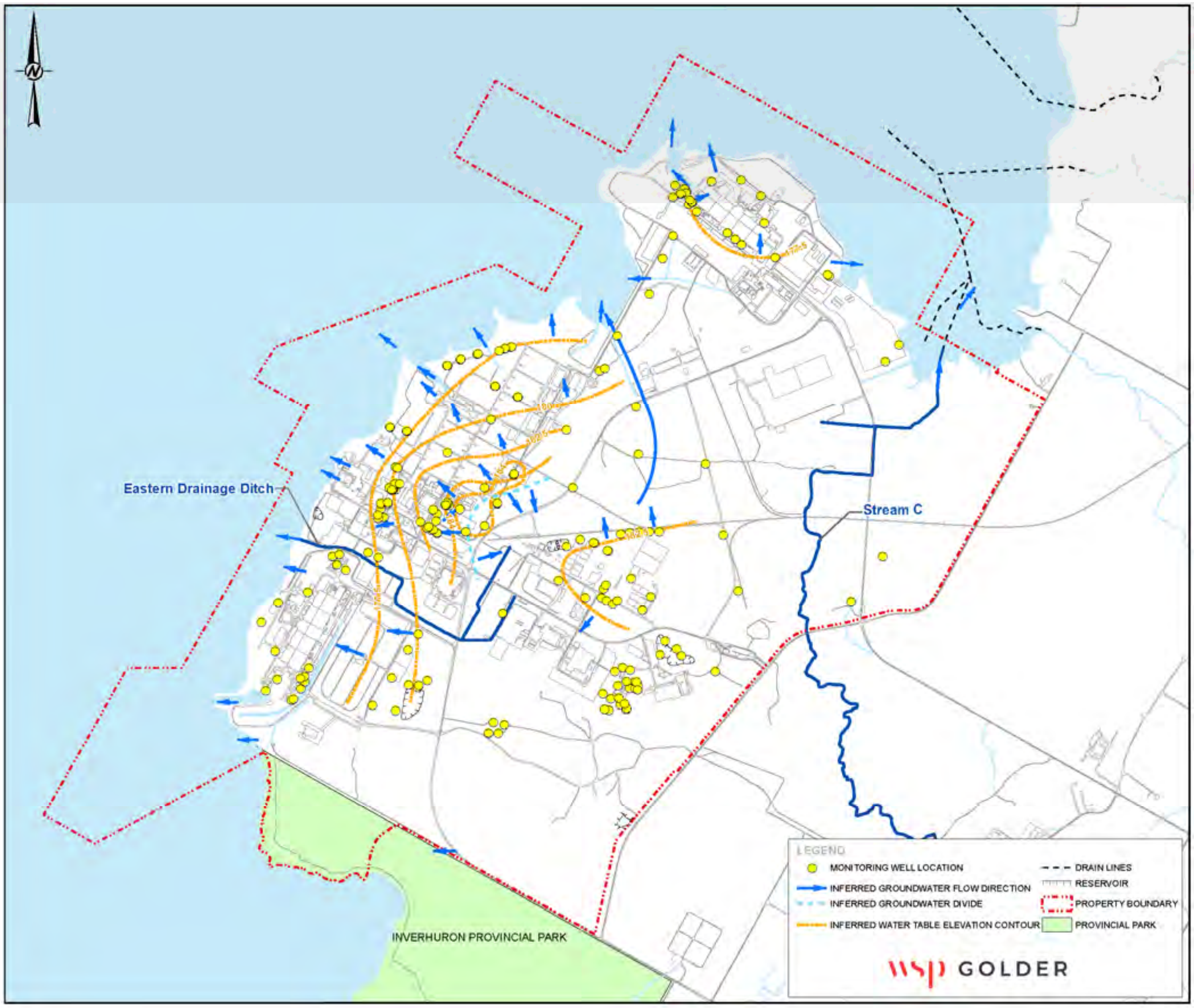

Figure 8 Groundwater Flow Direction for Shallow Bedrock

1.6 Vegetation Communities

The most recent assessment of vegetation communities at the Site was completed in 2016, which was an update to the vegetation assessment completed as part of the Bruce New Build EA in 2008 [R-13], and biodiversity studies in 2001 [R-23]. The following subsections summarize the findings from those assessments.

1.6.1 Plant Communities

An ecological land classification (ELC) for the Site was initially conducted by LGL Environmental Research Associates in 2001 using the ELC system for southern Ontario to identify and characterize the plant communities on the Site. As this work only covered about 60% of the Site, this work was updated in 2009 and 2016 and extended to all of the lands within the Site [R-13]. The ELC relied upon in the 2022 ERA is shown on Figure 9. Additional botanical surveys were conducted to capture the spring growing season in 2017 [R-21]. Data collection was completed in spring/summer 2017. The updated ELC mapping is included as Figure 9.

The ELC system in current use in southern Ontario [R-29] has been developed to classify the "more natural, less anthropogenic communities found in southern Ontario." The ELC system provides an inadequate treatment for culturally affected areas and plant communities, with an acknowledgement that it is a working document and that additional unit descriptors will be needed. This difficulty attends the ELC classification of much of the vegetation of the Site, where the vegetation has a long-standing history of human use and anthropogenic modification, including logging, farming and recreational usage, as well as the present industrial use. Several "non-standard" ecological site-types had been recognized [R-13]. These included the following:

- "Cultural Barren" for lands that have been cleared of vegetation but are presently idle and being recolonized by plants and those that have been cleared and graded, sometimes with imported fill, but are presently being recolonized by naturally-occurring vascular plants;
- "Cultural Grassland" that include lawns and manicured greenswards, sometimes complexed with "Cultural Woodland" where an extensive planting of shade trees or treed hedgerows has occurred;
- "Industrial Barren", where lands have been cleared of vegetation, graded, sometimes with imported fill, and often surfaced with fine or coarse gravel, for occasional or periodic industrial use, but are being sparsely recolonized by naturally-occurring plants; and,
- "Industrial Land" for lands that are presently occupied by buildings, storage compounds, parking lots and other intensive uses that severely limit plant colonization.

All other classification categories used in the present study are standard ELC types, and their application has been based upon the ELC methodology. In 2016-2017, a total of 72 separate ELC communities were identified within the study area [R-21]. In 2007, a total of 195 plant communities were identified within the Site. These represent a total of 15 broad categories of plant communities were identified within the Site including agriculture, alvar, beach, cultural barren, cultural grassland, cultural meadow, cultural thicket, cultural woodland, forest, industrial barren, industrial lands (active use), marsh, open water, submergent aquatics and swamp (these are consistent with the ELC classifications described above and as shown on Figure 9 [R-13].

Cultural communities occupy the largest proportion of the Site, and industrial lands occupy the largest area of that category. Generally, with the exception of the small patch of shrub-dominated alvar, the plant communities present within the Site are not outstanding examples of their community types in this part of the province.

The alvar community is classified as ALS 1-2, which constitutes a dwarf shrub alvar dominated by creeping juniper (*Juniperus horizontalis*), with scattered shrubby St. John's-wort (*Hypericum kalmianum*) and shrubby cinquefoil (*Potentilla fruticosa*). The alvar community occurs in the portion of Inverhuron Provincial Park that lies within the Bruce Power exclusion zone of the Site. This community type is ranked as "very rare" (S2) in Ontario by the National Heritage Information Centre (NHIC), with between five and 20 occurrences estimated in the province. From the alvar community, juniper and St. John's wort are used as medicinal and/or spiritual plants by the MNO community. St. John's wort is used as a pain reliever [R-30]. Also from the alvar community, the HSM lists juniper berries as medicinal plants collected by HSM members to treat stomach aliments, colds and arthritis [R-31].

Beach communities are present along the Site's shoreline. Eastern white cedar (*Thuja occidentalis*) is the most common tree species, with balsam poplar (*Populus balsamifera*) and trembling aspen (*Populus tremuloides*) scattered through some patches. Unlike the alvar community, which has a unique occurrence, the beach communities occur along the length of the Lake Huron shore in the wider area around the Site. The Site has 42% of the area of beach communities that occur in the surrounding terrestrial Local Study Area. There is no evidence to suggest that any of the special features associated with the beach communities on-site occur in the sections of beach outside the Site. From the beach community, the MNO lists cedar and poplar as medicinal and/or spiritual plants used by the Métis community. Cedar is used in spiritual ceremonies and as pest control and poplar is used as a pain reliever [R-30]. The HSM lists cedar as a medicinal plant collected by HSM members to make a tea used to treat stomach ache, and to use the bough chewed as a treatment for arthritis [R-31]. The SON lists white cedar as an important ceremonial (smudge) and shamanic plant that is also used for medicine (e.g., cough), tea, perfume, fibers from bark and timber for construction (e.g., toboggans, fishing spears). The SON also use balsam popular as a medicine (salve, bronchial/respiratory, gynecological, cardiovascular, orthopedic and general healing wash) and trembling aspen as a medicine (gynecological, cardiovascular, orthopedic) and veterinary aid [R-32].

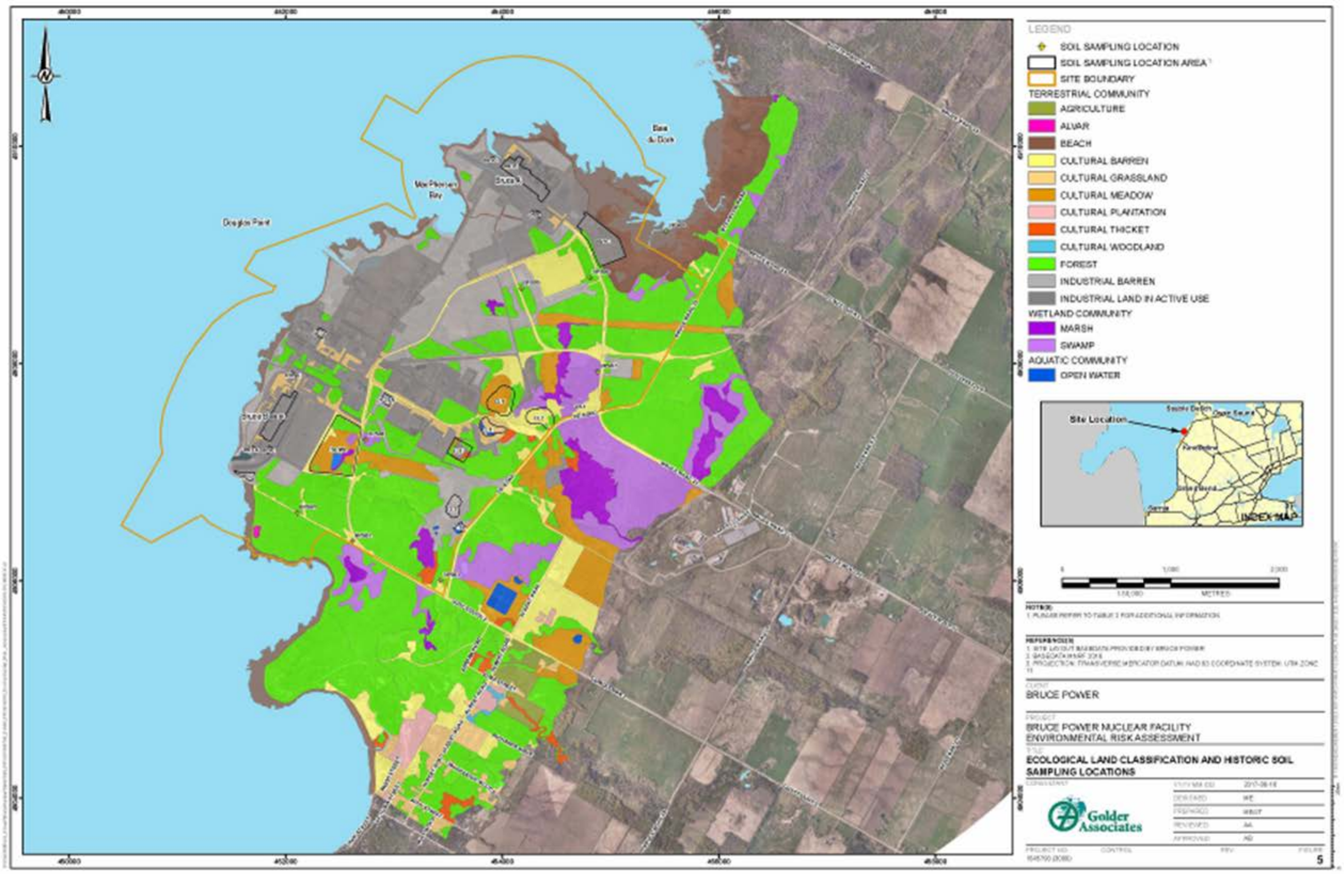

Figure 9 Ecological Land Classification and Historic Soil Sampling Locations

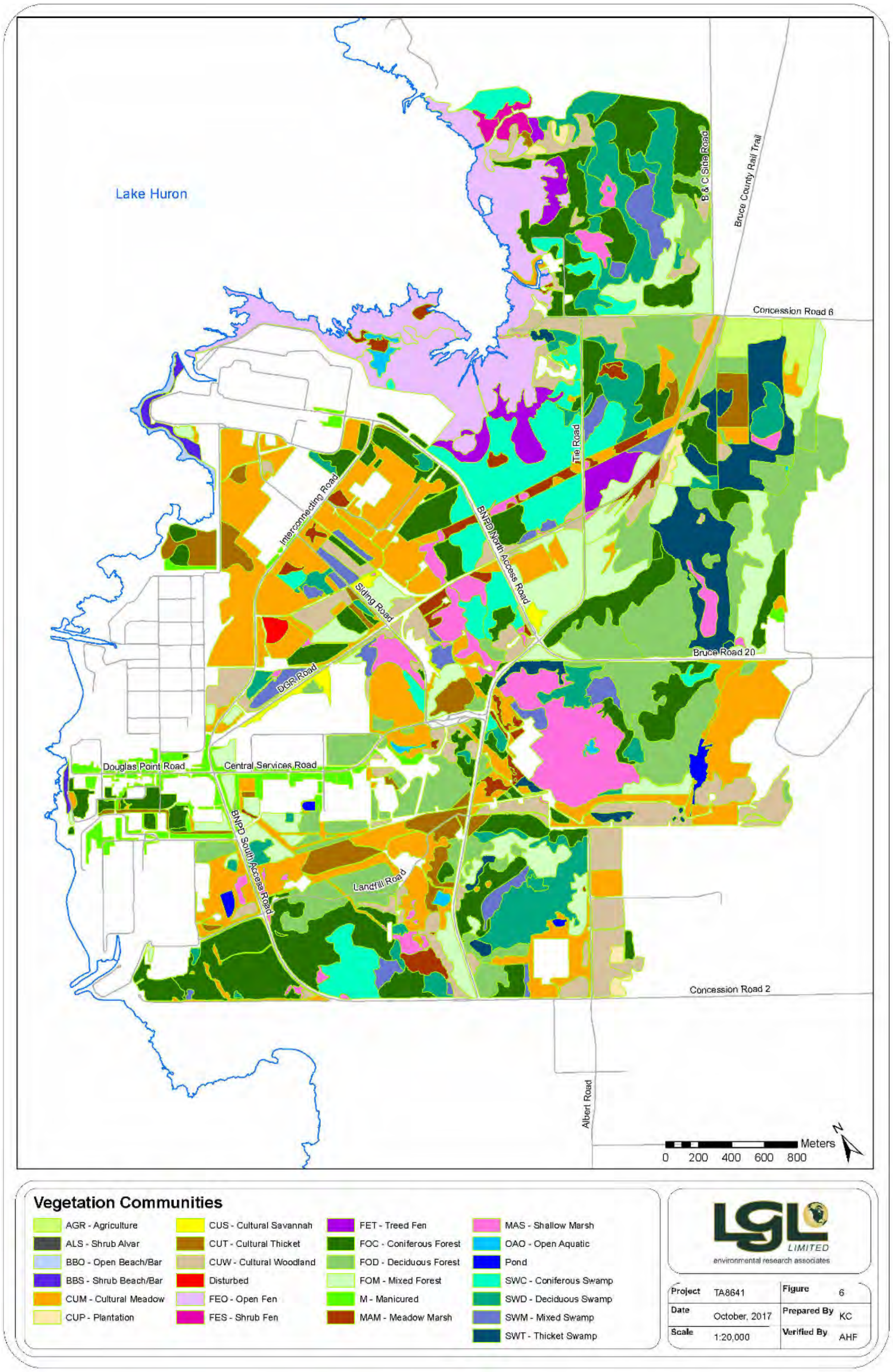

Figure 10 Vegetation Communities on the Bruce Nuclear Site (2016)

1.6.2 Plant Species

A total of 437 vascular plant species have been recorded within and surrounding the Bruce Power property to date. One hundred species or 24% of the total flora are identified as introduced or non- native to Ontario. Many of these species are found within communities that have experienced some form of disturbance [R-21].

One species at Risk, Butternut (*Juglans cinerea*) was observed during the 2016-2017 field investigation. This species is listed as Endangered under the Ontario Species at Risk Act, 2007 (ESA) and the Federal Species at Risk Act, 2002 (SARA). Butternut trees are in decline due to a fungal infection known as Butternut Canker which girdles the tree and eventually causes it to die. Occurrences of Butternut were found to occur outside of the fence (off site). Currently in Ontario, habitat for this species is considered to be a 50 m radius surrounding the tree. A Butternut Health Assessment would be required should activities be proposed within the habitat. A total of 97 locally significant plant species were identified according to Johnson (2016) during the 2016 -2017 field investigation. Forty of these species are considered introduced to Ontario however have been identified as rare or uncommon. Many of the rare and uncommon species are found within the wetland swamp and fen communities.

1.6.3 Culturally Significant Plant Species

Plant, vegetable, and medicinal plants have been identified by the Indigenous communities as important sources of subsistence. This includes gathering of plants, such as fruits and vegetables as part of traditional land use and harvesting activities. In 2019-2021, additional surveys of Saugeen Ojibway Nation (SON), Historic Saugeen Métis (HSM) and Métis Nation of Ontario (MNO) were conducted. Based on the results of these surveys, the Hunter/Fisher Resident (BHF) receptor was updated in the HHRA in order to refine the assumptions used in the ERA and ensure that they are representative of the relevant aspects of Indigenous lifestyles in the area [R-33]. This information was incorporated into the 2021 Bruce Power Site Specific Survey Report [R-26]. The BHF receptor was updated with the Indigenous diet survey results for the intake of wild game and fish. It was found that these groups consumed up to 24.3 times the amount of wild game and up to 1.35 times the amount of fish as the average Canadian diet. Furthermore, community-specific traditional use information has been shared with Bruce Power by SON, HSM and MNO [R-30]–[R-33].

SON have identified the importance of preserving black bear and reptile habitat and movement corridors, upland deciduous forests, riparian areas, wetlands, alvars and cliffs, coniferous and mixed forests and meadows, along with sites that support plants (Table 7) used for medicine, food or products of traditional, cultural or economic importance to SON [R-32].

Table 7 Vascular plants inventoried during the 2016 and 2017 field investigations and listed as important to SON [R-21][R-32]

Plant	Scientific Name	Use (if known)
Balsam Fir	*Abies balsamea*	Medicine (eyes, herbal steam for headache, stimulant, tuberculosis); ceremony (sweat lodge); resin (e.g., for canoes)
Red Maple	*Acer rubrum*	Medicine (eyes); leaf design often used in beadwork; bark used as deodorizer for traps
Silver Maple	*Acer saccharinum (and A. X freemanii)*	Medicine (venereal); cleaning ingredient
Sugar Maple	*Acer saccharum*	Food (syrup, sugar); lumber for a variety of uses (cooking tools, arrows, etc.)
Mountain Maple	*Acer spicatum*	Medicine (eyes); leaf design often used in beadwork; wood for arrows
Yarrow	*Achillea millefolia*	Medicine (poultice, fever-reduction, herbal steam for headache, stimulant); ceremonial (smoking) and shamanic uses; veterinary aid
White Baneberry	*Actaea pachypoda*	Medicine (anti-convulsive)
Red Baneberry	*Actaea rubra*	Medicine (root sometimes used for gastrointestinal ailments; gynecological)
Agrimony	*Agrimonia gryposepala*	Medicine (hemostatic, urinary)
Speckled Alder	*Alnus incana*	Medicine (emetic, eyes, gastrointestinal, gynecological); veterinary aid; dye (black, brown, red, yellow)
Pearly Everlasting / Bear Sage	*Anaphalis margaritacea*	Ceremony (smudge) and shamanic uses; medicine (herbal steam for headache, orthopedic, stimulant)
Canada Anemone	*Anemone canadensis*	Medicine (hemostatic, throat)
Thimbleweed	*Anemone cylindrica*	Medicine (pulmonary, tuberculosis)
Pussytoes	*Antennaria sp.*	Medicine (gynecological)
Indian Hemp	*Apocynum cannabinum*	Fibers considered the best cord-making material
Wild Columbine	*Aquilegia canadensis*	Medicine (gastrointestinal)
Wild Sarsaparilla	*Aralia nudicaulis*	Medicine (disinfectant, hemostatic, stimulant); hunting medicine; veterinary aid
Jack-in-the-Pulpit	*Arisaema triphyllum*	Medicine (eyes)
Wild Ginger	*Asarum canadense*	Seasoning in foods; medicine (poultice, digestive, orthopedic); perfume
Swamp Milkweed	*Asclepias incarnata*	Medicine (strengthening bath, especially for children); roots used in whistles for calling deer
Common Milkweed	*Asclepias syriaca*	Food (flowers, roots); medicine - roots (gynecological)
Lady Fern	*Athyrium filix-femina (var. angustum on Bruce Power site)*	Medicine (gynecological)
White (Paper) Birch	*Betula papyrifera*	Important for canoe-, box- & basket-making (bark), wood (utensils & many other objects); dye (red); syrup (sap); medicine; ceremonial (bark used in funerals); important fire starter (bark) and heating wood; rolled bark used as torch
Marsh Marigold	*Caltha palustris*	Medicine (diaphoretic, emetic, gynecological, tuberculosis); spring leaf shoots cooked with meat

Table 7 Vascular plants inventoried during the 2016 and 2017 field investigations and listed as important to SON [R-21][R-32]

Plant	Scientific Name	Use (if known)
Bellflower	*Campanula rotundifolia*	Medicine (for ears, pulmonary)
Blue-beech / American Hornbeam	*Carpinus caroliniana (ssp. virginiana on Bruce Power Site)*	Construction materials (ridge pole for tents, wigwams)
Scarlet Paintbrush	*Castilleja coccinea*	Medicine (orthopedic)
Blue Cohosh	*Caulophyllum thalictroides*	Medicine (roots – emetic, gastrointestinal, gynecological, pulmonary)
Climbing Bittersweet	*Celastrus scandens*	Medicine (diuretic, gastrointestinal, pediatric physic); inner bark used for soup in emergency situations
Water Hemlock	*Cicuta maculata*	Hunting medicine (roots)
Thistle	*Cirsium sp.(muticum,vulgare*, and arvense on Bruce Power Site)*	Medicine (gynecological)
Blue-bead Lily	*Clintonia borealis*	Medicine (gynecological)
Horseweed	*Conyza canadensis*	Medicine (gastrointestinal); hunting medicine; veterinary aid
Alternate-leaved (Pagoda) Dogwood	*Cornus alternifolia*	Medicine (eyes); hunting medicine; wood used for tool handles; twigs used for thatch and other materials; roots boiled to wash muskrat traps
Bunchberry	*Cornus canadensis*	Medicine (root infusion used for colic); food (berries)
Red-osier Dogwood	*Cornus sericea (ssp. sericea on Bruce Power site)*	Medicine (eyes); dye (black, red, yellow)
Hawthorn	*Crataegus spp. (monogyna on Bruce Power site)*	Medicine (gastrointestinal, gynecological, tuberculosis); food (fruit); bark smoke used as deer attractant
Yellow Lady's-slipper	*Cypripedium parviflorum*	Medicine (gastrointestinal, gynecological, toothache)
Northern Bush-honeysuckle	*Diervilla lonicera*	Medicine (diuretic, eyes, vertigo treatment, urinary, gastrointestinal, laxative)
Crested Wood Fern	*Dryopteris cristata*	Medicine (gastrointestinal)
Field Horsetail	*Equisetum arvense*	Medicine (kidneys, urinary, orthopedic); charm
Scouring-rush	*Equisetum hyemale*	Medicine (disinfectant)
Marsh Horsetail	*Equisetum palustre*	Medicine (gastrointestinal, laxative)
Philadelphia Fleabane	*Erigeron philadelphicum*	Medicine (fever-reduction); smoke used as deer attractant
Boneset	*Eupatorium perfoliatum*	Medicine
Large-leaved Aster	*Eurybia macrophylla*	Hunting medicine; roots used in soups
Grass-leaved Goldenrod	*Euthamia graminifolia*	Medicine (fever-reduction, pulmonary); hunting medicine
American Beech	*Fagus grandifolia*	Medicine (pulmonary); food (nuts); wood for construction (e.g., cooking tools, bowls)
Wild Strawberry	*Fragaria virginiana, F. vesca*	Food; medicine (gastrointestinal)
Ash, Black	*Fraxinus nigra*	Important species for basketry; construction materials; preferred wood for quiet fires because does not crackle or shoot sparks
Ash (White, Red)	*Fraxinus spp. (Americana and pennsylvanica present on Bruce Power site)*	Wood used for bows, arrows, fishing spears, snowshoe frames, basketry splints, cooking tools, spoons; medicine (stimulant, tonic); food (cambium layer cooked)
Cleavers	*Galium aparine*	Medicine (diuretic, urinary, kidneys)

Table 7 Vascular plants inventoried during the 2016 and 2017 field investigations and listed as important to SON [R-21][R-32]

Plant	Scientific Name	Use (if known)
Wintergreen	*Gaultheria procumbens*	Tea, flavouring (candy); food (fruit); medicine (analgesic, fever-reduction, tonic)
White Avens	*Geum canadense*	Medicine (gynecological)
Spotted Jewelweed	*Impatiens capensis*	Medicine (gastrointestinal, Poison Ivy antidote, orthopedic); dye (yellow)
Blue Flag Iris	*Iris versicolor*	Medicine (tuberculosis); leaves woven to make baskets
Butternut	*Juglans cinerea*	Important food (nuts); medicine (tonic); black dye (nut hulls); wood products
Soft Rush	*Juncus effuses (ssp. solutus present on Bruce Power site)*	Stems woven into bags
Common Juniper	*Juniperus communis*	Seasoning (berries); medicine (respiratory, urinary); fibre (bark for weaving); construction materials; ceremony (split strips placed on graves)
Tall Blue Lettuce	*Lactuca biennis*	Medicine (gynecological)
Wood Nettle	*Laportea canadensis*	Medicine (roots – diuretic, urinary); fibre (stalks – twine, thread)
Larch / Tamarack	*Larix laricina*	Fibres, roots used for construction (e.g., canoe-making); tea; medicine (anti-inflammatory); veterinary aid
Marsh Pea	*Lathyrus palustris*	Food (peas)
Labrador Tea	*Ledum groenlandicum*	Tea (leaves); medicine (leaves brewed to higher concentration); dye (brown)
Wood Lily	*Lilium philadelphicum*	Food (soups and stews); shamanic uses
Twinflower	*Linnaea borealis (ssp. longiflora on Bruce Power site)*	Medicine (gynecological)
Honeysuckle sp.	*Lonicera spp.(Canadensis, dioica and oblongifolia on Bruce Power site)*	Medicine (pulmonary; urinary – L. dioica)
Canada Mayflower	*Maianthemum canadense*	Medicine (gynecological, kidneys, throat)
False Solomon's-seal	*Maianthemum racemosum*	Medicine (gynecological, kidneys, stimulant, throat); food (roots cooked)
Ostrich Fern / Fiddlehead Fern	*Matteuccia struthiopteris*	Food (fiddleheads)
Field Mint	*Mentha arvensis*	Medicine (diaphoretic, fever-reduction, gastrointestinal, pulmonary); tea, flavouring
Wild Bergamot	*Monarda fistulosa*	Medicine (bronchial / respiratory, fevers, gastrointestinal)
Sweet Gale	*Myrica gale*	Dye (brown, yellow); smoke used as insect repellent smudge
Mountain Holly	*Nemopanthus mucronatus*	Medicine (tonic)
Sensitive Fern	*Onoclea sensibilis*	Medicine (gynecological)
Ironwood / Hop-hornbeam	*Ostrya virginiana*	Medicine (kidneys, pulmonary); construction materials
Thicket Creeper / Virginia Creeper	*Parthenocissus sp. (vitacea on Bruce Power site)*	Inner bark cooked and prepared as food
Iroquois Root / Wood-betony / Lousewort	*Pedicularis canadensis*	Medicine (gastrointestinal, aphrodisiac, throat)
Common Reed (native subspecies)	*Phragmites australis* ssp. *americanus*	Woven materials (e.g., berry-drying frames)
Ninebark	*Physocarpus opulifolius*	Medicine (emetic)

Table 7 Vascular plants inventoried during the 2016 and 2017 field investigations and listed as important to SON [R-21][R-32]

Plant	Scientific Name	Use (if known)
White Spruce	*Picea glauca*	Medicine (leaves – inhalant); salve for wounds (resin); tea (buds); caulking (resin); fibre (roots); lumber
Pine (Red, White)	*P. resinosa, P. strobus*	Medicine - needles, resin (pulmonary, stimulant); caulking (resin); lumber for construction; food (young staminate catkins of P. strobus cooked and stewed with meat); pitch used to make torches, and as caulking and waterproofing agent
Seneca Snakeroot	*Polygala senega*	Important medicinal plant (cardiovascular, hemostatic, stimulant, tonic)
Water Smartweed	*Polygonum amphibium*	Medicine (gastrointestinal); hunting medicine
Balsam Poplar	*Populus balsamifera*	Medicine (salve, bronchial/respiratory, gynecological, cardiovascular, orthopedic; general healing wash)
Large-toothed Aspen	*Populus grandidentata*	Medicine (hemostatic); food (cambium layer cooked)
Trembling Aspen	*Populus tremuloides*	Medicine (gynecological, cardiovascular, orthopedic); veterinary aid
White Rattlesnake-root	*Prenanthes alba*	Medicine (gynecological)
Heal-all	*Prunella vulgaris*	Medicine (gynecological); hunting medicine
Pin Cherry	*Prunus pennsylvanica*	Food; medicine
Black Cherry	*Prunus serotina*	Food, beverage; medicine (tuberculosis)
Choke Cherry	*Prunus virginiana*	Food, beverage; medicine (eyes, gastrointestinal, throat, gynecological, pulmonary, tuberculosis, tonic)
Bracken Fern	*Pteridium aquilinum(var. latiusculum on Bruce Power site)*	Medicine (gynecological); young tips used in soups
Oak (Red)	*Quercus rubra*	Traditionally an important food (prepared acorns – tannin removed with lye); medicine (bark) (gastrointestinal, orthopedic, pulmonary – Bur Oak; respiratory – Red Oak; cardiovascular, hemostatic – both species); dye (black, red) and mordant for dye; leaf design often used in beadwork; bark used in tanning leather; wood used for tools (e.g., awls)
Staghorn Sumac	*Rhus typhina (Rhus hirta present on Bruce Power site)*	Medicine (gastrointestinal, hemostatic, sore throat, oral); berries occasionally eaten for sour flavour; dye (orange)
Rose (Smooth, Swamp)	*Rosa blanda, R. palustris*	Perfume (petals), tea (hips), food (hips), medicine (inflammation, eye problems, gastrointestinal; R. blanda – orthopedic)
Raspberry (Wild Red, Dwarf, Purple-flowering) and Common Blackberry	*Rubus idaeus (ssp. strigosus on Bruce Power site), R. pubescens, R. alleghaniensis and R. occidentalis*	Food, beverage; medicine (eyes, gynecological; R. ideaus – measles)
Rudbeckia hirta	*Black-eyed Susan*	Dye (yellow)
Broadleaf Arrowhead	*Sagittaria latifolia*	Medicine (dermatological aid, poultice of bark applied to sores); food (roots prepared and cooked); planted as important waterfowl food

Table 7 Vascular plants inventoried during the 2016 and 2017 field investigations and listed as important to SON [R-21][R-32]

Plant	**Scientific Name**	**Use (if known)**
Willow	*Salix spp.(alba, X rubens,X sepulcralis present on Bruce Power site)*	Medicine (analgesic, sores, digestive issues, hemostatic, respiratory, sedative, stimulant); ceremonial uses; basketry
Common Elderberry	*Sambucus nigra ssp. Canadensis on Bruce Power site*	Food; medicine (emetic)
Bloodroot	*Sanguinaria canadensis*	Red, yellow or orange dye; medicine (throat, gastrointestinal, laxative, hemostatic, venereal, general healing wash, stimulant)
Pitcher Plant	*Sarracenia purpurea*	Medicine (roots) (gynecological); leaves used as disposable drinking cup
Wool Grass	*Scirpus cyperinus*	Stalks woven to make bags
Zig-zag Goldenrod	*Solidago flexicaulis*	Medicine (dried root chewed for sore throat)
Goldenrod	*Solidago spp.(caesia, Canadensis, gigantean, hispida var. hispida, juncea, nemoralis var. nemoralis, patula, rugose ssp. rugose and uliginosa on Bruce Power site)*	Medicine (various uses and parts of plant used for fevers; decoction used externally for gastrointestinal problems; throat)
Mountain Ash	*Sorbus decora*	Food (berries); medicine (venereal); wood (for canoe ribs, snowshoe frames, lacrosse clubs, etc.)
Heart-leaved Aster	*Symphyotrichum cordifolium*	Hunting medicine
New England Aster	*Symphyotrichum novae-angliae*	Hunting medicine; medicine (stimulant)
Tall Meadow-rue	*Thalictrum dasycarpum*	Medicine (poultices, fever-reduction, gastrointestinal); hunting medicine
White Cedar	*Thuja occidentalis*	Ceremonial (smudge) and shamanic uses; medicine (e.g., cough); tea; perfume; fibres from bark; timber for construction (e.g., toboggans, fishing spears); perfume
Basswood	*Tilia americana*	Fibre (for rope, thread, mats), wood (splints, spiles for maple sap extraction); tea (from flowers); food (inner bark, sap, young twigs)
Starflower	*Trientalis borealis (ssp. borealis on Bruce Power site)*	Roots combined with others to create scented deer attractant
Eastern Hemlock	*Tsuga canadensis*	Medicinal tea (inner bark and leaves used for colds, fevers, diarrhoea, gastrointestinal troubles, scurvy, hemostatic; bark also used in poultices); sweat lodge (leafy twigs); resin; dye (brownish-red) and mordant for dye; cleaning agent ingredient; bark used for fuel when re-boiling pitch
Common Cattail	*Typha latifolia*	Important food (pollen, flower heads, lower stalks, roots); medicine/salve (skin); fibre (leaves) for basketry, protective mats; mature heads used as stuffing or absorbent; war medicine
American Elm / White Elm	*Ulmus americana*	Medicine (gonorrhoea)
Stinging Nettle	*Urtica dioica (ssp. dioica on Bruce Power site)*	Food (greens boiled), tea, tonic; medicine (arthritis, fevers); fibre (cords, nets)
Lowbush Blueberry	*Vaccinium angustifolium*	Food; Medicine (psychiatric)
Bog Cranberry / Lowbush Cranberry	*Vaccinium oxycoccos*	Medicine (bladder, urinary tract), food (berries, when cooked with maple syrup)

Table 7 Vascular plants inventoried during the 2016 and 2017 field investigations and listed as important to SON [R-21][R-32]

Plant	Scientific Name	Use (if known)
Maple-leaved Viburnum	*Viburnum acerifolium*	Medicine (emetic, gastrointestinal)
Dog Violet/Downy Yellow Violet	*Viola sp. on Bruce Power site*	Medicine (cardiovascular)
Wild Grape	*Vitis riparia*	Food; vine sap used as shampoo; medicine (pulmonary)
*= Non-native species		

From the MNO report on traditional uses of plants for medicinal and spiritual uses, plants on site listed in Table 8 are reported to be of spiritual or medicinal value [R-30].The HSM report on the Métis traditional way of life study was also reviewed for culturally significant uses of plants [R-31].

Table 8 Vascular plants inventoried during the 2016 and 2017 field investigations and listed by MNO as having medicinal or spiritual value [R-21][R-30]

Plant	*Scientific Name*	Use (if known)
Alfalfa*	*Medicago sativa ssp. falcata*	Root – medicine (vitamins) Food – vegetable
Arrowhead (broad-leaf)	*Sagittaria latifolia*	Medicinal
Birch (yellow and white)	*Betula alleghaniensis* *Betula papyrifera*	Bark for canoes, moose calls, wood ash used to remove porcupine quills, birch twigs used for toothpicks (mint taste), in medicine bag, peel bark and boil black inside as a tea
Blackberry (Alleghany)	*Rubus allegheniensis*	Stem
Blueberry (low sweet)	*Vaccinium angustifolium*	Preserved and made into jam; wine; good for diabetes, antioxidant, boiled down and used as medicine
Burdock (common)*	*Arctium minus*	Root tea; blood purifier
Cattail (narrow-leaved and broad-leaved)	*Typha angustifolia* *Typha latifolia*	Root for consumption (like vegetable), roots to make pancakes, top of cattail to eat; use root to make flour and eat raw in stews. Inside of stem is good to eat. The “fluff” used to line clothing or moccasins for warmth and in pillows.
Cedar (eastern red and eastern white)	*Juniperus virginiana* *Thuja occidentalis*	Tea; heal-all medicine (root), in medicine bag; tying canoes and baskets, canoe wood, used in a smudge, used in ceremonies, carved, used for asthma, placed in coffin, for purification (in water or to burn); steam feathers over cedar to cleanse them.
Cherry (sweet*, pin, black and choke)	*Prunus avium* *Prunus pensylvanica* *Prunus serotina* *Prunus virginiana var. virginiana*	Pin cherry – food Medicinal
Chicory*	*Cichorium intybus*	Coffee substitute; added to coffee to make the coffee last longer, good as a tea.
Coltsfoot*	*Tussilago farfara*	Medicinal – used for respiratory ailments.
Cranberry (large and small)	*Vaccinium macrocarpon* *Vaccinium oxycoccos*	Good for urinary tract.

Table 8 Vascular plants inventoried during the 2016 and 2017 field investigations and listed by MNO as having medicinal or spiritual value [R-21][R-30]

Plant	*Scientific Name*	Use (if known)
Dandelion (common)	*Taraxacum officinale*	Roots and leaves in salves; whole herb is edible; clears heat and toxins from blood (used for boils and abscesses); root is a diuretic and liver (cleansing tonic for gallstones and jaundice) stimulant; leaves help reduce fluid retention and urinary disorders and are effective liver and digestive tonic; useful for constipation and joint inflammations; good for eczema and acne; salad is good for high blood pressure, gout and colds; makes good wine.
Dogwood (silky, red panicled, round-leaved and red-osier)	*Cornus amomum* *Cornus racemose* *Cornus rugosa* *Cornus sericea ssp. sericea*	Bark used with tobacco for smoking; inner bark used in tanning hides and to induce vomiting.
Eastern hemlock	*Tsuga canadensis*	Tea
Common elderberry	*Sambucus nigra ssp. Canadensis*	Good for wine; flowers used for tea; elderberry elixir (with brandy and cloves in it) used to relieve cold symptoms, cough syrup
Ferns (cinnamon, royal, eastern bracken, marsh, northern lady, bulblet bladder, spinulose wood, crested wood, ostrich and sensitive)	*Osumunda cinnamonea* *Osmunda regalis var. spectabilis* *Pteridium aquilinum var. latiusculum* *Thelypteris palustris var. pubescens* *Athyrium filix-femina var. angustum* *Cystopteris bulbifera* *Dryopteris carthusiana* *Dryopteris cristata* *Matteuccia struthiopteris var.* *Onoclea sensibilis*	Chase away mosquitos
Goldenrods (blue-stem, Canada, zig-zag, giant, hairy, early, gray, rough-leaved, rough and march)	*Solidago caesia* *Solidago canadensis* *Solidago flexicaulis* *Solidago gigantea* *Solidago hispida var. hispida* *Solidago junea* *Solidago nemoralis var. nemorlis* *Solidago patula* *Solidago rugose spp. Rugose* *Solidago* *Solidago uliginosa*	Medicine
Gooseberry (wild black current, prickly gooseberry, swap black current and currant)	*Ribes americanum* *Ribes cynosbati* *Ribes lacustre* *Ribes sp.*	Wine; consumption (if green they are sour, otherwise eat when purple)
Horsetail (field, water, scouring-rush, marsh)	*Equistrium arvense* *Equistrium fluviatile* *Equistrium hyemale var. affine* *Equistrium palustre*	Improve digestive problems. Used as a tea. Outside stem used to scrub away dead skin (on heels, or in a footbath). Also used as a sandpaper to smooth wood (sculptures, bowls).

Table 8 Vascular plants inventoried during the 2016 and 2017 field investigations and listed by MNO as having medicinal or spiritual value [R-21][R-30]

Plant	***Scientific Name***	**Use (if known)**
Jewel weed	*Impatiens capensis*	Antidote for poison ivy, takes down redness, helps anything that itches; juice from stem on mosquito bites or anything itchy.
Joe Pye weed (spotted)	*Eupatorium maculatum var. maculatum*	Medicinal
Juniper (common)	*Juniperus communis*	Berries
Labrador tea	*Ledum groenlandicum*	Older adults drink; let leaves steep for an antioxidant
Lily of the valley (wild)	*Maianthemum canadense*	Medicine
Maple (sugar)	*Acer saccharum var. saccharum*	Syrup used in cooking
Milkweed (swamp and common)	*Asclepias incarnate ssp. incarnate* *Asclepias syriaca*	Milk from seedpods good to remove warts; 'milk' is applied to warts, moles and ringworm, 'milk' also used in moccasins and clothing for warmth.
Mint (American wild and pepper*)	*Menta arvensis* *Menta X piperita*	Teas
Mullein*	*Vernascum thapsus*	Eases breathing problems. Tea eases throat congestion; dried mullein head was dipped in liquefied fat and lit as a torch. The flower used in teas. The soft leaves were put inside moccasins for comfort; easy to replace. A piece of the leaf could be put on a fish hook to catch fish.
Pine (eastern white)	*Pinus strobus*	Tea, needles mixed with honey for a cough medicine
Plantain leaves (common)*	*Plantago major*	Good for infections; rub it on cuts and scrapes; use for skin problems like rash, psoriasis, eczema; anti-inflammatory, anti-bacterial (prevents gangrene); put crushed leaves on cuts, bites, inflammations from poison ivy or stinging nettle
Poplar (silver)*	*Populus alba*	Medicine; habitat for partridge; buds – sticky resin gathered for ointment (on rheumatic or painful joints); inner bark used in sooting salve for earaches and nasal application to cure coughs and colds
Red clover*	*Trifolium pretense*	Skin conditioner; used medicinally as a fodder crop for cattle; flowers used as cleaning herb for skin complaints; flowers used for coughs (bronchitis and whooping cough); flowers used for insect bites and stings; eaten for eczema and psoriasis; compress use for arthritic pains and gout; ointment for lymphatic swellings; eyewash for conjunctivitis; douche used for vaginal itching; syrup for stubborn dry coughs; used for bee stings
Sarsaparilla	*Aralia nudicaulis*	Wine
Self heal (heal-all and common heal-all*)	*Prunella vulgaris ssp. lanceolata* *Prunella vulgaris ssp. vulgaris*	Medicinal
Spruce (white)	*Picea glauca*	Waterproofing canoes; root for medicine; spruce gum on cuts and chewed to make teeth white

Table 8 Vascular plants inventoried during the 2016 and 2017 field investigations and listed by MNO as having medicinal or spiritual value [R-21][R-30]

Plant	***Scientific Name***	**Use (if known)**
St. John's wort*	*Hypericum perforatum*	Bouquets; typically makes you feel good; orally can inhibit aliments
Stinging nettle*	*Utica diocia*	Medicinal; told to stay away from it because of skin irritation
Sumac (staghorn)	*Rhus hirta/typhina*	Tea from berries – high in Vitamin C, bitter taste
Tamarack	*Larix laracina*	In medicine bag (to heal); tea from bark good for colds; use with white sage and birch for calming burns
Thistle (Canada)*	*Cirsium arvense*	Salve for cough, tickling (rub on chest when sleeping)
Water cress*	*Rorippa nasturtium-aquaticum* *Nasturium officinale*	Medicinal
Water lily (pygmy)	*Nymphaea leibergii*	Medicinal; backyard plant (lily pad)
Wild ginger	*Asarum canadense*	Often traded; cooking; spiritual medicine from sturgeon plant; tea
Willow (white*, reddish*, hybrid*)	*Salix alba* *Salix X rubens* *Salix X sepulcralis*	Pain killer (asprin); ground willow bark used as pain killer for toothache and joint pain. Can also be taken as a tea. Red willow bark is used as a smoking mixture.
Wintergreen	*Pyrola asarifolia* *Gaultheria procumbens*	Chew instead of gun; tea in moderation for arthritis.
Witch hazel	*Hamamelis virginiana*	Used as an astringent
Yarrow (woolly)	*Archillea millefolium var. occidentalis*	Tea to suppress bleeding and fevers; flower has healing powers as infusion; anti-inflammatory, flowers are drunk for upper respiratory phlegm or as an eczema wash; inhalation for hay fever and mild asthma; oil is massaged into inflamed joints; chest rub for chesty colds and influenza, leaves stop a nosebleed; poultice wrap on cuts and grazes; reduce fevers and as a digestive tonic; tincture use for urinary disorders or menstrual problems and cardiovascular complaints; compress to sooth varicose veins; mild anesthetic; stopped itching of insect bites; flowers chewed to reduce swollen glands; tea to relieve pain during childbirth
Yellow dock (curly-leaf)*	*Rumex crispus*	Medicinal
**= Non-native species*		

A 2017 survey of MNO land and water uses in the area near Bruce Power found that approximately 35% of respondents used the area for berry gathering and 24% used the area for plant and medicine gathering [R-34]. A 2019 follow-up survey found that approximately 20% of respondents used the area for plant and medicine gathering, while approximately 25% used are for berry gathering [R-35].

The HSM community has historically harvested plants, vegetables and medicinal plants from the area near the Bruce Power site. This includes the following plant species [R-36]:

- Raspberries – Food
- Blueberries – Food
- Strawberries – Food
- Blackberries – Food
- Elderberries – Food
- Thimble berries – Food
- Cranberries – Food
- Plums – Food
- Watercress – Food
- Leeks – Food
- Fiddleheads – Food
- Puffballs – Food
- Morels – Food
- Willow Bark – Treat headaches
- Clove – Oil used to treat toothaches
- Cedar – Tea used for stomach ache, bough chewed for arthritis
- Pine – Stewed to make cough syrup
- Spruce – pitch chewed for teeth
- Goldenrod – Used as a poultice to treat bee stings
- Juniper Berries- Used for stomach ailments, arthritis and colds

1.7 Wildlife Habitat and Communities

The most recent assessment of wildlife habitat and communities at the Site was completed in 2016 [R-21], which updated the assessment that was a component of the Bruce New Build EA in 2008 [R-13]. Additional wildlife monitoring and SAR assessments were completed between 2016 to 2022 [R-37]–[R-42]. The following subsections summarize the findings from these assessments.

Wildlife habitat is generally associated with the native plant communities that occur in the study areas. For the Site, that includes mainly the forest and wetland community types (Figure 5), although some use is made of the cultural communities, depending upon the nature and frequency of disturbances. Where old field grasslands and meadows have developed, and disturbance is absent or very infrequent, ground nesting birds, such as killdeer (*Charadrius vociferus*), field sparrow (*Spizella pusilla*), vesper sparrow (*Pooecetes gramineus*) and wild turkey (*Maleagris gallopavo*), may be foraging and breeding. However, most breeding and denning activities of other wildlife species are likely restricted to the habitats that provide denser cover and more complex structure, such as the woodlands, or provide specialized habitat conditions, such as the watercourses and wetlands [R-21].

Most of the wildlife habitat on the Site occurs around the periphery of the Site, in Inverhuron Provincial Park, in the Baie du Doré Wetland Complex and in the conifer forest communities near or along the perimeter fence (Figure 9). As well, these areas provide access to a variety of different habitat types, such as the lake shore, dug ponds and the local watercourses, providing a range of foraging opportunities for locally resident wildlife, while acting as “core” natural habitat within which disturbance is absent or infrequent [R-21].

As discussed in Section 1.3.1, areas on the Site considered to have terrestrial wildlife habitat include BASC (as it is adjacent to forested area), BBED (as it acts as an ecological corridor to Lake Huron), CL4 (as it is a cultural grassland), FTF (as it includes areas of cultural thicket and forest), FSL (as it is a cultural meadow), DS1 (as it is adjacent to a cultural meadow, forested areas and swamp), DS2/DS4/DS5 (as it is adjacent to forested areas), DS8 (as it is adjacent to forested areas).

Semi-aquatic wildlife are also expected to frequent several water bodies on-Site, including, the B16 Pond, B31 Pond, EDD, FSL, Stream C, and the shoreline and nearshore habitat of Lake Huron.

1.7.1 Mammals

Camera traps were first set in the late summer and fall of 2016. In 2016, species recorded were largely mammals, comprising 164 observations (39% of observations in 2016). Bird observations comprised 145 records (35% of observations in 2016). Reptiles, a mixture of unknown turtles and Painted Turtles were captured in 91 images (22% of observations in 2016). Unknown frog species were document 13 times (3% of observations in 2016).

In 2017, the camera traps were moved to new locations and were set in spring and summer. During this second year there was 111 mammal observations (46% of observations in 2017), 123 bird observations (51% of observations in 2017), and 5 frog observations (2% of observations in 2017).

A total of 26 species of mammals have been reported on and around the Site based on evidence of presence (e.g., tracks, scat) or actual sightings. These species include both small and large mammals, such as the masked shrew (*Sorex cinereus*) and white-tailed deer (*Odocoiles virginianus*). In recent years, monitoring efforts have been expanded to include bat surveying and eight bat species were identified during acoustic monitoring surveys completed in 2016 [R-21]. The most abundant species was the little brown myotis (*Myotis lucifugus*).

The reported mammalian species have a variety of habitat preferences. Species such as the beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*) are wetland inhabitants which have been observed in wetland areas on the Site and in the Baie du Doré wetland. Other species such as the red squirrel (*Tamiasciurus hudsonicus*) and meadow vole (*Microtus pennsylvanicus*) likely utilize the conifer woodlands and cultural meadow and grasslands that are present on and around the site [R-13]. The black bear (*Ursus americanus*) has been reported around and on the Site.

White-tailed deer are the most common mammal species observed on and around the site [R-13]. Studies carried out on the white-tailed deer population of the Site provide a range of yearly estimates from a low of 55 animals in 1987 to a high of 144 in 1989; in the spring of 2001, the estimated population was 121 animals [R-23]. Biological populations can be expected to fluctuate from year to year as the levels of recruitment into the population (births and immigration) and losses (deaths and seasonal dispersal or emigration) vary from year to year. Additionally, it should be recognized that wildlife studies are generally inexact, using sampling methods that produce population estimates and not complete counts. Particularly for secretive species (i.e., white-tailed deer) and also small species, it can be very difficult to arrive at estimates of population numbers.

Species with federal and provincial status have been reported on the Site (see Section 2.2.6.4).

1.7.2 Birds

Point count surveys for breeding birds were conducted on May 30 to June 1, June 21 to 24 and July 7, 2016 [R-21]. Point counts were established across the site on the first visit in late May / early June in representative ELC communities. On the subsequent visit, many of these point counts were repeated and additional point counts were established in additional areas to increase data coverage from the first set of surveys. On the July 7, 2016 visit, most of these new counts were repeated, along with a few remaining from the initial set. Overall, 58 point counts were established and 2 sets of surveys were conducted at 48 of these locations. All birds seen or heard from the point were recorded; however birds beyond 100 m from the point and birds flying over were excluded from portions of the analysis. In most cases, more bird species were recorded on the first visit than the second visit. On average, 71.4% of the total species observed at a point count were recorded on the first visit while 49.5% were observed on the second visit, with an average of 21.0% overlap in species between the two visits. Detections of breeding birds often decrease as the season progresses. At the beginning of breeding season, males are focused on establishing territories and sing or display often, however as pairs begin to focus increasing attention on nests and nestlings bird song tends to decrease, making detection more difficult.

A total of 82 species were observed at the breeding bird point counts and an additional 12 species were observed incidentally during the breeding bird season. The most commonly encountered species (based on point counts which were visited twice, excluding flyovers and birds beyond 100 m from the point) was Red-eyed Vireo (*Viero olivaceus*) followed by American Robin (*Turdus migratorius*).

A number of birds with special conservation status have been observed on the Site, including several of which are reported to nest within the Site or its surrounding area, and others that may be local foragers [R-23][R-42] (see Section 1.7.4).

1.7.2.1 Bald Eagle and Winter Raptor Surveys

Bald Eagles (*Haliaeetus leucocephalus*) are currently listed as a species of *Special Concern* in Ontario. Since 2017, Bruce Power has monitored habitat use by Bald Eagles and other raptors in the vicinity of the Bruce Power Site during the overwintering period (Nov-Mar). Four Bald Eagle monitoring surveys were completed in each of the last 4 winter monitoring periods. Observations of Bald Eagles continued in 2020-2021 at 6 of the 7 original monitoring stations (Stn), labelled Stn. 1 and Stn. 3-7 on Figure 11. Stn. 2 (not labelled on Figure 11) was abandoned in 2019 due to lack of visibility because of woody shoreline vegetation.

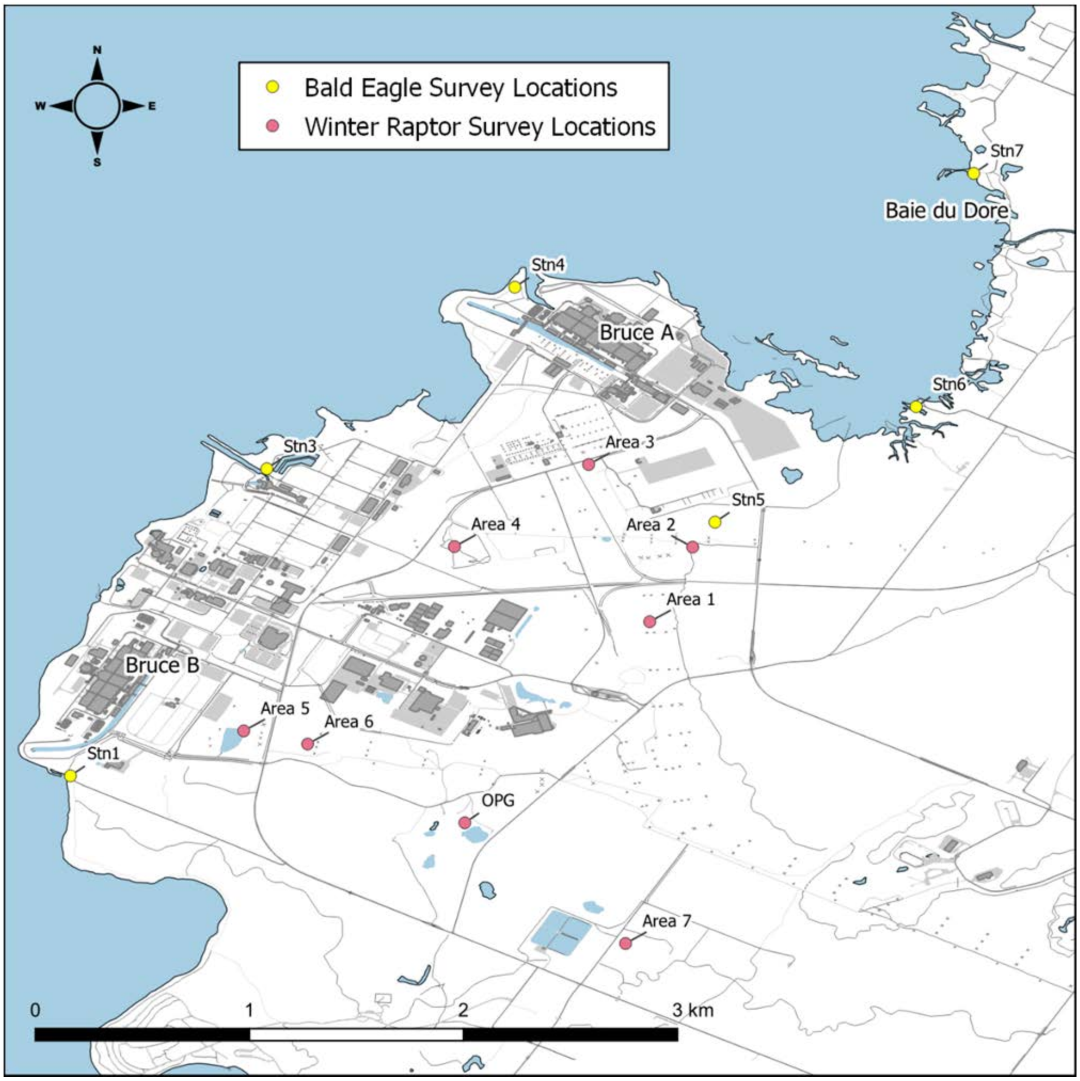

Figure 11 Bald Eagles and Winter Raptor Survey Locations

Bald Eagles are frequently observed at Stn. 4-7 and lower numbers are recorded at Stn. 1-3 where there are less foraging and perching opportunities than within Baie du Doré (Figure 11). Overall across the whole site, counts have increased in the last four years indicating an increase in the abundance of the local overwintering Bald Eagle population (Figure 11).

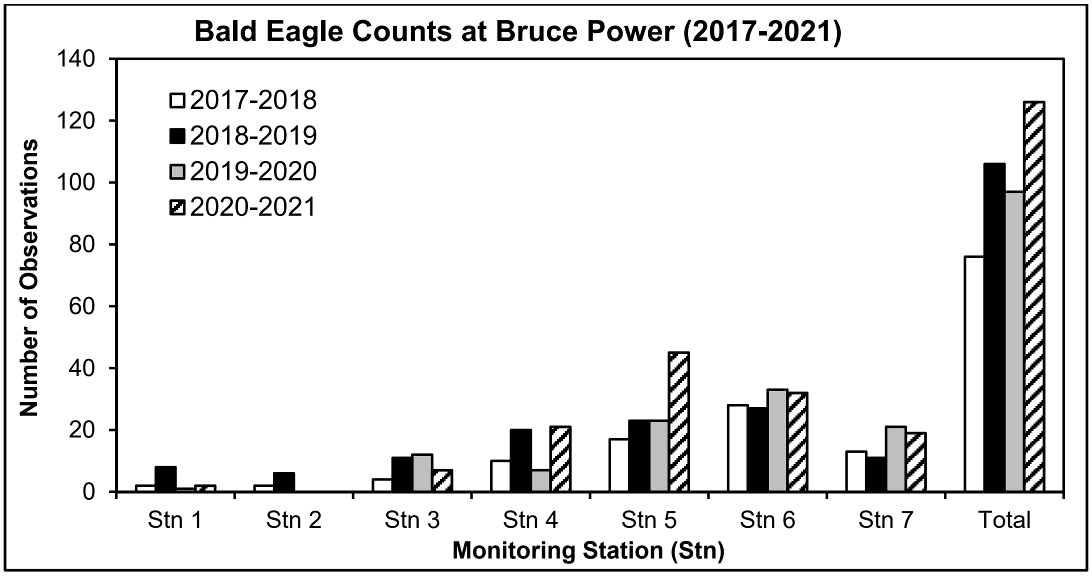

Figure 12 Bald Eagle Counts at Bruce Power, 2016-2020

Although other raptor species are frequently observed in the spring, summer and fall, few raptors are found on or near Bruce Power in the winter months. None were observed during winter raptor surveys conducted in 2017-2018 and 2020-2021. One Red-tailed Hawk was observed in 2018-2019, and one Snowy Owl and one Northern Harrier were recorded in 2019-2020. Winter raptor habitat availability in the local area is poor because a considerable snowpack often accumulates. This makes foraging for food difficult compared to areas inland and south of Bruce Power that have a smaller snowpack. Raptors can more easily find food in open agricultural fields where windswept areas expose rodents and other creatures to predation. Formal surveys for winter raptor species will not be continued but recording of incidental observations made by employees and Bruce Power field biologists will continue.

1.7.2.2 Waterfowl and Shoreline Bird Surveys

In 2016 and 2017, waterfowl, shorebirds and other coastal associated species were surveyed from a series of viewpoints along the Lake Huron shoreline. Across all surveys, a total of 20 species were observed, along with four unidentified species. The greatest number of species and individuals was observed on the late August visit. Most species observed were waterfowl (11 of 20 species). Only one shorebird, an unidentified plover, was observed. There is currently very little suitable habitat for shorebirds along the shoreline due to high water levels. In 2017, the most common waterfowl species observed was the Canada Goose followed by the Common Merganser and the Double-crested cormorant.

One of the species observed, Horned Grebe (*Podiceps auritus*), is assessed federally as Special Concern by COSEWIC (SARA No Schedule) and assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) as Special Concern in Ontario. Ten individuals were observed on October 19-20, 2016 mostly in Baie du Doré, but also one well offshore from McPherson Bay and one along the shore at the south end of the property.

Additional waterfowl and shorebird surveys were completed in 2019 and 2020. The purpose of waterfowl and shorebird surveys is to monitor overwintering and stopover migration areas to trend species abundance and distribution over time. The shoreline of Bruce Power is surveyed for waterfowl and shorebirds with both binoculars and a spotting scope from a set of 10 viewpoints which were selected to cover most of the shoreline from Gunn Point to Scott Point with very little overlap (Figure 13).

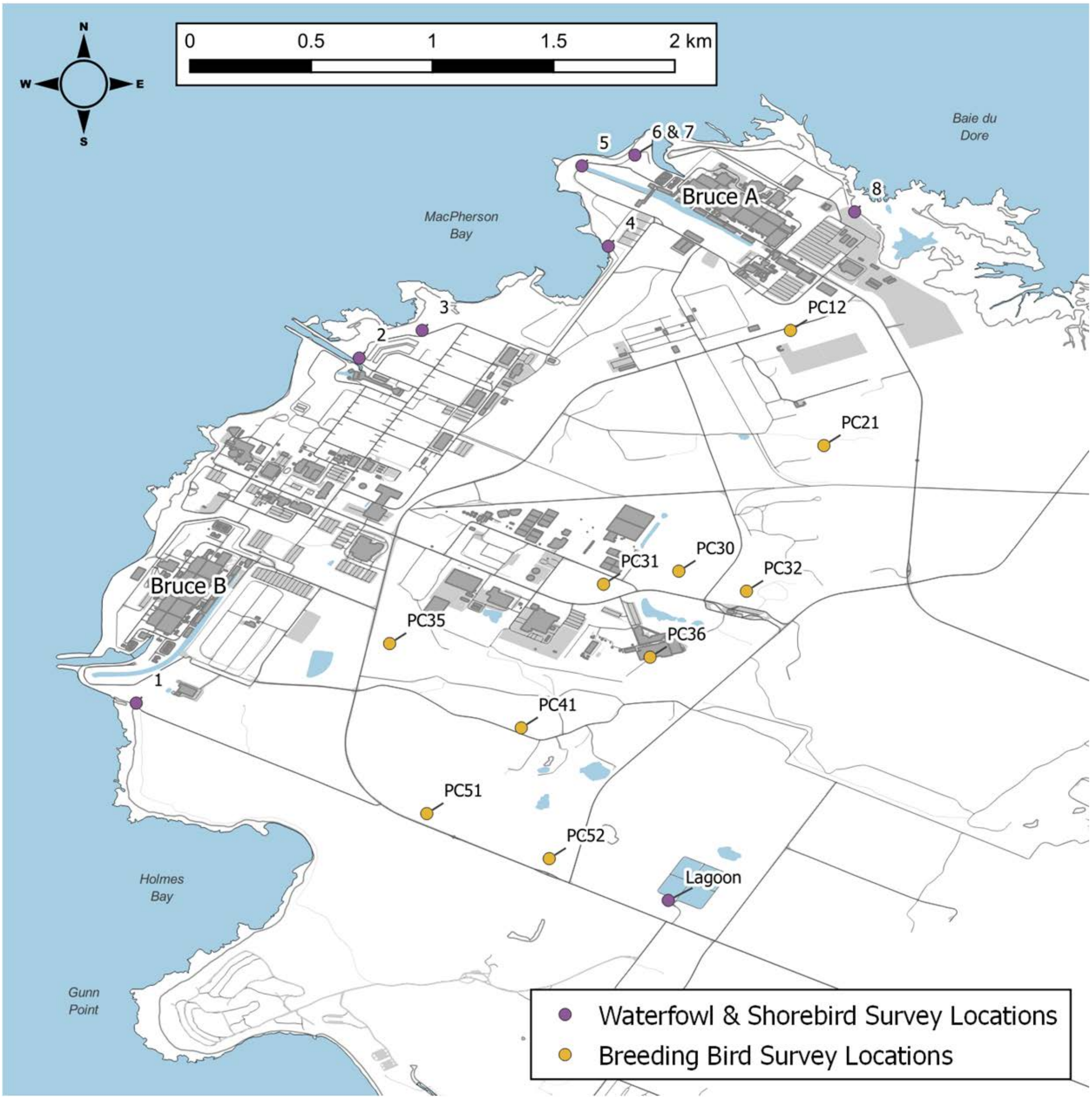

Figure 13 Waterfowl, Shoreline and Breeding Bird Monitoring Locations at Bruce Power

The total number of birds observed during the 2019 monitoring was 3043. A total of 44 species of birds were identified during the waterfowl/shorebird monitoring. Double-crested cormorant (*Phalacrocorax auritus*) was the most abundant bird observed in 2019 with a total of 631 individual observations. The next most common species were gulls, both the Ring-billed (*Larus delawarensis*) and Herring gull (*Larus argentatus*) were very common observations with there being 449 Herring gulls and 401 Ring-billed gull counted in total for all 6 of the survey dates. Ducks were relatively abundant with a total species count of 20. Bufflehead (*Bucephala albeola*) was the most abundant waterfowl species encountered with a total number of 150. Only 2 shore/wading birds species was recorded during the 2019 monitoring, they were single observations of a Greater yellowlegs (*Tringa melanoleuca*) and a Spotted sandpiper (*Actitis macularius*). In 2020, six spring/fall surveys were completed between April 7and November 25, recording a total of 1,995 birds across 32 species of waterfowl/shorebirds. A similar monitoring effort was completed in 2019 (6 surveys) when 3,043 birds were observed across 44 species. Overall, surveys in 2019 and 2020 have demonstrated that there are diverse populations of local and migrant waterfowl and shorebirds inhabiting the lands nearby Bruce Power, with the highest density in Baie du Doré (Figure 14).

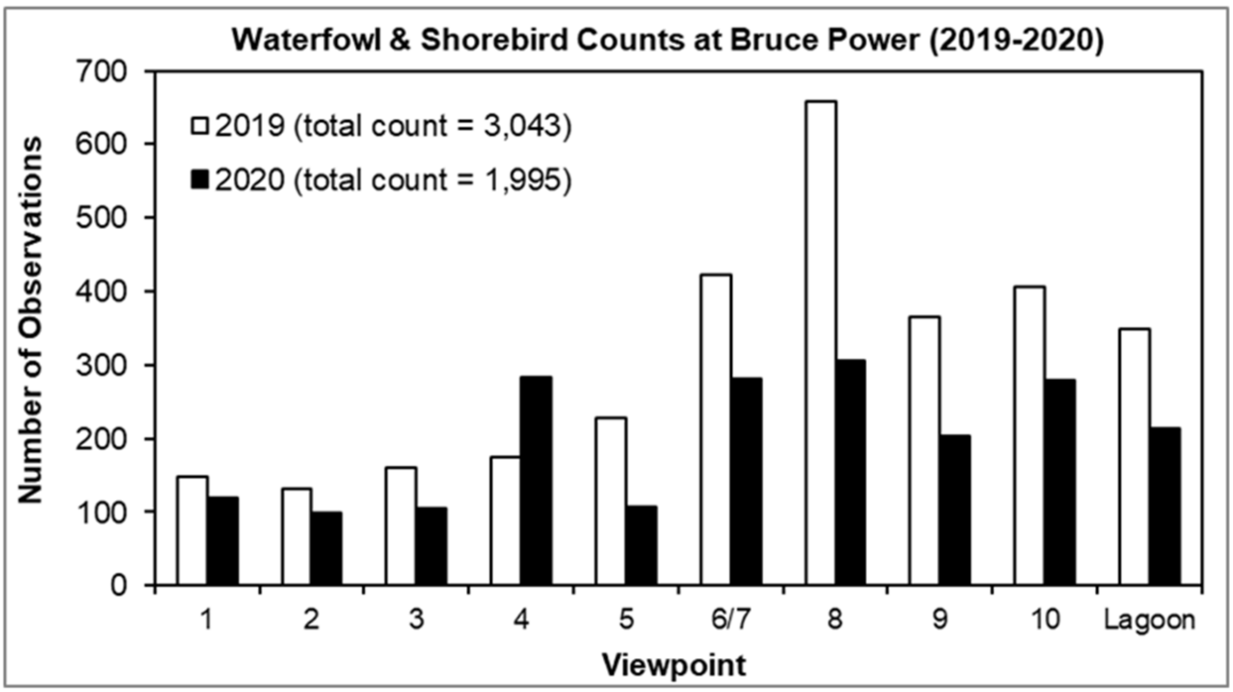

Figure 14 Counts of local waterfowl and shorebirds observed in 2019 and 2020

Canada Geese (*Branta Canadensis*) and Double-Crested Cormorant (*Phalacrocorax auritus*) were the most abundant birds observed in 2020 with a total of 425 Canada Geese and 237 Double-Crested Cormorants observed. The next most common bird species was the Herring Gull (*Larus argentatus*) with 203 observations. Ducks were relatively abundant in 2020 with 18 different species observed. Mallard (*Anas platyhynchos*) was the most abundant waterfowl species encountered with 136 observations.

The Greater Yellowlegs (*Tringa melanoleuca*) was observed on 2 occasions; the only shore/wading bird species recorded in 2020 along with 2 marsh bird species: the Pied-Billed Grebe (*Podilymbus podiceps*) and the Sora (*Porzana carolina*).

1.7.2.3 Breeding Bird Surveys

Breeding bird monitoring surveys were completed by Bruce Power and OPG biologists at 10 locations in the morning of June 4, 2020 (Figure 13). Monitoring protocols followed the standards prescribed by Birds Canada (formerly Bird Studies Canada) for the Ontario Breeding Bird Atlas [R-43]. A total of 43 bird species were documented during the 5-minute surveys at each location.

The most commonly observed species were the Red-Eyed Vireo (*Vireo olivaceus*) and American Goldfinch (*Spinus tristis*), which were each found at 8 of the survey locations. The Red-Winged Blackbird (*Agelaius phoeniceus*) and American Redstart (*Setophaga ruticilla*) were each found at 7 of the survey locations. Interesting observations included 4 SAR bird species: Eastern Wood Pewee (*Contopus virens*), Wood Thrush (*Hylocichla mustelina*), Eastern Meadowlark (*Sturnella magna*), and Bobolink (*Dolichonyx oryzivorus*). Two Sedge Wrens (*Cistothorus stellaris*) were observed and this bird is not locally common.

1.7.3 Reptiles and Amphibians

1.7.3.1 Amphibians

Amphibians are monitored as an indicator for ecosystem health as they have a dual life cycle (water and land) and are sensitive to pollutants during all life stages [R-44]. Incidental amphibian observations are recorded year-round during vehicle-wildlife interaction surveys, pedestrian surveys and with employee sightings. There was an incidental observation of a Spotted Salamander (*Ambystoma maculatum*) and a Red-Spotted Newt (*Notophthalmus viridescens*) in 2019 and another observation of the Spotted Salamander in 2020, which is not listed as a Species At Risk (SAR).

Targeted nocturnal amphibian vocalization surveys were conducted in the spring and summer of 2017 to 2020, following the methodology described by Bird Studies Canada/ Environment Canada Marsh Monitoring Protocol [R-44]. The protocol requires sampling on three separate calm, mild evenings at least 15 days apart to determine species presence and relative abundance. In addition to the targeted vocalization surveys, incidental observations were made throughout the year during other field studies (pedestrian surveys, vehicle/wildlife interaction surveys) in order to document evidence of amphibian breeding activity (e.g., egg masses, larvae, spermatophores, daytime calling). A total of 13 survey locations were established from 2017 to 2020 based on previous monitoring locations and proximity to wetlands, ponds, and ephemeral pools (Figure 15). Two new locations were added in 2020 based on joint environmental monitoring between Bruce Power and OPG (MMP2 and MMP5). Six different frog species were identified from 2017 to 2020 during surveys in April, May and July.

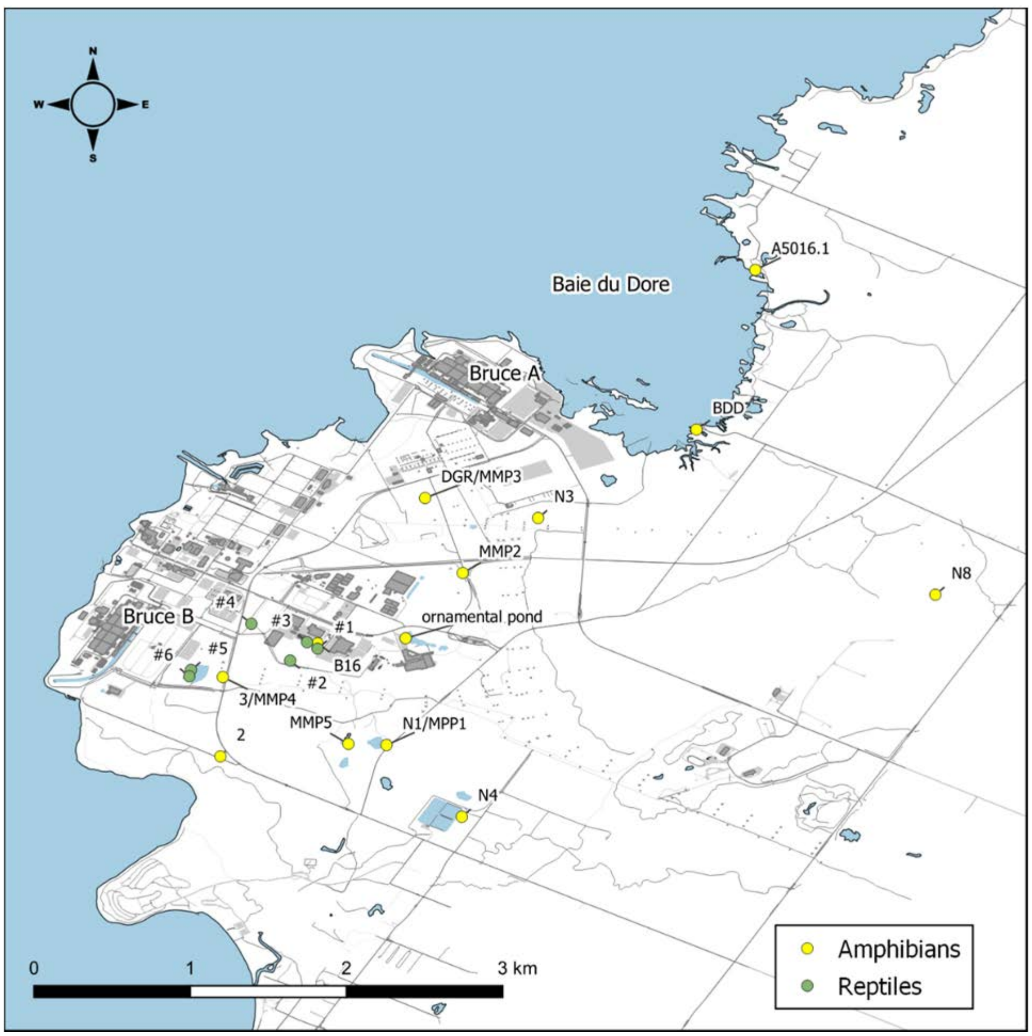

Figure 15 Amphibian and Reptile Monitoring Stations

Species frequency by station and year are displayed in Table 9. By far, the most common and abundant species documented was the Spring Peeper (*Pseudacris crucifer*). This early breeding frog species was heard calling at all of the 11 monitoring stations. Although this species was heard calling at high levels during early season visits; later season visits typically do not result in any calls, this can be a common finding with this early breeding amphibian species.

Another early breeder is the Wood Frog (*Lithobates sylvatica*), and this species is typically only heard during early season surveys, consistent with the early and short breeding window for this species. The Northern Leopard Frog (*Lithobates pipiens*), another early-mid season breeder, was documented at twelve of the stations and only was heard during the first visit.

Mid-season breeders typically include the American Toad (*Anaxyrus americanus*) and the Grey Treefrog (*Hyla versicolor*). The American Toad was heard at eleven of the monitoring stations. American Toads have probably the most diverse breeding habitat requirements and may be found in shallow ponds, shallow streams, river margins and even large puddles and roadside ditches. Observations of the Grey Treefrog were abundant, with the frogs being heard at eighteen of the stations. Late breeding frog species include the Green Frog (*Lithobates clamitans*). Green Frog was heard at 11 of the stations, all during the last visit of each year.

Table 9 Amphibian Monitoring Survey Results

Station	Year	Species						Total # of Species Heard
		AMTO	GRTR	GRFR	NLFR	SPPE	WOFR	
2	2017		x			x	x	3
	2018					x		1
	2019		x		x	x		3
	2020		x		x	x		3
3/MMP4	2017	x	x			x	x	4
	2018		x			x	x	3
	2019		x			x	x	3
	2020			x		x		2
21	2017					x		1
18	2017					x		1
23	2017		x			x	x	3
14	2017		x			x		2
10/11	2017		x			x		2
N1/MMP1	2017	x	x	x		x	x	5
	2018			x		x	x	3
	2019		x			x		2
	2020			x		x		2
N2	2017	x	x	x		x		4

Station	Year	Species						Total # of Species Heard
		AMTO	GRTR	GRFR	NLFR	SPPE	WOFR	
N3	2017	x	x	x	x	x		5
	2018			x	x	x	x	4
	2019	x	x		x	x		4
	2020	x			x	x		3
N4	2017	x	x		x	x		4
	2018					x		1
	2019		x	x	x	x		4
	2020	x	x	x	x	x		5
N5	2017		x	x	x	x		4
	2018	x			x	x		3
N6	2017		x			x		2
N7	2017		x			x		2
N8	2017		x	x	x	x	x	5
	2018					x		1
	2019		x			x		2
	2020					x		1
N9	2017		x	x	x	x	x	5
N10	2017				x	x		2
A5878.1	2018				x			1
A5878.3	2018	x				x		2
A5016.1	2018			x	x	x		3
	2019	x	x	x	x	x		5
	2020	x			x	x		3
DGR/MMP3	2019	x	x	x		x	x	5
	2020				x	x		2
B16	2019	x	x		x	x		4
	2020	x				x		2
OR. Pond	2019	x	x	x	x	x		5
	2020	x			x	x		3
MMP2	2020					x		1
	2021	x	x			x		3
MMP5	2020	x	x			x		3
	2021		x	x		x		3

AMTO: American Toad (*Anaxyrus americanus*) GRTR: Grey Treefrog (*Hyla versicolor*)
GRFR: Green Frog (Lithobates clamitans) NLFR: Northern Leopard Frog (*Lithobates pipiens*)
SPPE: Spring Peeper (*Pseudacris crucifer*) WOFR: Wood Frog (*Lithobates sylvatica*)

1.7.3.2 Reptiles

Due to the decline of certain snake populations in Ontario it is important for Bruce Power to collect data on their presence, diversity, and well-being so that sound land-use planning decisions can be made that are protective of these sensitive species. Snake monitoring has been ongoing since 2017 and has focused on locating and characterizing the species assemblage and identifying potential critical habitat within the facility lands. Incidental reptile observations are recorded year-round during vehicle-wildlife interaction surveys, pedestrian surveys and with employee sightings.

Focused snake board studies were initiated in 2020 in collaboration with OPG following guidelines for snake monitoring outlined in the Ontario Ministry of Natural Resources and Forestry (MNRF) survey protocol [R-45]. Bruce Power placed 6 snake boards in key habitat locations on-site (Figure 15) and surveyed them on 5 occasions between July 3, 2020 and August 14, 2020. OPG placed an additional 33 snake boards around the site and observed them on 5 occasions between May 6, 2020 and June 24, 2020. In total, 38 snakes were observed at all locations in 2020.

Five different snake species were observed in from 2017 to 2020: Eastern Garter Snake (*Thamnophis sirtalis*), Dekay's Brown Snake (*Storeria dekayi*), Red-bellied Snake (*Storeira ociptiomarulat*), Smooth Green Snake (*Opheodys vernalis*), and the Eastern Ribbonsnake (*Thamnophis sauritus*). The Eastern Ribbonsnake is a listed SAR in Ontario and Canada with a conservation status of *Special Concern* [R-46]. Snake species recorded on-site from year to year were generally consistent (Table 10), with the Smooth Green Snake being first observed in 2020.

Incidental observations were made of Snapping Turtle (*Chelydra serpentina*), Midland Painted Turtle (*Chrysemys picta marginata*), and an additional turtle species from 2017 to 2020 (Table 10). The CWMP program noted the presence of Painted Turtle in Baie du Doré in 2019 and 2020 [R-47][R-48].

Table 10 Reptile species presence recorded in the local area 2017-2020

Species	2017	2018	2019	2020
Dekay's Brown Snake	Yes	Yes	Yes	Yes
Eastern Garter Snake	Yes	Yes	Yes	Yes
Eastern Ribbonsnake	Yes	No	Yes	Yes
Red-bellied Snake	Yes	Yes	No	Yes
Smooth Green Snake	No	No	No	Yes
Midland Painted Turtle	Yes	Yes	Yes	Yes
Snapping Turtle	Yes	Yes	Yes	Yes

1.7.4 Culturally Significant Wildlife Species

Indigenous communities have identified hunting and trapping of wildlife species as part of traditional land use and harvesting activities.

Hunting is a popular activity in the area surrounding the Bruce Site. Typically hunters from the local population and some hunters from outside the area hunt within 5 km of the Site. As part of the 2016 Bruce Power Site Specific Survey Report [R-25], data was collected as to whether households consumed wild meat sourced within Bruce County. As noted above, they were also asked about their use of animal and plant products for medicinal or ceremonial purposes. Of the 258 households that completed the Local Population Survey, 38 (15%) indicated that they consumed wild animals from within Bruce County. Of these, 33 were permanent residents and 5 were seasonal. As part of the survey, residents indicated they consumed wild meat sourced within Bruce County from deer, rabbit, waterfowl, turkey and bear.

Furthermore, community-specific traditional use information has been shared with Bruce Power by the HSM and MNO and is included below.

The MNO have expressed concerns regarding the impact of reduced access to land for traditional hunting practices [R-34].

Species of importance to the MNO for hunting purposes include [R-34], but are not limited to:

- Rabbits (cottontail)
- Buffleheads
- Geese (Canada)
- Teal
- Black bear
- Mallards
- Pigeon
- Deer
- Merganser
- Grouse
- Fox
- Wild Turkey
- Black Duck
- Redhead

Species of hunting importance to the MNO not known to use the Bruce Power site include jack rabbits, wolf, snow geese, partridge, blue bill, moose, pheasant, whistlers, canvasback, greater scoot, lesser scoot, widgeon and pintail.

Species of importance to the MNO for trapping purposes include, but are not limited to:

- Muskrat
- Rabbit (Cottontail)
- Groundhog
- Raccoon
- Skunk
- Mink
- Beaver
- Fisher
- Weasel

Species of trapping importance to the MNO not known to use the Bruce Power site include jack and snowshoe rabbits, marten, rats, marmot. Species of gathering importance to the

MNO include, but are not limited to, leopard frogs, snapping turtle, bullfrogs and sea gull and duck eggs, all of which occur on the Bruce Power site.

A 2017 survey of MNO land and water uses in the area near Bruce Power found that approximately 21% of respondents used the area for hunting and an additional 9% and 6% used the area for trapping and frog, turtle and egg gathering, respectively [R-34]. A 2019 follow-up survey found that approximately 25% of respondents used the area for hunting activities, with additional approximately 5% participating in frog and turtle gathering [R-35].

HSM also describe hunting and harvesting as a traditional activity near Bruce Power, including the following species found on the Bruce Power site [R-36]:

- Bullfrog
- Black Duck
- Mallard
- Mergansers
- Wood Duck
- Canada goose
- Grouse
- Seagull Eggs
- Pidgeon
- Black Bear
- Red Fox
- Muskrat
- Black Squirrel
- Beaver
- White-tail deer
- Rabbit
- Raccoon
- Otter
- Muskrat
- Fisher/Marten
- Groundhog
- Mink
- Weasel
- Hares

Species of trapping importance to HSM not known to use the Bruce Power site include partridge, ring-necked pheasant, wolf, rats and marmot.

This information was considered when confirming the VECs used in the assessment (see Section 2.3.1.1) and exposure pathways (see Section 2.3.2).

1.8 Aquatic Habitat and Communities

The most recent assessment of aquatic habitat and communities at the Site was completed in 2008 [R-49], with habitat-specific studies through 2016, which updated the assessment that was a component of the Bruce New Build EA in 2008 [R-49]. The following subsections summarize the findings to date.

In addition to fishing for food, social and ceremonial purposes, SON has a proven Aboriginal and Treaty Right to a commercial fishery in the waters of Georgian Bay and Lake Huron, within SON Territory, including the waters adjacent to Bruce Nuclear site. SON have identified the importance of preserving all fish habitat [R-32].

The HSM and MNO also have asserted fishing rights for food, social and ceremonial purposes and all three Indigenous communities have expressed a strong connection to the Lake Huron fishery. A description of the fishery is provided in Section 1.8.7.

1.8.1 Aquatic Habitat

Areas providing aquatic habitat on and around the Site were identified as those that meet the definition of a water body under the *Environmental Protection Act*, Part XV.1, Ontario Regulation 153/04 [R-50]:

"A permanent stream, river or similar watercourse or a pond or lake, but does not include a pond constructed on the property for the purpose of controlling surface water drainage."

Two categories of aquatic habitat were considered in the 2022 ERA. The first consisted of those located that met the definition provided above, including areas considered as representing aquatic habitat included offshore and nearshore areas of Lake Huron in the immediate vicinity of site. Bottom substrates in the lake are generally bedrock or cobbles and boulders with some sand in local embayments [R-51]. Habitat in the nearshore and on-site areas includes:

- Bruce A discharge channel extends approximately 300 m into Lake Huron. It is lined with armourstone and has a bedrock bottom. A dock facility also exists in this channel and bottom substrates in depositional areas are sand and organic silt.
- Bruce B discharge channel was excavated out of bedrock and is lined with armourstone along much of its length. Substrates within the channel are almost exclusively exposed bedrock. A large triangular area was constructed off the main channel to accommodate a boat dock. Similar to the Bruce A discharge channel Bruce B also has sand and organic silt in areas of lower velocity flows.
- Lake Huron shoreline from McRae Point to the south through Loscombe Bank to the North. Inverhuron Bay, Holmes Bay and MacPherson Bay are small embayments between McRae Point and Douglas Point with similar substrates to main lake basin.
- Baie du Doré is an embayment along the eastern shore of Lake Huron immediately north of the Site. The bay is bisected by two rock/cobble shoals that run northeast, parallel to the Lake Huron shoreline. Shoals are exposed in low water years and subsequent mixing of water throughout the bay is affected. Recently, with higher water levels, shoals have been completely under water.
- Stream C (SW1 and SW2) is a cool-cold water stream which was originally part of the Little Sauble River watershed which drains into Inverhuron Bay to the south of Bruce B. Portions of Stream C were altered during the initial development of the Site in the 1950s when it was diverted to the north. It presently flows in a constructed channel across the northeast corner of the Site where it enters Baie du Doré immediately north of Bruce A. Approximately 1.5 km of Stream C is located on the Site. The lower 800 m of the stream flows outside of the property boundary and empties into Baie du Doré.

In general, aquatic communities in these areas include aquatic vegetation (macrophytes), phytoplankton, zooplankton, benthic invertebrates and fish, which are discussed further in Sections 1.8.2 to 1.8.6.

The second category of aquatic habitat assessed in the 2022 ERA included permanent drainage features that contain water year-round. While technically constructed only for the purposes of controlling surface water drainage and not meeting the definition of aquatic habitat, these areas are utilized by semi-aquatic wildlife (i.e., semi-aquatic birds, reptiles and amphibians). Permanent drainage features assessed in the 2022 ERA include:

- Former Sewage Lagoon located between the Interconnecting road and the Bruce B complex. A full description is included in Section 1.3.1.3.
- B31 Pond (formerly the Ornamental Pond) located between B31 and CL4. A full description is included in Section 1.3.1.3.
- B16 Pond located next to B16, an on-site warehouse.
- Distal end of the Eastern Drainage Ditch (SW3) located north of Bruce B and described in in Section 1.3.1.3.

Areas not considered to represent aquatic habitat include the following:

- Constructed ditches that exist between the Eastern Drainage Ditch and Bruce A (SW4, SW5 and SW6) that eventually drain into MacPherson Bay. These ditches are used to manage stormwater drainage [R-52] and the bottom of the ditch is alternately grass-lined or filled with cattails or lined with cobbles Drainage under the roads is conveyed through culverts, which are partially blocked by sediment and aquatic plants. The ditches discharge into MacPherson Bay via a grassy swale containing some cattails. These ditches generally have no water or stagnant water outside of storm events. Due to the lack of the regular presence of water at these locations, these areas were excluded as aquatic habitat.
- Areas located on OPG retained lands were also excluded from the 2022 ERA, including: Former Clariflocculator Sludge Lagoon (CSL) is a former sewage/sludge lagoon constructed and maintained for industrial use only.
- Railway Ditches that run north and south of the abandoned railway spur line located on the north side of the WWMF were constructed to collect stormwater drainage from the WWMF, including surface runoff from the WWMF as well as three discharge pipes from the facilities on the WWMF site [R-52][R-53]. The effects of OPG activities upstream from Stream C, within the South Railway ditch have been directly assessed by OPG ([R-2][R-53]) and are monitored as part of OPG's operations (i.e., Effluent and Environmental Monitoring Programs). Therefore, through the assessment of Stream C in this ERA, the upstream contribution of the South Railway Ditch is considered. Additionally, monitoring of surface water and sediment quality in Stream C is being carried out by Bruce Power: approximately every five years for sediment and more

frequently for surface water. Therefore, any potential contribution of contaminants from the South Railway Ditch is incorporated into the surface water and sediment quality of Stream C. Results of surface water and sediment sampling completed in the South Railway Ditch are included in the 2022 ERA as part of a regulatory request. Further risk assessment of these results was completed by OPG as part of the 2021 update to the WWMF ERA [R-2].

- The On-Site Wetland located east of the WWMF is to control stormwater drainage [R-53]. Water levels fluctuate throughout the year, and there are times when the wetland contains areas of open standing water. The On-Site Wetland largely contains cattails and large organic debris.

1.8.2 Aquatic Vegetation (Macrophytes)

The occurrence of emergent aquatic macrophytes is sparse within the boundary shoreline of the Site [R-49]. This is consistent with the exposed, high energy environment of the Lake Huron nearshore and coastal embayments. Wind, wave and ice scour influences shallow habitat areas such that coarse substrates prevail and conditions do not exist for plant growth. Areas of submerged aquatic vegetation occur in sheltered portions (i.e., areas of low flow or low velocity water) in the Bruce A and Bruce B discharge channels. *Elodea* spp. have colonized the Bruce A discharge channel, and the Bruce B channel has been colonized by *Myriophyllum* and *Potamogeton* spp. One single-stemmed aquatic macrophyte (species not identified) was identified in the Bruce A discharge channel in a recent benthos study to support thermal effects monitoring [R-54]. *Phragmites spp.* have been noted in ditches on-site and in Baie du Doré.

A few small localized patches of submerged vegetation have been noted in sheltered areas at the head of Baie du Doré and some species of emergent vegetation are present in this area. Three non-native species were identified in 2015, namely the emergent common reed (*Phragmites australis v. australis*), the emergent curly-leaf pondweed (*Potamogeton crispus*), and the submergent Eurasian milfoil (*Myriophyllum spicatum*) [R-55]. Additionally, a comparison of Wetland Macrophyte Index (WMI) scores from 1998 and 2015, which indicate the overall health of the wetland complex, indicates an improvement from 1998 to 2015, where the scores were interpreted as “somewhat impacted” in 1998 to “not impacted” in 2015 [R-55]. The distribution of vegetation types at CWMP monitoring sites in Baie du Doré in 2019-2020 is shown in Figure 16[R-47][R-48]. There is significantly more vegetation coverage and diversity at the Baie du Doré sites compared to the Inverhuron sites [R-48].

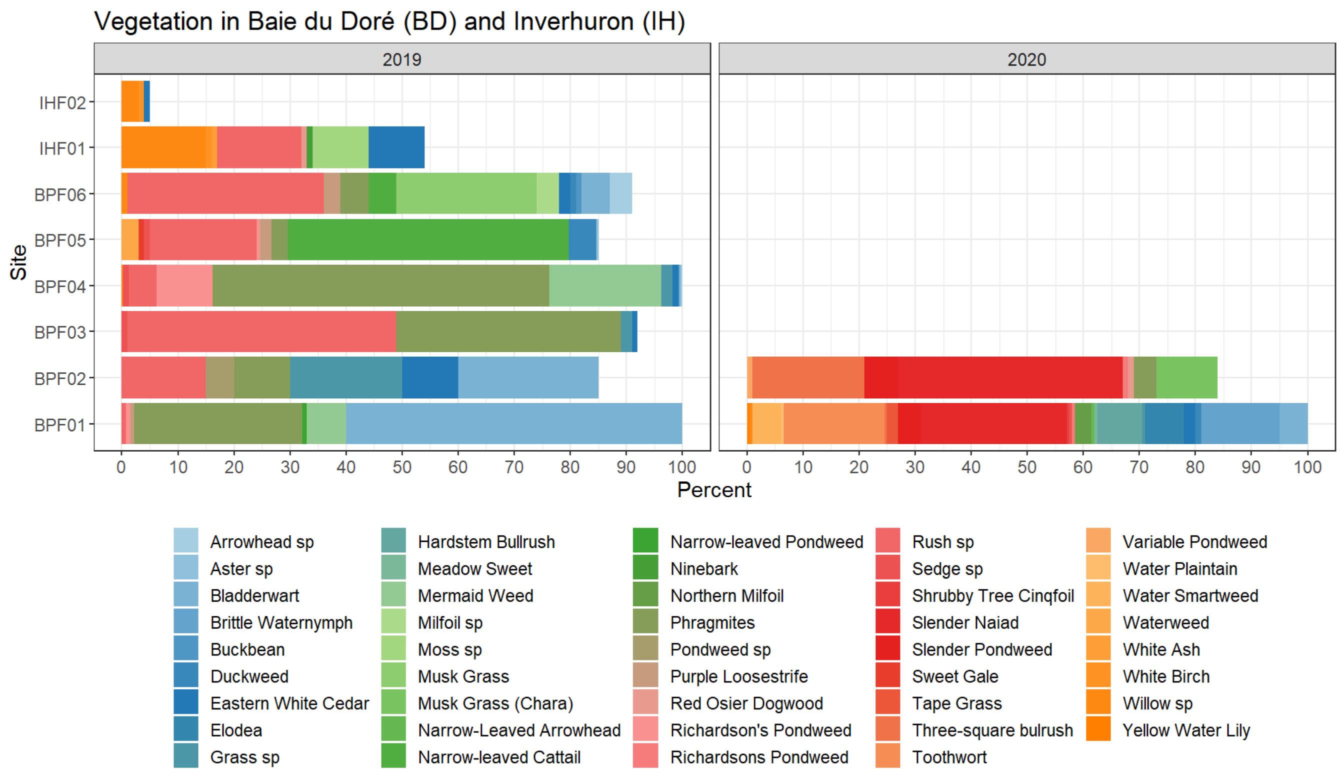

Figure 16 Distribution of Vegetation Types in Baie du Dore (BD/BPF) and Inverhuron (IHF) at CWMP Monitoring Sites, 2019-2020. Where the percent does not total 100%, the remaining area is listed as open without vegetation. Inverhuron Site IHS01-20 was listed as 100% open and does not appear on the figure.

1.8.3 Periphyton and Phytoplankton

Studies prior to the commissioning of the Site found that little attached algae (periphyton) was found on the shoreline or nearshore areas due to low nutrient levels, cool water temperatures and exposure to high energy environments [R-49]. In an algal growth study carried out along the Lake Huron shoreline, the presence of periphyton was confirmed in this area [R-56]. Locally, higher concentrations were noted in Baie du Doré, due to warmer temperatures, limited ice scour, and shelter from the wind and wave actions of Lake Huron.

Phytoplankton communities were examined at Gunn Point, the Bruce A and Douglas Point discharge channels and Baie du Doré between 1975 and 1979 [R-49]. Phytoplankton in these locations was characterized as highly variable and typically highest in Baie du Doré and lowest at Gunn Point. In general, phytoplankton density and diversity in Lake Huron was low due to the limited productivity of this oligotrophic lake.

In June of 2003, the occurrence of nuisance benthic algae, specifically *Cladophora,* was investigated along the southeastern shores of Lake Huron by the MECP following reports of shoreline fouling by decaying organic matter over the preceding 2 to 3 years [R-57]. The main species of benthic algae observed during the surveys was *Cladophora glomerta*, although its occurrence was intermittent and was thought to be localized to areas with lake nutrients that were supportive of growth, and minimal areas of shoreline fouling were observed. No significant areas of shoreline fouling were found in the investigated areas close to the Site.

More recently, a study of algal fouling along the southeastern shore of Lake Huron was carried out in 2007/2008 [R-58]. From coverage at 11% of sites in 1977, coverage increased to nearly 90% of sites by 2007, with the most abundant algae found in sheltered areas and those where shoreline irregularities interrupt longshore flow. The species found were 62% periphyton turf, followed by 30% *Chara* and 8% *Cladophora*.

1.8.4 Zooplankton

It is generally reported that Lake Huron has experienced dramatic changes in its zooplankton community structure (i.e., types of animals present) and overall abundance (i.e., number of animals) since the early 2000s. Studies have reported significant reductions in zooplankton abundance and changes in community structure; all of which have been associated with reductions in nutrient loading (as a direct result of water quality management policies) and the entrance of exotic species such as the highly predatory non-native cladoceran (*Bythotrephes longimanus*) and the zebra mussel (*Dreissena polymorpha*) [R-59]. While recent studies indicate some stability in the Lake Huron zooplankton community in recent years, there continues to be evidence suggesting impacts linked to nutrient loss (oligotrophy), the effects of invasive species competition or predation [R-59] and coastal area features [R-60] continue. A review of zooplankton studies conducted near the Site between 1975 and 1980 indicated that the water surrounding Site is represented by a diverse zooplankton community consisting of rotifers (most abundant) but also copepods (*Cyclops* sp.) and cladocerans (*Bosmina* sp.) represented in the data [R-49]. In light of studies indicating dramatic changes in zooplankton community of Lake Huron since 2003, it is anticipated that the zooplankton community around the site has also changed reflecting the broader ecosystem patterns that have established in Lake Huron, and will continue to reflect ongoing changes in the future.

1.8.5 Benthic Invertebrates

Prior to the commissioning of Bruce A, the benthic invertebrate community was observed to be characteristic of the unstable, relatively severe conditions typically found on exposed coastlines of the Great Lakes [R-49]. These conditions creates unstable substrates and promotes continuous removal of fine substrates (prohibits deposition) and rapid dilution of sediments. The community was found to be dominated by four major groups: Amphipoda, Chironomidae (Diptera – true flies), Ephemeroptera (mayflies) and Gastropoda (snails).

Several studies since then have shown that the benthic invertebrate communities in the wave-washed nearshore area are reduced in both density and diversity of organisms, and that only a few species are able to colonize this hostile habitat [R-49]. Benthic communities were limited to a number of primary groups including Oligochaeta (Naididae), Amphipoda, Chironomidae and Ephemeroptera. Amphipoda were the dominant group in the nearshore areas while naidids were the dominant group in the Bruce A discharge channel. In the Bruce B discharge channel the benthic community was dominated by oligochaetes in the shallow water and chironomids were the major species in deeper waters. No organisms were observed on exposed bedrock surfaces, which is evidence that physical conditions (i.e., lack of sediments) may render these areas too harsh for colonization of most benthic organisms. Similarly, it was found that the abundance and diversity of benthic invertebrates was limited in sandy depositional areas (which precludes the presence of most burrowing species such as chironomids and oligochaetes) and rocky substrates were colonized by a number of insect species, including mayflies, caddisflies, some chironomid, oligochaete and isopod species and some zebra/quagga mussels (*Dreissena sp*.).

In general, diversity and abundance of benthic invertebrates is highest in Baie du Doré, which is a direct result of habitat quality and quantity in the near-shore area versus further off-shore [R-49]. During the CWMP monitoring program, Cadisfly (*Trichoptera*), Damselfly Nymph (*Zygoptera*) and Scud (*Amphipoda*) were found in Baie du Doré in 2020. These same species were located in 2019, along with Water Beetle (*Coleoptera*), Crayfish (*Decapoda*), Water Boatman (*Hemiptera corixidae*), Giant Water Bug (*Belostomidae*), Water Strider (*Hemipteran*), Snail (*Gastropoda*), Leech (*Hirudinia o*), and Water Stick Bug (*Nepidae*) [R-47][R-48].

The presence of two species of terrestrial burrowing crayfish (*Fallicambarus fodiens* and *Orconectes immunis*) has been documented across much of the Site, including Baie du Doré and Stream C [R-49]. The documentation of *F. fodiens* on the Site represents an expansion of its known range. The MNRF's NHIC lists this species as uncommon, but not rare. *F. fodiens* is not currently listed in the Species at Risk database.

It is noted that in a study completed for the main basin of Lake Huron (not specific to Baie du Doré or area near the site), communities of benthos have undergone changes since the 1960s, largely influenced by nutrient abatement programs (i.e., restricting/reducing phosphorus inputs) in the late 1970s, which subsequently reduced phytoplankton biomass [R-61]. Following these events in Lake Michigan, densities of *Diporeia*, Oligochaeta and Sphaeriidae gradually declined at depths up to 50 m (negligible changes were observed >50 m); it was hypothesized that these same declines were likely to occur in Lake Huron as well [R-61].

1.8.6 Fish

1.8.6.1 Nearshore Fish Community

The fish community of Lake Huron can be divided into two general categories: offshore and nearshore [R-49]. The offshore fish community is generally composed of species that use open or deep habitats for the majority of their life cycles. Species included in this category are Round Whitefish (*Prosopium cylindraceum*), Lake Whitefish (*Coregonus clupeaformis*), Lake Trout (*Salvenlinus namaycush*), and Rainbow Smelt (*Osmerus mordax*). These fish make use of the nearshore areas during spawning and possible feeding and prefer cooler offshore deeper waters, particularly during the warmer summer months.

The nearshore fish community is comprised of those species that prefer shallow, warmer water. Along the shoreline of the main Lake Huron basin these habitats are located within sheltered, shallow embayments such as Baie du Doré and the discharge channels. The embayments located to the South of the Site, near Inverhuron Provincial Park, are more open (Figure 16) and have less diversity of fish species (Figure 17) compared to the shallower and more complex Baie du Doré (Figure 18).

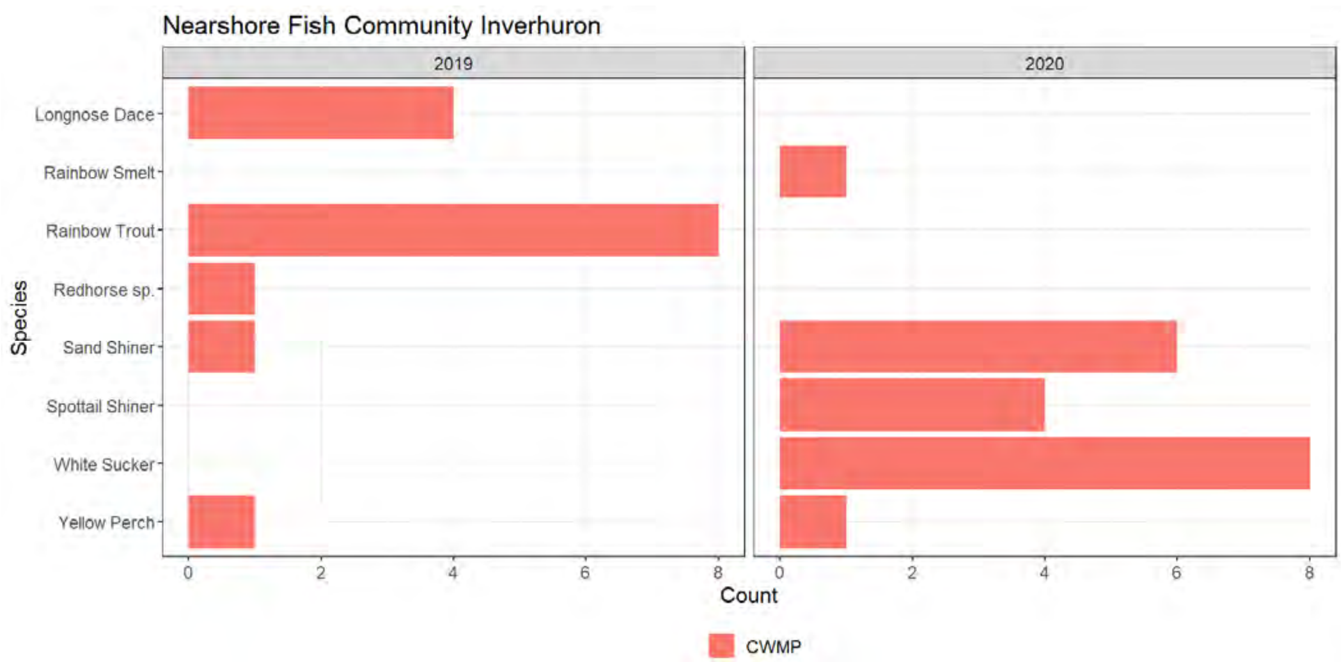

Figure 17 Summary of fish captured in fyke nets by the CWMP monitoring program (July 2019 and July 2020)

Species included in this category include Smallmouth Bass (*Micropterus dolomieu*), Yellow Perch (*Perca flavescens*), Rock Bass (*Ambloplites rupestris*) and Mimic Shiner (*Notropis volucellus*) [R-55]. Smallmouth Bass (*Micropterus dolomieu*) are common in the Bruce A and Bruce B discharge channels and Baie du Doré, and have been observed spawning in these areas. The non-native species Alewife (*Alosa pseudoharengus*) and Round Gobies (*Neogobius melanostomus*) have also been documented in the nearshore Baie du Doré area [R-55].

The Baie du Doré wetland is being monitored as part of a partnership between Bruce Power and the Invasive Phragmites Control Centre (IPCC) to understand the impact of phragmites on fish communities and to understand the impact of control activities on recovery of native plants and fish habitat. Fyke nets are set in the emergent zone in high, intermediate and low/no density invasive Phragmites communities. The nets are left overnight and sampled the following morning and then reset for a second night. Sampling takes place during the peak plant biomass period (August/September) and in 2018 a spring sampling event was added to capture spawning activity. The Baie du Doré nearshore fish community was also monitored by the CWMP program using fyke nets on July 31 and August 13, 2019 and August 24, 2020 [R-

47][R-48]. A summary of the fish species captured in Baie du Doré by year and by phragmites density when captured by the IPCC program is presented in Figure 18.

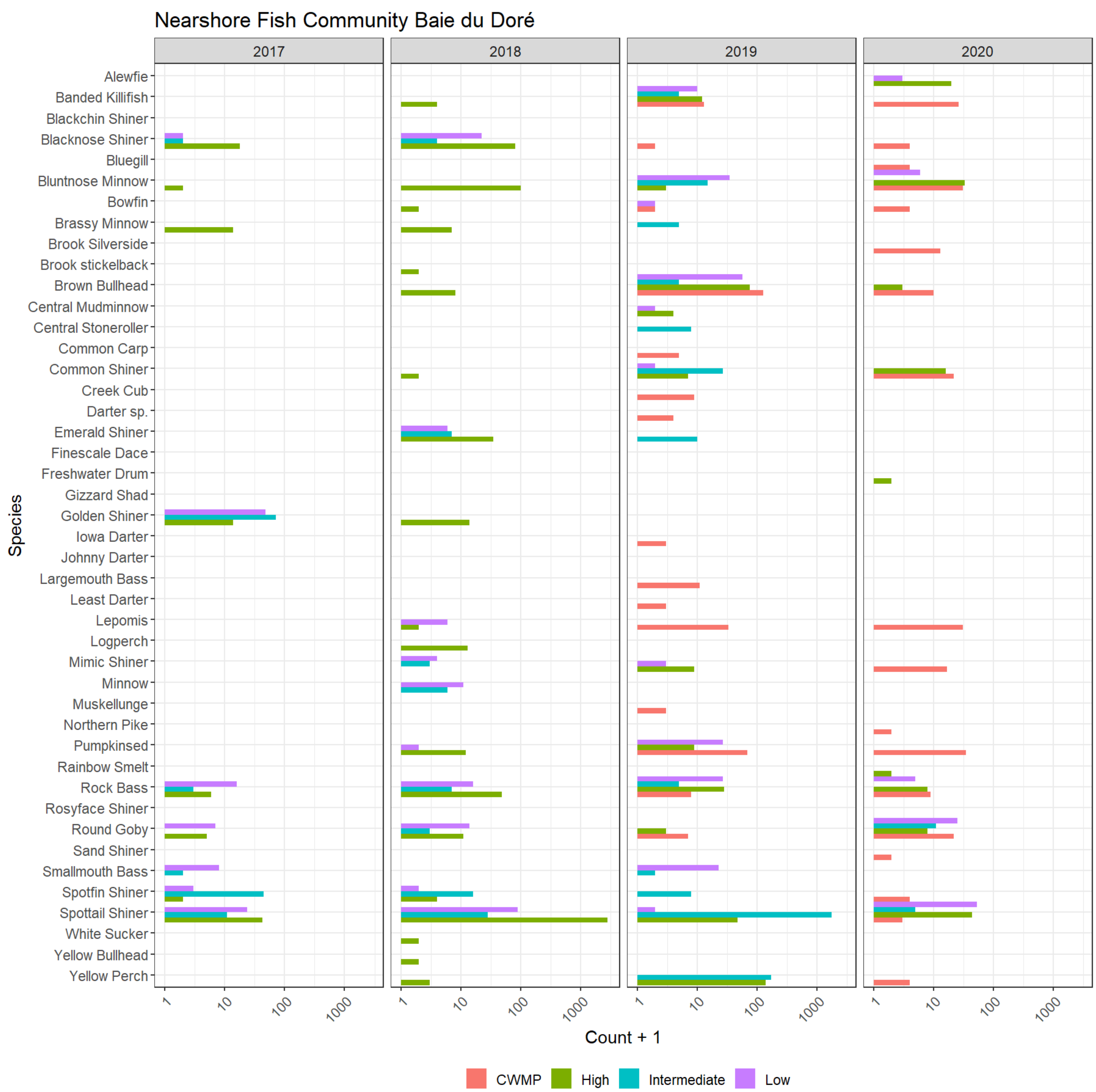

Figure 18 Summary of fish captured and released from High (Green), Intermediate (Blue), and Low (Purple) density Phragmites areas in the Baie du Doré coastal wetland (Aug and Sep, 2017-2020 and June 2018) and of fish captured in fyke nets by the CWMP (Pink) monitoring program (July and Aug 2019 and August 2020), presented using a log scale of the count plus one to show counts of one.

As was completed for aquatic macrophytes, a Wetland Fish Index (WFI) score was derived for the Baie du Doré of 3.57 in 2013, which is classified as “very good” [R-55]. The WFI is considered to reflect the “ecosystem integrity of the wetland” [R-55]. The Coastal Water Monitoring Program (CWMP) also assessed the WFI scores in Baie du Doré in 2019 and 2020 and the wetland achieved a score of “Good” in both years, with abundance scores of 3.37 and 3.59 [R-48]. The CWMP program also assessed the Inverhuron shoreline area as having a score of “Very Degraded” in both years, with scores of 2.59 and 2.54 [R-48]. This is likely related to the low density of vegetation and the lower number of fish species present in the Inverhuron area where the bathymetry drops off much more rapidly than in Baie du Doré and there is less protection from prevailing currents.

<u>Smallmouth Bass Nesting</u>

Smallmouth Bass nesting surveys to monitor local bass populations have occurred annually since 2009 (Bruce A and Bruce B discharge channels) and 2010 (Baie du Doré). These areas provide excellent Smallmouth Bass nesting habitat as there is abundant spawning conditions present (adequate depth, gravel/sand substrate and shelter from prevailing winds/wave action). Nests were observed throughout the season to monitor development and success criteria. Transects of the sampling areas were performed in a small boat (16 ft.), stopping to observe nesting sites with a custom viewing box (aquarium) that minimized glare and allowed for a clear view of the nest. Nests were assigned a unique identification number and GPS coordinates were recorded along with field notes on the stage of development. A standardized protocol was used classify nest development and outcome. A nest was considered ‘successful’ if it had reached development stage 6-8 (risen fry to green fry), ‘unsuccessful’ if it was abandoned and ‘remained active’ if it had reached development stage 1-5 during the extent of the survey. Nests were re-visited during each subsequent survey to reassess their development over time.

Nests are consistently located in similar geographic areas from one year to the next, which is likely due to site fidelity. Males are known to return to the same location year after year, with the majority returning to within 140 m of prior nesting sites [R-62]. Nests in Bruce A are generally found near the sheltered dock area, along the bedrock shelves and also in between the crevices within the large boulders that line the north and south areas of the discharge channel. This is consistent between all monitoring years. Nesting locations in the Bruce B discharge generally include the north side of the channel that is sheltered by the Bruce B dock, and the shallow areas along the discharge groyne. The sheltered shoreline areas of Baie du Doré and areas around the submerged island which separates the bay into east and west sections under high water conditions continues to be highly utilized for bass nesting.

Nesting success and the total number of nests at each location is shown in Figure 19, Figure 20 and Figure 21. Nesting success varies between years, generally between 40% and 95% of the nests are successful by the final survey. Bruce A generally has the fewest nests, with between 5 and 60 nests reported per year (Figure 19) while Bruce B normally has between 20 and 80 nests (Figure 20). Baie du Doré has the highest number of nests (Figure 21), typically between 50 and 150.

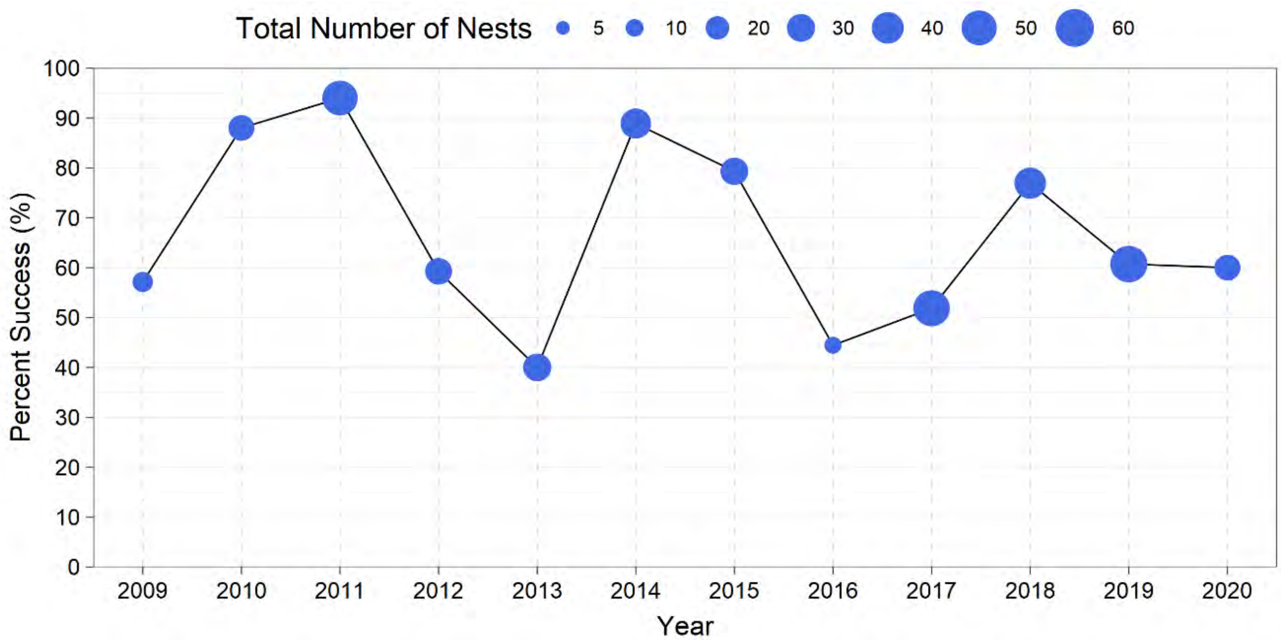

Figure 19 Bruce A discharge – Smallmouth Bass nest success at the final survey (2009-2020)

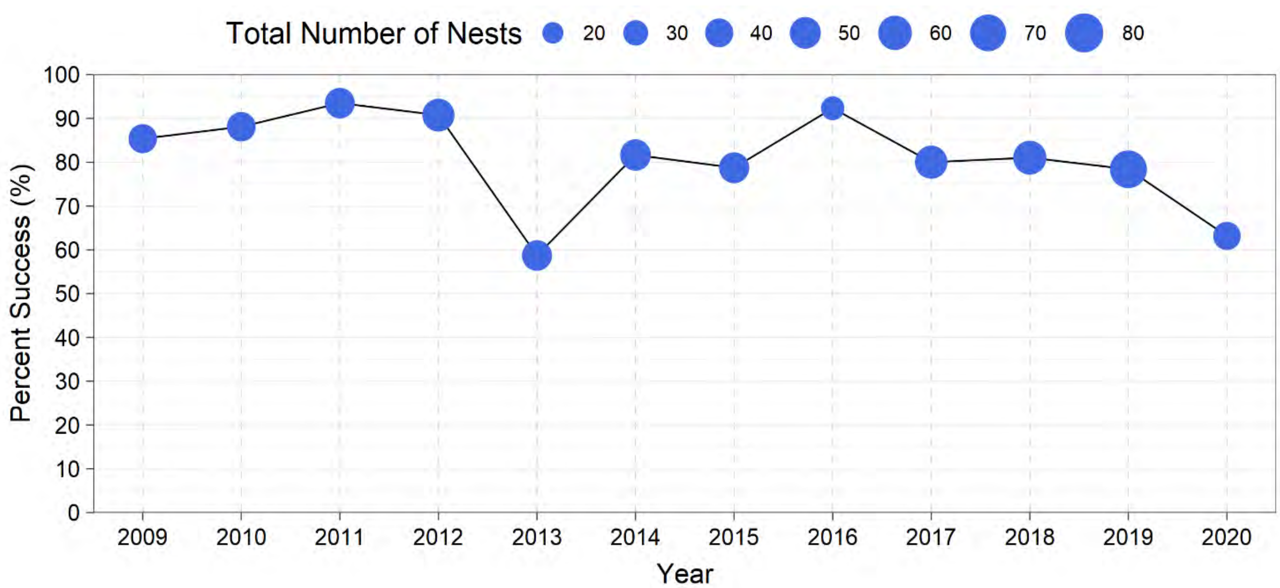

Figure 20 Bruce B discharge – Smallmouth Bass nest success at the final survey (2009-2020)

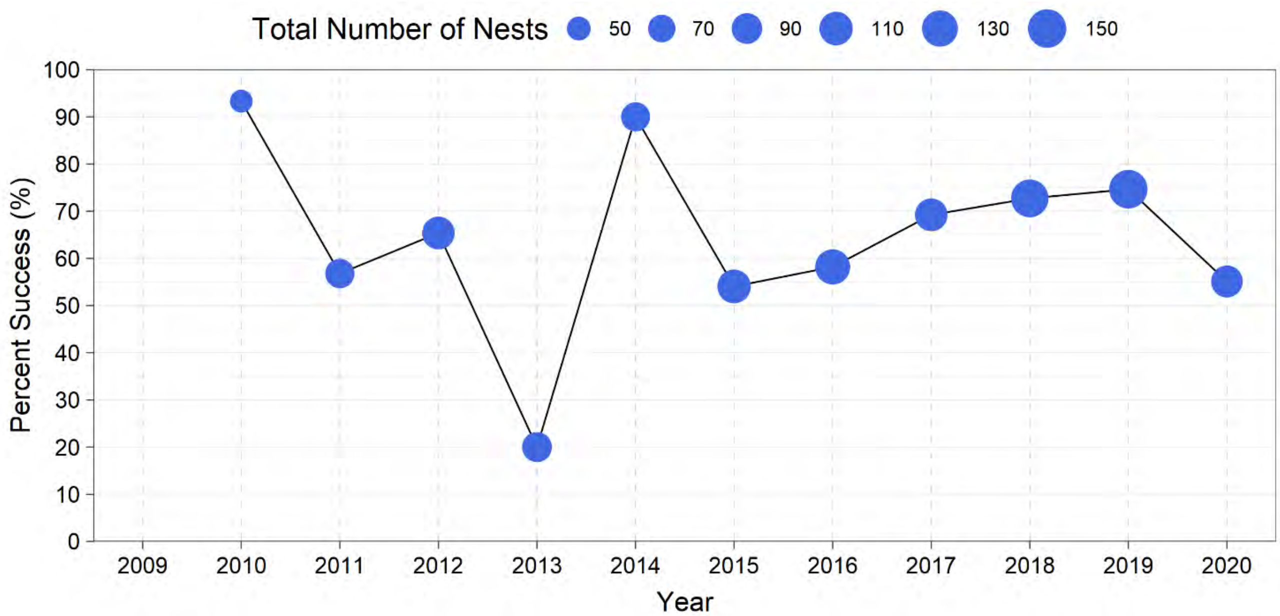

Figure 21 Baie du Doré – Smallmouth Bass nest success at the final survey (2010-2020). Surveys not completed in 2009.

1.8.6.2 Stream C

Stream C is a cool to coldwater stream that provides fish habitat [R-63]. Spawning activity of Rainbow Trout (*Oncorhynchus mykiss*), Chinook Salmon (*Oncorhynchus tshawytscha*) and Coho Salmon (*Oncorhynchus kisutch*) has also been documented in this stream [R-63][R-64]. White Sucker (*Catostomis commersoni*) and cyprinid species including Creek Chub (*Semotilus atromaculatus*) are also known to inhabit or have been observed spawning in Stream C [R-49].

In the early spring and late fall, salmonids migrate upstream to reach suitable cool-cold water spawning grounds. The female selects a nest site and begins excavating a pit, referred to as a redd. This redd is where eggs will be deposited for fertilization by one or more males. Redd surveys are a tool for assessing the productivity and health of a watercourse, as presence and success of spawning salmonids indicates the watercourse has the necessary environmental conditions to promote healthy spawning/hatching and rearing (i.e. substrate, temperature, and flow regimes). Timing of the start for the survey varies depending on conditions like water temperature, rainfall, and stream water levels. Stream C surveys are conducted in the spring to capture the migration of Rainbow Trout (*Onchorynkus mykiss*) and in the fall to observe various salmon species, which may include both Chinook (*Oncorhynchus tshawytscha*) and Coho (*Oncorhynchus kisutch)* salmon.

Redd surveys completed from 2017 to 2020 demonstrate consistent use of Stream C for spawning Rainbow Trout and Coho Salmon, with some use by Chinook Salmon (Figure 22). Increased beaver activity in Stream C over the last few years has caused lower stream flow downstream of the dam structures, requiring fewer redd surveys in the low flow areas. The consistent and high number of redds observed in Stream C since 2017 demonstrates there is high water quality and fish habitat in this stream.

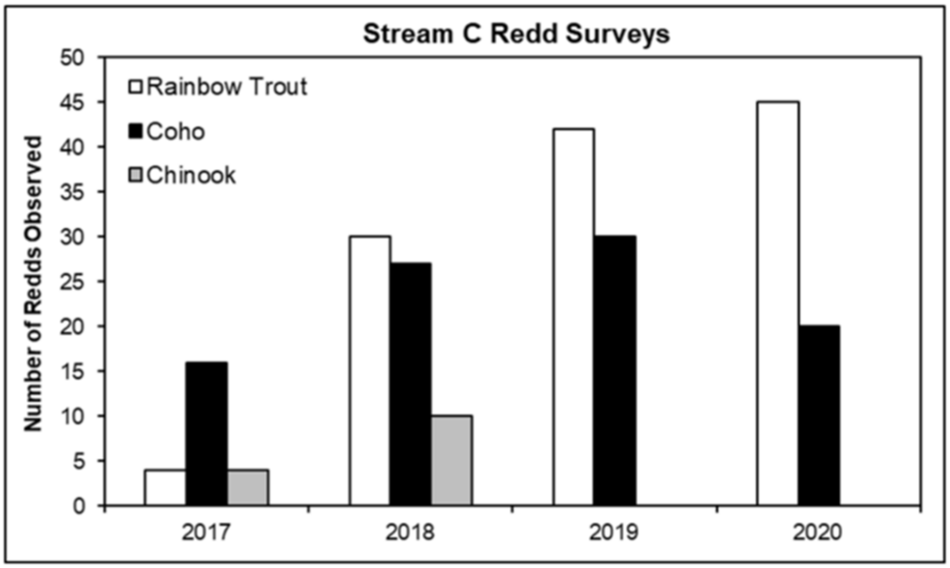

Figure 22 Counts of Redds Observed on Stream C between 2017 and 2020

1.8.7 Fishery

Lake Huron and its watersheds support a diverse community of fish that fill many ecological niches. Lake Huron has undergone substantial ecological change, including changes to nutrient concentrations, habitat and species diversity (aquatic invasive species). The historic offshore fish community consists of more prey species than predators. The current ecosystem has many more predators and the predator and prey communities are dominated by introduced species. The predators are largely supported by hatchery stocking of walleye, trout and salmon species. The Great Lakes Fishery Commission has established an overarching management objective for Lake Huron to restore an ecologically balanced and largely self-sustaining fish community dominated by top predators and capable of sustaining combined commercial and sport yields of 8.9 million kg annually [R-65]. Commercial fish in the area include Lake Whitefish, Lake Trout, Walleye and Yellow Perch [R-66].

The local Indigenous peoples have a strong connection to the Lake Huron fishery. Traditional and modern fishery uses include harvesting fish for food (subsistence), social and ceremonial uses and, in the case of the SON, for commercial purposes. The SON, HSM and MNO have all indicated that they value the fishery and have an interest in its protection.

In 2013, the MNRF announced that an agreement had been signed with the SON to manage the commercial fishery in the waters of Lake Huron and Georgian Bay around the Bruce Peninsula, which gives the SON the right to commercially harvest fish year round [R-

67]. The terms of the agreement state that the SON will be responsible for using catch sampling to monitor the commercial fishery, and will designate community fishers. Two previous agreements had been signed between the MNR and SON in 2000 and 2005. The agreement applies only to commercial fishing rights, and does not affect traditional fishing activities.

As stated in SON's submission as part of the Bruce Power 2015 Licence Renewal hearings, members of SON and their ancestors have been fishing these waters for sustenance and as the basis of trade and commerce for many hundreds of generations, and they continue to do so today. While Lake Whitefish have significant cultural and economic significance to SON, SON's fishing rights are not species specific and include the right to harvest all species of fish [R-68].

Lists of fish species with the potential to be impinged that are important to the HSM and MNO have been shared with Bruce Power. These are used as the basis for discussing potential thermal effects in Section 9.0, in selecting receptors for the EcoRA and in discussion of the physical effects of cooling water discharges and impingement and entrainment (see Section 4.1.1.2, 6.2, 6.3 and 6.4 of [R-22]).

Fish species of importance to the MNO that are known to use the waters near the Bruce Power site include, but are not limited to, the following [R-34]:

- Whitefish
- Cisco
- Cyprind sp.
- Northern Pike
- Walleye
- Salmon Sp.
- Rainbow Trout
- Brook Trout
- Yellow Perch
- Tullibee
- Muskellunge (muskie) Bass
- Lake Trout
- Lake Herring
- Burbot (Ling Cod)
- Bullhead
- Channel Catfish
- Bass
- Brown Trout

Approximately half of the MNO participants in a 2017 survey of local resource use, described using the area near the Bruce Power site for fishing [R-34]. A 2019 follow-up survey found that approximately 45% of respondents used the area near Bruce Power for fishing [R-35].

HSM has a long historical of fishing activities on Lake Huron, concentrated in the Fishing Islands area (Figure 23). HSM also describe fishing as a traditional activity near Bruce Power, including the following species [R-36]:

- Channel Catfish
- Yellow Perch
- Lake Trout
- Lake Whitefish
- Suckers
- Ling (Burbot)
- Carp
- Pike/Walleye
- Brook Trout
- Salmon
- Smelt
- Smallmouth Bass
- Chub
- Steelhead (Rainbow Trout)
- Splake
- Cisco/Lake Herring/Tullibee
- Lake Sturgeon
- Largemouth Bass

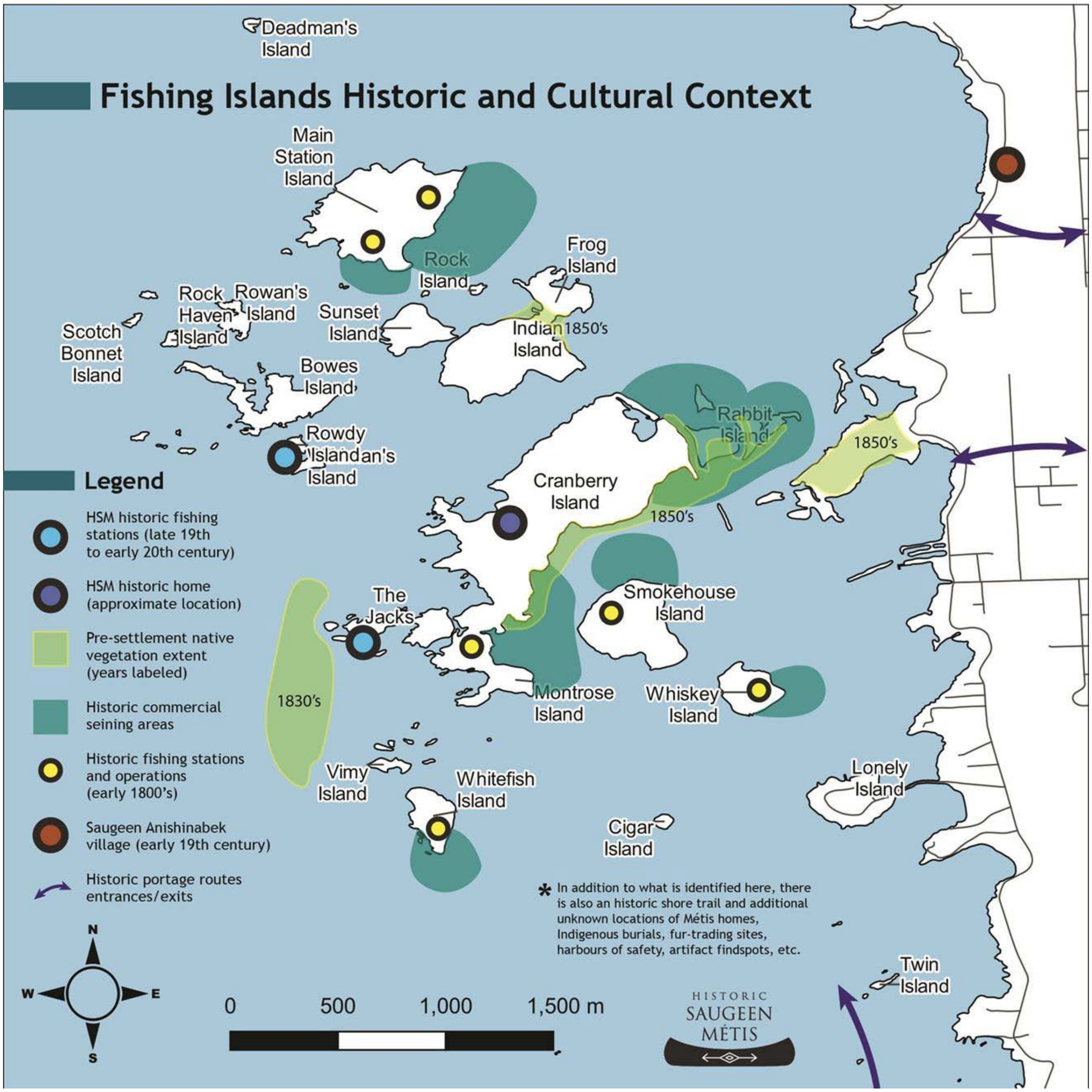

Figure 23 Historical Context of Fishing Islands Archipelago, based HSM Community Oral History, Historic Maps and Other Sources [R-69]

With respect to recreational and sport fishing, Bruce Power has conducted local creel surveys from 2009 to 2017 which provides an indication of the species targeted and harvested by local anglers. The most common species locally caught were Smallmouth Bass, Walleye, Chinook Salmon and Rainbow Trout [R-70].

1.8.8 Supplementary Aquatic Biota Research Studies

Bruce Power has been working with independent university researchers since 2011 to understand more about Lake Whitefish and Round Whitefish in Lake Huron. The research focused on how site operations might affect Lake and Round Whitefish and Yellow Perch and relevant findings are described in the thermal risk assessment in Appendix I Section 9.0. An update on the research program, currently run by the Nuclear Innovation Institute (NII), is available in their annual report [R-71][R-72].

1.8.9 Species at Risk

Deepwater Sculpin (*Myoxocephalus thompsonii*) are present in Lake Huron and this fish species is assessed by COSEWIC as Special Concern federally (Schedule 1). The current population in Lake Huron is not threatened or endangered, although the Special Concern status is indicative that a species is at risk of becoming threatened or endangered in the future. Under SARA, there is a Management Plan for the Deepwater Sculpin in Canada (Great Lakes – Western St. Lawrence Populations). The current Fisheries and Oceans Canada management plan for Deepwater Sculpin indicates that Canadian population estimates are not available due to the lack of standardized sampling of population sizes and trends [R-73]. In addition, the natural variability of the Lake Huron population of Deepwater Sculpin is not available at this time. Fisheries and Oceans Canada indicates that additional trawls for Deepwater Sculpin may occur in Lake Huron over the next several years (Personal communication, S.Staton, Fisheries and Oceans Canada to K. Gaudreau December 12, 2021). When new data becomes available, it will be incorporated into the ERA.

Spawning and associated spawning habitat requirements remain largely unknown. Larval Deepwater Sculpin are pelagic, whereas juveniles and adults are generally benthic. The species occupies cold (<7°C), deep, low nutrient lakes [R-73]. Because of this, Deepwater Sculpin generally only enter the Hydraulic Zone of Influence at the intake caps and become vulnerable to entrainment or impingement at Bruce Power during the larval phase. Note that only one juvenile and no adult Deepwater Sculpin were impinged or entrained at Bruce Power during the 2013 and 2014 monitoring program.

Fisheries and Oceans Canada lists the primary threat to Deepwater Sculpin populations in Lake Huron as invasive species and disease, including the arrival of the Alewife that feeds on the Deepwater Sculpin larvae. Further changes in abundance may have occurred with both a) the invasion of dreissenid mussels and b) the displacement of adult Deepwater Sculpin and consumption of Deepwater Sculpin eggs and larvae by Round Goby and Rainbow Smelt. Other threats to Deepwater Sculpin included water quality changes in smaller lakes (i.e. nutrient loading, contaminants and toxic substances) and climate change [R-73]. These primary threats to Deepwater Sculpin are unrelated to impingement and entrainment at once-through cooling water intakes.

The long-term management plan for the species aims to address knowledge gaps regarding Deepwater Sculpin in Lake Huron. Identified knowledge gaps include [R-73]:

1. Range, abundance and status of population;
2. Basic biology;
3. Habitat needs;
4. Life history and spawning;
5. Sensitivity to nutrient input; and,
6. Threats to survival.

Deepwater Sculpin populations in Lake Ontario, once thought to be extirpated, have recovered in recent years.[R-74] This recovery may be associated with salmonine management efforts (sea lamprey control and salmonine stocking) that reduced Alewife abundance. Lake Trout stocking in the near shore area has been linked to reduced abundance on Deepwater Sculpin in Lake Superior [R-75].

1.8.9.1 Adult Deepwater Sculpin

Overall, Deepwater Sculpin abundance and biomass has continued to decline in the Great Lakes [R-75]. In Lake Michigan, these declines may actually be because Deepwater Sculpin have moved to deeper water than covered by the trawls (see [R-76] cited in [R-75]). Factors suspected to contribute to the decline of Deepwater Sculpin include the collapse of Diporeia and the invasion of Dressnid mussels and Round Goby. These ecosystem changes have forced Deepwater Sculpin to rely on prey sources with reduced energy densities. Even in the presence of ecosystem changes, the length and weight of Deepwater Sculpin caught in United States Geological Survey (USGS) trawls has not significantly changed between 1974-1994 and 1995-2018, or before and after the Dressnid mussel invasion [R-75].

Lake Huron trawls were analyzed from September to November for the years 1976-1999 and 2001-2016 at 6 ports with depths of 9-110m (Figure 24) and converted to catch per effort (CPE, number caught per hectare). The mean depth of capture of Deepwater Sculpin in Lake Huron during these trawls was 80.6m. There was a small but significant trend of shallower depth of Deepwater Sculpin capture in Lake Huron from 1976 to 2016 (Figure 25). There is also a greater density of Deepwater Sculpin caught in offshore trawls beyond the typical 110m depths that suggest that the density of Deepwater Sculpin in Lake Huron may not be adequately represented by the trawl data ([R-77] and Bunnell et al. 2017 and Weidel et al. 2016 as cited in [R-75]). Statistical analysis of trends in Deepwater Sculpin abundance show generally greater declines at shallower depths compared to deeper depths in Lake Huron from 1992-2007. Exploratory trawls at 150m to 175m depth in Lake Huron found mainly Deepwater Sculpin and Burbot [R-78]. Exploratory sampling in Lake Michigan at deeper depths of 128-135m found higher Deepwater Sculpin at the deepest depth sampled [R-79].

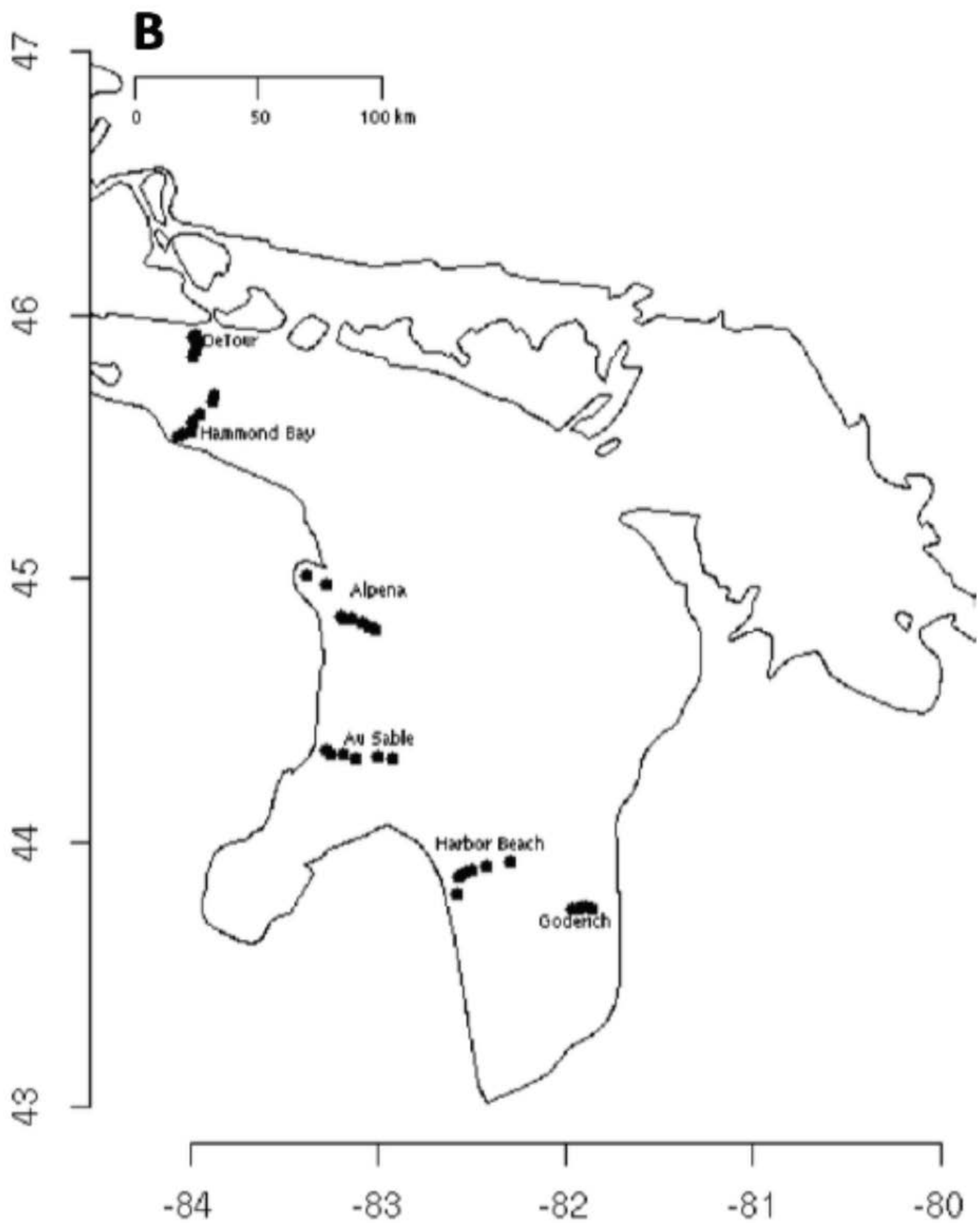

Figure 24 Port locations for Deepwater Sculpin trawls

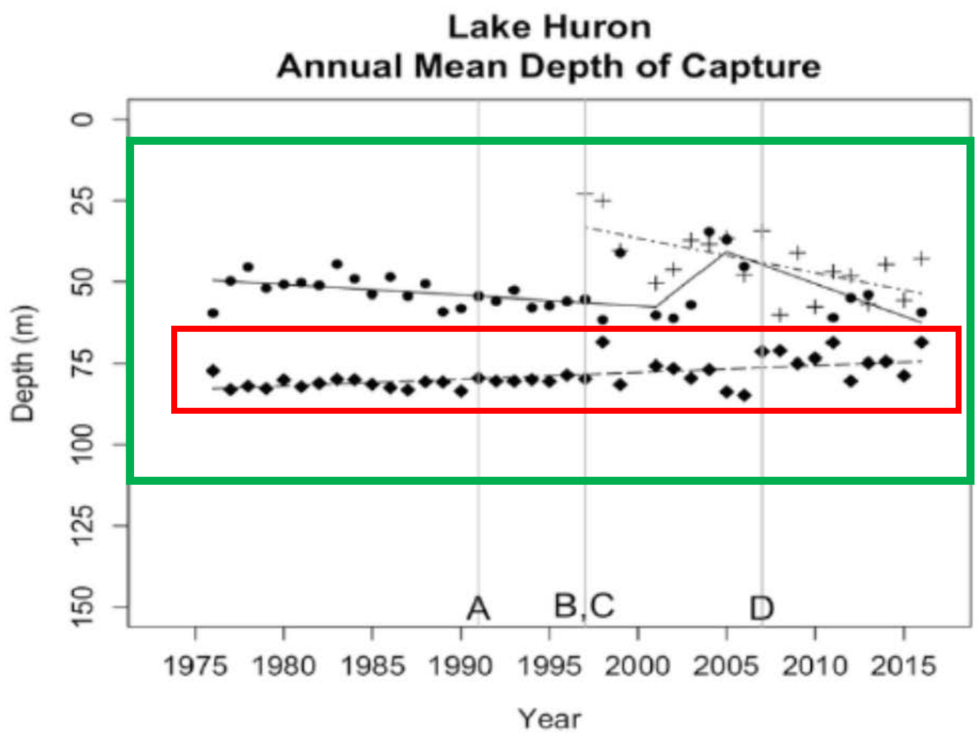

Figure 25 Annual Mean Depth of Capture of Round Gobies (cross symbols and black uneven dashed lines), Slimy Sculpin (closed circles and black solid lines) and Deepwater Sculpin (closed diamonds and black even dashed lines, taken directly from Vokel et al. (2019) [R-75] Boxes added for emphasis. Green box shows depths surveyed by the trawls and red box shows Deepwater Sculpin data, boxes added for emphasis.

Lake Ontario is an example of the potential movement of Deepwater Sculpin beyond the typical deep water trawl depths. Weidel et al (2017) summarized the results of Lake Ontario deep water trawls from 8-225m in depths occurring from 1998 to 2016. Figure 26 demonstrates the high density of Deepwater Sculpin found at depths greater than 110m. Figure 27 indicates that the average length of Deepwater Sculpin found in Lake Ontario increases with increasing depth. Lake Huron has a maximum lake depth of 229m and current USGS trawls survey depths to 110m only. Results in both Figure 26 and Figure 27 suggest that the USGS surveys in Lake Huron may be missing a substantial portion of the Deepwater Sculpin density and failing to sample a sufficient number of larger Deepwater Sculpin. Weidel et al. (2017) also suggests that it is possible that Deepwater Sculpin may acquire a bioenergetic advantage when they are located in deeper habitat, with increased food capture efficiency and/or improved metabolism [R-74].

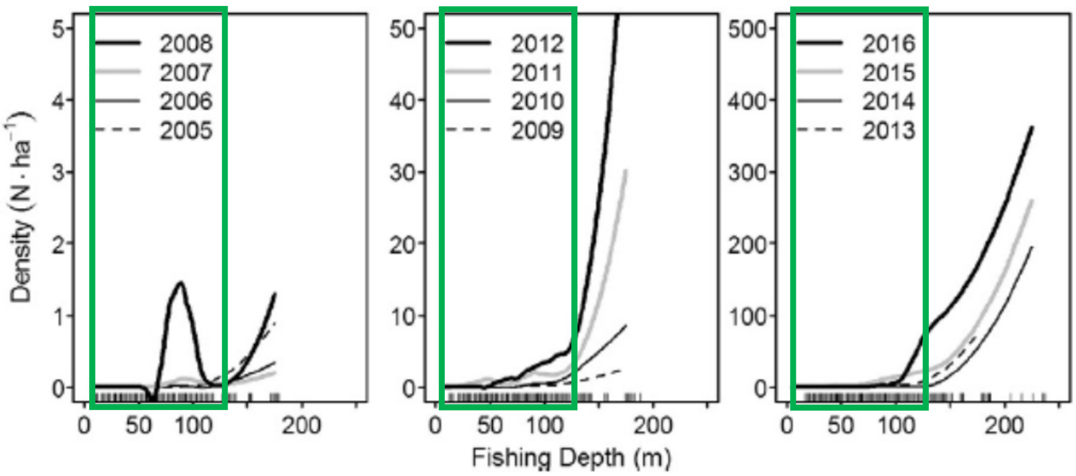

Figure 26 Density by depth of capture of Deepwater Sculpin in Lake Ontario, 2005-2016, taken directly from Weidel et al. 2017 [R-74] Green boxes added to show approximate depth of USGS trawls in Lake Huron.

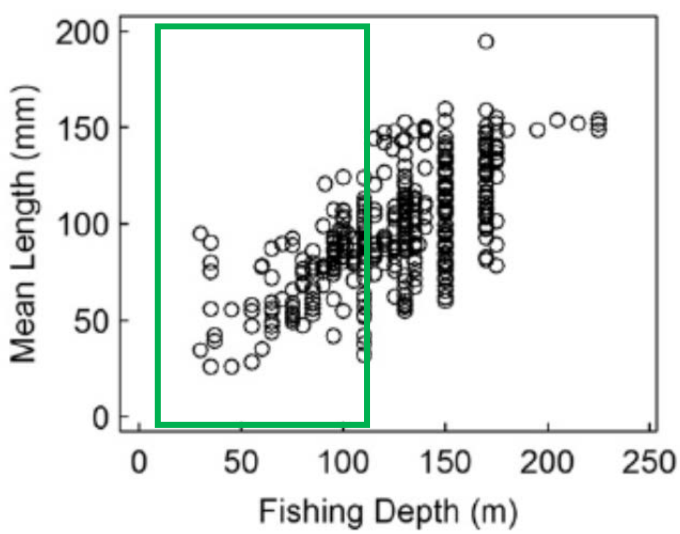

Figure 27 Mean length of Deepwater Sculpin by depth in Lake Ontario, 1998-2016, taken directly from Weidel et al. 2017 [R-74] Boxes added for emphasis. Green box added to show approximate depth of USGS trawls in Lake Huron.

1.8.9.2 Larval Deepwater Sculpin

Deepwater Sculpin were once thought to be extirpated from Lake Ontario based on trawl data. Welsh et al. (2017) describes the recent resurgence of the species in Lake Ontario. The recolonization of Deepwater Sculpin in Lake Ontario may have occurred through two possible mechanisms, either 1) Deepwater Sculpin were never extirpated and had continued to exist in low numbers in areas not sampled during trawls or 2) Deepwater Sculpin recolonized Lake Ontario from the Upper Great Lakes via larval drift. Genetic analysis of Deepwater Sculpin showed that the likely scenario was that larval drift from the Upper Great Lakes was the source of the resurgence of Deepwater Sculpin in Lake Ontario, [R-80].

Larval Deepwater Sculpin are expected to remain in a pelagic phase for between 40 and 60 days as they grow from 8mm to 20-25mm in length [R-81]–[R-83]. The 8mm larvae have little to no yolk sac remaining when captured during larval tows [R-81]. This suggests that the movement to pelagic habitat might be driven by the need for a higher density of plankton in the early larval stages that is only available during the early spring on the nearshore side of the thermal bar (i.e. surface temperatures >4°C, generally near 6°C). This is supported by the finding that larvae on the nearshore side of the thermal bar in Lake Michigan were found in greater densities and were larger with faster growth based on daily growth rings (Wang 2013 in [R-82]). Survival of Deepwater Sculpin larvae from the pelagic to benthic stages is estimated to be 0.1-0.4% (Geffen and Nash 1992 in [R-82]).

Deepwater Sculpin larvae were found at De Tour and Hammond Bay on Lake Huron from mid-April to June 2007, with larval density ranging from 0.4 to 2.4 larvae per 1,000m^3 [R-84]. This location of Deepwater Sculpin larvae far away from presumed deep water spawning grounds provide evidence of advection (i.e. movement with water flow) of the pelagic larval stage [R-81][R-82]. No quantitative assessment of the dispersal of adult Deepwater Sculpin has been completed to date [R-82].

1.9 Species at Risk

Based on the results of a desktop SAR screening completed in 2021 [R-42], the SAR listed in Table 11 were identified as having a moderate to high potential of being on-site:

Table 11 Species at Risk with Moderate or High Potential to Occur on the Site or in the Study Area

Common Name	Scientific Name	ESA	SARA	Potential to Occur on Site	Potential to Occur in the Study Area
Arthropods					
Monarch	*Danaus plexippus*	SC	SC	High	High
Yellow-banded bumble bee	*Bombus terricola*	SC	SC	Moderate	Moderate
Birds					
Bald eagle	*Haliaeetus leucocephalus*	SC	—	High	High
Bank swallow	*Riparia riparia*	THR	THR	High	High
Barn swallow	*Hirundo rustica*	THR	THR	High	High
Bobolink	*Dolichonyx oryzivorus*	THR	THR	High	High
Canada warbler	*Cardellina canadensis*	SC	THR	High	High
Chimney swift	*Chaetura pelagica*	THR	THR	Moderate	High

Table 11 Species at Risk with Moderate or High Potential to Occur on the Site or in the Study Area

Common Name	Scientific Name	ESA	SARA	Potential to Occur on Site	Potential to Occur in the Study Area
Common nighthawk	*Chordeiles minor*	SC	THR	High	High
Eastern meadowlark	*Sturnella magna*	THR	THR	High	High
Eastern whip-poor-will	*Antrostomus vociferus*	THR	THR	High	High
Eastern wood-pewee	*Contopus virens*	SC	SC	High	High
Grasshopper sparrow *pratensis* subspecies	*Ammodramus savannarum pratensis*	SC	SC	High	Moderate
Horned grebe	*Podiceps auratus*	SC	SC	High	High
Least bittern	*Ixobrychus exilis*	THR	THR	High	High
Peregrine falcon *anatum/tundrius* subspecies	*Falco peregrinus anatum/tundrius*	SC	SC	High	High
Red-headed woodpecker	*Melanerpes erythrocephalus*	SC	END	High	High
Wood thrush	*Hylocichla mustelina*	SC	THR	High	High
Fish					
Deepwater Sculpin - Great Lakes / Western St. Lawrence population	*Myoxocephalus thompsoni*	—	SC	High	High
Mammals					
Eastern small-footed myotis	*Myotis leibii*	END	—	High	Moderate
Little brown myotis	*Myotis lucifugus*	END	END	High	Moderate
Northern myotis	*Myotis septentrionalis*	END	END	High	Moderate
Tri-colored bat	*Perimyotis subflavus*	END	END	High	Moderate
Reptiles					
Eastern ribbonsnake - Great Lakes population	*Thamnophis sauritius*	SC	SC	High	Moderate
Midland painted turtle	*Chrysemys picta marginata*	—	SC	High	High
Milksnake	*Lampropeltis triangulum*	NAR	SC	Moderate	Moderate
Queensnake	*Regina septemvittata*	END	END	Moderate	Moderate
Snapping turtle	*Chelydra serpentina*	SC	SC	High	High
Spotted turtle	*Clemmys guttata*	END	END	High	High
Vascular Plants					
American ginseng	*Panax quinquefolius*	END	END	Moderate	Moderate
Butternut	*Juglans cinerea*	END	END	High	Moderate
Dwarf lake iris	*Iris lacustris*	SC	SC	Moderate	Moderate

Table 11 Species at Risk with Moderate or High Potential to Occur on the Site or in the Study Area

Common Name	Scientific Name	ESA	SARA	Potential to Occur on Site	Potential to Occur in the Study Area
Gattinger's agalinis	*Agalinis gattingeri*	END	END	Moderate	Moderate
Hill's pondweed	*Potamogeton hillii*	SC	SC	Moderate	Moderate
Houghton's goldenrod	*Solidago houghtonii*	THR	SC	Moderate	Moderate
Lakeside daisy	*Tetraneuris herbacea*	THR	THR	Moderate	Moderate
Pitcher's thistle	*Cirsium pitcheri*	THR	SC	Moderate	Moderate
Tuberous Indian-plantain	*Arnoglossum plantagineum*	SC	SC	Moderate	Moderate

ESA = *Endangered Species Act, 2007*; SARA = *Species at Risk Act*.
END = Endangered; THR = Threatened; SC = Special Concern; - = not listed.

1.10 Human Land Use and Population Density

The Site is located in the Municipality of Kincardine. According to the Municipality of Kincardine's Comprehensive Zoning By-law, the Site is zoned General Industrial. Land use in the surrounding municipalities is dominated by controlled development agricultural lands and small urban communities. Details related to land use are provided from the 2016 Census [R-85] where available.

The Municipality of Kincardine has a population of 11,389 as reported in the 2016 Census [R-85]. The Municipality of Kincardine contains two urban centres and several small communities within 25 km of the Site. The urban areas are the Town of Kincardine and Village of Tiverton. Other communities in the Municipality of Kincardine include Inverhuron, Glammis, Bervie, Underwood, Millarton, Armow and Scott Point. Immediately north of the Municipality of Kincardine is the Municipality of Saugeen Shores, containing the communities of Southampton and Port Elgin. These two population centres are located within 30 km of the Site.

Local communities rely on both water from Lake Huron and groundwater wells for their drinking water needs [R-86]. Surface water from Lake Huron is treated through two water treatment plants including the Southampton Water Treatment Plant, and the Kincardine Water Treatment Plant. Lake Huron and other larger watercourses such as the Saugeen River are popular destinations for recreational activities including boating, canoeing and angling. There is one drinking water well within the Site located on the Hydro One property used for hand washing and toilet flushing only.

1.10.1 Indigenous Populations

Descriptions of the locations of each of the Indigenous communities are provided below. These descriptions are intended to provide context for the development of the conceptual site model that forms the basis of the ERA.

The traditional territories of the Chippewas of Saugeen First Nation and the Chippewas of Nawash Unceded First Nation, together referred to as the Saugeen Ojibway Nations (SON), include most of Bruce and Grey Counties and extend into Huron, Perth, Wellington and Dufferin Counties to include the Maitland and Nattawasaga River watersheds [R-65] (Figure 28). Lake Huron and Georgian Bay off-shore of this region are also considered traditional territory and are the subject of an ongoing Aboriginal title claim. This territory represents area used by Indigenous people for hunting, fishing and other activities supporting a traditional lifestyle. Within this area, the Chippewas of Saugeen First Nation Reserve No. 29 is located adjacent to the community of Southampton on the shoreline of Lake Huron, between the mouths of the Saugeen and Sauble Rivers approximately 25 km from the Site. The 2016 population at the Chippewas of Saugeen First Nation Reserve No. 29 was 1,041 [R-85]. The Chippewas of Nawash Unceded First Nation is centered at Cape Croker Reserve No. 27, located on the north side of Colpoy's Bay and the east shore (Georgian Bay) of the Bruce Peninsula north of the town of Wiarton, approximately 70 km from the Site [R-65]. The 2016 population at the Chippewas of Nawash Unceded First Nation is centered at Cape Croker Reserve No. 27 was 615 [R-85]. SON asserts that fishing is a fundamental aspect of the SON as a people and is integral to SON culture and to the SON belief system. Preservation of the fishery is an important concern for SON. The identity of SON as a Nation is dependent on the connections to the land, water flora and fauna of their Territory, which encompasses the Bruce Power site [R-87].

The Métis Nation of Ontario (MNO) – Region 7 includes the Métis Councils of Georgian Bay, Moon River and Great Lakes (Figure 29). The Métis people participate fully in the community and are fully integrated into the regional population [R-88]. The Métis do not comprise one settlement but rather their citizens are integrated into the population of the local surrounding municipalities. The MNO asserts its right to Métis harvest, defined as "the taking, catching or gathering for reasonable personal use in Ontario of renewable resources by MNO citizens. Such harvesting includes plants, fish, wildlife and firewood, taken for heating, food, medicinal, social or ceremonial purposes and includes donations, gifts and exchange with Aboriginal persons..."[R-34]. Bruce Power falls within the Georgian Bay Traditional Harvesting Territory.

The Historic Saugeen Métis (HSM) community is located in Southampton and has been settled along the Lake Huron shoreline since circa 1816. The HSM began as traders at Saugeen, and have hunted, trapped, fished, and harvested in the Bruce Peninsula and Lake Huron shoreline [R-88]. The traditional fishing and harvesting areas of the HSM are shown on Figure 30.

The 2016 census revealed that there are 3,160 self-identified Indigenous People living in Bruce County. Métis people account for 685 (21.7%) of the Indigenous population [R-85].

Figure 28 The Saugeen Ojibway Nation Traditional Territory [R-47]

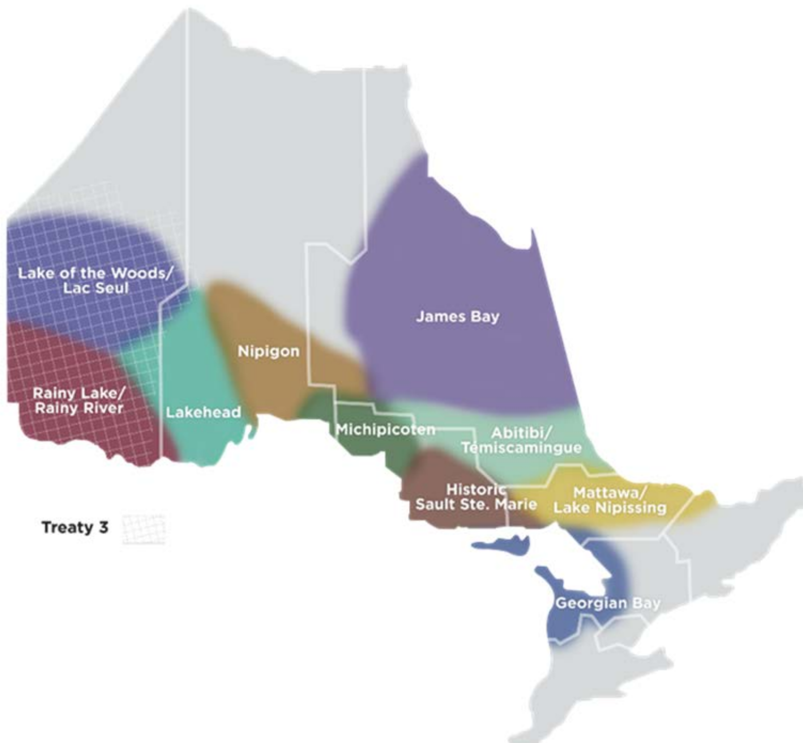

Figure 29 Métis Nation of Ontario Traditional Harvesting Map [R-89]

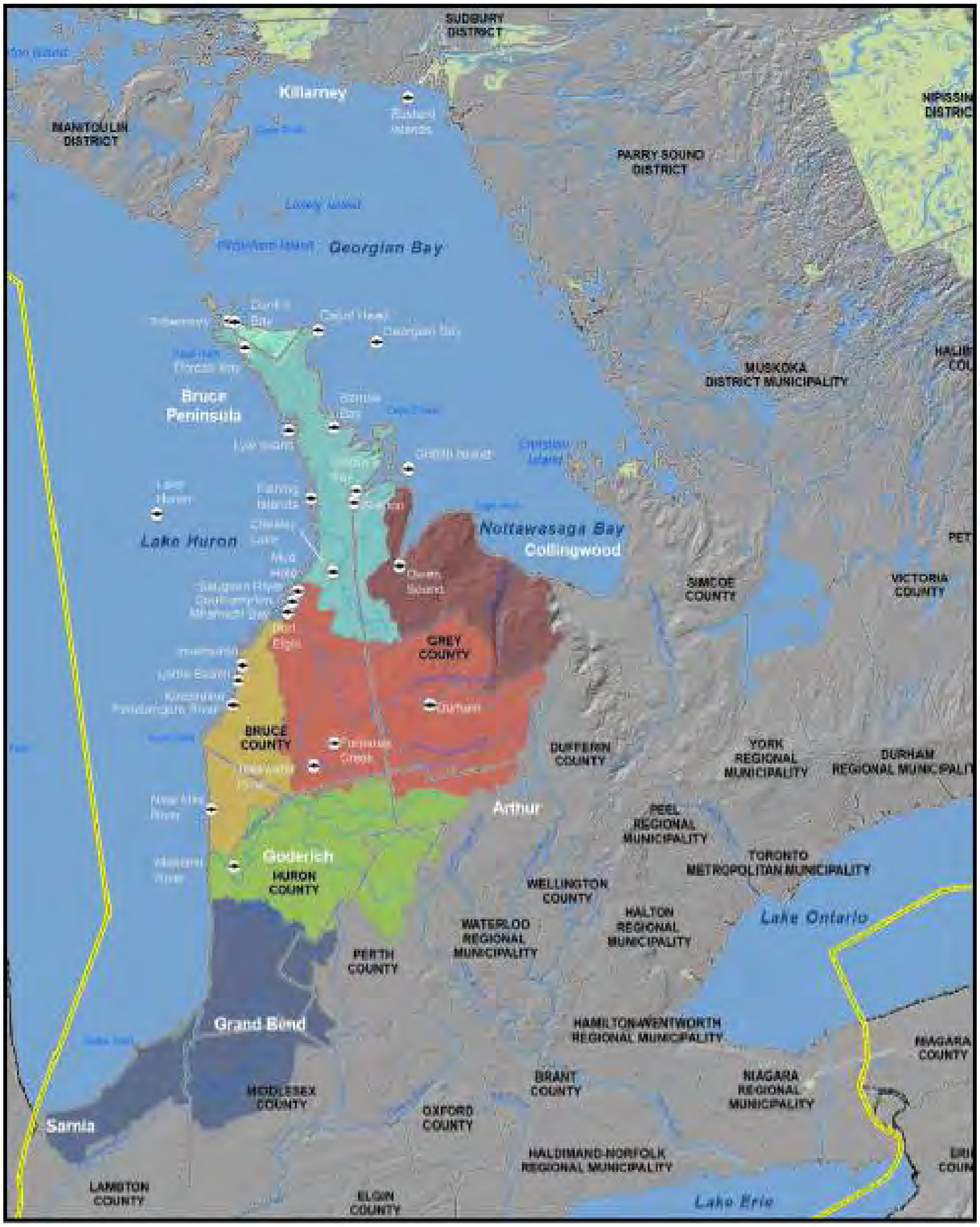

Figure 30 Traditional Fish Harvesting Locations of the Historic Saugeen Métis [R-36]

1.11 Climate Change and Future Conditions

Bruce Power has contributed to modelling the future impacts of climate change to mid-century through two efforts.

The first effort by Golder Associates Ltd considered of climate change modelling of the specific impacts to Lake Huron, including changes to air temperatures, water temperatures and water levels. The changes to water temperatures were modelled with and without the effect of Bruce Power operations.

The second effort by the Climate Risk Institute took a broader approach to climate change and focused on the broader impacts of a changing climate and how these would affect Indigenous Communities and agricultural activity in Grey, Bruce and Huron Counties. These efforts included consultations with SON, MNO and HSM to ascertain the potential impact of predicted climate change effects on habitats and species prioritized by each community.

The 2022 ERA considers the risk to the environment posed by current operations at the Bruce Power site using data from 2016 to 2021. The PERA assesses the potential impact of new activities occurring from 2021 to 2026. Both the ERA and PERA (if required) are updated every 5 years or sooner if required. As a result, the impacts of climate change will generally be integrated into the ERA as they occur.

1.11.1 Expected Climate Changes

Three one-year climate change scenarios - corresponding to the warmest, coolest and median air temperature conditions - were selected from multiple Global Climate Model (GCM) runs considering three emissions scenarios, otherwise known as Representative Concentration Pathways (RCP) of RCP4.5, RCP6.0 and RCP8.5. These RCP scenarios cover the climatic period between 2054 and 2074, with full details of these expected changes are available in [R-90]. A full range of meteorological parameters was used to initialize and generate boundary conditions for the Regional Climate Model (RCM) of the Lake Huron basin. The RCM was used to simulate local meteorological conditions over the lake for the 365-days corresponding to each selected climate scenario (e.g., warmest, coolest and median year).

Relative to the selected baseline year of 2011, mean annual air temperatures could increase by up to 2.2˚C under median climate change conditions or by up to 3.5˚C during an extreme warm year by 2064. These projections fall within the range of temperature forecast provided by ClimateData.ca (1.9˚C to 3.9 ˚C) and the Ontario Climate Change Data Portal (2.7˚C to 3.3˚C for RCP8.5). The largest increases in monthly average air temperature are expected to occur during the winter months, with increases relative to 2011 peaking at 3.2˚C and 3.8˚C in January for the median and extreme warm climate condition, respectively. In general, the winter period is projected to coincide with a greater degree of air temperature variability than expected for the summer months [R-90].

Work by the Climate Risk Institute offered additional information regarding changes to climate expected by the 2050s, summarized in Table 12 [R-91].

Table 12 Climate Change Impacts to Weather in Grey, Bruce and Huron Countries

Climate measure	Current trend (1981-2010) compared to 1961-1990	Future prediction (2050s) compared to 1981-2010
Mean temperature	↑ of 0.6°C, greatest increase in fall and winter	Increase of up to 3.5°C
Very hot days (>30°C)	↑ 3 days/year	↑ up to 20 days/year
Frost days	↓ 7 days/year	↓ 70 days/year
Growing season length	↑ 5 days/year	↑ 4 to 6 weeks/year
Total precipitation	↑ 5%	↑ 7%
Heavy precipitation events	↑ frequency, especially in spring and summer	Twice as frequent
Variability	↑ variability in precipitation patterns, lake levels and winter temperatures	↑ Heavy rainfall events ↑ Winter temperature variability

1.11.2 Impacts to Lake Huron

1.11.2.1 Water Temperature

Changes to water temperature occurring as a result of climate change are likely to have the greatest impact on the Bruce Power ERA. Future climate scenarios were integrated into the boundary conditions to drive the MIKE3 model of Lake Huron (excluding Georgian Bay) used for the thermal risk assessment (see Appendix I). Full details of the MIKE3 model are available elsewhere [R-92][R-93]. Annual historical low, average and high lake water level records and representative river inflows were used to inform the MIKE3 model of Lake Huron. The MIKE3 model was used to simulate the thermal and hydrodynamic responses to each climate scenario independently for maximum-recorded operational output from the Bruce A and Bruce B Condenser Cooling Water (CCW) discharges and for non-operational conditions (i.e. in the absence of CCW operations) [R-90].

In the absence of operations, the changes in climate meteorology projected for the era at the nominal end of Bruce Power's operational life in 2064 are expected to increase average annual nearshore water temperatures by approximately 1.5˚C and 2.2˚C for the median and extreme warm climate year, respectively. Regardless of the location within the water column (bottom or surface), changes to water temperature resulting from climate change are expected to be slightly greater in shallower water. In general, water temperatures within the lake are expected to increase most dramatically during the shoulder seasons (spring and fall) leading to establishment of stronger summer thermocline that maintains warmer surface and mid-depth temperatures. While the lake will remain dimictic (turnover twice a year), changing climate conditions are expected to result in a shortening of the winter thermocline and an expansion of the summer thermocline relative to baseline conditions [R-90].

Comparisons of all four climatic scenarios (including the 2011 baseline, future extreme cool year, future median year and future extreme warm year conditions) reveal that operational heating of the ten nearshore locations in the vicinity of the Bruce Power site will remain relatively consistent. Climate change does not appear to exacerbate or reduce the nearshore effects of operational heating [R-90].

Although water temperatures increases under operational and non-operational scenarios are expected to be similar in magnitude, these increases will present challenges to the ERA assessment in the area of thermal risk assessment.

1.11.2.2 Ice Cover

Between 1980 and 2010, annual ice cover declined by an average of 0.4% per year (Figure 31). There is expected to be a general decline in average ice cover on Lake Huron by 20 to 40% by 2050, while the considerable variation between years is expected to continue. This translates to 25 to 50 fewer days of ice coverage annually. Reduced ice cover may increase shoreline erosion and damage during the winter months. Spawning shoals may also me negatively impacted by the lack of protective ice cover and increased turbidity, impacting species with over-winter incubation periods such as Lake Whitefish, Round Whitefish and Lake Trout [R-94].

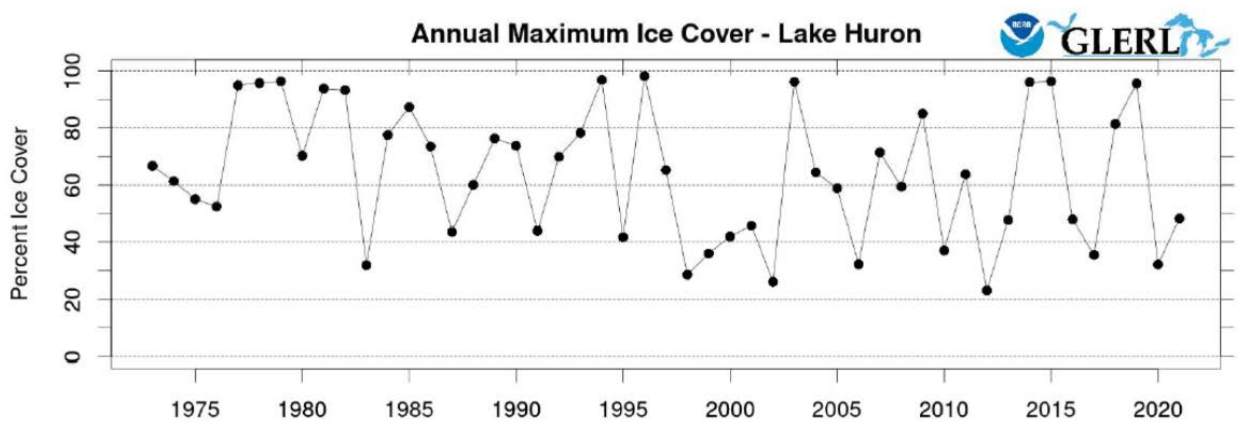

Figure 31 Annual Maximum Ice Cove on Lake Huron (1970-2021) [R-94]

1.11.2.3 Water Levels

Considerable uncertainty exists as to the potential impacts of climate change on water levels in Lake Huron [R-94]. More variability in water levels is expected under climate change scenarios [R-90]. Water levels do not generally have a large effect on lake temperatures in the area near the Bruce Power site [R-90].

1.11.3 Impacts to Agricultural Activities

An assessment of the potential impacts of climate change on agriculture in Grey, Bruce and Huron counties was completed in 2022. Warmer temperatures are expected to benefit agriculture by increasing crop yields, lengthening the growing and grazing seasons, and allowing new crops to be grown. Risks of climate change include soil erosion, nutrient depletion, increased runoff and water contamination, reduced yields, increased susceptibility to disease and higher production costs (Figure 32) [R-95]. These risks are related to increased frequency of heavy precipitation and flooding, drought, extreme heat, increased fall and winter temperatures, spring and fall frosts and extreme storms [R-96]

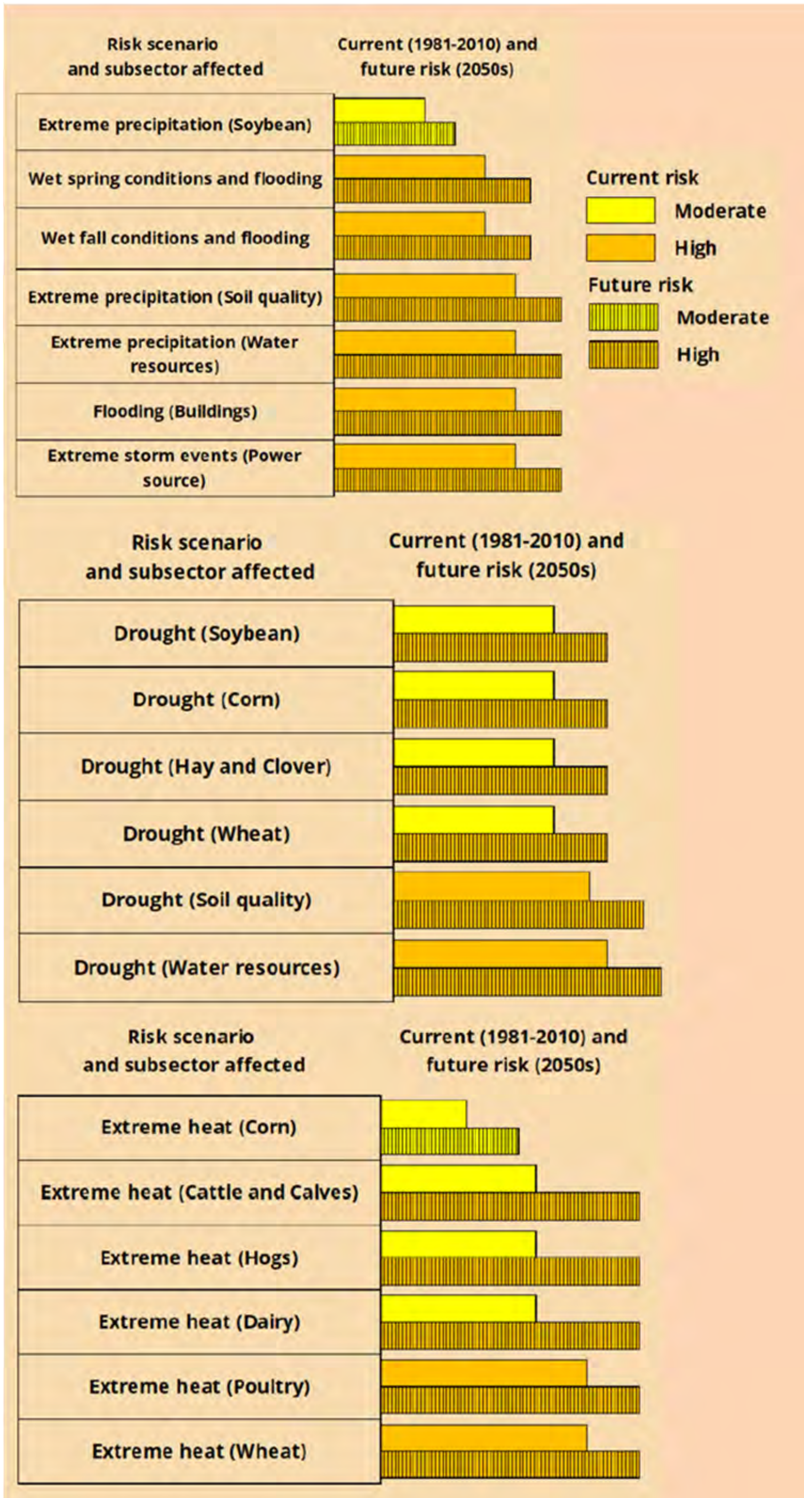

Figure 32 Potential Impacts of Climate Change to the Agricultural Sector

1.11.4 Impacts to Indigenous Communities

A discussion of the potential impacts of climate change on Indigenous activities is provided in Section 1.3.4 of the ERA [R-22].

2.0 APPENDIX B: ERA METHODOLOGY

2.1 Human Health Risk Assessment for Chemicals and Physical Stressors Methodology

All pathways for human health risk assessment exposures were considered incomplete during the problem formulation. As a result, no detailed methodology is included here.

2.2 Human Health Risk Assessment for Radiological Contaminants Methodology

2.2.1 Problem Formulation

2.2.1.1 Receptor Descriptions

The characteristics of each category of representative person are described below, based on the Site Specific Survey Report [R-26].

The non-farm resident (BR) is considered the typical, full-time resident in the area surrounding the Site. They use grocery stores for a large portion of their food intake.

The farm resident is more likely to consume their own crop or livestock, but still use grocery stores for a portion of their food intake.

The subsistence farm resident (BSF) gets a larger portion of their food, milk and water from local sources.

The dairy farm resident (BDF) is assumed to consume some fresh milk from their own farm, and a slightly higher fraction of locally grown produce and livestock.

The hunter/fisher resident (BHF) represents individuals who may catch and consume wild game and fish in significantly greater quantities than other residents. They are assumed to obtain all of their fish and wild game from local sources, and consume greater quantities of these foods than the average Canadian diet. For other food categories, some is sourced locally while the remainder is from grocery stores.

The characteristics of this resident have been developed based on surveys of the Saugeen Ojibway Nation (SON), Historic Saugeen Métis (HSM), and the Métis Nation of Ontario (MNO) undertaken from 2019 to 2021 [R-26]. The results of these surveys show that intake rates of wild game may be up to 24.3 times higher than the average Canadian diet, and intake rates of fish and shellfish may be up to 1.35 times higher than the average Canadian diet. The 95th percentile intake rates in N288.1 have been scaled by these factors, as shown in Table 13. Intake rates for other food categories were bounded by the values in N288.1, therefore the N288.1 values are used.

Table 13 Ingestion Rates of Fish and Wild Game for Hunter/Fisher Representative Group (g/d)

Age Group	Fish	Wild Game
Adult	45.63	32.08
Child	27.8	8.50
Infant	9.45	2.67

Additionally, the soil ingestion rates for the hunter/fisher receptor were modified to account for individuals potentially practicing a wilderness lifestyle. A 2014 study calculated mean soil ingestion rates for Indigenous Peoples in Alberta practicing a wilderness lifestyle to be 32 mg/d with a 90th percentile value of 152 mg/d. As per CSA Standard N288.1 the 95th percentile soil ingestion rates are 20 mg/d, 185 mg/d, and 204 mg/d for adult, child, and infants, respectively [R-97]. Therefore, the adult hunter/fisher receptor was assumed to have a soil ingestion rate of 152 mg/d. It is noted that this study did not specifically address soil ingestion rates of infants and children. Therefore, the 95th percentile soil ingestion rates from CSA Standard N288.1 were used for infants and children.

For consistency with previous studies related to Site environmental risk assessment, the Bruce Eco-Industrial park worker (BEC) will be hereafter referred to as a BEC worker, which corresponds to the former name of the facility, the Bruce Energy Centre. The assessment for a BEC worker represents occupational exposures at a location near the facility. It is assumed that the BEC worker does not also live at one of the other selected receptor locations, i.e., the BEC dose is independent of the other representative person doses.

A summary of the receptor description and locations is provided below in Table 14.

Table 14 Description of Receptor Groups

Group Name	General Characteristics and Location of Group	Easting	Northing
BR1	Non-farm resident, lakeshore at Scott Point (Located to the northeast of Bruce A at a distance of approximately 2 km and northeast of Bruce B at a distance of approximately 5 km)	455936.00	4911030.00
BR17	Non-farm resident, inland (Located to the southeast of Bruce A at a distance of approximately 4 km and east of Bruce B at a distance of approximately 5 km)	457026.00	4906433.00

Group Name	General Characteristics and Location of Group	Easting	Northing
BR25	Non-farm resident, inland (Located to the south of Bruce A at a distance of approximately 5 km and to the southeast of Bruce B at a distance of approximately 4 km)	454831.00	4904960.00
BR27	Non-farm resident, inland, trailer park (Located to the south of Bruce A at a distance of approximately 5 km and to the southeast of Bruce B at a distance of approximately 3 km)	453761.00	4904615.00
BR32	Non-farm resident, lakeshore (Located to the south of Bruce A in Inverhuron at a distance of approximately 6 km and to the south of Bruce B in Inverhuron at a distance of approximately 3 km)	452832.00	4904307.00
BR48	Non-farm resident, inland (Located to the southeast of Bruce A near Baie du Doré at a distance of approximately 2 km and to the east of Bruce B near Baie du Doré at a distance of approximately 3 km)	455834.19	4908915.83
BF8	Agricultural, farm resident (Located to the south of Bruce A at a distance of approximately 8 km and to the southeast of Bruce B at a distance of approximately 7 km)	457543.00	4903703.00
BF14	Agricultural, farm resident (Located to the south of Bruce A at a distance of approximately 5 km and to the southeast of Bruce B at a distance of approximately 3 km)	454081.00	4905041.00
BF16	Agricultural, farm resident (Located to the southeast of Bruce A at a distance of approximately 7 km and to the east of Bruce B at a distance of approximately 8 km)	460038.74	4906468.88
BSF2	Agricultural, subsistence farm resident (Located to the southeast of Bruce A at a distance of approximately 9 km and to the southeast of Bruce B at a distance of approximately 9 km)	457776.00	4900933.00

Group Name	General Characteristics and Location of Group	Easting	Northing
BSF3	Agricultural, subsistence farm resident (Located to the southeast of Bruce A at a distance of approximately 8 km and to the southeast of Bruce B at a distance of approximately 8 km)	458889.00	4902830.00
BHF1	Hunter/fisher resident (Located approximately 20 km north of the Site in Southampton)	470739.03	4927025.50
BDF1	Agricultural, dairy farm resident (Located to the northeast of Bruce A at a distance of approximately 11 km and to the northeast of Bruce B at a distance of approximately 14 km)	465133.00	4913714.00
BDF9	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 km and to the southeast of Bruce B at a distance of approximately 12 km)	461071.00	4899057.00
BDF12	Agricultural, dairy farm resident (Located to the east of Bruce A at a distance of approximately 13 km and to the northeast of Bruce B at a distance of approximately 15 km)	465588.00	4908323.00
BDF13	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 km and to the southeast of Bruce B at a distance of approximately 12 km)	458928.00	4897814.00
BDF14	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 14 km and to the southeast of Bruce B at a distance of approximately 13 km)	458333.00	4895871.00
BDF15	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 km and to the southeast of Bruce B at a distance of approximately 12 km)	455785.00	4896007.00

Group Name	General Characteristics and Location of Group	Easting	Northing
BEC	Worker in Bruce Energy Centre (Located to the southeast of Bruce A at a distance of approximately 4 km and to the east of Bruce B at a distance of approximately 4 km)	455781.00	4906226.00

2.2.1.2 Human Health Conceptual Model

The Integrated Model for the Probabilistic Assessment of Contamination Transport (IMPACT) was used to model and calculate the radiation dose to each human receptor, based on the conceptual model shown in Section 4.4 of the Environmental Quantitative Risk Assessment report. Meteorological and airborne emission and waterborne effluent characteristics used in the IMPACT model are described below.

IMPACT is a customizable tool that allows the user to assess the transport and fate of contaminants through a user-specified environment. IMPACT is able to quantify the human exposure to these environmental contaminants for nuclear power facilities. It covers all of the exposure pathways in accordance with CSA Standard N288.1. IMPACT version 5.5.2 was released in 2018 and is the latest version of the code. Version 5.5.2 fully implements the models of CSA Standard N288.1 and its recommended input parameter values. The development of IMPACT 5.5.2 has been guided by, and subject to, an overall Tool Qualification Program (TQP), which follows the CSA N286.7-99 guidelines for quality assurance in software development for nuclear power plants. A major component of the TQP has been a series of Verification and Validation exercises [R-98].

Meteorological Data

A discussion of current meteorological conditions at the Site is provided in Section 1.4.

The TJF meteorological file was imported into IMPACT to determine radionuclide concentrations in environmental media for any media and radionuclides that are not measured as part of environmental monitoring.

Precipitation at the Site is described in Section 1.4.3. Since the meteorological stations on and near the Site do not measure precipitation data, the precipitation rate in the IMPACT model was assumed to be a constant value equal to the average rate in Wiarton for the years 2010 to 2020, which is 1,116.9 mm/year [R-1]. For each of the 16 compass sectors, the portion of total time during which precipitation occurs within that sectors was calculated using the Site meteorological wind data and the Wiarton precipitation data.

Characteristics of Emissions

Annual release rates for all airborne and waterborne releases from the Site are provided in Appendix G.

The air plume characteristics used to model the airborne releases from the Site are listed in Table 15 [R-99]–[R-103]. Based on updates to the Bruce A, Bruce B, and CMF DRL reports, actual stack heights are used in the model. For WWMF and DPWMF, it is conservatively assumed that all airborne effluents are released at ground level.

Table 15 Characteristics of Airborne Emissions

Parameter	Bruce A	Bruce B	CMF	WWMF	DPWMF
Release Height (m)	57.9	57.9	22	0	0
Stack Exit Velocity (m/s)	15.2	17.1	33.4	13.1	3.41
Stack Inside Diameter (m)	1.4	1.4	1.0	0.41	2.1
Nearby Building Height (m)	44.5	44.5	14.1	13.7	42.8
Gas Temperature (°C)	21	21	25	21	25
Ambient Air Temperature (°C)	20	20	20	20	20
Cross Sectional Area of Buildings (m^2)	1950	1950	200	1350	1695

The water plume characteristics used to model waterborne releases from the Site are listed in Table 16 [R-26][R-99][R-100][R-103].

Table 16 Characteristics of Waterborne Emissions

Parameter	Bruce A	Bruce B	DPWMF
Discharge Rate (m^3/s)	156	133	0.4
Recirculation Factor (unitless)	2	2	1
Initial Dilution Factor (unitless)	1	1	1
Current Speed (m/s)	0.13 to North East and South West	0.12 to North East and South West	0.13 to North East and South West
Current Direction Factor (unitless)	0.47 to North East and 0.33 to South West	0.62 to North East and 0.26 to South West	0.47 to North East and 0.33 to South West
Proportionality Coefficient (unitless)	$2.59x10^{-8}$	$2.59x10^{-8}$	$2.59x10^{-8}$
Water Depth at Outfall (m)	10	10	10

2.3 Ecological Risk Assessment for Chemicals and Ecological Stressors

The Ecological Risk Assessment (EcoRA) component of the 2022 ERA prepared for the Site assessed the potential risks to terrestrial and aquatic ecological receptors that could come into contact with environmental media (i.e., soil, shallow groundwater, surface water and sediment).. This section focusses on potential risks to terrestrial and aquatic receptors due to non-radiological chemicals.

The EcoRA for chemicals used acceptable ecological risk assessment methods referred to in CSA Standard N288.6-12 [R-5] including those described by the CCME [R-104]. The EcoRA follows a multi-media approach as described in clause 7.2.5.4.2 of CSA Standard N288.6-12 [R-5], in which COPCs that exceeded their respective screening benchmark in one environmental medium were retained for assessment in all environmental media that are likely to contribute to exposure (to ensure that exposure from all relevant exposure pathways were considered). Using this approach, contribution to exposure from all potential sources is assessed. Potential risks were assessed with respect to endpoints such as survival, growth, and reproduction using representative exposure assumptions.

This section provides supplemental information for the EcoRA, describing the methods used to identify the receptors, detailed receptor characterization, exposure pathways, exposure estimates and effect concentrations for which HQs were calculated.

2.3.1 Problem Formulation

2.3.1.1 Receptor (Valued Ecosystem Component) Selection

Ecological receptors were selected for the EcoRA in consideration of the following criteria:

- Species and habitats observed on the Site as documented in previous environmental studies;
- Representation of all major plant and animal groups present on the Site (e.g., terrestrial, and semi-aquatic mammals and birds, amphibians and reptiles, terrestrial plants and soil organisms, aquatic planks, zooplankton, benthic invertebrates, fish);
- Receptors that reflect the interests of the facility, regulatory agencies, local Indigenous communities, and community stakeholders;
- Potential for exposure (i.e., diet, habitat preferences and behaviours that make the species likely to contact the COPCs);
- Receptors that play important roles in community structure and function (e.g., top predators and major herbivores);
- Inclusion of the various trophic levels (e.g., primary producer, herbivore, insectivore, and carnivore) for species that could potentially use the Site;
- Receptors that have cultural or socio-economic significance;
- The availability of information on the receptor, including exposure-related and ecotoxicological data; and,
- Species of conservation status (e.g., vulnerable, threatened, or endangered species).

Detailed descriptions of the selected terrestrial and aquatic receptors are provided below.

Terrestrial Receptors

Detailed descriptions of the terrestrial receptors selected for assessment are provided below. These receptors were selected to be protective of several SAR and culturally significant species that have moderate to high potential of being present on the Site, as discussed in Appendix A, Section 1.6.3, 1.7.4 and 1.9.

Terrestrial Plants

As described by Treshow [R-105], terrestrial plants perform key functions in ecosystems. They provide food and shelter for wildlife, contribute to soil development, store carbon, and produce oxygen. Some terrestrial plant species can be particularly important for ecological reasons (e.g., rare species) and/or social reasons (e.g., food and cultural importance), as discussed in Appendix A, Section 1.6.3 and 1.9.

Plants may absorb toxicants either directly from the atmosphere, through the leaves, or from soil or water through the roots. The most sensitive species can be used as bioindicators for the presence of toxic pollutants.

Soil Invertebrates

As described by Klinkenberg [R-106], invertebrates are animal species that do not possess or develop a vertebral column. Soil invertebrates play an important role in soil communities by contributing to the aeration and drainage of soil as they create and move through underground tunnels, thus playing a vital role in soil fertility and plant health. They also convert organic matter (e.g., dead leaves) to rich fertile humus. The feces of a worm are expelled in the form of a mineral and nutrient rich cast, which is important for plant health.

Earthworms are in direct contact with soil and can absorb chemicals both through their skin and through ingestion.

Meadow Vole (*Microtus pennsylvanicus*)

The meadow vole (*Microtus pennsylvanicus*) is a small, herbivorous rodent commonly found across all temperate areas of Canada. They are the most widespread vole in North America; they are very abundant and have no special status [R-107].

The total length of the meadow vole ranges from 128 to 195 mm with a tail about 40% of the body length. There is no sexual variation in size or color. The color of the meadow vole can vary from dark blackish brown to dark reddish brown with coarse black hairs in the dorsal surface. The ventral surface is grey or white and may be tinged with light brown [R-107].

The meadow vole can be found mainly in meadows, lowland fields, grassy marshes and along rivers and lakes. They can be found occasionally in flooded marshes, high grasslands near water and orchards or woodland if grassy [R-107]. At the Site, the meadow vole may be found across most areas on the Site including meadows and grassy marshes. When abundant, the meadow vole can be a pest.

The diet of this receptor consists primarily of vegetation such as grasses and leaves; however, the vole also consumes some fungi and insects.

The meadow vole is active at all times of the day, but tends to be more active at night during the summer, and during the day in winter. Females are territorial, and males have overlapping home ranges about three times larger than those of females.

Meadow vole population densities fluctuate widely from season to season and year to year, sometimes crashing to near zero before recovering in a few years to densities of several hundred per hectare [R-108]. Meadow voles are short-lived, rarely living for longer than one year in the wild [R-107]. They remain within their home range year-round.

Voles reach sexual maturity usually within several weeks after birth, with females maturing before males, but still continue to grow for several months. The gestation period usually last from 20 to 23 days. Reported litter sizes range from 1 to 11 [R-108].

The meadow vole is a significant portion of some predators diet specially owls, small hawks, and falcons. They can also be prey for snakes, red foxes, and weasels [R-107].

Northern Short-tailed Shrew *(Blarina brevicauda)*

The northern short-tailed shrew (*Blarina brevicauda*) is primarily a species of northeastern and north-central United States and southern Canada [R-108].

They are small mammals with dark slate-colored pelage. The tail of the northern short-tailed shrew is approximately 20% of total animal length. The length of the head and body ranges from 75 to 105 mm and the tail length ranges from 17 to 30 mm [R-107].

Northern short-tailed shrews are found in nearly all terrestrial habitats. However, their populations are most dense in damp brushy woodlands, bushy bogs and marshes, and weedy and bushy borders of fields. At the Site, shrews are found in forests, wetlands, and grasslands. They are active on the surface, in leaf litter, and below ground. A well-developed leaf litter is thought to be important in protecting shrews from moisture and temperature extremes [R-108].

Northern short-tailed shrews are reported to be active day and night throughout the year, but they show reduced activity during extended periods of cold temperatures. They breed from March to September [R-108]. Male short-tailed shrews reach sexual maturity within 65 days after birth, and females within 45 days after birth. Their gestation period ranges from 21 to 22 days. Reported litter sizes range from 4 to 7 pups [R-108].

Northern short-tailed shrew population densities vary by habitat and season, peaking from July to October, with peak densities ranging from 2.5 to 45 shrews per hectare, depending on the habitat. Winter mortality of up to 90 percent has been reported for the short-tailed shrew [R-108]. They do not undergo seasonal migration, and remain in their home area year-round.

White-tailed Deer *(Odocoileus virginianus)*

The white-tailed deer *(Odocoileus virginianus)* inhabit most of southern Canada and nearly all of the United States, extending through Central America to Bolivia [R-107].

White-tailed deer are large mammals with head and body length ranging from 150 to 200 cm, and tail length ranging from 10 to 28 cm. Their height at the shoulder ranges from 80 to 100 cm [R-107]. Dorsal fur colouration of the white-tailed deer differs with location and season. Generally, white-tailed deer have greyish dorsal colouration in winter and reddish dorsal colouration in summer with white fur banded behind the nose, around the eyes and across their ventral surface [R-107]. Male white-tailed deer annually grow antlers in the early spring which are shed between January and March [R-107].

The white-tailed deer uses a wide variety of habitats, including forests and forest edges, cedar swamps and swamp edges, open brushy areas, and mixed farmland [R-109]. Their preferred habitat is along the edges (high food density) of dense trees or brush (used for hiding) [R-107]. They are non-migratory but have extensive home ranges that range from 59 to 520 hectares [R-109].

White-tailed deer are the most common mammal observed on and around the Site [R-13].

The white-tailed deer is exclusively herbivorous, consuming buds and twigs of trees and shrubs as well as needles and leaves of evergreens in the winter and grasses, fruits, foliage of shrubs and trees and needles of evergreens in the summer, with diet depending entirely on their terrestrial environment [R-109].

White-tailed deer are considered a secretive species with highly nervous and shy behaviour [R-107]. They are generally considered to be solitary (i.e., single female traveling with her fawns), particularly males, but can be observed to graze in larger herds [R-107]. Males reach sexual maturity on average 417 days after birth and females reach sexual maturity on average 309 days after birth. Their gestation period averages 198 days with typical litter sizes consisting of two offspring [R-107].

Red Fox (*Vulpes vulpes*)

Red foxes (*Vulpes vulpes*) are found throughout much of the northern hemisphere from the Arctic circle to Central America, the steppes of central Asia, and northern Africa [R-107].

The coloration of the red fox can range from pale yellowish red to deep reddish on the upper parts and white, ashy, or slaty on the underside. The lower part of the legs is usually black, and the tail usually has a white or black tip. Red foxes are the largest of the Vulpes species with the length of head and body ranging from 455 to 900 mm, and tail from 300 to 555 mm [R-107].

Fox habitat is varied, and includes agricultural areas that incorporate cropland, rolling farmland, pastures, brush, and coniferous forests; foxes prefer areas that contain a balance of open areas and forested areas. Foxes are found across the Site mainly in areas that combine forested and open areas. Foxes are confirmed to be living on Site and dens have been located on Site.

The red fox feeds on a variety of food types, including small mammals (mainly meadow voles, mice, and rabbits), birds, insects, and fruit/berries.

Red foxes help to control populations of their prey animals, such as rodents and rabbits. The most significant predators on red foxes are humans, who hunt foxes for their fur and kill them in large numbers as pests [R-107]. Competition with other canids, especially coyotes, and seasonal limits on food availability also limit red fox abundance [R-108]. Red foxes have been known to live 10 to 12 years in captivity but live on average 3 years in the wild.

Breeding season is usually February to April in the north. Foxes usually produce pups their first year and litter size generally averages four to six pups.

Red foxes are solitary animals and do not form packs like wolves. During some parts of the year adjacent ranges may overlap somewhat, but parts may be regularly defended [R-107].

Foxes generally have relatively large home ranges, though the home range of females (96 ha) is much smaller than that of males (717 ha) [R-108]. Red foxes remain in the same home range for life. The typical population density of the red fox is one red fox family per 100 to 1,000 ha [R-108].

<u>Mourning Dove (*Zenaida macroura*)</u>

The mourning dove (*Zenaida macroura*) is among the most abundant and widespread terrestrial birds endemic to North and Middle America. The estimated population abundance ranges from 475 million to 350 million [R-110]. They are the leading game birds in North America [R-107].

Mourning doves are medium-sized birds in the pigeon family. They have a stream-lined appearance, with a relatively small head and a long, pointed tail [R-107]. They occupy a wide variety of open and semi-open habitats, such as urban areas, farms, prairie, grassland, and lightly wooded areas. The species has adapted well to areas altered by humans as they are highly adaptable birds. At the Site, mourning doves are found in open woodlands and forest edges near grasslands and fields [R-21].

Mourning doves migrate south from their northern breeding grounds in Canada each fall to a more hospitable climate for the winter months. During migration these birds may fly over 1,000 miles to reach their winter resting spot [R-107].

Mourning doves are monogamous, some pairs stay together through the winter. Mourning doves have the longest breeding season of all North American birds, from February to October. Mourning doves may breed several times in a breeding season, depending on food availability. Female mourning doves generally lay two small, white eggs in an open nest. Young are able to breed by 85 days old.

As they consume large quantities of seeds they act as seed dispersers, but they can occasionally become pests of crops as they eat cereal grains [R-107].

Mourning dove populations experience very high annual mortality rates; depending on geographical region, 50 to 75% of the population dies each year [R-110]. The known predators for the mourning doves are falcons, hawks, raccoons, domestic dogs and cats, and black rat snakes [R-107].

American Woodcock (*Scolopax minor*)

American woodcocks (*Scolopax minor*) are inland members of the sandpiper family that have a stocky build, long bill, and short legs. They have large heads and short necks, and their wings are broad and rounded compared to most other shorebirds. They are well camouflaged in light brown, black, buff, and gray-brown tones [R-111].

Woodcocks nest in young, shrubby, deciduous forests, old fields, and mixed forest-agricultural-urban areas across the eastern United States and southern Canada [R-111]. Woodcocks prefer woodlands and abandoned fields with abundant earthworm populations given that earthworms are their primary food source. They breed in a mixed habitat of open woodland, moist thickets, and brushy fields. In Ontario, American woodcocks are found widespread in lake plains [R-110]. At the Site, woodcocks are found in woodlots near open fields or forest clearings, or along the edges of Stream C [R-21].

American woodcocks spend most of their time hidden in fields and on the forest floor, where they probe for earthworms. Woodcocks have an earthworm consumption rate that can range from 50% to 100% of their diet.

American woodcocks in northern regions leave soon after the first heavy frost and return in late March to early April. The migration may take 4 to 6 weeks. Home ranges can vary considerably, from 3.1 ha for inactive males to 73.6 ha for active males. Population density can range from 1.7 male singing grounds per 100 hectares to 10.4 male singing grounds per 100 hectares [R-108].

The American woodcock breeds early in spring, and males mate with multiple females and give no parental care. The female builds a simple nest on the ground and lays 1 to 5 (usually 4) eggs shortly after mating [R-107]. Woodcocks attempt to raise only a single brood in a given year but may renest if the initial clutch is destroyed. In 12 years of study, it was found that 42 percent of all nests to be lost to predators and another 11 percent lost to other causes. Survival of juveniles in their first-year ranges from 20 to 40 percent, and survival of adults ranges from 35 to 40 percent for males to approximately 40 to 50 percent for females [R-108].

American woodcocks are polygamous and are generally solitary, though they may group into small clusters of 2 to 4 individuals [R-111].

Short-Eared Owl (*Asio flammeus*)

The short-eared owl *(Asio flammeus)* is one of the world's most widely distributed owls, and among the most frequently seen in daylight. It lives in large, open areas with low vegetation, including prairie and coastal grasslands, heathlands, meadows, shrubsteppe, savanna, tundra, marshes, dunes, and agricultural areas [R-112].

The owl's diet mostly includes small mammals, especially mice and voles. These owls also eat shrews, moles, lemmings, rabbits, pocket gophers, bats, rats, weasels, and muskrats. Short-eared Owl populations tend to fluctuate in close association with the cycling populations of their mammalian prey. They also eat birds including adult and nestling terns, gulls, shorebirds, songbirds, storm-petrels, and rails [R-112]. Short-eared owls have been sighted on Site and near Baie du Doré.

Short-eared owls nest on the ground amid grasses and low plants. They usually choose dry sites—often on small knolls, ridges, or hummocks—with enough vegetation to conceal the incubating female. Short-eared owls nest on the ground amid grasses and low plants. They usually choose dry sites—often on small knolls, ridges, or hummocks—with enough vegetation to conceal the incubating female [R-112].

Common Gartersnake *(Thamnophis sirtalis)*

Common gartersnakes are thin with few growing over 4 ft (1.2 m) long. Most have longitudinal stripes in many different colors, including green, blue, yellow, gold, red, orange, brown, and black [R-113].

The habitat of the common gartersnake ranges from forests, fields, and prairies to streams, wetlands, meadows, marshes, and ponds, and it is often found near water [R-114]. Eastern gartersnakes, a sub-species of the common gartersnake, have been located on the Site.

Prey of common gartersnake is variable and habitat dependent, but generally includes amphibians, earthworks, small mammals and birds, freshwater fishes, and leeches. The common gartersnakes prefer fish and amphibians, while juveniles primarily ate earthworms [R-114].

Wood Frog *(Lithobates sylvatica)*

The wood frog *(Lithobates sylvaticus)* may be reddish, tan, or dark brown but always has a dark mask under and behind the eyes. Some individuals have a light line down the middle of the back. This species has a dark blotch on the chest near each front leg. The belly is white and may have some dark mottling. Adult wood frogs can grow to up to eight centimeters in length [R-115].

Wood frogs may be found in forests, fields, muskegs, marshes, wet meadows, moist woodlands and brush [R-115]. Wood frog egg masses have been located on Site and this species has been recorded during frog vocalization surveys (see Appendix A, Section 1.7.3.1).

Adult and juvenile wood frogs are insectivores, primarily consuming arthropods such as insects and spiders. Secondary dietary items include snails and slugs and sometimes the earthworm. Tadpoles are opportunistic and omnivorous primarily feeding on algae, bacteria and single cell organisms [R-115].

Semi-Aquatic Receptors

Muskrat (*Ondatra zibethicus*)

Muskrats occur throughout most of North America, with the exception of Florida and coastal Georgia and South Carolina [R-116].

Muskrats are arranged in large family groups and live in definite territories. Adult muskrats measure about 410 to 620 mm in total length and weigh 680 to 1,800 g. Males average slightly larger than females [R-107].

Muskrats are found in marshes, ponds, lakes, and slow-moving rivers. Water at a site must be deep enough to not freeze in the winter, but shallow enough to allow the growth of aquatic vegetation (ideal water depth is between 1 and 2 m) [R-117]. Muskrats may be found around Stream C on the Site and in the Baie du Doré wetland.

Muskrats build a variety of structures depending on habitat conditions. Along rivers, where bank substrate is appropriate for digging, they construct extensive burrows with underwater entrances as a defense against predators. In marshes, muskrat build lodges out of vegetation and mud. They also build feeding platforms and “pushups,” shelters made of vegetation that cover a hole in the ice, which are used for feeding and as breathing holes. The population density of the muskrat is usually estimated by counting the number of houses or push-ups and multiplying by a factor ranging from 2.8 to 5. Muskrat population densities vary from 1 to 74 muskrats per hectares [R-108].

The age at first breeding varies but usually occurs during the first spring after birth. The gestation period usually lasts from 29 to 30 days. Southern populations produce more litters but with fewer pups in each than do northern populations. Litter size generally ranges from 1 to 12 young. Muskrats follow a 10-year cycle in most parts of Canada [R-108].

Muskrats are primarily herbivores, although they will eat some animal matter [R-116]. Broad-leaved cattail (Typha latifolia) is a preferred food source [R-118] and can support 2 to 7 times as many individuals as other vegetation types [R-116]. Stream dwelling muskrats tend to have more diverse diets than those that live in marshes. Individuals that inhabit lakes are more opportunistic feeders and may ingest more animal matter than other populations [R-116].

Muskrats are non-migratory and have home ranges reported to be as small as 0.048 ha in Ontario [R-108].

Muskrats influence the composition of local plant communities and are very important prey animals for predator populations. They are trapped for their fur, and they have long been one of the most valuable furbearers in North America. Also, the meat from a muskrat is suitable for human consumption [R-107].

Mink (*Mustela vison*)

U.S. EPA [R-108] describes mink as the most widespread and abundant predator in North America.

Adult mink males and females look different, they are sexually dimorphic. Males range in length from 330 to 430 mm and weigh 700 to 1,300 g, while females are 300 to 360 mm long and weigh 550 to 1,100 g [R-119].

While the U.S. EPA [R-108] lists a wide range of diet composition for this opportunistic predator, the mink is known to concentrate on fish and, to a lesser extent, crayfish, in some instances. U.S. EPA [R-108] notes that the diet of mink is typically comprised of approximately 63% fish and 11% crayfish.

Minks stay together in family groups during the summer, but are solitary in winter. Breeding occurs in February or March. Minks reach sexual maturity at 10 months to a year and may reproduce for 7 years, possibly more. Female mink can reproduce once per year and usually give birth to their first litters at 1 year of age [R-108]. The gestation period varies in length from approximately 40 to 80 days [R-119].

The mink's home range is variable based on food abundance, age, sex, season, and social stability [R-108]. The shape is based on habitat type, where in riverine habitats the range is essentially linear and more circular in marsh habitats. Mink are found around Stream C on the Site and in the Baie du Doré wetland. Their home range has been observed to range from 7.8 to 380 ha in riverine to prairie pothole habitats, and 1 to 5 km in a stream habitat [R-108]. The mink is non-migratory and has been observed on the Site during critical life stages. They have also been recorded during wildlife-vehicle interaction surveys. Population density depends on available cover and prey and typically ranges from 0.01 to 0.10 mink per hectare [R-108].

Minks are extensively trapped for their fur, but are also preyed upon by great horned owls, bobcats, coyotes, wolves, and black bears. Because they are at the top of the food chain, minks are very susceptible to bioaccumulation of chemicals [R-119].

Green-winged Teal (*Anas crecca*)

The green-winged teal (*Anas crecca*) is North America's smallest dabbling duck. It prefers shallow ponds with lots of emergent vegetation. Along the coast, it prefers tidal creeks, mudflats, and marshes to more open water. Green-winged teal breeds throughout most of Canada, Alaska, Maine, North Dakota, Minnesota, and Northern Michigan [R-110]. Green-winged teals have been documented in Baie du Doré during waterfowl and shorebird migration surveys (see Figure 14 in Section 1.7.2.2).

The teal has a narrow bill which is black colored. Teals are sexually dimorphic. Males have a cinnamon-colored head with an iridescent green crescent running through the eye to a small crest at the back. The sides and back appear grey but they are actually marked with tiny black and white stripes. Their wings and tail are a tannish-brown color, with pale yellow feathers along the side of the tail. Females are tannish-brown, and have a white chin and belly [R-110].

The green-winged teal has a broad diet including sedges, grasses, aquatic vegetation, aquatic insects and larvae, mollusks, crustaceans. They typically feed in shallow water, near shorelines, and on mudflats. This receptor has a home range of 6 ha [R-120].

Nearly all populations perform major spring and fall migrations. They migrate from wintering grounds February through April. After breeding, males have a molt migration with some populations moving in the general direction of the wintering grounds [R-110].

The population density of the green-winged teal reported in Canada is 2.3 to 6.5 birds per square mile on arctic deltas, 0.5 to 52.1 per square mile in boreal forests, 1.9 to 5.6 per square mile in parklands, and 0.5 to 53.7 per square mile in the mixed prairie regions of Canada and the U.S [R-110].

Green-winged teals begin courtship in the fall, typically between September and November. They form monogamous pairs every winter. Egg-laying typically begins in May. Their nests are typically in sedge meadows, grasslands, brush thickets, or woods near a pond. Most individuals attempt breeding in the first year; and once every year thereafter [R-110].

Spotted Sandpiper (*Actitis macularia*)

Spotted Sandpipers (*Actitis macularia*) are small shorebirds that are generally found running along sandy, rocky or muddy shores of interior lakes, ponds and streams, preferring relatively open areas [R-121]. Spotted sandpipers have been documented on Site.

The spotted sandpiper is migratory, and does not overwinter in Canada. Their breeding range is generally quite small.

The spotted sandpiper forages primarily on terrestrial and aquatic invertebrates but their diet can also include fish. Primary prey items include flies, grasshoppers, crickets, beetles, caterpillars, worms, mollusks, crustaceans, and spiders. Flying insects, such as midges and mayflies are also a major food source. They can easily catch flying insects and also pick insects off the water surface [R-121].

Belted Kingfisher (*Ceryle alcyon*)

The belted kingfisher (*Ceryle alcyon*) is a pigeon-sized member of the Alcedinidae family found throughout much of the United States and Canada. They have a stocky body, heavy bill, and a large head with a double-pointed crest. Both the male and female are blue-gray on the back and head with a white collar around the neck and white underparts [R-107].

Belted kingfishers live near streams, rivers, and small lakes [R-108]. They spend much of their time perched alone along the edges of streams, lakes, and estuaries, searching for small fish. Kingfishers have been documented along the Lake Huron shoreline at the Site [R-21].

Belted kingfishers are considered to be piscivores, which can include the consumption of fish, crustaceans, and other larger aquatic animals [R-108].

Belted kingfishers are solitary except during the breeding season when pairs form monogamous bonds. Male belted kingfishers establish a breeding territory that attracts females. Belted kingfishers establish their territory around April, roughly one month before females return from their winter location [R-107]. Once a pair bond is formed, both the male and female aggressively defend their territory.

Individual belted kingfishers including young of the year, also maintain a feeding territory outside of the breeding season. The home range varies from 2.19 ha during the breeding season to 0.39 ha during the non-breeding season [R-107].

Kingfishers are sensitive to disturbance and usually do not nest in areas near human activity. Kingfishers typically breed in the first season after they are born [R-108]. Breeding occurs usually once a year between the months of April and July, depending in part on their geographic location. Females lay 5 to 8 oval, glossy white eggs in the back of the nesting cavity which hatch in 23 or 24 days [R-107].

This kingfisher breeds over most of the area of North America and winters in most regions of the continental United States. Although most northern kingfishers migrate to southern regions during the coldest months, some may stay in areas that remain ice-free where fishing is possible [R-108]. Breeding densities of between 2 and 6 pairs per 10 km of river shoreline have been recorded [R-108].

Belted kingfishers are considered diurnal birds, and fossorial (i.e., burrowing) because of their excavating behavior during the nesting season [R-107].

Belted kingfishers are top predators in both marine and freshwater aquatic food webs. They have few natural predators, which may include accipiters and falcons, including Cooper's hawks, sharp-shinned hawks, and peregrine falcons [R-107].

Snapping Turtle (*Chelydra serpentina*)

The snapping turtle (*Chelydra serpentina*) is primarily aquatic, inhabiting freshwater and brackish environments, although they will travel overland. In eastern North America, snapping turtles are found in and near permanent ponds, lakes, and marshes. They spend most of their time lying on the bottom of deep pools or buried in the mud in shallow water with only their eyes and nostrils exposed. Young snapping turtles show a preference for areas with some obstructions that may provide cover or food [R-108]. This species has been observed on Site, including nests. They have also been recorded during wildlife-vehicle interaction surveys.

Snapping turtles are omnivorous. In early spring, when limited aquatic vegetation exists in lakes and ponds, they may eat primarily animal matter; however, when aquatic vegetation becomes abundant, they become more herbivorous. Young snapping turtles are primarily carnivorous and prefer smaller streams where aquatic vegetation is less abundant. Snapping turtles consume a wide variety of prey including insects, crustaceans, clams, snails, earthworms, leeches, tubificid worms, freshwater sponges, fish (adults, fry, and eggs), frogs and toads, salamanders, snakes, small turtles, birds, small mammals, and carrion and plant material including various algae. They feed via a pharyngeal mechanism (i.e., drawing water with food objects into the mouth) [R-108].

Northern Water Snake (*Nerodia sipedon*)

Northern water snakes (*Nerodia sipedon)* are brownish in appearance. The back and sides have a series of square blotches alternating with each other that may merge to form bands. The length of the snake is usually between 60 and 110 centimeters, but some individuals may be even larger [R-122].

The northern water snake is generally found in and around almost any permanent body of fresh water within its range, including lakes, rivers, and wetlands, usually close to shorelines habitats, in shoreline vegetation, basking on rocks and logs, or in other open habitats along the edges of the water or under rocks along the shoreline. It is an excellent swimmer [R-122]. This species has been confirmed on Site.

Northern water snakes hibernate underground in dens or crevices, or in beaver lodges and they breed in the spring after emerging from hibernation [R-122].

The northern water snake eats fish and amphibians. It hunts for preys along the water's edge or underwater. This snake usually swallows small prey headfirst upon capture, but it may carry large fish to shore before consuming them as well [R-122].

The northern water snake is one of the most commonly seen snakes around lakes and it is abundant in Canada. Waterfront construction development, water pollution, habitat loss, road mortality and persecution by humans are some of the threats to this species [R-122].

Aquatic Receptors

Detailed descriptions of the selected aquatic receptors are provided below.

Aquatic Plants

Aquatic plants can be classified into emergent, submergent, and phytoplankton (which include algae). Aquatic plants convert carbon dioxide and water into oxygen and glucose using sunlight. This biochemical process, termed photosynthesis, is an important process on earth because nearly all life depends on it. Given that this process requires sunlight, which can only penetrate in shallow waters, aquatic plants are most abundant along shorelines of deeper lakes and throughout shallow water bodies or streams [R-123]. Additional information about aquatic plants found in Baie du Doré can be found in Appendix A Section 1.8.2.

Zooplankton

Zooplankton are the small aquatic animals found near the water surface in aquatic environments that drift with water currents. Zooplankton are classified by size and/or by developmental stage. Size categories include: *picoplankton* (less than 2 µm), *nanoplankton* (2 to 20 µm), *microplankton* (between 20 to 200 µm), *mesoplankton* (0.2 to 20 mm), *macroplankton* (20 to 200 mm), and the *megaplankton*, which (over 200 mm). There are two categories used to classify zooplankton by their stage of development: *meroplankton* and *holoplankton* [R-124].

In aquatic food webs, zooplankton are a resource for consumers on higher trophic levels (including fish). Most zooplankton feed on smaller particles, including phytoplankton (microscopic plants), using sieve-like devices which may function like flypaper rather than sieves because viscous forces prevail in water at such small scales of motion. Other planktonic animals are omnivores or carnivores [R-124].

Benthic Invertebrates

Benthic invertebrates are organisms that live in or on the bottom sediments of rivers, streams, and lakes, and are animals without a spinal column. The benthic community is very dependent on the surroundings as it is strongly affected by its environment, including sediment composition and quality, water quality, and hydrological factors that influence the physical habitat. As a result, the benthic community serves as a biological indicator that reflects the overall condition of the aquatic environment and is commonly used as indicators in the evaluation of impacts to stream ecology and entire watersheds [R-125]. Since many aquatic species have a life span in water of approximately a year, they provide an indication of water quality conditions over that period [R-126].

Benthic invertebrates have been favoured in environmental effects monitoring because they are sessile or limited in their range of movement and therefore cannot avoid pollution. They are generally abundant and can be found year-round so are easily sampled [R-126]. Benthic invertebrates are found in water bodies in and around the Site. Additional information about benthic invertebrates found in Baie du Doré can be found in Appendix A Section 1.8.5.

Benthic invertebrates are an extremely important food source for many aquatic organisms including fish, as they are primary consumers in aquatic ecosystems, and are mediators in nutrient cycling in aquatic systems by the breakdown and utilization of suspended or attached organic material. As important prey items for many fish species, these organisms can transfer contaminants to higher trophic levels in aquatic food webs [R-127].

Many benthic invertebrates feed on algae and bacteria. Others eat shredded leaves and other organic matter present in the water [R-128].

Fish

Fish serve as prey species for other wildlife, are commercially and culturally significant to Indigenous communities (see Appendix A Section 1.8.7) and provide recreational value to anglers. The near shore of Lake Huron, Stream C and the permanent drainage features on-site support various fish populations as discussed in detail in Appendix A Section 1.8.1.

Fish can be classified as benthivores, planktivores, and piscivores; however, exposures through direct contact with water are the primary focus in ecological risk assessments. Fish are evaluated in this EcoRA based on toxicological benchmarks derived using standard aquatic toxicity testing of fish species exposed to chemicals within water. Although exposure can also occur through contact and incidental ingestion of contaminated sediments and via accumpation of prey, evaluating such exposures requires specialized test regimes that are rarely applied [R-129]. Therefore, selection of fish VECs based on their feeding guild (e.g., benthivores, planktivores and piscivores) is out of the scope of this EcoRA.

The most commonly tested species used to evaluate potential risks to fish include the juvenile and adult life stages of the Fathead Minnow (*Pimephales promelas)* and Rainbow Trout *(Oncorhynchus mykiss)*. In freshwater systems, salmonids (such as trout) are generally considered to be among the most sensitive fish. They are, therefore, included in the minimum data requirements for deriving the toxicological benchmarks used in the evaluation of fish in this EcoRA [R-130]. As such, the fish assessment applied in this EcoRA is considered protective of all fish populations document on-site.

Amphibians (embryonic and larval life stages)

Amphibians (including frogs, toads, and salamanders) in Canada can be loosely categorized into pond breeders or stream breeders. Pond breeders attach their eggs to submerged vegetation or lay them on the pond bottom or water surface; ponds can be permanent or temporary. Stream breeders attach their eggs to the undersides of in-stream logs and rocks. Frog and toad embryos hatch in about three to four days and are relatively immobile for one to two days post-hatch. Salamander embryos take longer to hatch, and they are more fully developed and more closely resemble their adult form upon hatching. The complete larval transformation into metamorphosed amphibians, also known as juveniles, can take from several weeks to a couple of years depending on the species. Both juveniles and adults are considered terrestrial, although many species spend a significant amount of time in or near freshwater environments [R-114]. Observations and amphibian vocalization surveys have consistently recorded several frog species (see Section 1.7.3), including northern leopard frog, American toad, wood frog, spring peepers, green frog and grey treefrog. Red spotted newt and spotted salamander have also been observed.

Amphibian embryo and larvae appear to be more susceptible to contaminants than the adult stage, where exposure through direct contact with contaminated water is considered a major pathway for the aquatic embryonic and larval life stages. Most water quality guidelines, including those provided by CCME, appear to provide adequate protection of amphibians [R-114].

2.3.2 Exposure Assessment

2.3.2.1 Probability of Exposure

The home ranges and seasonality features for each wildlife receptor are summarized in Table 17.

Table 17
Home Ranges and Seasonality for Wildlife

Receptor	Home Range (ha)	Seasonality
Terrestrial		
Meadow Vole	0.0069[g]	Non-migratory; expected to be on-site throughout the year.
Northern Short-tailed Shrew	0.39[a]	Non-migratory; expected to be on-site throughout the year.
White-tailed Deer	30[g]	Non-migratory; expected to be on-site throughout the year.
Red Fox	280[a]	Non-migratory; expected to be on-site throughout the year.
Mourning Dove	100[b]	Migratory; breeding expected to occur on-site.
American Woodcock	3.1[a]	Migratory; breeding expected to occur on-site.
Short-eared Owl	20[b]	Migratory, although may not migrate if preferred food sources are ample; breeding expected to occur on-site.
Common Gartersnake	1 [g]	Non-migratory; expected to be on-site throughout the year.
Wood Frog	25 [g]	Non-migratory; expected to be on-site throughout the year.
Semi-Aquatic		
Muskrat	0.03[g]	Non-migratory; expected to be on-site throughout the year.
Mink	6 [g]	Non-migratory; expected to be on-site throughout the year.
Green-winged Teal	6.0[e]	Migratory; breeding expected to occur on-site.
Spotted Sandpiper	1.2 [g]	Migratory; may cross through the Site on their way to and from breeding ground in northern Canada; presence on-site is expected to be transient.
Belted Kingfisher	0.39 km[a]	Migratory if water sources freeze in winter; may be breeding on-site.

Table 17
Home Ranges and Seasonality for Wildlife

Receptor	Home Range (ha)	Seasonality
Snapping Turtle	3 (h)	Non-migratory; expected to be on-site throughout the year.
Northern Water Snake	Not defined (h)	Non-migratory; the northern water snake usually stays in the same area of a stream or in the same pond for several years.
Notes: (a) [R-109] (b) [R-110] (c) [R-131] (d) [R-108] (e) [R-120] (f) [R-132] (g) [R-121] (h) [R-108]		

As noted in Appendix A: Section 1.3.1, there are a number of engineered site facilities considered to provide potential terrestrial ecological habitat or are adjacent to terrestrial ecological habitat. In addition, aquatic habitat is provided in Stream C, the permanent on-site drainage features (FSL, B16 Pond, B31 Pond and EDD), and the nearshore Lake Huron habitat near the Site. Each of the areas considered in the EcoRA, the habitat within each area, and the potential receptors considered to become exposed to COPCs at each area are presented in Table 18 and Figure 33 below.

Table 18
Areas Assessed in EcoRA

Area	Habitat Features	Media Assessed	Potential Receptors
TERRESTRIAL			
Bruce A Storage Compound (BASC) - 17 ha	Industrial Active: Minimal grass and weeds; fenced. Shallow groundwater. Area assessed because it is located next to a forest.	• Soil • Groundwater (<1.5 mbgs)	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants (both soil and shallow groundwater contact) and invertebrates
Bruce B Empty Drum Laydown Area	Industrial Barren: Gravel cover with	• Soil	• Terrestrial mammals and birds (meadow vole, northern

Table 18
Areas Assessed in EcoRA

Area	Habitat Features	Media Assessed	Potential Receptors
(BBED) - 1.4 ha	minimal grass and weeds. Area assessed because it may act as an ecological corridor to Lake Huron.		short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.
Construction Landfill #4 (CL4) - 3.8 ha	Cultural Grassland: Granular/aggregate cover and partially vegetated with grasses, weeds, and shrubs. Area assessed because it contains terrestrial ecological habitat. Adjacent B31 pond assessed as aquatic habitat below	• Soil	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.
Fire Training Facility (FTF) - 2.8 ha	Industrial Barren in Active Use Area assessed because it is adjacent to terrestrial ecological habitat, including areas of cultural thicket and forest	• Soil	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.
Former Sewage (Commissioning Waste) Lagoon (FSL) - 7 ha	Cultural Meadow: Includes swamp, marsh, and forested areas. Shallow groundwater Area assessed because it contains terrestrial	• Soil • Groundwater (<1.5 mbgs)	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog)

Table 18
Areas Assessed in EcoRA

Area	Habitat Features	Media Assessed	Potential Receptors
	ecological habitat. FSL also assessed as aquatic habitat below.		• Terrestrial plants (both soil and shallow groundwater contact) and invertebrates.
Distribution Station #1 (DS1) - 0.068 ha	Cultural Barren: Fenced; adjacent to cultural meadow, forested areas, swamp. Area assessed because it is adjacent to terrestrial ecological habitat	• Soil • Groundwater (>1.5 mbgs)	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.
Distribution Station #2/4/5 (DS2/DS4/DS5) - 0.05 ha	Industrial Barren: Graveled, patches of weeds, small trees, and shrubs; next to forested areas. Area assessed because it is adjacent to terrestrial ecological habitat	• Soil	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates.
Distribution Station #8 (DS8) - 0.21 ha	Active Industrial: Woodlot between two transformers; adjacent to forested areas south and east. Area assessed because it contains terrestrial ecological habitat	• Soil	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates
General Surface Soil Samples (BPS and SS series)	Collected around the BP site facilities mainly within grassed and forested ecological	• Soil	• Terrestrial mammals and birds (meadow vole, northern short-tailed shrew, white-tailed deer, red fox, mourning dove, American woodcock, short-eared

Table 18
Areas Assessed in EcoRA

Area	Habitat Features	Media Assessed	Potential Receptors
	habitat		owl). • Terrestrial amphibians and reptiles (common gartersnake and wood frog) • Terrestrial plants and invertebrates
PERMENANT WATER COURSE			
Stream C – 2.2 km	Adjacent to marsh, forest, cultural meadow, beach.	• Surface Water • Sediment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.
Lake Huron shoreline and nearshore habitat	Largely adjacent to active industrial, with some beach including at Inverhuron Park and Baie du Doré Wetland.	• Surface Water • Sediment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.
PERMENANT DRAINAGE FEATURE			
FSL (1 ha)	Considered aquatic habitat with frog and turtle species. FSL also assessed as terrestrial habitat above.	• Surface water • Sediment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.
B16 Pond (0.3 ha)	Considered aquatic habitat with frog and turtle species.	• Surface water • Sediment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake)

Table 18
Areas Assessed in EcoRA

Area	Habitat Features	Media Assessed	Potential Receptors
			• Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.
B31 Pond (at CL4) (0.4 ha)	Considered aquatic habitat with frog and turtle species. Terrestrial habitat assessed at adjacent Construction Landfill #4 assessed.	• Surface water • Sediment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.
Distal Eastern Drainage Ditch (0.09 ha)	Considered aquatic habitat with frog and turtle species.	• Surface water • Sediment	• Semi-aquatic mammals and birds (muskrat, mink, green-winged teal, spotted sandpiper, belted kingfisher). • Semi-aquatic reptiles (snapping turtle and northern water snake) • Aquatic plants, invertebrates, fish, embryonic and juvenile amphibians.

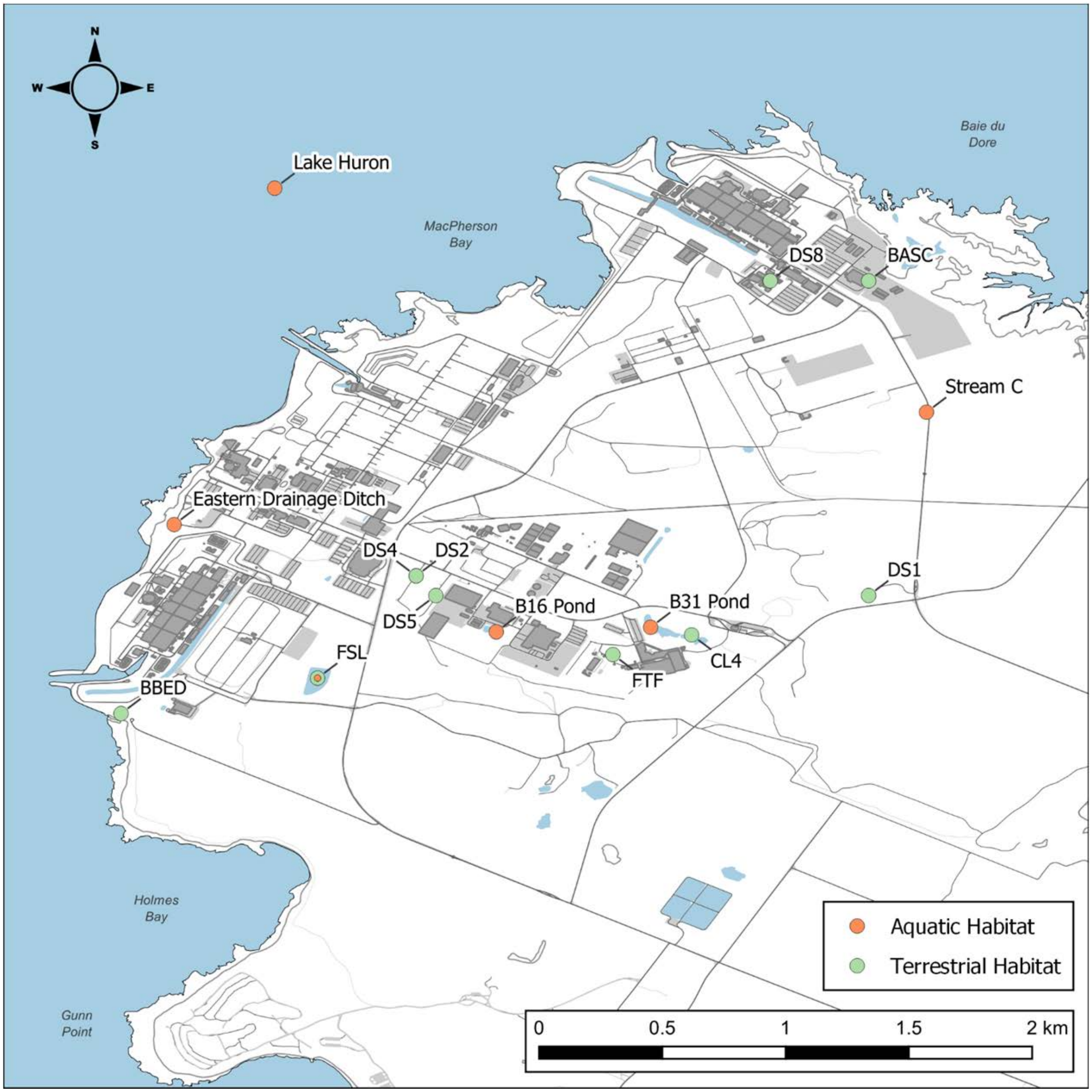

Figure 33 Areas Assessed in the EcoRA

2.3.2.2 Receptor Characterization

Receptor characterization involves quantifying the factors that govern exposure, namely body weight, food ingestion rate, and water ingestion rate, as these factors together with chemical concentrations govern a wildlife receptor's exposure dose. The receptor characteristics along with their proportions of various types of food in the diet were adopted from multiple sources, including the U.S. EPA Wildlife Exposure Factors Handbook [R-108] and Federal Contaminated Sites Action Plan (FCSAP) [R-121]. These proportions are determined largely through field studies that examine scat and stomach contents of wildlife. Incidental ingestion of soil or sediment may occur incidentally during ingestion of food items and/or due to grooming and preening.

Mammals

The receptor characteristics for the mammals assessed in the EcoRA were obtained from government sources including FCSAP[R-121], U.S. EPA Wildlife Exposure Factors handbook [R-108] and Sample et al. [R-109], as well as various online databases.

The receptor characteristics for the mammals assessed in the EcoRA are provided in Table 19. It is noted that the proportions of diet for the mink were selected with the objective of assessing these receptors with respect to their exposure to the aquatic environment for specific feeding guilds. In the wild, this receptor tends to have a more varied diet that may include some food items from the terrestrial environment. In addition to fish, the mink may also consume food from the terrestrial environment as part of its diet (e.g., small mammals). However, the red fox was selected to represent the terrestrial carnivore feeding guild. Therefore, for the purposes of the EcoRA, the mink was conservatively assessed as a solely piscivorous receptor.

Table 19
Receptor Characteristics for Mammals

Parameter (unit)	Meadow Vole	Northern Short-tailed Shrew	White-tailed Deer	Red Fox	Muskrat	Mink
Body Weight (kg)	0.0349 (a)	0.015 (b)	75 (a)	3.8 (a)	1.0 (a)	0.82 (a)
Water Ingestion Intake (L/ day)	-	0.0033 (b) (g)	-	-	-	-
Water Ingestion Rate (L/kg BW/day)	0.21 (a) (g)	0.22 (h)	0.06 (a) (g)	0.09 (a) (g)	0.10 (a)	0.03 (a)
Wet Food Ingestion Intake (kg ww / day)	-	0.009(b)	-	-	-	-
Wet Food Ingestion Rate (kg ww/kg BW/day)	0.33 (a)	0.6 (h)	0.13(l)	0.09 (a)	0.47(l)	0.14 (a)
Dry Food Intake (kg dw/day)	-	-	-	-	-	-
Dry Food Ingestion Rate	0.08(l)	0.11(l)	0.03 (a)	0.02(l)	0.07(a)	0.03(l)

Table 19
Receptor Characteristics for Mammals

Parameter (unit)	Meadow Vole	Northern Short-tailed Shrew	White-tailed Deer	Red Fox	Muskrat	Mink
(kg dw/kg BW/day)						
Dietary Proportions						
Proportion of Soil[j] (of dry food ingestion rate)	2.4% [(a)]	3%[(c)(k)]	2% [(i)]	2.8% [(a)]	0%	0%
Proportion of Terrestrial Plant	100% [(a)]	13% [(b)]	100% [(a)]	15% [(a)]	0%	0%
Proportion of Soil Invertebrate	0%	79% [(b)]	0%	25% [(a)]	0%	0%
Proportion of Mammals (prey)	0%	8% [(b)]	0%	60% [(a)]	0%	0%
Proportion of Sediment [(j)]	0%	0%	0%	0%	2%[(i)]	2% [(i)]
Proportion of Aquatic Plant	0%	0%	0%	0%	80% [(a)]	0%
Proportion of Benthic Invertebrate	0%	0%	0%	0%	15% [(a)]	35% [(a)]
Proportion of Fish (prey)	0%	0%	0%	0%	5%	65% [(a)]

Notes:

(a) [R-121]
(b) [R-109]
(c) [R-133]
(d) [R-134]
(e) Estimated using allometric equation [R-109].
(f) Assumed 100% benthic invertebrates as a conservative approach.
(g) Ingestion of surface water was considered to contribute negligibly to total exposure for terrestrial mammals and birds given that these receptors can meet their daily water requirements with the water content in their diet [R-108]. Therefore, this pathway was not quantitatively assessed.
(h) Food and water ingestion rates converted to a per mass basis by dividing intake rates (L/d or kg/d) by the body mass of the receptor
(i) Default of 2% applied in absence of species-specific values based on FCSAP [R-121].
(j) Proportion of soil/sediment is based on the % of the dry food ingestion rate.
(k) Proportion of soil from Sample et al. [R-109] not used for the shrew because it also incorporates litter invertebrate ingestion.
(l) Where a conversion from an original source was needed, food ingestion rates are adjusted for moisture in food items in the following moisture percentages based on [R-121]: 0.77/0.84/0.68 for terrestrial vegetation, soil invertebrates, and small mammal prey; 0.87/0.79/0.75 for aquatic vegetation, benthic invertebrates, and fish.

Birds

The receptor characteristics for the birds assessed in the EcoRA are provided in Table 20. As described in the previous section for the mink, the green-winged teal has a varied diet that includes terrestrial plants including grasses and sedges. However, given that the green-winged teal was selected to represent semi-aquatic birds in the herbivore feeding guild, and that the mourning dove was selected to represent terrestrial herbivorous birds, the food proportions of the green-winged teal were applied to aquatic sources only. Also, over 50% of the spotted sandpiper's diet is from ground insects; given the highly conservative nature of the uptake factors used to estimate benthic invertebrate concentrations from sediment, the terrestrial food proportions were not applied to aquatic sources for the spotted sandpiper.

Table 20
Receptor Characteristics for Birds

Parameter (unit)	Mourning Dove	American Woodcock	Short-eared Owl	Green-winged Teal	Spotted Sandpiper	Belted Kingfisher
Body Weight (kg)	0.12[(b)]	0.198[(c)]	0.35[(d)]	0.32[(d)]	0.037[(m)]	0.148[(e)]
Water Ingestion Intake (L/d)	0.014[(a)(f)]	0.02[(a)(e)]	0.03[(a)(f)]	0.027[(f)]	-	0.02[(e)]
Water Ingestion Rate (L/kg BW/day)	0.12[(n)]	0.10[(n)]	0.08[(n)]	0.08[(n)]	0.17[(m)]	0.14 [(n)]
Wet Food Ingestion Intake (kg ww/day)	-	0.15[(c)]	-	-	-	0.075[(e)]
Wet Food Ingestion Rate (kg ww/kg BW/day) [(n)]	0.83[(q)]	0.76[(n)]	0.25[(q)]	0.58[(q)]	0.30[(q)]	0.51[(n)]
Dry Food Ingestion Intake (kg ww/day) [(n)]	-	-	0.03 [(f)]	0.027[(f)]	-	-
Dry Food Ingestion Rate (kg dw/kg BW/day) [(n)]	0.19 [(b)]	0.13[(q)]	0.08[((n)]	0.08[(n)]	0.18[(m)]	0.12[(q)]
Dietary Proportions						
Proportion of Soil [(p)]	9.3%[(h)]	10.4%[(e)]	0%	0%	0%	0%
Proportion of Terrestrial Plant	100%[(b)]	10%[(i)]	0%	0%	0%	0%
Proportion of Soil Invertebrate	0%	90%[(i)]	0%	0%	0%	0%

Table 20
Receptor Characteristics for Birds

Parameter (unit)	Mourning Dove	American Woodcock	Short-eared Owl	Green-winged Teal	Spotted Sandpiper	Belted Kingfisher
Proportion of Mammals (prey)	0%	0%	100%[(j)]	0%	0%	0%
Proportion of Sediment [(p)]	0%	0%	0%	4%[(k)]	2%[(o)]	2%[(o)]
Proportion of Aquatic Plant	0%	0%	0%	90%[(d)]	5%	0%
Proportion of Benthic Invertebrate	0%	0%	0%	10%[(d)]	40%[(l)]	15%[(e)]
Proportion of Fish	0%	0%	0%	0%	5%	85%[(e)]

Notes:

(a) Ingestion of surface water was considered to contribute negligibly to total exposure for terrestrial mammals and birds given that these receptors can meet their daily water requirements with the water content in their diet [R-108]. Therefore, this pathway was not quantitatively assessed.
(b) [R-133]
(c) [R-10]
(d) [R-110]
(e) [R-109]
(f) Estimated using allometric equation [R-109].
(g) [R-135]
(h) Assumed to be equivalent to that of the wild turkey [R-136] which has a similar diet and feeding behavior.
(i) [R-108]
(j) [R-132]
(k) [R-137]
(l) The spotted sandpiper's diet includes ground insects and flying insects, but this was not included in the assessment.
(m) [R-121]
(n) Food and water ingestion rates converted to a per mass basis by dividing intake rates (L/d or kg/d) by the body mass of the receptor
(o) Default of 2% applied in absence of species-specific values based on [R-121].
(p) Proportion of soil/sediment is based on the % of the dry food ingestion rate.
(q) Where a conversion from an original source was needed, food ingestion rates are adjusted for moisture in food items in the following moisture percentages [R-108]: 0.77/0.84/0.68 for terrestrial vegetation, soil invertebrates, and small mammal prey; 0.87/0.79/0.75 for aquatic vegetation, benthic invertebrates, and fish.

Reptiles and Amphibians

The receptor characteristics for the reptiles and birds assessed in the EcoRA are provided in Table 21.

Table 21
Receptor Characteristics for Reptiles and Amphibians

Parameter (unit)	Common Gartersnake	Wood Frog	Snapping Turtle	Northern Watersnake
Body Weight (kg)	0.09 (a)	0.008 (a)	5.03 (b)	0.144 (b)
Water Ingestion Rate (L/day)	None Identified	None Identified	None Identified	None Identified
Wet Food Ingestion Rate (kg ww/kg BW/day)	0.03 (a)	0.24(h)	0.016 (b)	0.056 (b)
Dry Food Ingestion Rate (kg dw/kg BW/day)	0.01(h)	0.038 (d)	0.002(h)	0.014(h)
Dietary Proportions				
Proportion of Soil (g)	2% (c)	2% (c)	0%	0%
Proportion of Terrestrial Plant	0%	0%	0%	0%
Proportion of Soil Invertebrate	30% (a)	100% (a)	0%	0%
Proportion of Mammals (prey)	70% (a)	0%	0%	0%
Proportion of Sediment (g)	0%	0%	2% (c)	0%
Proportion of Aquatic Plant	0%	0%	70% (b)	0%
Proportion of Benthic Invertebrate	0%	0%	30% (b)	0%
Proportion of Fish	0%	0%	0% (e)	100% (b)

Notes:
(a) [R-121]
(b) [R-108]
(c) Default of 2% applied in absence of species-specific values based on [R-121].
(d) Food ingestion rate estimated based on the allometric equation provided by US EPA [R-108].
(e) Although the snapping turtle may consume fish species, their dietary consumption of fish is assumed to be zero in this EcoRA as the aquatic habitats on-site with COPCs contain no fish species (EDD, B31, B16, and FSL).
(f) Food and water ingestion rates converted to a per mass basis by dividing intake rates (L/d or kg/d) by the body mass of the receptor.
(g) Proportion of soil/sediment is based on the % of the dry food ingestion rate.
(h) Where a conversion from an original source was needed, food ingestion rates are adjusted for moisture in food items in the following moisture percentages based on [R-108]: 0.77/0.84/0.68 for terrestrial vegetation, soil invertebrates, and small mammal prey; 0.87/0.79/0.75 for aquatic vegetation, benthic invertebrates, and fish.

2.3.2.3 Exposure Equations and Exposure Doses

The following equations were used to estimate exposure doses to COPCs in wildlife receptors based on CCME [R-104].

The exposure doses for each assessed location, wildlife receptor and COPC are provided in Appendix F.

<u>Food Ingestion Rate</u>

Food ingestion rates (FIR), if not known for a receptor, can be estimated using allometric equations that estimate the weight of food intake per day for various feeding guilds divided by a receptor's body weight. Allometric equations to estimate dry food ingestion rate (kilograms of dry weight per kilogram of body weight per day (kg dw/kg BW/day) were obtained from US EPA [R-108] as follows:

Mammals	
All mammals	$= 0.0687(BW)^{0.822} \div BW$
Birds	
All birds	$= 0.0582(BW)^{0.651} \div BW$
Reptiles and Amphibians	
Herbivores	$= 0.019(BW)^{0.841}$ (in grams) ÷ BW
Insectivores	$= 0.013(BW)^{0.773}$ (in grams) ÷ BW

These dry weight food ingestion rates can be converted into wet weights as follows:

$FIR\ (wet) = FIR\ (dry) \div (1\text{-}mositure_{diet})$

Where:

FIR (wet) = wet food ingestion rate (kg ww/kg BW/day)
FIR (dry) = dry food ingestion rate (kg dw/kg BW/day)
$Moisture_{diet}$ = represents the weighted average moisture content in the diet of the animal, based on measured contents in tissues from the site or values from the literature

The moisture content of dietary items was obtained from US EPA [R-108] as follows:

Terrestrial	**Aquatic**
dicots: leaves (85% moisture)	bony fishes (75% moisture)
dicots: seeds (9.3% moisture)	emergent vegetation (62.5% moisture)
fruit: pulp, skin (77% moisture)	aquatic macrophytes (87% moisture)
earthworms (84% moisture)	benthic - average of bivalves, shrimp, isopods (78.5% moisture)
mammals (68% moisture)	

Soil/Sediment Ingestion Rate

Soil/sediment ingestion rates, if not known for a receptor, can be estimated from the food ingestion rate as follows:

$$SIR\ (dry) = FIR\ (dry) \times \Phi$$

Where:

SIR (dry) = dry soil/sediment ingestion rate (kg dw/kg BW/day)
FIR (dry) = dry food ingestion rate (kg dw/kg BW/day)
Φ = fraction of incidental soil or sediment ingested during feeding [if unknown, a default of 2% on a dry weight basis may be assumed]

Drinking Water Ingestion Rate

Drinking water ingestion rates, if not known for a receptor, can be estimated using allometric equations that estimate the volume of water intake per day divided by the receptor's body weight. Allometric equations to estimate drinking water rate (L/kg BW/ day) were obtained from US EPA [R-108] as follows:

Mammals	
All Mammals	$= 0.099(BW)^{0.90} \div BW$
Birds	
All birds	$= 0.059(BW)^{0.67} \div BW$
Reptiles and Amphibians	None identified

Dose from Soil/Sediment

Soil/sediment dose (mg/kg BW/day) = SIR x C_s

Where:
SIR (dry) = dry soil/sediment ingestion rate (kg dw/kg BW/day)
C_s = concentration of COPC in soil / sediment in dry weight (mg/kg dw)

Dose from Food

Food dose (mg/kg BW/day) = FIR x $\sum_1^j (C_{Fj} \times P_{Fj})$

Where:
FIR (wet) = wet feeding ingestion rate (kg ww/kg BW/day)
C_{Fj} = wet weight concentration of COPC in food item j in the diet of the receptor (mg/kg ww)
P_{Fj} = proportion of prey item j in the diet of the predator (unitless)

Dose from Drinking Water

Drinking water dose (mg/kg BW/day) = WIR x C_W

Where:
WIR = drinking water ingestion rate (L/kg BW/day)
C_w = concentration of COPC in surface water (mg/L)

Total Unadjusted Dose

Total unadjusted dose (DUT) (mg/kg BW/day) = DF + DS + DW*

Where:
DF = the dose from food (mg/kg BW/day)
DS = the dose from soil (mg/kg BW/day)
DW = the dose from water (mg/kg BW/day)

Total Adjusted Dose

The dose adjustment factor to account for territory/foraging range, habitat quality, and bioavailability of the COPCs was calculated using the equation below.

Dose adjustment factor (DAF) (unitless) = FRF x α

Where:
FRF (unitless) = the foraging range factor [= site area / home rage]
α (unitless) = the dietary uptake efficiency [100% bioavailability assumed]

The total adjusted dose through ingestion of all media as a function of territory/foraging range and bioavailability was calculated as follows:

Total adjusted dose (DAT) (mg/kg BW/day) = DUT x DAF

2.3.3 Effects Assessment

2.3.3.1 Toxicity Reference Values and Toxicological Benchmarks

The CSA Standard N288.6-12 [R-5] identifies several sources for toxicological benchmarks and TRVs, including Suter and Tsao (1996) for aquatic biota [R-138], Sample et al. (1996) [R-135] for wildlife and Efroymson et al. (1997) for plants and soil invertebrates [R-139][R-140]. However, preference was given to regulatory agencies who have derived toxicological benchmarks and TRVs based on more recent toxicological reviews and statistical interpretations of effect levels across multiple studies and species including FCSAP [R-141], US EPA [R-133], and CCME [R-130][R-11][R-142]. Detailed discussion on the selection of toxicological benchmarks and TRVs are provided within each media specific section below (Section 2.3.5 to Section 2.3.7).

The No Observed Adverse Effect Level (NOAEL) for chronic effects or an equivalent minimal effect level (e.g., EC_{20}) was selected for each COPC, where available, for the assessment of adverse effects to individuals (i.e., bird and reptile VECs selected to represent SAR species). For assessment of those receptors that were not used as surrogates for species at risk (i.e., mammal VECs), the Lowest Observed Adverse Effect Level (LOAEL) was used. Additionally, where the selected VEC species served as a surrogate for a SAR species but the area assessed was not considered suitable SAR habitat, the LOAEL was also presented.

2.3.4 Risk Characterization

Risk characterization is the final step in the risk assessment process, during which the exposure and effects assessments are integrated. The approaches to risk characterization for mammals and birds, terrestrial plants and soil invertebrates, and aquatic life are described further below.

2.3.4.1 Wildlife

Potential risks to terrestrial wildlife from exposure to COPCs in soil and potential risks to semi-aquatic wildlife from exposure to COPCs in surface water and sediment were assessed on a quantitative basis by calculating HQs.

The following equation was used to estimate exposure to COPCs in wildlife receptors:

$$HQ = \frac{EDI}{TRV}$$

Where:

HQ = Hazard Quotient (unitless)

EDI = Estimated Daily Intake (mg/kg day)

TRV = Toxicity Reference Value (mg/kg day)

2.3.4.2 Terrestrial Plants and Soil Invertebrates

Potential risks to terrestrial plants from exposure to COPCs in soil and shallow groundwater, and potential risks to soil invertebrates from exposure to COPCs in soil, were assessed on a quantitative basis by calculating HQs. The HQ is the ratio of the concentration of the COPC in the environmental media (i.e., soil or shallow groundwater) to the toxicological benchmark.

2.3.4.3 Aquatic Life

Potential risks to aquatic life from exposure to COPCs in surface water and sediment were assessed on a quantitative basis by calculating HQs. The HQ is the ratio of the concentration of the COPC in the environmental media (i.e., surface water or sediment) to the toxicological benchmark.

2.3.5 Soil

2.3.5.1 Environmental Fate and Transport Considerations

The fate and transport of chemicals, including those identified as COPCs (metals and organics in soil), is governed by a series of complex reactions that incorporate organic and inorganic constituents that are present within the soil. As a result, mineral solubility, which is largely dependent on variables such as pH, redox conditions, and dissolved concentrations of the key mineral compounds, can have a significant influence on the mobility of metals in the environment. Geochemical variables, such as pH and redox conditions, determine the speciation of the metals, which in turn determines the environmental and biological availability. The speciation, and therefore the fate and transport, of the metals have been considered in the EcoRA, including the expected behaviour of these chemicals in the terrestrial and aquatic environments. Considerations regarding the speciation, fate and transport of metals are summarized below; considerations of fate and transport related to organic chemicals in soil are addressed as well.

Metals

Metals exist in the soil solution as 1) free (un-complexed) metal ions, 2) dissolved compounds where the metal is complexed with inorganic or organic ligands, and/or 3) solid-phase compounds where the metal is bound with inorganic and organic colloidal material [R-143]. A complex is a unit in which a central metal ion is bonded by a number of associated atoms or molecules in a defined geometric pattern. The associated atoms or molecules are termed ligands. The total concentration of a metal in the soil solution is the sum of the free ion concentration, the concentration of dissolved organic and inorganic metal complexes, and the concentration of metals associated with colloidal material.

Complexation of metals with ligands can significantly affect the rate of transport through the soil matrix relative to the free elemental ions. With complexation, the resulting metal species may be positively charged, negatively charged or electrically neutral. The metal complex may be only weakly adsorbed or more strongly adsorbed to soil surfaces relative to the free metal ion. Speciation not only affects mobility of metals but also the bioavailability and toxicity of the metal. The free metal ion is, in general, the most bioavailable and toxic form of the metal [R-143].

The attenuation mechanisms for metals in soil environments include precipitation/co-precipitation with secondary mineral phases, adsorption/complexation of the metal onto the soil solid surfaces and solid-solution substitution reactions which results in ion exchange with the soil solids. The retention of metals in soil environments is controlled by the geochemical and physical properties of the soil, including pH, redox potential, surface area, cation exchange capacity, organic matter content, clay content, iron and manganese oxide content, and carbonate content [R-144]. In addition to soil properties, consideration must be given to the metal-specific properties, the metal concentration and to the presence and concentration of competing ions and complexing ligands [R-145].

VOCs

BTEX (benzene, toluene, ethylbenzene, and xylenes) are Volatile Organic Compounds (VOCs) that are typically found in petroleum products such as gasoline and diesel fuel. Xylenes are a mixture of three isomers: 2(o)-xylene, 3(m)-xylene and 4(p)-xylene.

The information provided below on the fate and transport of BTEX in air, soil and water was taken from the Hazardous Substances Data Bank [R-146]–[R-149].

If released to air, BTEX will exist solely as a vapour in the atmosphere based on its vapour pressures. Vapour-phase BTEX will be degraded in the atmosphere primarily by reaction with photochemically-produced hydroxyl radicals.

If released to soil, BTEX is expected to have moderate to very high mobility based on its Koc. Volatilization is expected to be an important fate process based upon its vapour pressures and Henry's Law constants. BTEX is also expected to biodegrade in soils.

If released to water, benzene, toluene, and xylenes are not expected to adsorb to suspended solids and sediment based upon their Koc values. Ethylbenzene may adsorb to suspended solids and sediment. Volatilization is expected to be an important fate process for BTEX in water based upon its Henry's Law constant. Benzene, toluene, and xylenes are biodegraded in water. Ethylbenzene is biodegraded in water and sediment.

BTEX are not considered persistent as half-lives are below persistence criteria established under the Canadian Environmental Protection Act [R-150].

The uptake of BTEX in animals may occur via many routes, including oral, inhalation and dermal absorption [R-151]–[R-154]. In ecological risk assessment, the majority of uptake of contaminants by wildlife is typically attributed to the oral route of uptake [R-109].

BTEX is absorbed and rapidly distributed throughout an animal's body [R-151]–[R-154]. It is preferentially stored in adipose tissue but also accumulates in the kidneys, liver, and brain. The major rout of elimination from the body is excretion in the urine.

BTEX are not considered to bioaccumulate because bioaccumulation factors (BAFs) and bioconcentration factors (BCFs) for algae, fish, mussels, and plants are less than bioaccumulation criteria established under the *Canadian Environmental Protection Act* [R-150].

PAHs

Polycyclic Aromatic Hydrocarbons (PAHs) are a group of organic compounds composed of two or more benzene rings. Sources of PAHs in the environment include anthropogenic sources but they are also produced naturally. PAHs are divided into two categories:

1. Low molecular weight (LMW) PAHs having fewer than four rings; and,

2. High molecular weight (HMW) PAHs having four or more rings.

PAHs are non-polar, hydrophobic compounds, which do not ionize. As a result, they have low solubilities in water. The solubilities of PAHs in water increase as the molecular weight (and number of rings) decreases, as the temperature increases and in the presence of dissolved organics.

Because of their hydrophobicity and low water solubilities, HMW PAHs tend to tightly sorb to soils, suspended particulates in water and sediments. LMW PAHs volatilize from soil and water and are predominantly present in the vapour phase in air.

PAHs are subject to microbial degradation in soil, water, and sediment [R-155][R-156]. Resistance to microbial degradation in soils and water increases with molecular weight and number of rings [R-155][R-156]. In aquatic systems, photodegradation is also an important process for HMW PAHs and can lead to the formation of compounds that are more toxic than the parent compound [R-156].

Based on Canadian Environmental Protection Act criteria [R-150], naphthalene is not considered persistent but most of the other LMW-PAHs are considered persistent, including acenaphthene, fluorene, phenanthrene, anthracene and fluoranthene. The HMW-PAHs are also considered persistent. They have half-lives above persistence criteria in air, soil, and sediment but below persistence criteria in water.

Terrestrial plants may take up LMW-PAHs from soils and translocate the PAHs from the roots to various plant parts, however, they do not appear to accumulate or magnify the concentrations relative to those in soil [R-157]. HMW-PAHs may sorb to plant roots, but are not expected to translocate to other plant parts or accumulate in the plant [R-155].

Gaseous phase transfer or deposition of particle-bound PAHs from the atmosphere to plant surfaces is the primary route of uptake of PAHs by terrestrial plants [R-157].

Earthworms take up PAHs primarily by direct contact (epidermal uptake) with soil pore water [R-157].

Animals may be exposed to PAHs in soil as the result of direct ingestion or indirect ingestion of food items [R-157]. Similar pathways of exposure apply to surface water and sediment. PAHs have limited ability to bioaccumulate in most animals because they are readily metabolized [R-158]. The mixed-function oxygenase (MFO) enzyme systems are responsible for the biotransformation and ultimate detoxification of PAHs in animals. The process includes the generation of toxic intermediate products before formation of nontoxic end products.

Based on Canadian Environmental Protection Act criteria [R-151], LMW- and HMW-PAHs bioaccumulate for some aquatic species. In fish and crustaceans, BCFs have been reported in the range of 10 to 10,000 [R-158]. In general, bioconcentration is greater for HMW- than LMW-PAHs. There is a high degree of variability in bioconcentration between species, depending on their ability to metabolize PAHs. Algae, mollusks, and other species cannot metabolize PAHs rapidly and exhibit the highest BCFs, while fish and many crustaceans, which readily metabolize PAHs, generally have lower BCFs [R-156].

<u>PHCs</u>

Petroleum hydrocarbons (PHCs) are a mixture of organic compounds that come from crude oil. PHCs are divided into four fractions based on carbon number as follows: F1 (C6 to C10), F2 (>C10 to C16), F3 (>C16 to C34) and F4 (C34+).

Lighter constituents (i.e., <C12) are water soluble and volatile while heavier constituents (i.e., >C21) are not soluble and non-volatile. Lighter compounds are likely present in air. Heavier compounds are more likely to be found bound to particulates in air, soil, suspended solids in water and sediment.

Biodegradation is a major fate process for PHCs as most soils and sediments have populations of bacteria and other organisms capable of degrading PHCs [R-159].

Lighter compounds (aliphatic and aromatic hydrocarbons <C26) have half-lives below persistence criteria, while heavier compounds (>C30) are considered persistent based on modelled degradation rates [R-160].

PHCs are not readily taken up and accumulated by plants [R-161]. In wildlife, PHCs do not tend to accumulate in tissues because they are readily metabolized and excreted [R-161]. As a result, ingestion rather than consumption of food items (plants or other animals) is the major route of exposure to wildlife from PHCs.

Dermal contact and ingestion of petroleum product may also be important. For example, oiling of feathers can lead to hypothermia in waterfowl, and petroleum product may be ingested by wildlife during preening of fur and feathers [R-161].

Based on Canadian Environmental Protection Act criteria [R-150], some PHCs bioaccumulate. Bioaccumulation of hydrocarbons increases with the octanal water partition coefficient (K_{ow}), which tends to increase with molecular weight for PHCs [R-162]. BAFs/BCFs above 5000 have been reported for some PHCs [R-160]. There is no evidence to suggest that these PHCs biomagnify in terrestrial and aquatic food chains [R-160].

Acid & Base Neutral Extractables

This group of substances comprises phenols including methyl- and chlorine- substituted varieties, phthalates, amines, chlorinated benzenes, and other such organic chemicals that may be present in neutral, cationic, or anionic species depending upon their acid dissociation constant (pKa).

In general, the ability of organic compounds to sorb to soils or other suspended particulates is determined by a variety of factors. For non-ionic organic chemicals (i.e., electrically neutral compounds), including chlorinated compounds, those with increased molecular weight and increased chlorination are more likely to sorb to soils, given their higher hydrophobicity and greater K_{ow} [R-133]. These compounds are also more likely to accumulate in the lipids of biota. Conversely, small, non-ionic organic chemicals with a low degree of chlorination would have less propensity to sorb to soils and accumulate in biota.

These compounds are generally semi-volatile or non-volatile, depending on the molecular weight and Henry's law constant of the specific chemical, wherein smaller compounds are generally more volatile.

2.3.5.2 Chemical Specific Factors and Dietary Concentrations

The uptake equations used in the EcoRA are provided in Table 22 for terrestrial food items (log octanol-water coefficients required for some uptake equations are provided in Table 23).

Table 22
Uptake Equations for Soil to Plants, Earthworms and Mammals

COPC	Soil to Plants	Source	Soil to Earthworms	Source	Soil to Mammals (Prey)	Source
Cadmium	$\ln(C_p) = 0.546*\ln(C_s)-0.475$	[R-133]	$\ln(C_e)=0.795*\ln(C_s)+2.114$	[R-133]	$\ln(C_m)=0.4723*\ln(C_s)-1.2571$	[R-133]
Lead	$\ln(C_p) =0.541*\ln(Cs)-1.328$	[R-133]	$\ln(Ce)=0.807*\ln(Cs)-0.218$	[R-133]	$\ln(Cm)=0.4422*\ln(Cs)-0.0761$	[R-133]
Selenium	$\ln(C_p)=1.104*\ln(C_s)-0.677$	[R-133]	$\ln(C_e)= 0.733*\ln(C_s)-0.075$	[R-133]	$\ln(C_m)=0.3764*\ln(C_s)-0.4158$	[R-133]
Silver	$C_p=0.014*C_s*(1-0.85)$ (c)	[R-133]	$C_e=2.045*C_s*(1-0.84)$(b)	[R-133]	$C_m=0.004*C_s*(1-0.68)$(d)	[R-133]
Zinc	$\ln(C_p)=0.554*\ln(C_s)+1.575$	[R-133]	$\ln(C_e)=0.328*\ln(C_s)+4.449$	[R-133]	$\ln(C_m)=0.0706*\ln(C_s)+4.3632$	[R-133]
Total LMW PAH	$C_p=e^{[0.4544*\ln (Cs) -1.3205]}*(1-0.85)$ (c)	[R-133]	$C_e=3.04*C_s*(1-0.84)$(b)	[R-133]	$C_m=0$	[R-133]
Total	$C_p=e^{[0.9469*\ln (Cs)-1.7026]}$	[R-133]	$C_e=2.6*C_s*$	[R-133]	$C_m=0$	[R-133]

Table 22
Uptake Equations for Soil to Plants, Earthworms and Mammals

COPC	Soil to Plants	Source	Soil to Earthworms	Source	Soil to Mammals (Prey)	Source
HMW PAH	* (1-0.85) (c)		(1-0.84)(b)			
Organics	$C_p = C_s * 10^{(1.588-(0.578*logKow))} * (1-0.85)$ (c)	[R-163]	$C_e = C_s * 10^{((0.819* logKow)-1.146)}$	[R-163]	$C_m = C_e * 16 * (10^{(-7.6+logKow)}) * (1-0.68)$(d)	[R-164]

Notes:
Cs = concentration in soil (mg/kg ww); Cp = concentration in plants (mg / kg ww); Ce = concentration in earthworms (mg/kg ww); Cm = concentration in small mammals (mg/kg dw) where the small mammal diet is assumed to be 100% earthworms.
(a) Assumed total uptake in the absence of available references.
(b) Uptake equation converted from dw of tissue to ww of tissue assuming an earthworm moisture content of 84% [R-108].
(c) Uptake equation converted from dw of tissue to ww of tissue assuming a vegetation (leaves) moisture content of 85% [R-108].
(d) Uptake equation converted from dw of tissue to ww of tissue assuming a small mammal moisture content of 68% [R-108].

Table 23
Log Octanol-Water Partition Coefficients for Soil COPCs and Calculated Uptake Equations

Chemical	$\log(K_{ow})$	Source	Soil to Plant Uptake Factor	Soil to Earthworm Uptake Factor	Soil to Prey Uptake Factor
Methyl Ethyl Ketone	0.29	[R-10]	3.949	0.026	2.5E-07
Benzyl Butyl Phthalate	4.84	[R-165]	0.009	0.260	8.9E-03
4-Bromophenyl Phenyl Ether	4.94	[R-165]	0.008	0.264	1.1E-02
Di-n-butyl Phthalate	4.61	[R-165]	0.013	0.250	5.2E-03
Di-n-octyl Phthalate	8.10	[R-165]	0.0001	0.396	1.6E+01
Diphenylamines (total)	3.50	[R-166]	0.055	0.199	4.1E-04
Hexachlorobenzene	5.73	[R-10]	0.003	0.298	6.9E-02
Isophorone	1.70	[R-166]	0.605	0.110	6.4E-06
Nitrobenzene	1.85	[R-166]	0.495	0.118	9.1E-06
2,3,4,5-Tetrachlorophenol	4.21	[R-165]	0.021	0.232	2.1E-03
2-Methylphenol	2.86	[R-165]	0.129	0.169	9.3E-05
Isophorone	1.70	[R-165]	0.605	0.110	6.4E-06

The resulting food concentrations are provided in Table 24, Table 25 and Table 26 for terrestrial food items.

Table 24
COPC Concentrations Modelled in Terrestrial Plants

COPC	Soil Concentration (mg/kg)		Plant Concentration (mg/kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile [1]
BASC				
Zinc	520	86	1.5E+02	5.7E+01
BBED				
None				
CL4				
Cadmium	6.5	0.55	1.7E+00	4.5E-01
Silver	2.6	1.8	5.3E-03	3.8E-03
Zinc	350	112	1.2E+02	6.6E+01
Benzo(a)pyrene	2.4	1.9	6.3E-02	5.0E-02
Benzo(g,h,i)perylene	1.7	1.4	4.5E-02	3.8E-02
Dibenzo(a,h)anthracene	0.79	0.79	2.2E-02	2.2E-02
Fluoranthene	4.4	3.5	1.1E-01	9.0E-02
Indeno(1,2,3-cd)pyrene	1.7	1.36	4.5E-02	3.7E-02
4-Bromophenyl Phenyl Ether	0.01	0.006	8.0E-05	4.8E-05
Di-n-butyl Phthalate	0.11	0.043	1.4E-03	5.6E-04
FTF				
Acenaphthylene	0.71	0.4	2.0E-02	1.1E-02
Dibenzo(a,h)anthracene	0.22	0.1	6.5E-03	3.1E-03
Benzyl butyl phthalate	0.1	0.04	9.0E-04	3.6E-04
Di-n-butyl Phthalate	0.06	0.05	7.8E-04	6.5E-04
Di-n-octyl Phthalate	0.02	0.005	2.0E-06	5.0E-07
Hexachlorobenzene	2.4	0.9	7.2E-03	2.7E-03
Nitrobenzene	4.5	0.7	2.2E+00	3.5E-01
Diphenylamines (total)	1.5	0.7	8.3E-02	3.9E-02
2,3,4,5-Tetrachlorophenol	32	5.1	6.7E-01	1.1E-01
2-Methylphenol	16	4.5	2.1E+00	5.8E-01
Isophorone	0.13	0.05	7.9E-02	3.0E-02

Table 24
COPC Concentrations Modelled in Terrestrial Plants

COPC	Soil Concentration (mg/kg)		Plant Concentration (mg/kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile [1]
FSL				
Silver	1.4	0.7	8.6E-03	4.3E-03
DS1				
None				
DS2/DS4/DS5				
None				
DS8				
None				
BPS / SS				
Lead	130	NA	3.7	NA
Selenium	2.8	NA	1.6E+00	NA

Notes:
"-" Parameter not a COPC for assessed area
NC – Not calculated as no uptake equation identified
NA – Not applicable as BPS/SS sample locations are dispersed and represent different habitats
1 The average concentration was applied where the data set for a COPC had less than 50% undetected concentrations, otherwise the 95th percentile was applied

Table 25
COPC Concentrations Modelled in Soil Invertebrates

COPC	Soil Concentration (mg/kg)		Soil Invertebrate Concentration (mg/kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile [1]
BASC				
Zinc	520	86	6.7E+02	3.7E+02
BBED				
None				
CL4				
Cadmium	6.5	0.55	3.7E+01	5.1E+00

Table 25
COPC Concentrations Modelled in Soil Invertebrates

COPC	Soil Concentration (mg/kg)		Soil Invertebrate Concentration (mg/kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile [1]
Silver	2.6	1.8	8.5E-01	5.9E-01
Zinc	350	112	5.8E+02	4.0E+02
Benzo(a)pyrene	2.4	1.9	1.0E+00	7.9E-01
Benzo(g,h,i)perylene	1.7	1.4	7.1E-01	5.8E-01
Dibenzo(a,h)anthracene	0.79	0.79	3.3E-01	3.3E-01
Fluoranthene	4.4	3.5	2.1E+00	1.7E+00
Indeno(1,2,3-cd)pyrene	1.7	1.36	7.1E-01	5.7E-01
4-Bromophenyl Phenyl Ether	0.01	0.006	2.6E-03	1.6E-03
Di-n-butyl Phthalate	0.11	0.043	2.8E-02	1.1E-02
FTF				
Acenaphthylene	0.71	0.4	3.5E-01	1.9E-01
Dibenzo(a,h)anthracene	0.22	0.1	9.2E-02	4.2E-02
Benzyl butyl phthalate	0.1	0.04	2.6E-02	1.0E-02
Di-n-butyl Phthalate	0.06	0.05	1.5E-02	1.3E-02
Di-n-octyl Phthalate	0.02	0.005	7.9E-03	2.0E-03
Hexachlorobenzene	2.4	0.9	7.2E-01	2.7E-01
Nitrobenzene	4.5	0.7	5.3E-01	8.3E-02
Diphenylamines (total)	1.5	0.7	3.0E-01	1.4E-01
2,3,4,5-Tetrachlorophenol	32	5.1	7.4E+00	1.2E+00
2-Methylphenol	16	4.5	2.7E+00	7.6E-01
Isophorone	0.13	0.05	1.4E-02	5.5E-03
FSL				
Silver	1.4	0.7	5.1E-01	2.6E-01
DS1				
None				
DS2/DS4/DS5				
None				

Table 25
COPC Concentrations Modelled in Soil Invertebrates

COPC	Soil Concentration (mg/kg)		Soil Invertebrate Concentration (mg/kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile [1]
DS8				
None				
BPS / SS				
Lead	130	NA		
Selenium	2.8	NA	2.0E+00	NA

Notes:
"-" Parameter not a COPC for assessed area
NC – Not calculated as no uptake equation identified
NA – Not applicable as BPS/SS sample locations are dispersed and represent different habitats
1 The average concentration was applied where the data set for a COPC had less than 50% undetected concentrations, otherwise the 95th percentile was applied

Table 26
COPC Concentrations Modelled in Small Mammals (including Prey)

COPC	Soil Concentration (mg/kg)		Small Mammals (including prey) Concentration (mg / kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile
BASC				
Zinc	520	86	1.2E+02	1.1E+02
BBED				
None				
CL4				
Cadmium	6.5	0.55	6.9E-01	2.1E-01
Silver	2.6	1.8	3.3E-03	2.3E-03
Zinc	350	112	1.2E+02	1.1E+02
Benzo(a)pyrene	2.4	1.9	0.0E+00	0.0E+00
Benzo(g,h,i)perylene	1.7	1.4	0.0E+00	0.0E+00
Dibenzo(a,h)anthracene	0.79	0.79	0.0E+00	0.0E+00
Fluoranthene	4.4	3.5	0.0E+00	0.0E+00

Table 26
COPC Concentrations Modelled in Small Mammals (including Prey)

COPC	Soil Concentration (mg/kg)		Small Mammals (including prey) Concentration (mg / kg ww)	
	Maximum	Average / 95th Percentile [1]	Maximum	Average / 95th Percentile
Indeno(1,2,3-cd)pyrene	1.7	1.36	0.0E+00	0.0E+00
4-Bromophenyl Phenyl Ether	0.01	0.006	2.9E-05	1.7E-05
Di-n-butyl Phthalate	0.11	0.043	1.4E-04	5.6E-05
FTF				
Acenaphthylene	0.71	0.4	0.0E+00	0.0E+00
Dibenzo(a,h)anthracene	0.22	0.1	0.0E+00	0.0E+00
Benzyl butyl phthalate	0.1	0.04	2.3E-04	9.3E-05
Di-n-butyl Phthalate	0.06	0.05	7.8E-05	6.5E-05
Di-n-octyl Phthalate	0.02	0.005	1.3E-01	3.1E-02
Hexachlorobenzene	2.4	0.9	4.9E-02	1.9E-02
Nitrobenzene	4.5	0.7	4.8E-06	7.5E-07
Diphenylamines (total)	1.5	0.7	1.2E-04	5.7E-05
2,3,4,5-Tetrachlorophenol	32	5.1	1.6E-02	2.5E-03
2-Methylphenol	16	4.5	2.5E-04	7.1E-05
Isophorone	0.13	0.05	9.2E-08	3.5E-08
FSL				
Silver	1.4	0.7	4.4E-01	2.6E-01
DS1				
None				
DS2/DS4/DS5				
None				
DS8				
None				

Table 26
COPC Concentrations Modelled in Small Mammals (including Prey)

COPC	Soil Concentration (mg/kg)		Small Mammals (including prey) Concentration (mg / kg ww)	
	Maximum	Average / 95th Percentile 1	Maximum	Average / 95th Percentile
BPS / SS				
Lead	130	NA		
Selenium	2.8	NA	9.7E-01	NA

Notes:
"-" Parameter not a COPC for assessed area
NA – Not applicable as BPS/SS sample locations are dispersed and represent different habitats
1 The average concentration was applied where the data set for a COPC had less than 50% undetected concentrations, otherwise the 95th percentile was applied

2.3.5.3 Toxicological Benchmarks for Terrestrial Plants and Soil Invertebrates

Soil toxicological benchmarks from the US EPA Eco-Soil Screening Levels (SSLs) [R-133] were primarily considered as they are derived from recent toxicological reviews and are based on a statistical assessment of no-effect levels from multiple studies and plant and invertebrate species. Given that several terrestrial plant species with conservation status were identified on the Site, the use of no-effect levels or a minimal effect level (e.g., EC_{20}) was considered to be more appropriate. In absence of US EPA benchmarks, alternate sources including Efroymson et al. [R-140], CCME [R-167], Ontario MECP [R-168], and the Los Alamos National Lab (LANL) [R-169] were also consulted. The soil benchmarks used in the EcoRA are shown in Table 27, and represent the lowest of the available benchmarks for both terrestrial plants and soil invertebrates.

Table 27
Selected Soil Toxicological Benchmarks for Terrestrial Plants and Soil Invertebrates

COPC	Benchmark (mg/kg)	Source	Description of Key Study(ies)
Boron (HWS)	1.5	[R-10]	Protective of sensitive plant species, but may result in deficiency for boron-tolerant species.
Chromium (VI)	8	[R-10]	Protective of terrestrial plants and soil organisms in agricultural coarse-textured soils.
Copper	70	[R-133]	Geometric mean of maximum acceptable toxicant concentration (MATC) and EC_{10} values for four test species of terrestrial plants.

Table 27
Selected Soil Toxicological Benchmarks for Terrestrial Plants and Soil Invertebrates

COPC	Benchmark (mg/kg)	Source	Description of Key Study(ies)
Selenium	0.52	[R-133]	Geometric mean of maximum acceptable toxicant concentration (MATC) and EC_{20} values for eight test species of plants. Selected over invertebrate benchmark because it is lower.
Zinc	120	[R-133]	Geometric mean of maximum acceptable toxicant concentration (MATC) and EC_{20} values for six test species of invertebrates. Selected over plant benchmark because it is lower.
Di-n-butyl Phthalate (also surrogated to Di-n-octyl Phthalate)	160	[R-169]	Geometric mean of four No Observed Effect Concentration (NOEC)-based exposure levels ranging from 3.87 to 1000 mg/kg for pea, spinach, corn, and lettuce.
PHC F1 (surrogated to purgeable hydrocarbons C5-C10)	210	[R-10][R-167]	The 25^{th} percentile of all of the LC_{25} and IC_{25} data for plants and invertebrates for F1
PHC F2 (also surrogated to TPH Light)	150	[R-10][R-167]	The 25^{th} percentile of all of the LC_{25} and IC_{25} data for plants and invertebrates for F2 (C10-C16).
PHC F3	300	[R-10][R-161]	Based upon protection of terrestrial plants and soil invertebrates for coarse-grained agricultural/residential soils.
Hexachlorobenzene	10	[R-169]	Chronic NOEC for lettuce (*Latuca sativa*) exposed to 10 mg/kg hexachlorobenzene in soil for 7 days.
Nitrobenzene	2.2	[R-169]	Chronic NOEC of 2.26 mg/kg for earthworm (*Eudrilus eugeniae*) survival based on 14-day LC_{50} of 226 mg/kg; adjusted to chronic NOEC using UF of 0.01; no values were available for terrestrial plants.
PAHs (total LMW)	29	[R-133]	Geometric mean of MATC and EC_{10} values for four test species of soil invertebrates (value for terrestrial plants could not be derived due to insufficient data set).
PAHs (total HMW)	18	[R-133]	Geometric mean of MATC and EC_{10} values for four test species of soil invertebrates (value for terrestrial plants could not be derived due to insufficient data set).

No soil benchmarks were available for either terrestrial plants or soil invertebrates for the following COPCs; therefore, quantitative assessment of these chemicals could not be carried out:

- Isophorone
- Acetone
- Benzyl Butyl Phthalate
- 4-Bromophenyl Phenyl Ether
- Diphenylamines (total)
- 2-Methylphenol
- 2,3,4,5-Tetrachlorophenol
- Strontium

2.3.5.4 Toxicity Reference Values for Terrestrial Wildlife

The selected TRVs for mammals and birds were primarily obtained from FCSAP 2021 [R-141] which recently selected default TRVs based on a detailed review of existing values from commonly used sources, including the US EPA [R-133], Sample et al. [R-135], CCME [R-11], and MECP [R-10]. FCSAP selected TRVs based on several data quality characteristics including: the number of studies used in TRV derivation; the LOAEL, NOAEL or dose-response (e.g., EC_{20}) derivation methods; bound or unbound toxicity data (for LOAEL/NOAEL-based TRVs); use of allometric scaling; use of uncertainty factors; and the level of protection. In absence of endorsed TRVs from FCSAP, TRVs were obtained from the CCME [R-11], MECP [R-10], US EPA [R-133], Sample et al [R-135] and LANL [R-169].

The NOAEL for chronic effects was selected for each COPC, where available, for the assessment of adverse effects to individuals (i.e., to all bird and reptile VECs, as these receptors were selected to represent several species of risk identified at the site. For the assessment of those receptors that were not used as surrogates for species at risk (i.e., mammals), the LOAEL was used.

Toxicity testing protocols for soil exposures are not available for amphibians and reptiles, and only a limited number of published studies on soil exposure toxicity testing are available [R-114]. The US EPA has developed a tool for calculating dietary exposure and the risk to terrestrial-phase amphibians and reptiles from pesticides [R-170], which uses avian toxicity data as a surrogate in absence of data on herpetofauna. The approach was also applied in this EcoRA.

The selected TRVs for mammals, birds, reptiles, and amphibians are provided in Table 28 and Table 29.

Table 28
Selected Toxicity Reference Values for Mammals

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
Benzyl Butyl Phthalate	159	159	[R-169]	Rats administered benzyl butyl phthalate orally for 26 weeks; effects on reproduction, development or survival were observed; value is a chronic NOAEL; NOAEL adopted as LOAEL.
Di-n-butyl Phthalate (also surrogated to Di-n-octyl Phthalate)	1340	1340	[R-169]	Geometric mean of three chronic NOAELs ranging from 600 to 2000 mg/kg-day in rodents; associated with reproduction, survival, and adult body weight change endpoints; NOAEL adopted as LOAEL.
Hexachloro-benzene	7.1	7.1	[R-169]	Based upon 3-day LD_{50} for deer mouse of 710 mg/kg-day; adjusted to chronic NOAEL using UF of 0.01; NOAEL adopted as LOAEL.
Methylphenol, 2-	220	220	[R-169]	Mink administered 100, 400 and 1600 mg/kg 2-methylphenol in the diet for 6 months during reproduction; the highest dose level was not associated with adverse effects, therefore a chronic NOAEL of 219 mg/kg-day was derived; NOAEL adopted as LOAEL.
Nitrobenzene	6.95	6.95	[R-169]	Chronic NOAEL of 6.95 mg/kg-day for oral exposure to mammals associated with no effects to reproduction, development, or survival; based upon the ratio of the chronic NOAEL to LD_{50} for closely related compound 1,3,5-trinitrobenzene; NOAEL adopted as LOAEL.
PAHs (total LMW)	65.6	328	[R-133][R-141]	Chronic NOAEL of 65.6 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species. The corresponding LOAEL is 328 mg/kg.
PAHs (total HMW)	0.615	3.01	[R-133][R-141]	Chronic NOAEL of 0.615 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival. The corresponding LOAEL is 3.01 mg/kg.
Cadmium	0.77	7.7	[R-141] [R-171]	Chronic NOAEL of 0.77 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from

Table 28
Selected Toxicity Reference Values for Mammals

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
				multiple studies and species. The corresponding LOAEL is 7.7 mg/kg-d
Lead	4.7	8.9	[R-141]	Chronic NOAEL of 4.7 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species. The corresponding LOAEL is 8.9 mg/kg-d
Selenium	0.143	0.215	[R-141] [R-172]	Chronic NOAEL of 0.143 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species. The corresponding LOAEL is 0.215 mg/kg-d
Silver	6.02	60.2	[R-133]	Due to insufficiency of data, NOAEL selected is the lowest LOAEL for reproduction and growth endpoints divided by 10.
Zinc	75.4	171	[R-141] [R-173]	Geometric mean of chronic NOAEL or LOAELs for growth and reproduction from multiple studies and species (mouse, rat, sheep, pig, hamster and cattle).

No TRVs were available for mammals for the following COPCs and as a result, a quantitative effects assessment could not be carried out:

- 2,3,4,5-Tetrachlorophenol
- 4-Bromophenyl Phenyl Ether
- Strontium

Table 29
Selected Toxicity Reference Values for Birds (Also Surrogated to Herpetofauna)

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
Di-n-butyl Phthalate (also surrogated to Di-n-octyl Phthalate)	0.14	1.4	[R-169]	Based upon chronic LOAEL of 1.4 mg/kg-day for egg-shell thickness in ringed turtle dove; chronic NOAEL of 0.14 mg/kg-day derived using UF of 0.1.

Table 29
Selected Toxicity Reference Values for Birds (Also Surrogated to Herpetofauna)

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
Diphenyl-amines	13.5	13.5	[R-169]	Bobwhite quail administered a single dose of diphenylamine at five dose levels in corn oil gavage and observed for 14 days; acute NOAEL of 1350 mg/kg bw was identified; adjusted to chronic NOAEL using UF of 0.01. The NOAEL adopted as LOAEL due to absence of data.
Hexachloro-benzene	5	5	[R-169]	Japanese quail administered two dose levels of hexachlorobenzene orally for 5 days; a chronic NOAEL for growth of 5 mg/kg-day was derived from the acute NOAEL of 500 mg/kg-day using a UF of 0.01. The NOAEL was adopted as LOAEL due to absence of data.
PAHs (total LMW)	165.3	165.3	[R-133]	Bobwhite quail administered seven dose levels of naphthalene in the diet for 5 days; no effects on behaviour, growth, or survival up to 1653 mg/kg-day; adjusted from sub chronic to chronic NOAEL using UF of 0.1 (Eco-SSL indicates too few studies to derive TRV; value derived using LANL standard procedures). The NOAEL was adopted for the LOAEL in absence of data.
PAHs (total HMW)	0.2	2	[R-133]	European starling administered three to four concentrations of 7,12-dimethylbenz (a) anthracene via gavage for 5 days; effects on biochemistry, pathology, and growth at 20 mg/kg-day (sub chronic LOAEL), and no effects as 2 mg/kg-day (sub chronic NOAEL); adjusted from sub chronic to chronic NOAEL using UF of 0.1; adjusted from sub chronic to chronic LOAEL using UF of 0.1 (Eco-SSL indicates too few studies to derive TRV; value derived using LANL standard procedures).

Table 29
Selected Toxicity Reference Values for Birds (Also Surrogated to Herpetofauna)

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
Cadmium	2.1	2.1	[R-141] [R-174]	Represents the lowest 20% effect level (EC20) derived from dose-response curves from six studies. The six studies considered included data for four species (quails, chickens, pheasants, and mallard ducks) and three endpoints (juvenile growth, reproductive endpoints, and survival). The level of protection is consistent with a minimal to low effect, and is selected to represent both the NOAEL and LOAEL.
Silver	2.02	20.2	[R-133]	Due to insufficiency of data, the NOAEL selected is the lowest LOAEL for reproduction and growth endpoints divided by 10.
Selenium	0.290	0.579	[R-141] [R-172]	Chronic NOAEL of 0.29 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species. The corresponding LOAEL is 0.579 mg/kg-d.
Zinc	66.1	297	[R-141] [R-173]	Geometric mean of chronic NOAEL or LOAELs for growth and reproduction from multiple studies and species (chicken, duck, turkey and quail).

No TRVs were available for birds for the following COPCs and as a result, a quantitative effects assessment could not be carried out:

- 2,3,4,5-Tetrachlorophenol
- 2-Methylphenol
- Benzyl Butyl Phthalate
- 4-Bromophenyl Phenyl Ether
- Isophorone
- Nitrobenzene
- Strontium

2.3.5.5 Toxicological Assessment of PAHs

Given that TRVs have not been derived for each PAH identified as a COPC in soil, it was considered appropriate to adopt the approach used to derive the U.S. EPA Eco-SSLs [R-133]. The groupings of low- and high-molecular weight PAHs are shown in Table 30. To maintain a conservative approach, all PAHs in each group were included in the exposure assessment; that is, whether the individual PAH exceeded its Tier 2 screening value, it was incorporated into the sum of total Low Molecular Weight PAHs or High Molecular Weight PAHs to ensure that contribution from all PAHs was considered.

Table 30
Groupings of Polycyclic Aromatic Hydrocarbons

Low Molecular Weight PAHs	High Molecular Weight PAHs
Acenaphthene Acenaphthylene Anthracene Fluoranthene Fluorene Naphthalene (including methyls) Phenanthrene	Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoranthene Chrysene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Pyrene

2.3.6 Sediment

2.3.6.1 Environmental Fate and Transport Considerations

The fate and transport of chemicals, including those identified as COPCs (metals in sediment), is governed by a series of complex reactions that incorporate organic and inorganic constituents that are present within the water column, and sediments. As a result, mineral solubility, which is largely dependent on variables such as pH, redox conditions, and dissolved concentrations of the key mineral compounds, can have a significant influence on the mobility of metals in the environment. Geochemical variables, such as pH and redox conditions, determine the speciation of the metals, which in turn determines the environmental and biological availability. The speciation, and therefore the fate and transport, of the metals have been considered in the EcoRA, including the expected behaviour of these chemicals in the terrestrial and aquatic environments. Considerations regarding the speciation, fate and transport of metals are summarized below.

Metals

Uptake of metals by aquatic organisms can occur directly from water or indirectly through diet. In pelagic organisms such as fish, the major route of exposure is considered to be from the water column. Therefore, adsorption to respiratory surfaces has been identified as the major route of uptake for most metals. For most water column organisms, ingestion of metals has been considered a minor pathway of uptake, and the focus has been on those forms of metals taken up through the waterborne route. Metals in this form can interfere with respiration (usually through adsorption to gill surfaces, as can occur with aluminum and iron), or induce toxicity at the cellular level after being absorbed through respiratory, and sometimes dermal, surfaces as is the case for most divalent metals [R-175][R-176]. Sediment organisms can be exposed to both soluble metals in the sediment pore water, and through direct ingestion of sediment.

The behaviour of metals and their complexation with ligands in large measures explains the observed anomaly in many aquatic studies: the presence of high concentrations of metals, often well in excess of available criteria, and the concurrent lack of biological effects. Thus, while potential pathways of exposure may exist for aquatic organisms (and terrestrial organisms that feed upon them), there are factors that limit the bioavailability of the metals. As such, the bulk sediment concentration of a metal is not a particularly useful guide to the potential biological effects and often, the effect levels are much higher than predicted by conservative criteria [R-177]. The development of criteria to protect against adverse biological effects due to COPCs in water or sediments should therefore be based on measured biological impacts, rather than bulk concentrations that may be unreflective of the actual availability of the COPCs.

Metal behaviour in sediments is similarly complex as to that of metals in soil solution, whereby metal mobility is controlled by the geochemical characteristics, including pH, redox potential, surface area, cation exchange capacity, organic matter content, clay content, iron and manganese oxide content, and carbonate content. Metal accumulation from sediments can be directly through ingestion of metal contaminated sediments, or through sorption of free ions from pore water. The factors that control the presence or release of free metal ions in the water column also controls metal bioavailability and hence control toxicity of metals in sediments (i.e., the metals have to be available to be toxic). As a result, metals bound to sediments are typically much less bioavailable [R-178]. A number of solid-phase materials present in sediments have been identified as materials that have the potential to sequester, and therefore control COPC availability, including organic carbon, sulphides, iron and manganese hydroxides, and carbonates [R-179]. The importance of the solid-phase materials in controlling the availability depends on the environmental conditions, with the pH and redox conditions typically being the most important geochemical variables [R-180].

Under oxic conditions, a considerable amount of the COPCs within sediments can be bound to iron and manganese complexes (hydroxides and oxides). The ability of iron and manganese hydroxides to scavenge other metals and effectively bind them within the hydroxide shell of the molecule has been shown in many instances [R-181][R-182]. In most surficial sediments, the zone of oxygen penetration of the sediment is confined to the top 2 or 3 centimeters (cm), and it is within this zone that the solubility of metals is controlled primarily by iron and manganese hydroxides.

Below this level, oxygen concentrations in sediment decrease rapidly, and a reducing environment develops within a few centimeters of the sediment surface. Under reducing (anoxic) conditions, the iron and manganese hydroxides undergo reductive dissolution. As a result, the iron, manganese, and other bound metals are released to the pore water as the oxygen is consumed. In sulphide-rich sediments, these metals are usually quickly bound in metal sulphide complexes which, in undisturbed conditions, are very stable. Under reducing conditions, most metals such as copper, nickel and zinc tend to form insoluble complexes with sulphide. Left undisturbed, these are very stable complexes and little metal is cycled back into the environment. The result is that little free metal ion is available in these environments, relative to the bulk sediment concentration of metals. Therefore, under stable redox conditions, the solubility of most metals, and hence the biological availability, appears to be low and is controlled primarily by the iron and manganese hydroxides under oxic conditions, and by sulphide under anoxic conditions. The major releases of metals appear to occur with changes in redox (i.e., when conditions change from oxidizing to reducing or vice versa). Since toxicity is determined by the availability of free metal ions, it is those changes, such as alteration of redox conditions, that result in release of free ions into the pore water that appear to have the most significant biological consequences.

The other major environmental factor controlling metal binding is pH [R-182]. Different metal-ligand complexes are favoured under different pH conditions. With most metals, the presence of the free ionic form increases under low pH, with the result that changes in pH can result in the dissolution of some metal-ligand complexes and the formation of new ones. This has important implications for organisms, both in the amount of free ion available in the water column, and in the ability of organisms to extract metals through ingestion. Since the gut pH of most invertebrates has been shown to be between pH 6 and 7 [R-183], metals ingested as part of a metal-ligand complex would not likely be present in the gut in the free ion form. Thus, for most pelagic organisms the major exposure pathway for metals would be the solubilized (free ionic) form, which is controlled by the presence of other complexing ligands. Ingestion appears to be the more important route of uptake for sediment-dwelling organisms, though sediment dwelling species can also be exposed through concentrations in the pore water. Direct availability from sediment through ingestion, while important, is mainly influenced by the strength of binding to sediment organic and mineral constituents.

In aquatic environments, most metals will exist as a complex balance between free ions, that are biologically reactive, and complexed metals, that are generally biologically unavailable. The approach to completing the EcoRA has recognized the various pathways through which metals can affect biota. Therefore, exposure cannot be simply considered on the basis of the total concentrations of COPCs in water or sediment samples.

2.3.6.2 Chemical Specific Factors and Dietary Concentrations

The uptake equations used in the EcoRA are provided in Table 31 for aquatic food items for estimating bioconcentration from sediment. Uptake equations for water to algae are available from U.S. EPA [R-163]. However, given that most semi-aquatic receptors would be expected to consume emergent aquatic plants that have their roots in sediment substrate (e.g., cattails by the muskrat and green-winged teal), uptake equations for soil to terrestrial plants were adopted.

Table 31
Uptake Equations for Sediment to Plants and Benthics

COPC	Sediment to Plants	Source	Sediment to Benthics	Source
Cadmium	$C_p = e^{[0.546 * \ln(Cs) - 0.475]} * (1-0.87)^{(b)}$	[R-133]	$C_b=C_{sed}*3.4$	[R-163]
Lead	$C_p = e^{[0.541 * \ln(Cs)1.328]} * (1-0.87)^{(b)}$	[R-133]	$C_b=C_{sed}*0.63$	[R-163]
Vanadium	$C_p = 0.00485*C_s * (1-0.87)^{(b)}$	[R-133]	$C_b=C_{sed}$	(a)

Zinc	$C_p = e^{[0.554*\ln(Cs)+1.575]} * (1-0.87)$ [(b)]	[R-133]	$C_b=C_{sed}*0.57$	[R-163]

Notes:
C_{sed} = concentration in sediment (mg/kg) ; C_p = concentration in plants (mg / kg ww); C_b = concentration in benthos (mg /kg ww)
[(a)] Assumed in the absence of available references.
[(b)] Uptake equation converted from dw of tissue to ww of tissue assuming a vegetation (emergent macrophytes) moisture content of 87% [R-108]

The resulting food concentrations are provided in Table 32 and Table 33 for aquatic food items:

Table 32
COPC Concentrations Modelled in Aquatic Plants

COPC	Maximum Sediment Concentration (mg/kg)			Aquatic Plant Concentration (mg /kg ww) [(a)]		
	EDD	FSL	B31 Pond	EDD	FSL	B31 Pond
Cadmium	-	2	-	-	0.12	-
Lead	-	50	-	-	0.29	-
Vanadium	100	-	-	0.21	-	-
Zinc	390	-	360	17.1	-	16.4

Notes:
"-" Parameter not a COPC for assessed area
(a) Converted from dw to ww assuming a percent moisture of 87% in emergent aquatic vegetation based on [R-108]

Table 33
COPC Concentrations Modelled in Benthic Invertebrates

COPC	Maximum Sediment Concentration (mg/kg)			Benthic Invert Concentration (mg /kg ww)		
	EDD	FSL	B31 Pond	EDD	FSL	B31 Pond
Cadmium	-	2	-	-	6.8	-
Lead	-	50	-	-	31.5	-
Vanadium	100	-	-	100	-	-
Zinc	390	-	360	222.3	-	205.2

Notes:
"-" Parameter not a COPC for assessed area

2.3.6.3 Toxicological Benchmarks for Aquatic Life

Toxicological benchmarks selected for aquatic life are presented in Table 34.

Metals

The CCME Interim Sediment Quality Guidelines (ISQGs) and Probable Effect Levels (PELs) were derived using a modified National Status and Trends Program (NSTP) approach [R-142]. The NSTP approach utilizes North American field-based studies with co-occurring chemical and biological effects data. Acceptable data was compiled into a database referred to as the Biological Effects Database for Sediments (BEDS). The BEDS differentiates the data into measured concentrations associated with observed biological effects and measured concentrations associated with no biological effects. For each chemical, a threshold effect level (TEL) and probable effect level (PEL) is calculated. The TEL is calculated as the square root of the geometric mean of the lower 15th percentile concentration of the effect data set and the 50th percentile concentration of the no-effect data set. Safety factors are applied to the TEL if the uncertainty associated with the TEL is high. The PEL is calculated as the square root of the geometric mean of the 50th percentile concentration of the effect data set and the 85th percentile concentration of the no-effect data set. The TEL and PEL represent three ranges of concentrations: those that are rarely associated with biological effects (i.e., <TEL), those that are occasionally associated with biological effects (i.e.,>TEL<PEL), and those that are frequently associated with biological effects (i.e., >PEL) [R-142]. The TEL and PEL represent three ranges of concentrations: those that are rarely associated with biological effects (i.e., <TEL), those that are occasionally associated with biological effects (i.e.,>TEL<PEL), and those that are frequently associated with biological effects (i.e., >PEL) [R-142].

Given that sediment COPCs were only identified within the on-site drainage features, the toxicological benchmarks for sediment were adopted from the CCME PELs. These protection levels were appropriate given that these areas are man-made features surrounded by industrial operations, and that they do not support any fish SAR.

BTEX and PHCs

Atlantic Partnership in RBCA Implementation (PIRI) has developed total petroleum hydrocarbon (TPH) sediment criteria [R-184]. These criteria are provided as products, including gas, diesel, and lube oil. Ecological screening levels were developed based on PETROTOX and equilibrium partitioning model. PETROTOX was used to derive surface water criteria protective of plants, invertebrates, and fish. The equilibrium partitioning model was then applied to derive sediment criteria with the assumption that the toxicity of a chemical in sediment is the result of chemical concentrations in the aqueous phase. The partitioning of the organic is a function of the carbon-water partitioning coefficient (Koc) and the sediment's fraction of organic carbon (foc), where a default Foc of 0.01 was assumed.

Guidelines are derived for two sediment categories: 1) "Typical" where sediment is used to support sensitive components of aquatic ecosystems such as fish spawning and intertidal zones that are important for the preservation of fish and wildlife; and 2) "Other" for sediments not classified as “typical” such as ditches and industrial-influenced receiving areas. The “other” guidelines were applied given that sediment COPCs were only identified within the on-site drainage features, which are man-made features surrounded by industrial operations, and that they do not support any aquatic SAR.

Table 34
Toxicological Benchmarks for Sediment for Aquatic Life

COPC	Toxicological Benchmark (mg/kg)	Source
Copper	197	CCME PEL [R-185]
Mercury	0.49	CCME PEL [R-186]
Selenium	None Identified	-
Vanadium	None Identified	-
Zinc	315	CCME PEL [R-187]
Toluene	6.1	Atlantic PIRI – “Other” [R-184]
PHC F3	112	Atlantic PIRI – “Other” [R-184] Based on diesel
PHC F4	192	Atlantic PIRI – “Other” [R-184] Based on oil/lube

2.3.6.4 Toxicity Reference Values for Semi-Aquatic Wildlife

The selected TRVs for semi-aquatic wildlife from sediment COPCs are provided in Table 35 and Table 36 and were selected based on the same approach as soil as discussed in Section 2.3.5. The TRVs are based on soil exposures, which have been used as a surrogate to sediment.

Table 35
Selected Toxicity Reference Values for Mammals

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
Cadmium	0.77	7.7	[R-141] [R-171]	Chronic NOAEL of 0.77 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species. The corresponding LOAEL is 7.7 mg/kg-d
Lead	4.7	8.9	[R-141] [R-188]	Chronic NOAEL of 4.7 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from

Table 35
Selected Toxicity Reference Values for Mammals

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
				multiple studies and species. The corresponding LOAEL for the study representing the NOAEL is 8.9 mg/kg-d
Vanadium	4.16	8.31	[R-141] [R-189]	Chronic NOAEL of 4.16 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species. The corresponding LOAEL is 8.31 mg/kg-d
Zinc	75.4	171	[R-141] [R-173]	Geometric mean of chronic NOAEL or LOAELs for growth and reproduction from multiple studies and species (mouse, rat, sheep, pig, hamster and cattle).

Table 36
Selected Toxicity Reference Values for Birds (Also Surrogated to Herpetofauna)

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
Cadmium	2.1	2.1	[R-141] [R-174]	Represents the lowest 20% effect level (EC20) derived from dose-response curves from six studies. The six studies considered included data for four species (quails, chickens, pheasants, and mallard ducks) and three endpoints (juvenile growth, reproductive endpoints, and survival). The level of protection is consistent with a minimal to low effect, and is selected to represent both the NOAEL and LOAEL.
Lead	1.63	3.26	[R-141] [R-188]	Chronic NOAEL of 1.63 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival from multiple studies and species (chicken, mallard, kestrel, zebra finch and quail).The corresponding LOAEL is 3.26 mg/kg-d.
Vanadium	0.344	0.688	[R-141] [R-189]	Chronic NOAEL of 0.344 mg/kg-day is equivalent to the highest bounded NOAEL lower than the lowest bounded

Table 36
Selected Toxicity Reference Values for Birds (Also Surrogated to Herpetofauna)

COPC	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source	Description of Key Study(ies)
				LOAEL for reproduction, growth, or survival from multiple studies and species (chicken, duck and quail). The corresponding LOAEL is 3.26 mg/kg-d.
Zinc	66.1	297	[R-141] [R-173]	Geometric mean of chronic NOAEL or LOAELs for growth and reproduction from multiple studies and species (chicken, duck, turkey and quail).

2.3.7 Surface Water

2.3.7.1 Environmental Fate and Transport Considerations

The fate and transport of chemicals, including those identified as COPCs (metals in surface water), is governed by a series of complex reactions that incorporate organic and inorganic constituents that are present within the water column, and sediments. As a result, mineral solubility, which is largely dependent on variables such as pH, redox conditions, and dissolved concentrations of the key mineral compounds, can have a significant influence on the mobility of metals in the environment. Geochemical variables, such as pH and redox conditions, determine the speciation of the metals, which in turn determines the environmental and biological availability. The speciation, and therefore the fate and transport, of the metals have been considered in the EcoRA, including the expected behaviour of these chemicals in the terrestrial and aquatic environments. Considerations regarding the speciation, fate and transport of metals are summarized below.

Metals

The risk posed by metals in the environment is determined by the amount of biologically available metal (i.e., the free ion). Under the Free Ion Activity Model (FIAM), the toxicity of metals is considered to be controlled mainly by the availability of the metal in a biologically reactive form [R-176][R-190]. However, for most metals, a number of factors such as pH, redox conditions and the presence of reactive ligands govern the availability of free ions. As a result, the concentration of free metal ions is often a small percentage of the total dissolved concentration. Even where free or readily ionizable species are present in the water column, the presence of other competing ions can influence the potential toxicity of a metal in solution [R-191]. Therefore, the amount of biologically available metals in the water column is controlled by a number of factors that are usually specific to the body of water. For example, in the water column, the presence of competing ions, such as calcium and magnesium, can be preferentially consumed through uptake sites in the organism. The presence of organic ligands (e.g., humic and fulvic acids) and inorganic ligands (e.g., sulphides and iron/manganese hydroxides) can complex metals and reduce biological availability. As a result, the presence of high concentrations of essential elements for physiological functioning that compete for uptake (i.e., calcium and magnesium) or high concentrations of ligands that bind metals can result in a reduction in exposure to metals in the water column.

Uptake of metals by aquatic organisms can occur directly from water or indirectly through diet. In pelagic organisms such as fish, the major route of exposure is considered to be from the water column. Therefore, adsorption to respiratory surfaces has been identified as the major route of uptake for most metals. For most water column organisms, ingestion of metals has been considered a minor pathway of uptake, and the focus has been on those forms of metals taken up through the waterborne route. Metals in this form can interfere with respiration (usually through adsorption to gill surfaces, as can occur with aluminum and iron), or induce toxicity at the cellular level after being absorbed through respiratory, and sometimes dermal, surfaces as is the case for most divalent metals [R-175][R-176].

The behaviour of metals and their complexation with ligands in large measures explains the observed anomaly in many aquatic studies: the presence of high concentrations of metals, often well in excess of available criteria, and the concurrent lack of biological effects. Thus, while potential pathways of exposure may exist for aquatic organisms (and terrestrial organisms that feed upon them), there are factors that limit the bioavailability of the metals. As such, the bulk water or sediment concentration of a metal is not a particularly useful guide to the potential biological effects and often, the effect levels are much higher than predicted by conservative criteria [R-177]. The development of criteria to protect against adverse biological effects due to COPCs in water should therefore be based on measured biological impacts, rather than bulk concentrations that may be unreflective of the actual availability of the COPCs.

In aquatic environments, most metals will exist as a complex balance between free ions, that are biologically reactive, and complexed metals, that are generally biologically unavailable. The approach to completing the EcoRA has recognized the various pathways through which metals can affect biota. Therefore, exposure cannot be simply considered on the basis of the total concentrations of COPCs in water or sediment samples.

2.3.7.2 Chemical Specific Factors and Dietary Concentrations

The uptake equations used in the EcoRA are provided in Table 37 for aquatic food items for estimating bioconcentration from surface water.

Table 37
COPC Uptake Equations for Surface Water to Fish

COPC	Water to Fish	Source
Cadmium	$C_f = 907^* C_w$	[R-163]
Lead	$C_f = 0.09^* C_w$	[R-163]
Vanadium	$C_f = C_w$	(a)
Zinc	$C_f = C_w{}^*142$	[R-192]

Table 37
COPC Uptake Equations for Surface Water to Fish

COPC	Water to Fish	Source
Notes: Cw = concentration in water (mg/L) ; C_f = concentration in fish (mg / kg ww) (a) Assumed in the absence of available references.		

The resulting food concentrations are provided in Table 38 for aquatic food items.

Table 38
COPC Concentrations Modelled in Fish

COPC	Maximum SW Concentration (mg/L)			Fish Concentration (mg/kg-ww)		
	EDD	**FSL**	**B31 Pond**	**EDD**	**FSL**	**B31 Pond**
Cadmium	-	0.00009	-	-	0.082	-
Lead	-	0.0005	-	-	0.000045	-
Vanadium	0.021	-	-	0.021	-	-
Zinc	0.016	-	0.012	2.3	-	1.7
Notes: "-" Parameter not a COPC for assessed area						

2.3.7.3 Toxicological Benchmarks for Aquatic Life

The toxicological benchmarks for surface water were adopted from the CCME Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (long-term) in Table 39. The CCME CWQGs are derived based on long-term exposure studies on fish, amphibians, aquatic invertebrates, plants, and algae. Studies are selected based on reporting applicable low-effect level endpoints (i.e., preferably EC10/IC10, followed by NOAEC and LOAEC) and based on meeting minimum data quality requirements. A species sensitivity distribution curve is then created with the toxicity data to develop a relationship between the concentration of a substance and the percent of species affected. The concentration corresponding to the 5th percentile of affected species is selected as the CWQG. In the derivation of the guideline value, the influence of exposure and toxicity-modifying factors (ETMFs) (such as pH, temperature, hardness [Ca2+, Mg2+], organic matter, oxygen, other substances) is incorporated to the extent possible, provided that the scientific information to do so is available [R-130].

As the Deepwater Sculpin was identified as a species of special concern within Lake Huron, an additional analysis was completed with ammonia and zinc identified as COPCs for this waterbody. The lowest chronic toxicity value for fish used to derive the CCME CWQG was compared to the CCME CWQG:

The CCME CWQG for un-ionized ammonia incorporated four fish toxicity studies (*O. Nerka, Mykiss, L. Marcochirus and I. Puctatus*). All effect endpoint from these studies (62-d EC20, LOEC, 30-d IC20 and 7-d IC20) are above the derived CCME CWQG. The CCME CWQG for ammonia is therefore assumed to be protective of long-term effects to the Deepwater Sculpin [R-193].

- The CCME CWQG for zinc incorporated nine fish toxicity studies (J. floridae, C. bairdi, P. phoxinus, P. promelas, O.mykiss, S. trutta, P. williamsoni, S. fontinalis, O. clarkia pleuriticus, O. nerka, L. marcochirus and I. puctatus). All effect endpoint for these studies (100 day MATC, 30 day EC10, 150 day LC10, 10 week LC10, 7 day IC10, 30 day LC10, 28 day IC10, 58 day MATC, 90 day IC10, 24 week IC10, and 30 day MATC) were above the derived CCME CWQG. The CCME CWQG for zinc is therefore assumed to be protective of long-term effects to the Deepwater Sculpin [R-194].

In absence of CCME CWQGs, the MECP Aquatic Protection Values (APVs) were applied.

For iron and aluminum, the CCME CWQG is based on the 1987 derivation process, which has been replaced by the 2007 protocol [R-130]. Based on the 2007 protocol, ECCC developed Federal Environmental Quality Guidelines (FEQGs) in 2019/2021[R-195] that are relied upon in the EcoRA.

Table 39
Toxicological Benchmarks for Surface Water for Aquatic Life

COPC	Toxicological Benchmark (µg/L)	Source
Ammonia	0.016	CCME CWQG [R-193]
Aluminum	See note c	ECCC 2021 [R-196]
Copper	2[a]	CCREM 1987 [R-197]
Iron	604	FEQG 2019 [R-198]
Vanadium	20	MECP APV [R-10]
Zinc	See note b	CCME CWQG [R-194]

Notes:

'a - CWQG is depended on hardness, the average hardness measured within each water feature was used to calculate a Tier 2 screening criteria as follows:

COPC	CCME CWQG
	B31 Pond *Hardness = 80 mg/L*
Copper	2

'b - CWQG is depended on hardness, pH and DOC [CWQG = exp(0.947[ln(hardness mg·L$^{-1)}$] - 0.815[pH] + 0.398[ln(DOC mg·L^{-1})] + 4.625]. The average hardness and pH measured within each water feature and an assumed DOC value of 1 mg/L based on measured DOC concentrations in Lake Huron was used to calculate a Tier 2 screening criteria as follows:

COPC	CCME CWQG			
	Lake Huron *Hardness = 94 mg/L* *pH = 8.1*	**EDD** *Hardness = 230 mg/L* *pH = 8.0*	**B31 Pond** *Hardness = 80 mg/L* *pH = 7.7*	**FSL** *Hardness = 55 mg/L* *pH = 9.54*
Zinc	13.07	26	15.34	2.46

'c - CWQG is depended on hardness, pH and DOC [CWQG = exp([0.645 x ln(DOC mg·L^{-1})] + [2.255 x ln(hardness)] + [1.995 x pH] + [-0.284 x (ln(hardness) x pH)] -9.898)]. The average hardness and pH measured within each water feature and an assumed DOC value of 1 mg/L based on measured DOC concentrations in Lake Huron was used to calculate a Tier 2 screening criteria as follows:

COPC	CCME CWQG		
	Lake Huron *Hardness = 94 mg/L* *pH = 8.1*	**EDD** *Hardness = 250 mg/L* *pH = 8.2*	**B31 Pond** *Hardness = 80 mg/L* *pH = 7.7*
Aluminum	426.34	425.61	318.10

Surface water pH is evaluated based on an acceptable range that is not expected to cause toxic effects to aquatic biota. According to the US EPA [R-199], a pH range of 6.5 to 9 is protective of freshwater biota. Fluctuating pH or sustained pH outside this range can physiologically stress many species and can result in decreased reproduction, decreased growth, disease or death. This can then cause reduced biological diversity in streams.

2.3.7.4 Toxicity Reference Values for Semi-Aquatic Wildlife

TRVs are required to evaluate an exposure dose from surface water ingestion by semi-aquatic wildlife. COPCs for surface water ingestion were identified based on sediment screening, as sediment exposures are considered the dominant exposure pathway. Therefore, the TRVs listed under 'Sediment' under Section 2.3.6.4 were applied.

2.4 Ecological Risk Assessment for Radiological Contaminants Methodology

2.4.1 Exposure Assessment

2.4.1.1 Terrestrial Exposure Point Concentrations

The dose rate to terrestrial biota is calculated based on the concentrations of radionuclides in air and soil. As per guidance in CSA N288.6, the on-site locations with the maximum measured radionuclide concentrations were used for the dose assessment. If the assessment results in a Hazard Quotients (HQ) close to or greater than 1, a more detailed examination of other locations would be required in a radiological DQRA; otherwise the use of locations with maximum measured radionuclide concentrations is deemed appropriate in concluding that there is no radiological risk to the respective representative biota.

Airborne concentration of carbon-14 is measured within the Site boundary. As shown in Figure 34, there are a total of 14 passive air samplers located across the Site, six of which are on the perimeter of the WWMF. The ecological risk to non-human biota resulting from airborne emissions from the WWMF is assessed in the WWMF ERA [R-2] and is excluded from this assessment. During the five-year period of 2016 to 2020, the maximum annual average concentration on the site excluding the immediate area around the WWMF was measured in 2020 at location C11-PC, which is north of Bruce A. The maximum annual average concentration of carbon-14 in air was 989.5 Bq/kg C, which corresponds to a background-corrected concentration of 0.1635 Bq/m^3.

Using the annual carbon-14 emission data and the on-site measurements of carbon-14 in air, a Dilution Factor (DF) for carbon-14 was calculated for Bruce A radiological emissions, which is the dominant contributor to exposure at C11-PC given the close proximity to the receptor location. Assuming this dilution factor applies to the dispersion of tritium, and assuming that all other sources of airborne emissions on the Site have a negligible effect on the concentration at location C11-PC compared to Bruce A, the concentration of tritium at location C11-PC was determined using the following equation:

$$C_{\text{HTO,C\#11}} = A_{\text{HTO,Bruce A}} \times \frac{C_{\text{C-14,C\#11}}}{A_{\text{C-14,Bruce A}}}$$

Where:

$A_{\text{HTO,Bruce A}}$	is the release rate of tritium from Bruce A (Bq/s)
$C_{\text{C-14,C\#11}}$	is the measured concentration of carbon-14 in air at C11-PC(Bq/m^3)
$A_{\text{C-14,Bruce A}}$	is the release rate of carbon-14 from Bruce A (Bq/s)

This calculation was performed for each year from 2016-2020, and the maximum concentration of tritium in air at location C11-PC was calculated to be 58 Bq/m^3.

In the fall of 2019, a sampling campaign was conducted to analyze the gamma-emitter radioactivity in soil at 15 locations on or near the Site (see Figure 35). Sampling location selection took into consideration the predominant wind directions with respect to Bruce A and Bruce B, as well as proximity to both stations. Further discussion of the selection of these locations is provided in Appendix N.

Excluding cesium-137 and naturally occurring radionuclides (potassium-40, beryllium-7, and the progenies of radon, uranium and thorium), all radionuclides measured were below critical levels. The radionuclides cobalt-60, cesium-134 and iodine-131 were not detected. Therefore, cesium-137 was the only gamma emitter identified above critical levels. The concentration of cesium-137 ranged from 0.517 Bq/kg dw to 30.92 Bq/kg dw, with an average concentration of 6.013 Bq/kg-dw (see Appendix N). For comparison, the provincial average for cesium-137, which is based on samples taken from Cobourg, Goderich and Lakefield analyzed every 5 years, was measured to be 5.39 Bq/kg-dw in 2017. The maximum concentration was measured at SS05, which is south of Bruce A and northeast of Bruce B. For the purpose of a bounding ecological risk assessment, it is assumed that all terrestrial biota are exposed to soil with the maximum background-subtracted on site concentration (25.53 Bq/kg-dw).

Since concentrations in deer tissue are measured from road kill samples, the maximum concentrations of tritium and carbon-14 from 2016 to 2020 were used directly in the assessment of internal dose to large mammals.

The IMPACT model was used to determine the following remaining exposure point concentrations in the terrestrial environment based on maximum annual emissions from the Site from 2016-2020:

- Iodine (mfp) in soil (Bq/kg);
- Plutonium-239 in soil (Bq/kg); and
- Noble gases in air (Bq/m^3).

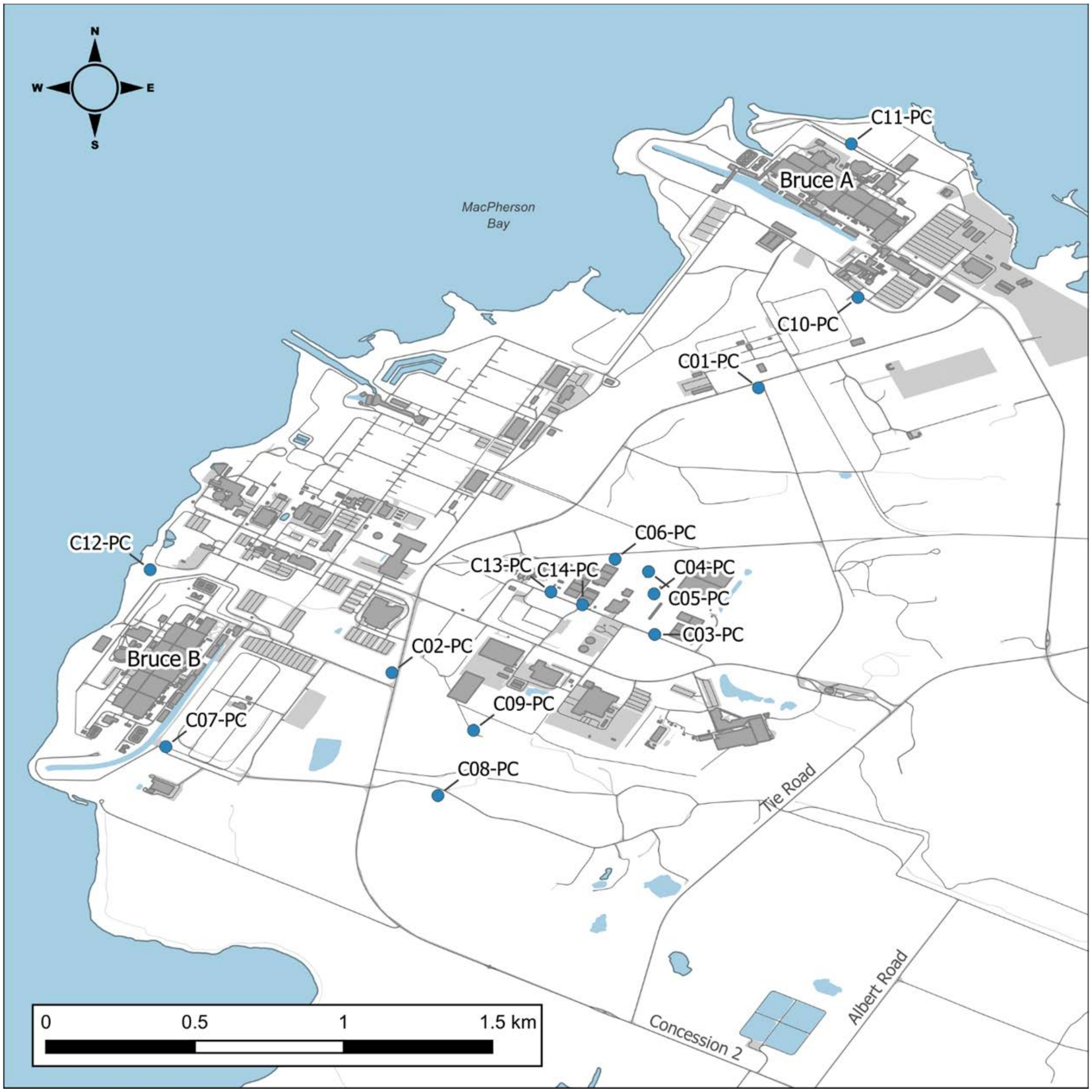

Figure 34
Locations of Carbon-14 Passive Air Samplers on Site (C01-C14)

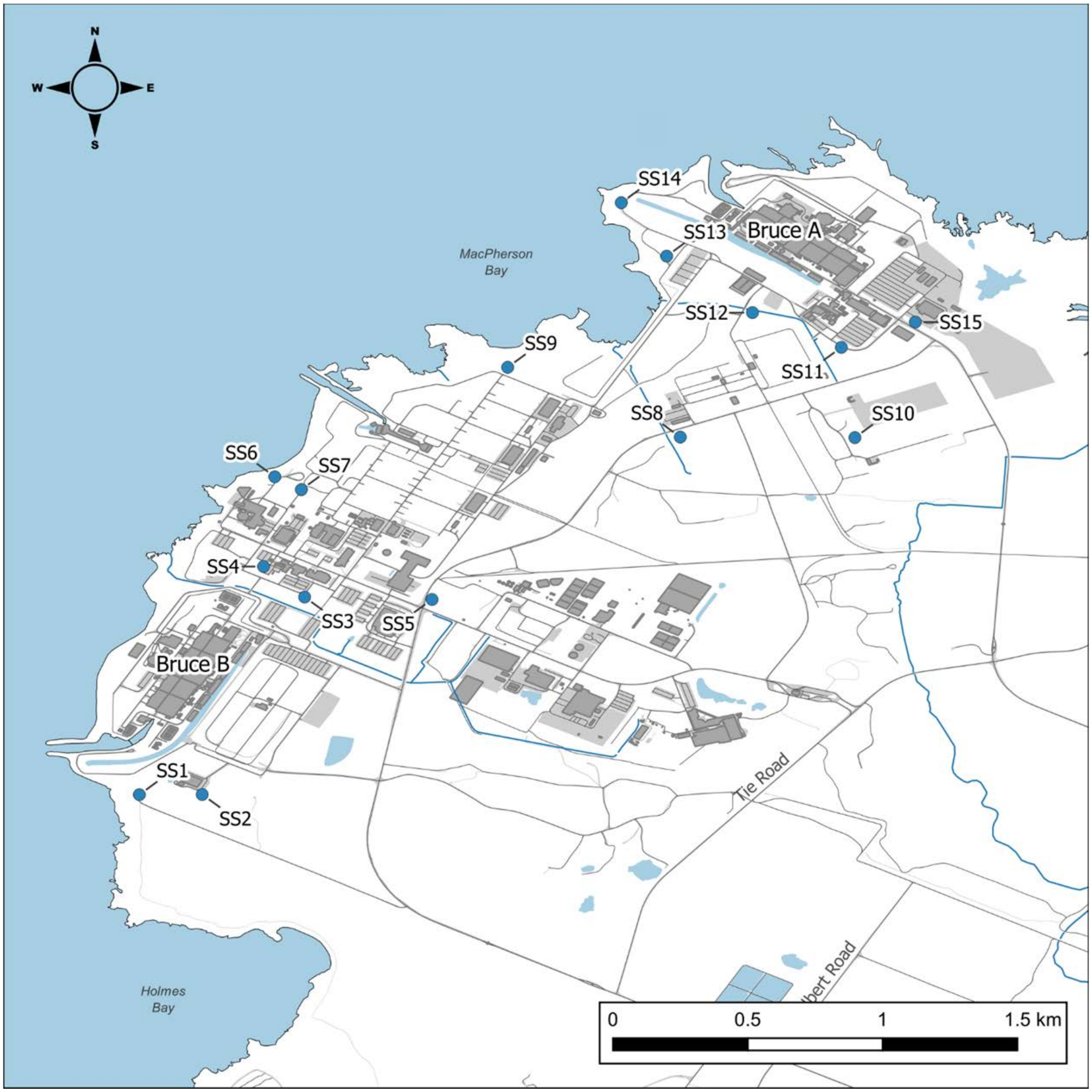

Figure 35 2019 Soil Sampling Locations (SS1 – SS15)

2.4.1.2 Terrestrial Exposure Equations

For each radionuclide considered in the EcoRA, the radiation dose was calculated for terrestrial biota using the equations shown below, following the guidance provided in CSA Standard N288.6 [R-5]. For the internal dose to terrestrial biota, Concentration Ratios (CRs) were used to correlate the tissue concentration to the concentration in air, water, sediment or soil. All CRs, dose coefficients, and occupancy factors were obtained from the tables provided in the ERICA Tool [R-200].

Alpha dose calculations utilize the bounding CR among all potential alpha radionuclides, in order to conservatively manage uncertainty associated with representative radionuclide selection.

Radiation Dose Calculations for Terrestrial Organisms

$$D_{\text{int}} = DC_{\text{int}} C_t$$

$$D_{ext,s} = DC_{ext,s} OF_s C_s$$

$$D_{ext,ss} = DC_{ext,ss} OF_{ss} C_{ss}$$

$$D_{ext,a} = DC_{ext,a} OF_a C_a$$

$$D = D_{\text{int}} + D_{ext,s} + D_{ext,ss} + D_{ext,a}$$

Where:

D_{int} = internal radiation dose ($\mu Gy \cdot h^{-1}$)
$D_{ext,s}$ = external radiation dose in soil ($\mu Gy \cdot h^{-1}$)
$D_{ext,ss}$ = external radiation dose on soil surface ($\mu Gy \cdot h^{-1}$)
$D_{ext,a}$ = external radiation dose in air due to noble gas ($\mu Gy \cdot h^{-1}$)
DC_{int} = dose coefficient for radionuclide in tissue ($\mu Gy \cdot h^{-1} \cdot Bq^{-1} \cdot kg$)
$DC_{ext,s}$ = dose coefficient for radionuclide in soil ($\mu Gy \cdot h^{-1} \cdot Bq^{-1} \cdot kg$)
$DC_{ext,ss}$ = dose coefficient for radionuclide on soil surface ($\mu Gy \cdot h^{-1} \cdot Bq^{-1} \cdot m^2$)
$DC_{ext,a}$ = dose coefficient for radionuclide (noble gas) in air ($\mu Gy \cdot h^{-1} \cdot Bq^{-1} \cdot m^3$)
OF_s = fraction of time spent immersed in soil (unitless)
OF_{ss} = fraction of time spent on the soil surface (unitless) [R-51]
OF_a = fraction of time spent air (unitless)
C_t = whole body tissue concentration ($Bq \cdot kg^{-1}$ *fw*)
C_s = soil concentration ($Bq \cdot kg^{-1}$ *dw*)
C_{ss} = surface soil concentration ($Bq \cdot m^{-2}$)
C_a = air concentration of noble gas ($Bq \cdot m^{-3}$)

As specified in the ERICA Tool, internal dose coefficients for low-energy beta and alpha radiation were scaled by factors of 3 and 10, respectively, to account for the increased relative biological effectiveness (RBE) of low energy beta particles and alpha particles [R-201].

The tritium CRs implemented in the ERICA Tool for terrestrial biota account for both HTO and Organically Bound Tritium (OBT) in determining the total tritium in the tissue of biota exposed to HTO in environmental media [R-202]. Furthermore, the methodology used for deriving tritium dose coefficients is based solely on the energy emitted by tritium decay, and is independent of factors such as biological half-life which may be influenced by chemical form. Therefore, no additional consideration of OBT dose is required for determining total tritium dose to biota exposed to environmental HTO.

For large mammals, the calculation of total tritium dose is based solely on measurements of HTO in deer tissue. Based on review of the derivation of tritium CRs in FASSET D5 [R-203], the OBT/HTO ratio for large mammals is approximately 0.48-0.49. Therefore, a factor of 1.5 is applied to the calculated HTO dose to large mammals in order to account for OBT. Based on these approaches, OBT in biota tissue is considered in the dose assessment, and direct measurement of OBT in animal tissue is not required.

For large mammals, the calculation of total tritium dose is based solely on measurements of HTO in deer tissue. Based on review of the derivation of tritium CRs in FASSET D5 [R-203], the OBT/HTO ratio for large mammals is approximately 0.48-0.49. Therefore, a factor of 1.5 is applied to the calculated HTO dose to large mammals in order to account for OBT.

The specific equations used to calculate the internal dose from HTO are shown below, for cases of whether:

1. No tritium concentrations in tissue are available;

2. Concentrations of HTO in tissue, but not OBT in tissue, are available; or

3. Concentrations of both HTO and OBT in tissue are available.

Internal Dose Due to Tritium (No Measured Concentrations of Tritium in Tissue)

$$D_{\text{int}\,tritium} = (DC_{\text{int}\,low\beta} W_{low\beta} + DC_{\text{int}\,\beta}) C_m CR$$

$DC_{\text{int}\,low\beta}$	=	low energy beta dose coefficient for H-3 in tissue (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{\text{int}\,\beta}$	=	beta dose coefficient for H-3 in tissue (µGy•h^{-1}•Bq^{-1}•kg)
C_m	=	concentration of HTO in environmental media (Bq/m^3 air or Bq/L water)
CR	=	concentration Ratio (tritium in tissue Bq/kg per unit tritium concentration in environmental media)
$W_{low\beta}$	=	weighting factor of 3 for low energy beta (unitless)

Internal Dose Due to Tritium (Measurements of HTO in Tissue Available, No Measurements of OBT in Tissue)

$$D_{\text{int}\,tritium} = (DC_{\text{int}\,low\beta} W_{low\beta} + DC_{\text{int}\,\beta}) C_m CR \cdot F_{OBT}$$

$DC_{\text{int}\,low\beta}$	=	low energy beta dose coefficient for H-3 in tissue (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{\text{int}\,\beta}$	=	beta dose coefficient for H-3 in tissue (µGy•h^{-1}•Bq^{-1}•kg)
C_m	=	concentration of HTO in environmental media (Bq/m^3 air or Bq/L water)
CR	=	concentration Ratio (tritium in tissue Bq/kg per unit tritium concentration in environmental media)
$W_{low\beta}$	=	weighting factor of 3 for low energy beta (unitless)
F_{OBT}	=	factor of 1.5 to account for additional 50% dose from OBT for large mammals (unitless)

Internal Dose from Tritium (Measurements of HTO and OBT in Tissue are Available)

$$D_{\text{int}\,tritium} = (DC_{\text{int}\,low\beta} W_{low\beta} + DC_{\text{int}\,\beta}) C_{t,HTO} + (DC_{\text{int}\,low\beta} W_{low\beta} + DC_{\text{int}\,\beta}) C_{t,OBT}$$

$DC_{\text{int}\,low\beta}$	=	low energy beta dose coefficient for H-3 in tissue (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{\text{int}\,\beta}$	=	beta dose coefficient for H-3 in tissue (µGy•h^{-1}•Bq^{-1}•kg)
$C_{t,HTO}$	=	whole body tissue concentration of HTO (Bq•kg^{-1} *fw*)
$C_{t,OBT}$	=	whole body tissue concentration of OBT (Bq•kg^{-1} *fw*)
$W_{low\beta}$	=	weighting factor of 3 for low energy beta (unitless)

2.4.1.3 Aquatic Exposure Point Concentrations

The dose rate to aquatic biota is calculated based on the concentrations of radionuclides in surface water and sediment. As per guidance in CSA N288.6, the on-site locations with the maximum measured radionuclide concentrations were used for the dose assessment. If the assessment results in a Hazard Quotients (HQ) close to or greater than 1, a more detailed examination of other locations would be required in a radiological DQRA; otherwise the use of locations with maximum measured radionuclide concentrations is deemed appropriate in concluding that there is no radiological risk to the respective representative biota.

The locations included in the assessment are Baie du Doré, which is the Lake Huron location with the highest concentrations of radionuclides, as well as the Former Sewage Lagoon, which is the on-site waterbody with the highest concentrations.

In the Baie du Doré, the following measurements are taken as part of environmental monitoring:

- HTO in surface water and fish (Bq/L);
- Carbon-14 in fish (Bq/kg-C);
- Gamma emitters (Cobalt-60, Cesium-134, Cesium-137) in fish and sediment (Bq/kg);

Doses were calculated based on the maximum of the average radionuclide concentrations measured in 2016-2020. As discussed in Section 5.1.3 of the ERA [R-22], only Cesium-137 has been measured above detection limits in sediments and fish samples, therefore Cesium-137 is chosen as the sole beta/gamma-emitting radionuclide for the ecological risk assessment.

The concentration of carbon-14 in surface water was calculated using the concentrations in fish, which are measured as part of environmental monitoring:

$$C_{C-14,water} = \frac{C_{C-14,fish}}{CR_{a,w}}$$

Where:

$C_{C-14,fish}$	is the maximum measured concentration of carbon-14 in fish (Bq/kg)
$CR_{a,w}$	is the concentration ratio for aquatic animals (i.e., fish) and surface water as defined in CSA Standard N288.1 (5,700 L/kg)

The maximum average background-subtracted Cs-137 concentration in Baie du Doré sediment was used in the assessment (1.45 Bq/kg-dw, 2019). The concentration of alpha-emitting radionuclides (curium-244) in water at Baie du Doré was determined using the IMPACT model.

Since concentrations of HTO, OBT, carbon-14, and cesium-137 in fish tissue are measured for both pelagic and benthic fish in Baie du Doré, these concentrations are used directly in the assessment of internal dose to fish.

The highest annual average values of background-subtracted measurements of radionuclides in fish from 2016-2020 were conservatively used in the assessment. For HTO, the highest measured average values were 11.74 Bq/kg-fw (Benthic Fish, 2017) and 3.90 Bq/kg-fw (Pelagic Fish, 2018). For OBT, these were 3.34 Bq/kg-fw (Benthic Fish, 2016) and 0.63 Bq/kg-fw (Pelagic Fish, 2018). For carbon-14, these were 1.08 Bq/kg-fw (Benthic fish, 2019) and 0.37 Bq/kg-fw (Pelagic fish, 2019). For cesium-137, these were 0.095 Bq/kg-fw (Benthic fish, 2019) and 0.27 Bq/kg-fw (Pelagic fish, 2016).

For on-site waterbodies, measurements of HTO in water are taken at several sampling locations including Stream C, the B31 Pond, South Railway Ditch, and the Former Sewage Lagoon (FSL) (Appendix N). The maximum HTO concentration was found in the FSL location in 2021 measuring 655 Bq/L, therefore this was used as the bounding value in the dose calculation. Measurements of C-14 and alpha emitters in water were not available, therefore concentrations were modelled in IMPACT based on airborne emissions and deposition to the FSL. For alpha emitters, Pu-239 was used as the representative radionuclide, as this was used for all airborne emissions. These methods generally lead to overestimating the results, thereby ensuring a conservative approach.

Additional sampling of the FSL, Stream C, South Railway Ditch, the B31 Pond, and B16 Stormwater Pond was undertaken in 2021. This additional sampling confirmed that the FSL was the bounding on-site waterbody for tritium concentrations, and provided data on gamma emitters in sediment. The maximum measured concentration of cesium-137 in FSL sediment was found to be 134 Bq/kg; this value was conservatively used in the dose calculation.

Concentrations of cesium-137 in water at the FSL were calculated based on solid-liquid distribution coefficients, as described in Section 5.2.3 of the ERA [R-22].

2.4.1.4 Aquatic Exposure Equations

For each radionuclide considered in the EcoRA, the radiation dose was calculated for both aquatic and terrestrial biota using the equations shown below, following the guidance provided in CSA Standard N288.6-12 [R-5]. For the internal dose to aquatic and terrestrial biota, CRs were used to correlate the tissue concentration to the concentration in air, water, sediment or soil. All CRs, dose coefficients, and occupancy factors were obtained from the tables provided in the ERICA Tool [R-200].

Alpha dose calculations utilize the bounding CR among all potential alpha radionuclides, in order to conservatively manage uncertainty associated with representative radionuclide selection.

Radiation Dose Calculation for Aquatic Organisms

$$D_{\text{int}} = DC_{\text{int}} C_t$$

$$D_{ext} = DC_{ext}\{(OF_w + 0.5\,OF_{ws} + 0.5\,OF_{ss})\,C_w + (OF_s + 0.5\,OF_{ss})\,C_s\}$$

$$D = D_{\text{int}} + D_{ext}$$

Where:

D	=	total radiation dose (µGy)
D_{int}	=	internal radiation dose (µGy•h^{-1})
D_{ext}	=	external radiation dose (µGy•h^{-1})
DC_{int}	=	dose coefficient for radionuclide in tissue (µGy•h^{-1}•Bq^{-1}•kg)
OF_s	=	fraction time spent immersed in sediment (unitless)

OF_{ss} = fraction of time spent on the sediment surface (unitless)
OF_w = fraction of time spent in the water column (unitless)
OF_{ws} = fraction of time spent on the water surface (unitless)
C_t = whole body tissue concentration (Bq•kg^{-1} *fw*)
C_w = water concentration (Bq•L^{-1})
C_s = sediment concentration (Bq•kg^{-1} *fw*)

As specified in the ERICA Tool, internal dose coefficients for low-energy beta and alpha emitters were scaled by factors of 3 and 10, respectively, to account for the increased relative biological effectiveness (RBE) of low energy beta particles and alpha particles [R-201].

The tritium CRs implemented in the ERICA Tool for aquatic biota account for both HTO and Organically Bound Tritium (OBT) in determining the total tritium in the tissue of biota exposed to HTO in environmental media [R-202]. Furthermore, the methodology used for deriving tritium dose coefficients is based solely on the energy emitted by tritium decay, and is independent of factors such as biological half-life which may be influenced by chemical form. Therefore, no additional consideration of OBT dose is required for determining total tritium dose to biota exposed to environmental HTO.

Dose equations for internal dose due to tritium are listed in Section 2.4.1.2 above. For the majority of aquatic biota, no measurements of radionuclide levels in biota tissue are available, therefore concentrations are calculated using concentration ratios. For tritium, these account for both HTO and OBT. For benthic and pelagic fish in Baie du Doré, measurements of HTO and OBT are available. These are incorporated directly in the calculation of dose for these receptors.

3.0 APPENDIX C: IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

3.1 Summary of Data Relied Upon in the 2022 ERA

Environmental monitoring completed across the site since 2000 (e.g., air, soil, groundwater, surface water, sediment, and drinking water) were considered in the 2022 ERA. For the 2017 ERA, over 300 environmental reports were reviewed and data from 2000 to 2016 was compiled. The 2022 ERA builds on this assessment by considering additional data from 2017 to 2022.

To focus the preliminary chemical screening in the 2022 ERA on those source-pathway-receptor linkages that are complete, the analytical dataset compiled considered the following with respect to human health and ecological exposures.

3.1.1 Human Health Data Considerations

Given that the HHRA focused on health risks for off-site receptors, the data relied upon for the HHRA for chemicals included off-site environmental quality data for the following environmental media:

- Bruce A and Bruce B surface water discharges;
- Air emissions;
- Surface water from various locations off-shore in Lake Huron; and,
- Drinking water from shallow residential wells and nearby water treatment plants.

There is an Indigenous Spirit Site on-site that is occasionally visited by members of Indigenous communities. The Spirit Site is located on OPG-retained lands and is therefore not within the scope of the 2022 ERA.

There is a groundwater well located near building B37 and the Bruce A switchyard, however this well does not supply drinking water and is only used for hand washing and toilet operation at B37. Members of the public do not have access to this non-potable groundwater well. Given that groundwater is not used on-site as a drinking water supply and is only used for hand-washing at B37, exposure to humans via ingestion is an incomplete exposure pathway. Any dermal exposures from hand washing are considered negligible and are not further evaluated.

Surface water quality from Lake Huron for the HHRA was screened against drinking water quality guidelines to assess exposures during recreational activities.

3.1.2 Ecological Data Considerations

Given that the EcoRA assessed environmental health risks for on-site receptors such as plants and soil invertebrates, aquatic communities (including fish, plants and invertebrates) and wildlife, the data relied upon in the EcoRA for chemicals included on-site data for the following environmental media:

- Surface soil (i.e., <1.5 mbgs);
- Shallow groundwater (i.e., <1.5 mbgs);
- Surface water; and,
- Sediment.

Off-site ecological receptors were considered to be exposed to lake surface water and sediment in Lake Huron.

The following was also considered for the 2022 EcoRA:

- The 2022 ERA is supported by environmental quality data collected since the 2017 ERA (i.e., from 2017 to 2021) for transient environmental media including Bruce A and Bruce B discharges, air, groundwater, surface water, sediment, and drinking water. This ensures that the assessment is reflective of current site conditions. The soil assessment relies on historical and recent data (i.e., data from 2000 to 2021) to account for updated assessment criteria not available for the 2017 ERA.
- Soil and groundwater analytical data collected from areas that represent viable ecological habitat or are adjacent to areas that represent viable ecological habitat were considered further as described in Section 1.3.1 and shown on Figure 4. Data collected from areas used for active industrial operations with no adjacent ecological habitat were not considered further.
- Surface water and sediment data collected from areas that represent aquatic habitat were considered as described in Section 1.8.1.
- Only surface soil (i.e., soil that was less than 1.5 mbgs) was retained for further consideration. This is a conservative depth at which terrestrial ecological receptors may be exposed to COPCs in soil and is in line with the MECP and CCME evaluation of soil exposure pathways for terrestrial ecological receptors [R-104][R-10].
- Only shallow groundwater (i.e., groundwater that was less than 1.5 mbgs) from on-site groundwater monitoring wells was retained for further consideration in the 2022 ERA, and only with respect to potential root uptake by terrestrial plants (i.e., groundwater sampling data used from locations with link to receptors). Groundwater discharge to surface water and subsequent effects to aquatic receptors were evaluated using surface water quality data. While surface water sampling locations did not always align with the exact groundwater discharge points in Lake Huron, it was reasonably assumed that given the significant dilution and dispersion of groundwater concentrations that would occur in a large surface water body such as Lake Huron, the surface water data would

be representative of concentrations found in the vicinity of these groundwater discharge points.

3.2 Applicable Screening Values

For Bruce A and Bruce B discharges to surface water and atmospheric emissions, COPCs were identified by comparing measured concentrations of chemicals to their respective site-specific limits established in the regulatory permits for the Site (i.e., as cited in the EMEL, ECA or ESDM reports).

For soil, groundwater, surface water, sediment and drinking water, site-specific regulatory limits were not available and as such, COPCs were identified by comparing measured concentrations of chemicals to preliminary and/or secondary benchmarks, which were selected as the more stringent of the provincial and federal standards (i.e., screening values).

The chemical data in Appendix E are shown next to applicable provincial and federal screening values. The most stringent/protective of these available screening values was adopted as the preliminary benchmark, which is consistent with the CSA Standard N288.6-12 [R-5]. In general, both federal and provincial guidelines were derived based upon the same principles: that the standards are set at levels that are protective of long-term exposure by the most sensitive receptor. Where different land use categories apply for preliminary screening criteria, the industrial land use value was used. Where standards/guidelines were available for different soil textures, the coarse texture value was used as a conservative measure given the varying soil types across the site.

The definition of "negligible risk" differs between federal and provincial regulatory agencies with respect to the assessment of cancer-causing substances for humans. Cancer is not considered to be an endpoint of concern for ecological receptors and is not considered when setting federal and provincial ecological guidelines. The province of Ontario defines a negligible cancer risk level to be a rate of one cancer case in a population of one million (or 1×10^{-6}), while Health Canada and Canadian Council of Ministers of the Environment (CCME) applies one in one hundred thousand (or 1×10^{-5}) as an acceptable target risk. Therefore, where federal guidelines were based upon the protection of human health due to carcinogenic endpoints, these federal guidelines were reviewed to confirm that they are protective of a cancer risk level of 1×10^{-6} to be consistent with Ontario, and adjusted as necessary. Three chemicals in soil were examined further: arsenic, benzene, and trichloroethylene. The CCME soil quality guideline factsheet provided for benzene [R-151] provides two sets of guidelines based upon 1×10^{-5} or 1×10^{-6} incremental lifetime cancer risk levels; the soil quality guideline based upon the more protective risk level was selected and used in the preliminary screening. For arsenic and trichloroethylene, the guideline was derived considering a target cancer risk level of 1×10^{-6}, and as such no further adjustment was required [R-156][R-204].

The specific federal and provincial guidelines considered in the selection of the preliminary screening values for each media are described below.

For the EcoRA, where chemicals exceed their respective preliminary benchmarks, the chemical was further screened against secondary benchmarks protective of specific ecological receptor groups and exposure pathways as discussed in Section 3.5.

3.3 Canadian Council Ministers of the Environment

The CCME Canadian Environmental Quality Guidelines (which include the Canadian Soil Quality Guidelines for the protection of Human Health [$CSQG_{HH}$] and the Canadian Soil Quality Guidelines for the protection of Ecological Health [$CSQG_{E}$]) represent an integrated set of national environmental quality guidelines for all environmental media (i.e., water, soil, sediment, tissue residue and air) designed to help evaluate the risk posed to the health of Canadians and the Canadian environment by chemicals at a site for four land use categories: agricultural, residential/parkland, commercial, and industrial [R-205].

The CCME Canadian Soil Quality Guidelines (CSQG) for the Protection of Environmental and Human Health for industrial land use [R-205] are based on the minimum of the soil direct contact pathways for plants and soil invertebrates, the energy and nutrient cycling pathway for microbes and the protection of freshwater life from groundwater leaching ($CSQG_{E}$), and for humans, the soil ingestion pathway, vapour intrusion of volatiles into indoor air and the protection of potable groundwater ($CSQG_{HH}$). Given that Canadian people are potentially exposed to up to five different media, including air, water, soil, food and consumer products, the soil quality guidelines apportion only 20% of the tolerable daily intake to soils. This allows for the remaining 80% of the remaining tolerable incremental exposure to be reserved for other media (i.e., food, air, water, and consumer products). The CCME notes that it is unlikely that soils containing a chemical at the guideline level will cause the total exposure from all media (air, water, food and soil), via all direct and indirect pathways, to exceed the tolerable daily intake [R-11]. The CCME notes that it is unlikely that soils containing a chemical at the guideline level will cause the total exposure from all media (air, water, food and soil), via all direct and indirect pathways, to exceed the tolerable daily intake [R-11]. For PHCs, 50% of the tolerable daily intake is applied for evaluating risk because only consumer products are considered to account for high background exposures to PHCs [R-161]. The CSQGs were used in the preliminary screening and the $CSQG_{E}$ were used in the secondary screening.

The CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG-PALs) provides both short-term and long-term water quality guidelines for freshwater environments [R-205]. The short-term freshwater guidelines are derived with severe effects data for short-term exposure periods, and their purpose is to give guidance on the impacts of severe but short-term situations. The long-term guidelines are intended to protect all forms of aquatic life for indefinite periods; these long-term guidelines were considered applicable for screening purposes. CCME Sediment Quality Guidelines for the Protection of Aquatic Life (CCME SEQG) are numerical guidelines derived for the protection of aquatic ecological receptors. The guidelines are divided into freshwater and marine water categories within which interim sediment quality guidelines (ISQGs) and probable effect levels (PELs) are provided. The ISQG and PEL represent the lower and upper range of concentrations respectively for sediment concentrations associated with adverse biological effects [R-142]. As a conservative approach, the ISQGs were used in the preliminary screening [R-205]. The ISQGs represent concentrations that are rarely associated with biological effects. The PELs were used in the secondary screening given the industrial nature of the permanent drainage ditches on-site that contained COPCs.

3.3.1 Health Canada

The Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ) are based on health effects, aesthetic effects and operational considerations for drinking water [R-206]. Health-based standards are listed as maximum acceptable concentrations and are established based on comprehensive review of known health effects, exposure levels and the availability of treatment and analytical technologies. If no health-based guideline was available for a given chemical, then an aesthetic objective or operational guideline was considered. Aesthetic objectives (i.e., taste and odour) are established based on whether people will consider the water drinkable. Operational guidelines are established based on levels that may interfere or impair water treatment processes or technology or adversely affect drinking water infrastructure.

3.3.2 Federal Contaminated Sites Action Program

The Federal Contaminated Sites Action Plan (FCSAP)'s Federal Interim Groundwater Quality Guidelines (FIGQGs) were established to help federal departments, agencies and consolidated Crown corporations address federal contaminated sites, to reduce environmental and human health risks as well as federal financial environmental liability associated with the higher risk federal contaminated sites. The FIGQG have been adopted from other jurisdictions, with some modifications; however, these guidelines have generally been developed using methods consistent with nationally approved protocols published by CCME. The FIGQGs were developed based on various land uses. For industrial land use they are based on consideration of several potential receptors and exposure pathways, including: groundwater transport to surface water at least 10 m from the contamination and subsequent exposure of freshwater and marine life; direct contact of soil organisms with contaminated groundwater; as well as migration of contaminant vapours to indoor air and subsequent inhalation by humans [R-207]. The Tier 1 FIGQG provides the lowest guideline of these pathways and were used in the preliminary screening. The pathway specific FIGQGs were used in the secondary screening.

3.3.3 Ontario Ministry of the Environment, Conservation and Parks

The Ontario Ministry of the Environment, Conservation and Parks (MECP) provides standards and guidelines for the province of Ontario under various ministerial names in recent years. For simplicity, the Ontario MECP is used to refer to previous ministerial names, including the Ministry of the Environment (MOE) and the Ministry of the Environment and Climate Change (MOECC).

The MECP Tables 1-9 Site Condition Standards (SCSs) are provided in the document "Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" [R-10]. For soil, groundwater, and sediment, the applicable SCS provided in Table 1 Full Depth Background Site Condition Standards for coarse-textured soils (Table 1 SCS) for industrial land use were considered in the preliminary screening. These standards were developed to protect against the potential for risks to human and ecological health in areas considered to be environmentally sensitive as defined by Ontario Regulation 153/04 [R-50]. Given the presence of endangered/threatened species both on the Site and in areas adjacent to the Site, in addition to elevated soil pH across many of the investigated areas of the Site, the use of Table 1 SCSs is considered to be applicable. The Table 1 SCSs are generally set as typical Ontario background concentrations for soil, concentrations in groundwater that are protective of both human ingestion and direct contact with aquatic life, and low-effect level concentrations in sediment. Note that for sediment, the Table 1 SCS for soil were considered applicable to use in the preliminary sediment screening where no other screening values were available.

The province of Ontario also provides drinking water standards applicable for the preliminary screening. The primary purpose of the Ontario Regulation (O.Reg.) 169/03 Ontario Drinking Water Standards (ODWS) is to protect public health through the provision of safe drinking water [R-9]. The standards are protective against unsafe concentrations of toxic metals, radioactive substances, and disease-causing organisms. Like the drinking water quality standards from Health Canada, ODWS are presented as maximum acceptable concentrations above which there are known or suspected adverse health effects. Standards can also be based on aesthetic objectives, including taste, odour, turbidity and colour, or operational guidelines, including corrosiveness, however, these were not selected as the preliminary benchmark in the preliminary screening.

The MECP Provincial Water Quality Objectives (PWQOs) are intended to be protective of aquatic life and recreational uses of surface waters [R-16]. While these objectives are intended for protection of aquatic life, it is considered that they are also protective of human and wildlife health because PWQOs are typically lower than drinking water guidelines and livestock watering guidelines. Given these guidelines are protective of overall exposure to humans and aquatic life, and cannot be further broken out to pathway specific values, they were only used in the preliminary screening. For soil, in the absence of the applicable preliminary screening values from CCME, FCSAP or MECP SCS, the MECP Ontario Typical Range concentrations (OTR_{98}) representing the 97.5th percentile concentrations of parameters in soil measured at locations throughout Ontario, were considered. These values are provided in the document “Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario” [R-10]. Land use categories include urban parks and rural parks. The values for old urban parks were used in the 2022 ERA given that the urban parks values are intended to be used for urban areas with known anthropogenic sources [R-10]. Note that the MECP Table 1 SCS were derived using the same approach as the OTR_{98} except that the OTR_{98} were initially derived in 1993, and the Table 1 SCS incorporate newer data points from supplemental sampling completed after 1993. Further, while these values are soil background concentrations, they were considered applicable to compare against sediment in the preliminary screening where no other screening values were available.

For groundwater, in the absence of the applicable preliminary screening values from CCME, Health Canada, FCSAP or MECP SCS, the MECP Ontario Background Groundwater Concentrations from the Provincial Groundwater Monitoring Information System (PGMIS) representing the 97.5th percentile concentrations of parameters in groundwater measured at locations throughout Ontario, were considered. These values are provided in the document "Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario" [R-10]. As with the OTR_{98} for soil, these values were adopted as the Table 1 SCS for groundwater unless effects-based values (e.g., based upon drinking water or migration of volatile substances to indoor air) were lower.

For the secondary screening for soil and groundwater, the MECP also provides ecological health soil and groundwater component values in their Modified Generic Risk Assessment "Approved Model" [R-208]. Table 2 and 8 component values are protective of a potable water scenario. While the Site obtains water from Lake Huron for drinking, there is a Hydro One groundwater well located near B37 that is used for hand washing and toileting purposes. Table 2 is applied to sites greater than 30 metres from a water body, and Table 8 is applied to sites within 30 metres of a water body. These component values contain effect-based criteria for soil, water and sediment quality that are protective of human and ecological health. For soil, the Table 2 and 8 component values are the same regardless of distance to water, and therefore, only the Table 2 component values were used. For groundwater, component values relevant for ecological health were derived based on aquatic protection values (APVs). The APVs were applied for secondary screening of groundwater for protection of shallow root update as the MECP considers these to be protective of terrestrial exposures [R-10].

For the secondary screening for sediment, the MECP provides severe effect levels (SELs) in the document "Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario" [R-209]. The SELs indicates a level of contamination that is expected to be detrimental to the majority of sediment-dwelling organisms and sediments exceeding the SEL are considered heavily contaminated. These SELs were considered for secondary screening given the industrial and degraded nature of the permanent drainage ditches on-site that contained COPCs.

3.3.4 Other Sources

As there are limited published sediment quality guidelines available, Thompson et al. (2005) provides lowest effect levels (LELs) and severe effect levels (SELs) concentrations using the closest observation method for several metals in the article "Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Milling Activities in Canada" [R-210]. These LELs and SELs were developed to determine the likelihood of adverse effects on benthic invertebrate communities, and it was determined that with the exception of chromium, the derived LELs were highly reliable. The SELs were considered to have low reliability in a uranium mining and milling context, and therefore as a conservative approach, they were not included in the screening. Therefore, for the preliminary screening, the LELs derived by Thompson et al. were considered as screening values.

3.4 Preliminary Chemical Screening

3.4.1 Bruce A, Bruce B and COS Discharges

3.4.1.1 Data Relied Upon

Surface water samples have been collected from multiple control points within the Bruce A, Bruce B and ancillary facilities under separate ECA and EMEL requirements for the Bruce A (ECA Number 0732-B2MKLY), Bruce B (ECA Number 6506-8VEKWT), and Centre of Site facilities (ECA Number 9809-9KXLEB). For the purpose of the 2022 ERA, only data pertaining to the Bruce A and Bruce B Condensing Cooling Water (CCW) and COS Sewage Treatment Plant (STP) discharge points are considered relevant, as they are the end-of-pipe discharge points for the facilities to Lake Huron. Ecological receptors would not be expected to come into contact with discharges within the facility before they reach end-of-pipe.

Data for Bruce A, Bruce B, and COS discharges and air emissions are summarized and reported in Environmental Compliance Approval (ECA) reports, Effluent Monitoring and Effluent Limits (EMEL) reports, and/or Wastewater Systems Effluent Regulations (WSER) reports. Table 40 and Table 41 below provide 5-year summaries to demonstrate typical discharge results in comparison to site-specific limits.

3.4.1.2 Screening Approach

As described above, the CCW discharge points of the Bruce A and Bruce B facilities have their own respective ECA limits. Appendix G provides an evaluation of the ECA limits to determine whether they are protective of human health and aquatic life. Over the last five years (2017 to 2021), there were no exceedances of the ECA limits established for the Bruce A and Bruce B CCW. Discharges from the COS STP (and their respective limits) are not unique to Bruce Power operations and are typical of sewage treatment discharges that routinely occur from small facilities across Canada. Some of the parameters in the COS STP discharges (ammonia, pH) are evaluated in Appendix G because they are included in the BA and BB CCW limits.

3.4.1.3 Results

A summary of the monthly measured concentrations from 2017 to 2021 for the Bruce A and B CCW compared to the ECA limits is provided in Table 40. No COPCs in the Bruce A and Bruce B discharges were retained for further assessment because maximum concentrations were below the ECA limits that are protective of the environment.

Table 40
Bruce A and Bruce B Condensing Cooling Water (CCW) Discharge Concentrations from Q1 2017 to Q4 2021

				Bruce A CCW		Bruce B CCW	
				Q1 2017 to Q4 2021		Q1 2017 to Q4 2021	
Parameter	**Units**	**Method Detection Limit (MDL)[a]**	**ECA Limit**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Ammonia (unionized)	µg/L	varies[b]	<20	<MDL	2.2	<MDL	0.8
Boron, (total as B)[c]	µg/L	4	5,000	<MDL	180	N/A	N/A
Hydrazine	µg/L	3	100	<MDL	20	<MDL	73
Morpholine	µg/L	15	2,500	<MDL	770	<MDL	<MDL
Total Residual Chlorine (TRC)	µg/L	1	<10	<MDL	<MDL	<MDL	<MDL
pH	—	—	6.0 to 9.5	7.0	8.4	6.8	8.5
Phosphorus[d]	*µg/L*	*5*	*1,000 [D]*	*<MDL*	*110*	*<MDL*	*54*

[a] Value shown is the current MDL (year 2022).

[b] Unionized ammonia (NH_3) is calculated from measurements of total ammonia (NH_3 + NH_4^+), temperature and pH (see section 3.4.5.2). The MDL for total ammonia is 10 µg/L, and the MDL for unionized ammonia will vary as it is dependent on temperature and pH.

[c] Boron additions are only performed at Bruce A

[d] Bruce A and Bruce B do not have ECA limits for Total Phosphorous, rather there is a 1,000 µg/L objective established for each facility.

A summary of the COS STP discharge concentrations from 2017 to 2021 compared to the ECA and WSER limits are provided in Table 41. No COPCs were retained for further assessment because maximum concentrations were below the site-specific limits that are protective of the environment. There was one exceedance of the biochemical oxygen demand from carbonaceous compounds (CBOD) that occurred in 2019. This had little-to-no impact on the receiving and no observed effect on aquatic biota in Lake Huron because there is significant dilution of the STP effluent as it is discharged into Lake Huron.

Table 41
Centre of Site (COS) Sewage Treatment Plant (STP)
Discharge Concentrations from Q1 2017 to Q4 2021

						Q1 2017 to Q4 2021	
Parameter	**Units**	**Method Detection Limit (MDL)**	**WSER Quarterly Avg. Limit**	**Daily ECA Limit**	**Monthly ECA Limit**	**Minimum**	**Maximum**
Biochemical Oxygen Demand (5-day) (BOD5)	mg/L	—	—	—	25.0	2.0	5.8
Nitrogen (Ammonia + Ammonium)	mg/L	0.006	—	—	7.000	0.011	5.420
Total Phosphorus	mg/L	0.014	—	—	1.000	0.120	0.499
Total Suspended Solids (TSS)	mg/L	0.4	—	44.0	18.0	5.4	12.5
Oil and Grease	mg/L	1.0	—	38.0	12.0	0.4	2.2
pH	—	—	—	6.0-9.5	—	6.1	8.2
E. coli	CFU/100 mL	—	—	—	200[b]	0	18.4
Carbonaceous Biochemical Oxygen Demand (CBOD)	mg/L	2.0	25.0	—	—	<MDL	62.4
Total Suspended Solids (WSER)	mg/L	2.0	25.0	—	—	<MDL	16.8
Acute Lethality	Pass/Fail[a]	—	—	—	—	Pass[c]	

[a] Pass = ≤ 50% mortality.
[b] Based on a rolling geometric mean of 5 samples.
[c] All quarterly toxicity tests for rainbow trout and *Daphnia magna* passed Q1 2017–Q4 2021.

3.4.2 Air

3.4.2.1 Data Relied Upon

Ground-level air concentrations at the Site boundary predicted in the 2017 to 2020 ESDM Reports [R-211]–[R-214] were relied upon to characterize concentrations of chemicals in air to which human receptors may be exposed via inhalation (refer to the main report Section 4.1.1.3 for discussions regarding ecological receptors).

3.4.2.2 Screening Approach

For air emissions, COPCs were identified by comparing measured concentrations of chemicals to their respective site-specific limits established in the regulatory permits for the Site (i.e., as cited in the EMEL, ECA or ESDM reports). The site-specific emission limits cited in the 2020 ESDM report were used for preliminary screening. Appendix H provides an evaluation of the MECP Point of Impingement (POI) limits used in the ESDM to determine whether they are protective of human health.

The following general screening approach was used to identify COPCs in air:

- If the maximum detected concentration was less than its site-specific limit, the chemical was not identified as a COPC. Comparison to these standards/objectives was considered to represent a conservative evaluation of the potential for risks to human health. Therefore, parameters with concentrations that were less than site-specific limits were considered to pose negligible risk to human health and were not retained for further assessment.
- If the maximum detected concentration was greater than its site-specific limit, the chemical was identified as a COPC and carried forward in the 2022 ERA for the assessment of potential risks to human health.

3.4.2.3 Results

The ESDM reports were prepared in support of the facility's ECA for Air (Certificate Number 7477-8PGMTZ) under O. Reg. 419/05. The objective of the ESDM reports was to demonstrate that the facility meets the MECP POI limits under O. Reg. 419/05. An ESDM report is required to be maintained at all times. A written summary is submitted annually to the MECP, including any modifications that would result in changes to the calculated concentration at the POI. The 2020 ESDM [R-211] was updated to include modifications to facility operations and shutdown of some facilities.

In brief, the atmospheric dispersion model used to estimate the POI concentrations at ground level at the facility's property line considered the rates at which chemicals could be emitted from each significant industrial source (e.g., stacks) when operating at their reasonable maximum capacity within the facility together with meteorological data for the area. Using these concentrations, compliance with the POI limits in Schedule 3 of O. Reg. 419/05 or other applicable guidelines was demonstrated.

The ESDM POI limits in Schedule 3 of O. Reg 419/05 are common with Ontario's Ambient Air Quality Criteria (AAQC). AAQCs are most commonly used in environmental assessments, special studies using ambient air monitoring data, and the assessments of general air quality in a community. The MECP can propose to include an AAQC in one of the Schedules and these changes are posted in the Environmental Bill of Rights (EBR).

The ESDM report is considered to be appropriate considering the objectives of the 2022 ERA, which are to assess potential health risks as a result of current operations at the Site for the purposes of identifying whether updated environmental conditions have changed since the 2017 ERA report, and to also inform ongoing monitoring. The ESDM reports focus on significant sources of emissions from the facility and use conservative assumptions in the dispersion model and emission rates. All predicted concentrations were less than their respective POI limits as shown in Table 42. The POI limits are described in further detail below the table.

Table 42 Emissions at Maximum Point of Impingement (MPOI) and Comparison to MECP POI Limits (2017-2021)

Contaminant	**Averaging Period** (h)	**Maximum POI Concentration** (μg/m^3)	**MOE POI Limit** (μg/m^3)	**Limiting Effect**	**Reg. Sch. No.**	**% of MOE POI Limit**
Ethyl Benzene	24	1.66E+00	1000	Health	3	0.2%
	10 min	4.61E+01	1900	Odour	G	2%
Nitrogen Oxides [1]	0.5	1.29E+03 ***	1880	-	EGC	68%
Nitrogen Oxides [2]	24	1.03E+02	200	Health	3	52%
	1	3.61E+02 ***	400	Health	3	90%
Morpholine	24	1.95E+01	200	Health	SL-JSL	10%
2-Butoxy Ethanol	10 min	4.61E+01	500	Odour	G	9%
	24	1.66E+00	2400	Health	G	0.07%
Butyl Acetate	1	1.17E+02	15000	Health	G	1%
	10 min	1.93E+02	1000	Odour	G	19%
Ferric Oxide	24	6.23E-01	25	Soiling	3	2%
Xylene	24	9.98E+00	730	Health	3	1%
	10 min	2.77E+02	3000	Odour	G	9%
Ethanolamine	24	1.46E+00	35	Health	SL-JSL	4%
Ethyl Acetate	1	1.68E+02	19000	Odour	G	1%
Hydrazine	24	1.69E-01	0.143	-	MGLC	≤ MGLC
	annual	2.14E-02+	-	-	-	-
Propylene Glycol	24	3.80E-01	120	Particulate	G	0.3%
Ethanol	1	1.93E+00	19000	Odour	G	0.01%
n-Butyl Alcohol	24	1.74E+00	920	Health	3	0.2%
	10 min	4.82E+01	2100	Odour	G	2%
Manganese	24	1.16E-01	0.4	Health	3	29%
Hexavalent Chromium	annual	3.34E-06 **	0.00014	Health	3	2%
Sulphur Dioxide	24	1.23E+01	275	Health & Vegetation	3	4%
	1	5.30E+01	690	Health & Vegetation	3	8%
Methylamine	24	1.59E+00	25	Odour	G	6%
Sodium Bisulphite	24	0.00E+00	120	Part. & Health	G	<0.01%
Hydrogen Chloride	24	8.01E-01	20	Health	3	4%
Ammonia	24	1.12E+01	100	Health	3	11%
Methyl Ethyl Ketone	24	3.04E+01	1000	Health	3	3%
Glycolic Acid	24	1.31E-02	20	Health	SL-JSL	0%
2-(2 aminoethoxyl)ethanol	24	3.31E-01	19	Health	SL-JSL	2%
Particulate Matter	24	1.31E+01	120	Visibility	3	11%

Mineral Spirits [3]	24	4.53E+01	2600	Health	3	2%
NOTE: This assessment was completed using AERMOD/AERMET version 19191. Table based on data provided from the 2017 to 2021 ESDM reports [R-211]–[R-215] [1] Nitrogen Oxides emissions from all significant combustion sources. [2] Nitrogen Oxides emissions from all significant non-emergency combustion sources. [3] Includes emissions from Aliphatic Naphtha (CAS #64742-88-7) and Stoddard Solvent (CAS #8052-41-3). **5-year annual average result was increased by a factor of 140% to account for potential variability between the overall 5-year annual average versus the maximum annual result per individual year. *** After removal of highest 8 hours per meteorological year. + Maximum annual (not average) concentration presented. Value was multiplied by 2 to provide flexibility. Reg. Sch. or Regulation Schedule: 3 Standard - Schedule 3 of Reg. 419 [R-216] G Guideline - Summary of Standards and Guidelines to support O.Reg.419: Air Pollution - Local Air Quality, April 2012 [R-216]. SL-** Screening Level-JSL, MD, PA, ACB List January 2018 (JSL) MGLC Maximum Ground Level Concentration as approved by the MOE for the facility for ECA No. 7477-8PGMTZ. EGC Emergency Generator Checklist limit, November 2010						

The limits used for each of the chemicals and averaging times above are protective of the most sensitive endpoint, which include but are not limited to health, odour, or corrosivity. Given that no concentrations were greater than their POI limits, no COPCs in air were identified and thus none were carried forward into the HHRA.

Following a recommendation in the 2015 ERA to further understand the concentration of Nitrogen Oxides (NOx) on Site, air monitoring was carried out in 2016. The MECP developed Ambient Air Quality Criteria (AAQCs) to assess general air quality resulting from all sources of a contaminant to air; the effects considered may be health, odour, vegetation, soiling, visibility, corrosion, and other effects. The 24-hour health AAQC for NO is 9,000 µg/m^3. The 1-hour health AAQC for nitrogen dioxide (NO_2) is 400 µg/m^3 (0.20 ppm) [R-216]. The World Health Organization (WHO) has a 1-hour guideline value of 200 µg/m^3 for NO_2. There is no AAQC or WHO guideline for nitrogen oxides (NOx); therefore, the 1-hour NO_2 averaging times should only be compared to monitored NO_2 data [R-217].

Ambient air quality sampling was conducted on site between July 8, 2016 and August 4, 2016 to measure NO, NO_2 and NOx. Significant sources of NO, NO_2 and NOx (i.e., emergency diesel generators) were run various times throughout the sampling period. The maximum hourly NO concentration during the sampling period was 110 µg/m^3 resulting in 4.58 µg/m^3 if averaged over a 24 hour period [R-218]. This is well below the 24-hour health AAQC for NO of 9,000 µg/m^3. The maximum NO_2 during the sampling period was 0.07 ppm which is well below the AAQC 1-hour NO_2 limit of 0.20 ppm. Given that the results of the sampling conducted on site were below the AAQC limits, it is anticipated that the concentrations of NO and NO_2 at a receptor would also fall below the AAQC limits as the distance from significant sources would be greater. The measured values did not reach the limit; therefore, it was screened out.

The maximum POI concentration for NOx (0.5 hr averaging period) of 1,290 µg/m^3 for emergency generators in the 2020 ESDM Report is a result of modelling the worst-case scenario and is not reflective of actual operation of emergency generators.[R-211] The emergency generator checklist limit provides more flexibility for safety system testing of emergency diesel generators (i.e. Bruce A and B Standby Generators, Qualified Power Systems and Emergency Power Generators) to prove availability and reliability provided certain criteria is met.

An assessment of acrolein emissions had been completed previously for the site encompassing future construction activities [R-219]. The assessment, which was based on a conservative background concentration of acrolein, predicted the maximum 1-hour ambient air concentration of acrolein would be below the MECP Ambient Air Quality Criteria (AAQC) of 4.5 µg/m^3. The acrolein assessment also predicted that the 24-hour MECP AAQC of 0.4 µg/m^3 is not likely to be exceeded, except for a single receptor located on the DGR site. As this location is within the fence line, the AAQC does not apply. Further, for the 24-hour averaging period, the background is a larger contributor to the total predicted concentration than the modelled concentration resulting from proposed construction activities.

Ambient air monitoring data from Environment Canada (National Air Pollution Surveillance) for three urban locations in Ontario, from 1996 to 1998, showed that the mean concentration of acrolein in 1996 ranged from 0.14 to 0.25 µg/m^3. As the site's setting is rural, rather than urban, it is assumed that the background concentration of acrolein would be less at the Site than in urban locations, and is conservative to use this as background data in the assessment.

Subsequent to the acrolein assessment, air quality monitoring was completed in 2016 to verify the assumption that background acrolein concentrations used in the assessment were conservative. All measured levels were below the detection limit; however, the detection limit of the analytical method used, which was the best detection limit available, was greater than the MECP AAQC. In the absence of background acrolein concentration data, a second line of reasoning was evaluated. A qualitative argument can be made that the background concentration of acrolein in the vicinity of the site is likely less than the background concentration using monitoring data for nitrogen dioxide (NO_2), an indicator air quality parameter. This argument is based on the fact that acrolein and NO_2 have similar sources of emissions (fuel combustion) and the fact that the monitored data showed that the concentration of NO_2 were significantly lower than background NO_2 concentrations available from the MECP for various nearby urban centers.

Background air quality concentrations for NO_2 that were evaluated are provided in Table 43. Background NO_2 concentrations for Tiverton, London, Kitchener, and Sarnia were obtained from the MECP. Of these four locations, it can reasonably be assumed that the London, Kitchener, and Sarnia locations can be considered similar to the urban locations in Ontario from which the acrolein background concentration were taken.

Table 43
Background Air Quality Concentrations for NO_2

Indicator	Urban Background Concentration (µg/m³)[a]	Monitored Concentration (µg/m³)[b]	Monitored Concentration Percentage of Urban Background
1-hour NO_2	47.0	5.3	11%
24-hour NO_2	41.0	3.7	9%

[a] See Table 5.4.1-14 of the Atmospheric Technical Supporting Document dated March 2011.

[b] 90th percentile concentration from the 2016 Air Quality Monitoring Program

As demonstrated, the monitored concentration of NO_2 in the vicinity of the site is likely to be no more than 11% of the background concentration in an urban location in Ontario. Based on this, it is reasonable to assume that the acrolein background concentration in the vicinity of the site would be significantly lower than that assumed in the assessment. As such, the assessment is highly conservative in terms of its predicted acrolein concentration and over predicted the potential exposure of receptors to acrolein during construction activities. Therefore, it is not expected that emissions of acrolein are likely to cause adverse impacts on air quality during ongoing operation of the site and was not considered further in the risk assessment.

3.4.3 Soil

The 2017 ERA reported that no COPCs were identified in soil at sampling location BPS03, which is located closest to the on-site Indigenous Spirit Site and the only location within the fenceline that may be accessed by members of the public including Indigenous members of the public. This location is on OPG retained land and is not assessed further in the 2022 ERA.

As discussed in Section 3.1.2, soil quality data have been collected across the Site over various years since 2000, most recently in 2021.

Soil samples collected from 2000-2021 were included in the EcoRA, and data considered were from areas within the Site that are representative of suitable ecological habitat or areas adjacent to ecological habitat. These locations include: Bruce A Storage Compound (BASC), Bruce B Empty Drum Laydown Area (BBED), Construction Landfill #4 (CL4), Fire Training Facility (FTF), Former Sewage Lagoon (FSL), Distribution Stations (DS1, DS2/DS4/DS5, DS8) and general soil sampling locations (BPS/SS).

For each assessed area, only surficial soil quality data (<1.5 mbgs) collected since 2000 was considered because it is unlikely that any ecological receptor would be exposed to soil greater than this depth. All soil quality data considered in the 2022 ERA and the preliminary screening for each investigated area are presented in Appendix E, Table 85 to Table 124. Surficial soil samples (<1.5 mbgs) were analyzed for metals and inorganics; Total Petroleum Hydrocarbons (TPH) and Petroleum Hydrocarbons (PHC) fractions (F1-F4); Benzene, Toluene, Ethylbenzene and Xylenes (BTEX); acid and base neutral extractables;

Polycyclic Aromatic Hydrocarbons (PAHs); Volatile Organic Compounds (VOC); and Polychlorinated Biphenyls (PCB). Polyfluoroalkyl Substances (PFAS) were also analyzed at FTF.

The locations of the general soil sampling areas (associated with the engineered site facilities) and surficial soil locations are shown on Figure 4 in Section 1.3.1.

3.4.3.1 Preliminary Screening Values and Screening Approach

No site-specific limits were available for soil; therefore, the following provincial and federal screening values were considered in the preliminary screening and the most stringent of the values was selected as the preliminary benchmarks:

- MECP Table 1 Full Depth Background SCS: Soil Standards for Industrial/Commercial/Community Property Use[R-10];
- CCME CSQGs for the Protection of Environmental and Human Health: Industrial Land Use [R-155]; and,
- In the absence of screening values from the above sources, the MECP OTR_{98} concentrations for old urban parks were used [R-220].

The following general screening approach was used to identify COPCs in soil:

- If the maximum detected concentration was less than its preliminary benchmarks for industrial sites, the chemical was not identified as a COPC. Comparison to these preliminary benchmarks was considered to represent a conservative evaluation of the potential for risks to ecological health. Therefore, parameters with concentrations that were less than preliminary benchmarks were considered to pose negligible risk to ecological health and were not retained for further assessment.
- If the maximum detected concentration was greater than its preliminary benchmark for industrial sites, the chemical was identified as a COPC and carried forward in the 2022 ERA for the assessment of potential risks to ecological health. For the EcoRA, these COPCs were also subject to a secondary screening process as described in Section 3.6 to 3.9.
- Chemicals for which there are no preliminary benchmarks were evaluated further as follows: if all concentrations in soil were less that the MECP OTR_{98} [R-220], the chemical was not identified as a COPC; and if all concentrations of a parameter were less than its method detection limit (MDL), then the parameter was not considered to be present at greater than background levels and was not retained as a COPC.
- Frequency of exceedance was also considered when identifying COPCs. For example, if a chemical exceeded its preliminary benchmark once, and was not exceeded at any other locations, this chemical was not retained as a COPC. To ensure a sufficient sample size for an area where this methodology was used, this rationale was applied only if 10 or more

discrete sampling locations were present within the area being assessed. Further, both the average and 95th percentile concentration had to be below the preliminary benchmark to be excluded on the basis of frequency of exceedance [Note: that for samples with concentrations reported as below the MDL, the full MDL value was considered when calculating averages and percentiles]. If fewer than 10 sampling locations were available, a chemical was retained as a COPC even if the chemical only exceeded its preliminary benchmark once. Incorporating frequency of exceedance into screening of COPCs is common practice in risk assessment and is considered to be technically defensible. Statistical assessments of data (including averages and percentiles) for identifying COPCs is a practice that has recently been adopted under the new Ontario Excess Soil Quality Standards [R-168]. The co-location of isolated exceedances of a parameter with other impacts was also considered when identifying anomalous results.

- An exceedance of the pH range in the preliminary benchmark may be looked at as an average to get a more representative soil pH. Given that pH is based on a logarithmic scale, the use of arithmetic and geometric means is not appropriate. To average pH, the following method was used:

  $pH = -\log_{10}[H+]$, where [H+] is the hydrogen ion activity.

  $[H+] = 10^{-pH}$

  $\text{Mean } [H+] = ([H+]_{\text{sample 1}} + [H+]_{\text{sample 2}} + \ldots [H+]_{\text{sample n}}) / n$

  Mean pH = -log(Mean [H+]

  The averaging of pH in soils was done for samples within a two-metre radius and within the same unit or horizon. This is in line with a technical update by the MECP [R-221] in regard to clause 41(1)(b) of *O. Reg 153/04*.

The preliminary screening for soil is presented in Appendix E, Table 85 to Table 124 and the results are summarized below for each assessed area.

3.4.3.2 Results

General COPC Exclusions in Soil

The chemical screening process included the elimination of essential elements that are fundamentally non-toxic, including calcium, iron, potassium, and magnesium.

Parameters attributable to road salting practices during the winter months as part of the facility's general maintenance programs such as sodium, chloride and electrical conductivity were also eliminated. The Ontario MECP has exempted the effects of road salting including associated changes to sodium, chloride and electrical conductivity in risk assessments carried out under Ontario Regulation 153/04 [R-50]. These elevated parameters are localized and are not widespread throughout the remainder of the Site and therefore, these parameters were not retained as COPCs in soil in the 2022 ERA.

Several acid & base neutral extractables and VOC soil samples analyzed had MDLs that were greater than the current preliminary benchmarks. The MDL achievable were either the lowest available at the time of analysis or there is possibility that the MDL was elevated by additional dilution of a sample required to overcome matrix interference from components in the sample affecting the laboratory analysis. Chemicals with MDLs above the preliminary benchmarks were not retained in the EcoRA if they were not detected across the assessed sites. These include: 1,2,4-Trichlorobenzene, 2,4,6-Trichlorophenol; 2,4,5-Trichlorophenol; 2,4-Dichlorophenol; 2,4-Dimethylphenol; 2-Chlorophenol; Pentachlorophenol; 1,2,4-Trichlorobenzene; Hexachlorobutadiene; Hexachloroethane; Trichloroethene; 1,3-Dichlorobenzene; bis(2-chloroethyl)ether; Diethyl Phthalate; p-Chloroanaline. Further, these chemicals are not used on-site or released through any effluent stream and, as a result, were not retained as COPCs.

The preliminary screening results for each assessed area are described in the following sections.

Bruce A Storage Compound

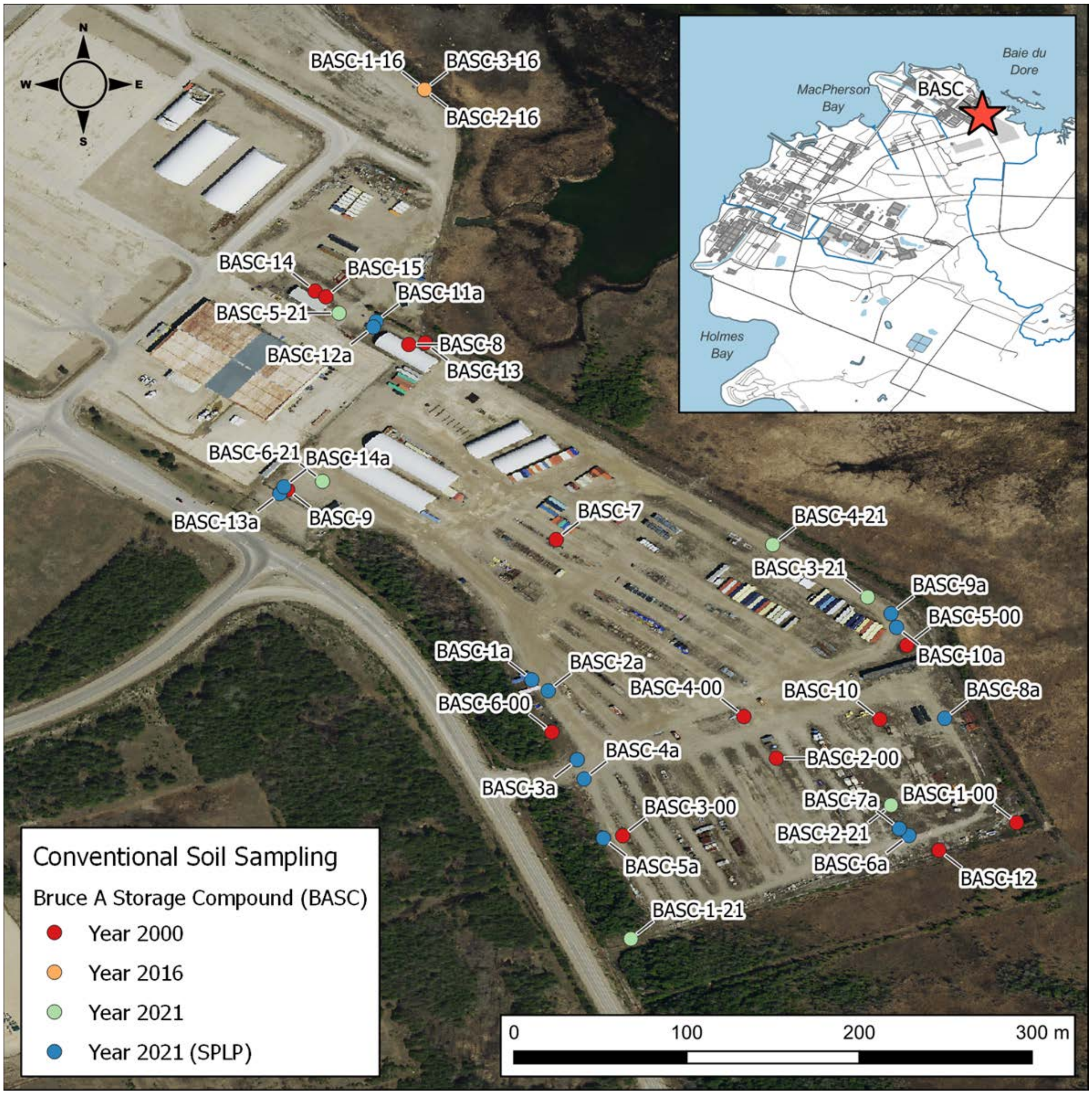

Figure 36
Soil Sampling Locations - BASC

A detailed description of the BASC is provided in Section 1.3.1.3. The BASC was sampled in the 2000, 2016 and 2021 campaigns (Figure 36) and analyzed for metals, PHCs, PCBs, extractables and VOCs.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within BASC:

- Antimony
- Zinc
- Boron (HWS)
- Chromium VI
- Benzene
- Xylene
- PHC F2
- PHC F3
- PHC F4

COPC Exclusion Justifications

The following results exceeded the preliminary benchmarks but were not carried forward as they were detected in less than 10% of sample locations (out of at least 10 sample locations) and the average and 95th percentiles met the preliminary benchmark; therefore, these parameters are considered to present negligible exposures to receptors:

- Mercury: measured concentrations exceeded the preliminary benchmark of 0.27 mg/kg at one sample location (1.2 mg/kg at BASC-14) among 24 sampled locations and 44 analyzed samples. The average concentration (0.04 mg/kg) and the 95th percentile (<0.05 mg/kg) were below the preliminary benchmark. The isolated mercury exceedance occurred in 2000, where follow-up sampling in 2016 and 2021 had concentrations below detection limits. The mercury exceedance was also not co-located with any other metal impacts.

- Molybdenum: measured concentrations exceeded the preliminary benchmark of 2 mg/kg at one sample location (5.6 mg/kg at BASC-1-00) among 24 sampled locations and 53 analyzed samples. Out of the 53 analyzed samples, 44 samples were below detection limits. The average concentration (0.71 mg/kg) and the 95th percentile (1.5 mg/kg) were below the preliminary benchmark. The molybdenum exceedance was also not co-located with any other metal impacts.

- Acetone: measured concentrations exceeded the preliminary benchmark of 0.5 mg/kg at one sample location (0.97 mg/kg at BASC-10) among 15 sampled locations and 27 analyzed samples. Out of the 27 analyzed samples, 22 samples were below detection limits. The average concentration (0.15 mg/kg) and 95th percentile (<0.05 mg/kg) were below the preliminary benchmark.

The following parameters were also not carried forward in the EcoRA:

- TPH: In 2000, TPH light and heavy fractions were measured across BASC. Measured concentrations exceeded the preliminary benchmark of 10 mg/kg for TPH light and 120 mg/kg for TPH heavy at one sample location (BASC-15 at 0.91 mbgs) among 15 sampled locations and 44 analyzed samples. TPH concentrations measured at BASC-15 within shallower samples (0.06 and 0.46 mbgs) were not detected. In 2016 and 2021, PHC concentrations were measured across BASC, including adjacent to the historical TPH impacts. Therefore, TPH data will not be retained for further assessment (as this is a historical analytical suite) and the petroleum impacts at BASC will be assessed using recent PHC F1 to F4 sampling data.

- pH: There were 47 samples from 24 sample locations analyzed for pH; pH at BASC-5 and BASC-13 were 1.03 times above the preliminary benchmarks (9.25 and 9.26, respectively). When averaged within their respective locations and soil horizons, pH in both samples met the preliminary benchmarks and was excluded as COPCs as described under “General COPC Exclusions”.

- PAHs: Acenaphthylene, biphenyl, naphthalene and phenanthrene had MDLs exceeding the preliminary benchmarks at one location (BASC-16) among 16 sampled locations. All other samples were non-detected, with the exception of naphthalene that had a detected concentration within one sample that was measured below the preliminary benchmark. The elevated MDLs are the result of additional dilution of the sample required to overcome matrix interference. BASC-16 is also not co-located with any other impacts. PAHs are therefore not considered a COPC at the Site.

- Benzyl butyl phthalate and di-n-butyl phthalate did not have any identified preliminary benchmarks; however, these parameters were only detected in one sample (BASC-6-00) out of 44 analyzed samples. BASC-6-00 is also not co-located with any other impacts. Given the low number of detections, exposures to benzyl butyl phthalate and di-n-butyl phthalate are considered negligible and these parameters are not carried forward as COPCs.

- Several other phenols, acid and base extractables, and VOCs with higher MDLs above the preliminary benchmark were not carried forward as they were not detected across the Site as discussed under “General COPC Exclusions”.

Bruce B Empty Drum Laydown

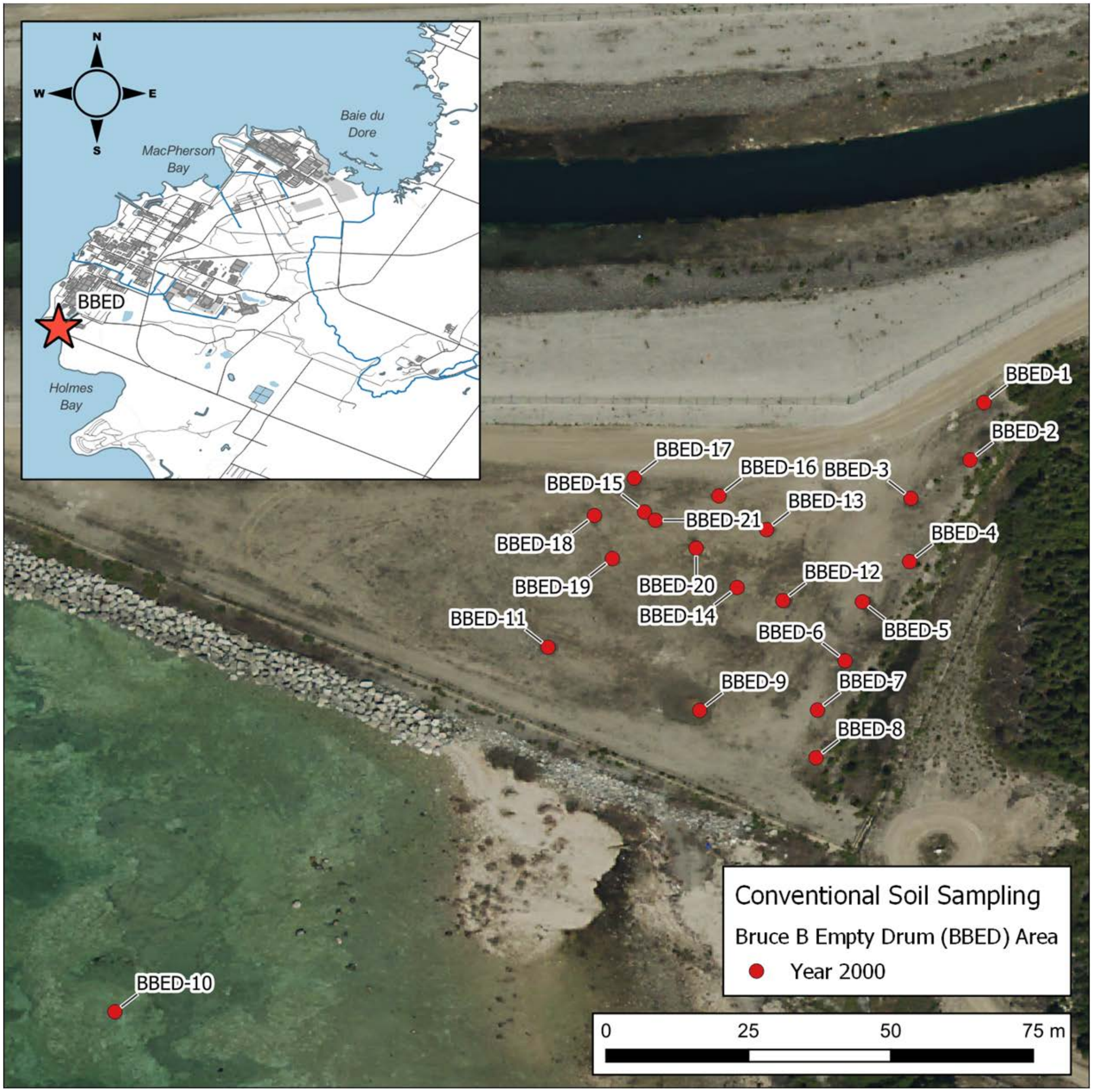

Figure 37
Soil Sampling Locations - BBED

A detailed description of BBED is provided in Section 1.3.1.2. The BBED was sampled in 2000 (Figure 37) for TPHs, PCBs and VOCs.

Identified COPCs

Based on screening against the preliminary benchmarks, no COPCs were carried forward for further evaluation of soil quality within BBED.

COPC Exclusion Justifications

TPHs light and heavy exceeded the preliminary benchmark at two sample locations in 2000, >0.6 mbgs, among 21 sampled locations and 59 analyzed samples analyzed at the site. Samples collected in the top 0.2 m were not detected across the BBED site. There is negligible exposure potential from TPHs at BBED due to the depth of the contamination; therefore, these parameters were not retained as COPCs for further assessment.

Four samples from two locations were analyzed for pH; pH from BBED-12 (9.11) was 1.01 times higher than the preliminary benchmark at one sample depth. When averaged within its respective sample location and the same soil horizon, pH met the preliminary benchmark. As a result, pH was excluded as a COPC as described under “General COPC Exclusions” in Section 3.4.3.2.

Construction Landfill #4

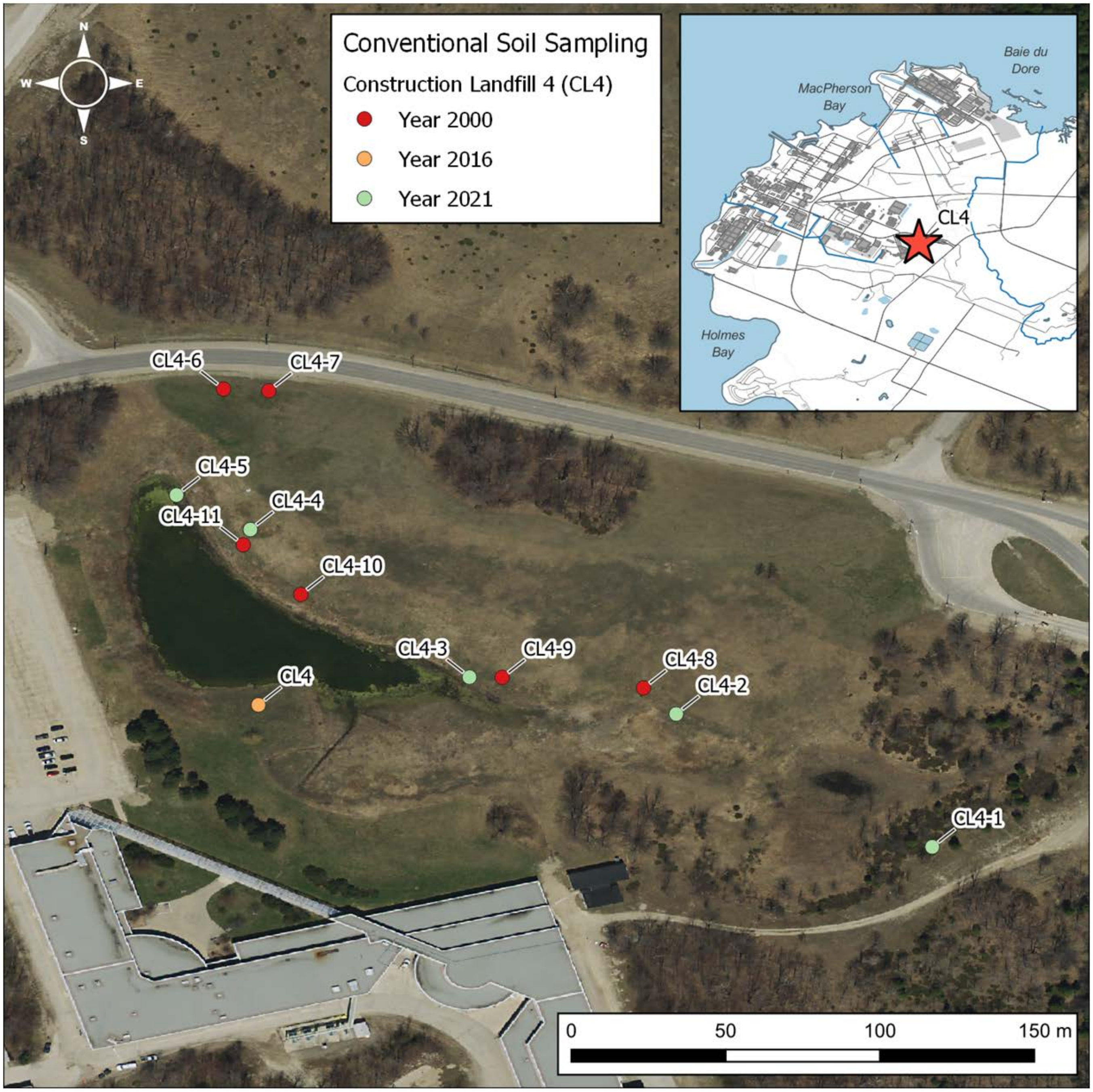

Figure 38
Soil Sampling Locations – CL4

A detailed description of CL4 is provided in Section 1.3.1.3. Samples collected in 2000, 2016, and 2021 (Figure 38) at CL4 from within Bruce Power-leased lands were used to identify potential contamination from the historic landfill. Samples obtained in 2000 that were included in the 2017 ERA and located on OPG retained land were excluded from further assessment. Soil was analyzed for metals, acid & base neutral extractables, PAHs and VOCs. Generally, a reduction in concentration is observed between 2000 and 2021.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within CL4:

- Cadmium
- Copper
- Silver
- Molybdenum
- Uranium
- Zinc
- 4-Bromophenyl Phenyl Ether
- Di-n-butyl Phthalate
- Benzene
- Acenaphthene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Phenanthrene

COPC Exclusion Justifications

Magnesium and sodium had elevated concentrations above the preliminary benchmarks but were not carried forward as discussed under “General COPC Exclusions”

Several other phenols, acid and base extractables, and VOCs with higher MDLs above the preliminary benchmarks were not carried forward as they were not detected across the Site as discussed under “General COPC Exclusions”.

Fire Training Facility

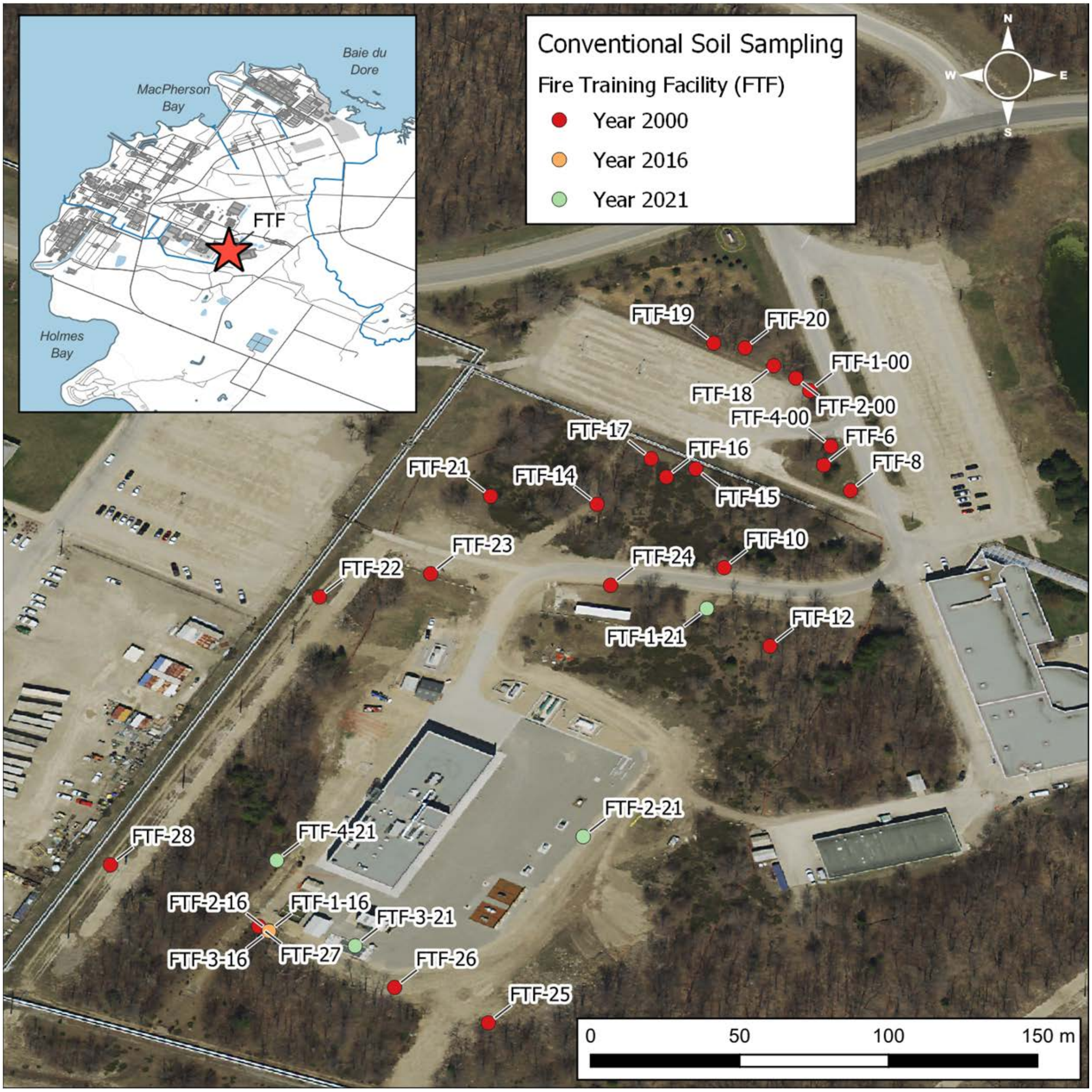

Figure 39
Soil Sampling Locations – FTF

A detailed description of the FTF is provided in Section 1.3.1.3. The FTF was sampled in the 2000, 2016 and 2021 campaigns (Figure 39) and analyzed for metals, PHCs, PCBs, acid & base neutral extractables, PAHs, VOCs and PFAS.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within FTF:

- TPH Light (C10-24)
- Benzyl butyl phthalate
- Di-n-butyl Phthalate
- Di-n-octyl Phthalate
- Hexachlorobenzene
- Nitrobenzene
- Diphenylamines (total)
- 2,3,4,5-Tetrachlorophenol
- Phenol
- 2-methylphenol
- Isophorone
- Acetone
- Benzene
- Chloroform
- Ethylbenzene
- Methyl ethyl ketone
- Purgeable Hydrocarbons (C5-C10)
- Toluene
- Xylene
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Dibenzo(a,h)anthracene
- Fluorene
- Naphthalene
- Phenanthrene

COPC Exclusion Justifications

The following results exceeded the preliminary benchmarks but were not carried forward as they were detected in less than 10% of analyzed samples (out of at least 10 sample locations) and the average and 95th percentiles met the preliminary benchmark; therefore, these parameters are considered to present negligible exposures to receptors:

- Silver: measured concentrations exceeded the preliminary benchmark of 0.5 mg/kg at one sample location (1.3 mg/kg at FTF-2-00) among 20 sampled locations and 65 analyzed samples. All other samples were measured below detection limits. The average concentration (0.14 mg/kg) and the 95th percentile concentration (<0.25 mg/kg) were below the preliminary benchmark. The silver exceedance is also not co-located with any other metal exceedances.

- Zinc: measured concentrations exceeded the preliminary benchmark of 290 mg/kg at one sample location (350 mg/kg at FTF-10), among 20 sampled locations and 65 analyzed samples. The average concentration (45 mg/kg) and the 95th percentile concentration (94 mg/kg) were below the preliminary benchmark. The zinc exceedance is also not co-located with any other metal exceedances.

- Biphenyl: higher MDLs exceeded the preliminary benchmark of 0.05 mg/kg at one sample location (<0.1 mg/kg at FTF-2-16) among 15 sampled locations and 53 analyzed samples. Only three other samples had detected concentrations, all of which were below the preliminary benchmark. The average concentration (0.004 mg/kg) and the 95th percentile concentration (0.02 mg/kg) were below the preliminary benchmark.

The following parameters were also not carried forward in the EcoRA:

- pH: There were 75 samples from 7 locations analyzed for pH; pH at FTF-4, FTF-6, FTF-8, and FTF-12 exceeded the preliminary benchmark. When averaged within their respective sample locations and soil horizons, all samples met the preliminary benchmark. pH was not carried forward as a COPC.

- Sodium had concentrations above the preliminary benchmarks but was not carried forward as discussed under “General COPC Exclusions”

- VOCs: The majority of VOCs had higher MDLs above the preliminary benchmarks at only one sample location (FTF-1-16) among 21 sample locations and 53 analyzed samples. However, only the VOCs with detected concentrations above the preliminary benchmarks among the rest of the analyzed samples were identified as COPCs, including 1,1,2,2- tetrachloroethane, chlorobenzene, and styrene.
  1,1,2,2- tetrachloroethane, chlorobenzene, and styrene

- Several other phenols and VOCs with higher MDLs above the preliminary benchmarks were not carried forward as they were not detected across the Site as discussed under “General COPC Exclusions”.

Former Sewage Lagoon

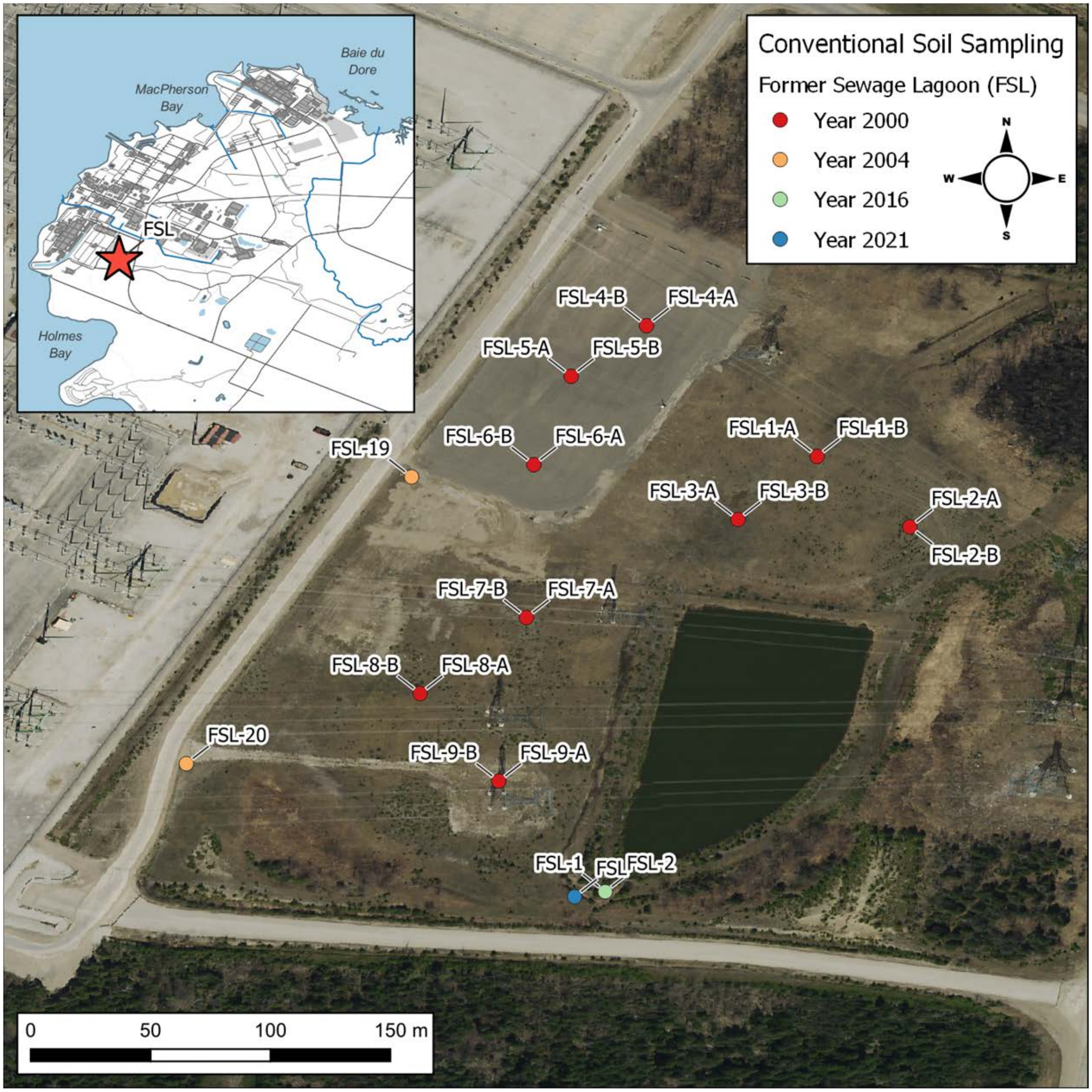

Figure 40
Soil Sampling Locations – FSL

A detailed description of FSL is provided in Section 1.3.1.3. The FSL was sampled in the 2000, 2004, 2016 and 2021 campaigns (Figure 40) and analyzed for metals, PHCs, PCBs, acid & base neutral extractables, PAHs and BTEX.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within FSL:

- Molybdenum
- Silver
- Uranium
- PHC F2

COPC Exclusion Justifications

Calcium and sodium had concentrations above the preliminary benchmarks but was not carried forward as discussed under “General COPC Exclusions”

There were 30 samples from 13 locations analyzed for pH; pH at FSL-2-A was 1.02 times above the preliminary benchmark (9.12, 9.15, and 9.21 across three sample depths). No other locations across FSL had elevated pH levels. Exposure to elevated pH across FSL is considered negligible and was not retained for further assessment. Further, the elevated pH levels at FSL are likely associated with the natural geology of the site. The underlying bedrock in the area is limestone, comprised of calcium carbonate known to increase soil pH. This is supported by the elevated calcium levels measured in soils within FSL.

The majority of PAHs had MDLs above the preliminary screening benchmarks; however, there were no detected PAHs on-site, therefore PAHs were not identified as COPCs.

Several other phenols, acid base extractables, and VOCs with higher MDLs above the preliminary benchmarks were not carried forward as they were not detected across the Site as discussed under “General COPC Exclusions”.

Distribution Station #1

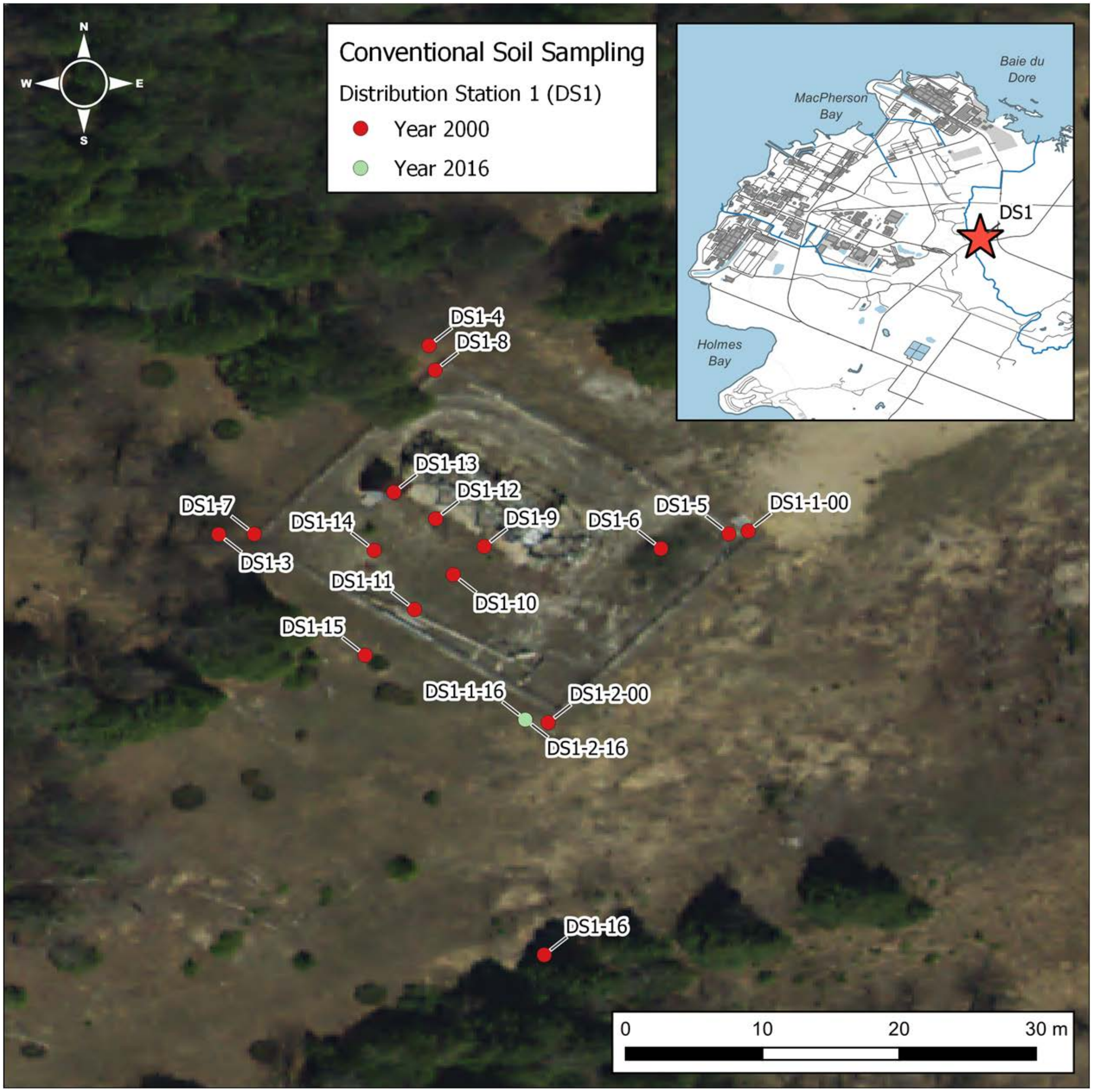

Figure 41
Soil Sampling Locations – DS1

A detailed description of DS1 is provided in Section 1.3.1.3. DS1 was sampled in the 2000 and 2016 campaigns (Figure 41) and analyzed for metals, PHCs, PCBs, acid & base neutral extractables, PAHs and VOCs.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within DS1:

- TPH Light (C10-C24)
- Total PCBs

COPC Exclusion Justifications

Naphthalene and phenanthrene had higher MDLs above the preliminary benchmarks in two samples analyzed in 2000; these parameters along with other PAHs were not detected in any other samples across the Site. PAHs were therefore not retained as COPCs.

There were 39 samples collected from 6 locations analyzed for pH; pH at DS1-5, and DS1-7 to DS1-11 exceeded the preliminary benchmark. When averaged within their respective sample locations and soil horizons, all samples met the preliminary benchmark. pH was therefore not retained as a COPC as discussed under “General COPC Exclusions”.

Sodium had higher MDLs above the preliminary benchmarks but was not carried forward as discussed under “General COPC Exclusions”.

Several other phenols, acid and base extractables, and VOCs with higher MDLs above the preliminary benchmarks were not carried forward as they were not detected across the Site as discussed under “General COPC Exclusions”.

Distribution Station #2/4/5

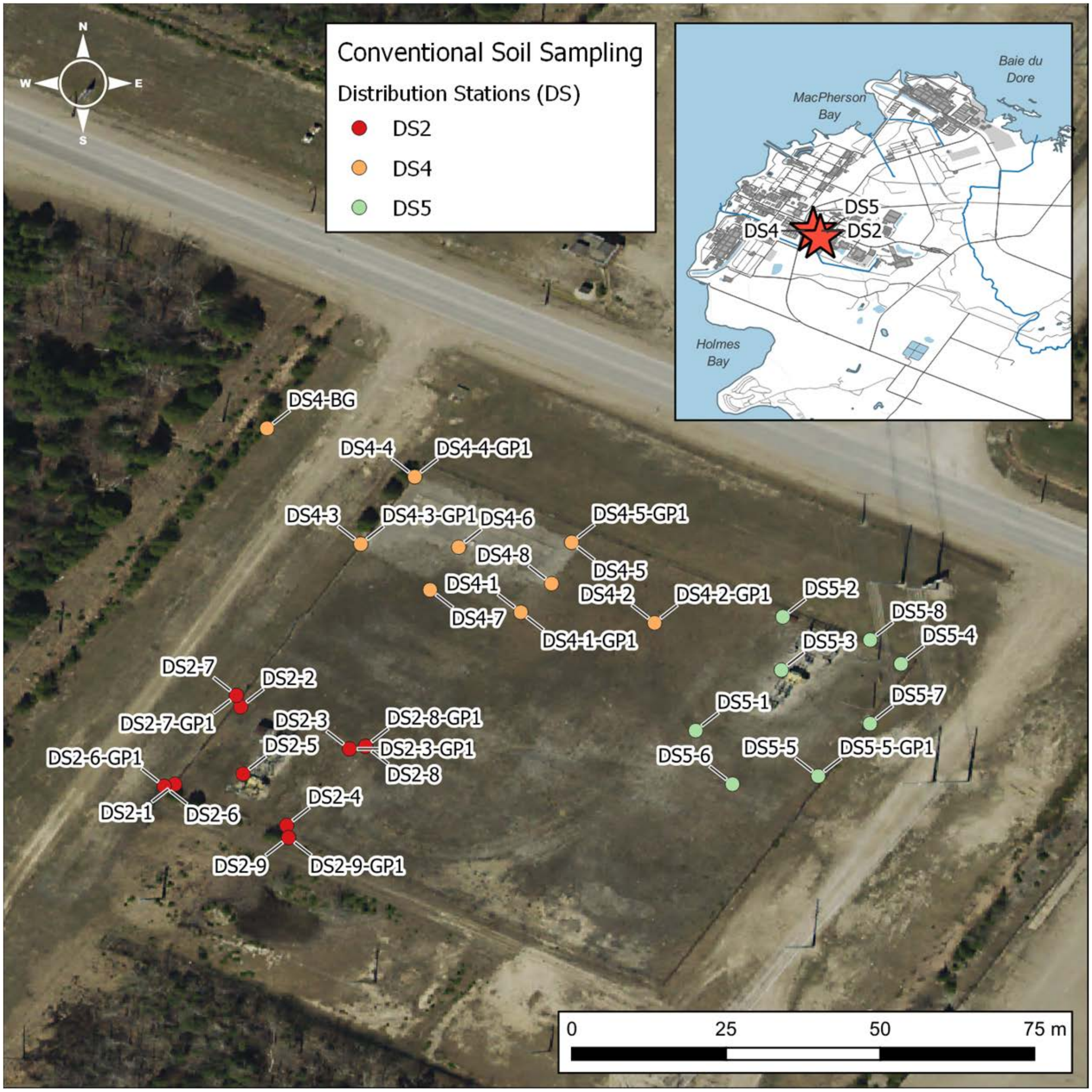

Figure 42
Soil Sampling Locations, 2000 – DS2/4/5

A detailed description of DS2/4/5 is provided in Section 1.3.1.3. DS2/4/5 was sampled in the 2000 campaign (Figure 42) and analyzed for metals, PHCs, PCBs, acid & base neutral extractables, PAHs and VOCs.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within DS1:

- TPH Light (C10-C24)
- Xylenes

COPC Exclusion Justifications

There were 29 samples from 8 locations analyzed for pH; pH at DS5-3 exceeded the preliminary benchmark at one sampled depth. When averaged within their sample location and soil horizon, pH levels met the preliminary benchmark.

Chlorodibromomethane was 1.6 times above the preliminary benchmark in one sample collected from DS4 (DS4-BG-0.2-A; 0.08 vs 0.05 mg/kg). The remaining samples collected at the site were measured below detection limits. Chlorodibromomethane has not been detected across all of the assessed areas. Further, all other VOCs (with the exception of BTEX) were not detected at DS4. Potential exposures from chlorodibromomethane are considered negligible and it is not retained as COPC for further assessment.

Distribution Station #8

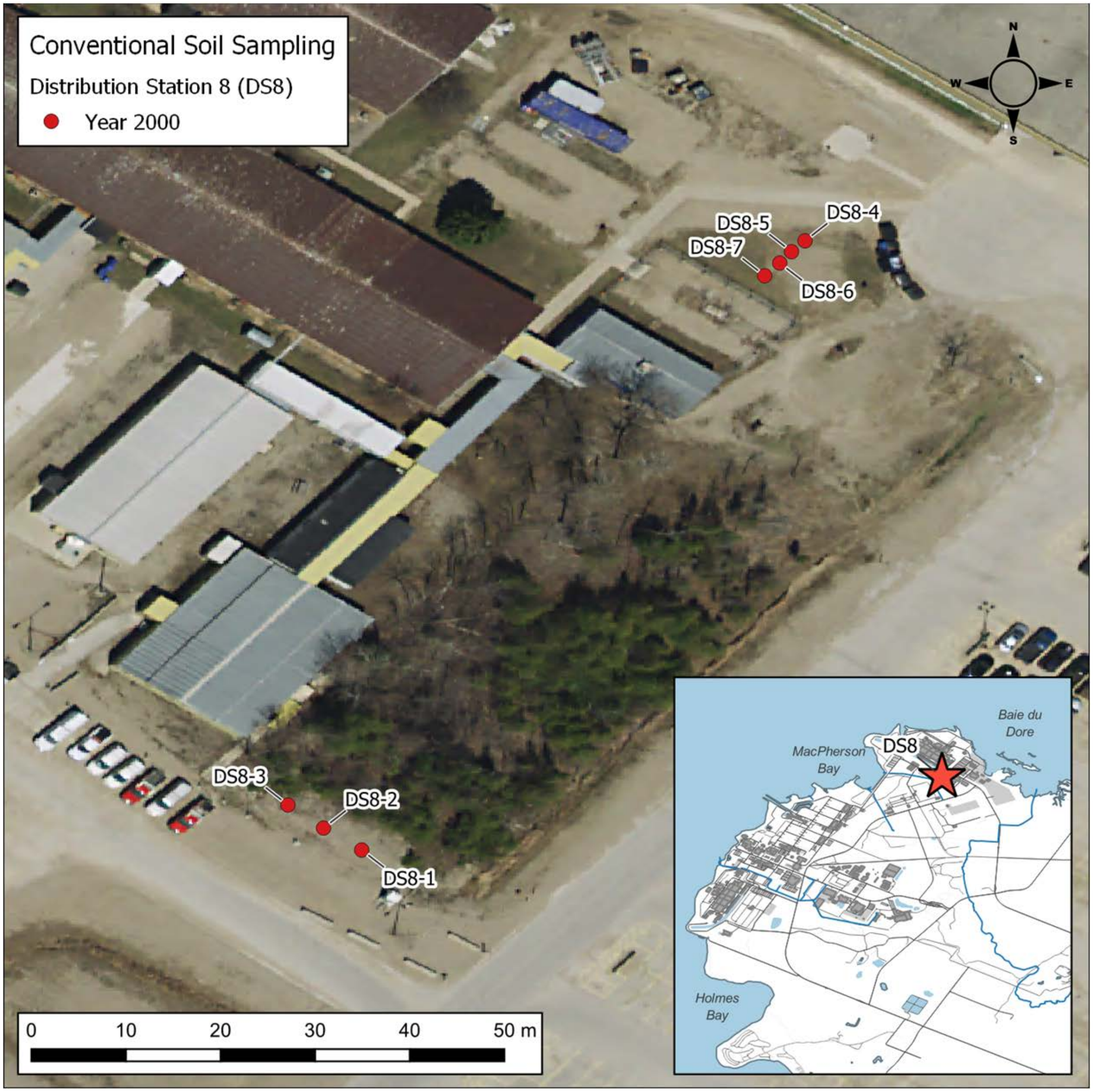

Figure 43
Soil Sampling Locations – DS8

A detailed description of DS8 is provided in Section 1.3.1.3. DS8 was sampled in the 2000 campaign (Figure 43) and analyzed for metals, PHCs and PCBs.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within DS8:

- TPH Light (C10-C24)

COPC Exclusion Justifications

There were 21 samples from 7 locations analyzed for pH; pH at DS8-2 and DS8-6 exceeded the preliminary benchmark. When averaged within their respective locations and soil horizon, pH levels met the preliminary benchmark. pH was therefore not carried forward as a COPC as discussed under “General COPC Exclusions”.

General Surface Soil Samples (BPS/SS)

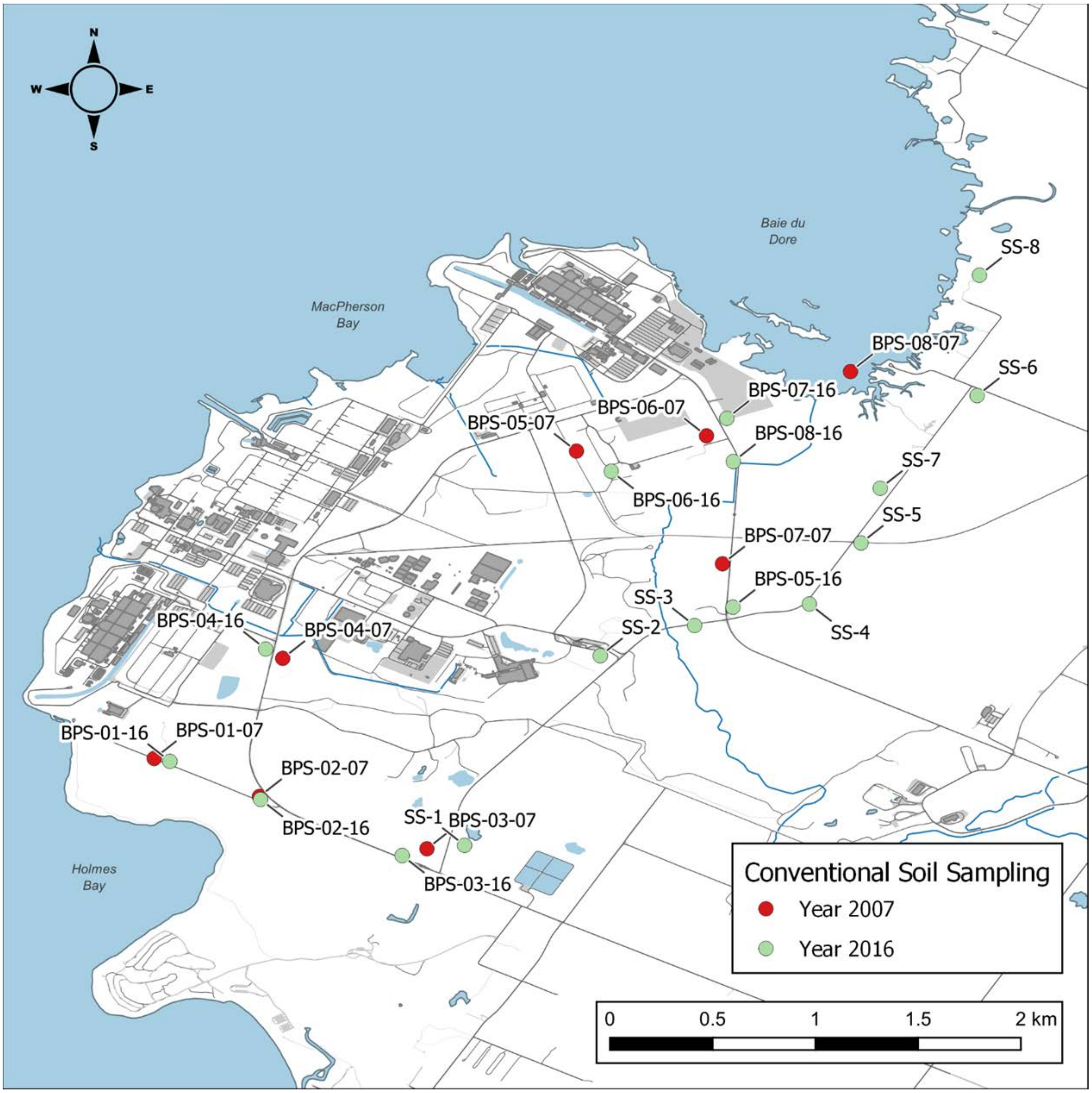

Figure 44
Soil Sampling Locations – BPS / SS

Surface soil samples (BPS/SS sampling series) were collected in 2007 and 2016 to increase the spatial representation of soil samples collected across the site (Figure 44). Samples were analyzed for metals, PHCs, PCBs, acid and base extractables and VOCs.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of soil quality within the general surface soil samples:

BPS-04-07
- Boron (HWS)
- Cadmium
- Selenium
- Uranium

BPS-01-07
- PHC F2
- PHC F3
- PHC F4
- Strontium

BPS-02-07
- Strontium

BPS-01-16
- PHC F2

BPS-04-16
- PHC F2

BPS-06-16
- PHC F2

BPS-05-07
- PHC F2

BPS-04-07
- PHC F3
- PHC F4

SS-1
- PHC F2
- Acetone

SS-6
- Lead
- PHC F2

SS-7
- PHC F2
- Acetone

COPC Exclusion Justifications

Measured concentrations of cyanide exceeded the preliminary benchmark at one sample location (BPS-08-1). The maximum measured concentration was 1.4 times above the preliminary benchmark (0.07 vs. 0.051 mg/kg). The elevated cyanide concentrations were not co-located with any other impacts. Therefore, cyanide exposure is considered negligible and is not retained for further assessment in the EcoRA.

Calcium, magnesium, sodium, conductivity, and chloride had concentrations above the preliminary benchmarks but was not carried forward as discussed under “General COPC Exclusions”

Nitrate, orthophosphate, and sulphate have no identified preliminary benchmark but were detected within the general surface soil samples. These parameters represent general soil chemistry and are not associated with any ecological risks. They were not identified as COPCs for further assessment.

Several other phenols, acid and base extractables and VOCs (including BTEX) with higher MDLs above the preliminary benchmarks were not carried forward as they were not detected across the site as discussed under “General COPC Exclusions”.

3.4.4 Groundwater

3.4.4.1 Data Relied Upon and Sampling Locations

The CNSC and MECP administer groundwater management at nuclear facilities through the application of the Nuclear Safety and Control Act and the Brownfield's Act [R-222][R-223] respectively. Groundwater quality has been monitored on site, first by OPG starting in the 1990s, and followed by Bruce Power starting in 2001.

Bruce Power has a comprehensive groundwater monitoring program in place which was developed from studies that took place in the 1990s. OPG began a program to voluntarily perform environmental site assessments at all OPG (then Ontario Hydro) owned facilities in 1995. In 1997, MECP issued a Directors Order requiring Environmental Site Assessment (ESA) plans to be developed to investigate specific sites within specified timelines. In 1998, Ontario Hydro Nuclear (OHN) instituted an Integrated Improvement Plan to assess OHN contaminated lands. Locations were ranked by a third-party consultant as having a high potential for environmental impact which were covered under the Director's Order. Phase I ESA was completed January 2000 and a Phase II ESA was completed in March 2001 [R-8][R-224]. As an outcome of these assessments, a plan was made and implemented to address any impact from past activities. Additionally, areas were identified which required long term monitoring. This formed the basis of Bruce Power's current groundwater monitoring program. Since the birth of the groundwater monitoring program that evaluated 59 groups of sites, fourteen subject sites were actively monitored based on their risk of environmental impact. Currently there are sixteen sites which are routinely monitored. Since this initial evaluation, two additional sites have been added.

The main objective of the Bruce Power Groundwater Monitoring Program is to evaluate the groundwater quality and conditions at the above-mentioned subject sites based on monitoring and sampling of the existing monitoring wells. As mentioned, these existing monitoring wells were installed during previous ESAs and investigations at the sites. Additional wells were installed in 2012 to help further evaluate the groundwater quality at specific subject sites. Based on year-to-year evaluation, wells that are ineffective or are no longer representative of groundwater quality are decommissioned as per regulations under the Ontario Water Resources Act [R-225].

Groundwater was only retained in the 2022 ERA for potential root uptake by terrestrial plants. As a result, only data from groundwater monitoring wells with groundwater levels less than 1.5 mbgs were considered given that plant roots generally do not extend beyond that depth. Additionally, areas that are actively used as part of the ongoing operations were not considered suitable habitat for ecological receptors as many of these areas are paved and do not contain the shelter and food sources that can support ecological life. Groundwater data from active industrial locations lacking ecological habitat were not applicable for the 2022 ERA. Given these considerations, the BASC and FSL were the only locations at which shallow groundwater was present in an area that may also serve as ecological habitat (see Table 18). The potential risk from groundwater discharging into surface water was evaluated based on the measured concentrations in surface water bodies containing aquatic habitat (see Section 1.8.1).

The Indigenous Spirit Site is the only area on-site that are used by on-Site human receptors and is located on OPG retained lands. This area is not located in close proximity to on-Site buildings and as such, vapour migration is not considered a complete pathway. Further, groundwater on-site is not used as a potable drinking water source available to the public. Potential off-site migration was considered in the HHRA when evaluating off-site shallow residential drinking water wells, which was assessed in Section 3.4.7 below. As such, on-site groundwater was not considered in the HHRA.

All groundwater analytical data considered in the ERA is provided in Appendix E, Table 125 to Table 128. Groundwater results from 2017 to 2020 were considered in the 2022 ERA. These groundwater results were considered to be reflective of the current site conditions. Within the BASC and FSL, groundwater has been analyzed for metals & inorganics, PHCs (F1-F4), PAHs, and VOCs.

The approximate locations of the groundwater monitoring wells containing shallow groundwater (for root uptake by terrestrial plants) relied upon in the 2022 ERA are shown on Figure 45 and Figure 46 below.

Areas are excluded from further groundwater assessment within the ERA when the water level is observed to be below a level which would impact receptors through root system uptake or receptors would not be anticipated to come into direct contact with groundwater. This is typically at levels below 1.5 mbgs. Monitoring of groundwater occurs in areas which would be considered industrial barren however migration of groundwater may occur to areas where it may discharge to surface water. Where impacts to groundwater are observed and there is an increased potential for these impacts to migrate to areas where discharge to surface water occurs they may subsequently be included in the ERA for further assessment. A general description of the Bruce Power Groundwater Monitoring Program can be found in [R-22], Section 1.5.5. The Bruce Power Groundwater Protection Program, which is in alignment with CSA N288.7, has implemented groundwater monitoring at many of the sites which have been previously excluded from further assessment. This program serves to inform the ERA should conditions change such that further assessment would be necessary. Bruce Power aligned with CSA N288.7 at the end of 2020 and continues to improve groundwater protection at the Bruce Power site in accordance with principles from the standard. Further development of the conceptual site model continues to inform the ERA as does annual groundwater monitoring.

3.4.4.2 Preliminary Screening Values and Screening Approach

No site-specific limits were available for groundwater; therefore, the following provincial and federal screening values were considered in the preliminary screening and the most stringent of the values were selected as the preliminary benchmarks:

- MECP Table 1 Full Depth Background SCS: Ground Water: All Types of Property Uses [R-69];
- Ontario Regulation (O.Reg.) 169/03 ODWS [R-73];

- Health Canada GCDWQ [R-72];
- FCSAP FIGQGs: Table 3 - Tier 1 Criteria for Industrial Use [R-77]; and
- In the absence of screening values from above sources, the MECP PGMIS 97.5th percentile background groundwater concentrations were used [R-10].

Note that several groundwater screening values depend on physio-chemical water chemistry, such as pH, temperature, hardness and dissolved organic carbon (DOC). For these screening values, the site-specific conditions of the receiving water body (i.e., Lake Huron) were considered and are presented in Section 3.4.4.3 below.

The following general screening approach was used to identify COPCs in groundwater:

- If the maximum detected concentration was less than its preliminary benchmarks for industrial sites, the chemical was not identified as a COPC. Comparison to these preliminary benchmarks was considered to represent a conservative evaluation of the potential for risks to ecological health. Therefore, parameters with concentrations that were less than preliminary benchmarks were considered to pose negligible risk to ecological health and were not retained for further assessment.
- If the maximum detected concentration was greater than its preliminary benchmark for industrial sites, the chemical was identified as a COPC and carried forward in the 2022 ERA for the assessment of potential risks to ecological health. For the EcoRA, these COPCs were also subject to a secondary screening process as described in Section 3.4.
- Chemicals for which there are no preliminary benchmarks were evaluated further as follows: if all concentrations in soil were less that the MECP PGMIS 97.5th percentile background groundwater concentration [R-220], the chemical was not identified as a COPC; and if all concentrations of a parameter were less than its MDL, then the parameter was not considered to be present greater than background levels and was not retained as a COPC.

The preliminary screening for groundwater is presented in Appendix E, Table 125 to Table 128 and the results are summarized below for each assessed area.

3.4.4.3 Results

General COPC Exclusions for Groundwater

The following chemicals were not retained as COPCs for groundwater within any of the assessed areas:

- Fluoride was above the preliminary benchmark across all groundwater samples; however, it is not retained as a COPC as it is not a chemical constituent emitted due to operations and is elevated in regional groundwaters due to its geologic origin [R-40].

- Chloride was above the preliminary benchmarks across the majority of groundwater samples; however, it is not retained as a COPC as it is attributable to road salting practices as part of the facility's general maintenance programs.

- Orthophosphate did not have preliminary screening values available from any jurisdiction; and it is not retained as a COPC as it is considered a general chemistry parameter that does not have a direct effect on environmental health. It is a natural occurring form of elemental phosphorous sourced from soil and can also be sourced from agricultural activities (such as commercial fertilizer and livestock waste).

- Beryllium, silver, and bromide had MDLs exceeding their respective preliminary benchmarks across all groundwater samples. The MDLs achievable were either the lowest available at the time of analysis or there is possibility that the MDL was elevated by additional dilution of a sample required to overcome matrix interference from components in the sample affecting the laboratory analysis. Detected concentrations have not been measured in recent years, between 2017 and 2021. As such, these parameters were not retained as COPCs in groundwater.

Bruce A Storage Compound

Figure 45
Shallow Groundwater Monitoring Well Locations - BASC

Groundwater data was considered from four monitoring wells located around the BASC (BASC-16, BASC-22, BASC-23, BASC-24), as these locations (Figure 45) contained shallow groundwater (as deep as 1.43 mbgs).

Identified COPCs

Based on the screening approach described above, the following chemicals were identified as COPCs for the BASC:

- Copper
- Zinc
- Sulphate

COPC Exclusion Justifications

The detection limits for vanadium were elevated and exceeded its preliminary benchmark in two of the five groundwater samples in the BASC. Detectable concentrations were not measured at these locations. In samples where detectable concentrations of vanadium were measured, the concentrations were below the preliminary benchmark. Given this, vanadium was not retained as a COPC in groundwater for the BASC.

Former Sewage Lagoon

Figure 46
Shallow Groundwater Monitoring Well Locations - FSL

Groundwater data was considered from five monitoring wells located around the FSL (FSL-16A, FSL-18, FSL-19, FSL-20, FSL-21), as these locations (Figure 46) contained shallow groundwater (ranging from 0.3 to 1.45 mbgs).

Identified COPCs

Based on the screening approach described above, the following chemicals were identified as COPCs for further evaluation of the FSL in the EcoRA:

- Copper
- Selenium
- Uranium
- Sulphate

COPC Exclusion Justification

The detection limit for vanadium was elevated and exceeded its preliminary benchmark in six of the 14 groundwater samples in the FSL. In some of these samples, these detection limits were adjusted as a result of additional dilution required to reduce interference from sample matrix effects, likely due to sediments in the sample. The maximum detected concentration of vanadium in the FSL was below the preliminary benchmark. Given the above, vanadium was not retained as a COPC in groundwater for the FSL.

Out of 14 samples, the detection limit for zinc exceeded its preliminary benchmark during one sampling event in September 2017 at location FSL-19. The detection limits in this sample were adjusted due to matrix effects that are likely the result of sedimentation in the sample. Zinc was non-detect again and below the preliminary benchmark during the subsequent sampling event conducted in October 2018. Given this, zinc was not retained as a COPC in groundwater for the FSL.

Cobalt exceeded the preliminary benchmark in one out of 14 samples collected and analyzed from FSL in September 2017 from FSL-21. The sampling event experienced high matrix effects and the elevated cobalt levels are likely the result of sedimentation in the sample. Subsequent sampling events in 2018 and 2019 have been below the preliminary benchmarks at this location. Cobalt is therefore not retained as a COPC in the EcoRA.

3.4.5 Surface Water

3.4.5.1 Data Relied Upon and Sampling Locations

Three surface water categories were assessed in the 2022 ERA as these areas are considered to have aquatic habitat: off-site permanent waterbodies (Lake Huron nearshore environment), on-site permanent water courses (Stream C), and on-site permanent drainage features (Eastern Drainage Ditch (EDD), B16 Pond, B31 Pond, FSL) (see Section 1.8.1 for further details). Of note, Stream C constitutes both upstream and downstream sampling locations, referred to as Stream C Upstream (US) and Stream C Downstream (DS). Therefore, Stream C US samples were considered representative of reference concentrations for screening purposes because groundwater inputs and surface water drainage to Stream C US are not impacted from site operations.

The surface water features assessed incorporate all potential locations where groundwater from the Site may discharge to surface water. Given groundwater discharge to Lake Huron will occur in a diffuse manner (both in shallow and deeper waters), dilution and dispersion of groundwater in Lake Huron would rapidly occur. As a result, the surface water sampling locations near the Site sufficiently capture inputs from groundwater for preliminary screening purposes.

Note that recreational users are off-Site human receptors because they are exposed to surface water when they use Lake Huron for recreational purposes. As such, the preliminary screening considers COPCs in Lake Huron only for human receptors.

Surface water results from 2017 to 2021 were considered in the 2022 ERA. These results were considered to be reflective of the current site conditions.

All surface water quality data considered in the 2022 ERA for each investigated area are presented in Appendix E, Table 129 to Table 132. Surface water samples were analyzed for one or more of the following: inorganics, total metals, PHCs (F1 to F4, benzene, toluene, ethylbenzene, and xylene (BTEX), phenol, morpholine and hydrazine.

Surface water sampling locations considered in the EcoRA are shown on Figure 47 and Figure 48.

3.4.5.2 Preliminary Screening Values and Screening Approach

No site-specific limits were available for surface water; therefore, the following provincial and federal screening values were considered in the preliminary screening and the most stringent of the values were selected as the preliminary benchmarks:

- CCME CWQG for the Protection of Aquatic Life: Freshwater, Long Term [R-226];
- Health Canada GCDWQ [R-206];
- Ontario Regulation (O.Reg.) 169/03 Ontario Drinking Water Standards (ODWS) [R-9]; and,
- Ontario PWQOs [R-16].

Several surface water screening values depend on physio-chemical water chemistry, such as pH, temperature, hardness and dissolved organic carbon (DOC). For these screening values, the site-specific conditions of the water body at the time of sampling were considered to derive a preliminary benchmark for each sampling event. DOC was not measured for any of the assessed waterbodies. A value of 1.9 mg/L was assumed based on DOC measured by Zhou [R-227] at a sampling location in Lake Huron closest to the Site (Station LH-04 in Zhou [R-227]). The concentration of DOC at this location was 158 µmol/L, which is equivalent to 1.896 mg/L.

Additionally, un-ionized ammonia (NH_3) is calculated from total ammonia measurements (NH_3 plus NH_4^+) and field-measured pH and temperature according to the equations outlined below and described by [R-228]:

un-ionized NH_3 (µg/L) = total ammonia (µg/L) × the fraction (f) of NH_3, where

$f = 1/(10^{(pKa - pH)} + 1)$, and the acid dissociation constant (pKa) is

pKa = 0.09018 + 2727.92/T, where T is the temperature in Kelvin.

Ammonia concentrations reported in mg/L NH_3 units were converted to mg/L NH_3-N units by multiplying by 0.82247.

The following general screening approach was used to identify COPCs in surface water:

- Maximum detected concentrations were compared against preliminary benchmarks. If the maximum detected concentration was less than preliminary benchmarks, the chemical was not identified as a COPC. Comparison to these preliminary benchmarks was considered to represent a conservative evaluation of the potential for risks to human and ecological health. Therefore, parameters with concentrations that were less than preliminary benchmarks were considered to pose negligible risk to human and ecological health and were not retained for further assessment.
- If the maximum detected concentration was greater than its preliminary benchmark, the chemical was identified as a COPC and carried forward in the 2022 ERA for the assessment of potential risks to ecological health. For the EcoRA, these COPCs were also subject to a secondary screening process as described in Section 3.5.
- For Stream C samples, if the maximum concentration was greater than the preliminary benchmark it was subsequently compared to the Stream C US samples taken from the same date. If the Stream C US sample was greater than the Stream C DS sample, it was assumed that the COPC originated from off-site and was therefore not carried forward into the secondary assessment.
- Chemicals for which there were no preliminary benchmarks were evaluated further as follows: if all concentrations of a parameter were less than its MDL, then the parameter was not considered to be present at greater than background levels and was not retained as a COPC. If the concentration was detected in samples collected within the assessed area, it was retained as a COPC.

The preliminary screening for surface water is presented in Appendix E, Table 129 to Table 132 and the results are summarized below for each assessed area.

3.4.5.3 Results

General COPC Exclusions in Surface Water

Several of the general chemistry parameters do not have preliminary screening values available from any jurisdiction or the available values are related to aesthetic or operational objectives (e.g., conductivity, temperature, hardness, total dissolved solids (TDS), total suspended solids (TSS), alkalinity and sulphate). These parameters are not considered to have a direct effect on human and environmental health and as such were not retained as COPCs in the 2022 ERA.

Parameters attributable to road salting practices during the winter months as part of the facility's general maintenance programs such as sodium, chloride and electrical conductivity were also eliminated. The Ontario MECP has exempted the effects of road salting including associated changes to sodium, chloride and electrical conductivity in risk assessments carried out under Ontario Regulation 153/04 [R-50].

Parameters with detection limits above their preliminary benchmarks such as selenium and mercury were also not retained as COPCs in the 2022 ERA. With respect to selenium, the detection limits exceeding the preliminary benchmarks are a function of the MDL that were achievable at the time of the analysis or the MDL may have been elevated due to matrix interference (e.g., sediment in the sample). Detectable concentrations of selenium were below the preliminary benchmark across all analyzed samples. Mercury has not been detected since 2017 and was not retained as a COPC in surface water. Due to a lack of detection, selenium and mercury were not retained as COPCs in surface water for the 2022 ERA.

Although above the preliminary benchmarks, the following chemicals were also not retained as COPCs for surface water within any of the assessed areas as described below:

- The preliminary benchmark for phosphorus in Lake Huron (20 µg/L) is based on the PWQO in order to avoid nuisance algae issues. Phosphorus concentrations within Lake Huron >20 µg/L were only detected in December 2018 and October 2020, with concentrations 1.4 times above the preliminary benchmark. Studies along the Lake Huron shoreline have identified that agricultural land uses are a significant source of phosphorous to Lake Huron [R-56]. The Ontario Provincial Water Quality Monitoring Network (PWQMN, https://data.ontario.ca/dataset/provincial-stream-water-quality-monitoring-network) has active monitoring stations near Bruce Power to the north (Mill Creek) and south (Pine River). Data from these PWQMN stations demonstrates that these local rivers are impacted by agriculture as Phosphorus concentrations are almost always above the preliminary benchmark concentration of 20 µg/L (Table 44). Phosphorus inputs to Lake Huron from across the lake fringe watersheds can reasonably account for the elevated Phosphorus concentrations observed in surface water samples collected on-site and within Lake Huron from 2017-2021. Bruce Power discharges of Phosphorus from the Bruce A and Bruce B CCW system and from the COS Sewage Treatment Plant also contribute phosphorus inputs into Lake Huron; however, as discussed in Section 3.4.1, phosphorus discharges within the last 5 years have met the ECA objective. As a result, phosphorus was not retained as a COPC in the EcoRA.

Table 44
Total Phosphorus Concentrations (µg/L) Measured in Nearby Rivers (2017-2020)

Location	Sample Size (*n*)	Min.	Max.	Median	Mean	standard deviation (1 σ)
Mill Creek (26 different measurement dates)	40	27	412	71	92	69
Pine River (24 different measurement dates)	38	13	111	31	39	24

- Dissolved oxygen (DO) is an important indicator of water quality and essential for the survival of fish and other aquatic organisms. DO levels were below the preliminary benchmark for Stream C and the on-site permanent drainage features in the months of July and August when the biological oxygen demand is greater as a result of higher amount of algae/aquatic plant species present during this time. Given that nutrients such as phosphorus and ammonia were not considered to be attributed to industrial activities within these areas, and therefore are not likely contributing to eutrophication in these water features, DO was not carried forward as a COPC.

- Fluoride will not be retained for on-site surface water assessment as this is not a chemical constituent used or emitted from Bruce Power operations. Fluoride is commonly elevated in local groundwaters and surface waters and it is naturally sourced from local geologic materials.

The COPCs identified for each assessed area are discussed below.

Lake Huron Nearshore Environment

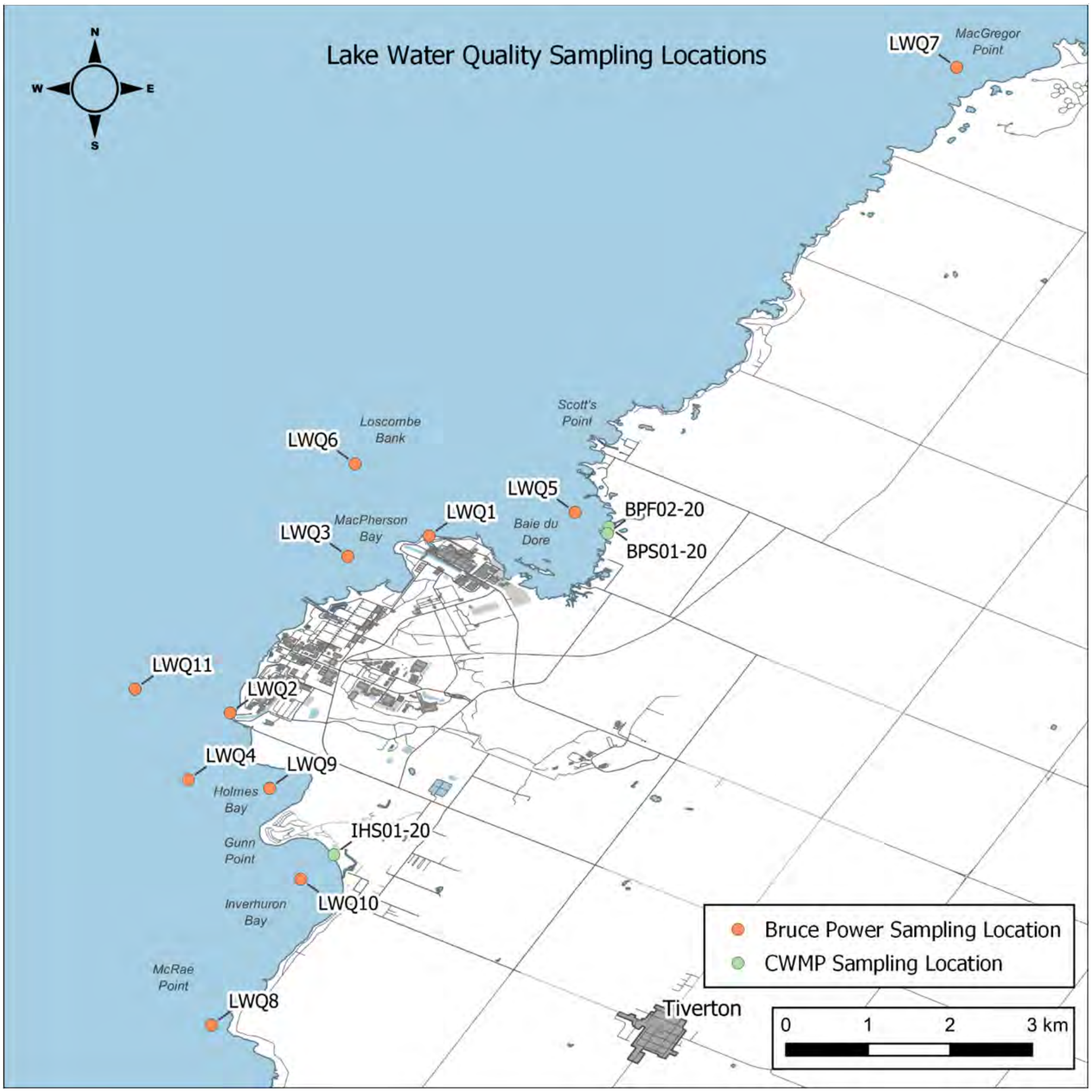

Figure 47
Lake Water Quality Sampling Locations

Surface water samples have been collected most recently from several locations within Lake Huron from 2017 to 2021 (Figure 47). These locations include Bruce A Discharge Channel (LWQ1), Bruce B Discharge (LWQ2), LWQ3, LWQ4, Baie du Dore (LWQ5 and BPS01-20), Loscombe Bank (LWQ6), MacGregor Point, (LWQ7), McRae Point (LWQ8), Holmes Bay (LWQ9), Inverhuron Bay (LWQ10 and IHS01-20) and Off Bruce B Discharge Channel (LWQ11). The locations sampled vary per sampling event, with the most frequently sampled locations being LWQ1, LWQ2, LWQ5, LWQ7 and LWQ8. Sample collection was mostly completed within 1 m of the water surface; however, occasionally there have been additional samples at MacPherson Bay and Gunn Point collected from 10 m or 20 m below the water surface. All surface water samples were used to evaluate potential effects to aquatic and semi-aquatic ecological receptors and human receptors.

Identified COPCs

Based on screening approach described above, the following COPCs were carried forward for further evaluation of Lake Huron surface water quality in the EcoRA:

- Ammonia
- Zinc

The preliminary benchmark for unionized ammonia-nitrogen (NH_3-N) is 16 µg/L. Unionized ammonia concentrations in Lake Huron exceeded the preliminary benchmark in 7 of the 65 samples collected from 2017 to 2021 (6 samples in Aug 2017, 1 sample in Dec 2018). None of the 19 samples collected in 2020 and 2021 exceeded the benchmark. The concentration of unionized ammonia in Lake Huron is dependent on the concentration of total ammonia, and the temperature and pH of the lake water. As temperature and pH rises, the fraction of unionized ammonia increases, which likely explains why the majority of the exceedances were observed in August 2017 (see Figure 69 to Figure 74 in Appendix I for lake temperature trends year-round).

Ammonia is discharged from Bruce Power through its COS Sewage Treatment Plant and through the Bruce A and Bruce B CCW systems. Hydrazine is added to boiler feedwater systems at Bruce Power because it is an oxygen scavenger and it prevents corrosion of the boilers. Ammonia is a by-product of hydrazine degradation and is therefore present at low concentrations in the Bruce A and Bruce B CCW discharges. CCW discharges are regulated by Provincial ECAs and the limits are equal to the preliminary benchmark. There were no exceedances of this limit from 2017-2021 (see Section 3.4.1) and therefore CCW discharges are not the most likely cause of the preliminary benchmark exceedances in Aug 2017 and Dec 2018. Ammonia discharges from the Bruce Power Sewage Treatment Plant from 2017-2021 also met all the regulatory limits established in its ECA (see Section 3.4.1).

It is likely that ammonia inputs into Lake Huron from sewage, agriculture, and/or nearby industry contributed to the observed exceedances in 2017 and 2018. In addition to Bruce Power's Sewage Treatment Plant which discharges into Lake Huron near CNL's Douglas Point facility, there is a location near Bruce B where treated sewage is discharged from the Municipality of Kincardine' s Bruce Energy Centre. Further, there are active and historic septic systems along the shoreline that contribute ammonia to Lake Huron throughout the year, and ammonia inputs from agricultural sources (via nearby rivers/streams) occur throughout the year as documented in nearby Provincial Water Quality Monitoring Network (PWQMN) monitoring sites and off-site samples collected from within Stream C (Stream C US). Although Bruce Power operations are not likely the only source of the elevated ammonia concentrations, it was carried forward in the EcoRA.

Elevated zinc concentrations were detected in the nearshore Lake Huron samples in Dec 2018 (MacGregor Point) and at 4 locations near Bruce Power in June 2021. The reason for this anomaly is unknown, but it is noted that pH was also elevated during this event. Zinc was carried forward as there was no subsequent sampling data available to confirm the anomaly.

None of the parameters within Lake Huron exceeded the Health Canada GCDWQ or ODWS. Therefore, no COPCs in surface water were carried forward into the HHRA for the protection of human receptors that may use Lake Huron for recreational purposes.

COPC Exclusion Justifications

The pH exceeded the preliminary benchmarks in 6 of 46 surface water samples collected from Lake Huron with a maximum pH value of 8.8 compared to the preliminary benchmark of 8.5. Although the Bruce Power ECA allows discharge up to a pH of 9.5, the elevated pH levels within Lake Huron have only occurred in the summer months (June to August) potentially because of higher photosynthetic activity during this time [R-199]. The preliminary benchmark for pH is based on the MECP acceptable range of 6.5 to 8.5 [R-229]; where freshwater bodies are considered to be the most productive. The CCME acceptable pH range for freshwater is between 6.5 to 9.0 [R-130]. The range from 6.5 to 9.0 is considered to be protective of fish and benthic invertebrate toxicity [R-199]. Although the toxicity of other contaminants, such as ammonia, aluminum and zinc, may be affected by pH changes; the preliminary benchmarks for these parameters account for the effects of site-specific pH levels on toxicity. pH was not retained as a COPC for Lake Huron as it is within the acceptable range of the CCME guidelines, protective of toxicological effects to biota.

Stream C

Samples were collected from two locations along Stream C (one upstream referred to as Stream C US [SW1] used to represent background water quality in the stream, and one downstream, referred to as Stream C DS [SW2] – see Figure 48 below). These samples were used to evaluate potential effects to aquatic and semi-aquatic receptors.

Identified COPCs

Based on screening approach described above, no COPCs were carried forward for further evaluation of Stream C surface water quality in the EcoRA.

COPC Exclusion Justifications

The maximum measured concentration of aluminum in Stream C DS exceeded its preliminary benchmark in 3 out of 13 analyzed samples. All Stream DS samples have been measured at concentrations lower than the corresponding US concentrations measured during the same period, with the exception of one sampling event in December 2020 where the DS concentration of aluminum (216 µg/L) was 1.6 times higher than the US concentration (131 µg/L). Further, the average US concentration over the past 5 years (318 µg/L) is higher than the average DS concentration (243 µg/L). Given this, aluminum is not retained as a COPC in Stream C for the EcoRA.

The maximum measured concentration of iron in Stream C DS (1360 µg/L, Mar 2021) exceeded the preliminary benchmark (300 µg/L). The corresponding concentration of iron at the upstream Stream C location on the same date was only marginally lower (1300 µg/L). Subsequent sampling completed in July and November 2021 showed iron concentrations in Stream C DS were non-detect or well below the Stream C US concentration during those same periods. Iron can originate from natural sources including sub-oxic groundwater that has higher concentrations of reduced iron (there are several groundwater discharge zones in Stream C [R-17]). Given this, iron was not retained as a COPC in Stream C for the EcoRA.

Permanent Drainage Features

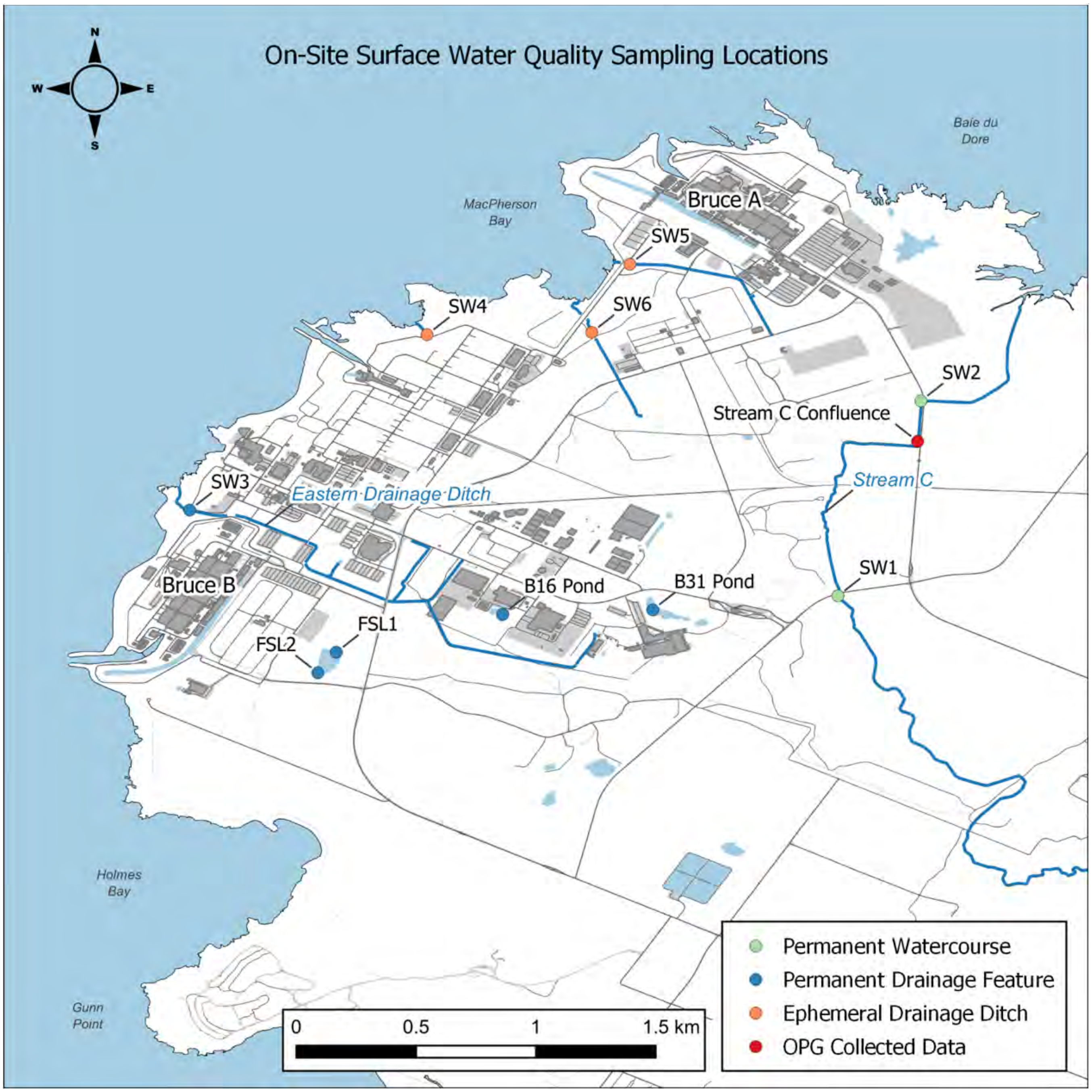

Figure 48
On-Site Surface Water Sampling Locations

Surface water samples collected from the on-site drainage features at Eastern Drainage Ditch (EDD), B16 Pond, B36 Pond and FSL (Figure 48) were considered with respect to aquatic and semi-aquatic receptors.

Identified COPCs

Based on screening approach described above, the following COPCs were carried forward for further evaluation of surface water quality in the permanent drainage features for the EcoRA:

EDD

- Aluminum
- Iron
- Vanadium
- Zinc

B16 Pond

- Iron

B31 Pond

- Aluminum
- Copper
- Iron

FSL

- Copper
- Zinc
- pH

COPC Exclusion Justifications

Ammonia was measured in surface water in the EDD in July 2021 above the preliminary benchmarks. These concentrations were 1.3 times above the preliminary benchmark (0.02 vs 0.016 µg/L). Further, the ammonia concentrations subsequently measured in November 2021 were below the benchmark. Given this, ammonia was not retained as a COPC in the EDD for the EcoRA.

3.4.6 Sediment

3.4.6.1 Data Relied Upon and Sampling Locations

Three sediment categories were assessed in the 2022 ERA as these areas are considered to have aquatic habitat: off-site permanent water courses (Lake Huron Nearshore Environment), on-site permanent water courses (Stream C), and on-site permanent drainage features (Eastern Drainage Ditch, B16 Pond, B31 Pond, FSL) (discussed in detail in Section 1.8.1). As previously discussed, Stream C constitutes both upstream and downstream sampling locations referred to as Stream C US and Stream C DS. Therefore, Stream C US samples will be considered representative of reference concentrations for screening purposes.

Note that recreational users are considered potential off-Site human receptors that may use Lake Huron for recreational activities; however, it is unlikely that these receptors will be significantly exposed to sediment. As such, sediment exposure for human receptors was considered an incomplete pathway and the preliminary screening does not consider COPCs for the HHRA.

Given that the 2017 ERA considered sediment data collected up to (and including) 2016, sediment results collected from 2017 to 2021 were considered in the 2022 ERA. These results were considered to be reflective of the current site conditions.

All sediment quality data considered in the 2022 ERA for each location are presented in Appendix E, Table 133 to Table 138. Sediment samples were analyzed for one or more of the following: inorganics, metals, PHCs (F1 to F4), BTEX, PAHs, PCBs, VOCs, and phenol.

Sediment sampling locations considered in the EcoRA are shown on Figure 49 and Figure 50.

3.4.6.2 Preliminary Screening Values and Screening Approach

No site-specific limits were available for sediment; therefore, the following provincial and federal screening values were considered in the preliminary screening and the most stringent of the values were selected as the preliminary benchmarks:

- MECP Table 1 Full Depth Background SCS for Sediment: All Types of Property Uses [R-10];
- CCME Sediment Quality Guidelines for the Protection of Aquatic Life: Freshwater ISQG [R-205];
- Thompson et al., 2005: LELs derived using the closest observation method. [R-210]; and,
- In the absence of screening values from the above sources, the MECP Table 1 Full Depth Background SCS for soil (Industrial/Commercial/Community Property Use) [R-10] followed by the MECP OTR_{98} concentrations for old urban parks were used [R-10].

The following general screening approach was used to identify COPCs in sediment:

- Maximum detected concentrations were compared against their preliminary benchmarks.
- If the maximum detected concentration was less than its preliminary benchmark, the chemical was not identified as a COPC. Comparison to these preliminary benchmarks was considered to represent a conservative evaluation of the potential for risks to ecological health. Therefore, parameters with concentrations that were less than preliminary benchmarks were considered to pose negligible risk to ecological health and were not retained for further assessment.
- If the maximum detected concentration was greater than its preliminary benchmark, the chemical was identified as a COPC and carried forward in the 2022 ERA for the assessment of potential risks to ecological health. For the EcoRA, these COPCs were also subject to a secondary screening process as described in Section 3.5.
- For Stream C samples, if the maximum concentration was greater than the preliminary benchmark it was subsequently compared to the maximum concentration from Stream C US samples. If the Stream C US concentration was greater than the Stream C DS concentration, it was assumed that the COPC originated from off-site and was therefore not carried forward into the secondary assessment.

- Chemicals for which there were no preliminary benchmarks were evaluated further as follows: if all concentrations of a parameter were less than its MDL, then the parameter was not considered to be present greater than background levels and was not retained as a COPC; however, if the concentration was detected in samples collected within the assessed area it was retained as a COPC.

The preliminary screening for sediment is presented in Appendix E, Table 133 to Table 138 for the Site and the results are summarized below for each assessed area.

3.4.6.3 Results

<u>General COPC Exclusions in Sediment</u>

TOC, moisture, and pH do not have preliminary screening values available from any jurisdiction; however, these parameters are not considered to have a direct effect on human and environmental health and as such were not retained as COPCs in the 2022 ERA.

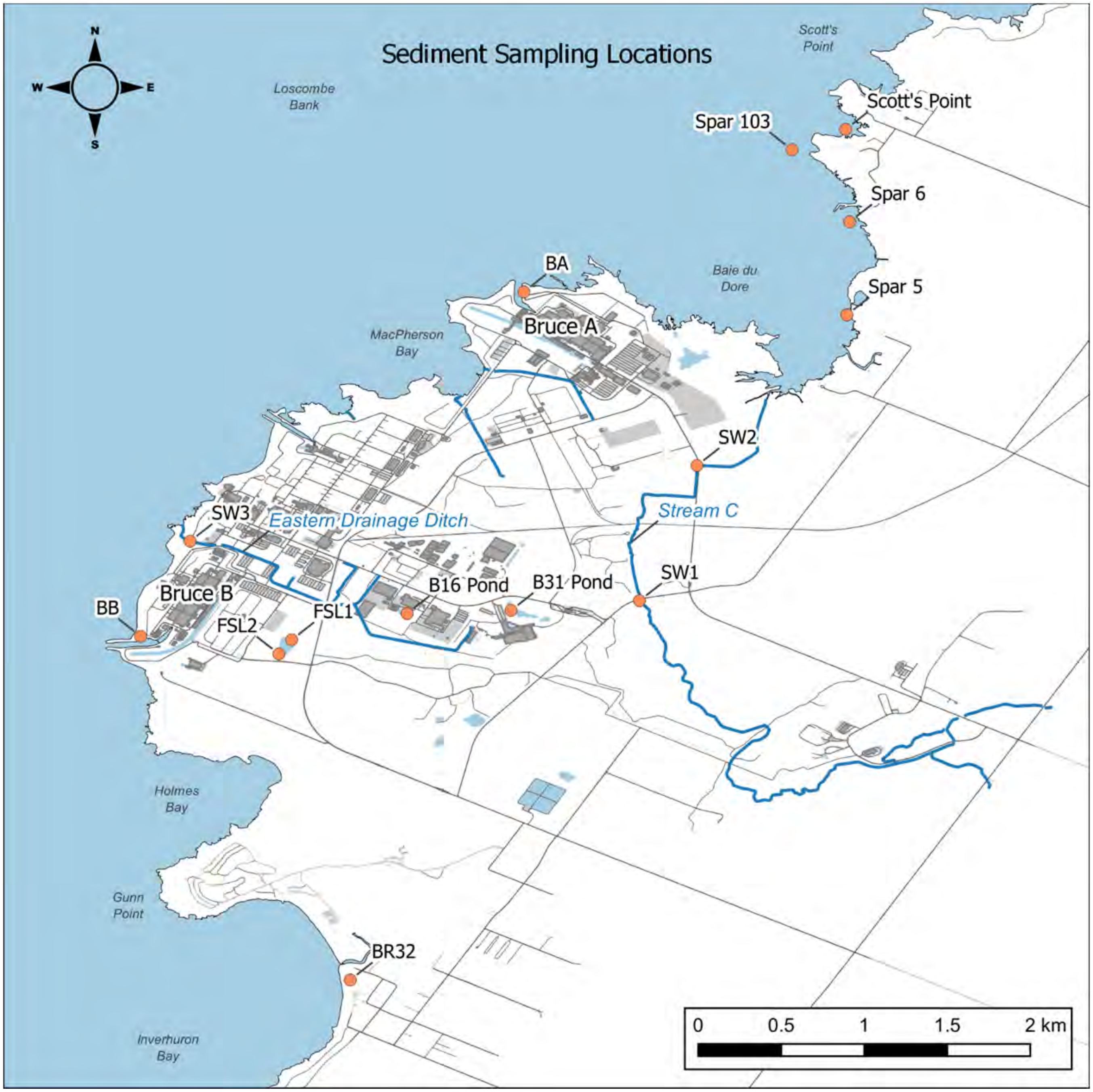

Figure 49
Sediment Sampling Locations On-Site

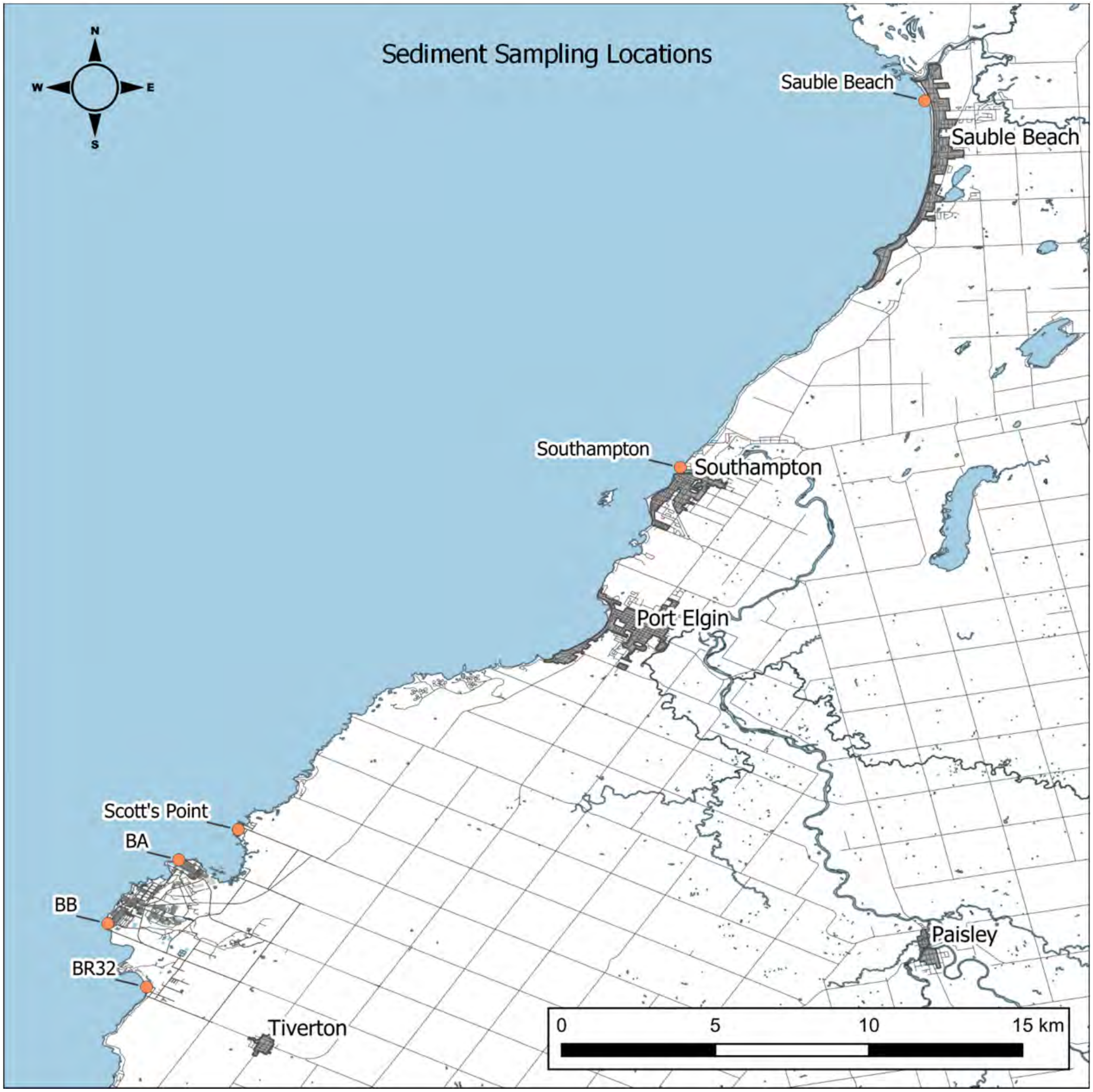

Figure 50
Off-Site Sediment Sampling Locations

Lake Huron Nearshore Environment

Sediment samples have been collected from several locations within Lake Huron from 2017 to 2021. These locations include Sauble Beach, Inverhuron (BR32) Bruce A Discharge Channel (BA), Bruce B Discharge Channel (BB), Scott's Point, Southampton, and Baie du Dore (SPAR5, SPAR6 and SPAR103). These samples were used to evaluate potential effects to aquatic and semi-aquatic receptors.

Identified COPCs

Concentrations of chemicals within Lake Huron sediment samples were below the preliminary benchmarks and therefore no COPCs were retained for further assessment in the EcoRA.

COPC Exclusion Justification

The maximum measured concentration of toluene (0.59 mg/kg) was 2.95 times the preliminary benchmark (0.2 mg/kg) in one out of ten samples collected from Lake Huron in 2021. This sample was collected in the Bruce B discharge channel and a duplicate sample collected at the same time did not exceed the preliminary benchmark at 0.15 mg/kg. Seven of the Lake Huron samples were below MDLs. The preliminary benchmark for toluene was based on the MECP Table 1 SCS for soil in the absence of sediment screening values. There are no sediment criteria available for toluene as there is limited toxicological information available. Further, toluene was also undetected across all surface water samples collected from Lake Huron. The isolated elevated levels in sediment are not expected to have an impact on aquatic receptors. Therefore, toluene is not carried forward as a COPC for Lake Huron. Monitoring of toluene should continue a part of routine surface water sampling in Lake Huron to confirm its limited impact.

The detection limit for benzene and total xylenes exceeded their respective preliminary benchmarks in sediment. However, benzene was not detected in any sediment samples considered in the 2022 ERA and as such, was not retained as a COPC. With respect to xylenes, the reportable detection limit was elevated in only one of 10 sediment samples within Lake Huron., However, total xylenes was also not retained for further assessment in the EcoRA because only one sample had detectable concentrations that were below the preliminary benchmarks.

The chemical 2-methylnapthalene exceeded the CCME ISQG of 0.0202 µg/g at one location, Scott's Point in a historical sample from 2016 (0.067 µg/g). This triggered subsequent sampling in 2021, where 2-methylnapthalene was non-detected, however, the MDL (0.10 µg/g) was above the CCME ISQG. The remaining historical samples collected within Lake Huron in 2016 were less than CCME ISQG guidelines. These concentrations, including the 2021 sample, were well below the probable effects level (PEL) of the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CSQG) (0.2017 µg/g). The CSQG has published spiked-sediment toxicity tests [R-230], indicating that toxic levels of PAHs to marine and benthic organisms are consistently above the ISQGs [R-205]. This confirms that effects to aquatic life are likely to be observed when PAH concentrations exceed the PELs. Further, the Scott's Point location is found to the north-east of the Site, approximately 2 km from the facility. Due to the infrequency of the exceedance, the distance of the location from the facility, and the low likelihood of aquatic effects at the measured concentrations, 2-methylnaphthalene was not retained as a COPC for sediment.

Stream C

Samples were collected from two locations along Stream C (one upstream referred to as Stream C US [SW1] used to represent background water quality in the stream, and one downstream referred to as Stream DS [SW2]). These samples were used to evaluate potential effects to aquatic and semi-aquatic receptors.

Identified COPCs

Concentrations of chemicals within Stream C sediment samples were below the preliminary benchmarks and therefore no COPCs were retained for further assessment in the EcoRA.

COPC Exclusion Justifications

The maximum measured concentrations of PHC F2 and F3 (35 mg/kg and 290 mg/kg, respectively) slightly exceeded their respective preliminary benchmarks (10 mg/kg for PHC F2 and 200 mg/kg for PHC F3) in Stream C in January 2017. PHC F2 was measured below detection limits and PHC F3 was below the preliminary benchmark in subsequent sediment sampling completed in June 2021 as well as across all surface water sampling events. Historical data from September 2009 also did not detect PHC concentrations in sediment within Stream C [R-231]. Heavy hydrocarbons such as PHC F3 found in sediment can be the result of organic matter breakdown in the aquatic environment [R-232]. Further, the preliminary benchmark was based on the MECP Table 1 SCS for soil in the absence of sediment criteria. There are no sediment criteria available for PHCs as there is limited toxicological information. The isolated elevated levels are not expected to have an impact on aquatic receptors. Therefore, PHC F2 and F3 were not carried forward as COPCs for Stream C. Monitoring of PHCs in Stream C should continue to confirm these results.

The detection limit for PHC F4 exceeded its preliminary benchmark and Stream C US in January 2017 however; PHC F4 was not detected in the subsequent monitoring event in June 2021. As such, it was not retained as a COPC.

Acetone was detected (1.2 µg/g) in a single downstream sample of Stream C in January 2017 and exceeded the Stream C US concentration (<0.5 µg/g). There is no preliminary benchmark for acetone in sediment, so the chemical was compared to preliminary benchmarks for soil. Acetone was 2.4 times the MECP Table 1 SCS of 0.5 µg/g at the Stream C DS sampling location and it was not co-located with any other VOC impacts. Overall, acetone exposure in sediment is considered negligible as it is highly soluble in water and so the primary media where it would have a toxicological effect is surface water where it was not included as a COPC. This isolated exceedance was not retained as a COPC for sediment.

Permanent Drainage Features

Sediment samples were collected from the following permanent drainage features that are considered to have aquatic habitat: Eastern Drainage Ditch (EDD), B16 Pond, B36 Pond and FSL.

Identified COPCs

Based on screening against the preliminary benchmarks, the following COPCs were carried forward for further evaluation of sediment quality within on-site ponds in the EcoRA:

EDD

- Cadmium
- Copper
- Nickel
- Selenium
- Vanadium
- Zinc
- Toluene
- PHC F3

FSL

- Cadmium
- Chromium
- Chromium (III)
- Copper
- Lead
- Mercury
- Nickel
- Zinc
- PHC F3
- PHC F4

B16 Pond

- None

B31 Pond

- Copper
- Nickel
- Selenium
- Zinc

COPC Exclusion Justifications

Antimony exceeded the Table 1 standard for soil (applied in the absence of MECP, CCME or Thompson et al. sediment criteria) in one sample collected from FSL. The other sample collected from FSL was non-detected and all other samples collected from drainage features were below the Table 1 standard. The elevated antimony levels are unlikely associated with site activities as analytical results for other media at FSL show the parameter was not detected in surface water and was below the Table 1 SCS for soil. As such, antimony was not retained as a COPC.

Silver exceeded the Table 1 standards for sediment within EDD and FSL. The elevated silver concentrations are unlikely associated with site activities as analytical results for other media at FSL show the parameter was not historically detected in surface water and was below the Table 1 SCS for soil. Similarly, silver at BBSG located upgradient from SW3 did not have detected silver concentrations in historical soil samples. As such, silver was not retained as a COPC.

Detection limits for total xylenes, PHC F1 and PHC F2 were above their respective preliminary benchmarks, however, no detectable concentrations have been recently measured from 2017 to 2021 in sediment. As such, these parameters were not retained as COPCs.

3.4.7 Drinking Water

The Site's drinking water is not municipally serviced as it uses treated water from Lake Huron for drinking and does not rely on potable wells. The drinking water pathway is therefore relevant for off-site human receptors that may be affected by the same groundwater aquifer as the Site.

The 2017 ERA reported drinking water samples were collected from four shallow residential wells. Drinking water samples were analyzed for one or more of the following: residual chlorine, oil & grease, total animal/vegetable oil & grease, total oil & grease mineral/synthetic, and VOCs. There were no COPCs identified in these drinking water samples.

No new drinking water samples were available from off-site wells for this ERA compared to the 2017 ERA. The reason for this was that there is no groundwater flow from on-site to any off-site location with a drinking well; therefore, there is no complete exposure pathway for off-site drinking water.

As discussed in Section 3.4.5, raw surface water collected from Lake Huron was below the Health Canada GCDWQ and ODWS.

No COPCs were therefore retained for further evaluation of drinking water exposures for the HHRA.

3.4.8 Summary of the Preliminary Chemical Screening

The purpose of the preliminary chemical screening was to focus the HHRA and EcoRA on the chemicals that may be associated with a potential human or ecological health risk. Through comparison with health-based guidelines and Ontario background concentrations (or site-specific limits for Bruce A and Bruce B discharges as well as air emissions), COPCs were identified for further assessment in the risk assessment. Chemicals present at concentrations less than their respective preliminary benchmarks were considered to be associated with a negligible human or ecological health risk and therefore were not evaluated further in the risk assessment.

For human health, there were no COPCs identified based on chemical concentrations measured in air, soil, surface water and drinking water. No COPCs were also identified for the Bruce A and Bruce B discharges.

For ecological health, the following COPCs (Table 45) were identified for further evaluation in the EcoRA:

Table 45
Summary of COPCs Retained in the EcoRA Following Preliminary Chemical Screening

Assessed Area	Soil COPCs	Groundwater COPCs	Sediment COPCs	Surface Water COPCs
BASC	Antimony Boron (HWS) Chromium VI Zinc Benzene Xylene PHC F2 PHC F3 PHC F4	Copper Zinc Sulphate	NA	NA
BBED	None	NA		
CL4	Cadmium Copper Silver Molybdenum Uranium 4-Bromophenyl Phenyl Ether Di-n-butyl Phthalate Benzene Acenaphthene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Dibenzo(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene Naphthalene Phenanthrene	NA		
FTF	TPH Light (C10-24) Benzyl butyl phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Hexachlorobenzene Nitrobenzene	NA		

Table 45
Summary of COPCs Retained in the EcoRA Following Preliminary Chemical Screening

Assessed Area	Soil COPCs	Groundwater COPCs	Sediment COPCs	Surface Water COPCs
	Diphenylamines (total) 2,3,4,5-Tetrachlorophenol Phenol 2-methylphenol Isophorone Acetone Benzene Chloroform Ethylbenzene Methyl ethyl ketone Purgeable Hydrocarbons (C5-C10) Toluene Xylene Acenaphthene Acenaphthylene Anthracene Benzo(a)anthracene Dibenzo(a,h)anthracene Fluorene Naphthalene			
FSL (Land)	Molybdenum Silver Uranium PHC F2	Copper Selenium Uranium Sulphate		
DS1	TPH Light (C10-C24) Total PCBs	NA		
DS#2/4/5	TPH Light (C10-C24) Xylenes	NA		
DS#8	TPH Light (C10-C24)	NA		
BPS / SS	Boron (HWS) Cadmium Lead Selenium Strontium Uranium PHC F1 PHC F2 PHC F3 PHC F4 Acetone	NA	NA	NA

Table 45
Summary of COPCs Retained in the EcoRA Following Preliminary Chemical Screening

<table>
<tr><th>Assessed Area</th><th>Soil COPCs</th><th>Groundwater COPCs</th><th>Sediment COPCs</th><th>Surface Water COPCs</th></tr>
<tr><td>Lake Huron</td><td rowspan="6">NA</td><td rowspan="6">NA</td><td>None</td><td>Ammonia
Zinc</td></tr>
<tr><td>Stream C</td><td>None</td><td>None</td></tr>
<tr><td>EDD</td><td>Cadmium
Copper
Nickel
Selenium
Vanadium
Zinc
Toluene
PHC F3</td><td>Aluminum
Iron
Vanadium
Zinc</td></tr>
<tr><td>B16 Pond</td><td>None</td><td>Iron</td></tr>
<tr><td>B31 Pond</td><td>Copper
Nickel
Selenium
Zinc</td><td>Aluminum
Copper
Iron</td></tr>
<tr><td>FSL (Pond)</td><td>Cadmium
Chromium
Chromium (III)
Copper
Lead
Mercury
Nickel
Zinc
PHC F3
PHC F4</td><td>Copper
Zinc
pH</td></tr>
</table>

Notes: NA – Not applicable as area is not assessed for this medium.

3.5 Secondary Chemical Screening for the EcoRA

For the EcoRA, the chemicals that exceeded the most stringent of the provincial/federal screening values (i.e., preliminary benchmarks) were further screened against secondary benchmarks protective of specific ecological receptor groups and exposure pathways, including:

- Terrestrial plants and soil invertebrates from direct contact with soil;
- Terrestrial plants and soil organisms from direct contact with groundwater;
- Soil and food ingestion by wildlife;
- Aquatic receptors from direct contact with surface water;
- Aquatic receptors from direct contact with sediment; and,
- Sediment and food ingestion by semi-aquatic wildlife.

COPCs were retained for further assessment in the EcoRA if their maximum concentrations were greater than the risk based ecological guidelines (i.e., pathway-specific secondary benchmarks).

A summary of the secondary chemical screening for soil, groundwater, surface water and sediment are provided below.

3.5.1 Soil

3.5.1.1 Terrestrial Plants and Soil Organisms

The following provincial and federal component values/guidelines protective of terrestrial ecological receptors from soil exposures were considered in the secondary screening:

- MECP Table 2 Ecological Soil Component Values for Full Depth Potable Ground Water Condition:
    - Plants & Soil Organisms (P&SO) – Protective of plants and soil-dwelling organisms from direct soil contact.
- CCME Canadian Soil Quality Guidelines for the Protection of Ecological Health ($CSQG_E$):
    - Ecological Soil Contact – Protective of plants and soil-dwelling organisms from direct soil contact.

The residential/parkland ecological guidelines from MECP and CCME were considered to ensure adequate protection of plants and soil organisms within naturalized areas on-site and adjacent to the site.

Secondary screening was completed using the more stringent of the provincial and federal ecological component values/standards listed above against the maximum soil concentration of the COPCs identified following preliminary screening. This chemical screening process is presented in Table 46 and Table 47.

Table 46
Secondary Screening of COPCs in Soil for Terrestrial Plants and Soil Organisms at BASC, CL4, FTF and FSL

COPC	Maximum Concentration				MECP P&SO *Res/Park*	CCME Soil Contact *Res/Park*
	BASC	CL4	FTF	FSL		
Antimony	4	-	-	-	20	nv
Boron (HWS)	**6.3**	-	-	-	1.5	nv
Cadmium	**-**	6.5	-	-	12	10
Chromium VI	**1**	-	-	-	8	0.4
Copper	-	**120**	-	-	140	63
Molybdenum	-	2.68	-	2.57	40	10
Silver	-	2.6	-	1.35	20	20
Uranium	-	2.6	-	3.597	500	500
Zinc	**520**	**350**	-	-	400	250
Benzene	<0.040 (0.003)	<0.040 (0.007)	0.42	-	25	31
Toluene	-	-	2.5	-	150	75
Ethylbenzene	-	-	1.5	-	55	55
Xylene	<0.080 (0.059)	-	6.8	-	95	95
TPH Light (C10-24)	-	-	**9,676**	-	150	nv
PHC F2	30	-	-	24	150	150
PHC F3	**340**	-	-	-	300	300

Table 46
Secondary Screening of COPCs in Soil for Terrestrial Plants and Soil Organisms at BASC, CL4, FTF and FSL

COPC	Maximum Concentration				MECP P&SO *Res/Park*	CCME Soil Contact *Res/Park*
	BASC	CL4	FTF	FSL		
PHC F4	130	-	-	-	2,800	2,800
Purgeable Hydrocarbon (C5-C10)	-	-	**222**	-	150	150
Acenaphthylene	-	-	**0.71**	-	nv	nv
Acenaphthene	-	**0.48**	**0.41**	-	nv	nv
Anthracene	-	1.2	0.47	-	2.5	nv
Benzo(a)anthracene	-	**2.6**	**2.1**	-	0.5	nv
Benzo(a)-pyrene	-	2.4	-	-	20	20
Benzo(b)fluoranthene	-	**5**	-	-	nv	nv
Benzo(g,h,i)perylene	-	1.7	-	-	6.6	nv
Dibenzo(a,h)anthracene	-	**0.79**	**0.22**	-	nv	nv
Fluoranthene	-	4.4	-	-	50	50
Indeno(1,2,3-cd)-pyrene	-	**1.7**	-	-	0.38	nv
Naphthalene	-	0.09	<0.06	-	0.6	nv
Phenanthrene	-	3.7	<0.1 (0.08)	-	6.2	nv
Acetone	-	-	**1.8**	-	nv	nv
Benzyl butyl phthalate	-	-	**0.1**	-	nv	nv
4-Bromophenyl Phenyl Ether	-	**0.01**	**-**	-	nv	nv
Chloroform	-	-	0.42	-	34	nv
Di-n-butyl Phthalate	-	**0.11**	**0.06**	-	nv	nv
Di-n-octyl Phthalate	-	-	**0.02**		nv	nv
Hexachlorobenzene	-	-	**2.4**	-	nv	nv

Table 46
Secondary Screening of COPCs in Soil for Terrestrial Plants and Soil Organisms at BASC, CL4, FTF and FSL

COPC	Maximum Concentration				MECP P&SO *Res/Park*	CCME Soil Contact *Res/Park*
	BASC	CL4	FTF	FSL		
Nitrobenzene	-	-	**4.5**	-	nv	nv
Diphenylamines (total)	-	-	**1.5**	-	nv	nv
2,3,4,5-Tetrachlorophenol	-	-	**32**	-	nv	nv
Phenol	-	-	2.6	-	17	nv
2-methylphenol	-	-	**16**	-	nv	nv
Isophorone	-	-	**0.13**	-	nv	nv
Methyl ethyl ketone	-	-	1.7	-	35	nv

Table 47
Secondary Screening of COPCs in Soil for Terrestrial Plants and Soil Organisms at DS1, DS2/4/5, DS8 and BPS/SS

COPC	**Maximum Concentration**				**MECP P&SO *Res/Park***	**CCME Soil Contact *Res/Park***
	DS1	**DS2/4/5**	**DS8**	**BPS/ SS**		
Boron (HWS)	-	-	-	**6.56**	1.5	nv
Cadmium				1.5	12	10
Lead				130	250	300
Selenium				**2.8**	10	1
Strontium				**110**	nv	nv
Uranium				13	500	500
Xylene	-	0.11	-	-	95	95
TPH Light (C10-24)	**384**	12	50	-	150	150
PHC F1	-	-	-	<50	210	210
PHC F2	-	-	-	**500**	150	150
PHC F3	-	-	-	**1500**	300	300
PHC F4	-	-	-	1400	2800	2800
Acetone	-	-	-	**1.1**	nv	nv
PCB	0.38	-	-	-	33	33

Notes:
All concentrations presented in µg/g
Bold and shaded indicates maximum concentration exceeds the most stringent secondary benchmark or secondary benchmark was unavailable
"-" – Not applicable, not identified as a COPC following preliminary screening
nv – no guideline identified

The COPCs listed in Table 48 were carried forward the evaluation of terrestrial plants and invertebrates from soil exposures as their maximum concentrations exceeded the secondary benchmarks or because no secondary screening criteria were available.

Table 48
Summary of COPCs in Soil for Terrestrial Plants and Soil Organisms

<table>
<tr><th>BASC</th><th colspan="2">CL4</th><th>FTF</th><th>FSL</th></tr>
<tr><td>Boron (HWS)
Chromium VI
Zinc
PHC F3</td><td colspan="2">Copper
Zinc
Acenaphthene
Benzo(a)anthracene
Benzo(b)fluoranthene
Dibenzo(a,h)anthracene
Indeno(1,2,3-cd)pyrene
4-Bromophenyl Phenyl Ether
Di-n-butyl Phthalate</td><td>TPH Light (C10-24)
PHC F3
Purgeable Hydrocarbons (C5-C10)
Acenaphthene
Acenaphthylene
Benzo(a)anthracene
Dibenzo(a,h)anthracene
Acetone
Benzyl butyl phthalate
Di-n-butyl Phthalate
Di-n-octyl Phthalate
Hexachlorobenzene
Nitrobenzene
Diphenylamines (total)
2,3,4,5-Tetrachlorophenol
2-methylphenol
Isophorone</td><td>None</td></tr>
<tr><th>DS1</th><th>DS2/4/5</th><th>DS8</th><th colspan="2">BPS / SS</th></tr>
<tr><td rowspan="5">TPH Light
(C10-24)</td><td rowspan="5">None</td><td rowspan="5">None</td><td>BPS-01</td><td>PHC F2
PHC F3</td></tr>
<tr><td>BPS-04</td><td>Boron (HWS)
Selenium
PHC F2
PHC F3</td></tr>
<tr><td>BPS-05, BPS-06, SS-6</td><td>PHC F2</td></tr>
<tr><td>SS-1, SS-7</td><td>Acetone
PHC F2</td></tr>
<tr><td>BPS-01-07
BPS-02-07</td><td>Strontium</td></tr>
</table>

3.5.1.2 Terrestrial Wildlife

The following provincial and federal component values/guidelines protective of terrestrial ecological receptors from soil exposures were considered in the secondary screening:

- MECP Table 2 Ecological Soil Component Values for Full Depth Potable Ground Water Condition:
  - Mammals & Birds (M&B) – Protective of mammals and birds from incidental soil ingestion and ingestion of food items. The residential/parkland guidelines were applied as they consider insectivorous species, whereas the industrial guidelines

do not. This will ensure adequate protection of insectivorous species within naturalized areas on and adjacent to the Site.

- CCME Canadian Soil Quality Guidelines for the Protection of Ecological Health ($CSQG_E$)
  - Soil & Food Ingestion (S&FI) - Protective of mammals and birds from incidental soil ingestion and ingestion of food items. These guidelines are only provided under agricultural land use.

Tier 2 screening was completed using the more stringent of the provincial and federal ecological component values/standards listed above against the maximum soil concentration of the COPCs identified following preliminary screening. This chemical screening process is presented in Table 49 and Table 50.

Table 49
Secondary Screening of COPCs in Soil for Terrestrial Wildlife at BASC, CL4, FTF and FSL

COPC	Maximum Concentration				MECP M&B *Res/Park*	CCME S&FI *Agri*
	BASC	CL4	FTF	FSL		
Antimony	4	-	-	-	25	nv
Boron (HWS)	6.3	-	-	-	NA (2)	NA (2)
Cadmium	**-**	**6.5**	-	-	1.9	3.8
Chromium VI	1	-	-	-	910	nv
Copper	-	120	-	-	770	300
Molybdenum	-	2.68	-	2.57	6.9	nv
Silver	-	**2.6**	-	**1.35**	nv	nv
Uranium	-	2.6	-	3.6	33	nv
Zinc	**520**	**350**			340	960
Benzene	<0.040 (0.003)	<0.040 (0.007)	0.42	-	370	25
Toluene	-	-	2.5	-	140	1400
Ethylbenzene	-	-	1.5	-	90	910
Xylene	<0.080 (0.059)	-	6.8	-	96	3700

Table 49
Secondary Screening of COPCs in Soil for Terrestrial Wildlife at BASC, CL4, FTF and FSL

COPC	Maximum Concentration				MECP M&B *Res/Park*	CCME S&FI *Agri*
	BASC	CL4	FTF	FSL		
TPH Light (C10-24)	-	-	9676	-	NA(1)	NA(1)
PHC F2	30	-	-	24	NA(1)	NA(1)
PHC F3	340	160	-	-	NA(1)	NA(1)
PHC F4	130	80	-	-	NA(1)	NA(1)
Purgeable Hydrocarbons (C5-C10)	-	-	222	-	NA(1)	NA(1)
Acenaphthylene	-	-	**0.71**	-	nv	nv
Acenaphthene	-	0.48	0.41	-	6600	21.5
Anthracene	-	1.2	0.47	-	38000	61.5
Benzo(a)anthracene	-	2.6	2.1	-	nv	6.2
Benzo(a)pyrene	-	**2.4**	-	-	1600	0.6
Benzo(b)fluoranthene	-	5	-	-	nv	6.2
Benzo(g,h,i)perylene	-	**1.7**	-	-	nv	nv
Dibenzo(a,h)anthracene	-	**0.79**	**0.22**	-	nv	nv
Fluoranthene	-	**4.4**	-	-	0.69	15.4
Indeno(1,2,3-cd)pyrene	-	**1.7**	-	-	nv	nv
Naphthalene	-	0.09	-	-	380	8.8
Phenanthrene	-	3.7	<0.1 (0.08)	-	2700	43
Acetone	-	-	1.8	-	56	nv
Benzyl butyl phthalate	-	-	**0.1**	-	nv	nv
4-Bromophenyl Phenyl Ether	-	**0.01**	-	-	nv	nv

Table 49
Secondary Screening of COPCs in Soil for Terrestrial Wildlife at BASC, CL4, FTF and FSL

COPC	**Maximum Concentration**				**MECP M&B *Res/Park***	**CCME S&FI *Agri***
	BASC	**CL4**	**FTF**	**FSL**		
Chloroform	-	-	0.42	-	81	nv
Di-n-butyl Phthalate	-	**0.11**	**0.06**	-	nv	nv
Di-n-octyl Phthalate	-	-	**0.02**		nv	nv
Hexachlorobenzene	-	-	**2.4**	-	nv	nv
Nitrobenzene	-	-	**4.5**	-	nv	nv
Diphenylamines (total)	-	-	**1.5**	-	nv	nv
2,3,4,5-Tetrachlorophenol	-	-	**32**	-	nv	nv
Phenol	-	-	2.6	-	9.4	nv
2-methylphenol	-	-	**16**	-	nv	nv
Isophorone	-	-	**0.13**	-	nv	nv
Methyl ethyl ketone	-	-	1.7	-	9900	nv

Table 50
Secondary Screening of COPCs in Soil for Terrestrial Wildlife at DS1, DS2/4/5, DS8 an BPS/SS

COPC	Maximum Concentration				MECP M&B *Res/Park*	CCME S&FI Agri
	DS1	DS2/4/5	DS8	BPS/ SS		
Boron (HWS)	-	-	-	6.56	NA	NA
Cadmium	-	-	-	1.5	1.9	3.8
Lead				**130**	32	70
Selenium	-	-	-	**2.8**	2.4	4.5
Strontium				**110**	nv	nv
Uranium	-	-	-	13	33	nv
Xylene	-	0.11	-		96	3700
TPH Light (C10-24)	384	12	50		NA(1)	NA(1)
PHC F1	-	-	-	<50	NA(1)	NA(1)
PHC F2	-	-	-	500	NA(1)	NA(1)
PHC F3	-	-	-	1,500	NA(1)	NA(1)
PHC F4	-	-	-	1,400	NA(1)	NA(1)
Acetone	-	-	-	1.1	56	nv
PCB	0.38	-	-		1.1	1.3

Notes:
All concentrations presented in µg/g
Bold and shaded indicates maximum concentration exceeds the most stringent Tier 2 benchmark
"-" – not identified as a COPC following preliminary screening
NA – Not applicable
(1) PHCs are not expected to accumulate in biota and have limited movement through trophic levels. Vertebrates are likely to metabolize PHCs into forms that are readily excreted from the body [R-161]
(2) Parameter specific to the evaluation of plant and soil invertebrate toxicity

COPCs listed in Table 51 were carried forward the evaluation of terrestrial wildlife from soil exposures as their maximum concentrations exceeded the secondary screening criteria or because no secondary screening criteria were available:

Table 51
Summary of COPCs in Soil for Terrestrial Wildlife

<table>
<tr><th>BASC</th><th>CL4</th><th>FTF</th><th colspan="2">FSL</th></tr>
<tr><td>Zinc</td><td>Cadmium
Silver
Zinc
Benzo(a)pyrene
Benzo(g,h,i)perylene
Dibenzo(a,h)anthracene
Fluoranthene
Indeno(1,2,3-cd)pyrene
4-Bromophenyl Phenyl Ether
Di-n-butyl Phthalate</td><td>Acenaphthylene
Dibenzo(a,h)anthracene
Benzyl butyl phthalate
Di-n-butyl Phthalate
Di-n-octyl Phthalate
Hexachlorobenzene
Nitrobenzene
Diphenylamines (total)
2,3,4,5-Tetrachlorophenol
2-methylphenol
Isophorone</td><td colspan="2">Silver</td></tr>
<tr><th>DS1</th><th>DS2/4/5</th><th>DS8</th><th colspan="2">BPS /SS</th></tr>
<tr><td rowspan="3">None</td><td rowspan="3">None</td><td rowspan="3">None</td><td>SS6</td><td>Lead</td></tr>
<tr><td>BPS-04</td><td>Selenium</td></tr>
<tr><td>BPS-01-07
BPS-02-07</td><td>Strontium</td></tr>
</table>

3.5.2 Groundwater

3.5.2.1 Terrestrial Plants and Soil Invertebrates

The following provincial and federal component values/guidelines protective of terrestrial ecological receptors from groundwater exposures were considered in the secondary screening:

- MECP Aquatic Protection Values
  - The MECP assumed that the GW3 values provides a sufficient degree of protection to terrestrial plants, so separate calculations for these receptors for direct contact exposure to shallow groundwater was not completed [R-10]. The GW3 values are based on the aquatic protection values (APVs) with consideration of attenuation processes during groundwater transport to a receptor. As a conservative measure, and given these values do not consider attenuation, the APVs were applied as a surrogate for screening COPCs for the direct contact with shallow groundwater pathway by terrestrial receptors.
- FCSAP FIGQG – Table 3: Tier 2 Criteria:
  - Soil Organisms Direct Contact – Protective of plants and soil organisms from direct groundwater contact, calculated from the CSQG for these receptors [R-207].

Secondary screening was completed using the more stringent of the provincial and federal ecological component values/standards listed above against the maximum groundwater concentration of the COPCs identified following preliminary screening. This chemical screening process is presented in Table 52.

Table 52
Secondary Screening of COPCs in Groundwater for Terrestrial Plants and Soil Invertebrates for BASC and FSL

COPC	Maximum Concentrations		Secondary Benchmarks	
	BASC	FSL	MECP APVs	FCSAP FIGQG Soil Organisms
Copper	0.0052	0.0038	0.0069	-
Selenium	NA	0.00106	0.005	-
Uranium	NA	0.0115	0.033	-
Zinc	0.015			0.089
Sulphate	**484**	**396**	-	-

Notes:
All concentrations presented in mg/L; NA = not applicable, not identified as a COPC following preliminary screening
Bold and shaded = maximum concentration exceeds the most stringent secondary benchmark or secondary benchmark was unavailable

No secondary benchmarks were available for sulphate for the protection of terrestrial plants due to limited information in the literature on its toxicological effects. Sulfur, a component of sulfate, is an essential nutrient for plants and toxicity is low [R-233]. Based on the limited toxicological effects known about sulfur, sulphate was not retained as a COPC for further assessment of terrestrial plants in the EcoRA.

Given the lack of COPCs identified in shallow groundwater at the BASC and FSL, conventional groundwater monitoring will be discontinued unless changes to the site activities in these areas warrant additional monitoring. The need for additional monitoring will be determined by the Groundwater Protection Program in alignment with CSA N288.7-15 [R-234].

3.5.3 Sediment

3.5.3.1 Benthic Invertebrates

The following provincial and federal component values/guidelines protective of benthic invertebrates from sediment exposures were considered in the secondary screening:

- MECP Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario [R-209];
  - Severe Effect Level (SEL): Sediments with concentrations greater than the SEL are defined as being “grossly polluted”. At this level, a pronounced disturbance of the sediment-dwelling community can be expected.
- CCME Canadian Sediment Quality Guidelines for the Protection of Aquatic Life: Freshwater [R-205]
  - Probable Effect Levels (PELs): Sediments with concentrations greater than the PELs are defined as frequently associated with biological effects.

Given that sediment COPCs were only identified within the on-site drainage features, these protection levels were appropriate given that these areas are man-made features surrounded by industrial operations, and that they do not support any fish SAR. This chemical screening process is presented in Table 53.

Table 53
Secondary Screening of COPCs in Sediment for Benthic Invertebrates at EDD, FSL and B31 Pond

COPC	Maximum Concentrations			Secondary Benchmarks	
	EDD	FSL	B31 Pond	MECP SEL	CCME PEL
Cadmium	0.74	2	NA	10	3.5
Chromium	NA	37	NA	110	90
Chromium (III) (1)	NA	37	NA	110	90
Copper	37	**210**	**150**	110	197
Lead	NA	50	NA	250	91.3
Mercury	NA	**0.61**	NA	2	0.49
Nickel	17	17	22	75	-
Selenium	**1.1**	NA	**1**	-	-
Vanadium	**100**	NA	NA	-	-
Zinc	**390**	310	**360**	820	315
Toluene	**0.26**	NA	NA	-	-
PHC F3	**500**	NA	**1,100**	-	-
PHC F4	NA	NA	**230**	-	-

Notes:
All concentrations presented in µg/g
Bold and shaded indicates maximum concentration exceeds the most stringent secondary benchmark or secondary benchmark was unavailable
NA – Not Applicable, not identified as a COPC following preliminary screening
(1) Guideline for total chromium (Cr) applied to Cr (III)

COPCs presented in Table 54 were carried forward the evaluation of aquatic receptors from sediment exposures as their maximum concentrations exceeded the secondary screening criteria or because no secondary screening criteria were available (i.e., toluene and PHCs):

Table 54
Summary of COPCs in Sediment for Benthic Invertebrates

EDD	FSL	B31
Selenium Vanadium Zinc Toluene PHC F3	Copper Mercury	Copper Selenium Zinc PHC F3 PHC F4

3.5.3.2 Semi-Aquatic Wildlife

The sediment quality standards and guidelines were derived to be protective of benthic invertebrates and not of semi-aquatic wildlife. Considering that contact with sediment by semi-aquatic wildlife is similar to contact with soil, any sediment COPC identified during preliminary screening were then compared to the most stringent ecological guidelines for soil protective of terrestrial wildlife:

- MECP Table 2 Ecological Soil Component Values for Full Depth, Potable Ground Water Condition:
    - Mammals & Birds (M&B) – Protective of mammals and birds from incidental soil ingestion and ingestion of food items. The residential/parkland guidelines were applied as they consider insectivorous species, whereas the industrial guidelines do not. This will ensure adequate protection of insectivorous species at risk identified on the Site.
- CCME Canadian Soil Quality Guidelines for the Protection of Ecological Health ($CSQG_E$)
    - Soil & Food Ingestion (S&FI) - Protective of mammals and birds from incidental soil ingestion and ingestion of food items. These guidelines are only provided under agricultural land use.

This chemical screening process is presented in Table 55.

Table 55
Secondary Screening of COPCs in Sediment for Semi-Aquatic Wildlife

COPC	Maximum Concentration			Secondary Benchmark	
	EDD	FSL	B31 Pond	MECP M&B *Res/Park*	CCME S&FI *Agriculture*
Cadmium	0.74	**2**	NA	1.9	3.8
Chromium	NA	37	NA	160	-
Chromium (III) (1)	NA	37	NA	160	-
Copper	37	210	150	770	300
Lead	NA	**50**	NA	32	70
Mercury	NA	0.61	NA	20	-
Nickel	17	17	22	5,000	528
Selenium	1.1	NA	1	2.4	4.5
Vanadium	**100**	NA	NA	18	-
Zinc	**390**	310	**360**	340	960
Toluene	0.26	NA	NA	140	1400
PHC F3	500	NA	1100	NA (2)	
PHC F4	NA	NA	230	NA (2)	

Notes:
All concentrations presented in µg/g
Bold and shaded indicates maximum concentration exceeds the most stringent secondary benchmark
NA – Not Applicable, not identified as a COPC following preliminary screening
NR – Not Required,
(1) Guideline for Cr (total) applied to Cr (III)
(2) PHCs are not expected to accumulate in biota and have limited movement through trophic levels. Vertebrates are likely to metabolize PHCs into forms that are readily excreted from the body [R-161].

COPCs listed in Table 56 were carried forward the evaluation of semi- aquatic receptors from sediment exposures as their maximum concentrations exceeded the secondary criteria:

Table 56
Summary of COPCs in Sediment for Semi-Aquatic Wildlife

EDD	FSL	B31
Vanadium Zinc	Cadmium Lead	Zinc

3.5.4 Surface Water

The following provincial and federal component values/guidelines protective of aquatic communities from surface water exposures were considered in the secondary screening:

- CCME Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life: Freshwater: Long Term [R-130]; and,
- MECP Aquatic Protection Values (APVs) [R-10]

Secondary screening was completed using the more stringent of the provincial and federal ecological component values/standards listed above against the maximum surface water concentration of the COPCs identified following preliminary screening. This chemical screening process is presented in Table 57.

Table 57
Secondary Screening of COPCs in Surface Water for Aquatic Communities

COPC	Maximum Concentration						Secondary Benchmark	
	Lake Huron	Stream C	EDD	B16 Pond	B31 Pond	FSL	MECP APV	CCME CWQG
Ammonia	**300**	NA	NA	NA	NA	NA	-	16
Aluminum	NA	NA	**775**	NA	**210**	NA	-	100[c]
Copper	NA	NA	NA	NA	**4.8**	**2.8**	6.9	2[a]
Iron	NA	NA	**1310**	**370**	**310**	NA	-	300
Vanadium	NA	NA	**20.5**	NA	NA	NA	20	-
Zinc	**130**	NA	**34**	NA	NA	**8.7**	89	Lake Huron: 10[b] FSL:2.6[b] EDD:31[b]
pH	NA	NA	NA	NA	NA	**9.5**	-	6.5-9

Notes:
All concentrations presented in µg/L
Bold and shaded = maximum concentration exceeds the most stringent secondary benchmark
NA – Not Applicable, not identified as a COPC following preliminary screening
'a - CWQG is depended on hardness, the average hardness measured within each water feature was used to calculate a secondary screening criteria.
'b - CWQG is depended on hardness, pH and DOC, the average hardness and pH measured within each water feature and an assumed DOC value of 1.9 mg/L was used to calculate a secondary screening criteria.
'c - CWQG is depended on pH. If pH > 6.5, the CWQG is set to 100 µg/L.

COPCs listed in Table 58 were carried forward the evaluation of aquatic receptors from surface water exposures as their maximum concentrations exceeded the secondary screening criteria or because no secondary screening criteria were available.

Table 58
Summary of COPCs in Surface Water for Aquatic Communities

Lake Huron	EDD	B16 Pond	B31 Pond	FSL
Ammonia Zinc	Aluminum Iron Vanadium Zinc	Iron	Aluminum Copper Iron	Copper Zinc pH

3.5.4.1 Semi-Aquatic Wildlife

Note that the above surface water screening is protective of aquatic communities only. While semi-aquatic wildlife may also be exposed to surface water, and their total exposure will consider exposure from both surface water and sediment, the more dominant and significant exposures for these receptors are associated with sediment pathways. As such, any sediment COPCs retained in Section 3.5.3 for semi-aquatic wildlife were retained as surface water COPCs for semi-aquatic wildlife.

3.5.5 Summary of Secondary Chemical Screening

In summary, the EcoRA will quantitatively evaluate the ecological receptor groups, exposure pathways and COPCs listed in Table 59 based on the secondary chemical screening.

Table 59
Summary of COPCs Retained in the EcoRA Following Secondary Chemical Screening

Receptor Group and Exposure Pathway	Assessed Area	Soil COPCs	Groundwater COPCs	Sediment COPCs	Surface Water COPCs
Terrestrial Plants and Soil Organisms Direct Contact	BASC	Boron (HWS) Chromium VI Zinc PHC F3	None	Not Applicable	Not Applicable
	BBED	None	Not Applicable		
	CL4	Copper Zinc Acenaphthene Benzo(a)anthracene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene 4-Bromophenyl Phenyl Ether Di-n-butyl Phthalate	Not Applicable		
	FTF	TPH Light (C10-24) PHC F3 Purgeable Hydrocarbons (C5-C10) Acenaphthene Acenaphthylene Benzo(a)anthracene Dibenzo(a,h)anthracene Acetone Benzyl butyl phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Hexachlorobenzene Nitrobenzene Diphenylamines (total) 2,3,4,5-Tetrachlorophenol 2-Methylphenol Isophorone	Not Applicable		
	FSL	None	None		

Table 59
Summary of COPCs Retained in the EcoRA Following Secondary Chemical Screening

Receptor Group and Exposure Pathway	Assessed Area	Soil COPCs	Groundwater COPCs	Sediment COPCs	Surface Water COPCs
	DS1	TPH Light (C10-24)	Not Applicable		
	DS#2/4/5	None	Not Applicable		
	DS#8	None	Not Applicable		
	BPS/SS	Boron (HWS) Selenium Strontium Acetone PHC F2 PHC F3	Not Applicable		
Terrestrial Wildlife (Mammals, Birds, Amphibians and Reptiles) Soil and Food Ingestion	BASC	Zinc	Not Applicable	Not Applicable	Not Applicable
	BBED	None			
	CL4	Cadmium Silver Zinc Benzo(a)pyrene Benzo(g,h,i)perylene Dibenzo(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene 4-Bromophenyl Phenyl Ether Di-n-butyl Phthalate			

Table 59
Summary of COPCs Retained in the EcoRA Following Secondary Chemical Screening

Receptor Group and Exposure Pathway	Assessed Area	Soil COPCs	Groundwater COPCs	Sediment COPCs	Surface Water COPCs
	FTF	Acenaphthylene Dibenzo(a,h)anthracene Benzyl butyl phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Hexachlorobenzene Nitrobenzene Diphenylamines (total) 2,3,4,5-Tetrachlorophenol 2-methylphenol Isophorone			
	FSL	Silver			
	DS1	None			
	DS#2/4/5	None			
	DS#8	None			
	BPS/SS	Lead Selenium Strontium	Not Applicable	Not Applicable	Not Applicable
Aquatic Communities Direct Contact	Lake Huron	Not Applicable	Not Applicable	None	Ammonia Zinc
	Stream C			None	None
	EDD	Not Applicable	Not Applicable	Selenium Vanadium Zinc Toluene PHC F3	Aluminum Iron Vanadium Zinc
	B16 Pond	Not Applicable	Not Applicable	None	Iron
	B31 Pond	Not Applicable	Not Applicable	Copper Selenium Zinc PHC F3 PHC F4	Aluminum Copper Iron
	FSL	Not Applicable	Not	Copper Mercury	Copper Zinc

Table 59
Summary of COPCs Retained in the EcoRA Following Secondary Chemical Screening

Receptor Group and Exposure Pathway	Assessed Area	Soil COPCs	Groundwater COPCs	Sediment COPCs	Surface Water COPCs
			Applicable		pH
Semi-Aquatic Wildlife (Mammals, Birds, Amphibians and Reptiles) Sediment, Surface Water and Food Ingestion	Lake Huron	Not Applicable	Not Applicable	None	*Total exposure from sediment and surface water was considered for semi-aquatic receptors. COPCs were identified based on sediment screening, as sediment exposures are considered the dominant exposure pathway*
	Stream C			None	
	EDD			Vanadium Zinc	
	B16 Pond			None	
	B31 Pond			Zinc	
	FSL			Cadmium Lead	

4.0 APPENDIX D: PREDICTIVE ENVIRONMENTAL RISK ASSESSMENT

This appendix provides the detailed information to support the conclusions of the PERA provided in Sections 3.3, 4.5, 5.6 ,6.5 and 7.3 of the main report [R-22], including a description of planned future activities on site, including Lu-177 production (Section 4.2) and Life Extension and MCR activities (Section 4.3).

The environmental outcomes of activities predicted to have an increased environmental impact in the 2017 PERA [R-1], along with any other new activities that have occurred on site in the last 5 years are described in Section 4.5. All sections in the predictive risk assessment incorporate human and ecological effects by media.

New activities occurring in the next five years (2021-2026) with a potential environmental impact are described in Section 4.6. The conclusions of the 2017 PERA outcomes and the 2022 PERA Tier 1 Screening have been included in the main ERA document [R-22].

4.1 Predictive Risk Assessment Methodology

The overall approach for predicting and assessing effects of future site activities, including Lu-177 production, Life-Extension and MCR activities, is based on CSA N288.6-12 [R-5]. The CSA N288.6-12 standard does not provide specific guidance on predictive effects assessment scenarios; therefore, modifications to the ERA to complete the PERA are discussed in this section. The approach is presented schematically on Figure 51 (modified from Figure 5.1 in CSA N288.6-12 [R-5]). The PERA is designed to focus on those pathways which may introduce new or modified effects on the environment, as well as focusing on those interactions most likely to cause an adverse environmental risk. Beneficial changes are identified, but are not considered further.

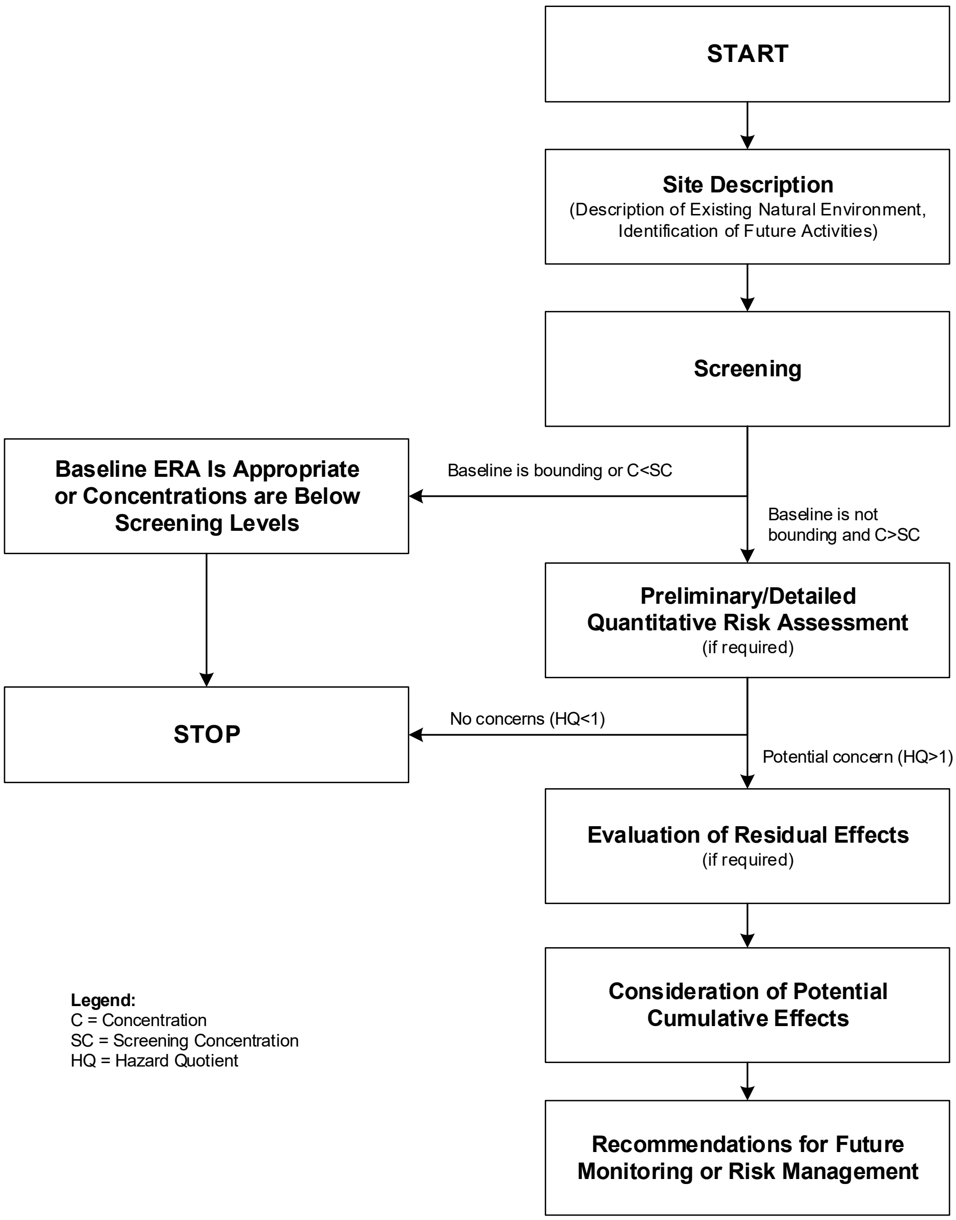

Figure 51 Predictive Effects Assessment Approach

The following sections describe project-environment interactions associated with future site activities for each aspect of the environment considered in the ERA. A step-wise predictive screening was carried out to identify and classify plausible interactions between future site activities and the environment. A summary of this screening is presented in each discipline specific subsection of the Human Health Risk Assessment and the Ecological Risk Assessment. Each interaction is evaluated in detail in Section 4.6 below.

4.1.1 Predictive Risk Assessment Outcomes

Outcomes of Life Extension activities completed between June 2016 and June 2021 listed in the 2017 predictive risk assessment are described under each section and any measurable changes from routine operations are described. Additional activities and outcomes that represent a change from the 2017 predictive risk assessment are also included.

In future ERAs, activities described as complete in this ERA will be integrated into routine effluent and environmental monitoring activities on the Bruce Power site and will no longer be discussed in the predictive risk assessment section.

4.1.2 Preliminary Screening

The preliminary screening includes evaluation of potential interactions of future site activities, including Lu-177 production, Life-Extension and MCR activities, with the environment to identify those receptors, exposure pathways and Contaminants of Potential Concern (COPC) that may warrant further assessment. The potential environmental interactions were evaluated to determine whether they are bound by existing or historical operational conditions and therefore adequately assessed in the current ERA or whether they are within screening criteria. Interactions bound by current or historical operations were not considered further in the PERA. Those interactions not readily bound by current or historical operations were considered in the PERA to identify whether predicted effects could exceed accepted screening values or compliance limits for the protection of human health and the environment. If the screening values or compliance limits were predicted to be exceeded, the interaction was evaluated further in the predictive quantitative risk assessment, if required.

For the human and ecological receptors, an evaluation is made regarding how exposure pathways may be modified in ways that have effects on the receptors(s) or their habitat as a result of future site activities, including MCR activities. The potential changes are discussed in the physical pathway-interaction discussions (e.g., for air quality and surface water quality).

Taking into consideration the description of future site activities in Section 4.2, 4.3 and 4.4, the potential for interaction with each environmental pathway is considered and summarized in a table within each relevant media in Section 4.6 for radiological and non-radiological contaminants. Where a potentially increasing interaction is identified, details are provided to describe and evaluate the interaction and the predicted change during future site activities. Proposed activities and the associated hazards are compared to periods of similar activity that have taken place. Each interaction is evaluated as potentially resulting in:

- An increased interaction with the environment compared to current operational conditions (denoted in the summary table with an arrow pointing up “↑”);
- A decreased interaction with the environment compared to current operational conditions (denoted in the summary table with an arrow pointing down “↓”);
- No change or negligible change from current or historical operational conditions (denoted in the summary table with an arrow pointing to the right “→”); or

- No interaction/not applicable (i.e., the system or structure does not have an interaction with the specified environmental pathway (denoted in the summary table with "—" [not applicable]).

This screening assessment, which is documented in each relevant media, is conducted using professional judgment and an understanding of Bruce Power operations. Where an interaction is identified, details are provided to describe and evaluate the interaction and the change during future site activities, including MCR activities. Those interactions that are likely to result in decreased or equivalent environmental effects are considered to be negligible and are not considered further in the PERA. For these interactions, the effects of the existing Bruce Power operations as described in the ERA are considered to be bounding.

Potential increases relative to existing or historical conditions are discussed further in the preliminary screening with the objective of determining if more detailed assessment is required. The predicted conditions are compared to accepted screening values or compliance limits for the protection of human health and the environment. If the predicted conditions exceed screening values, the interaction is then evaluated further in a predictive quantitative risk assessment.

4.1.3 Predictive Quantitative Risk Assessment

Where a pathway or receptor is not bound by current or historical operational conditions and the predicted change to a COPC and/or physical stressor cannot be screened using accepted guidelines, then the pathway and/or receptors are described in the conceptual site model and evaluated further in the predictive quantitative risk assessment, if required.

The quantitative risk assessment, if required, is a HHRA and EcoRA conducted in accordance with CSA N288.6 [R-5]. The predictive quantitative risk assessment is focused only on those elements carried forward from the preliminary screening.

4.1.4 Recommendations for Future Monitoring

Based on the results of the assessment, recommendations for monitoring or risk management may be made. Per CSA N288.4 [R-235], CSA N288.5 [R-236], and CSA N288.7 [R-237] the results of the PERA will inform the Bruce Power Environmental Monitoring Program (EMP), Emissions & Effluent Monitoring Program and the Groundwater Protection and Monitoring Program (GWMP). Monitoring recommendations from the PERA will be made in consideration of criteria provided in CSA N288.4 [R-235] and in CSA N288.7 [R-237]. Recommendations may include modifications to the EMP or GWMP if the emissions/effluents and pathways for environmental effects are predicted to change as a result of future site activities. The recommended changes to monitoring programs would be implemented to demonstrate that environmental effects from future site activities are acceptable. Risk management measures may also be recommended to manage risks from predicted adverse effects. Recommendations are summarized in Section 4.7.

4.1.1 Quality Assurance and Quality Control

For QA/QC procedures undertaken during the planning and preparation of the PERA refer to Section 1.8 of the main report [R-22].

4.2 Lutetium-177 Production

The radio-isotope Lutetium-177 (Lu-177) is a beta emitter that decays to stable Hafnium-177 (Hf-177) with a half-life of 6.647 days. Lu-177 emits beta radiation with three branching ratios having a maximum energy of 498 keV (79.4%), 385 keV (9.0%) and 177 keV (11.6%) and low-energy gamma radiation at 113 keV (6.17%) and 208 keV (10.36%) [R-238]. Lu-177 can be produced by neutron activation of Yb-176. This creates Ytterbium-177 (Yb-177) which decays into Lu-177 with a half-life of 1.9 hours.

The production of Lu-177 in Bruce B Unit 7 will be managed and operated by Bruce Power personnel. Bruce Power operators will load fresh targets in the Isotope Production System (IPS) and retrieve them after irradiation.

The IPS delivers Yb-176 targets to the reactor core, retrieves the irradiated product after the activation period, and deposits it into canisters for transportation to processing facilities:

- The targets will be pushed pneumatically through a line connected to the Target Finger Tubes (TFTs), into the reactor core.
- After one week of irradiation, the targets will be extracted pneumatically and dropped into a Transport Container (TC).
- The TC will be sealed, checked for contamination, and shipped to an external processing facility.

The initial production will be achieved with one TFT in a Guide Tube Assembly accessible from the Reactivity Mechanism Deck. The targets will be irradiated for one week, and all targets will be harvested each week. The irradiation process uses greater than 99.6% enriched Yb-176 in the form of oxide ceramic powder (Yb_2O_3).

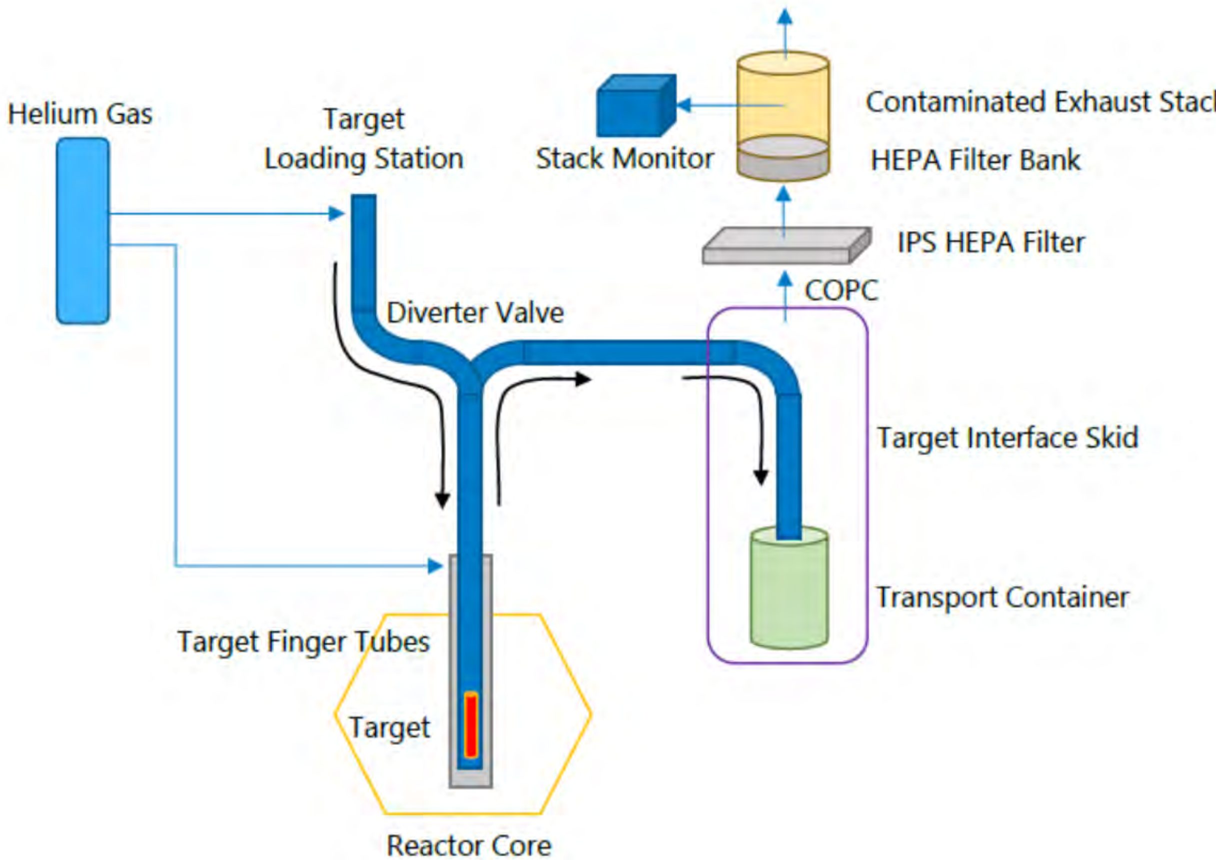

Figure 52 Isotope Production System Conceptual Diagram

A conceptual description of the IPS, shown in Figure 52, shows the pathway of the targets within the system, the process flow for helium gas, and the release point of contaminants:

1. The Target Ampules, displayed in Figure 53, are sealed and leak-tested before being inserted in a Target Carrier.

2. The Target Carrier, shown in Figure 54, provides protection for the Target Ampule placed within it. The Target Carrier is designed to maintain its ability to act as an additional barrier against leakage/release of the target material during insertion and withdrawal from the reactor.

3. The IPS uses helium gas to pneumatically move the targets through the system. Helium gas is chemically and radiologically inert. During each operation, carrier gas flow will only be required for short periods of time for target insertion, target retrieval, system purge, and target braking.

4. Since the carrier gas is routed through the reactor, the spent carrier gas from the IPS may contain potentially activated particulates, Carbon-14 and Argon-41.

5. The carrier gas vent lines will be connected to the Contaminated Exhaust Stack of Unit 7.

6. The vent lines are each equipped with a 30-micron High Efficiency Particulate Air (HEPA) filter to prevent the entry of activated material or any Contaminants of Potential Concern (COPC) into the Unit Ventilation System Contaminated Exhaust Stack.

7. In addition, the gaseous emission stream will be routed to one of the Contaminated Exhaust Stack's four HEPA filter banks. Each bank contains a prefilter and an absolute filter. The prefilter removes the larger particles. The absolute filter removes 99.97% of all particles 0.3 microns or larger.

8. The effectiveness of the filters is validated with radioactive stack monitors located prior to discharge through the stack to atmosphere.

9. There will be no radioactive waste generated at the Bruce Power site; the processing facility will be responsible for its own waste.

In summary, the IPS is not expected to generate radioactive effluents or emissions that materially change the existing emissions from the station.

Figure 53 Target Ampule

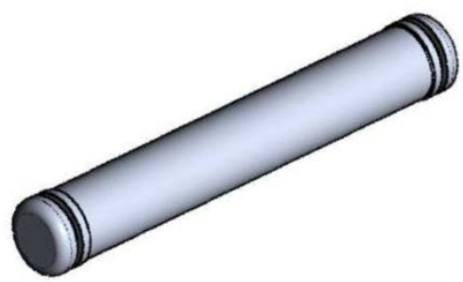

Figure 54 Target Carrier

The target ampules are sealed and leak-tested before being inserted in a Target Carrier, so no activity from the target material is expected in the carrier gas. Additionally, the Target Carriers are sealed and leak-tested to withstand the expected thermal pressure during irradiation.

The Isotope Production System periodically uses helium gas to pneumatically move the targets through the system which, when routed through the reactor, may contain potentially activated particulates and gases. Radionuclides potentially created during the movement of the Target Assembly could include:

- Zirconium-95 (Zr-95), an activation product of zircalloy which is a material widely used in CANDU reactors. Zr-95 has a half-life of about 64 days and is already monitored in the emission streams of the station;

- Niobium-95 (Nb-95), a progeny of the radioactive decay of Zr-95. Nb-95 has a half-life of about 35 days and is also routinely monitored in the emission streams;

- Aluminum-28 (Al-28), an activation product of aluminum which is the material used in the Target Carrier. Al-28 has a short half-life of 2.25 minutes, which means its activity becomes negligible very quickly after the target leaves the reactor core, although it would be detected as part of existing monitoring;

- Carbon-14 (C-14), an activation product of N-14 which can be present in the isotope production system due to air ingress during the target loading operation.C-14 is mostly generated in CANDU reactors from the nitrogen impurity in the moderator cover gas and the liquid-zone-control helium system; C-14 has a half-life of about 5,730 years and can be released in elemental particulate form, or CO_2 gaseous form, which are already monitored in the emission streams for all contaminated stacks; and

- Argon-41 (Ar-41), an activation product of Ar-40 which can be present in the isotope production system due to air ingress during the target loading operation. Ar-41 is already generated in CANDU reactors from the very small argon impurity present in the carbon dioxide gas used for the annulus-gas system, and in the helium used for the moderator cover gas and the liquid-zone-control helium system. The half-life of Ar-41 is about 110 minutes. Ar-41 is already monitored as part of noble gas monitoring in the emission streams.

It should be noted that very small volumes of carrier gas are expected, since the gas flow will only be required for short periods of time for target insertion, target retrieval and system purge. The gaseous emissions stream will be discharged to the Unit Ventilation System contaminated exhaust where particulates are filtered twice. This means that any small quantities of particulates that may be present would be attenuated considerably by the filters. C-14 in CO_2 chemical form is a gas that will not be captured by the filters. Similarly, Ar-41 is a noble gas that will not be attenuated by the filters. All other potentially released radionuclides are expected to be in particulate form, and would thus be captured by the filters.

The annual release of Ar-41 and C-14 from operation of the IPS has been conservatively estimated based on activation of air in the Target Finger Tubes. Assuming the entire volume of cover gas within the TFTs is replaced by air following insertion and prior to purge, and at the normal time of harvesting, the activity of Ar-41 and C-14 from air activation has been calculated [R-239]. Assuming bounding irradiation times and this scenario recurring each week, the maximum annual releases of Ar-41 and C-14 are calculated to be 3.27E+10 Bq-MeV/y and 4.75E+06 Bq/y, respectively. These are compared to current average Bruce B emissions and Derived Release Limits for noble gases and C-14 in Table 60.

Given that target material is sealed in the ampules, and any small volumes of activated particulates that may be present in the carrier gas would be attenuated by particulate filters, releases of particulates from the IPS during normal operations are expected to be negligible. Furthermore, although the operation of the IPS is a new activity, the radionuclides potentially emitted by this activity would be measured by existing emissions monitoring for the operation of the Bruce B reactor. These existing radionuclide releases from the operation of Bruce B are currently monitored, and the magnitude of those releases is known. However, in order to mitigate uncertainty associated with the potential activity of particulates that may be released, Bruce Power will collect data to confirm that there is no impact on gaseous emissions from operation of the IPS, as discussed in Section 4.2.1.

The projected IPS emissions during normal operations are compared to 2016-2020 average Bruce B emissions and Derived Release Limits in Table 60. The maximum annual IPS emissions are a small fraction (<0.1%) of current average Bruce B emissions, and far below the DRLs. It is confirmed that the IPS will not generate radioactive emissions that materially change the existing emissions from the Bruce B station during normal operations.

Table 60 Projected IPS emissions during normal operations

Radioactive Emission	**Maximum annual IPS emissions during normal operations (Bq/y)**	**Bruce B 2016-2020 Average Emission Rate (Bq/y)**	**IPS maximum annual emissions Rate (% of existing Bruce B emissions)**	**Derived Release Limit (Bq/y)**	**IPS maximum annual emissions Rate (% of DRL)**
Particulate (beta-gamma)	Estimated to be negligible	3.36E+06	-	1.37E+12	-
Carbon-14	4.75E+06	1.11E+12	4.27E-04%	4.09E+15	1.16E-07%
Noble gases[1]	3.27E+10	4.07E+13	8.05E-02%	3.77E+17	8.68E-06%

[1] Noble gas releases and DRLs are in Bq-MeV/y.

Potential releases from the IPS during Anticipated Operational Occurrences (AOO) are also assessed. Ampule failure and release of some activated target material is considered an AOO, and the subsequent release of particulates is conservatively estimated. Air ingress in the system during the weekly irradiation is also considered an AOO and is estimated separately.

Under normal operation, the activated target material is sealed within the Target Ampule. In the event of a failure of the ampule where the Target Carrier remains intact, most of the activated material would be contained within the Target Carrier. While the Target Carrier is also sealed, it is conservatively assumed that some powder may leak out in the event of ampule failure. Assuming that the Target Carrier remains inside the IPS, a small fraction of the target powder could escape the Target Carrier and enter the carrier gas stream. The particulates in the exhaust of the carrier gas would be attenuated by the multiple filtration barriers described above.

Emissions entering the gas stream would be bounded by the activity inside an irradiated Target Assembly. The most radiologically significant radionuclides present in an irradiated target are Lu-177, Yb-175 and Yb-177. These radionuclides are the most likely to be detectable on the particulate filters from the stack monitor because of their activity and half-life. Other radionuclides have lower activity, shorter half-life, or both which means that they contribute a negligible amount to the total activity in the target and are less likely to be detectable.

The Safety Analysis examines the doses to the public following a postulated out of core IPS failure that damages up to 58 ampules and target carriers (the maximum number of targets that can be loaded at the same time) leading to a release of irradiated target materials in powder form [R-240]. The consequences of the failure are evaluated against the applicable public dose limits.

Based on the estimated frequency of occurrence, the out of core failure of the IPS is considered a Design Basis Accident (DBA), and as such is not assessed in the ERA. Nevertheless, the results of the calculation are discussed here since they are bounding for the AOO.

The Safety Analysis calculated the total activity released for a DBA as 3.13E+11 Bq. The activity released is obtained by multiplying the activity in 58 targets by an airborne release fraction for material in powder form.

This event results in a dose to the critical individual at the site boundary of less than 8.9E-04 mSv and 1.2E-03 mSv at the 90th and 95th percentiles, respectively.

Based on the release and doses calculated for the target failure DBA presented above, the potential release for the ampule failure AOO is estimated using the following assumptions:

- The activity of Lu-177, Yb-175 and Yb-177 available for release in one target is 2.70 TBq.
- Based on the operating experience at FRM II in Germany, it is expected that there will be fewer than 3 ampule failures per year at the maximum production rate of about 3000 target irradiations per year at the Bruce Power reactor.
- A bounding value of 0.001 of the activated material is assumed to escape the Target Carrier (bounding airborne release fraction for powder held in can) [R-241].
- The HEPA filter installed on the vent lines of the IPS captures 99.9% of the particles 30 microns and larger
- The bank of stack filters captures 99.97% of all particles 0.3 microns or larger

The release to the environment is calculated as follows (Equation 1):

$$R[Bq] = A[Bq] \times ARF \times AF_{IPS-Filter} \times AF_{STACK-Filter}$$

$$R\ [Bq] = A\ [Bq] \times ARF \times AF_{IPS-Filter} \times AF_{STACK-Filter}$$

Eq. 1

R	Release to environment [Bq]
A	Activity in one target [Bq]
ARF	Airborne release fraction for powder held in a can
$AF_{IPS\text{-}Filter}$	Attenuation factor of the IPS HEPA filter
$AF_{STACK\text{-}Filter}$	Attenuation factor of the stack HEPA filter

Using Equation 1, the estimated release for the failure of one ampule gives a release of 8.11E+02 Bq. Assuming a maximum of 3 ampule failures/year, the annual release from AOO events is 2.43E+03 Bq/year. The DRL for Bruce B airborne beta-gamma particulate is 1.37E+12 Bq/year and the existing annual average release of particulates from the station is 3.36E+06 Bq/year (2016-2020). The release rate corresponding to the AOO events is a negligible fraction of the DRL and the existing annual release rate of particulates from Bruce B.

The largest contributor to the uncertainty of the activity released is the airborne release fraction for powder held in a can. The airborne release fraction of 0.001 is bounding for this type of event, but the actual release fraction could be much less. The size distribution of the powder material is another source of uncertainty which impacts the effectiveness of the filters. Samples of the powder material show coarse grains that would be effectively captured by the filters. The uncertainty on number of ampule failures per year is high, since it is based on a single event that occurred after more than a thousand target irradiations at the FRM II reactor in Germany. The actual failure rate per irradiation of target could be a lot less, based on the recent OPEX from the FRM II which showed no further failures. The FRM II reactor never experienced a failure of both the ampule and Target Carrier at the same time inside the IPS.

Using the same methodology as the Safety Analysis, the release from one ampule failure gives a dose of 2.3E-12 mSv at the 90th percentile and 3.1E-12 mSv at the 95th percentile. The annual dose from AOO events (3 ampule failures/year) is 6.9E-12 mSv/year at the 90th percentile and 9.3E-12 mSv/year at the 95th percentile. This is a negligible dose that has no impact on human receptors. In the Safety Analysis, the release of the powder from the powerhouse is without buoyancy and at ground-level. This assumption is conservative relative to a release through the Contaminated Exhaust System, which would be elevated.

Given that an AOO release of 2.43E+03 Bq/year is a small fraction of annual particulate beta-gamma releases from Bruce B, the impact on the dose to ecological receptors is negligible. The baseline ERA determined the dose rates to non-human biota to be less than 1% of applicable UNSCEAR benchmark values. Based on the relative magnitude of releases from the postulated ampule failure as compared to emissions considered in the baseline ERA, no appreciable change to non-human biota dose is expected.

The calculation of the Maximum Probable Emission Rate (MPER) is based on the maximum number of ampules that could fail during one irradiation. The MPER corresponds to the failure of 58 ampules and can be estimated using the same methodology as the AOO, multiplying the release for a single failure calculated above by 58. The corresponding activity released is 4.70E+04 Bq. The MPER is a small fraction (~1%) of the 2016-2020 annual average release of particulates, 3.36E+06 Bq/year. Additionally, it is noted that the MPER for failure of ampules is a small fraction of the current MPER for particulate releases from Bruce B Contaminated Stacks, which is 3.48E+08 Bq/wk.

As per the Bruce Power Radiological Emissions and Effluents Monitoring Program, measurement of a radionuclide in a given emission stream is required if the MPER exceeds 0.05% of the operational DRL, or the Normal Operating Level (NOL) release contributes greater than 10% to the total station NOL emissions of that radionuclide. As discussed, normal emission levels are expected to be negligible. The MPER for failure of ampules is less than 0.02% of the Bruce B particulate beta/gamma operational DRL. Therefore, measurement of radionuclides that may be released from failed ampules is not required. However, these would be monitored inherently as part of gross beta-gamma monitoring, and additional monitoring will be performed to confirm that radionuclides associated with Lu-177 production (i.e., Lu-177, Yb-175 and Yb-177) are not present, as this would indicate a target failure.

The second AOO scenario assesses the releases resulting from the ingress of air in the Target Finger Tube for the duration of the weekly irradiation. The activity of Ar-41 and C-14 released is estimated assuming the entire volume of the TFTs is filled with air and irradiated for 7 days. As a result, instead of containing 0.13% of air, the IPS contains 100% air. This event will be detected by the operators during the weekly check of the IPS, before the target transfer operations. It is therefore estimated that this event is possible, but unlikely to happen more than once a year.

This event is considered to be the MPER for noble gas and C-14 releases from the IPS. The estimated release of activity for this event is 6.53E+10 Bq (or 8.39E+10 Bq-MeV) of Ar-41 and 6.77E+07 Bq of C-14. This activity is a negligible fraction of the annual DRL and the Bruce B 2016-2020 Average Emission Rate. Furthermore, these releases are a small fraction of the existing MPERs, which are 3.00E+13 Bq-MeV/wk for noble gases and 3.70E+11 Bq/wk for C-14 from the contaminated stacks. The MPER release from the IPS corresponds to ~0.001% and ~0.0001% of the operational DRLs for noble gases and C-14 respectively. Therefore, specific monitoring for these releases from the IPS is not required. However, potential noble gas and C-14 releases from the IPS will be monitored regardless through the existing Bruce B contaminated stack monitoring.

The comparison of Lu-177 production system MPERs to existing MPERs and operational DRLs is summarized in Table 61.

Table 61 Comparison of Lu-177 production system MPERs to existing MPERs and DRLs

Radioactive Emission	MPER for Lu-177 Production (Bq/wk)	Existing Bruce B Contaminated Stack MPER (Bq/wk)	Derived Release Limit (Bq/wk)	Lu-177 MPER as fraction of Operational DRL (%)
Particulate (beta-gamma)	4.70E+04	3.48E+08	2.64E+10	1.78E-04
Carbon-14	6.77E+07	3.70E+11	7.86E+13	8.61E-05
Noble gases[1]	8.39E+10	3.00E+13	7.25E+15	1.16E-03

[1] Noble gas releases and DRLs are in Bq-MeV/y.

4.2.1 Air Emission Monitoring of Lu-177 Production

All air emissions exhausted into the Unit Ventilation System contaminated exhaust are monitored with particulate, iodine, and noble gas (PING) monitors located prior to discharge to atmosphere through the stack. Releases are continuously monitored and any releases of particulate gross beta/gamma emitting radionuclides to the environment would be detected and quantified.

Any increase in the particulate and noble gas activity released through the contaminated stack due to the operation of the IPS would be detected by the PING monitor. Additionally, potential C-14 releases would be detected through existing continuous monitoring of the contaminated stack, included as part of weekly effluent reporting. The environmental impact of increased activity would be included in the weekly effluent report and would be reported as part of the station compliance monitoring. Although no impact on the environment is expected, Bruce Power will collect data to verify and confirm that there are no changes to atmospheric emissions. During commissioning of the IPS and for a limited period thereafter, the particulate filters from the stack monitor will be analyzed for the presence of Lu-177, Yb-175 and Yb-177 in the air emissions. The results will be used to confirm that there is no impact on air emissions.

If stack monitoring shows the presence of Lu-177, Yb-175 or Yb-177 in air emissions, Bruce Power will assess the magnitude and frequency of these events. If they generate a material change to the releases of the station, Bruce Power would consider implementing adaptive measures to minimize the environmental impact of these incremental releases. Such measures could include modifications to the design of the target assembly to make it more robust, modifications to the pneumatic system to minimize damage to the targets, and modifications to the HEPA filters to reduce releases through the contaminated exhaust stack.

4.2.2 Liquid Effluent Monitoring of Lu-177 Production

The IPS does not contain any liquid. There is no potential for a leak or spill of radiological or conventional liquid that could affect the environment. No changes to the liquid effluents are expected as a result of Lu-177 production.

4.2.3 Transportation of Radioactive Material for Lu-177 Production

After being placed in a Type B(U) Transport Container, the irradiated targets will be transported off-site to a licensed processing facility. The Transport Containers are robust and designed to protect the radioactive material.

If there was a transport accident, the Transport Container would contain the radioactive material and an emergency response team would be deployed to recover the container. There are no environmental effects expected from the transportation of the irradiated targets.

4.2.4 Radioactive and Conventional Waste Related to Lu-177 Production

The irradiated targets will be sent to the processing facility in the same form as they arrived at the Bruce Power site. No residual material or waste will be generated by the isotope production activities. The processing facility is responsible for managing its own waste.

4.3 Ongoing Operations

The current layout of the Site is shown on Figure 2. As outlined in Appendix A: Site Description, current operation of the Site involves, but is not limited to, the following works and activities:

- Operation and maintenance of Bruce A and B Generating Stations (CANDU pressurized heavy water reactors, control mechanisms, fuelling, heat transport, steam generators and auxiliary equipment).
- Operation and maintenance of the Transformer Area, and standby emergency generators at each of the Bruce A and Bruce B sites, as well as five distribution stations across the Site.
- Operation and maintenance of the supporting facilities, collectively known as Centre of Site

Engineered site facilities are listed in Table 1 in Appendix A: Site Description.

Routine operations of these site facilities are anticipated to continue in the future. Potential environmental interactions associated with these ongoing operations in conjunction with other future site activities, such as planned outages and MCR activities, are discussed further below.

4.3.1 Routine Outages

Bruce Power's Reactor Units are either operating connected to the grid and generating electricity or are off-line in an outage. Bruce Power undertakes regular planned outages to allow for ongoing improvements and upgrades, equipment repairs, and preventative and predictive maintenance; these outages permit work activities to be safely executed that cannot be done during normal online plant operation.

An Outage Work Management Program is in place at Bruce Power to plan, implement, assess and continuously improve work performed on a reactor unit when a reactor unit is shutdown. For the purpose of this document, planned outages scheduled during the PERA time period are being included in the analysis. These outages include planned and maintenance outages, station containment outages, and vacuum building outages. Forced outages, resulting from unplanned shutdowns of reactor units, are not within the scope of this document.

Note that the MCR outage is also a planned outage in which the major life limiting components (i.e., fuel channels, feeders and steam generators) are replaced. Given the extensive activities associated with a MCR Unit Outage, MCR activities are discussed in Section 4.4.

Planned and Maintenance Outages

Planned outages are defined as the scheduled shutdown of a unit for a predetermined scope of approved work. These outages typically follow a 2-year or more planning window. Maintenance outages are similar to planned outages, though are typically of shorter duration and have less than a six month planning window. Planned and maintenance outages, similar to those planned during the future time frame under consideration (i.e., 2021 to 2026), have previously taken place on the Site.

In order to reduce the overall dose taken by worker in the vault, Bruce Power is developing source term reduction strategies.

Station Containment and Vacuum Building Outages

The Bruce A and Bruce B station containment structures are designed to contain any radioactivity released following a postulated design basis accident. The containment envelope includes the four reactor vaults, the fueling duct and service areas, the pressure relief duct and valve manifold, and the vacuum building.

The leak tightness and structural integrity of the containment structures are tested and inspected on a regular basis to confirm the integrity of this safety system, in accordance with CNSC requirements. For Station Containment Outages (SCOs), Bruce Power is required to carry out testing to measure the leakage rate at full design pressure of station containment and inspect the associated concrete structures and components. The required frequency is once every six years. The last SCOs at Bruce A and B occurred in 2016 and 2015, respectively. Pressurization and inspection does not include the vacuum building, though the structure is offline.

For Vacuum Building Outages (VBOs), Bruce Power is required to carry out testing to measure the leakage rate at full design pressure from the vacuum building and inspect the vacuum building concrete structure and components. The required frequency is once every twelve years. The last VBO at Bruce A and Bruce B occurred in 2009 and 2015, respectively.

During SCOs and VBOs, all four reactor units associated with the containment structures are removed from service. As such, SCOs and VBOs offer unique opportunities to maintain common station systems not normally removed from service when reactor units are in operation. Maintaining these common systems may include activities such as the draining of process fluid, including the dousing tank at the top of the vacuum building.

Given the uniqueness of these outages, SCOs and VBOs have been included in the PERA. The next VBOs for Bruce A and Bruce B, tentatively scheduled for 2022 and 2024, are within the scope of this PERA assessment (Table 62).

Table 62 Tentative Planned VBO and SCO Schedule

Outage Type	Bruce A	Bruce B
VBO	2022	2024
SCO	2028	2030

4.4 Planned and Occurring Life Extension and MCR Activities

The Bruce Power MCR program is responsible for implementing and executing the refurbishment of Units 3 through 8 by carrying out focused major component replacements on a range of nuclear and non-nuclear systems. The MCR program commenced with Unit 6 in 2020 and will end with Unit 8 in 2033. Facilities specifically supporting MCR activities (e.g., administrative building, training facility) will be installed, some of which may be located off-site. Installation of MCR infrastructure for Bruce B was completed in 2019 and 2020. Installation of MCR infrastructure for Bruce A is ongoing. Installation of MCR Infrastructure is described in detail in Section 4.4.2.

For each of Units 3 to 8, MCR involves the following primary activities and are described in detail for Unit 6:

- Lead In (i.e., activities to prepare the reactor and work area);
- Reactor Retube and Feeder Replacement;
- Steam Generator Replacement; and
- Lead Out.

In addition to the primary MCR activities, additional projects will be conducted during the MCR window to take advantage of the system configurations as these projects would otherwise extend normal planned outage duration. These projects are collectively known as the Balance of Plant program and are further described in Section 4.4.7. Section 4.4.8 details the MCR Waste Management and Project Demobilization program.

The MCR schedule has been optimized to allow for unit overlap, resulting in some of the above activities occurring in parallel for two units at a time.

4.4.1 Lessons Learned

Lessons learned is a process ensuring information gained during the completion of past projects will govern the planning and execution of current activities onsite. Lessons learned from Units 1 and 2 Restart project, the Site life-extension activities since 2001, the 2011 West Shift Plus life extension outage (Unit 3 life extension outage), the first portion of the Unit 6 MCR and other external mega projects continue to shape the approach to the MCR to ensure refurbishment is successful. Bruce Power has identified 172 key lessons learned during the Site's major project past experience. These lessons learned are grouped into seven themes: (1) Governance, (2) Strategies, (3) Planning and Setup, (4) Oversight & Management, (5) Skills & Resources, (6) Infrastructure, and (7) Integration.

Key lessons learned that are relevant to the PERA are:

- Rigorous implementation of lessons learned and good practices through a formal process with oversight.
- Have a fully integrated Project Management Team, led by experienced Bruce Power staff, with roles and responsibilities clearly identified, and with significant owner involvement in all key roles. This team will include a fully integrated commercial strategy group to oversee procurement and contract management.
- Use of existing proven Bruce Power processes and procedures.
- Implement an independent oversight function with responsibility across key elements of the project.
- Sufficiently staff the project team with qualified and experienced resources to a level commensurate with the volume and complexity of the work.
- Minimize first-of-a-kind tools, equipment, facilities or evolutions in order to reduce complexity, and limit first-of-a-kind work. There are no first-of-a-kind works for the MCR activities.
- Establish a tool testing and maintenance unit for the reactor tooling.
- Develop series-to-series transition schedules in detail.
- Monitor and maintain system layup conditions to the maximum extent possible.
- Have completely functional infrastructure and facilities for MCR activities prior to the start of field work.
- Consider community perspective regarding hazards associated with project activities during planning (e.g., transportation of contaminated material over waterways).

In addition to the above, Bruce Power and Ontario Power Generation are also collaborating with regards to lessons learned and executing the various activities associated with MCR as the refurbishments of Units 1 to 4 at the Darlington Nuclear Generating Station are completed in parallel with those at Bruce Power.

One example of a Lesson Learned during the Restart of Units 1 and 2 at Bruce A is the management of fuel defects during replacement of major reactor components. Details of this example lesson and mitigation actions taken for MCR are described below.

4.4.1.1 Radiological Emissions and Effluent Controls for MCR

Planned MCR activities require opening of radiological systems such as the Primary Heat Transport System (PHTS) and this has the potential to introduce foreign material. Foreign material exclusion (FME) is a priority for open system work. Operating experience from the restart of Units 1 and 2 shows that debris within the Primary Heat Transport System can result in a higher frequency of fuel defects. The impacts of past fuel failures on Iodine-131 air emissions was discussed in the 2014 EPR [R-242].

In response to the Lesson Learned during Restart, the MCR FME program will also install strainers during PHT system fill. These strainers will collect any remaining debris prior to entering the fuel channel. As part of the preparation of the 2017 PERA, the nature of fuel defects and the impacts of such events on actual releases was provided as background information in response to a regulatory request [R-243]. The following is more information on how this lesson learned impacts the environment:

When there is a fuel defect such as a crack or pinhole (Figure 55) in a fuel element, high-pressure D_2O (primary coolant) penetrates the Zircaloy cladding and directly contacts the irradiated uranium dioxide (UO_2). This interaction releases fission and activation products to the PHTS. Gamma-spectrometry of grab samples of PHTS D_2O readily detects the presence of elevated levels of gamma-emitting radionuclides such as I-131 and is a useful adjunct to other, more specific, defective fuel detection techniques (such as delayed neutron counting). As a result of fuel defects, noble gases and mobile radionuclides such as radioiodines and other beta/gamma emitters circulate through the PHTS and may become aerosolized in the reactor vault, (e.g., as failed fuel is removed, etc.) and exhausted through the active ventilation system. Alpha emitting and other immobile radionuclides in the PHTS become incorporated into the oxide scales on exposed surfaces, such as feeder pipes and steam generator tubes. During intrusive activities such as feeder pipe replacement during MCR, these alpha emitters may become mobilized and dispersed into the reactor vault.

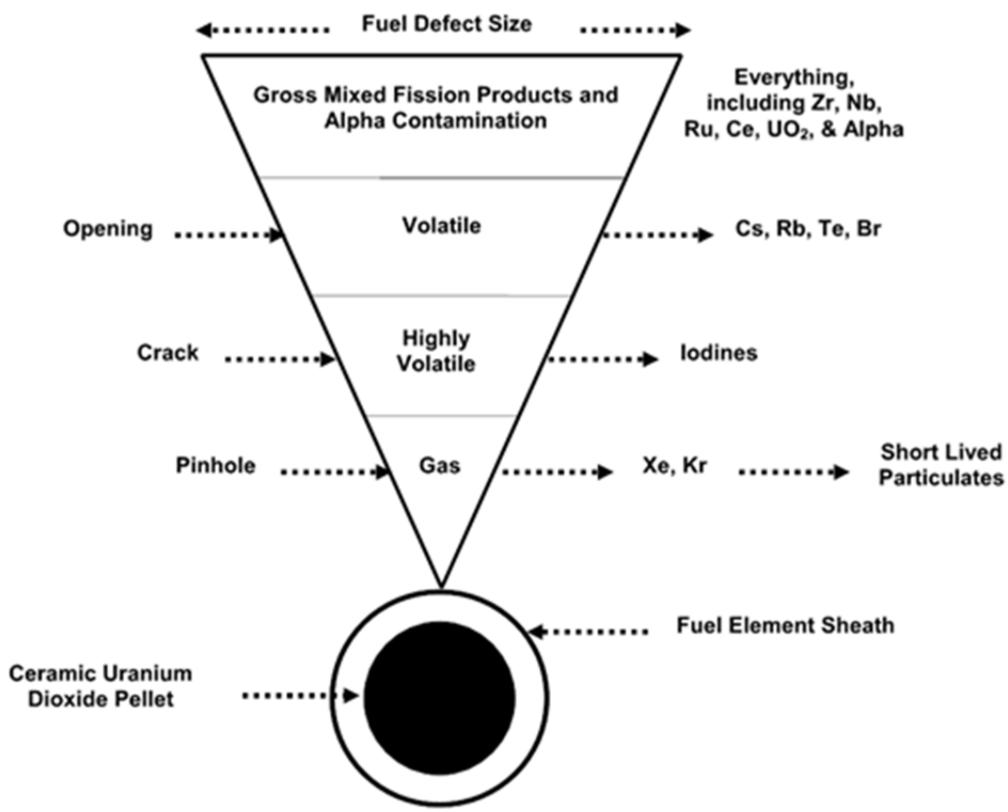

Figure 55 Defective Fuel Defect Size vs Release [R-244]

Radioactive particulates in the PHTS are partially removed through ion exchange systems as part of the D_2O purification circuit. Resin slurrying operations cause a portion of radionuclides to be transferred from the resin to Active Liquid Waste (ALW) tanks, which are discharged to surface water. Spent resins are disposed as radioactive waste.

The majority of the radioactivity release to the surface water environment is from the ALW system. Sumps collect wastewater and direct it to ALW collection tanks. These tanks are recirculated and sampled prior to pump out to the Condenser Cooling Water (CCW) discharge. There are two primary mitigation measures to ensure that the radioactivity in the pump out remains within safe limits. First, grab samples of each batch are taken and analyzed for tritium and gross beta. The Station Manager must approve each pump out based on a comparison of the analysis results with prescribed discharge criteria. Second, a Liquid Effluent Monitor (LEM) continuously monitors the gamma radiation from the discharged contents and if it exceeds the alarm set-point, the pump out is stopped.

To mitigate the airborne release of radioiodines and particulates, High Efficiency Charcoal Air (HECA) and High Efficiency Particulate Air (HEPA) filters are installed in the active ventilation stacks. Each stack also includes a control monitoring system that is connected to the

Main Control Room and provides a real-time measurement of the radioactivity being released to the environment. Alarm set points are set at a fraction of the corresponding Derived Release Limits (DRLs) to ensure that Operations staff has sufficient time to rectify higher than normal releases well before there is any risk to members of the public or the environment.

There are several administrative control measures as part of the Environmental Protection Program. These are implemented in the form of Internal Investigation Levels (IILs) and Action Levels (ALs). An IIL is set at the upper range of normal releases for each radionuclide, for each discharge stream to the environment. If an IIL is exceeded, an investigation is triggered and if necessary, a causal analysis is performed and corrective actions are taken to ensure releases remain within the normal range. An AL is set at a value significantly higher than the IIL, but significantly lower than the DRL. This is an additional administrative barrier to prevent releases from exceeding prescribed limits. If an AL is exceeded, the same actions are taken as for an IIL exceedance and the Canadian Nuclear Safety Commission (CNSC) is notified of the exceedance.

4.4.2 Installation of Major Component Replacement Infrastructure

This activity involves the installation of facilities specifically required to support MCR activities, including new buildings, building extensions and renovations. Some of these facilities are located off-site. The new and planned locations of MCR facilities and infrastructure as of June 2021 are shown on Figure 56 and are described in the subsequent sections. Installation of MCR Infrastructure started in late 2017 and is continuing for Bruce A Infrastructure.

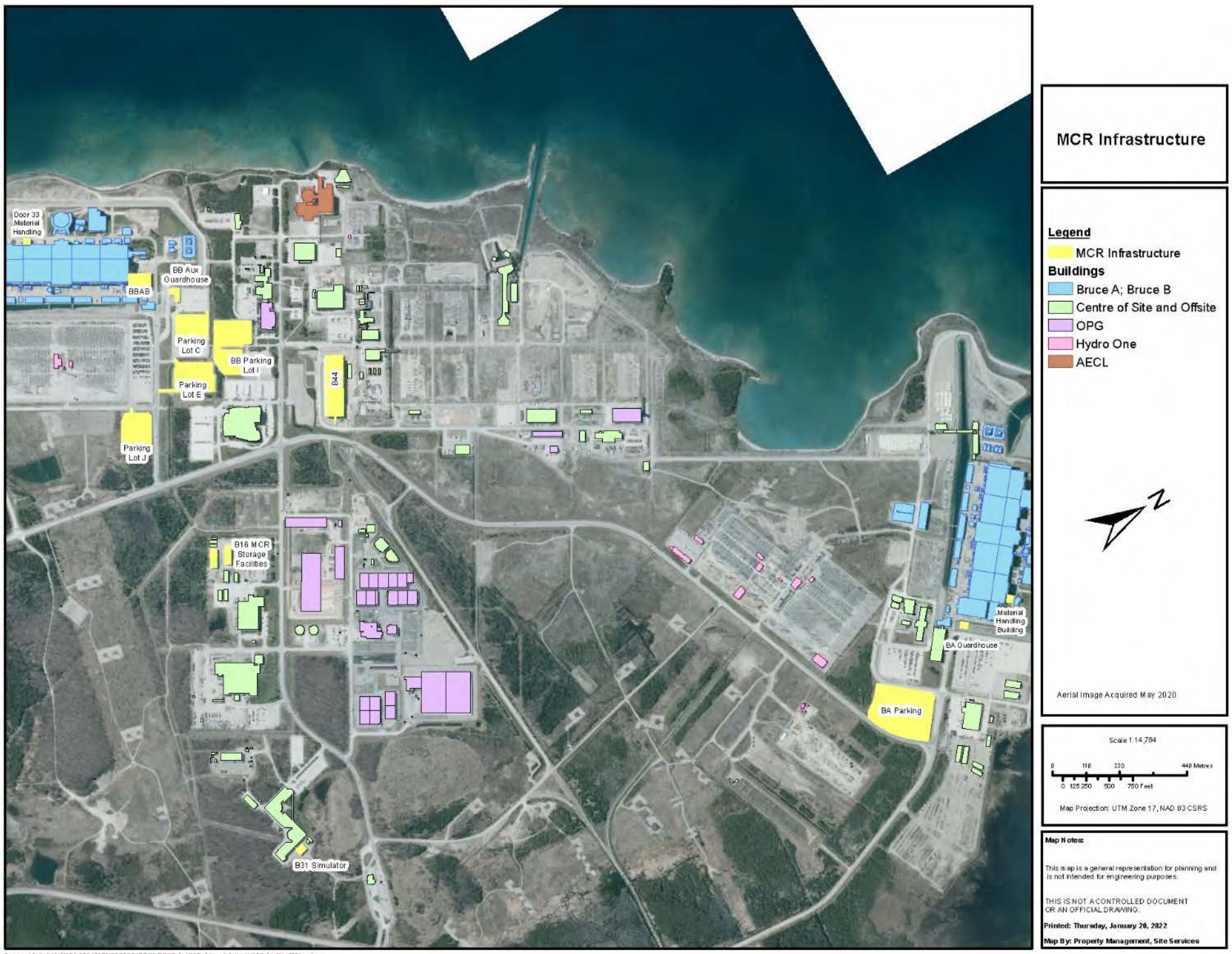

Figure 56 Location of Major Component Replacement Facilities and Infrastructure

4.4.2.1 B72 Kincardine MCR Training Facility

An Office Complex was not constructed on the Bruce Power site. Instead, the MCR Training Facility (B72) was constructed in the Town of Kincardine in 2019. This leased building includes a two-story, modern office space as well as a shop area with welding booths and training mock-ups that replicate the environment inside Bruce Power's reactor vault. Because of the off-site location, assessment of related impacts does not fall under the scope of the ERA and PERA.

4.4.2.2 Bruce B Security Fence Modifications

Modifications to the Bruce B double-perimeter security fence were completed to accommodate the Steam Generator Replacement program crane laydown area near Units 5 and 6. The security fence modifications involved soil excavation.

4.4.2.3 Bruce A Parking Lot Expansion

An existing parking lot was modified and expanded to accommodate future needs for Bruce A MCR work. A mostly open field was utilized for the expanded lot. Ground cover was removed and granular fill material brought in to build a proper base for the lot. A road was re-aligned as part of the work and to accommodate this some tree removals were necessary. Stormwater ditches were modified to effectively drain the new and modified lots and this was documented in a modification to the Bruce A ECA.

4.4.2.4 Bruce B Parking Lot Expansion

The existing Bruce B parking lot was expanded in two phases between 2016 and 2020 (Figure 56) as follows:

1. Phase 1 included the creation of three new paved lots and minor upgrades to one gravel overflow lot. For the paved lots, the Saugeen Valley Conservation Authority (SCVA) conducted a forest study and determined there were no endangered or at risk species.[R-245] These trees were removed along with the shallow overburden. Granular fill was brought into the site to build up the proper base. Several stormwater changes were completed and documented in an ECA modification; this included a new culvert, catch basins and piping to existing infrastructure. A self-assessment under the fisheries act was conducted for the culvert installation.

2. Phase 2 included expansion with a gravel lot adjacent to the Phase 1 lots. It involved the removal of additional trees previously evaluated by the SVCA, but no major changes to the stormwater system.

4.4.2.5 Bruce B Guardhouse Modification

The Bruce B guardhouse was modified to increase personnel throughput capacity. The modifications to the guardhouse were internal to the facility.

4.4.2.6 Bruce B Auxiliary Guardhouse

In order to meet the increased volume of staff during MCR, it was determined that an auxiliary guardhouse was required to handle volumes during peak turnover periods. This building was not part of the 2017 PERA. The auxiliary guardhouse was constructed in 2019 and completed by February 2020. This is located in the BB Parking lot to the north of the existing guardhouse. Tree removal was required for the construction.

4.4.2.7 Temporary Crane Storage Area

A temporary crane storage area has been established on the former industrial lands shown on Figure 56. The temporary crane storage area is approximately 1 ha in size.

4.4.2.8 Storage Facilities

B16 MCR Storage Facilities

Two new MCR storage facilities were constructed adjacent to the Bruce Power Stores Storage Compound (B16 – known in the 2017 PERA as the Central Storage Facility) to accommodate storage of the new steam generators and empty, clean radiological waste containers for reactor fuel channel installation and feeder replacement waste. These two MCR storage facilities are clear-span, pre-engineered buildings with concrete foundations and are located on an existing gravel yard surrounded by a fence. A bio-swale was constructed to improve stormwater management around the storage buildings.

Construction of the storage facilities involved soil excavation, conventional construction waste (including concrete slurry) and conventional air emissions from construction equipment. No deep excavations (e.g., for foundations) occurred.

B44 Central Storage Facility

This MCR Central Storage Facility (CSF – not planned or discussed in the 2017 PERA) is a 1,115m^2 pre-engineered building that was constructed on a concrete foundation on an existing gravel lot. This facility will store contaminated tooling, equipment, and components in seacans between MCR outages. The facility has a radiation work area to prepare and refurbish tools and equipment prior to them being shipped to the station. Any active liquid waste (ALW) generated in this facility will be taken to BA for processing. The steam generator project will also use this facility to sever the old BB Units so that the top steam drum can be recycled and the lower generator portion will go into long term storage at OPG.

Construction included soil excavation, conventional construction waste (including concrete slurry) and conventional air emissions from construction equipment. The facility also includes washrooms, offices, change rooms, and a lunchroom. Sewage and domestic water for the new facility were tied into the existing system.

4.4.2.9 Bruce B Simulator

A new control room simulator was constructed to train operators on the new unit configuration. The Bruce B simulator includes an office for instructors, debrief rooms, and an IT room. The Bruce B simulator is located at the Bruce Learning Centre (BLC), adjacent to the existing structure, beside the operation trailers to the east of the building, as shown on Figure 56.

The Bruce B simulator does not have washroom facilities; therefore, no domestic water or sewage facilities were required. Construction included soil excavation, removal of trees, conventional construction waste (including concrete slurry) and conventional air emissions from construction equipment.

4.4.2.10 Bruce B Administrative Building

The available Bruce B work stations, meeting rooms, locker rooms, and lunch facility could not accommodate the MCR support and construction workforce and the operating staff simultaneously. The BB Administrative Building (BBAB – known in the 2017 PERA as the Bruce B Protected Office Area Complex) was constructed in 2018-2019 on the former site of the Unit 8 trailer complex, located inside the Bruce B security fence. The Unit 8 trailer complex and adjacent gardens were demolished, and a new office complex was constructed to accommodate support, construction and operation workers.

BBAB construction included soil excavation, and generated conventional construction waste (including concrete slurry) and conventional air emissions from construction equipment. Sewage for the new facility was tied into the existing system. Runoff is routed to existing storm drainage channels via a catch basin (e.g., the east boundary drainage ditch).

Demolition and construction waste was appropriately disposed. Waste segregation, including recycling, was done as feasible (see Section 4.4.8).

4.4.2.11 Bruce B and Bruce A Material Handling Buildings

These buildings were not discussed the 2017 PERA. During execution of MCR activities, a large volume of materials will be moved in and out of the station. This requires adequate room for staging to minimize backlogs and delays on both shipping and receiving logistics. The outside door is inverse locked to the state of the overhead door to prevent the spread of loose contamination from the powerhouse.

Construction included soil excavation, conventional construction waste (including concrete slurry) and conventional air emissions from construction equipment. Runoff is routed to existing storm drainage.

4.4.2.12 Decontamination Facility

The decontamination facility was not built. Decontamination activities are performed in the station following existing procedures, or at the Central Storage Facility (B44) or outsourced to external vendors.

4.4.2.13 Bruce A Future Major Component Replacement Office Support

Office support at Bruce A for MCR activities is being accommodated through renovations of existing Bruce A office space and a modular office complex behind Unit 2. The modular office will be located on an existing trailer lot with a gravel and asphalt surface.

4.4.2.14 B29 Feeder Welding Mockup

The B29 feeder welding mockup facility was not completed. Mockup training is being done at the Kincardine MCR Training Facility (B72).

4.4.2.15 Increased Sewage and Domestic Water

Installation of MCR infrastructure may result in increased sewage and domestic water. The sewage will be routed to the existing sewage treatment plant. Domestic water will be sourced from the existing domestic water supply. The increase in sewage and domestic water usage related to MCR has been offset by the period of remote work for many office workers due to the COVID-19 pandemic. This potential impact will be assessed in the 2027 PERA.

4.4.3 Lead In

Lead In activities includes those tasks required to safely take a unit undergoing MCR from an operational state to one that allows the MCR refurbishment activities to take place. Activities include shutting down and defueling the reactor, vault preparations such as installing bulkheads, system lay-up, fuel machine bridge and carriage refurbishment as described below.

4.4.3.1 Reactor Shutdown and Defueling

Reactor shutdown and defueling involves the removal of all fuel bundles in accordance with existing Bruce Power procedures and fuel handling equipment. Fueling/defueling a reactor is a common activity that is done to a lesser extent as part of daily operations.

4.4.3.2 Vault Preparation

Vault preparation involves installation of bulkheads in the MCR unit to isolate the vault from main fuel duct to create a safe working environment for refurbishment activities to take place.

<u>Bulkhead Installation and Vault Pressure Test</u>

Each unit undergoing MCR will be isolated from the rest of containment using a bulkhead system to isolate the reactor vault from the fuelling machine duct. Bulkhead installation and the associated draining and drying of the reactor systems will allow a reduction of tritium to levels for which respiratory protection for workers will change from plastic suits to PAPR (Powered Air Purification Respirator) units.

The bulkheads will be prefabricated off-site. Welding will be done during bulkhead fabrication and installation. A vault pressure test will be conducted to confirm the bulkheads have been adequately installed and that the unit is separated from the containment system. Pressure test air will be released through the active ventilation system.

<u>Vault Air Conditioning</u>

During MCR activities, vault Air Conditioning Units (ACUs) will be physically removed from the vault. This resulted in significant loss of heat removal capability in the vault and to compensate for this loss, temporary air conditioning will be installed in the vault (transfer chamber) for worker comfort and to address HVAC concerns. Cooling water will be supplied by LPSW, either from the MCR unit or a temporary supply from the adjacent unit when the

MCR unit supply is unavailable. Condensate from the temporary air conditioners will be directed to the ALW system.

Vault Vapour Recovery Operation

The Vault Vapour Recovery (VVR) system is a permanent ventilation system used to remove heavy water vapour from the vault atmosphere. This is important from both an economic and environmental perspective as heavy water (and tritium) is collected and not released to the environment. During MCR, the VVR system will be modified to enable ventilation from tented and vented work areas. The VVR operation will have the option to bypass the drying function to avoid unnecessary condensate collection and increase air flow. Exhaust will be directed to the active ventilation system. Should conditions warrant, such as increasing tritium concentrations in the vault, operation of the VVR system with drying capability and associated condensate collection is an option that can be used.

4.4.3.3 Reactor Drain and Dry

The primary heat transport (PHT) system and moderator (i.e., heavy water) systems will be drained and dried to prepare the vault for reactor work. The PHT and moderator systems will be, to the extent practical, drained, and the heavy water collected will be transferred to the station's heavy water collection system. Remaining heavy water in the PHT system will be vacuum dried while the moderator system will utilize ventilation and drying skids to accomplish the water removal.

The primary purpose of the reactor drain and dry activities is to remove heavy water from the reactor to allow retube, steam generator and feeder replacement and to help maintain vault tritium levels below levels acceptable for worker safety. Draining and drying will also facilitate removal of water from the reactor components (e.g. fuel channels and feeder tubes) to meet waste disposal criteria (i.e. no liquid water and minimal moisture).

4.4.3.4 Systems Lay Up

To ensure system and component asset preservation during the MCR outage duration, lay-ups of station system and components will be executed and the system condition monitored. Station systems (32 in total) include both primary (reactor) and secondary (conventional) side station systems. For the most part, system lay-ups will follow existing station practices though enhancements, such as the use of dehumidifiers or cover gases, may be used as deemed necessary to protect the assets from degradation due to corrosion. Film Forming Amines (FFA's) were selected as an alternative to maintaining the systems dry with forced, dehumidified air where possible. The FFA's are injected with a portable FFA injection cart and once circulated through the Secondary Side Water and Steam Cycle (WSC) applies a chemical, hydrophobic coating on the internal pipe surfaces and components to inhibit corrosion. All process fluid discharges to Lake Huron will be conducted in compliance with the ECA/Effluent Monitoring Effluent Limits (EMEL) requirements.

Temporary Dehumidifiers

Temporary, portable dehumidifiers will be used to condense water vapour, thereby lowering atmospheric tritium levels and maintaining a comfortable work environment. Munter dehumidifiers are being used and do not have drain lines that need to be routed. The Munter desiccant dehumidification systems remove moisture from the air by using a desiccant, a material which easily attracts and holds water vapor. Any other dehumidifiers will have condensate directed to the appropriate drains. Airborne emissions will be directed to the active ventilation system.

4.4.4 Reactor Retube and Feeder Replacement

The MCR Reactor Retube and Feeder Replacement program is required in support of extending the reactor unit life and focuses on the removal and subsequent replacement of feeders, pressure tubes, calandria tubes and the re-installation of new components. The reactor retube and feeder replacement program dominates the critical path for the MCR program.

The purpose of the retube and feeder replacement program is to replace the existing fuel channels, feeders and associated components as they are nearing end of their operating life. The tubes are exposed to high pressure and temperature and will be replaced to extend the safe operating life of the unit. Reactor retube involves removal of the existing 480 fuel channels, 480 calandria tubes and associated components (e.g., fuel channel assemblies) and inspection of the calandria vessel, followed by placement of 480 new fuel channel and 480 new calandria tubes and associated components (e.g., fuel channel assemblies). Specific activities associated with reactor retube include:

- Calandria Tube Installation: The calandria tubes will be replaced with items that are conceptually the same as the ones removed; and
- Pressure Tube Installation: The pressure tubes will be replaced with items that are conceptually the same as the ones removed. Commissioning will be required, but will largely be done along with testing the PHT, annulus gas and moderator systems (e.g., hydrostatic and operational tests).

Reactor face shielding will be in place during reactor retube to minimize dose to workers. Workers will be adequately trained to carry out the work safely.

The removal, installation and inspection require the use of highly specialized tooling designed for a radiation work environment. Tooling developed for MCR is refurbished between MCRs for reuse for each subsequent MCR and when no longer operational, tools will be demobilized, decontaminated, and disassembled.

The function of the feeders is to distribute PHT heavy water either to or from the headers to the individual fuel channels. Feeder orientation can be either vertical or horizontal to the reactor face and the feeders are divided into upper and lower sections. Removal of the 960 feeder pipes is anticipated to notably reduce radiation fields in the vault. Conventional air emissions from welding and radiological emissions to air are anticipated. Emissions will be directed to the active ventilation system.

From an environmental perspective, there is the potential for air quality interaction from particulate (radiological and non-radiological) during cutting and welding activities.

Fuel channel and feeder tube removal activities will generate low and intermediate level radioactive waste as described further in Section 4.4.8.

4.4.5 Steam Generator Replacement

The Steam Generator Replacement (SGR) Program includes the removal, replacement and reconnection of steam generators (8 for each MCR unit) and occurs in parallel with the reactor retube and feeder replacement program activities.

The steam generators are the principle heat sink for the reactor. The steam generators boil water into steam, which is then used to drive a turbine that generates electricity. There are 8 steam generators in each unit that will be replaced. At Bruce B, each steam generator has a steam drum attached and the entire assembly will be removed and replaced. After removal from Bruce B, the steam drum (the upper portion) will be separated and disposed of as conventional waste, and the steam generator (the lower portion) will be sent to OPG for radiological waste storage and ultimate disposal. At Bruce A, there is a common steam drum for four steam generators. These common steam drums are not being removed and will be moved out of the way to allow for removal and replacement of the steam generators. Figure 57 shows a cutaway illustration of the steam generator assemblies at Bruce A and Bruce B.

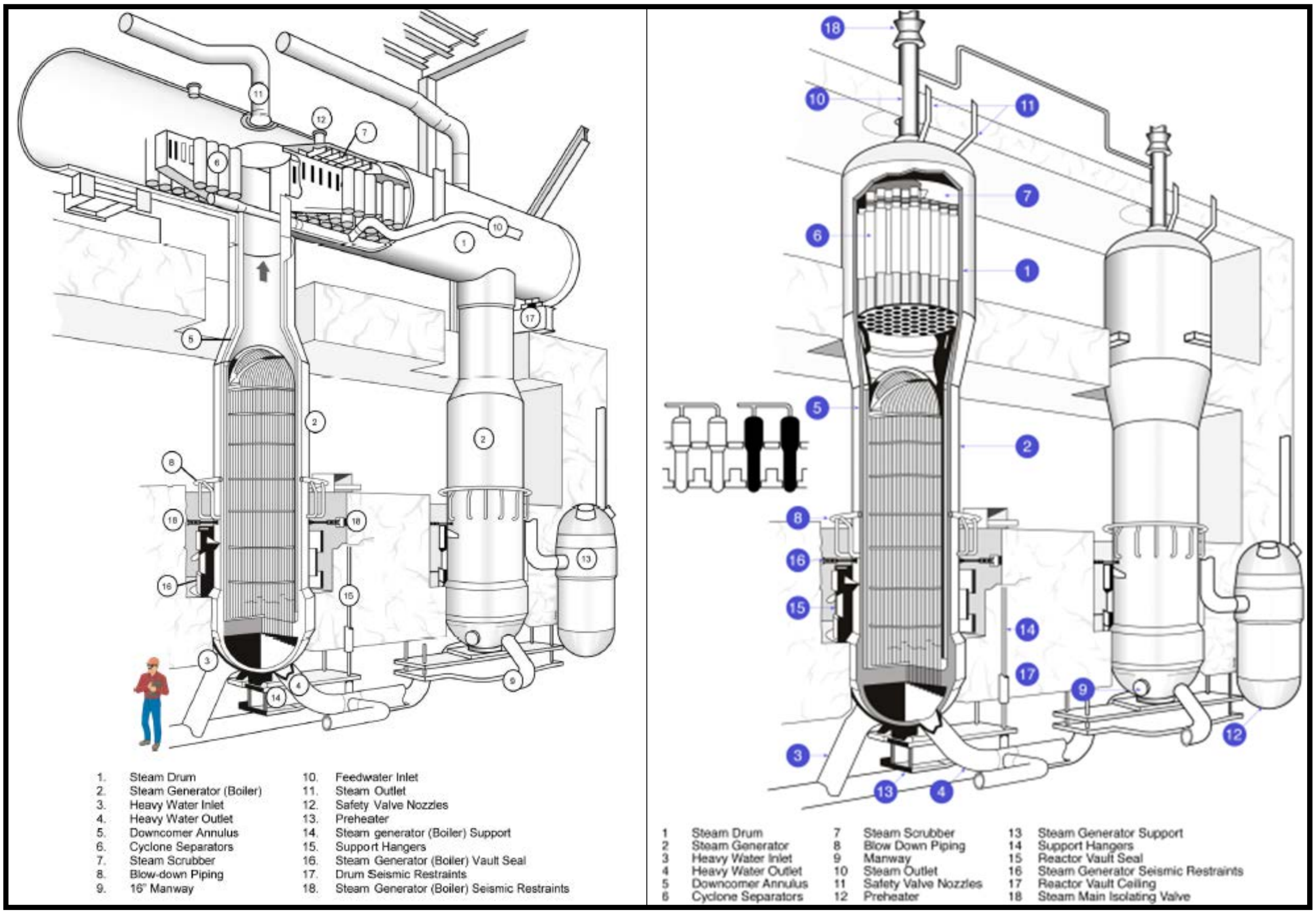

Figure 57 Cutaway View of Two Steam Generators and Steam Drums at Bruce A (left) and Bruce B (right)

Removal of the steam generators will take place through the roof of the reactor building through the Powerhouse Roof Enclosure described below. Interferences (e.g., pipe work, electrical components, and duct work) will be removed to allow for free movement of the steam generators out of and into the reactor building. Cutting will be required to remove interferences.

Prior to removing the steam generators from the Protected Area, they will be sealed and their outer surfaces surveyed to ensure there is no loose contamination present. Following removal, the steam generators will be temporarily staged in the Protected Area prior to transfer to OPG's WWMF in accordance with OPG requirements.

Steam generator replacement activities will generate low level radioactive waste as described further in Section 4.4.8.

Cutting and grinding activities will occur inside the station and are not expected to result in any releases to the environment.

4.4.5.1 Powerhouse Roof Opening

Reactor building roof modifications are required for removal and installation of the steam generators. This work includes cutting temporary openings in the reactor building roof and installation and subsequent removal of temporary roof enclosures over the openings. This work also allows for relocation of existing steam drums (only at Bruce A). The method of steam generator removal and replacement involves rigging of the various components by a Heavy Lift Crane (HLC). Once complete, the restoration of the roof will be completed to existing configuration or approved engineered alternative.

The Steam Drum Enclosure Roof inside the powerhouse will also be removed and reinstalled. This includes removal of concrete and steel components to allow clearance to remove the Old Steam Generators (OSGs), Crane Construction and Transportation

Consistent with refurbishment of Unit 1 and Unit 2, the HLC will be transported to site in sections and constructed using other lift and mobile cranes. Additional resources are required for the installation and transportation of the steam generators between the station and on-site storage locations. Equipment anticipated to be required to construct the approximately 1,600 ton heavy lift crane includes several smaller cranes, a crawler and several other pieces of heavy lift equipment.

A structural landing pad will be built to support operation of a HLC at both Bruce A and B. The crane laydown area will be located on former industrial lands (used for the former Bruce Heavy Water Plant).

Assembly of the crane is anticipated to result in noise. It is expected that noise from assembly of the crane will be greater in magnitude than noise associated with operation of the crane. The crane is visible at distances up to 20 km away.

4.4.5.2 Steam Generator Removal

Eight new steam generators will be installed in each MCR unit in a sequential order that considers structural loads inside the reactor building. This includes:

- Removal of insulation from each steam generator assembly and non-steam generator equipment from both the reactor vault and steam generator room;
- Clearing interferences in the area of the steam generator;
- Disconnection and lifting of steam generators and removal from plant; and
- Severing of steam generators and drum, and capping of openings (only at Bruce B).

Removal of the steam generators will result in conventional waste, radiological waste, conventional air emissions (from construction equipment and welding and cutting activities), noise and potential radiological emissions (from the openings in the roof).

4.4.5.3 Steam Generator Installation

The eight steam generators associated with each unit will be installed in a sequential order that considers structural loads inside the reactor building. The new steam generators will have similar specifications to the existing ones.

Interferences will be replaced around each steam generator assembly. Insulation on each steam generator assembly, including all removable insulation patches required for future periodic inspection program locations, will be reinstalled. Welding will be required to install the new steam generators.

4.4.5.4 Crane Removal and Roof Closure

Once the major lifts are completed, and each replacement steam generator assembly has been installed, the HLC will be dismantled in the crane laydown area, packaged and shipped off-site or stored until ready to be mobilized to the next unit. The HLC may stay assembled on site between the MCR for Units 3 and 4.

The concrete enclosure roof above each steam drum will be restored with heavy concrete sections. The openings in the powerhouse roof will be restored and the outer roof membrane will be repaired or replaced, as necessary.

4.4.6 Lead Out

Lead out encompasses the final activity of the MCR program and includes returning all unit systems back to service from the main life extension programs, commissioning all systems to ensure they are available for operational use, completing a full core refuel, re-establishing the containment structure and then conducting a final series of tests/evolutions before returning the unit back to operational control. Key Lead Out activities include:

- Moderator and auxiliaries refill and flush;
- Establish Over Poisoned Guarantee Shutdown State (OPGSS);
- Loading of new reactor fuel;
- Vault containment restored;
- PHT refill and pressurization for cold flush;
- PHT Heat Up and Hot Conditioning; and
- Power Up and Synchronization to the Grid.

4.4.6.1 Moderator Refill and Establishing OPGSS

Moderator refill can be started as soon as all calandria tubes are installed and the moderator system work is complete; though this activity may be deferred until all fuel channels are also installed. The moderator will be refilled with the heavy water that was drained during Lead In and will be circulated through a commissioning strainer to collect any debris not collected during the Calandria clean or that became mobilized during the system refurbishment.

Following moderator refill, OPGSS must be established. Gadalinium nitrate liquid is added to the moderator, this is a strong neutron “poison”, that preferentially absorbs neutrons to ensure a sustaining chain reaction cannot take place (the reactor cannot go critical). The addition of gadalinium, a neutron absorbing “poison”, will allow the neutron flux of the reactor to reach an appropriate level in a controlled manner once refueling has occurred. OPGSS must be accepted by the CNSC prior to the start of refueling the reactor.

4.4.6.2 Refueling

Fuel bundles are manufactured off-site and shipped to Bruce Power enclosed in protective palletized crates. Facilities will be provided to store the fuel and to move it to loading facilities and inspection stations. The new fuel bundles are then loaded into each channel by using approved fuel handling operations procedures.

4.4.6.3 Vault Containment Restoration

Removal of the bulkheads will allow for the unit to rejoin station containment. A pre-requisite to breaking the bulkhead containment boundary is a vault pressure test to ensure that the vault in its entirety meets containment leak tightness requirements. This test requires that all airlocks and penetrations have been returned to service. With a successful test(s) outcome, the bulkheads are able to be removed, essentially a reverse operation to their installation. Bulkhead removal is anticipated to involve grinding operations.

Other activities required to restore the vault include: removal of the bulkhead fill-in floor, the floor leveling plates, the reinstallation of the permanent ACUs and removal of temporary ones, and the reversal of any other temporary modifications.

4.4.6.4 PHT Refill, Pressurization, Cold Flush and Hot Conditioning

The PHT system refill is followed by a series of stepwise increases in pressure which provides the opportunity to ensure the system welds and other connections are leak-free. The PHT system cold flush will ensure there is minimal debris (e.g., particles) in the PHT system. Based on experience from the refurbishment of Units 1 and 2, strainer elements will be incorporated into modified shield plugs to reduce deposits on fuel elements while purification filters will be used to remove the bulk of the debris. The use of shield plug strainers is an improvement as the frequency of future fuel defects is reduced. Also based on Bruce Power’s experience with the Units 1 and 2 refurbishments, it is known that PHT filter change frequency will be higher during refurbishment start up than during normal operations.

Following the PHT Cold Flush, PHT system temperature is increased and hot conditioning commences. Hot conditioning of the PHT system is performed as part of chemistry control. The purpose is to clean the internal surfaces of the carbon steel piping in the system followed by establishing a protective iron oxide (magnetite) layer. Chemicals added to the PHT system as part of hot conditioning are removed using the existing PHT purification system. Removed resins are stored and disposed of as intermediate level waste using existing procedures.

4.4.6.5 Power Up and Synchronization to the Grid

Returning the unit to service closely follows normal post-outage procedures: approach to critical, Safety System Tests (SSTs), increases in reactor power, and synchronization to the grid. These usual steps are supplemented by procedures and additional SSTs required due to the unique circumstance of starting up a unit with an entire core of new fuel, and a unit with new major components (fuel channels, feeders and steam generators).

4.4.7 Balance of Plant

The Balance of Plant Program is intended to contribute to the overall health of station equipment and systems to address asset End of Life (EOL). The Program is divided into system based windows, each being managed independently during MCR to manage project risk and effectively manage resources. The system windows are as follows:

- Turbine/Generator;
- Cooling Water;
- Primary Heat Transport;
- Electrical;
- Safety Systems/Moderator;
- Steam/Feedwater; and
- Auxiliary.

Effectively, Balance of Plant (or asset management) projects are the equivalent of projects managed during planned and maintenance outages. Specifically for Balance of Plant projects executed during MCR, system draining, lay-up, and venting activities in preparation for project execution are already covered under the various sections, such as, Lead In, Systems Lay Up and Lead Out, in the report. For completeness, the PERA Tier 1 Screening does include “Routine Asset Management Activities” which are examples of Balance of Plant/Asset Management Projects that will be executed.

4.4.8 MCR Waste Management and Project Demobilization

The MCR Waste Management Strategy describes the approach taken by Bruce Power to safely and effectively manage wastes and demobilized materials generated by the MCR Program. The Strategy defines the organizational framework, interfaces, responsibilities, facilities, documentation, materials, tools, equipment and processes required to ensure compliance with all regulatory requirements and in accordance with Bruce Power governance such that risks are minimized and the MCR Program remains within budget and schedule.

The scope of the Strategy outlines the requirements to ensure adequate planning and subsequent infrastructure is in place for the timely disposition radioactive and non-radioactive wastes and demobilization of all materials generated from MCR Program execution activities.

4.4.8.1 Non-Radiological Waste

Collection and transfer of non-radiological (e.g. conventional and hazardous wastes) is performed in accordance with Bruce Power procedures.

Conventional waste volumes generated by Bruce Power over the past five years are provided in Table 63 and include MCR6 volumes starting in 2020. Due to the COVID-19 pandemic, the number of regular on-site workers has been reduced since March of 2020 and remains below baseline levels. As a result, the waste estimates from the first two years of MCR are not representative of the impact of MCR activities in combination with regular site operations with all staff present on-site. This reduction in number of personnel present on-site has not significantly affected the production of scrap wood, recyclable metal or commercial and construction waste, with the impacts from reduced personnel limited to compost, recyclable and domestic waste.

Table 63 Non Radiological Waste Types and Volumes for the Bruce Power Site in Metric Tons (MT), including the first two years of MCR Unit 6 Life Extension Activities in 2020 and 2021

Waste Type	Examples	Bruce Power Site Waste Volume Estimates (MT)				
		Pre-MCR			Unit 6 MCR	
		2017	2018	2019	2020	2021
Recyclables/Compost	• Paper • Plastics • Glass • Food waste • Paper towels	329	428	523	418	392
Scrap Wood	• Wood pallets • Wood packaging	155	191	177	267	210
Scrap Metal	• Recyclable scrap metal	449	529	420	497	535
Landfill	• Domestic • Construction • Commercial	462	572	609	511	597

Hazardous waste produced through MCR activities on the Bruce Power site are handled in accordance with all regulatory requirements to ensure proper handling, storage and off-site disposal. All hazardous wastes are sampled, packaged and labelled in accordance with all provincial and federal requirements. Pails and drums of hazardous wastes are transferred to a Station Chemical Waste Facility, where the waste is processed and prepped for shipment with other Bruce Power hazardous wastes. Bulk hazardous wastes are directly collected for disposal from its point of origin. Bruce Power ensures all hazardous wastes are transferred and received by licensed waste vendors.

4.4.8.2 Radiological Waste

MCR activities generate intermediate (ILW) and low level radiological wastes (LLW). Radiological waste is collected, monitored, segregated, sorted, processed, packaged and transferred to a third party waste contractor. To the extent practical, radioactive waste processing targets waste volume reduction so as to minimize the long-term storage volumes and costs. A comparison of the predicted types and volumes of radiological waste generated by MCR activities at Units 3, 4 and 6 is provided in Table 64. Final volumes for Unit 6 MCR will be provided at the completion of the MCR.

Table 64 Estimated Radiological Waste Types and Volumes for Major Component Replacement Activities at Units 6, 3 and 4 [R-246]

Radioactive Waste Type	Examples	Unit 6	Unit 3	Unit 4
		2020-2023	2023-2026	2025-2027
Low Level Radioactive Waste (LLW)	• Incinerables (personal protective equipment, liquids/oils) • Compactible (insulation) • Metals • Non-processible (feeders, tubes)	440 m^3	432 m^3	432 m^3
	• Steam Generators	330 m^3	349 m^3	349 m^3
Intermediate Level Waste (ILW)	• Filters • Tooling • Components • Valves	9 m^3	17 m^3	17 m^3
	• Reactor Components Waste	427 m^3	427 m^3	427 m^3

4.4.8.3 Waste Streams for each MCR Activity

Waste streams for MCR Lead In, Reactor Retube and Feeder Replacement, Steam Generator Replacement and Lead Out are presented in Table 65.

To reduce radiological air emission, processing, volume reduction and steel/concrete container packing of nuclear system radiological waste from MCR activities involving the reactor core will be undertaken within the reactor vault, whenever possible. Pressure and calandria tubes are crushed into small squares and deposited into a waste container and then transferred to the OPG's WWMF.

The Bruce B steam generators were processed into radiological and non-radiological waste components. The steam generators were transferred to the CSF (B44) where the steam drum was separated from the steam generator. The steam generator is then sent to OPG's NSS-W for long term storage/disposal and the steam drum is to be surveyed for disposition as non-radiological waste. This separation is not required for Bruce A as there is no steam drum attached to the Bruce A steam generators – they share a single, common steam drum that does not get removed during refurbishment.

In addition to the above component-specific waste management steps, general volume reduction techniques used by third party vendors include decontamination, incineration, compaction and metal melt. These techniques are used to minimize radiological waste volumes based on the application of relevant cost benefit analyses, and consistent with ALARA in the handling, processing and disposal of these wastes.

Table 65 Waste Streams by MCR Program

Task	Waste Streams
Lead In	
Reactor Shutdown and De-fuelling	• Not Applicable.
Vault Preparation	• The old calandria and shield tank seals contributed to a small proportion of the radiological waste generated at Unit 6. • The bulkheads and shielding from Unit 6 MCR will be re-used for the other Bruce B units. Separate bulkheads and shielding will be used for Bruce A Units 3 and 4. • Less than 5% of the bulkhead material is anticipated to be LLW at the end of an MCR outage.
Reactor Drain and Dry	• Activated carbon and HEPA filters (approximately 600 kg per MCR) used during the drying and calandria ventilation process to capture loose contamination will become radiological waste. • Tooling and material (e.g., instrument tubing, small bore piping) from system isolations and system tie-ins will become radiological waste. For Unit 6, this represented a small amount of waste (approximately 700 kg). • Particulate filters to be used on the inlet flow to the calandria to minimize dust infiltration will become non-radiological waste. • Welding operations will generate waste in the form of electrodes, metal dust, particulates, and fumes. • Installation and set-up of the vacuum skid, monitoring equipment, and purge systems is anticipated to generate non-radiological waste.
System Lay Up	Not Applicable.
Reactor Retube and Feeder Replacement	
Reactor Fuel Channel Removal	• Pressure tubes and calandria tubes will be cut and placed in specially designed waste containers prior to leaving the vault. The containers will be transferred directly to OPG's WWMF for long term storage and disposal. • Cutting operations will generate metal swarf, metal dust, and worn metal cutting discs which will become radiological waste.
Reactor Fuel Channel Installation	• Welding preparation and the welding operations will generate waste in the form of electrodes, metal dust, particulates and fumes.
Feeder Replacement	• Cutting operations will generate metal swarf, metal dust, and worn metal cutting discs which will become radiological waste. • Welding preparation and the welding operations will generate waste in the form of electrodes, metal dust, particulates and fumes.

Table 65 Waste Streams by MCR Program

Task	Waste Streams
Steam Generator Replacement	
Powerhouse Roof Opening	• Waste generated by cutting the roof will include pieces of decking, roof membrane and concrete slab material. • Cutting the containment concrete block above the steam generators will generate concrete slurry from the cutting lubricant.
Crane Construction	• Construction waste associated with the structural landing pad will be appropriately managed and disposed of.
Steam Generator Removal	• When cutting and removing interferences above and around each steam generator assembly, instrumentation tubing and small bore piping under 2 inch sections will be discarded as waste. • Insulation and insulation cladding will be inspected. If they are not acceptable for reuse, they will be treated as waste. Contaminated insulation and cladding will be disposed as radiological waste. • When removing interferences above each steam generator assembly, there is potential to find lighting ballasts that contain PCB. This hazardous waste will be disposed of appropriately. To date at Unit 6, this has only occurred for a single lighting ballast. • The original steam drum (at Bruce B only) will be removed. All cutting operations will generate metal swarf, metal dust, and worn metal cutting discs and disposed as radiological waste. • The original steam drum will be recycled and the original steam generator cartridges (lower portion of the steam generator) are planned to be transferred to OPG's WWMF for long term storage and disposal. • When the bellows seal containment seal is being cut, contaminated seal plate material will be discarded as radiological waste.
Steam Generator Installation	• Welding preparation and the welding operations generate waste in the form of electrodes, metal dust, particulates and fumes. • Steam generator installation involves multiple welding operations, including machining and weld preparation of the PHT inlet and outlet nozzles, steam outlet nozzles, steam generator safety relief valve nozzles and feed water inlet nozzles.
Crane Removal and Roof Closure	• Construction waste associated with the structural landing pad will be appropriately managed and disposed of. • A form is required for installation of the replacement concrete roof enclosed; some waste will be generated during the fabrication of the concrete form.
Return to Service	
Lead Out	• Grindings to remove the bulkhead will be segregated waste. • PHT filters used in PHT hydrostatic testing and cold flush will be disposed of. • PHT heat up and hot conditioning will result in increased spending of ion-exchange resins and corresponding production of ILW. This activity has not yet started at Unit 6.
Commissioning	Not Applicable.

4.5 PERA Outcomes (2016-2020)

No adverse outcomes impacting radiological air emissions or waterborne effluent have occurred to date resulting from new activities occurring on site. In the absence of substantial changes to air emissions or waterborne effluent resulting from MCR activities, there has been no substantial change in environmental monitoring results. With these stable environmental monitoring results, there has been no change to the overall outcome of the HHRA or EcoRA resulting from new activities occurring on site between 2016 and 2021.

4.5.1 Overview Emission and Effluent Outcomes

4.5.1.1 Overview of Conventional Emissions and Effluent Outcomes

Specific outcomes of the 2017 PERA are detailed by activity in the tables contained in the following sections. This section summarizes the conventional emissions and effluent outcomes to date.

Conventional Air Emissions and Noise

The estimated conventional air emissions from 2012 – 2016 as considered in the previous PERA are comparable to 2016 – 2020. Additional combustion sources were incorporated into the 2017 ESDM Report [R-212] to provide flexibility for combustion equipment used during MCR infrastructure projects which resulted in an increase in the NOx emissions (1 hour and 24 hour for non-emergency combustion sources). In 2018, refinements to emission estimates from steam venting operations during normal operations resulted in an increase to hydrazine emissions [R-213] . This is considered conservative when a unit is offline for Major Component Replacement. The injection of film forming amines (FFA) at the low pressure heaters prior to U6 MCR resulted in a new contaminant of potential concern, tallow amines. Estimated emissions were less than 3% of the MECP point of impingement (POI) limits [R-247].

All modifications and baseline air quality measurements met their respective site-specific limits. This includes air monitoring that was completed in 2016 (nitrogen oxide [NO_x] and particulate matter 2.5 µm or less [$PM_{2.5}$]) where all reported levels were well within regulatory limits. Air emissions at the Site are adequately managed and the MCR activities are not anticipated to result in air quality levels beyond those already experienced at site.

The ESDM Reports prepared by Bruce Power from 2016 – 2020 and the ECA (7477-8PGMTZ) [R-211][R-212][R-214][R-247]–[R-249]issued by the MECP demonstrate that Bruce Power operates in compliance with applicable MECP limits. These limits have been shown to be protective of human and non-human biota in the surrounding environment.

Noise investigations conducted in 2012 and 2015/2016 [R-250] as considered in the previous PERA are comparable to the noise investigations conducted in 2017, 2018, 2019 and 2020 [R-251]–[R-254]. The noise investigations demonstrated that the sound levels at receptor locations complied with the quantitative limits stipulated by the MECP NPC-232 Sound Level Limits for Stationary Sources in Class 3 Areas (Rural). The investigations revealed meteorological conditions influence the propagation of sound from the stations (i.e., Bruce Power is slightly audible during periods of low background noise).

Traffic increases as a result of MCR were offset by the reduced traffic to site as a result of remote work during the COVID-19 pandemic. On-site shuttle buses and bus service to site were suspended. Traffic impacts related to MCR will be evaluated further in the 2027 ERA.

The Acoustic Assessment Reports prepared for Bruce Power and the ECA (7477-8PGMTZ) [R-249]–[R-254]issued by the MECP demonstrate that Bruce Power operates in compliance with applicable MECP limits, including environmental noise guideline NPC-300 Stationary and Transportation Sources. Existing off-site noise levels reflect a rural sound environment and are generally characterized by the sound of nature, with noise from the Site being audible occasionally (infrequent, short-term exceedances of nighttime limit).

Conventional Water Emissions

Bruce A and Bruce B conventional water effluents from 2012-2016, as considered in the previous PERA, are comparable to 2016-2020. From 2016-2020, there were no exceedances of regulatory limits (e.g., of Bruce B’s Environmental Compliance Approval or the former Effluent Monitoring Effluent Limits regulation revoked July 1, 2021) attributed to MCR 6 activities.

Injection of film forming amines (FFA) and required monitoring was conducted in accordance with a modification to the Bruce B Environmental Compliance Approval. Discharges of FFA did not exceed the limits established in the modification.

Bruce Power routinely reports the results of the conventional effluent monitoring program to the Ministry of Environment, Conservation, and Parks in accordance with regulatory requirements (e.g., Environmental Compliance Approvals, Permits to Take Water). Releases from 2016-2020 are listed in Appendix C Section 3.4.1.

4.5.1.2 Overview of Radiological Emissions and Effluent Outcomes

Specific outcomes of the 2017 PERA are detailed by activity in the tables contained in the following sections. This section summarizes the radiological emissions and effluent outcomes to date.

Site radiological airborne emissions and waterborne effluents are controlled to meet regulatory requirements, prevent pollution and reduce releases, and to minimize environmental impacts. Bruce Power routinely reports the results of the radiological emissions and effluent monitoring in accordance with their CNSC licence. Releases from 2016-2020 are listed in Appendix J.

From 2009 to late 2012, Bruce A Units 1 and 2 were being refurbished and therefore only 6 of the 8 Bruce Power reactors were in operation. Bruce A Units 1 and 2 resumed operations in October of 2012. As discussed in the 2017 ERA [R-231], the radiological emisisons and effluents during and after refurbishment remained relatively constant. During the first 5 years of MCR (2016 to 2021), including the start of work on Unit 6 in 2020 and 2021, no major changes in radiological emissions or effluent has occurred. Therefore, it is assumed that the emissions and effluents from the Site during the next five years (2021 to 2026 inclusive), when Major Component Replacement for Bruce B Unit 6 will continue and Unit 3 and 4 will commence, will be similar to the emissions and effluents over the past five years (2016 to 2020 inclusive) and to the pre-MCR period prior to 2016.

Radiological Airborne Emissions and Waterborne Effluents

The average airborne emissions and waterborne effluents from 2012-2016 as considered in the previous ERA are comparable to 2016-2020 releases. Average tritium releases are slightly lower, with airborne releases reducing to 1.02E+15 Bq/y from 1.05E+15 Bq/y, and waterborne releases reducing to 8.72E+14 Bq/y from 8.73E+14 Bq/y.

Average emissions of noble gases have increased by approximately 25%. This may be attributable to changes in noble gas monitoring (i.e., the installation of PING monitoring systems).

Airborne emissions of iodine, beta/gamma particulates and alpha particulates are significantly lower (2.12E+07 Bq/y versus 1.98E+08 Bq/y for iodine, and 4.82E+06 Bq/y versus 1.10E+07 for beta/gamma; and 3.85E+04 Bq/y versus 1.96E+06 Bq/y for alpha). One factor contributing to this decrease is the change in emissions reporting methodology, where results below the minimum detectable activity (MDA) are no longer included in reported emissions. This has reduced the over conservatism seen in previously reported airborne releases.

Waterborne releases of gross alpha are higher, increasing from 5.75E+06 Bq/y to 9.44E+06 Bq/y. This is driven by higher reported releases from DPWMF, while reported releases from Bruce Power facilities have decreased due to the changes in reporting noted above. Furthermore, it is noted that while gross alpha releases have increased, the calculated doses from alpha releases remain negligible, contributing a maximum of ~0.2% to total dose.

Waterborne effluents of gross beta/gamma have not significantly changed. The average value for 2012-2016 was 3.56E+09 Bq/y, as compared to the 2016-2020 average value of 3.58E+09Bq/y.

Airborne emissions and waterborne effluent of C-14 have decreased by approximately 23% and 65%, respectively.

The Site has demonstrated that it operates in compliance with regulatory requirements. Air emissions and waterborne effluents at the Site are adequately managed and the MCR activities are not anticipated to result in air or water quality levels beyond those already experienced at the Site. In the prediction of radiological emissions and effluents during MCR activities, monitoring data from the past five years (2016-2020) that encompassed routine operations and the first portion of the MCR for Unit 6 were analyzed. The collected release data for this period encompassed all sources of emissions and effluents from the facility and used conservative assumptions where data was not available. As noted in the annual Environmental Protection Reports [R-37]–[R-40][R-255] the trended historical data for airborne and waterborne releases capture maintenance outage work (single and multi-unit outages) that would be comparable to MCR. During these outages, emissions and effluents were well below regulatory limits.

4.5.2 Environmental Monitoring Outcomes

Radiological and conventional environmental monitoring outcomes to date for MCR activities are reported each year in the Environmental Protection Reports [R-37]–[R-40][R-255]. No substantial changes have occurred in radiological or conventional monitoring results since the start of MCR activities. Radiological and conventional environmental monitoring programs are established, regularly reviewed and continue on an ongoing basis.

4.5.3 Noise

Environmental outcomes of completed activities predicted to have increases in environmental interactions in the 2017 predictive risk assessment are reported in Table 66.

Table 66 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Noise (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
MCR Centralized Office Complex	This complex was constructed in the Municipality of Kincardine. Potential interaction likely to result in a temporary residual adverse effect, but not likely to require additional monitoring or compensatory action.	Off-site facility constructed in Kincardine and excluded from further evaluation in the predictive risk assessment.
Bruce B Security Fence Modifications	The inner fence was moved towards the outer fence to provide laydown space for the crane construction and operation, which entailed use of: • A vacuum truck, which is associated with high-pitched noise, for excavation; • Concrete mixing trucks; and • Other construction equipment.	Work was completed during the day, and no attributable noise complaints received.
Bruce B Parking Lot Expansion	Outdoor construction activities (including construction with reclaimed asphalt) are anticipated to produce measurable noise.	Work was completed during the day, and no attributable noise complaints received.
Bruce A Parking Lot Expansion	Outdoor construction activities (including construction with reclaimed asphalt) are anticipated to produce measurable noise.	Work was completed during the day, and no attributable noise complaints received.
B16 MCR Storage Facilities	The B16 Storage Facilities are two clear-span, pre-engineered buildings. Construction involved use of cement trucks and construction equipment.	Work was completed during the day, and no attributable noise complaints received.

Table 66 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Noise (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Bruce B Simulator	Clearing of land, installation of foundations and construction of the structure using mechanical equipment is anticipated to produce measurable noise.	Work was completed during the day, and no attributable noise complaints received.
Bruce B Administrative Building (BBAB)	Demolition/removal of the existing trailers and construction of a two-story modular building.	Any loud activities were completed during the day. No attributable noise complaints received.
Bruce B Auxiliary Guardhouse	Clearing of land, installation of foundations and construction of the structure using mechanical equipment is anticipated to produce measurable noise.	Work was completed during the day, and no attributable noise complaints received.
B44 Central Storage Facility	Clearing of land, installation of foundations and construction of the structure using mechanical equipment is anticipated to produce measurable noise.	Work was completed during the day, and no attributable noise complaints received.
Lead In		
Bulkhead Installation and Vault Pressure Test	These activities will take place in the vault. The vault pressure test involves the use of large compressors that may increase noise levels. The increase in noise levels is similar to that experienced during SCO and VBO pressure tests.	No attributable noise complaints received.
Steam Generator Replacement		
MCR6 Roof Opening, Roof Enclosure Installation and Closure	A roof enclosure was installed on the roof of Unit 6. After installation, a hole was cut in the roof to enable the steam generator removals. Given that the unit will be shut down, and there is an enclosure, noise that could emerge from the roof opening will be minimal. It is anticipated that work will take place during daytime hours only.	As of July 2021, the opening is complete and no attributable noise complaints received. This activity is ongoing as the roof closure will occur after steam generator replacements
MCR6 Crane Construction and Removal	A gravel landing pad was constructed to provide a level surface for the heavy lift crane and diesel-powered cranes will be used to build the heavy lift crane. Cranes construction is occurring on site. These are large diesel powered units and are anticipated to produce measurable noise. It is anticipated that work will take place during daytime hours only.	No attributable noise complaints received related to the crane pad construction. Crane removal has not yet commenced.

Based on the outcome of the 2022 ERA, no risks were identified from noise to human receptors. Noise to wildlife could not be assessed due to lack of benchmarks. As a result, there are no measured impacts on noise as a result of life extension activities from 2016-2021.

4.5.4 Air Quality

4.5.4.1 Conventional Air Quality

Environmental outcomes of completed activities predicted to have increases in environmental interactions in the 2017 predictive risk assessment are reported in Table 67.

Table 67 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Conventional Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Ongoing Operations		
Routine Site Operations		
Centre of Site Facilities – CMF, FTF, administration buildings	Traffic may increase during MCR activities, resulting in increased air emissions. Traffic volumes (i.e., commuter vehicles, shuttle buses, delivery vans and pickup) and mobilization and demobilization of construction equipment anticipated as part of the project are not expected to be beyond that previously experienced at site.	Traffic increases as a result of MCR were offset by the reduced traffic to site as a result of remote work during the COVID-19 pandemic. On-site shuttle buses and bus service to site were suspended. Traffic impacts related to MCR will be evaluated further in the 2027 ERA.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
MCR Centralized Office Complex	MCR Office Complex was built off-site. It was predicted that there would be a change to conventional air emissions due to combustion of diesel fuels associated with use of construction equipment and particulate matter associated with soil moving activities. Consistent with existing practices on site, construction equipment was requested to meet Tier 3 emissions standards as required.	Off-site facility constructed in Kincardine and excluded from further evaluation in the predictive risk assessment.
Bruce A Parking Lot Expansion	Changes to conventional air emissions due to combustion of diesel fuels associated with use of construction equipment and particulate matter associated with soil moving activities. Consistent with existing practices on site, construction equipment will meet Tier 3 emission standards as required.	Construction equipment met emission standards and there were no issues noted during the construction of the parking lot. No further monitoring required.

Table 67 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Conventional Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Bruce B Parking Lot Expansion	Changes to conventional air emissions due to combustion of diesel fuels associated with use of construction equipment and particulate matter associated with soil moving activities. Consistent with existing practices on site, construction equipment will meet Tier 3 emission standards as required.	Construction equipment met emission standards and there were no issues noted during the construction of the parking lot. No further monitoring required.
Bruce B Simulator	Changes to conventional air emissions due to combustion of diesel fuels associated with use of construction equipment and particulate matter associated with soil moving activities was predicted. Construction equipment will meet Tier 3 emission standards where feasible. As per Site procedures and protocols, any halocarbon containing equipment (e.g., HVAC system) that has a cooling capacity greater than 19 kW will have an annual leak check, and halocarbon-containing equipment will be managed to ensure compliance with the *Federal Halocarbon Regulations, 2003* [R-256].	Building construction was completed in January 2019. Halocarbon containing equipment has been managed according to regulations and procedures are in place to maintain the equipment. Construction equipment met emission standards and no issues observed. No further monitoring required.
Bruce B Administrative Building (BBAB)	A change in conventional air emissions due to combustion of diesel fuels associated with use of construction equipment. Construction equipment will meet Tier 3 emission standards where feasible.	The BBAB was completed in Fall 2019. Construction equipment met emission standards and no issues during construction. Halocarbon containing equipment has been managed according to regulations and procedures are in place to maintain the equipment No further monitoring required.
Bruce B Auxiliary Guardhouse	In 2017, only internal modifications to the guardhouse were proposed. No anticipated air emissions were associated with the modifications.	Modifications to the guardhouse were assessed to not be adequate. An additional auxiliary building was constructed to handle the increased workforce. Halocarbon containing equipment has been managed according to regulations and procedures are in place to maintain the equipment Construction equipment met emission standards and no issues identified during construction. No further monitoring required.

Table 67 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Conventional Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Storage Facilities	This was expanded from the 2017 PERA to include the two B16 Storage Buildings and the B44 Central Storage Facility.	Halocarbon containing equipment has been managed according to regulations and procedures are in place to maintain the equipment Construction equipment met emission standards and no issues identified during construction. No further monitoring required.
Decontamination Facility	Activities to establish the Decontamination Facility within the CMF will be encompassed within the existing facility.	A separate decontamination facility was not constructed. This is excluded from further evaluation in the predictive risk assessment.
Bruce A Future MCR Office Support	Change to conventional air emissions due to use of trucks to move trailers to the Site.	Renovating existing office spaces inside Bruce A and also using the Off-site facility constructed in Kincardine. MCR Trailer Office Complex is constructed of modular trailers located inside the protected area. This work has started and is ongoing. No impacts have been noted to date. This is excluded from further evaluation in the predictive risk assessment.
B29 Feeder Welding Mockup	Change to conventional air emissions as a result of emissions produced during welding activities. A portable ventilation system will be in place to protect workers, the public and the environment.	B29 is not being used for Feeder Welding Mockup. This is part of the Off-site facility constructed in Kincardine. This is excluded from further evaluation in the predictive risk assessment.
Lead In		
Bulkhead Installation and Vault Pressure Test	Change to conventional air emissions as a result of running a set of diesel compressors outside the station and welding of bulkheads and use of sealants (e.g., decothane) within the station with emissions directed to the active ventilation system.	Conventional air emissions were modelled and confirmed to be in compliance with the ECA and MECP POI limits. This test is repeated again at the end of MCR6 and monitoring will continue.

Table 67 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Conventional Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
PHT Drain and Dry	Conventional emissions, ozone and nitrogen oxides may be produced from radiolysis of heavy water and nitrogen. Other potential sources of conventional air emissions are from metal cutting, welding and grinding, which may be required to support PHT drain and dry activities (such as cutting and capping). Emissions will be directed to active ventilation.	Conventional Air emissions were modelled and confirmed to be in compliance with the ECA and MECP POI limits. No further monitoring required.
Moderator Drain and Dry	Conventional emissions, ozone and nitrogen oxides may be produced from radiolysis of heavy water and nitrogen.	Conventional Air emissions were modelled and confirmed to be in compliance with the ECA and MECP POI limits. No further monitoring required.
Systems Lay Up	Changes in conventional air emissions, may result as systems are placed under nitrogen blankets. Inert gases and atmospheric gases that are produced will be directed to the atmosphere. There may be a minimal ozone production in lay up of moderator. During layup emissions are well managed and within regulatory limits.	Conventional Air emissions also considered emissions from Film Forming Amine (FFA) application technology that was used to help prevent corrosion in the feedwater system. All conventional air emissions were modelled and confirmed to be in compliance with the ECA and MECP POI limits. No further monitoring required.
Reactor Retube and Feeder Replacement		
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	Change in conventional air emissions is anticipated with the installation of the roof enclosure and as the opening for the steam generator lift is created. The roof enclosure is assembled offsite and craned into place. Some welding involved. Once installed the opening in the roof can be completed. This involves cutting the steel and membrane on the station roof and then using concrete cutting tools to open the boiler containment roof inside the building.	There were no issues with installation or cutting the roof opening. No further monitoring required.
Crane Construction	A change in conventional air emissions resulting from building the heavy lift crane, as additional heavy equipment is required to complete this task. This equipment is mainly powered by	There were no issues with the construction of the crane. No further monitoring required.

Table 67 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Conventional Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
	gasoline and diesel fuel, which will generate emissions. Construction equipment will meet Tier 3 emission standards where feasible.	
Steam Generator Removal and Installation	The roof enclosures will only be open during steam generator removal and replacement activities using the heavy lift crane. Limit switches will be installed on the enclosures of each opening to monitor length of time each enclosure is open. Additional controls, such as coordinating vault air lock openings will be implemented to restrict chimney effect air flow and movement of air from the vault. The vault will be evacuated during heavy lifts, limiting direct vault to atmosphere effects. Emissions associated with these activities are anticipated to be maintained within compliance limits.	Ongoing – will be complete in July or August 2021

Based on the outcome of the 2022 ERA, no risks were identified from conventional air quality to human and ecological receptors. As a result, there are no measured impacts on conventional air quality as a result of life extension activities from 2016-2021.

4.5.4.2 Radiological Air Quality

Completed activities covered in the 2017 PERA [R-231] that had potential adverse environmental outcomes are reported in Table 68. Any new activities that have since occurred on site that were not discussed in the 2017 PERA, if applicable, are also discussed in this section. No adverse impact of MCR activities in Unit 6 on radiological air quality have occurred through to June 30, 2021.

Table 68 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Radiological Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Ongoing Operations		
Routine Site Operations		
Fueling Ahead with Enhanced Boric Acid	This is a new activity that has occurred since the submission of the 2017 PERA. The use of enhanced boric acid reduces the volume of ion exchange resin that is needed and provides flexibility for fueling machine maintenance and MCR no-fuel windows. However, fueling ahead sometimes prevents the change out of ion exchange columns prior to an outage. This has the potential to increase carbon-14 emissions.	Although some periods of elevated carbon-14 emissions have occurred to date, emissions continue to be within compliance limits.
Installation of MCR Infrastructure		
Storage Facilities	The B44 Central Storage Facility is the only storage facility with radiological air emissions.	Monitoring of airborne radiological emissions from the Central Storage Facility began in December 2020. Emissions are reported quarterly to the CNSC and have been well below compliance limits since the building was commissioned.

Table 68 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Radiological Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Lead In		
Moderator Drain and Dry	Moderator Drain and Dry took place in accordance with the ALARA principle. Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.	Elevated tritium emissions were seen during the first week of the Unit 6 Moderator Ventilation Mode, but these emissions were still well below compliance limits. It is unknown whether this increase in tritium was the result of Moderator Ventilation Mode or the confinement dryer that was out of service. For the remainder of the Unit 6 Moderator Drain and Dry evolution, airborne emissions of tritium, carbon-14 and gross beta/gamma through the Unit 6 stacks were consistent with average emissions for the time period between 2015 and 2019.
PHT Drain and Dry	Radiological airborne emissions were predicted to occur as a result of: • Opening the PHT system and auxiliary systems during equipment isolations (cutting and capping activities) and establishing flow paths (e.g., check valve flapper removal). • During the drying phase, heavy water vapour is condensed with non condensables (mainly air) and residual heavy water vapor purged to the active ventilation, either directly or through an additional dryer. • PHT water drumming will be performed as a backup collection method only. With this method there is the potential for emissions from drum opening/closing. Emissions will be directed to the active ventilation. • Nitrogen purge and negative pressure ventilation stages could result in emissions that will be directed to the active ventilation.	During the Unit 6 PHT Drain and Dry evolution, airborne emissions of tritium, carbon-14 and gross beta/gamma through the Unit 6 stacks were consistent with average emissions for the time period between 2015 and 2019
Vault Vapour Recovery	Change to radiological air emissions due to airborne contaminants being released to the atmosphere. Overall, radiological emissions will be lower as the unit is shut down and the reactor systems drained and dried. To maintain negative pressure in the vault, VVR operation will be modified to ventilate two dryers directly to active	Vault air continues to be routed through VVR dryers with desiccant. The transition to dryers without desiccant has not occurred yet. No adverse impacts have been noted to date.

Table 68 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Radiological Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
	ventilation. Desiccant will be removed from these two dryers, but air will continue to be routed through filters prior to discharge. Should vault conditions change with respect to tritium concentrations, VVR operation will be altered to include the use of a desiccant containing dryer to lower tritium concentrations prior to discharge to active ventilation. Emissions associated with these activities are anticipated to be maintained within compliance limits.	
Reactor Retube and Feeder Replacement		
Feeder Replacement	Potential interaction not identified as resulting in a likely measurable change in radiological air emissions. Iron oxide (magnetite) inside a tube could become airborne during processing. These emissions will be directed to the active ventilation system.	The feeders have been removed which has not resulted in a measurable change to air emissions. Installation of new feeders had not yet started as of mid-2021.
Fuel Channel Removal and Installation	This could result in radiological emissions to the atmospheric environment from processing, volume reduction and packaging activities. These will be undertaken within the reactor buildings and airborne contaminants will be directed to the active ventilation. Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.	Fuel channel removal is complete and installation has not yet started as of mid-2021. Monitoring continues and no adverse impacts have been identified.

Table 68 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Radiological Air Quality (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Steam Generator Replacement		
Steam Generator Removal and Installation	Changes in radiological emissions to the environment. Sections of the roof will be open during steam generator removal and installation, which is an unmonitored pathway for radiological emissions to the environment. Radiological emissions to air through the roof opening have been conservatively estimated to inform work plans. A Maximum Probable Emission Rate (MPER) study was conducted to calculate the effect of a release through the roof openings. The roof enclosures will only be open during steam generator removal and replacement activities using the heavy lift crane. Limit switches will be installed on enclosures of each opening to monitor length of time each enclosure is open. Additional controls, such as coordinating vault air lock openings will be implemented to restrict chimney effect air flow and movement of air from the vault. Emissions associated with these activities are anticipated to be maintained within compliance limits.	The Maximum Probable Emission Rate (MPER) calculations showed that emissions for tritium, carbon-14, noble gases, gross beta particulate and alpha particulate were below 0.05% of the respective Derived Release Limit (DRL) and therefore, radiological emissions through the roof openings do not require monitoring [R-257]. This activity is ongoing and will continue in late 2021.
Waste Handling, Management and Demobilization		
Waste Handling and Waste Management and Demobilization	Change in radiological emissions to the environment as a result of resin change-outs. These emissions will be directed to the active ventilation system. However, emissions are anticipated to be maintained within compliance limits.	No adverse impacts noted to date. In preparation for MCR, ion exchange resins were regenerated to optimize the health of purification systems. This resulted in an increase in C-14 emissions which were within normal range and well below compliance limits.

Based on the outcome of the 2022 ERA, no risks were identified from radiological air quality to human and ecological receptors. As a result, there are no measured impacts on radiological air quality as a result of life extension activities from 2016-2021.

4.5.5 Surface Water

4.5.5.1 Conventional Surface Water

Environmental outcomes of completed activities that were predicted to involve increases in environmental interactions in the 2017 predictive risk assessment are reported in Table 69.

Table 69 Outcomes of Predicted Future Site Interactions for Surface Water (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Routine Asset Management Activities (Examples Only)		
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	When the CCW pump is taken out of service for the unit undergoing MCR, feedwater chemical emissions in the station discharge may be of higher concentration due to reduced dilution in the CCW duct. Additionally, draining and drying of low pressure service water systems may result in corrosion, scale, and hardness returned to the lake. Replacement of copper piping would have a positive effect as this would reduce copper discharge to the lake. However, effluents are anticipated to be maintained within compliance limits.	There was no increase in emissions reported with having the minimum number of CCW pumps running for the station. There were also no issues noted during replacement or overhaul of components. CCW outage is still ongoing as of mid-2021. Replacement of copper piping will continue on site. Surface water discharges continue to be tested and meet discharge criteria prior to release.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
MCR Centralized Office Complex	For an on-site or offsite facility, new tie-ins with the existing stormwater management system (e.g., catch basins) and new tie-ins to an existing sewage system will be required.	Off-site facility was constructed in Kincardine by a developer and leased to Bruce Power. This is excluded from further evaluation in the predictive risk assessment.
Bruce B Security Fence Modifications	Construction activities could result in runoff that could impact waterways. Silt and sediment barriers will be used, as necessary to protect fish habitat.	Erosion and sediment controls were in place during construction. There were no issues noted during the construction. No further monitoring required.
Bruce B Parking Lot Expansion	Runoff is anticipated to be affected by the parking lot expansion. Changes are planned to the stormwater system, which may include new catch basins in the expanded portion of the parking lot and installation of swales, if required. Drainage from the expanded parking lot will be routed to the east drainage ditch. If new catch basins are required, requisite ECA modifications will be obtained. Construction activities could result in runoff	A modification to the Amended Environmental Compliance Approval was completed for the work as required. Storm drainage plan implemented during construction. There were no issues noted during the construction of the parking lot. No further monitoring required.

Table 69 Outcomes of Predicted Future Site Interactions for Surface Water (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
	that could impact waterways. Silt and sediment barriers will be used, as necessary to protect fish habitat.	
Bruce A Parking Lot Expansion	Not included in 2017 PERA. Runoff is anticipated to be affected by the parking lot expansion. Changes are planned to the stormwater system, which may include new catch basins in the expanded portion of the parking lot and installation of swales, if required. Drainage from the expanded parking lot will be routed to the existing ditches that eventually discharge into Lake Huron. If new catch basins are required, requisite ECA modifications will be obtained. Construction activities could result in runoff that could impact waterways. Silt and sediment barriers will be used, as necessary to protect fish habitat.	A modification to the Amended Environmental Compliance Approval was completed for the work as required. Storm drainage plan implemented during construction. There were no issues noted during the construction of the parking lot. No further monitoring required.
Storage Facilities	This was expanded from the 2017 PERA to include the two B16 Storage Buildings and the B44 Central Storage Facility. The Central Storage Facilities were built on what was a graveled storage lot. Stormwater runoff designs for this new building include installation of drainage with swales, if required. Requisite ECA amendments will be obtained if required.	Amended Environmental Compliance Approval was updated as required. Storm drainage plan implemented during construction. There were no issues noted during the construction. No further monitoring required.
Bruce B Simulator	The Bruce B Simulator was built on a storage lot. Stormwater runoff designs for this new building include installation of drainage with swales if required. If required, requisites ECA amendments will be obtained.	Amended Environmental Compliance Approval was updated as required. Storm drainage plan implemented during construction. There were no issues noted during the construction. No further monitoring required.
Bruce B Administrative Building (BBAB)	The Bruce B Administrative Building will feature new tie-ins with the existing stormwater management system (e.g., catch basins) and new tie-ins to the existing pressurized sewage system. There is no anticipated need for an ECA amendment. If new catch basins are required, requisite ECA amendments will be obtained. To manage runoff associated with concrete production, a concrete slurry cleanup area was established so that dried concrete can be removed upon completion of construction and disposed of as waste.	Amended Environmental Compliance Approval was updated as required. Storm drainage plan implemented during construction. There were no issues noted during the construction. No further monitoring required.

Table 69 Outcomes of Predicted Future Site Interactions for Surface Water (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
	Construction activities could result in runoff that could impact waterways. Silt and sediment barriers will be used, as necessary to protect fish habitat. Any bulk fuel oil tanks or diesel generators associated with the facility will have secondary containment with 110% capacity of the fuel oil being stored. Circle checks will be conducted daily for all fuel containing equipment prior to using that equipment that day. Connections on hoses and piping will be protected before work begins. During fueling activities, drip trays will be used to ensure over filling or other drips associated with fueling activities are contained.	
Bruce A MCR Trailers	The Bruce A MCR Trailers are planned to be built on what is currently a gravel lot with partial asphalt cover that is designed for drainage. The existing stormwater management system is planned to be used. If new catch basins are required, requisite ECA amendments will be obtained. Construction activities could result in runoff that could impact waterways. Silt and sediment barriers will be used, as necessary to protect fish habitat.	This work has started and is ongoing. No impacts have been noted to date.
Increased Sewage and Domestic Water	Increased sewage and domestic water associated with MCR activities are anticipated to be within current discharge limits, and the recent station containment outage experienced at site is considered representative of the anticipated future conditions.	The impacts of MCR on increased sewage and domestic water use have been offset to date by the remote work period required by the COVID-19 pandemic. A third Sewage Processing Plant (SPP) treatment train is being constructed and an ECA amendment is in progress to address increased sewage loading. These effects will be evaluated in the 2027 ERA.
Lead In		

Table 69 Outcomes of Predicted Future Site Interactions for Surface Water (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
System Lay Up	Drainage of systems will be directed to either the ALWMS or the CCW, which needs to meet ECA/Effluent Monitoring and Effluent Limits (EMEL) limits prior to discharge. The dry lay up of systems may result in the formation of corrosion products (e.g., iron oxides) and upon system refill and subsequent draining; corrosion products may be discharged to the lake.	Film Forming Amine (FFA) application technology is being used to help prevent corrosion as described in Section 4.4.4. This was injected into systems prior to MCR during normal operation and provides a protective coating on the systems when they are drained. There were no issues with drainage of systems. System refill has not yet occurred as of mid-2021.

To optimize the management of on-site stormwater, ditches, swales, pipes and drains are used to collect and manage stormwater, which is discharged directly to Lake Huron at various locations. Bruce Power employs at-source controls, including site design, good housekeeping, and solid reduction measures (e.g., slow flow and vegetation establishment) to improve water quality prior to release to the environment, and storm water quality is monitored. The Bruce B Parking Lot Expansion affected the existing forest to the south-east of the existing parking lot footprint. Additionally, the Bruce A parking lot expansion affected the existing forest to the east of the existing lot footprint. The establishment of all other facilities avoids substantial tree clearing and is encompassed by existing disturbed area (e.g., graveled area). Stormwater runoff designs for each new building were reviewed to determine if changes to the existing stormwater management at the Site were required to accommodate the facility. All stormwater is managed in accordance with existing Site procedures and protocols, therefore, construction dewatering were discharged to grade and erosion and sedimentation controls were in place to manage sediment runoff to waterways.

Based on the outcome of the 2022 EcoRA, the only identified risks from surface water in Lake Huron is from zinc. This risk is based on a single sampling event in July 2021 and on an assumed DOC for Lake Huron to derive toxicological benchmarks. This risk will be addressed by the recommendations in Section 5.7 of the main report [R-22]. The activities occurring as a part of life extension work would not cause an increased zinc value in Lake Huron. As a result, there are no measured impacts on conventional surface water as a result of life extension activities from 2016-2021.

4.5.5.2 Radiological Surface Water

Completed activities covered in the 2017 PERA that had potential adverse environmental outcomes are reported in Table 70. Any new activities that have since occurred on site that were not discussed in the 2017 PERA, if applicable are also discussed in this section. No adverse impact of MCR activities in Unit 6 on radiological surface water quality have occurred through to June 30, 2021.

Table 70 Outcomes of Predicted Radiological Future Site Interactions for Surface Water (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Ongoing Operations		
Routine Site Operations		
Fueling Ahead with Enhanced Boric Acid	This is a new activity that has occurred since the submission of the 2017 PERA. The use of enhanced boric acid reduces the volume of ion exchange resin that is needed and provides flexibility for fueling machine maintenance and MCR no-fuel windows. However, fueling ahead sometimes prevents the change out of ion exchange columns prior to an outage. This has the potential to increase carbon-14 in effluent.	Although some periods of elevated carbon-14 in waterborne effluent have occurred to date, effluent continues to be within compliance limits.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Storage Facilities	The B44 Central Storage Facility does not have an ALW system. All radiological waste water is drummed and transferred to Bruce A.	ALW waste transfers to Bruce A meet procedural requirements for acceptance of radiological waste water.
Decontamination Facility	Activities to establish the Decontamination Facility within the CMF will be encompassed by the existing facility. Further, discharge will occur via a monitored pathway to verify compliance.	A separate decontamination facility was not constructed. This is excluded from further evaluation in the predictive risk assessment.
Lead In		
Vault Air Conditioning	Condensation containing waterborne contaminants will be directed to the ALWMS and could affect lake water quality. Proceduralized processes will be in place to manage this potential residual adverse effect, to ensure that water quality parameters are within compliance limits. Further, discharge will occur via a monitored pathway to verify compliance.	Vault Air conditioning was installed and condensate directed to ALW. There have been no issues with this small amount of discharge to the ALWMS.
Temporary Dehumidifiers	A portion of condensate from temporary dehumidifiers will be directed to the ALWMS and could contain waterborne contaminants that affect lake water quality. Proceduralized processes will be in place to manage this potential residual adverse effect, to ensure that water quality parameters are within compliance limits. Further, discharge will occur via a monitored pathway to verify compliance.	Dehumidifiers have been installed and are being used when required. Condensate from the dehumidifiers is collected and tested for tritium concentration and D_2O isotopic. Water that is equal to or <0.5% D_2O is directed to the ALWMS. Water that is >0.5% D_2O is directed to the D_2O upgraders and has no impact on waterborne effluent. No issues have been noted to date, as a result of this condensate being discharged through the ALWMS.

Table 70 Outcomes of Predicted Radiological Future Site Interactions for Surface Water (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
PHT Drain and Dry	No direct waterborne effluent is expected. All drained water will be stored and reintroduced to the system during refill.	No changes to waterborne effluent were identified. Surface water could be affected by downwash resulting from airborne emissions. See Section 4.5.4.2.
Moderator Drain and Dry	No direct waterborne effluent is expected. All drained water will be stored and reintroduced to the system during refill.	No changes to waterborne effluent were identified. Surface water could also be affected by downwash resulting from airborne emissions. See Section 4.4.3.
Reactor Retube and Feeder Replacement		
Feeder Replacement	If draining and drying of the feeders is not completely effective, there is potential for heavy water to be directed to the ALWMS.	No impact to ALW resulting in a measurable change.
Fuel Channel Removal and Installation	If draining and drying of the fuel channels is not completely effective, there is potential for heavy water to be directed to the ALWMS, which needs to meet compliance limits prior to discharge.	Fuel channel removals are complete. No impact to ALW resulting in a measurable change.
Steam Generator Replacement		
Steam Generator Removal and Installation	If there is residual water in steam generator tubes that are cut, radiological water could be released. It is unlikely that steam generator tubes will be cut as part of MCR activities, and it is anticipated that any residual water would be contained in previously plugged tubes. In the unlikely event, residual water released would be contained and sent to ALWMS, which needs to meet compliance limits prior to discharge.	Steam generator removal in progress. Steam drums to be severed from the generators in Fall 2021 and it is not anticipated that the tubes will be cut.
Waste Handling and Waste Management		
Waste Handling and Waste Management and Demobilization	Change in radiological effluent to the environment as a result of resin change-outs. Water from resin dewatering will be directed to the D2O upgraders or ALWMS. However, effluent is anticipated to be maintained within compliance limits.	In preparation for Unit 6 MCR, ion exchange resins were regenerated to optimize the health of purification systems. This resulted in an increase in C-14 effluent which was within normal range and well below compliance limits.

Based on the outcome of the 2022 ERA, no risks were identified from radiological surface water to human and ecological receptors. As a result, there are no measured impacts on radiological surface as a result of life extension activities from 2016-2021.

4.5.6 Groundwater

Environmental outcomes of completed activities predicted to involve increases in environmental interactions in the 2017 predictive risk assessment are reported in Table 71. No interactions related to radiological impacts to groundwater were identified in the 2017 PERA or in findings from environmental monitoring programs from 2016-2021.

Table 71 Outcomes of Predicted Future Site Interactions for Groundwater (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
MCR Centralized Office Complex	Runoff from the MCR Centralized Office Complex site could affect groundwater quality. The complex will result in a greater paved area being treated with salt during winter conditions, which could affect groundwater quality. Runoff will be routed to existing or new catch basins.	Off-site facility constructed in Kincardine and excluded from further evaluation in the predictive risk assessment.
Bruce B Parking Lot Expansion	Runoff from the expanded parking lot could affect groundwater quality. Expansion of the parking lot will result in a greater paved area being treated with salt during winter conditions, which could affect groundwater quality. Runoff will be routed to existing or new catch basins.	No impacts on groundwater noted in the groundwater monitoring program results.
Bruce A Parking Lot Expansion	Runoff from the expanded parking lot could affect groundwater quality. Expansion of the parking lot will result in a greater paved area being treated with salt during winter conditions, which could affect groundwater quality. Runoff will be routed to existing or new catch basins and/or ditches.	No impacts on groundwater noted in the groundwater monitoring program results. No new catch basins were added.

Based on the outcome of the 2022 ERA, no risks were identified from shallow groundwater quality at FSL or BASC to ecological receptors. No complete pathways exist for exposure to off-site human receptors. As a result, there are no measured impacts on shallow groundwater quality as a result of life extension activities from 2016-2021.

4.5.7 Geology, Sediment and Soil

Environmental outcomes of completed activities predicted to involved increases in environmental interactions in the 2017 predictive risk assessment are reported in Table 72. No interactions related to radiological impacts to geology, sediment and soil were identified in the 2017 PERA or in findings from environmental monitoring programs from 2016-2021.

Table 72 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Geology, Sediment and Soil (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Ongoing Operations		
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	Specifically, underground maintenance activities could affect soil quality.	No impact to soil quality. Soil management practice was followed and no impact to soil quality.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
MCR Centralized Office Complex	Excavation of soil will be required.	Off-site facility constructed in Kincardine and excluded from further evaluation in the predictive risk assessment.
Bruce B Security Fence Modifications	Specifically, excavation of soil will be required and handled under the Bruce Power Soil Management Program. Specifically, land clearing activities, including removal of trees, are anticipated to occur on-site, however, activities could also disturb wildlife. Mitigation activities, such as planting equivalent trees in an appropriately selected area, are being considered. Construction workers will be aware of wildlife (e.g., nests) during demolition and will adhere to legislative requirements. Pre-job orientations/briefs will take place to orient workers to environmental considerations at the Site.	Soil Management Program was followed and there was no measurable change.
Bruce B Parking Lot Expansion	Land clearing activities, including removal of trees, are anticipated to occur to accommodate the expansion of the parking lot, however, activities could also disturb wildlife. In addition, expansion of the parking lot will result in a greater paved area being treated with salt during winter conditions, which could affect soil quality. Mitigation activities, such as planting equivalent trees in an appropriately selected area, are being considered. Construction workers will be aware of wildlife (e.g., nests) during demolition and will adhere	Construction was conducted after a survey of trees to confirm the absence of bird nests. Approximately 4.4 ha of forested land were cleared to create the new parking lots. An equal amount of protected forested land was purchased offsite as a mitigating activity. Erosion and sediment controls were in place during construction. There were no issues noted during the construction. No further

Table 72 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Geology, Sediment and Soil (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
	to legislative requirements. Pre-job orientations/briefs will take place to orient workers to environmental considerations at the Site. Construction dewatering or dewatering of temporary soil lay down areas will be confirmed "clean" (no contamination) before being discharged to grade and erosion and sedimentation controls will be in place to manage sediment runoff to waterways. Soil will be handled under the Bruce Power Soil Management Program.	monitoring required.
Bruce B Simulator	Land clearing activities, including removal of trees, are anticipated to occur on-site, however, activities could also disrupt wildlife. Mitigation activities, such as planting equivalent trees in an appropriately selected area, are being considered. Construction workers will be aware of wildlife (e.g., nests) during demolition and will adhere to legislative requirements. Pre-job orientations/briefs will take place to orient workers to environmental considerations at the Site. The building design will consider strategies to avoid bird-window strikes. Soil will be handled under the Bruce Power Soil Management Program.	Tree removal was evaluated prior to construction and conducted prior to nesting season. Soil Management program was followed and there was no measurable impact.
Bruce B Administrative Building (BBAB)	Land clearing will be required and activities could disrupt wildlife. Construction workers will be aware of wildlife (e.g., nests) during demolition and will adhere to legislative requirements. Pre-job orientations/briefs will take place to orient workers to environmental considerations at the Site. The building design will consider strategies to avoid bird-window strikes. Construction dewatering or dewatering of temporary soil lay down areas will be confirmed "clean" (no contamination) before being discharged to grade and erosion and sedimentation controls will be in place to manage sediment runoff to waterways. Soil will be handled under the Bruce Power Soil Management Program. A soil	This location was an industrial site with gardens. No issues during clearing of the area. Soil Management plan was followed and there was no measurable impact. Erosion and sediment controls were in place during construction. Soil impacted by TSS8 mineral oil spill in 2018 was removed from site and taken to a soil recycling facility (see Section 1.5.2 of [R-22]). No additional clean-up or remediation activities are required. There were no other issues noted during the construction. No further

Table 72 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Geology, Sediment and Soil (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
	management area was construction inside the Bruce B protected area to manage soils from this project.	monitoring required. A gull mitigation system was installed on the roof to prevent gull nesting.
Bruce A Future MCR Office Support	The establishment of a building on an existing gravel surface is anticipated to have a limited interaction with wildlife (e.g., establishment of temporary perch habitat, additional noise and activity within an industrial site).	This is ongoing and not complete. Outcomes will be reported in the 2027 ERA.
Bruce A Parking Lot Expansion	Construction dewatering or dewatering of temporary soil lay down areas will be confirmed “clean” (no contamination) before being discharged to grade and erosion and sedimentation controls will be in place to manage sediment runoff to waterways. Soil will be handled under the Bruce Power Soil Management Program.	Construction was conducted in off season for nesting birds. Approximately 0.9 ha of forested land was cleared to create the new parking lots. Protected higher quality forested land was purchased offsite as a mitigating activity (see Table 73). Erosion and sediment controls were in place during construction. There were no issues noted during the construction. No further monitoring required.
Decontamination Facility	Soil will be handled under the Bruce Power Soil Management Program.	A separate decontamination facility was not constructed. This is excluded from further evaluation in the predictive risk assessment.
Crane Construction	The addition of gravel or pre-formed concrete blocks may be required for the construction of the crane pad. Bore holes will be drilled as part of the geotechnical study to verify subsurface ground properties. These holes will be back-filled after confirming results of study.	The crane pad is complete and was constructed inside the protected area. No impacts resulting in a measureable change.
Roof Opening, Roof enclosure Installation and Closure	There is potential for interaction with nesting bird species that utilize site infrastructure for habitat or perches. Approved deterrents used on site will be used, as necessary. If the removal or relocation of nests/eggs is required, it will be done in accordance with applicable permit obtained under 3949 Migratory Bird Regulations.	Work was well integrated with existing processes and procedures in accordance with the Migratory Bird permit. No issues during the installation of the roof enclosure. Area continues to be monitored for nesting activity during project execution

Table 72 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for Geology, Sediment and Soil (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Crane Construction	There is potential for wildlife to be disturbed by the construction of the crane, and the crane could provide potential perch habitat. There is the potential for interaction with nesting bird species that utilize site infrastructure for habitat or perches. Approved deterrents used on site will be used, as necessary. If the removal or relocation of nests/eggs is required, it will be done in accordance with applicable permit obtained under 3949 Migratory Bird Regulations.	Work was well integrated with existing processes and procedures in accordance with the Migratory Bird permit. No issues during the installation of the roof enclosure. Area continues to be monitored for nesting activity during project execution.

Based on the outcome of the 2022 ERA, risks were to ecological receptors from historic conventional soil COPCs at Construction Landfill #4, Fire Training Facility, Distribution Station #1 and at specific general soil sampling locations (BPS-04-07/SS6/BPS-07-07/BPS-01-07/BPS-02-07) and from sediment at the Eastern Drainage Ditch. These results occur at locations not impacted by Life Extension and MCR activities or by Lu-177 production. As a result, there are no measured impacts on soil or sediment quality as a result of life extension activities from 2016-2021.

4.5.8 Terrestrial Environment (Species and Habitat)

Based on the 2017 PERA, no environmental changes in risk were predicted for radiological impacts to terrestrial receptors. No significant changes in radiological outcomes have been measured for terrestrial receptors on site since the beginning of Life Extension and MCR.

A total of 7.2 hectares of land have been cleared as part of the installation of MCR infrastructure, including the B31 simulator and additional parking lots at Bruce A and Bruce B. As part of the ESG program, an internal target was set to protect 887 hectares of high-quality habitat on-site or contribute to the protection of an equivalent amount offsite. This target was established from an Ecological Land Classification study completed in 2017 [R-21] that identified 887 ha of undisturbed forest, open, or wetland habitats present on the Bruce Power site. Bruce Power has contributed towards the preservation of 61.6 hectares of high quality habitat during this same time period that land was cleared, significantly exceeding our target (Table 73).

Table 73 Bruce Power Land Clearing Offsets (2017-2021)

Year	Hectares of land cleared (or otherwise significantly disturbed) in given year (ha)	Land Disturbance Comment	Hectares of land preserved in given year (ha)	Land Preservation Comment
2017	0.0	Baseline year.	0.0	No data recorded
2018	0.3	Small land clearing for construction of B31 Simulator (east extension of B31)	57.5	Bruce Power provided over 50% of the total cost for the preservation of 142 acres of land via the Bruce Trail Conservancy, the property purchased has an ecological value of over $1.5 million.
2019	0.0	No land clearing or significant disturbances.	2.0	Bruce Power contributed to the preservation of 5 acres of land locally through a partnership with Ontario Nature and their initiative to expand Petrel Point and Sauble Dunes existing nature reserves.
2020	6.9	Creation of MCR parking lots at Bruce A and Bruce B.	0.0	No land preservation effort occurred as funding was redirected to support community COVID-19 response.
2021	0.0	No land clearing or significant disturbances.	2.2	Bruce Power provided 40% of the funding to Biosphere Escarpments Bieman Property for the purchase of 2.84 acres, crediting 1.14 acre of the credit to Bruce Power. Bruce Power also provided funding towards the expansion of the Brittan Lake Acquisition (creating 1,100 acres of connected conservation). Based on our financial contribution, Bruce Power is accrediting 4.2 acres of this contribution.

Local conservation, environmental education, and environmental awareness and research initiatives are also supported annually through Bruce Power's Environment and Sustainability (E&S) Fund. One partnership through this fund is with Saugeen Valley Conservation Authority (SVCA), helping to expand their seedling planting program. As of 2021 the planting of 181,005 seedlings were funded, with a commitment to continue to fund this program through 2025.

4.5.9 Aquatic Environment (Species and Habitat)

There were no radiological or conventional impacts to surface water predicted to arise from MCR. From 2016 to 2021, no radiological or conventional impacts related to MCR have been measured during routine environmental monitoring programs. No interactions related to radiological impacts to aquatic species or habitat were identified in the 2017 PERA or in findings from environmental monitoring programs from 2016-2021.

4.5.10 Human Environment

Environmental outcomes of completed activities predicted to involve increases in environmental interactions in the 2017 predictive risk assessment are reported in Table 74. No interactions related to radiological impacts to the human environment were identified in the 2017 PERA or in findings from environmental monitoring programs from 2016-2021.

Table 74 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for the Conventional Human Environment (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
MCR Centralized Office Complex	Specifically, establishment of infrastructure could reduce the aesthetics of the landscape. Area to be disturbed will be on-site or off-site in an industrial area. The timeline for the construction will be communicated to external stakeholders.	Off-site facility constructed in Kincardine and excluded from further evaluation in the predictive risk assessment.
Bruce A Parking Lot Expansion	Specifically, establishment of infrastructure could reduce the aesthetics of the landscape. Areas to be disturbed are on-site, and have for the most part been previously disturbed (i.e., graveled).	Completed with minimal aesthetic impact given the already industrial nature of the site.
Bruce B Parking Lot Expansion	Specifically, establishment of infrastructure could reduce the aesthetics of the landscape. Areas to be disturbed are on-site, and have for the most part been previously disturbed (i.e., graveled).	Completed with minimal aesthetic impact given the already industrial nature of the site.

Table 74 Outcomes of 2017 PERA Site Interactions with a Predicted Environmental Impact for the Conventional Human Environment (2016-2021)

Site System, Structure or Activity	Summary of Predicted Interaction as Stated in the 2017 PERA	Outcomes of Completed System, Structure or Activity
Increase in Workers, Payroll and Purchasing	Specifically, MCR will significantly extend the life of Bruce A & Bruce B generating stations, and will result in a 5 year increase period of increased activity on-site. These changes are predicted to result in a likely measurable change to: • Maintenance of workforce for the foreseeable future, including local and Indigenous employees, resulting in sustainable contribution to local economy, as well as other socio-economic benefits. • Increase in local population, resulting in a short-term increase in demand on local services, which could affect municipal finances, community infrastructure and services, and community facilities and resources. • An increase of 2 to 3% in population, is within the growth predictions in the Official Community Plans for both the Municipality of Kincardine and Saugeen Shores, therefore, it is not likely that MCR will result in a measurable change. • Increased competition for temporary accommodations, which may affect tourism.	No significant negative impacts noted to date.
Lead In		
Crane Construction	Specifically, establishment of infrastructure could reduce the aesthetics of the landscape. Areas to be disturbed are on-site, and have for the most part been previously disturbed (i.e., graveled). The timeline for the crane being transported and erected will be communicated to external stakeholders. It is anticipated that the crane may be visible from the Baie du Doré, the bluffs to the east of the Site (i.e., Bruce Power Visitors' Centre, the wind energy park and the Bruce Energy Centre), and as far away as 20 km on Lake Huron.	No significant negative impact noted as of mid-2021 (Figure 58).

Figure 58 Cranes constructed in support of MCR at Unit 6

No substantial negative environmental impacts to the conventional human environment were predicted in 2017 as a result of activities associated with Life Extension or MCR. As of mid-2021, no substantial negative impacts to the conventional human environment have been measured.

While some reported emissions and effluent have decreased (see Section 4.5.1) and some have increased, the overall impact on the HHRA is minimal. The calculation of dose to public is primarily based on environmental monitoring data, and is generally not sensitive to changes in reported releases. While the highest average dose has increased to ~2.5 µSv/y in the present ERA from ~1.4 µSv/y in the previous ERA, doses to human receptors remain below the 10 µSv *de minimis* value, and changes are not considered to be significant or attributable to variations in emission or effluent rates. Significant factors resulting in the change in dose rates are variations in environmental and background data, and the use of modelled concentrations where samples are not available.

The historical radiological releases from 2012 – 2016 considered in the previous 2017 ERA [R-231] were predicted to bound MCR and other future activities, and the resulting radiation doses to human receptors were anticipated to remain negligible. The results of the present radiological HHRA demonstrate that the doses to human receptors have remained negligible, with maximum calculated doses continuing to be below the 10 µSv *de minimis* value, and less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y).

4.5.11 Conclusion

During Life Extension and MCR activities completed between 2016 and mid-2021, there has been no substantial change to radiological and conventional emissions and effluents from the Bruce Power site. Given the lack of substantial changes to radiological and conventional emissions and effluents, routine environmental monitoring programs have not detected significant changes to environmental outcomes related to MCR and Life Extension Activates.

MCR activities discussed in the outcomes section that will not occur for future MCRs (i.e., installation of MCR infrastructure) will transition into routine operations and will be incorporated into the main body of the 2027 ERA. Outcomes of activities that occur in future MCRs will continue to be discussed in the 2027 PERA.

4.6 PERA Preliminary Screening of Future Site Activities

For human and ecological receptors, an evaluation is made regarding how exposure pathways may be modified in ways that have effects on the receptors(s) or their habitat as a result of future site activities, including MCR activities. The potential changes are discussed in the physical pathway-interaction discussions (e.g., for air quality and surface water quality).

The following sections describe Project-environment interactions associated with future site activities for each aspect of the environment considered in the ERA. A step-wise predictive screening was carried out to identify and classify plausible interactions between future site activities and the environment. The results of this screening are presented in the following sections. Each interaction is evaluated as potentially resulting in:

- An increased interaction with the environment compared to operational and outage conditions (denoted in the summary table with an arrow pointing up "↑");
- A decreased interaction with the environment compared to operational and outage conditions (denoted in the summary table with an arrow pointing down "↓");
- No change or negligible change from operational and outage conditions (denoted in the summary table with an arrow pointing to the right "→"); or
- No interaction/not applicable (i.e., the system or structure does not have an interaction with the specified environmental pathway; indicated by a "—").

In the interaction tables provided below, those interactions denoted with a symbol indicating a potentially increasing environmental effect as a result of a Project-environment interaction (i.e., a ↑) are discussed or evaluated in the preliminary screening assessment.

As experience with Life Extension and MCR activities at Bruce Power grows, the outcome of these activities will be used to adjust the preliminary screening outcomes. As a result of this adaptive management process, the potential for environmental impact and the description of the potential impact has been adjusted from the 2017 ERA throughout this section.

4.6.1 Noise

Future site activities are evaluated for the potential to have an impact on noise in Table 75. Future activities that are predicted to have an increased environmental impact are discussed below.

Table 75 Future Site Activities with Potential for Impacts on Noise during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A and Bruce B Generating Stations, including all systems and cooling water channels	→	No change anticipated. Noise associated with the primary heat transport pumps, ventilation systems and standby emergency generators will continue for operating units.
Transformer Area and Standby Emergency Generators	→	No change anticipated. Standby emergency generators will continue to be tested at a regular frequency.
Centre of Site Facilities – CMF, Fire Training Facility (FTF), administration buildings	→	Traffic may increase during MCR activities, resulting in increased noise. Traffic volumes (i.e., commuter vehicles, shuttle buses, delivery vans and pickup) and mobilization and demobilization of construction equipment as part of the project are not expected to be beyond that previously experienced at site. Anticipated traffic volumes for MCR would be comparable to that experienced during the last station containment outage.
Transfer of Waste	→	Transfer of waste (to the Western Waste Management Facility [WWMF]) is anticipated to continue at a similar frequency as currently experienced or experience a minor increase (Central Storage Facility to the WWMF), and completed using existing procedures and protocols.
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B. These outages require approximately 15 compressors to be operated outside the station, resulting in increased noise; however, these outages occur outside of MCR activities as part of operations (required every six years).
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B. These outages require approximately 15 compressors to be operated outside the station, resulting in increased noise; however, these outages occurred outside of MCR activities as part of operations (required every 12 years).
Planned and Maintenance Outages	→	Activities associated with these outages will be located inside buildings, with no anticipated change to noise levels outside of the buildings.
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	Maintenance of underground power cables routinely takes place on-site.

Table 75 Future Site Activities with Potential for Impacts on Noise during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Maintenance of Aboveground Power Infrastructure	→	Maintenance of aboveground power cables routinely takes place on-site.
Replacement of PHT Motors, Pumps and Valves	→	These activities will be enclosed within the reactor buildings, with no change to noise levels outside the building.
Replacement of Moderator Motors, Pumps and Valves	→	These activities will be enclosed within the reactor buildings, with no change to noise levels outside the building.
Replacement of Steam/Feedwater Motors, Pumps and Valves	→	These activities will be enclosed within the reactor buildings, with no change to noise levels outside the building.
Replacement of Condenser - Cooling Water (CCW) and Service Water Motors, Pumps and Valves	→	These activities will take place in the pumphouse, with no change to noise levels outside the building.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	→	Construction of this temporary building (trailers or modular portables) is not anticipated to produce measurable noise. The building is anticipated to be built on blocks or at grade (i.e., no installation of foundations is expected to be required). No land clearing is associated with construction of this facility.
Crane Laydown Area	→	Fenced off area where containers will be stored. Existing concrete area. No construction activities required to establish the laydown area. Previous industrial land (former heavy water site).
Increased Sewage and Domestic Water	→	—
Increase in Workers, Payroll and Purchasing	→	—

Table 75 Future Site Activities with Potential for Impacts on Noise during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Lead In		
Reactor Shutdown and De-fuel	→	These activities will take place in the vault, with no anticipated change to noise levels outside the building.
Bulkhead Installation and Vault Pressure Test	↑	Bulkhead installation activities will take place in the vault. The vault pressure test involves the use of large compressors outside that may increase noise levels. The increase in noise levels is similar to that experienced during SCO and VBO pressure tests.
Vault Air Conditioning	→	These activities will take place in the vault, with no anticipated change to noise levels outside the building.
Temporary Dehumidifiers	→	
Vault Vapour Recovery Operation	→	
PHT Drain and Dry	→	
Moderator Drain and Dry	→	
Systems Lay Up	→	
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	These activities will take place in the vault, with no anticipated change to noise levels outside the building.
Detube	→	
Retube	→	
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	↑	A roof enclosure is installed on the roof of the MCR unit. After installation a hole is cut in the roof to enable the steam generator removals. Given that the unit will be shut down, and there is an enclosure, noise that could emerge from the roof opening will be minimal. It is anticipated that work will take place during daytime hours only. Advance notice to the public and the MECP will be provided if noticeable noise is anticipated.
Interference Removal and Re-installation	→	These activities, including cutting and welding, will take place within the reactor building, with no anticipated change to noise levels outside the building.
Crane Construction and Removal	↑	A gravel landing pad will be constructed to provide a level surface for the heavy lift crane and diesel-powered cranes will be used to build the heavy lift crane. It is anticipated that work will take place during daytime hours only.
Steam Generator Removal and Installation	→	The diesel-powered lift crane will be in operation during both the removal and installation of the steam generators.

Table 75 Future Site Activities with Potential for Impacts on Noise during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Lead Out		
Moderator Refill and Establishing OPGSS	→	These activities will take place in the reactor buildings, with no anticipated change to noise levels outside the building.
Refueling	→	
Vault Containment Restoration including Bulkhead Removal	→	
PHT Refilling, Pressurization and Cold Flush	→	
PHT Hot Conditioning	→	
Power up Process and Synchronizing to the Grid	→	
Waste Handling and Waste Management		
Waste Handling and Waste Management	→	Waste handling and waste management tasks are not anticipated to result in changes to noise levels, with the exception of a relatively minor increase in traffic due to transfer between the station and either OPG's WWMF or off-site waste processing facilities.

Notes:
↓ = Effects decreasing relative to operational and outage conditions.
↑ = Effects potentially increasing relative to operational and outage conditions.
→ = No change to effects from or similar to operational and outage conditions.
— = No potential interaction identified.

The level of activity required is not considered routine for the Site, therefore these sources could potentially result in noise levels above those associated with ongoing Site operations. However, these activities are not new to the Site and representative levels of activity that have occurred at the Site recently (e.g., Bruce A Refurbishment for Life Extension [R-258]). Although the fleet of large construction equipment required for MCR is comparable (e.g., large crane, waste, and increased traffic proposed) with that experienced in the past (e.g., Bruce A Refurbishment), potential changes to noise are discussed below.

Increased Traffic Associated with Major Component Replacement Activities

Increased traffic associated with MCR activities is likely to cause a measurable change in noise. Traffic levels were anticipated to be similar to those experienced during refurbishment of Units 1 and 2, as well as those experienced in 2016 as a result of a relatively long station containment outage. These conditions were evaluated in a traffic study completed for the Site [R-259]. The COVID-19 pandemic has resulted in a significant decrease in traffic to site as a result of remote work, effectively eliminating the predicted increase in traffic-related noise levels. During the peak of the pandemic, an average of only approximately 2,300 workers were attending site daily. Traffic is anticipated to return to near normal levels at the completion of the remote work period.

The effect of MCR on noise levels was evaluated by predicting potential noise levels from the Site activities and comparing them to applicable limits and existing (i.e., baseline) conditions. The baseline conditions used were those established through a noise monitoring program conducted July 2020 at the Site, including representative points of reception that have been chosen as the closest or as sensitive points where prolonged exposure to noise levels could occur to members of the public [R-254]. The overall automated sound levels from the operating facility, including background noise, were an average of 45 dBA. During periods when background sound levels were at a minimum, the Bruce Power facility was faintly audible at 129 Lake Street and Inverhuron Provincial Park. However, during such periods, the sound levels were as low as 22 to 24 dBA, which are well within the applicable criteria of 40 dBA.

The noise screening used a well-established database of noise sources to predict the noise associated with increased traffic at the nearest receptor location.

The predicted noise levels indicate that increased traffic associated with MCR will result in predicted noise levels around 30 dBA at all off-site receptor locations. This is below the current noise levels, and no change to the ambient noise levels would occur as a result of project activities. Further, the level of activity anticipated is not above that experienced at the Site in the past.

The predicted noise levels indicate that the construction of the 1,600 tonne lift crane, and the subsequent removal and installation of the steam generators as part of MCR activities will result in predicted noise levels around 40 dBA at all receptor locations. This is consistent with the current noise levels, and no change to the ambient noise levels is expected to occur as a result project activities. Predicted changes are also consistent with those identified in the Bruce A Refurbishment for Life Extension EA [R-258]. A change from 41 dBA to 43 dBA (2 dBA change) is not anticipate to result in an adverse effect, as it is recognized that a 3 dBA change is barely noticeable to the human ear. A minimum change of about 5 dBA is required for most listeners to be able to perceive a difference in noise levels. The next noise monitoring campaign to confirm the PERA predictions is planned for a period when site activities have returned to normal following COVID-19, likely in 2023.

There are no noise benchmarks available that are protective of health effects to wildlife populations. No benchmarks are available from federal or provincial regulatory agencies, including the U.S. EPA, and the scientific literature focusses on behavioural adaptations to elevated noise levels (e.g., avoidance) rather than health effects. The Government of Canada's recommendations to reduce risks to migratory birds indicate that consideration of increased setbacks from the nests of migratory birds should occur with significant sources of disturbance, including noise exceeding 10dB above ambient noise levels and noise greater than about 50dB [R-260]. The predicted noise increase with MCR in dBA is below the level of significant disturbance. Due to the lack of benchmarks, noise effects to wildlife were not quantitatively assessed. Noise levels anticipated are not predicted to result in an adverse residual effect to humans, and the type of noise expected to be generated during MCR are typical for the Site, therefore, wildlife that utilize the area will be accustomed to this level of disturbance.

4.6.1.1 Conclusion

The predicted change in noise levels as a result of MCR activities will not likely be measurable (i.e., not discernible from existing conditions) at off-site receptors locations, as the predicted levels are consistent with current conditions. The estimate is also based on conservative assumptions (e.g., using the smallest possible distance from receptor to activities and not including potential dampening provided by site-specific buildings and/or topography). Under existing conditions there are occasional noise complaints received during the summer months, and it is recognized that meteorological conditions influence the audibility of Bruce Power. However, during such periods, the sound levels were within applicable limits. Most noisy outdoor construction work will take place during daytime hours. Further, predicted effects are under the control of the Site and are readily reversible. The first 18 months of MCR activities have demonstrated that the change in noise levels have not had a measurable impact. The impact of increased traffic to site will be assessed in the 2027 ERA due to the substantial reductions in site traffic that occurred as a result of the COVID-19 pandemic.

The site has demonstrated that it operates in compliance with applicable MECP limits, including environmental noise guideline NPC-300 Stationary and Transportation Sources. Noise levels at the Site are adequately managed and the MCR activities to date have not resulted in noise levels beyond those already experienced recently at the Site. However, it is recognized that infrequent, short-term exceedances of the nighttime limit are possible.
In general, the most effective form of noise mitigation involves controlling the sources of noise. This includes using equipment that is well maintained and, as reasonable, has characteristics that abate noise generation or attenuation (e.g., shields, dampeners, etc.). Further, as is reasonable, noisy activities associated with project components identified as potentially resulting in residual effects will continue to be limited to daytime hours. Day or night, effort will continue to be made to ensure that noisy equipment is only operated when necessary (i.e., switching off equipment when not in use) in order to limit impacts. Time constraints and controls on the sources of noise have effectively reduced impacts, even during sensitive time periods. Further, the Site will continue to be responsive to feedback from neighbours and investigate complaints as required. Currently, planned activities with the potential for residual impacts are temporary and the magnitude of which do not warrant additional monitoring or compensatory action.

4.6.2 Air Quality

4.6.2.1 Conventional Air Quality

Future site activities are evaluated for the potential to have an impact on conventional air quality in Table 76. Future activities that are predicted to have an increased environmental impact are discussed below.

Table 76 Future Site Activities with Potential for Impacts on Conventional Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A and Bruce B Generating Stations, including all systems and cooling water channels	→	—
Transformer Area and Standby Emergency Generators	→	—
Centre of Sites Facilities – CMF, FTF, administration buildings	↑	Traffic may increase during MCR activities, resulting in increased air emissions. Traffic volumes (i.e., commuter vehicles, shuttle buses, delivery vans and pickup) and mobilization and demobilization of construction equipment anticipated as part of the project are not expected to be beyond that previously experienced at site.
Transfer of Waste	→	Transfer of waste (to OPG's WWMF) is anticipated to continue at a similar frequency as currently experienced or experience a minor increase (Central Storage Facility to the WWMF), and completed using existing procedures and protocols.
Planned Outages		
Station Containment Outages	↑	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B. There will be emissions associated with running 15 diesel compressors for the pressure test activities; however, emissions are anticipated to be maintained within compliance limits.
Vacuum Building Outages	↑	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B. There will be emissions associated with running 15 diesel compressors for the pressure test activities; however, emissions are anticipated to be maintained within compliance limits.

Table 76 Future Site Activities with Potential for Impacts on Conventional Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Planned and Maintenance Outages	→	—
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	—
Maintenance of Aboveground Power Infrastructure	→	—
Replacement of PHT Motors, Pumps and Valves During MCR	→	Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.
Replacement of Moderator Motors, Pumps and Valves During MCR	→	Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	Emissions associated with these activities will be directed to the inactive ventilation system and are anticipated to be maintained within compliance limits.
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	↑	There may be welding and cutting associated with these activities. Particulate matter and other emissions will be released to the environment, however, emissions are anticipated to be maintained within compliance limits.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	↑	A change to conventional air emissions due to use of trucks to move trailers to the Site.
Increased Sewage and Domestic Water	→	—
Increase in Workers, Payroll and Purchasing	→	—
Lead In		
Reactor Shutdown and De-fuel	→	—

Table 76 Future Site Activities with Potential for Impacts on Conventional Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Bulkhead Installation and Vault Pressure Test	↑	There may be a change to conventional air emissions as a result of running a set of diesel compressors outside the station and welding of bulkheads and use of sealants (e.g., decothane) within the station with emissions directed to the active ventilation system.
Vault Air Conditioning	→	—.
Temporary Dehumidifiers	→	—
Vault Vapour Recovery	→	—
PHT Drain and Dry	↑	Conventional emissions, ozone and nitrogen oxides may be produced from radiolysis of heavy water and nitrogen. Other potential sources of conventional air emissions are from metal cutting, welding and grinding, which may be required to support PHT drain and dry activities (such as cutting and capping). Vapour condensing equipment without halocarbons will be selected, when possible. Emissions will be directed to active ventilation.
Moderator Drain and Dry	↑	Conventional emissions, ozone and nitrogen oxides may be produced from radiolysis of heavy water and nitrogen. Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.
Systems Lay Up	↑	Change in conventional air emissions, may result as systems are placed under nitrogen blankets. Inert gases and atmospheric gases that are produced will be directed to the atmosphere. There may be a minimal ozone production in lay up of moderator. During layup emissions are well managed and within regulatory limits.
Reactor Retube and Feeder Replacement		
Feeder Replacement	↑	Welding could result in air emissions, which will be directed to the active ventilation system. Iron oxide (magnetite) inside a tube could become airborne during processing. These emissions will be directed to the active ventilation system.
Fuel Channel Removal	→	—
Fuel Channel Installation	↑	This could result in conventional air emissions from welding activities. These emissions will be directed to the active

Table 76 Future Site Activities with Potential for Impacts on Conventional Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
		ventilation.
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	↑	Change in conventional air emissions is anticipated with the installation of the roof enclosure and as the opening for the steam generator lift is created. The roof enclosure is assembled offsite and craned into place. There is some welding involved. Once the roof enclosure is installed, the opening in the roof can be completed. This involves cutting the steel and membrane on the station roof and then using concrete cutting tools to open the boiler containment roof inside the building.
Interference Removal	→	A change in conventional air emissions resulting from cutting and welding from interference removal activities, including use of metal cutting, grinding and welding tools. These emissions will be directed to the active ventilation system. The roof is anticipated to be closed during these activities.
Crane Construction	↑	A change in conventional air emissions resulting from building the heavy lift crane, as additional heavy equipment is required to complete this task. This equipment is mainly powered by gasoline and diesel fuel, which will generate emissions. Construction equipment will meet Tier 3 emission standards where feasible. Traffic may increase during crane construction and demobilization but is not expected to be beyond that previously experienced at site.
Steam Generator Removal and Installation	↑	The roof enclosures will only be open during steam generator removal and replacement activities using the heavy lift crane. Limit switches will be installed on enclosures of each opening to monitor the length of time each enclosure is open. Additional controls, such as coordinating vault air lock openings will be implemented to restrict chimney effect air flow and movement of air from the vault. The vault will be evacuated during heavy lifts, limiting direct vault to atmosphere effects. Emissions associated with these activities are anticipated to be maintained within compliance limits.
Lead Out		
Moderator Refill and Establishing OPGSS	→	—
Refueling	→	—
Vault Containment Restoration including	↑	There may be a change to conventional air emissions as a result of running a set of diesel compressors outside the station and

Table 76 Future Site Activities with Potential for Impacts on Conventional Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Bulkhead Removal		welding of bulkheads and use of sealants (e.g., decothane) within the station with emissions directed to the active ventilation system. Plates will be cut to allow removal of the bulkhead. Emissions will be directed to the active ventilation system.
PHT Refill, Pressurization and Cold Flush	→	—
PHT Hot Conditioning	→	—
Power-up Process and Synchronizing to the Grid	↑	During the power up process, increased testing of the boiler steam relief system (e.g., Atmospheric Steam Discharge Valves [ASDVs] and Boiler Safety Valves [BSVs]) could result in an increase in conventional emissions, specifically, feedwater chemicals (hydrazine and ammonia) to air.

Note:
↓ = Effects decreasing relative to operational and outage conditions.
↑ = Effects potentially increasing relative to operational and outage conditions.
→ = No change to effects from or similar to operational and outage conditions.
— = No potential interaction identified.

Life Extension and MCR activities have the potential to interact with air quality through the production of airborne emissions. Specifically, the following activities could potentially result in emissions to air above those associated with ongoing site operations:

- Increased traffic associated with MCR activities;
- Operation of diesel stationary and transportation equipment;
- Construction and demolition activities associated with the Installation of MCR Infrastructure;
- Welding, cutting, crushing, and grinding tasks associated with the Lead In, Reactor Retube and Feeder Replacement, Steam Generator Replacement and Lead Out activities;
- Activities part of Systems Lay Up;
- Activities part of PHT and moderator drain and dry; and

- Increased testing of ASDVs and BSVs during Power Up process.

Those changes identified as having potential to increase conventional air emissions relative to current operations are discussed and screened below to determine whether further evaluation is required.

Increased traffic associated with MCR activities is likely to cause increased emissions to air through the release of tailpipe emissions (i.e., burning of fossil fuels) including Nitrogen Oxides ($NO_{x)}$, Carbon Monoxide (CO), Sulfur Dioxide ($SO_{2)}$, suspended particulate matter SPM, particulate matter 10 micrometres (μm) or less (PM_{10}), and particulate matter 2.5 μm or less ($PM_{2.5}$). Emissions from construction and demolition equipment, as well as soil moving activities and the use of diesel generators will also contribute to these conventional air emissions. In addition, traffic surveys and air quality monitoring were undertaken in 2016 during a station containment outage, which is a period of activity on the Site with similar levels of additional workforce as will be required for MCR. A traffic impact study update was completed to evaluate MCR traffic volumes and identify any necessary mitigation [R-259], based on the assumption that the on-site full-time and contract employees would increase to about 7,100. The study indicated that the project traffic increase results in the level of service at four intersections would be lowered, resulting in measurable delays in traffic flow. Recommendations were made in the study to address this congestion, and mitigation requirements will be addressed. Due to reduced site traffic associated with the COVID-19 pandemic and remote work, further evaluation of the impact of MCR on traffic will be differed to the 2027 ERA.

Air modelling completed for previous refurbishment activities on the Site, indicated that increased vehicle traffic and diesel-equipment use could result in exceedance of 24-hour SPM, 24-hour PM_{10}, 24-hour $PM_{2.5}$, and 24-hour NO_x [R-258]. Through follow-up monitoring during these activities, the modelling was shown to be conservative (e.g., load and operating duration). Further, during a station containment outage completed in 2016 air monitoring showed that emissions were well within regulatory limits. [R-261] The activities proposed as part of MCR are comparable to those completed as part of the Bruce A Refurbishment for Life Extension assessed in 2005, and all activities will be conducted in accordance with Site procedures and protocols, including requirement consistent with exiting procedures at Site that construction equipment will meet Tier 3 emission standards, where feasible.

Emissions generated through welding, cutting and grinding activities within the reactor buildings would be directed to the active ventilation system, which provides an engineered barrier (HEPA to capture loose contamination and HECA to remove ozone) in place to limit releases to the environment. To protect the public and the environment, these emissions will be managed through existing controls and the implementation of Site procedures and protocols. Airborne contaminates generated during the steam generator removal and installation (i.e., roof enclosures open) and during welding and cutting activities completed within the pumphouse will not be contained and directed to an active ventilation system. Activities to be completed under these conditions will be limited, for example, steam generators will be fully prepped for removal before the roof opening is initiated. As well, emissions generated during PHT and moderator drain and dry activities will be directed to the active ventilation system.

The activities to be completed as part of MCR are comparable to those completed as part of the Bruce A Refurbishment for Life Extension and conservative modelling completed to assess those activities prior to initiation [R-258] showed that emissions would be protective of human and non-human biota surrounding the Site. These activities will be conducted in accordance with Site procedures and protocols.

The predicted change in air quality levels as a result of MCR activities will likely result in relatively short durations of measurable effect. Although the breadth of the activities to be undertaken as part of MCR is not considered routine for the Site, the individual activities are not new to the Site; therefore, there are period of monitoring data representative of this future condition. Further, predicted effects are under the control of the Site and readily reversible. As such, all construction activities are anticipated to meet MECP POI limits and be protective of the public and the environment.

A Traffic Impact Study (TIS) was carried out in 2016 to update information reported in 2008 [R-259]. In relation to ongoing operational activities, traffic levels may increase as a result of MCR activities; however, the anticipated levels would be comparable to that experienced during the last station containment outage (in 2016) or during the refurbishment of Units 1 and 2. These conditions were evaluated in the TIS from a traffic management perspective, while monitoring data encompassing these timeframes of high activity were used in the evaluation of potential environmental effects [R-259]. The TIS was not repeated for the 2022 ERA due to the reduced on-site workforce related to the COVID-19 pandemic in 2020 and 2021. Traffic levels related to MCR will be considered in the 2027 PERA.

Air modelling completed for previous refurbishment activities on the site had indicated that increased vehicle traffic and diesel-equipment use could result in exceedance of 24-hour limits for Suspended Particulate Matter (SPM), Particulate Matter 10 Micrometers or Less (PM10), 24-hour Particulate Matter 2.5 Micrometers or Less (PM2.5), and Nitrogen Oxides (NOx). However, via follow-up monitoring during these activities, the modelling was shown to be conservative; air modelling in 2016 during station containment outage showed that emissions were well within regulatory limits [R-261]. Concerns about airborne emissions for future activities were included above by using monitoring and modelling data from the past five years (2016-2020) that encompassed routine operations, as well as any process or refurbishment changes.

An assessment of acrolein emissions had previously been completed for the site encompassing future construction activities [R-219]. The results showed that acrolein emissions would be below conservative background levels, especially in comparison to urban settings (see Section 3.4.2.3). Emissions from MCR activities are expected to be orders of magnitude lower than would be found on a typical urban setting. Air monitoring during the site-wide outage in 2016, during which there were significantly more workers and equipment on-site and therefore at a time of peak activity likely to be similar to that during MCR, found that acrolein levels were within regulatory limits. The emissions of acrolein during MCR are expected to be similar to those measured during the station outage and are not considered to be a likely cause of adverse effects.

All atmospheric predictions and baseline air quality measurements met their respective site-specific limits. This includes air monitoring that was completed in 2016 (Nitrogen Oxide [NO_x] and particulate matter 2.5 µm or less [$PM_{2.5}$]) where all reported levels were well within regulatory limits. The limits used for each of the contaminants and averaging times above are protective of the most sensitive endpoint, which include but are not limited to, health, odour or corrosivity. No concentrations were greater than their POI limit, therefore, there are no non-radiological COPCs for airborne emissions identified.

Conclusion

The conventional air emissions for activities completed to date, have been as expected and shown compliance with ECA modelling and MECP POI limits. Reporting for air emissions regulations has been completed without any concerns.

The site has demonstrated that it operates in compliance with regulatory requirements. Air emissions at the Site are adequately managed and the MCR activities are not anticipated to result in air quality levels beyond those already experienced at the Site. Site conventional air emissions are controlled further to prevent pollution, reduce emissions, and minimize environmental impacts. Currently, planned activities with the potential for residual impacts are temporary and the magnitude of which do not warrant additional monitoring or compensatory action. To verify this ongoing air quality monitoring will be established to monitor emissions to the environment during MCR, with the next air monitoring event planned for 2023. If monitoring data indicates that impacts from MCR activities may have been underestimated, additional monitoring and mitigation options are available.

Historical emissions associated with outage and maintenance activities are predicted to bound MCR activities based on the nature of planned MCR activities.

4.6.2.2 Radiological Air Quality

Future site activities are evaluated for the potential to have an impact on radiological air quality in Table 77. Only activities with a potential for impact to radiological air quality are included.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Lu-177 production	→	Negligible effect on air emissions expected. Air ingress into the Lu-177 delivery system could result in activation products such as argon-41 and carbon-14. However, estimates of possible emissions indicate there will be no significant impacts to radiological air quality. To ensure this, stack emissions will be monitored for elevated levels of noble gases and carbon-14. In the unlikely event of a Lu-177 capsule breaking, Lu-177, Yb-175 and Yb-177 could be released, but the resulting increase in gross beta/gamma particulate emissions is estimated to be negligible. Stack emissions will be monitored for the presence of these radionuclides.
Bruce A and Bruce B Generating Stations, including all systems and cooling water channels	→	No change to radiological emissions is expected compared to normal or historical operations.
Source Term Reduction	↑	Bruce Power is working on various strategies to reduce the overall dose taken by the workers during defueled guaranteed shutdown state outage work. Primary Heat Transport System decontamination will be executed in MCR for Unit 3, with potential for use in the future defueled guaranteed shutdown state outages. The PHT system components are coated inside with activated fission products imbedded in a magnetite layer from decades of operations of the PHT system and may result in increased airborne radiological emissions.
Transfer of Waste	→	No change to radiological emissions is expected compared to normal or historical operations. Transfer of waste (to OPG's WWMF) is anticipated to continue at a similar frequency as currently experienced or experience a minor increase (Central Storage Facility to the WWMF), and completed using existing procedures and protocols.
Planned Outages during MCR		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B and are out of scope for this ERA.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B. Radiological air quality is expected to be similar to previous VBOs. No changes to radiological air quality are expected.
Planned and Maintenance Outages	→	No change to radiological emissions is expected compared to normal or historical operations. Radiological air quality parameters are expected to remain below compliance limits during these outages.
Routine Asset Management Activities (Examples Only)		
Replacement of PHT Motors, Pumps and Valves During MCR	→	No change to radiological emissions is expected compared to normal or historical operations. Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.
Replacement of Moderator Motors, Pumps and Valves During MCR	→	No change to radiological emissions is expected compared to normal or historical operations. Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	No change to radiological emissions is expected compared to normal or historical operations. Emissions associated with these activities will be directed to the inactive ventilation system and are anticipated to be maintained within compliance limits.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Lead In		
Central Storage Facility	→	No change to radiological emissions is expected compared to normal or historical operations. Emissions of tritium and gross beta/gamma particulate are being monitored at this facility. Components will be drained and dried prior to being moved to the Central Storage Facility, minimizing airborne tritium emissions from the building. To date, all radiological emissions have been well below compliance limits.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Reactor Shutdown and De-fuel	↓	Predicted to result in reduced radioactivity in the atmospheric environment due to the shutting down of the reactor.
Vault Air Conditioning	↓	Predicted to result in reduced radioactivity in the atmospheric environment due to the vault air conditioning condensing potential radiological air emissions into the liquid phase.
Temporary Dehumidifiers	↓	Temporary dehumidifiers will be utilized to reduce airborne tritium concentrations in the vault. The dehumidifiers are expected to also reduce airborne tritium emissions to the environment.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Vault Vapour Recovery	→	No change to radiological emissions is expected compared to normal or historical operations. Overall, radiological emissions may be lower as the unit is shutdown and the reactor systems drained and dried. To maintain negative pressure in the vault, VVR operation will be modified to ventilate two dryers directly to active ventilation. Desiccant will be removed from these two dryers, but air will continue to be routed through filters prior to discharge. Should vault conditions change with respect to tritium concentrations, VVR operation will be altered to include the use of a desiccant containing dryer to lower tritium concentrations prior to discharge to active ventilation. Based on experience with Unit 6, this modification may not be necessary in future MCRs. If the modification is necessary, emissions are still anticipated to be maintained within compliance limits.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
PHT Drain and Dry	→	No change to radiological emissions is expected compared to normal or historical operations. Radiological airborne emissions are predicted to occur as a result of: • Opening the PHT system and auxiliary systems during equipment isolations (cutting and capping activities) and establishing flow paths (e.g., check valve flapper removal). • During the drying phase, heavy water vapour is condensed with non-condensables (mainly air) and residual heavy water vapor purged to the active ventilation, either directly or through an additional dryer. • PHT water drumming will be performed as a back-up collection method only. With this method there is the potential for emissions from drum opening/closing. Emissions will be directed to the active ventilation. • Nitrogen purge and negative pressure ventilation stages, could result in emissions that will be directed to the active ventilation. PHT Drain and Dry, like all future site activities, will take place in accordance with the ALARA principle. Equipment will be maintained and operated in a state that minimizes radiological emissions (e.g., all equipment shall be operated and maintained in good working condition, including exhaust filters, and stack monitoring equipment). Emissions associated with these activities will be directed to the active ventilation system and based on experience with Unit 6, are anticipated to be maintained within compliance limits.
Moderator Drain and Dry	→	No change to radiological emissions is expected compared to normal or historical operations. Moderator Drain and Dry, like all future site activities, will take place in accordance with the ALARA principle. Emissions associated with these activities will be directed to the active ventilation system and based on experience with Unit 6, are anticipated to be maintained within compliance limits.
Systems Lay Up	→	No change to radiological emissions is expected compared to normal or historical operations.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	No change to radiological emissions is expected compared to normal or historical operations.
Fuel Channel Removal	→	No change to radiological emissions is expected compared to normal or historical operations. This activity could result in radiological emissions to the atmospheric environment from processing, volume reduction and packaging activities. These will be undertaken within the reactor buildings. Emissions associated with these activities will be directed to the active ventilation system and are anticipated to be maintained within compliance limits.
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	→	No change to radiological emissions is expected compared to normal or historical operations. Opening of the roof will establish a temporary direct pathway for radiological emissions to be potentially released to the environment. The roof enclosures will only be open during steam generator removal and replacement activities using the heavy lift crane. Limit switches will be installed on enclosures of each opening to monitor length of time each enclosure is open. Based on past experience at the Site, and a Maximum Probable Emission Rate study, emissions associated with these activities are anticipated to be maintained within compliance limits.
Steam Generator Removal and Installation	→	No change to radiological emissions is expected compared to normal or historical operations. Sections of the roof will be open during steam generator removal and installation, which is an unmonitored pathway for radiological emissions to the environment. Radiological emissions to air through the roof opening have been conservatively estimated to inform work plans. Additional controls, such as coordinating vault air lock openings will be implemented to restrict chimney effect air flow and movement of air from the vault. Emissions associated with these activities are anticipated to be maintained within compliance limits.
Lead Out		
Moderator Refill and Establishing OPGSS	→	No change to radiological emissions is expected compared to normal or historical operations.
Refueling	→	No change to radiological emissions is expected compared to normal or historical operations.

Table 77 Future Site Activities with Potential for Impacts on Radiological Air Quality during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
PHT Refill, Pressurization and Cold Flush	→	No change to radiological emissions is expected compared to normal or historical operations. Based on experience following the Unit 1 and Unit 2 Restart, filtration and straining of particulate is planned to prevent an increase to radiological emissions. All emissions will continue to be directed to the active ventilation system.
PHT Hot Conditioning	→	No change to radiological emissions is expected compared to normal or historical operations.
Waste Handling, Management and Demobilization		
Waste Handling and Waste Management and Demobilization	→	No change to radiological emissions is expected compared to normal or historical operations. Resin change-outs were completed in preparation for MCR for Unit 6. Resin change-outs for Unit 3 and 4 are still in the planning stage. These emissions will be directed to the active ventilation system. However, based on previous experience emissions are anticipated to be maintained within compliance limits.
Note: ↓ = Effects decreasing relative to operational and outage conditions. ↑ = Effects potentially increasing relative to operational and outage conditions. → = No change to effects from or similar to operational and outage conditions. — = No potential interaction identified.		

Site radiological air emissions are controlled to meet performance standards stipulated as DRLs, which ensure that site activities are completed in accordance with CNSC and IAEA regulations and guidance.

Although activities such as system draining and drying, welding, cutting, crushing and grinding are anticipated to result in airborne contamination, there are several administrative and engineered barriers in place to minimize emissions. For radionuclides with short half-lives or typically contained within the fuel (e.g. noble gases and iodine-131), emissions are reduced by the removal of fuel from the core and allowing time for decay before venting to the stack. HEPA filters are in place to capture airborne particulates (beta/gamma and alpha) and HECA filters are designed to trap any remaining iodine-131. These filters are routinely tested to ensure their efficiency remains within an acceptable range. Tritium is an activation product in the heavy water system, and leaks or maintenance activities could result in releases of tritium to the environment through the ventilation stacks. VVR dryers minimize airborne emissions by removing moisture (including tritium) from vault air prior to release through the stacks. Finally, to prevent air ingress and production of C-14 and other activation products, helium is used as a cover gas over the heavy water (i.e., Reactor drain and dry). Based on Lessons Learned with Unit 1 and 2 restart described in Section 4.4.1, Unit 6 MCR activities to date and normal inage and outage operations, emissions related to continued Life Extension and MCR activities are expected to continue to remain below compliance limits.

During previous refurbishment activities on-site, temporary construction openings have been made in the roofs of reactor buildings. Sliding, mechanized coverings will be in place to prevent precipitation from entering the building, and openings will be covered when not in use, as is feasible. Further, the bulk of the required opening of systems will be completed prior to the roof openings being established.

The MCR activities will be conducted in accordance with the Site procedures and protocols, and additional proven air quality controls will be implemented including:

- Vault air conditioning condensation will be directed to the D2O upgraders or ALWMS; and
- Temporary, portable dehumidifiers will be used to lower atmospheric tritium. The dehumidification systems remove moisture from the air by using a desiccant, a material which easily attracts and holds water vapour. Condensate from the dehumidifiers will be collected and tested for tritium concentration and D20 isotopic. Water that is equal to or <0.5% D2O will be directed to the ALWMS. Water that is >0.5% D2O will be directed to the D2O upgraders and will have no impact on waterborne effluent.

Radiological airborne emissions are well below regulatory limits, even considering periods of activity above normal operations including:

- Cobalt removal, management of fuel failure and work on PHT, moderator heat exchangers and steam generator components;
- Normal outage activities, including VBOs and SCOs; and
- MCR Lead In for Unit 6, which included reactor shut down and defuel, PHT drain and dry and moderator drain and dry.

Radiological air emissions from the Site are controlled to meet regulatory requirements, prevent pollution and reduce emissions, and to minimize environmental impacts.
Bruce Power routinely reports the results of radiological airborne emissions monitoring, in accordance with their CNSC licence.

Between 2016 and 2021, Bruce Power's radiological airborne emissions were well below regulatory limits (i.e., below Action Levels). Historical trends are dominated by the implementation of the As Low As Reasonably Achievable (ALARA) principle, and all radionuclide concentrations are below Derived Release Limits (DRLs) that have been developed by Bruce Power to ensure release limits to the environment will not exceed the annual regulatory public dose limits. These limits have been shown to be protective of human and non-human biota in the surrounding environment.

Lu-177 Production

Monitoring of air emissions related to Lu-177 production is discussed in Section 4.2.1. Given that there are negligible potential air emissions from the Lu-177 production, no measurable changes to the dose to the public are expected.

4.6.3 Surface Water

4.6.3.1 Conventional Surface Water

Future site activities are evaluated for the potential to have an impact on conventional surface water in Table 78. Future activities that are predicted to have an increased environmental impact are discussed below. In this discussion, surface water includes changes in flow and quality, and considers changes in physical stressors such as thermal profile, entrainment and impingement.

Table 78 Future Site Activities with Potential for Impacts on Conventional Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Lu-177 production	→	No liquid used in Isotope Production System so and no surface water effluents possible.
Bruce A and Bruce B Generating Station, including all systems and cooling water channels	↓	Cooling water needs will be decreased when a unit is taken offline for MCR activities. Waterborne effluents, such as feedwater chemical emissions (e.g., hydrazine and morpholine) from blowdown and other sources will also be reduced when a unit is taken offline for MCR activities.
Transformer Area and Standby Emergency Generators	→	—
Centre of Site Facilities – CMLF, FTF, administration buildings	→	—
Transfer of Waste	→	Transfer of wastes (to the Western Waste Management Facility) is anticipated to continue at a similar frequency as currently experienced, and using existing procedures and protocols.
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B. These outages occur outside of MCR activities as part of operations, and are not predicted to result in a residual adverse effect on lake water quality.

Table 78 Future Site Activities with Potential for Impacts on Conventional Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
		Higher concentrations of hydrazine may be discharged during a station containment outage than during normal operations due to the shutdown of four reactor units with shutdown state concentrations of hydrazine in the feedwater. Processes are in place to manage this potential short-term residual adverse effect and to ensure that water quality parameters are within discharge criteria.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B. These outages occur outside of MCR activities as part of operations, and are not predicted to result in a residual adverse effect on lake water quality. In addition to the hydrazine issue identified above for Station Containment Outages, vacuum building outages have the potential to drain large volumes of chemically treated water (e.g., from service water systems for cooling, emergency water storage systems) in accordance with discharge criteria.
Routine Outages	→	These outages occur outside of MCR activities as part of operations, and are not predicted to result in a residual adverse effect on lake water quality. Systems may be drained to allow for maintenance activities to take place. Processes are in place to manage this potential short-term residual adverse effect and to ensure that water quality parameters are within discharge criteria.
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	—
Maintenance of Aboveground Power Infrastructure	→	—
Replacement of PHT Motors, Pumps and Valves During MCR	→	—
Replacement of Moderator Motors, Pumps and Valves During MCR	→	—
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	—

Table 78 Future Site Activities with Potential for Impacts on Conventional Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	↑	When the CCW pumps are taken out of service for the unit undergoing MCR, feedwater chemical emissions in the station discharge may be of higher concentration due to reduced dilution in the CCW duct. However, removal of the CCW pumps from service for the unit undergoing MCR does not limit the ability to achieve sufficient dilution and meet discharge criteria. Additionally, draining and drying of low pressure service water systems may result in corrosion, scale, and hardness returned to the lake. Replacement of copper piping will continue on site and this will reduce the management of copper levels prior to surface water discharge. Surface water discharges will continue to be tested and meet discharge criteria prior to release.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Future Site System, Structure or Activity	**Direction of Potential Effect Relative to Current Operations**	**Discussion of Potential Interaction**
Bruce A MCR Trailers	↑	The Bruce A Future MCR trailers is planned to be built on what is currently a gravel lot with partial asphalt cover that is designed for drainage. The existing stormwater management system is planned to be used. If new catch basins are required, requisite ECA amendments will be obtained.
Increased Sewage and Domestic Water	↑	Increased sewage and domestic water associated with MCR activities are anticipated to be within current discharge criteria, and the recent station containment outage experienced at site is considered representative of the anticipated future conditions.
Increase in Workers, Payroll and Purchasing	→	—
Lead In		
Reactor Shutdown and De-fuel	→	—
Bulkhead Installation and Vault Pressure Test	→	—

Table 78 Future Site Activities with Potential for Impacts on Conventional Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Vault Air Conditioning	↑	Condensation containing waterborne contaminants will be directed to the ALWMS and could affect lake water quality. Processes will be in place to manage this potential residual adverse effect, to ensure that water quality parameters are within discharge criteria.
Temporary Dehumidifiers	↑	Condensation containing waterborne contaminants will be directed to the ALWMS and could affect lake water quality. Processes will be in place to manage this potential residual adverse effect, to ensure that water quality parameters are within discharge criteria.
Vault Vapour Recovery Operation	→	—
PHT Drain and Dry	↑	Active exhaust could become downwash and could potentially affect lake water quality. However, it is not anticipated that there would be any more downwash than during normal operations.
Moderator Drain and Dry	↑	—
System Lay Up	↑	Drainage of systems will be directed to either the ALWMS or the CCW, which needs to meet ECA/Effluent Monitoring and Effluent Limits (EMEL) limits prior to discharge. The dry lay up of systems may result in the formation of corrosion products (e.g., iron oxides) and upon system refill and subsequent draining; corrosion products may be discharged to the lake. Film Forming Amine (FFA) application technology is being used to help prevent corrosion. This is injected into systems prior to MCR during normal operation and provides a protective coating on the systems when they are drained.
Reactor Retube and Feeder Replacement		
Feeder Replacement	↑	—
Fuel Channel Removal and Installation	↑	—
Retube	→	—
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	→	—
Interference Removal and Re-installation	→	—
Crane Construction	→	—
Lead Out		
Moderator Refill and	→	—

Table 78 Future Site Activities with Potential for Impacts on Conventional Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Establishing OPGSS		
Refueling	→	—
Vault Containment Restoration	→	—
PHT Refill, Pressurization and Cold Flush	→	—
PHT Hot Conditioning	→	—
Refilling the Moderator	→	—
Power-up Process and Synchronizing to the Grid	→	—
Waste Handling and Waste Management		
Waste Handling and Waste Management and Demobilization	→	—

Note:
↓ = Effects decreasing relative to operational and outage conditions.
↑ = Effects potentially increasing relative to operational and outage conditions.
→ = No change to effects from or similar to operational and outage conditions.
— = No potential interaction identified.

Near-shore Flow

Monitoring data encompassing the Bruce A Refurbishment for Life Extension activities and the first portion of the Unit 6 MCR represents the conditions anticipated during the remainder of MCR. From 2020 to 2053, it is anticipated that at one time three units will be in operation at one station or the other. Therefore, no future site activities were found to have a likely measurable change on nearshore circulation.

Stormwater

All stormwater is managed in accordance with existing Site procedures and protocols, therefore, construction dewatering will be discharged to grade and erosion and sedimentation controls will be in place to manage sediment runoff to waterways. However, if new catch basins or the installation of drainage with swales are identified as required to accommodate the construction of the infrastructure required as part of MCR, requisite ECA modifications will be obtained.

Inland Surface Water Quality

No future site activities were found to have a likely measurable change on inland surface water quality.

Bruce A and Bruce B Discharges

In the Bruce A Refurbishment for Life Extension EA, it was concluded that there would be no residual effects to surface water due to refurbishment activities [R-258]. The monitoring confirmed the EA follow-up prediction of no residual effects to surface water. Surface water effluents at Bruce B for the first portion of the Unit 6 MCR have continued to meet discharge criteria (Table 40). Based on this monitoring data, it is concluded that there are no conventional COPCs to carry forward into the predictive assessment.

Future site activities could affect lake water quality. Aqueous wastes generated on the Site are processed and the resulting effluent is discharged through the CCW duct, which is a monitored pathway to the environment. No change in operation of the ALWMS collection, handling and treatment system is expected as a result of MCR activities. These are proceduralized processes on-site, and emissions are anticipated to be maintained within compliance limits.

The MCR unit will have a short duration where the CCW and Service water pumps and motors will be out of service. This has minimal impact as the station can meet the ECA minimum flow requirements with the other operating units. Draining and drying tasks for system layup could result in corrosion, scale and hardness in the discharge being elevated. There are periods of operational monitoring data representative of this future condition, and emissions are anticipated to be maintained within compliance limits.

MCR equipment such as vault air conditioning, dehumidifiers, drain and dry equipment will have condensate directed to the ALWMS, and subsequently the CCW. These predicted changes are not anticipated to be measurable. There are periods of operational monitoring data representative of this future condition, and emissions are anticipated to be maintained within compliance limits.

Surface Water

In the ERA, surface water was represented by Environmental Protection Report data [R-37]–[R-41]. The potential negligible direct emissions from the Site to surface water bodies in the vicinity of the Site are considered to be fully represented by past activites on Site.

4.6.3.2 Radiological Surface Water

Future site activities are evaluated for the potential to have an impact on radiological surface water in Table 79. Only activities with a potential for impact to radiological surface water quality are included.

Table 79 Future Site Activities with Potential for Impacts on Radiological Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Lu-177 production	—	The Isotope Production System does not contain liquid of any kind, so no waterborne releases are possible.
Bruce A and Bruce B Generating Station, including all systems and cooling water channels	→	No change to radiological effluents is expected compared to normal or historical operations.
Source Term Reduction	↑	Bruce Power is working on various strategies to reduce the overall dose taken by the workers during defueled guaranteed shutdown state outage work. Primary Heat Transport System decontamination will be executed in MCR for Unit 3, with potential for use in the future defueled guaranteed shutdown state outages. The PHT system components are coated inside with activated fission products imbedded in a magnetite layer from decades of operations of the PHT system and may result in an increase in waterborne radiological effluent.
Centre of Site Facilities – CMLF, CSF, FTF, administration buildings	→	No change to radiological effluents is expected compared to normal or historical operations. There will be no direct, radiological waterborne releases from these buildings to the environment. Active liquid waste from the CMLF and CSF are directed to the ALWMS at Bruce A.
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B and are out of scope for this ERA.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B. Radiological water quality is expected to be similar to previous VBOs. There is the potential for Emergency Water Storage (EWS) water to be drained to the lake. EWS water has an elevated tritium concentration. Planning is in progress to manage these drains and maintain tritium in effluent within compliance limits.
Routine Outages	→	No change to radiological effluents is expected compared to normal or historical operations.

Table 79 Future Site Activities with Potential for Impacts on Radiological Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Lead In		
Vault Air Conditioning	→	No change to radiological effluents is expected compared to normal or historical operations. Condensation containing waterborne contaminants will be directed to the ALWMS and could affect lake water quality. Procedures are in place to manage this process and ensure that water quality parameters are within compliance limits. Further, discharge will occur via a monitored pathway to verify compliance. Based on experience with Unit 6 MCR, no adverse effects are expected.
Temporary Dehumidifiers	→	No change to radiological effluents is expected compared to normal or historical operations. Some condensation containing waterborne contaminants may be directed to the ALWMS and could affect lake water quality. Procedures are in place to manage this process and ensure that water quality parameters are within compliance limits. Further, discharge will occur via a monitored pathway to verify compliance. Based on experience with Unit 6 MCR, no adverse effects are expected.
Vault Vapour Recovery Operation	—	No waterborne effluent is expected to be generated from this activity. Condensate from Vault Vapour Recovery dryers is directed to the D2O upgraders.
PHT Drain and Dry	—	No waterborne effluent is expected to be generated from this activity. All water removed from the systems will be stored and re-introduced to the system during refill.
Moderator Drain and Dry	—	No waterborne effluent is expected to be generated from this activity. All water removed from the systems will be stored and re-introduced to the system during refill.
System Lay Up	→	No change to radiological effluents is expected compared to normal or historical operations. Drainage of systems other than the PHT and Moderator will be directed to either the ALWMS or the CCW, and must be below compliance limits.
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	No change to radiological effluents is expected compared to normal or historical operations. If draining and drying of the feeders is not completely effective, there is potential for heavy water to be directed to the ALWMS, which needs to be below compliance limits before it can be discharged.
Fuel Channel Removal	→	No change to radiological effluents is expected compared to normal

Table 79 Future Site Activities with Potential for Impacts on Radiological Surface Water during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
and Installation		or historical operations. If draining and drying of the fuel channels is not completely effective, there is potential for heavy water to be directed to the ALWMS, which needs to be below compliance limits before it can be discharged.
Waste Handling and Waste Management		
Waste Handling and Waste Management and Demobilization	→	No change to radiological effluents is expected compared to normal or historical operations. Based on past experience with Unit 6 MCR resin changeouts, waterborne effluents are expected to stay within compliance limits.

Note:

↓ = Effects decreasing relative to operational and outage conditions.

↑ = Effects potentially increasing relative to operational and outage conditions.

→ = No change to effects from or similar to operational and outage conditions.

— = No potential interaction identified.

As noted in the table above, a small number of activities have the potential to generate water. Some of this water will be collected and processed in the D20 upgraders for reintroduction to station systems and some will be processed through the ALWMS and then discharged through the CCW duct. The decision on how the water will be handled is based on the D20 isotopic of the water. Generally, water with a D2O isotopic of > 0.5% will be processed through the upgraders, while water with a D2O isotopic of 0.5% or less will be directed to the ALWMS. No changes in the operation of the ALWMS collection, handling and treatment systems are expected as a result of MCR activities and discharges will be maintained within compliance limits as per normal operation.

For all future activities, radiological waterborne effluent is anticipated to be similar to releases that have occurred in the past during normal or outage operations and no changes to radiological surface water quality are expected. Therefore the radiological exposure associated with surface water is not expected to change as a result of Lu-177 production, life extension or MCR activities.

4.6.4 Groundwater

Future site activities are evaluated for the potential to have an impact on groundwater in Table 80. The groundwater flow regime is not anticipated to change substantively during the course of the future site activities contemplated in this report. No changes to radiological contaminants in groundwater are expected as part of Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4.

Table 80 Future Site Activities with Potential for Impacts on Groundwater during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A & Bruce B Generating Stations, including all systems and cooling water channels	→	Reactor building foundation drains will continue to collect groundwater. No predicted change.
Transformer Area and Standby Emergency Generators	→	—
Centre of Site Facilities – CMLF, FTF, administration buildings	→	—
Waste Transport	→	—
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B.
Routine Outages	→	—
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	—
Maintenance of Aboveground Power Infrastructure	→	—
Replacement of PHT Motors, Pumps and Valves During MCR	→	—
Replacement of Moderator Motors, Pumps and Valves During MCR	→	—
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	—
Replacement of CCW and	→	—

Table 80 Future Site Activities with Potential for Impacts on Groundwater during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Service Water Motors, Pumps and Valves During MCR		
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	→	—
Increased Sewage and Domestic Water	→	—
Increase in Workers, Payroll and Purchasing	→	—
Lead In		
Reactor Shutdown and De-fuel	→	—
Bulkhead Installation and Vault Pressure Test	→	—
Vault Air Conditioning	→	—
Temporary Dehumidifiers	→	—
Vault Vapour Recovery Operation	→	—
PHT Drain and Dry	→	—
Moderator Drain and Dry	→	—
System Lay Up	→	—
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	—
Fuel Channel Removal and Installation	→	—
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	→	—
Interference Removal and Re-installation	→	—
Crane Construction	→	—

Table 80 Future Site Activities with Potential for Impacts on Groundwater during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Steam Generator Removal and Installation	→	—
Lead Out		
Moderator Refill and Establishing OPGSS	→	—
Refueling	→	—
Vault Containment Restoration, including Bulkhead Removal	→	—
PHT Refill, Pressurization and Cold Flush	→	—
PHT Hot Conditioning	→	—
Power-up Process and Synchronizing to the Grid	→	—
Waste Handling and Waste Management		
Waste Handling and Waste Management and Demobilization	→	—

Note:
↓ = Effects decreasing relative to operational and outage conditions.
↑ = Effects potentially increasing relative to operational and outage conditions.
→ = No change to effects from or similar to operational and outage conditions.
— = No potential interaction identified.

In the Bruce A Refurbishment for Life Extension EA, no interactions between refurbishment activities and groundwater quality were identified [R-258]. As part of the EA FUP, the prediction that tritium activity would be below the generic screening criterion for non-potable groundwater was verified. Tritium activity was measured in off-site shallow wells and in multi-level wells close to the station. Measured tritium levels were confirmed to be substantially below the criterion and no trend towards the criterion was observed.

During MCR activities, foundation drains and associated sumps and pumps will continue to remain in operation. Therefore, groundwater flow will continue to be controlled by groundwater collection system. Site preparation activities could interact with groundwater recharge and flow by temporarily hardening surfaces, thus potentially limiting surface recharge to groundwater; however, this is not anticipated to be measureable as variation will not be beyond seasonal variability. The only MCR activities that were identified as potentially resulting in a measureable change in groundwater was the Bruce A and Bruce B Parking Lot Expansion. The runoff from the expanded parking lots could affect groundwater quality, as there will be a greater paved area being treated with salt during winter conditions. Sodium chloride and electrical conductivity were not included in the Baseline ERA, as these parameters were shown to be localized to areas adjacent to roads and not widespread throughout the Site, let alone the environment. Further, the increased footprint is a small incremental change from existing conditions and proceduralized processes are in place to manage this potential residual adverse effect and to ensure that groundwater quality parameters are within compliance limits.

There are no predicted changes in conventional or radiological groundwater quantity or quality as a result of MCR activities. The groundwater monitoring program will continue to monitor groundwater across site. Where the potential exists for exposure of ecological receptors to contaminants, sampling of relevant nearby environmental media will be completed to determine the extent of exposure, if any. These sampling results will be included in subsequent ERAs.

4.6.5 Geology, Sediment and Soil

Future site activities are evaluated for the potential to have an impact on geology, sediment and soil in Table 81. Future activities that are predicted to have an increased environmental impact are discussed below. No radiological changes to geology, sediment or soil are expected during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4.

Table 81 Future Site Activities with Potential for Impacts on Geology, Sediment and Soil during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A & Bruce B Generating Stations, including all systems and cooling water channels	→	—
Transformer Area and Standby Emergency Generators	→	—
Centre of Site Facilities – CMLF, FTF, administration buildings	→	—
Waste Transport	→	—
Planned Outages		

Table 81 Future Site Activities with Potential for Impacts on Geology, Sediment and Soil during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B.
Routine Outages	→	—
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	↑	Underground maintenance activities could affect soil quality.
Maintenance of Aboveground Power Infrastructure	→	—
Replacement of PHT Motors, Pumps and Valves During MCR	→	—
Replacement of Moderator Motors, Pumps and Valves During MCR	→	—
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	—
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	→	—
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	→	—
Increased Sewage and Domestic Water	→	—
Increase in Workers, Payroll and Purchasing	→	—
Lead In		
Reactor Shutdown and De-fuel	→	—
Bulkhead Installation and Vault Pressure Test	→	—
Vault Air Conditioning	→	—

Table 81 Future Site Activities with Potential for Impacts on Geology, Sediment and Soil during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Temporary Dehumidifiers	→	—
PHT Drain and Dry	→	—
System Lay Up	→	—
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	—
Fuel Channel Removal and Installation	→	—
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	→	—
Interference Removal and Re-installation	→	—
Crane Construction	↑	Addition of gravel or pre-formed concrete blocks may be required for the construction of the crane pad. Bore holes will be drilled as part of the geotechnical study to verify subsurface ground properties. These holes will be back-filled after confirming results of study.
Steam Generator Removal and Installation	→	—
Lead Out		
Moderator Refill and Establishing OPGSS	→	—
Refueling	→	—
Vault Containment Restoration, including Bulkhead Removal	→	—
PHT Refill, Pressurization and Cold Flush	→	—
PHT Hot Conditioning	→	—
Power-up Process and Synchronizing to the Grid	→	—
Waste Handling and Waste Management and Demobilization		

Table 81 Future Site Activities with Potential for Impacts on Geology, Sediment and Soil during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Waste Handling and Waste Management	→	—

Note:
↓ = Effects decreasing relative to operational and outage conditions.
↑ = Effects potentially increasing relative to operational and outage conditions.
→ = No change to effects from or similar to operational and outage conditions.
— = No potential interaction identified.

For radiological impacts to soil due to atmospheric downwash of airborne emissions, there was no predicted change in environmental conditions from anticipated future activities, including Lu-177 production, life extension and MCR activities. Changes to airborne emissions from Lu-177 production are expected to be negligible. In conclusion, radionuclide concentrations in soils are not expected to change from future site activities.

Conventional environmental impacts to soil have occurred on site. These impacts are localized, well characterized and effectively managed. During MCR direct effects to soil will be limited to the Site, the majority of the areas to be impacted have already been disturbed and to a great extent have already been graveled. Further, as material handling procedures and protocols in place for the Site will encompass MCR activities, the potential indirect interactions with soil quality from proposed excavation activities are limited. No future activities were found to have a likely measurable change on soil quality.

Bruce B Parking Lot Expansion and Bruce B Simulator

All construction activities were completed in accordance with standard procedures and protocols, including mitigation activities. As such, planting equivalent tree offsets to those that will be removed to accommodate the temporary infrastructure required as part of MCR in an appropriately selected area (see Section 4.5.8). Further, to reduce disturbance construction workers were aware of wildlife (e.g., nests) during demolition and adhered to legislative requirements. In particular, bat habitat (sugar maples with potential maternal roost cavities) and Species at Risk trees are known to be in the vicinity of the Bruce B Simulator site. Though none of these trees were removed, tree removal was performed outside of the maternal roost season to prevent disruption to the area. No Species at Risk trees are near the construction site. Additionally, pre-job orientations/briefs will take place to orient workers to environmental considerations at the Site.

Considering the control in place to limit impact from an increase in project footprint, and that all areas to be affected are on-site and for the most part have been previously been disturbed, these potentially changes are not expected to result in a residual effect that requires additional monitoring or compensatory action; no significant adverse effect is predicted.

4.6.6 Terrestrial Environment (Species and Habitat)

Future site activities are evaluated for the potential to have an impact on the terrestrial environment in Table 82. Future activities that are predicted to have an increased environmental impact are discussed below.

As identified in Section 4.6.2, 4.6.3 and 4.6.5, no changes to air, soil and surface water quality on or near site with respect to radiological contaminants are expected from Lu-177 production, life extension and MCR facilities. Therefore no changes to the terrestrial environment, and the associated radiological exposure to terrestrial receptors, are anticipated.

Table 82 Future Site Activities with Potential for Impacts on the Terrestrial Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A & Bruce B Generating Stations, including all systems and cooling water channels	→	—
Transformer Area and Standby Emergency Generators	→	—
Centre of Site Facilities – CMLF, CSF. FTF, administration buildings	→	—
Waste Transport	→	—
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B.
Routine Outages	→	—
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	—
Maintenance of Aboveground	→	—

Table 82 Future Site Activities with Potential for Impacts on the Terrestrial Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Power Infrastructure		
Replacement of PHT Motors, Pumps and Valves During MCR	→	—
Replacement of Moderator Motors, Pumps and Valves During MCR	→	—
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	—
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	→	—
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	↑	Establishment of a building on an existing gravel surface is anticipated to have a limited interaction with wildlife (e.g., establishment of temporary perch habitat, additional noise and activity within an industrial site).
Increased Sewage and Domestic Water	→	—
Increase in Workers, Payroll and Purchasing	→	—
Lead In		
Reactor Shutdown and De-fuel	→	—
Bulkhead Installation and Vault Pressure Test	→	—
Vault Air Conditioning	→	—
Temporary Dehumidifiers	→	—
Vault Vapour Recovery Operation	→	—
PHT Drain and Dry	→	—
Moderator Drain and Dry	→	—
System Lay Up	→	—

Table 82 Future Site Activities with Potential for Impacts on the Terrestrial Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	—
Fuel Channel Removal and Installation	→	—
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	↑	There is potential for interaction with nesting bird species that utilize site infrastructure for habitat or perches. Approved deterrents used on site will be used, as necessary. If the removal or relocation of nests/eggs is required, it will be done in accordance with applicable permit obtained under 3949 Migratory Bird Regulations.
Interference Removal	→	—
Crane Construction	↑	There is potential for wildlife to be disturbed by the construction of the crane, and the crane could provide potential perch habitat. There is the potential for interaction with nesting bird species that utilize site infrastructure for habitat or perches. Approved deterrents used on site will be used, as necessary. If the removal or relocation of nests/eggs is required, it will be done in accordance with applicable permit obtained under 3949 Migratory Bird Regulations.
Steam Generator Removal and Installation	→	—
Roof Operation and Replacement of Steam Generators	→	—
Cutting and Welding	→	—
Crane Removal	→	—
Roof Closure	→	—
Lead Out		
Bulkhead Removal and Restoring the Vault Containment	→	—
PHT Hydrostatic Testing and Cold Flush	→	—

Table 82 Future Site Activities with Potential for Impacts on the Terrestrial Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Heating the PHT and Hot Conditioning	→	—
Refilling the Moderator	→	—
Establishing an OPGSS	→	—
Refueling	→	—
Power-up Process	→	—
Synchronizing to the Grid	→	—
Waste Handling and Waste Management		
Waste Handling and Waste Management	→	—
Note: ↓ = Effects decreasing relative to operational and outage conditions. ↑ = Effects potentially increasing relative to operational and outage conditions. → = No change to effects from or similar to operational and outage conditions. — = No potential interaction identified.		

Wildlife are already deterred from using the Site (e.g., fenced boundary, nesting bird deterrents for facilities), therefore, the establishment of infrastructure (e.g., heavy lift crane) and changes to infrastructure (e.g., reactor building roof opening) on-site that may result in an interaction with wildlife is not anticipated to result in a measurable effect. Existing site procedures and protocols will be implemented to ensure conditions are safe for workers and wildlife.

Current operational conditions have been shown to be bounding of predicted changes, as a result of future activities at site, for:

- Noise quality;
- Air quality;
- Surface water quality, including physical characteristics such as temperature, and hydrology;

- Geology and soil quantity and quality; and
- Groundwater quality and flow.

As such, changes predicted in these environmental components are not considered as potentially effecting terrestrial receptors.

The results of the radiological EcoRA demonstrate that doses to terrestrial non-human biota on-site remain a small fraction of UNSCEAR benchmarks [R-262]. Lu-177 production is not expected to have any impacts on doses to terrestrial receptors. Radiation dose rates for non-human biota are not anticipated to appreciably change with continued Life Extension and MCR activities.

4.6.7 Aquatic Environment (Species and Habitat)

Future site activities are evaluated for the potential to have an impact on the terrestrial environment in Table 83. Future activities that are predicted to have an increased environmental impact are discussed below.

As identified in Sections 4.5.5 and 4.5.7, no changes to sediment and surface water quality on or near site with respect to radiological contaminants are expected from Lu-177 production, life extension and MCR facilities. Therefore no changes to the aquatic environment, and the associated radiological exposure to aquatic receptors, are anticipated.

Table 83 Future Site Activities with Potential for Impacts on the Aquatic Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A & Bruce B Generating Stations, including all systems and cooling water channels	→	—
Transformer Area and Standby Emergency Generators	→	—
Centre of Site Facilities – CMFL, FTF, administration buildings	→	—
Waste Transport	→	—
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B.

Table 83 Future Site Activities with Potential for Impacts on the Aquatic Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Routine Outages	→	—
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	—
Maintenance of Aboveground Power Infrastructure	→	—
Replacement of PHT Motors, Pumps and Valves During MCR	→	—
Replacement of Moderator Motors, Pumps and Valves During MCR	→	—
Replacement of Steam/Feedwater Motors, Pumps and Valves During MCR	→	—
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	↓	Reduced water intake during MCR, as a result of fewer CCW pumps may result in decreased impingement and entrainment as volume of intake reduced by 25% for a short duration. Thermal loading remains proportional (less heat output and also less flow). Bass nesting was not affected during Unit 1 and 2 restart as a result of decreased flow and thermal output. Gas Bubble Trauma (GBT) was also not observed.
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	↑	Construction activities could result in runoff that could impact waterways. Silt and sediment barriers will be used, as necessary to protect fish habitat.
Increased Sewage and Domestic Water	→	—
Increase in Workers, Payroll and Purchasing	→	—
Lead In		
Reactor Shutdown and De-fuel	→	—
Bulkhead Installation and Vault Pressure Test	→	—
Vault Air Conditioning	→	—
Temporary Dehumidifiers	→	—
Vault Vapour Recovery	→	—
PHT Drain and Dry	→	—

Table 83 Future Site Activities with Potential for Impacts on the Aquatic Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Moderator Drain and Dry	→	—
System Lay Up	→	—
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	—
Fuel Channel removal and Installation	→	—
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	→	—
Interference Removal and Re-installation	→	—
Crane Construction	→	—
Steam Generator Removal and Installation	→	—
Lead Out		
Moderator Refill and Establishing OPGSS	→	—
Refueling	→	—
Vault Containment Restoration	→	—
PHT Refill, Pressurization, and Cold Flush	→	—
PHT Hot Conditioning	→	—
Power-up Process and Synchronizing to the Grid	→	—
Waste Handling and Waste Management		
Waste Handling and Waste Management	→	—

Note:
↓ = Effects decreasing relative to operational and outage conditions.
↑ = Effects potentially increasing relative to operational and outage conditions.
→ = No change to effects from or similar to operational and outage conditions.
— = No potential interaction identified.

Current operational conditions have been shown to be bounding of predicted changes, as a result of future activities at site, for:

- Surface water quality (including physical characteristics such as temperature and near shore circulation) and hydrology;
- Geology and soil quantity and quality; and
- Groundwater quality and flow.

As such, changes predicted in these environmental components are not considered as potentially effecting aquatic receptors. This includes changes in near shore circulation that could result in entrainment of fish. Some MCR activities have the potential to increase the Site water demand (e.g., increased workforce) while others will decrease the Site water demand (e.g., generating station shutdown). During MCR, condenser cooling water pumps will be turned off for maintenance and thus flows and the resulting impingement and entrainment will be reduced during these time periods.

The Site currently operates three water intakes that draw from Lake Huron for site operations and water is then discharged to Lake Huron via the CCW duct and discharge channel. All intakes are governed by permits and approvals (Sections 7.4 of the main report [R-22] and Appendix I: Thermal Risk Assessment). Thermal effluent from the station undergoing MCR will be reduced by a similar amount as during a routine outage for the duration of the MCR and these temperature changes are visible on the discharge thermal loggers (see January 2020 in Figure 70, Figure 72, Figure 74 of Appendix I: Thermal Risk Assessment Section 9.4.2). No significant change in overall impingement and entrainment rates have occurred since the Unit 6 MCR began in 2020 (see Section 6.4.3 of [R-22]). The potential impact on fish communities has been assessed and all work has demonstrated that mitigation measures are effective. The monitoring data supports the conclusion that entrainment and impingement rates and thermal effluent discharge will not increase as a result of MCR, and that existing conditions are representative of predicted future conditions. Further, no future site activities were found to have a likely measurable change on aquatic habitat or aquatic biota.

The results of the radiological EcoRA demonstrate that doses to aquatic non-human biota on-site remain a small fraction of UNSCEAR benchmarks [R-262]. Lu-177 production is not expected to have any impacts on doses to aquatic receptors. Radiation dose rates for non-human biota are not anticipated to appreciably change with continued Life Extension and MCR activities.

4.6.8 Human Environment

Future site activities are evaluated for the potential to have an impact on the environment in Table. Future activities that are predicted to have an increased environmental impact are discussed below.

As identified in Sections 4.6.2 and 4.6.3, no changes to air and surface water quality with respect to radiological contaminants are expected from Lu-177 production, Life Extension and MCR facilities. The radiological concentrations in environmental media off-Site are not expected to change significantly from normal or outage operational conditions and therefore the radiation dose to members of the public is anticipated to continue to be less than the 10 μSv *de minimis* value, the level which is considered to be negligible or insignificant [R-263].

Table 84 Future Site Activities with Potential for Impacts on the Human Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Ongoing Operations		
Routine Site Operations		
Bruce A & Bruce G Generating Stations, including all systems and cooling water channels	→	—
Transformer Area and Standby Emergency Generators	→	—
Centre of Site Facilities – CMLF, FTF, administration buildings	→	Traffic may increase during MCR activities, resulting in increased noise and airborne emissions. Traffic volumes (i.e., commuter vehicles, shuttle buses, delivery vans and pickup) and mobilization and demobilization of construction equipment are anticipated as part of the project but are not expected to be beyond that previously experienced at site. Anticipated traffic volumes for MCR would be comparable to that experienced during the last station containment outage.
Waste Transport	→	—
Planned Outages		
Station Containment Outages	→	The next SCOs are planned in 2028 for Bruce A and in 2030 for Bruce B.
Vacuum Building Outages	→	The next VBOs are planned in 2022 for Bruce A and 2024 for Bruce B.
Routine Outages	→	—
Routine Asset Management Activities (Examples Only)		
Maintenance of Underground Power Cables	→	—
Maintenance of Aboveground Power Infrastructure	→	—
Replacement of PHT Motors, Pumps and Valves During MCR	→	—
Replacement of Moderator Motors, Pumps and Valves During MCR	→	—

Table 84 Future Site Activities with Potential for Impacts on the Human Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Replacement of Steam/Feedwater Motors, Pumps	→	—
Replacement of CCW and Service Water Motors, Pumps and Valves During MCR	→	—
Major Component Replacement Activities		
Installation of Major Component Replacement Infrastructure		
Bruce A Future MCR Office Support	→	—
Increased Sewage and Domestic Water	→	—

Table 84 Future Site Activities with Potential for Impacts on the Human Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Increase in Workers, Payroll and Purchasing	↑	MCR will significantly extend the life of Bruce A & Bruce B generating stations, and will result in a 5 year increase period of increased activity on-site. These changes are predicted to result in a likely measurable change to: - Maintenance of workforce for the foreseeable future, including local and Indigenous employees, resulting in sustainable contribution to local economy, as well as other socio-economic benefits. - Increase in local population, resulting in short-term increases in demand on local services, which could affect municipal finances, community infrastructure and services, and community facilities and resources. - Increased competition for temporary accommodations, which would affect tourism and the Inverhuron Provincial Park. - An increase of 2 to 3% in population, is within the growth predictions in the Official Community Plans for both the Municipality of Kincardine and Saugeen Shores, therefore, it is not likely that MCR will result in a measurable change. Further, the recent station containment outages undertaken at site are comparable to MCR and would have been accommodated in 2016.
Lead In		
Reactor Shutdown and De-fuel	→	—
Bulkhead Installation and Vault Pressure Test	→	—
Vault Air Conditioning	→	—
Temporary Dehumidifiers	→	—
PHT Drain and Dry	→	—
Moderator Drain and Dry	→	—
System Lay Up	→	—
Reactor Retube and Feeder Replacement		
Feeder Replacement	→	—

Table 84 Future Site Activities with Potential for Impacts on the Human Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Fuel Channel removal and Installation	→	—
Steam Generator Replacement		
Roof Opening, Roof Enclosure Installation and Closure	→	—
Interference Removal	→	—
Crane Construction	→	Establishment of infrastructure could reduce the aesthetics of the landscape. Areas to be disturbed are on-site, and have for the most part been previously disturbed (i.e., graveled). The timeline for the crane being transported and erected will be communicated through social media. It is anticipated that the crane may be visible from the Baie du Doré, the bluffs to the east of the Site (i.e., Bruce Power Visitors' Centre, the wind energy park and the Bruce Energy Centre), and 20 km or more along Lake Huron.
Steam Generator Removal and Installation	→	—
Lead Out		
Moderator Refill and Establishing OPGSS	→	—
Refueling	→	—
Vault Containment Restoration, including Bulkhead Removal	→	—
PHT Refill, Pressurization and Cold Flush	→	—
PHT Hot Conditioning	→	—
Power-up Process and Synchronizing to Grid	→	—
Waste Handling and Waste Management		
Waste Handling and Waste Management	→	—

Table 84 Future Site Activities with Potential for Impacts on the Human Environment during Lu-177 Production, Life Extension and MCR Activities for Units 6, 3 and 4 (2021-2026)

Future Site System, Structure or Activity	Direction of Potential Effect Relative to Current Operations	Discussion of Potential Interaction
Note: ↓ = Effects decreasing relative to operational and outage conditions. ↑ = Effects potentially increasing relative to operational and outage conditions. → = No change to effects from or similar to operational and outage conditions. — = No potential interaction identified.		

No impacts to the conventional human environment are expected as part of future site activities from 2021 to 2026, with the exception of the ongoing social pressures related to the increase in workers.

The radiation doses to human receptors in the vicinity of the Site are less than the 10 μSv *de minimis* value, i.e., the dose below which the effects to humans are considered to be negligible or insignificant [R-263]. The predicted radiation doses are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.

4.7 PERA Conclusion and Recommendations

With the successful execution of a large portion of the higher risk Life Extension and MCR activities for Unit 6, including the draining of systems and the removal of components, no substantial changes to baseline radiological and conventional emissions and effluents are expected to occur during Life Extension and MCR. As the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, the 2022 ERA is, therefore, shown to be bounding of the proposed activities.

The outcomes of predicted activities occurring from 2021 to 2026 will be reported in the 2027 ERA. The PERA process will be repeated for new activities predicted to occur on site from 2026 to 2031. For future site activities, there are no changes expected for air and surface water quality outside of normal or outage operational conditions. Therefore, no substantial environmental impacts to the human environment are expected as a result of planned activities associated with Lu-177 production, Life Extension or MCR.

To support the objectives of MCR, an Environmental team was made up of in-house Environmental Technical Officers assigned to focus solely on environmental protection during execution of project deliverables. This team provides environmental governance and oversight of the project, through stakeholder involvement in design reviews and work packages, completion of Environmental Impact Workflows (EIW), procedural adherence, and walk downs. EIW's are Bruce Power's Environmental Management System tool to capture the environmental evaluation, and outline environmental requirements necessary to ensure the work is carried out in an environmentally protective manner, mitigate risk, and ensure the evolutions remain in compliance with regulatory requirements. Environmental Management Plans (EMP's) are created to capture environmental concerns related to larger projects. EIWs and EMPs provide project execution vendors with key information regarding emissions, waste, spills and other notable issues for awareness including event reporting and regulatory requirements.

Environment personnel are key stakeholders in life extension and MCR projects and provide document reviews and feedback throughout all stages of planning and execution. In the field walk downs and observations provide timely guidance and oversight in respect of activities which have the potential to impact the environment.

5.0 APPENDIX E: ENVIRONMENTAL QUALITY DATA TABLES AND CHEMICALS AND PRELIMINARY SCREENING

5.1 Soil

5.1.1 Bruce A Storage Compound (BASC)

Table 85 Preliminary Screening for Soil of Metals at BASC

Location								BASC-1-00			BASC-2-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Aluminum	26000	µg/g	NV	NV	26000	6400	6400	-	-	-	-	-	-
Antimony	1.3	µg/g	1.3	40	0.99	**4**	**4**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	µg/g	18	12	18	6.804	6.804	2.402	1.943	2.406	2.401	1.463	3.242
Barium	220	µg/g	220	2000	180	207.518	207.518	144.135	39.233	38.502	73.452	56.765	91.034
Beryllium	2.5	µg/g	2.5	8	0.99	0.719	0.719	<0.200	0.302	0.225	<0.200	0.38	0.549
Boron	36	µg/g	36	NV	26	13	13	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	**6.3**	**6.3**	0.56	**3.96**	0.54	0.3	1.5	0.7
Cadmium	1.2	µg/g	1.2	22	1.2	0.53	0.53	0.482	0.257	<0.200	<0.200	0.284	<0.200
Chromium	70	µg/g	70	87	63	27.538	27.538	10.433	15.52	15.505	5.056	15.798	24.894
Calcium	49000	µg/g	NV	NV	49000	25300	25300	-	-	-	-	-	-
Chromium (III) [b]	70	µg/g	70	87	63	19	19	-	-	-	-	-	-
Chromium (VI)	0.66	µg/g	0.66	1.4	NV	**1**	**1**	-	-	-	-	-	-
Chromium (Total)	70	µg/g	70	87	63	19	19	-	-	-	-	-	-
Cobalt	21	µg/g	21	300	17	11.428	11.428	2.728	4.618	5.391	1.234	3.749	7.131
Copper	91	µg/g	92	91	66	40	40	9.652	11.807	12.427	3.14	15.123	14.623
Iron	34000	µg/g	NV	NV	34000	27000	27000	5800	7800	8900	4000	9200	17600
Lead	120	µg/g	120	600	1500	25	25	8.694	12.935	4.363	7.669	10.124	5.788
Magnesium	15000	µg/g	NV	NV	15000	9000	9000	-	-	-	-	-	-
Manganese	1400	µg/g	NV	NV	1400	445.187	445.187	147.254	156.271	286.706	72.137	151.985	337.197

Table 85 Preliminary Screening for Soil of Metals at BASC

Location								BASC-1-00			BASC-2-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Mercury	0.27	µg/g	0.27	50	0.27	**1.209**	**1.209**	<0.01	<0.01	0.02	0.014	0.039	0.012
Molybdenum	2	µg/g	2	40	1.3	**5.586**	**5.6**	**5.6**	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	µg/g	82	89	50	32.878	32.878	<1.000	5.222	<1.000	<1.000	9.407	12.842
Selenium	1.5	µg/g	1.5	2.9	1.1	1.4	1.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	µg/g	0.5	40	0.33	<0.250	-	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	µg/g	NV	NV	1000	*< 5000*	436	300	350	325	215	385	385
Thallium	1	µg/g	1	1	NV	<0.500	0.11	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	µg/g	NV	NV	4700	434.151	434.151	76.448	119.943	96.822	54.911	269.456	194.495
Uranium	2.5	µg/g	2.5	300	1.9	2.457	2.457	2.195	1.282	0.681	1.733	1.079	0.926
Vanadium	86	µg/g	86	130	72	49.234	49.234	9.169	14.15	12.973	4.671	16.957	22.057
Zinc	290	µg/g	290	410	180	**520**	**520**	49.531	42.551	20.961	194.449	34.529	30.113
Cyanide (free)	0.051	µg/g	0.051	0.9	-	< 0.01	-	-	-	-	-	-	-
Conductivity	0.57	mS/cm	0.57	200	-	0.15	0.15	-	-	-	-	-	-
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	**9.26**	**9.26**	8.46	7.61	8.67	8.66	7.64	7.73
Sodium Adsorption Ratio	2.4	SAR	2.4	5	-	0.32	0.32	-	-	-	-	-	-

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		BASC-3-00		BASC-4-00			BASC-5-00			BASC-6-00		
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	0.06	0.91	1.22	0.06	0.30	1.07	0.06	0.46	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark											
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	1.832	2.487	1.599	2.461	6.804	3.009	<1.000	2.188	<1.000	<1.000	3.199
Barium	220	12.155	55.934	51.579	48.544	58.601	29.801	58.051	52.207	11.531	7.315	74.644
Beryllium	2.5	<0.200	0.307	<0.200	0.328	0.469	0.237	<0.200	0.25	<0.200	<0.200	0.506
Boron	36	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.5	0.33	0.4	1	0.5	0.3	0.3	1.56	0.6	0.54	0.48
Cadmium	1.2	<0.200	<0.200	<0.200	0.373	<0.200	<0.200	<0.200	0.231	<0.200	<0.200	<0.200
Chromium	70	8.478	17.451	6.759	10.396	22.472	12.131	<1.000	<1.000	<1.000	<1.000	<1.000
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	3.241	5.911	2.179	3.539	7.975	3.747	<1.000	3.669	2.661	1.88	8.46
Copper	91	9.721	11.646	5.405	13.761	18.608	12.51	1.364	13.822	6.127	1.559	18.426
Iron	34000	5500	9600	6000	9500	18000	9700	1200	7700	5300	3600	16400
Lead	120	3.705	7.084	3.167	14.149	5.897	6.321	<1.000	11.764	3.302	1.469	7.217
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	280.745	319.658	186.501	169.85	445.187	425.489	37.087	155.251	226.974	164.288	313.948

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		BASC-3-00		BASC-4-00			BASC-5-00			BASC-6-00		
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	0.06	0.91	1.22	0.06	0.30	1.07	0.06	0.46	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark											
Mercury	0.27	0.015	0.015	<0.01	0.01	0.013	0.016	0.027	0.037	<0.01	<0.01	<0.01
Molybdenum	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	<1.000	<1.000	<1.000	7.915	12.834	3.405	<1.000	7.667	<1.000	<1.000	14.861
Selenium	1.5	<1.0	<1.0	<1.0	1.4	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	310	305	250	260	350	250	155	260	215	200	300
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	131.787	117.685	111.323	96.419	181.686	232.621	71.091	297.195	241.148	254.01	325.084
Uranium	2.5	0.519	0.764	1.275	1.286	0.8	0.944	2.16	1.153	0.447	0.352	0.755
Vanadium	86	9.305	15.053	7.81	10.051	22.889	12.791	<2.500	17.057	<2.500	<2.500	39.409
Zinc	290	98.822	24.294	15.079	44.427	30.948	35.631	14.907	41.464	38.399	10.832	42.358
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.47	8.57	8.53	7.68	8.2	8.64	**9.25**	7.61	8.29	8.72	8.31
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		**BASC-7**				**BASC-8**		**BASC-9**			**BASC-10**			**BASC-11**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.06**	**0.61**	**0.61**	**0.06**	**1.22**	**0.06**	**0.61**	**1.22**	**0.06**	**0.91**	**1.22**	**0.06**	**0.91**	**1.07**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**															
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	1.815	1.777	3.425	1.943	1.8	1.596	2.551	1.755	<1.000	1.603	2.548	3.253	2.043	1.485	2.842
Barium	220	23.122	18.511	96.296	72.266	11.786	49.758	27.678	97.918	8.886	52.107	32.163	72.373	57.975	31.862	70.951
Beryllium	2.5	<0.200	<0.200	0.719	0.368	<0.200	0.272	<0.200	0.299	<0.200	<0.200	0.213	0.436	<0.200	0.286	0.581
Boron	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.66	0.57	1.1	1.7	0.3	0.6	0.3	0.33	0.42	0.33	**4.56**	0.51	0.87	1.98	0.7
Cadmium	1.2	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.281	<0.200	<0.200	<0.200	<0.200
Chromium	70	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	6.723	12.603	26.339	7.84	15.076	27.538
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	4.234	3.534	11.428	6.788	2.564	4.768	3.687	5.05	1.973	2.062	3.64	9.05	2.36	4.132	8.712
Copper	91	13.49	13.105	22.946	16.376	23.467	11.917	12.388	11.671	5.518	5.149	10.411	19.602	7.256	10.116	17.854
Iron	34000	6950	6100	20900	12800	9440.154	11179.21	10655.58	11702.49	5196.062	3200	6150	14000	4500	7200	16000
Lead	120	5.235	4.948	9.675	11.5	12.219	4.659	19.037	4.784	2.114	6.206	16.489	6.419	9.092	7.327	6.233
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	306.701	277.99	373.972	261.714	258.027	229.576	307.204	323.778	196.922	138.722	194.293	366.75	170.891	212.38	372.198

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		**BASC-7**				**BASC-8**		**BASC-9**			**BASC-10**			**BASC-11**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.61	0.61	0.06	1.22	0.06	0.61	1.22	0.06	0.91	1.22	0.06	0.91	1.07
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**															
Mercury	0.27	0.022	0.023	<0.010	0.022	0.022	0.026	0.013	<0.010	<0.010	<0.01	0.046	0.021	0.025	0.021	0.027
Molybdenum	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	1.06	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	3.927	2.693	21.718	12.104	<1.000	6.673	1.778	5.84	<1.000	<1.000	1.786	3.367	<1.000	2.944	8.51
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	250	270	410	315	220	250	230	310	245	280	300	335	320	320	370
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	434.151	345.839	180.901	283.567	257.859	213.674	284.48	191.618	62.001	74.302	154.217	107.49	107.389	129.157	108.76
Uranium	2.5	0.618	0.544	1.042	0.99	0.542	0.86	0.925	1.015	0.601	1.755	0.905	0.806	1.841	0.741	0.855
Vanadium	86	5.087	<2.500	49.234	26.073	<2.500	12.841	3.945	13.042	<2.500	8.183	12.527	19.916	9.84	12.99	19.826
Zinc	290	219.087	258.878	68.791	119.68	142.029	34.731	89.349	39.288	11.298	19.969	36.867	32.827	35.958	31.391	32.465
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.83	8.79	8.1	8.34	8.56	8.38	8.64	8.47	8.95	8.58	7.47	8.34	8.2	7.97	8.41
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		BASC-12			BASC-13			BASC-14			BASC-15		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	1.07	1.22	0.06	0.46	0.91	0.06	0.61	0.91	0.06	0.46	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	<1.000	2.572	2.564	6.282	2.405	<1.000	2.215	4.183	1.435	1.592	2.834	<1.000
Barium	220	207.518	73.245	93.203	13.884	28.737	83.566	17.14	29.644	67.652	13.273	18.99	37.799
Beryllium	2.5	<0.200	0.443	0.424	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Boron	36	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.24	**6.3**	0.7	0.6	0.93	0.54	0.54	1.2	0.9	0.6	0.84	0.54
Cadmium	1.2	<0.200	0.317	<0.200	0.253	<0.200	<0.200	<0.200	<0.200	<0.200	0.319	<0.200	<0.200
Chromium	70	3.916	19.392	26.182	14.804	7.15	3.256	10.273	9.087	6.451	8.1	7.634	3.488
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	1.555	6.042	8.89	3.734	2.206	<1.000	3.579	5.391	1.929	2.299	3.538	1.256
Copper	91	2.686	17.022	17.834	24.341	6.24	2.972	7.485	12.086	5.157	7.397	10.748	3.22
Iron	34000	1250	9800	13000	21200.83	6687.851	2821.872	7241.896	10696.36	5587.325	6687.281	8372.77	3491.76
Lead	120	1.333	14.828	6.168	17.172	3.772	1.953	20.468	3.966	2.835	18.249	3.948	3.61
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	51.409	179.594	352.632	389.203	177.752	74.602	224.625	374.036	164.012	229.205	318.382	89.505

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		BASC-12			BASC-13			BASC-14			BASC-15		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	1.07	1.22	0.06	0.46	0.91	0.06	0.61	0.91	0.06	0.46	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Mercury	0.27	0.01	0.021	0.017	<0.0100	<0.0100	<0.0100	**1.209**	<0.0100	<0.0100	0.07	<0.0100	<0.0100
Molybdenum	2	<1.000	<1.000	<1.000	1.44	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	<1.000	7.298	4.311	2.247	<1.000	<1.000	32.878	5.307	<1.000	3.384	1.027	<1.000
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	275	375	375	300	320	350	436	370	366	340	367	371
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	41.643	100.92	109.723	183.357	172.144	95.427	143.543	337.275	172.475	169.775	273.195	96.923
Uranium	2.5	2.457	1.272	0.876	0.49	1.085	1.809	0.749	0.67	1.281	0.648	0.712	1.61
Vanadium	86	5.708	15.487	18.846	29.243	9.553	5.437	8.198	14.046	9.069	8.658	11.906	6.144
Zinc	290	29.059	49.594	32.449	157.821	31.422	7.536	58.241	29.596	15.868	73.55	24.391	9.483
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.95	7.76	8.31	8.63	8.75	**9.26**	8.88	8.74	7.75	8.52	8.78	8.89
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-	-

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		BASC-16			BASC-1-21	BASC-2-21	BASC-3-21	BASC-4-21	BASC-5-21	BASC-6-21
Sample ID		BASC-1-16	BASC-2-16	BASC-3-16	-	-	-	-	-	-
Sample Depth (m)		0-0.1 m	0.1-0.3 m	0.3-0.4 m	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	**Preliminary Benchmark**									
Aluminum	26000	-	-	-	6400	3200	3000	2700	3100	2700
Antimony	1.3	0.45	< 0.20	< 0.20	0.23	0.43	0.4	0.91	0.81	**4**
Arsenic	12	2.8	2.6	2.6	1.9	2.5	3.9	6	2.7	1.9
Barium	220	17	20	22	31	120	28	22	13	13
Beryllium	2.5	< 0.20	< 0.20	< 0.20	-	-	-	-	-	-
Boron	36	7.4	7.4	7.6	13	11	8.2	8	7.2	5.4
Boron - Hot Water Ext. [a]	2	0.15	0.066	< 0.050	-	-	-	-	-	-
Cadmium	1.2	0.18	< 0.10	< 0.10	0.17	0.53	0.19	0.19	0.41	0.21
Chromium	70	17	12	8.7	-	-	-	-	-	-
Calcium	49000	25300	17700	15600	-	-	-	-	-	-
Chromium (III) [b]	70	-	-	-	15	12	12	19	16	11
Chromium (VI)	0.66	**1**	< 0.2	< 0.2	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18
Chromium (Total)	70	-	-	-	15	12	12	19	16	11
Cobalt	21	3.5	4.5	3.9						
Copper	91	26	15	14	12	15	18	27	40	16
Iron	34000	-	-	-	11000	10000	16000	27000	15000	9300
Lead	120	25	7.9	4.7	12	17	12	19	21	21
Magnesium	15000	9000	3300	2100	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-

Table 85 Preliminary Screening for Soil of Metals at BASC

Location		BASC-16			BASC-1-21	BASC-2-21	BASC-3-21	BASC-4-21	BASC-5-21	BASC-6-21
Sample ID		BASC-1-16	BASC-2-16	BASC-3-16	-	-	-	-	-	-
Sample Depth (m)		0-0.1 m	0.1-0.3 m	0.3-0.4 m	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	Preliminary Benchmark									
Mercury	0.27	< 0.050	< 0.050	< 0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum	2	1.2	< 0.50	< 0.50	<0.50	1.5	1.3	**2.2**	1.4	0.59
Nickel	82	10	10	8.6	12	11	12	24	13	8.9
Selenium	1.5	< 0.50	< 0.50	< 0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver	0.5	< 0.20	< 0.20	< 0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium	1000	*< 5000*	*< 5000*	*< 5000*	-	-	-	-	-	-
Thallium	1	0.082	0.1	0.11	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-
Uranium	2.5	0.57	0.52	0.59	0.49	1.9	0.82	0.78	0.53	0.37
Vanadium	86	13	19	14	20	12	13	16	13	15
Zinc	290	280	86	49	42	280	97	260	**490**	**520**
Cyanide (free)	0.051	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-
Conductivity	0.57	0.15	0.096	0.091	-	-	-	-	-	-
pH	5 to 9	7.47	7.86	7.85	-	-	-	-	-	-
Sodium Adsorption Ratio	2.4	0.22	0.29	0.32	-	-	-	-	-	-

Table 85 Preliminary Screening for Soil of Metals at BASC

BASC Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

b In absence of standards for Chromium (III), standards for Chromium (Total) were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter;

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 86 Preliminary Screening for Soil of PHCs & PCBs at BASC

Location								BASC-1-00			BASC-2-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Petroleum Hydrocarbons - F1 (C6-C10)	25	µg/g	25	240	NR	<20	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	µg/g	25	240	NR	<20	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	µg/g	10	260	NR	**37**	**37**	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	µg/g	240	1700	NR	**340**	**340**	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	µg/g	120	3300	NR	**130**	**130**	-	-	-	-	-	-
Reached Baseline at C50	NA	NA	NA	NA	NA	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	µg/g	10	260	NR	**582**	**582**	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-50)	120	µg/g	120	1700	NR	**180**	**180**	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Aroclor 1248	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Aroclor 1254	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Aroclor 1260	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
PCBs	0.3	µg/g	0.3	33	NR	<0.100	0.01	<0.100	<0.100	<0.100	-	-	-

Table 86 Preliminary Screening for Soil of PHCs & PCBs at BASC

Location		**BASC-3-00**		**BASC-4-00**			**BASC-5-00**			**BASC-6-00**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.91**	**0.06**	**0.91**	**1.22**	**0.06**	**0.30**	**1.07**	**0.06**	**0.46**	**0.61**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**											
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-
PCBs	0.3	-	-	0.007	0.01	0.006	-	-	-	-	-	-

Table 86 Preliminary Screening for Soil of PHCs & PCBs at BASC

Location		BASC-7				BASC-8		BASC-9			BASC-10		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.61	0.61	0.06	1.22	0.06	0.61	1.22	0.06	0.91	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-
PCBs	0.3	-	-	-	-	-	-	-	-	-	<0.100	<0.100	<0.100

Table 86 Preliminary Screening for Soil of PHCs & PCBs at BASC

Location		**BASC-11**			**BASC-12**			**BASC-13**			**BASC-14**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.91**	**1.07**	**0.06**	**1.07**	**1.22**	**0.06**	**0.46**	**0.91**	**0.06**	**0.61**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 86 Preliminary Screening for Soil of PHCs & PCBs at BASC

Location		BASC-15			BASC-16			BASC-1-21	BASC-2-21	BASC-3-21	BASC-4-21	BASC-5-21	BASC-6-21
Sample ID		-	-	-	BASC-1-16	BASC-2-16	BASC-3-16	-	-	-	-	-	-
Sample Depth (m)		0.06	0.46	0.91	0-0.1 m	0.1-0.3 m	0.3-0.4 m	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	**Preliminary Benchmark**												
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	< 10	< 10	< 10	<20	<20	<10	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	< 10	< 10	< 10	<20	<20	<10	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	< 10	< 10	< 10	<10	**18**	<10	**13**	**12**	**30**
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	< 50	< 50	< 50	82	**340**	74	71	59	120
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	< 50	< 50	< 50	<50	83	<50	<50	<50	**130**
Reached Baseline at C50	NA	-	-	-	YES	YES	YES	YES	YES	YES	YES	YES	YES
TPH Light (C10-24)	10	<10	<10	**582**	-	-	-	-	-	-	-	-	-
TPH Heavy (C24-50)	120	<100	<100	**180**	-	-	-	-	-	-	-	-	-
Aroclor 1242	NV	-	-	-	< 0.010	< 0.010	< 0.010	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	< 0.010	< 0.010	< 0.010	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	< 0.010	< 0.010	< 0.010	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	< 0.010	< 0.010	< 0.010	-	-	-	-	-	-
PCBs	0.3	<0.100	<0.100	<0.100	< 0.010	< 0.010	< 0.010	-	-	-	-	-	-

Table 86 Preliminary Screening for Soil of PHCs & PCBs at BASC

BASC PHC & PCBs Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location								**BASC-1-00**			**BASC-2-00**		
Sample ID								**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)								**0.06**	**0.91**	**1.22**	**0.06**	**0.91**	**1.22**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**BASC**							
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**						
Phenols													
2,3,5-Trichlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	< 0.2	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	< 0.2	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,3,4-Trichlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	< 0.2	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,6-Dichlorophenol	5	µg/g	NV	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	< 0.4	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,4-Dinitrophenol	2	µg/g	2	NV	NR	< 1	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chlorophenol	0.1	µg/g	0.1	5	NR	< 0.2	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	< 0.2	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	0.5	µg/g	0.5	3.8	NR	< 0.2	0.035	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Semi-Volatile Organic Compounds													
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	< 0.06	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.06	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1- & 2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.085	-	-	-	-	-	-	-
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	< 1	0.04	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Acenaphthene	0.072	µg/g	0.072	NV	NR	< 0.06	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location								BASC-1-00			BASC-2-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Acenaphthylene	0.093	µg/g	0.093	NV	NR	*< 0.1*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	0.16	µg/g	0.16	32	NR	< 0.06	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Benzo(b)fluoranthene	0.47	µg/g	0.47	10	NR	0.3	0.3	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	0.2	0.2	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	0.2	0.2	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	< 0.2	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	0.11	0.11	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Biphenyl	0.05	µg/g	0.05	NV	NR	*< 0.1*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chloroethoxy)methane	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	< 2	0.1	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Chrysene	2.8	µg/g	2.8	NV	NR	0.2	0.2	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	< 0.1	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	< 0.4	0.011	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fluoranthene	0.56	µg/g	0.56	180	NR	0.2	0.2	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluorene	0.12	µg/g	0.12	NV	NR	< 0.06	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	< 0.2	-	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Naphthalene	0.013	µg/g	0.09	0.013	NR	*< 0.06*	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenanthrene	0.046	µg/g	0.69	0.046	NR	*< 0.1*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	1	µg/g	1	100	NR	0.1	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location								BASC-1-00			BASC-2-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Volatile Organic Compounds													
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.1*	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2,3,4,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,5,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,4,5-Tetrachloropheonol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2-Chloronaphthalene	NV	µg/g	NV	NV	NV	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylphenol	NV	µg/g	NV	NV	NV	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
4-Bromophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
4-Chloro-3-methyl-phenol	NV	µg/g	NV	NV	NV	<0.015	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
4-Chlorophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
4-Nitrophenol	10	µg/g	NV	10	--	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzyl Butyl Phthalate	NV	µg/g	NV	NV	NV	**0.01**	**0.01**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Di-n-butyl Phthalate	NV	µg/g	NV	NV	NV	**0.02**	**0.02**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Di-n-octyl Phthalate	NV	µg/g	NV	NV	NV	<0.006	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Hexachlorobenzene	0.01	µg/g	0.01	10	--	<0.005	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobutadiene	0.01	µg/g	0.01	NV	--	*<0.020*	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hexachlorocyclopentadiene	NV	µg/g	NV	NV	NV	<0.020	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachloroethane	0.01	µg/g	0.01	NV	--	*<0.020*	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isophorone	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrobenzene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N-Nitrosodi-n-propylamine	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
N-Nitrosodiphenylamine	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Diphenylamines (total)	NV	µg/g	NV	NV	NV	<0.008	-	-	-	-	-	-	-

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		**BASC-3-00**		**BASC-4-00**			**BASC-5-00**			**BASC-6-00**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	0.06	0.91	1.22	0.06	0.30	1.07	0.06	0.46	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**											
Phenols												
2,3,5-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,3,4-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,6-Dichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dimethylphenol	0.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,4-Dinitrophenol	2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Pentachlorophenol	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	0.5	<0.004	<0.004	<0.004	0.035	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Semi-Volatile Organic Compounds												
1-Methylnapthalene	0.59	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
2-Methylnaphthalene	0.59	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,6-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3,3'-Dichlorobenzidine	1	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
p-Chloroanaline	0.5	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Acenaphthene	0.072	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-3-00		BASC-4-00			BASC-5-00			BASC-6-00		
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	0.06	0.91	1.22	0.06	0.30	1.07	0.06	0.46	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**											
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	0.16	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Benzo(b)fluoranthene	0.47	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)anthracene	0.36	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)pyrene	0.3	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	0.48	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Biphenyl	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chloroethoxy)methane	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
bis(2-chloroethyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chlorisopropyl)ether	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-ethylhexyl)phthalate	5	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Chrysene	2.8	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dimethylphthalate	0.5	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fluoranthene	0.56	<0.003	<0.003	0.006	<0.003	<0.003	<0.003	<0.003	<0.003	0.007	<0.003	<0.003
Fluorene	0.12	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-cd)pyrene	0.23	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenanthrene	0.046	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-3-00		BASC-4-00			BASC-5-00			BASC-6-00		
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	0.06	0.91	1.22	0.06	0.30	1.07	0.06	0.46	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark											
Volatile Organic Compounds												
1,2,4-Trichlorobenzene	0.05	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,5,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,4,5-Tetrachloropheonol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2-Chloronaphthalene	NV	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylphenol	NV	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
4-Bromophenyl Phenyl Ether	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
4-Chloro-3-methyl-phenol	NV	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
4-Chlorophenyl Phenyl Ether	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
4-Nitrophenol	10	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzyl Butyl Phthalate	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Di-n-butyl Phthalate	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	<0.005
Di-n-octyl Phthalate	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Hexachlorobenzene	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobutadiene	0.01	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hexachlorocyclopentadiene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachloroethane	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isophorone	NV	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrobenzene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N-Nitrosodi-n-propylamine	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
N-Nitrosodiphenylamine	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Diphenylamines (total)	NV	-	-	-	-	-	-	-	-	-	-	-

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-7				BASC-8		BASC-9			BASC-10		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.61	0.61	0.06	1.22	0.06	0.61	1.22	0.06	0.91	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Phenols													
2,3,5-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,3,4-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,6-Dichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dimethylphenol	0.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,4-Dinitrophenol	2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Pentachlorophenol	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	0.5	<0.004	<0.004	<0.004	<0.004	0.03	0.03	0.03	<0.004	<0.004	<0.004	<0.004	<0.004
Semi-Volatile Organic Compounds													
1-Methylnapthalene	0.59	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
2-Methylnaphthalene	0.59	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,6-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3,3'-Dichlorobenzidine	1	0.008	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	<0.005
p-Chloroanaline	0.5	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Acenaphthene	0.072	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-7				BASC-8		BASC-9			BASC-10		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.61	0.61	0.06	1.22	0.06	0.61	1.22	0.06	0.91	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**												
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	0.16	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Benzo(b)fluoranthene	0.47	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)anthracene	0.36	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)pyrene	0.3	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	0.48	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Biphenyl	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chloroethoxy)methane	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
bis(2-chloroethyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chlorisopropyl)ether	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-ethylhexyl)phthalate	5	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.01	<0.006
Chrysene	2.8	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	<0.002	0.011	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fluoranthene	0.56	<0.003	<0.003	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01	<0.003
Fluorene	0.12	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-cd)pyrene	0.23	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.001
Phenanthrene	0.046	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		**BASC-7**				**BASC-8**		**BASC-9**			**BASC-10**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.61	0.61	0.06	1.22	0.06	0.61	1.22	0.06	0.91	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**												
Volatile Organic Compounds													
1,2,4-Trichlorobenzene	0.05	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,5,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,4,5-Tetrachloropheonol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2-Chloronaphthalene	NV	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylphenol	NV	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
4-Bromophenyl Phenyl Ether	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
4-Chloro-3-methyl-phenol	NV	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
4-Chlorophenyl Phenyl Ether	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
4-Nitrophenol	10	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzyl Butyl Phthalate	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.01**	<0.002
Di-n-butyl Phthalate	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Di-n-octyl Phthalate	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Hexachlorobenzene	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobutadiene	0.01	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hexachlorocyclopentadiene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachloroethane	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isophorone	NV	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrobenzene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N-Nitrosodi-n-propylamine	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
N-Nitrosodiphenylamine	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Diphenylamines (total)	NV	-	-	-	-	-	-	-	-	-	-	-	-

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-11			BASC-12			BASC-13		
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	1.07	0.06	1.07	1.22	0.06	0.46	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
Phenols										
2,3,5-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,3,4-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,6-Dichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dimethylphenol	0.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,4-Dinitrophenol	2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Pentachlorophenol	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	0.5	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Semi-Volatile Organic Compounds										
1-Methylnapthalene	0.59	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004	<0.004	<0.004
2-Methylnaphthalene	0.59	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003	<0.003	<0.003
2,6-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3,3'-Dichlorobenzidine	1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.020	<0.020	<0.020
p-Chloroanaline	0.5	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Acenaphthene	0.072	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-11			BASC-12			BASC-13		
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	1.07	0.06	1.07	1.22	0.06	0.46	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Anthracene	0.16	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Benzo(b)fluoranthene	0.47	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)anthracene	0.36	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)pyrene	0.3	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.001	<0.001	<0.001
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	0.48	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003
Biphenyl	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.010	<0.010	<0.010
bis(2-chloroethoxy)methane	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
bis(2-chloroethyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
bis(2-chlorisopropyl)ether	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-ethylhexyl)phthalate	5	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.005	<0.005	<0.005
Chrysene	2.8	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.002	<0.002	<0.003
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fluoranthene	0.56	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluorene	0.12	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Indeno(1,2,3-cd)pyrene	0.23	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenanthrene	0.046	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Pyrene	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-14			BASC-15			BASC-16		
Sample ID		-	-	-	-	-	-	BASC-1-16	BASC-2-16	BASC-3-16
Sample Depth (m)		0.06	0.61	0.91	0.06	0.46	0.91	0-0.1 m	0.1-0.3 m	0.3-0.4 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark									
Phenols										
2,3,5-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	-	-
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	*< 0.2*	< 0.1	< 0.1
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	*< 0.2*	< 0.08	< 0.08
2,3,4-Trichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	-	-
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	*< 0.2*	< 0.1	< 0.1
2,6-Dichlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	-	-
2,4-Dimethylphenol	0.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	*< 0.4*	< 0.2	< 0.2
2,4-Dinitrophenol	2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 1	< 0.5	< 0.5
2-Chlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	*< 0.2*	< 0.08	< 0.08
Pentachlorophenol	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	*< 0.2*	< 0.1	< 0.1
Phenol	0.5	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	< 0.2	< 0.09	< 0.09
Semi-Volatile Organic Compounds										
1-Methylnapthalene	0.59	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	< 0.06	< 0.03	< 0.03
2-Methylnaphthalene	0.59	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	< 0.06	< 0.03	< 0.03
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	< 0.085	< 0.042	< 0.042
2,4-Dinitrotoluene	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.2	< 0.1	< 0.1
2,6-Dinitrotoluene	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.2	< 0.1	< 0.1
3,3'-Dichlorobenzidine	1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	< 1	< 0.5	< 0.5
p-Chloroanaline	0.5	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	< 0.4	< 0.2	< 0.2
Acenaphthene	0.072	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.06	< 0.03	< 0.03

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-14			BASC-15			BASC-16		
Sample ID		-	-	-	-	-	-	BASC-1-16	BASC-2-16	BASC-3-16
Sample Depth (m)		0.06	0.61	0.91	0.06	0.46	0.91	0-0.1 m	0.1-0.3 m	0.3-0.4 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark									
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	*< 0.1*	< 0.05	< 0.05
Anthracene	0.16	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	< 0.06	< 0.03	< 0.03
Benzo(b)fluoranthene	0.47	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.3	< 0.1	< 0.1
Benzo(a)anthracene	0.36	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.2	< 0.05	< 0.05
Benzo(a)pyrene	0.3	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.2	< 0.05	< 0.05
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.2	< 0.1	< 0.1
Benzo(k)fluoranthene	0.48	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.11	< 0.03	< 0.03
Biphenyl	0.05	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	*< 0.1*	< 0.05	< 0.05
bis(2-chloroethoxy)methane	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-
bis(2-chloroethyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.4	< 0.2	< 0.2
bis(2-chlorisopropyl)ether	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.2	< 0.1	< 0.1
bis(2-ethylhexyl)phthalate	5	0.1	<0.005	<0.005	0.1	<0.005	<0.005	< 2	< 1	< 1
Chrysene	2.8	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.2	< 0.05	< 0.05
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.1	< 0.05	< 0.05
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.4	< 0.2	< 0.2
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.4	< 0.2	< 0.2
Fluoranthene	0.56	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.2	< 0.05	< 0.05
Fluorene	0.12	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.06	< 0.03	< 0.03
Indeno(1,2,3-cd)pyrene	0.23	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	< 0.2	< 0.08	< 0.08
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	*< 0.06*	*< 0.03*	*< 0.03*
Phenanthrene	0.046	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	*< 0.1*	*< 0.05*	*< 0.05*
Pyrene	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.1	< 0.05	< 0.05

Table 87 Preliminary Screening for Soil of Extractables at BASC

Location		BASC-14			BASC-15			BASC-16		
Sample ID		-	-	-	-	-	-	BASC-1-16	BASC-2-16	BASC-3-16
Sample Depth (m)		0.06	0.61	0.91	0.06	0.46	0.91	0-0.1 m	0.1-0.3 m	0.3-0.4 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16
Parameter	**Preliminary Benchmark**									
Volatile Organic Compounds										
1,2,4-Trichlorobenzene	0.05	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	*< 0.1*	< 0.05	< 0.05
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-
2,3,5,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-
2,3,4,5-Tetrachloropheonol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-
2-Chloronaphthalene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-
2-Methylphenol	NV	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	-
4-Bromophenyl Phenyl Ether	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-
4-Chloro-3-methyl-phenol	NV	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	-	-
4-Chlorophenyl Phenyl Ether	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-
4-Nitrophenol	10	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	-	-
Benzyl Butyl Phthalate	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-
Di-n-butyl Phthalate	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-
Di-n-octyl Phthalate	NV	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-	-	-
Hexachlorobenzene	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-
Hexachlorobutadiene	0.01	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	-	-
Hexachlorocyclopentadiene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	-	-
Hexachloroethane	0.01	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	-	-
Isophorone	NV	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-
Nitrobenzene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-
N-Nitrosodi-n-propylamine	NV	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-
N-Nitrosodiphenylamine	NV	-	-	-	-	-	-	-	-	-
Diphenylamines (total)	NV	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	-	-

Table 87 Preliminary Screening for Soil of Extractables at BASC

BASC Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location								BASC-1-00			BASC-4-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
1,1,1,2-Tetrachlroethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	µg/g	0.5	NV	NR	**0.97**	**0.97**	<0.105	<0.105	0.28	<0.105	<0.105	<0.105
Benzene	0.02	µg/g	0.02	0.03	NR	*<0.040*	**0.025**	<0.002	<0.002	0.003	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location								BASC-1-00			BASC-4-00		
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.06	0.91	1.22	0.06	0.91	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BASC							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Chloroethane	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	µg/g	0.05	50	NR	< 0.050	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	0.005
Chloromethane	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	< 0.030	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-	-	-
Dichloromethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	<0.040	0.031	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	< 0.50	0.02	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	< 0.50	-	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070
methyl t-Butyl Ether	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	µg/g	0.05	6.5	NR	< 0.050	-	-	-	-	-	-	-
Styrene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	µg/g	0.2	0.37	NR	0.09	0.09	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
trans-1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	< 0.040	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.01	µg/g	0.05	0.01	NR	*< 0.050*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	< 0.050	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	< 0.020	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	<0.080	**0.062**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	NV	µg/g	NV	NV	NV	**0.044**	**0.044**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes, Total	0.05	µg/g	0.05	11	NR	**0.094**	**0.094**	-	-	-	-	-	-

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		**BASC-10**			**BASC-11**			**BASC-12**			**BASC-13**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	1.22	0.06	0.91	1.07	0.06	1.07	1.22	0.06	0.46	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**												
1,1,1,2-Tetrachlroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	<0.105	**0.97**	0.42	<0.105	<0.105	<0.105	0.32	<0.105	0.19	<0.105	<0.105	<0.105
Benzene	0.02	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		**BASC-10**			**BASC-11**			**BASC-12**			**BASC-13**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**0.91**	**1.22**	**0.06**	**0.91**	**1.07**	**0.06**	**1.07**	**1.22**	**0.06**	**0.46**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												
Chloroethane	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.008	0.01	0.008
Methyl Ethyl Ketone	0.5	<0.008	0.02	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Methyl Isobutyl Ketone	0.5	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070
methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	<0.002	<0.002	<0.002	<0.002	0.007	0.005	<0.002	<0.002	0.003	<0.002	<0.002	<0.002
trans-1,2-Dichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.04**	**0.05**	**0.04**
o-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.007**	**0.009**	**0.007**
Xylenes, Total	0.05	-	-	-	-	-	-	-	-	-	0.047	**0.059**	0.047

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		**BASC-14**			**BASC-15**			**BASC-16**			**BASC-1-21**	**BASC-2-21**	**BASC-3-21**
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**BASC-1-16**	**BASC-2-16**	**BASC-3-16**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.61**	**0.91**	**0.06**	**0.46**	**0.91**	**0-0.1 m**	**0.1-0.3 m**	**0.3-0.4 m**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Oct-16**	**Oct-16**	**Oct-16**	**Jun-21**	**Jun-21**	**Jun-21**
Parameter	**Preliminary Benchmark**												
1,1,1,2-Tetrachlroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
1,1,2,2-Tetrachloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.050	< 0.050	< 0.050	-	-	-
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	< 0.050	< 0.050	< 0.050	-	-	-
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
Acetone	0.5	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	< 0.50	< 0.50	< 0.50	-	-	-
Benzene	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	< 0.020	< 0.020	*<0.040*	*<0.040*	<0.020
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
Chlorobenzene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		BASC-14			BASC-15			BASC-16			BASC-1-21	BASC-2-21	BASC-3-21
Sample ID		-	-	-	-	-	-	BASC-1-16	BASC-2-16	BASC-3-16	-	-	-
Sample Depth (m)		0.06	0.61	0.91	0.06	0.46	0.91	0-0.1 m	0.1-0.3 m	0.3-0.4 m	0-0.15	0-0.15	0-0.15
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21
Parameter	**Preliminary Benchmark**												
Chloroethane	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-
Chloroform	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	-	-	-
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.030	< 0.030	< 0.030	-	-	-
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	< 0.050	< 0.050	< 0.050	-	-	-
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
Ethylbenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	< 0.020	< 0.020	<0.040	<0.040	<0.020
Methyl Ethyl Ketone	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	< 0.50	< 0.50	< 0.50	-	-	-
Methyl Isobutyl Ketone	0.5	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	< 0.50	< 0.50	< 0.50	-	-	-
methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	< 0.050	< 0.050	< 0.050	-	-	-
n-Hexane	0.05	-	-	-	-	-	-	< 0.050	< 0.050	< 0.050	-	-	-
Styrene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	< 0.050	< 0.050	-	-	-
Toluene	0.2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	< 0.020	< 0.020	<0.040	<0.040	<0.020
trans-1,2-Dichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	< 0.050	< 0.050	-	-	-
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.040	< 0.040	< 0.040	-	-	-
Trichloroethene	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	*< 0.050*	*< 0.050*	*< 0.050*	-	-	-
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	< 0.050	< 0.050	< 0.050	-	-	-
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.020	< 0.020	< 0.020	-	-	-
m-Xylene + p-Xylene	NV	<0.002	<0.002	**0.003**	<0.002	<0.002	<0.002	-	-	-	<0.080	<0.080	<0.040
o-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	<0.040	<0.040	<0.020
Xylenes, Total	0.05	-	-	0.003	-	-	-	< 0.020	< 0.020	< 0.020	*<0.080*	*<0.080*	<0.040

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		BASC-4-21	BASC-5-21	BASC-6-21	BASC 1a	BASC 2a	BASC 3a	BASC 4a	BASC 5a	BASC 6a	BASC 7a
Sample ID		-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Jun-21	Jun-21	Jun-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21
Parameter	Preliminary Benchmark										
1,1,1,2-Tetrachlroethane	0.05	-	-	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	0.05	-	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	0.05	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	0.05	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	0.05	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	0.05	-	-	-	-	-	-	-	-	-	-
1,2-Dibromoethane	0.05	-	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	0.05	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	0.05	-	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	0.05	-	-	-	-	-	-	-	-	-	-
1,3-Dichlorobenzene	0.05	-	-	-	-	-	-	-	-	-	-
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	-	-	-	-	-	-	-	-	-	-
Acetone	0.5	-	-	-	-	-	-	-	-	-	-
Benzene	0.02	<0.020	<0.020	<0.020	<0.0068	<0.0068	0.0069	<0.0068	<0.0068	<0.0068	<0.0068
Bromodichloromethane	0.05	-	-	-	-	-	-	-	-	-	-
Bromoform	0.05	-	-	-	-	-	-	-	-	-	-
Bromomethane	0.05	-	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	0.05	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	0.05	-	-	-	-	-	-	-	-	-	-
Chlorodibromomethane	0.05	-	-	-	-	-	-	-	-	-	-

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		**BASC-4-21**	**BASC-5-21**	**BASC-6-21**	**BASC 1a**	**BASC 2a**	**BASC 3a**	**BASC 4a**	**BASC 5a**	**BASC 6a**	**BASC 7a**
Sample ID		-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Jun-21	Jun-21	Jun-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21
Parameter	**Preliminary Benchmark**										
Chloroethane	NV	-	-	-	-	-	-	-	-	-	-
Chloroform	0.05	-	-	-	-	-	-	-	-	-	-
Chloromethane	NV	-	-	-	-	-	-	-	-	-	-
cis-1,2-Dichloroethene	0.05	-	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene [a]	0.05	-	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	-	-	-	-
Dichloromethane	0.05	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	0.05	<0.020	<0.020	<0.020	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018
Methyl Ethyl Ketone	0.5	-	-	-	-	-	-	-	-	-	-
Methyl Isobutyl Ketone	0.5	-	-	-	-	-	-	-	-	-	-
methyl t-Butyl Ether	0.05	-	-	-	-	-	-	-	-	-	-
n-Hexane	0.05	-	-	-	-	-	-	-	-	-	-
Styrene	0.05	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	0.05	-	-	-	-	-	-	-	-	-	-
Toluene	0.2	<0.020	<0.020	<0.020	<0.080	<0.080	0.09	<0.080	<0.080	<0.080	<0.080
trans-1,2-Dichloroethane	0.05	-	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene [a]	0.05	-	-	-	-	-	-	-	-	-	-
Trichloroethene	0.01	-	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	0.25	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	0.02	-	-	-	-	-	-	-	-	-	-
m-Xylene + p-Xylene	NV	<0.040	<0.040	<0.040	<0.030	<0.030	**0.062**	<0.030	<0.030	<0.030	<0.030
o-Xylene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	**0.032**	<0.020	<0.020	<0.020	<0.020
Xylenes, Total	0.05	<0.040	<0.040	<0.040	<0.050	<0.050	**0.094**	<0.050	<0.050	<0.050	<0.050

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		**BASC 8a**	**BASC 9a**	**BASC 10a**	**BASC 11a**	**BASC 12a**	**BASC 13a**	**BASC 14a**	
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**BASC 14a**	**BASC 14a (dup)**
Sample Depth (m)		**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Aug-21**	**Aug-21**	**Aug-21**	**Aug-21**	**Aug-21**	**Aug-21**	**Aug-21**	**Aug-21**
Parameter	**Preliminary Benchmark**								
1,1,1,2-Tetrachlroethane	0.05	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	0.05	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	0.05	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	0.05	-	-	-	-	-	-	-	-
1,1-Dichloroethane	0.05	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	0.05	-	-	-	-	-	-	-	-
1,2-Dibromoethane	0.05	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	0.05	-	-	-	-	-	-	-	-
1,2-Dichloroethane	0.05	-	-	-	-	-	-	-	-
1,2-Dichloropropane	0.05	-	-	-	-	-	-	-	-
1,3-Dichlorobenzene	0.05	-	-	-	-	-	-	-	-
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	-	-	-	-	-	-	-	-
Acetone	0.5	-	-	-	-	-	-	-	-
Benzene	0.02	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	**0.025**
Bromodichloromethane	0.05	-	-	-	-	-	-	-	-
Bromoform	0.05	-	-	-	-	-	-	-	-
Bromomethane	0.05	-	-	-	-	-	-	-	-
Carbon Tetrachloride	0.05	-	-	-	-	-	-	-	-
Chlorobenzene	0.05	-	-	-	-	-	-	-	-
Chlorodibromomethane	0.05	-	-	-	-	-	-	-	-

Table 88 Preliminary Screening for Soil of VOCs at BASC

Location		BASC 8a	BASC 9a	BASC 10a	BASC 11a	BASC 12a	BASC 13a	BASC 14a	
Sample ID		-	-	-	-	-	-	BASC 14a	BASC 14a (dup)
Sample Depth (m)		0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21
Parameter	**Preliminary Benchmark**								
Chloroethane	NV	-	-	-	-	-	-	-	-
Chloroform	0.05	-	-	-	-	-	-	-	-
Chloromethane	NV	-	-	-	-	-	-	-	-
cis-1,2-Dichloroethene	0.05	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene [a]	0.05	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	-	-
Dichloromethane	0.05	-	-	-	-	-	-	-	-
Ethylbenzene	0.05	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	0.031
Methyl Ethyl Ketone	0.5	-	-	-	-	-	-	-	-
Methyl Isobutyl Ketone	0.5	-	-	-	-	-	-	-	-
methyl t-Butyl Ether	0.05	-	-	-	-	-	-	-	-
n-Hexane	0.05	-	-	-	-	-	-	-	-
Styrene	0.05	-	-	-	-	-	-	-	-
Tetrachloroethene	0.05	-	-	-	-	-	-	-	-
Toluene	0.2	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
trans-1,2-Dichloroethane	0.05	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene [a]	0.05	-	-	-	-	-	-	-	-
Trichloroethene	0.01	-	-	-	-	-	-	-	-
Trichlorofluoromethane	0.25	-	-	-	-	-	-	-	-
Vinyl Chloride	0.02	-	-	-	-	-	-	-	-
m-Xylene + p-Xylene	NV	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
o-Xylene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	**0.044**
Xylenes, Total	0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Table 88 Preliminary Screening for Soil of VOCs at BASC

BASC VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 89 Preliminary Screening for Soil of Leachate at BASC

Location					BASC 1a	BASC 2a	BASC 3a	BASC 4a	BASC 5a	BASC 6a	BASC 7a	BASC 8a	BASC 9a	BASC 10a	BASC 11a	BASC 12a	BASC 13a	B
Sample ID					-	-	-	-	-	-	-	-	-	-	-	-	-	BASC 14a
Sample Depth (m)					0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled					Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21	Aug-21
			BASC															
Parameter	**Preliminary Benchmark**	**Units**	**Maximum**	**Maximum Detected**														
Aluminum	NV	µg/L	**830**	**830**	**110**	<100	<100	<100	**830**	<100	<100	**690**	**300**	<100	<100	**650**	<100	**250**
Antimony	NV	µg/L	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Arsenic	NV	µg/L	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Barium	NV	µg/L	<200	0	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
Beryllium	NV	µg/L	<2.0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Boron	NV	µg/L	<500	0	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Cadmium	NV	µg/L	<0.10	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium	NV	µg/L	<30000	**16500**	**7200**	**7000**	**16500**	**10700**	**9500**	<30000	<30000	**12000**	**12200**	**7300**	**7500**	**13800**	<15000	**8200**
Chromium (Total)	NV	µg/L	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cobalt	NV	µg/L	<2.0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Copper	NV	µg/L	**82**	**82**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**82**	<10	<10
Iron	NV	µg/L	**1020**	**1020**	<500	<500	<500	<500	**790**	<500	<500	**750**	<500	<500	<500	**1020**	<500	<500
Lead	NV	µg/L	**4.7**	**4.7**	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	**2.7**	<2.0	<2.0	<2.0	**4.7**	<2.0	<2.0
Magnesium	NV	µg/L	**4210**	**4210**	**2140**	**2310**	**4210**	**3350**	**2130**	**2290**	**2640**	**2460**	**2360**	**2390**	**2310**	**2310**	**3210**	**2170**
Maganese	NV	µg/L	**32**	**32**	<10	<10	<10	<10	**11**	<10	<10	**14**	<10	<10	<10	**32**	<10	<10
Molybdenum	NV	µg/L	<10	0	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nickel	NV	µg/L	<20	0	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Postassium	NV	µg/L	<10000	0	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Selenium	NV	µg/L	<1.0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	NV	µg/L	<0.25	0	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Sodium	NV	µg/L	**150000**	**150000**	<100000	<100000	**150000**	**140000**	<100000	<100000	<100000	<100000	<100000	<100000	<100000	<100000	<100000	<100000
Thallium	NV	µg/L	<0.80	0	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80
Uranium	NV	µg/L	<15	0	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Vanadium	NV	µg/L	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc	NV	µg/L	**65**	**65**	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	**65**	<30	<30

Table 89 Preliminary Screening for Soil of Leachate at BASC

Location		ASC 14a
Sample ID		BASC 14a (dup)
Sample Depth (m)		0-0.15
Date Sampled		Aug-21
Parameter	Preliminary Benchmark	
Aluminum	NV	**360**
Antimony	NV	<5.0
Arsenic	NV	<5.0
Barium	NV	<200
Beryllium	NV	<2.0
Boron	NV	<500
Cadmium	NV	<0.10
Calcium	NV	**13400**
Chromium (Total)	NV	<5.0
Cobalt	NV	<2.0
Copper	NV	<10
Iron	NV	<500
Lead	NV	<2.0
Magnesium	NV	**2630**
Maganese	NV	<10
Molybdenum	NV	<10
Nickel	NV	<20
Postassium	NV	<10000
Selenium	NV	<1.0
Silver	NV	<0.25
Sodium	NV	<100000
Thallium	NV	<0.80
Uranium	NV	<15
Vanadium	NV	<5.0
Zinc	NV	<30

Table 89 Preliminary Screening for Soil of Leachate at BASC

BASC Leachate Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for Chromium (III), standards for Chromium (Total) were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

5.1.2 Bruce B Empty Drum Laydown Area (BBED)

Table 90 Preliminary Screening for Soil of PHCs at BBED

Location								BBED-1				BBED-2	BBED-3
Sample ID								-	-	-	-	-	-
Sample Depth (m)								0.23	0.61	0.91	1.22	0.23	0.23
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	BBED							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
TPH Light (C10-C24)	10	µg/g	10	260	NR	**826**	**826**	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-C50)	120	µg/g	120	1700	NR	**159**	**159**	<100	<100	<100	<100	<100	<100
PCB in soil	0.3	µg/g	0.3	33	NR	<0.10	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	**9.11**	**9.11**	-	-	-	-	-	-

Location		BBED-4			BBED-5		BBED-6		BBED-7					
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.23	0.61	0.91	0.23	0.91	0.23	0.91	0.23	0.23	0.61	0.61	1.22	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark													
TPH Light (C10-C24)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-C50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
PCB in soil	0.3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
pH	5 to 9	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 90 Preliminary Screening for Soil of PHCs at BBED

Location		**BBED-8**			**BBED-9**			**BBED-10**			**BBED-11**			**BBED-12**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.23**	**0.61**	**1.22**	**0.23**	**0.91**	**1.22**	**0.23**	**0.61**	**1.22**	**0.23**	**0.61**	**1.22**	**0.23**	**0.61**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**															
TPH Light (C10-C24)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**35**	**11**
TPH Heavy (C24-C50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	**159**	<100
PCB in soil	0.3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.100	<0.10
pH	5 to 9	-	-	-	-	-	-	-	-	-	-	-	-	-	8.48	**9.11**

Location		**BBED-13**				**BBED-14**		**BBED-15**				**BBED-16**			**BBED-17**	
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.23**	**0.61**	**0.91**	**1.22**	**0.23**	**1.22**	**0.23**	**0.23**	**1.07**	**1.07**	**0.06**	**1.07**	**1.22**	**0.06**	**0.61**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**
Parameter	**Preliminary Benchmark**															
TPH Light (C10-C24)	10	<10	<10	<10	<10	<10	<10	<10	<10	**564**	**826**	< 10	< 10	< 10	< 10	< 10
TPH Heavy (C24-C50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	< 100	< 100	< 100	< 100	< 100
PCB in soil	0.3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-	-	-
pH	5 to 9	8.64	8.59	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 90 Preliminary Screening for Soil of PHCs at BBED

Location		
Sample ID		-
Sample Depth (m)		**1.22**
Date Sampled		**Jul-00**
Parameter	**Preliminary Benchmark**	
TPH Light (C10-C24)	10	< 10
TPH Heavy (C24-C50)	120	< 100
PCB in soil	0.3	-
pH	5 to 9	-

Location		**BBED-18**		**BBED-19**		**BBED-20**			**BBED-21**	
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**1.07**	**0.06**	**0.91**	**0.06**	**0.91**	**1.22**	**0.06**	**1.07**
Date Sampled		**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**
Parameter	**Preliminary Benchmark**									
TPH Light (C10-C24)	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
TPH Heavy (C24-C50)	120	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
PCB in soil	0.3	-	-	-	-	-	-	-	-	-
pH	5 to 9	-	-	-	-	-	-	-	-	-

Table 90 Preliminary Screening for Soil of PHCs at BBED

BBED PHC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 91 Preliminary Screening for Soil of VOCs at BBED

Location							
Sample ID							
Sample Depth (m)							
Date Sampled							
			MECP	**CCME**	**Ontario**	**BBED**	
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**
Chloromethane	NV	µg/g	NV	NV	NV	<0.003	-
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	<0.003	-
Bromomethane	0.05	µg/g	0.05	NV	NR	<0.003	-
Chloroethane	NV	µg/g	NV	NV	NV	<0.002	-
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	<0.004	-
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	<0.002	-
Acetone	0.5	µg/g	0.5	NV	NR	<0.105	-
Dichloromethane	0.05	µg/g	0.05	50	NR	<0.003	-
trans-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	<0.003	-
Methyl t-Butyl Ether	0.05	µg/g	0.05	NV	NR	<0.015	-
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	<0.002	-
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	<0.003	-
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	<0.008	-
Chloroform	0.05	µg/g	0.05	50	NR	<0.003	-
1,1,1-Trichloroethane	0.05	µg/g	0.05	50	NR	<0.003	-
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	<0.002	-
Benzene	0.02	µg/g	0.02	0.03	NR	<0.002	-
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	<0.002	-

Table 91 Preliminary Screening for Soil of VOCs at BBED

Location							
Sample ID							
Sample Depth (m)							
Date Sampled							
			MECP	CCME	Ontario	BBED	
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected
Trichloroethene	0.01	µg/g	0.05	0.01	NR	<0.003	-
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	<0.002	-
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	<0.002	-
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	<0.003	-
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	<0.07	-
Toluene	0.2	µg/g	0.2	0.37	NR	<0.002	-
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	<0.002	-
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	<0.002	-
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	<0.002	-
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	<0.002	-
1,2-Dibromoethane	0.05	µg/g	0.05	NV	NR	<0.002	-
Chlorobenzene	0.05	µg/g	0.05	10	NR	<0.003	-
1,1,1,2-Tetrachloroethane	0.05	µg/g	0.05	NV	NR	<0.002	-
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	<0.002	-
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	<0.002	-
o-Xylene	NV	µg/g	NV	NV	NV	<0.002	-
Styrene	0.05	µg/g	0.05	50	NR	<0.002	-
Bromoform	0.05	µg/g	0.05	NV	NR	<0.002	-
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	<0.003	-
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.002	-
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.002	-
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.001	-
Acrolein	NV	µg/g	NV	NV	NV	<0.1	-
Acrylonitrile	NV	µg/g	NV	NV	NV	<0.05	-

Table 91 Preliminary Screening for Soil of VOCs at BBED

Location		BBED-16			BBED-17		BBED-18		BBED-19		BBED-20			BBED-21	
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	1.07	1.22	0.06	1.22	0.06	1.07	0.06	0.91	0.06	0.91	1.22	0.06	1.07
Date Sampled		Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00
Parameter	**Preliminary Benchmark**														
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chloroethane	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Methyl Ethyl Ketone	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Chloroform	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzene	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 91 Preliminary Screening for Soil of VOCs at BBED

Location		**BBED-16**			**BBED-17**		**BBED-18**		**BBED-19**		**BBED-20**			**BBED-21**	
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**1.07**	**1.22**	**0.06**	**1.22**	**0.06**	**1.07**	**0.06**	**0.91**	**0.06**	**0.91**	**1.22**	**0.06**	**1.07**
Date Sampled		**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**
Parameter	**Preliminary Benchmark**														
Trichloroethene	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Methyl Isobutyl Ketone	0.5	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Toluene	0.2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,1,2-Tetrachloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ethylbenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
m-Xylene + p-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Styrene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,2,2-Tetrachloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acrolein	NV	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acrylonitrile	NV	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Table 91 Preliminary Screening for Soil of VOCs at BBED

BBED VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.3 Construction Landfill #4 (CL4)

Table 92 Preliminary Screening for Soil of Metals at CL4

Location								CL4-6				CL4-7		
Sample ID														
Sample Depth (m)								0.23	0.61	0.91	1.22	0.23	0.46	0.91
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark	Units	MECP Table 1 SCS [1]	CCME SQG [2]	Ontario OTR_{98} [3]	CL4 Maximum	CL4 Maximum Detected							
Aluminum	26000	µg/g	NV	NV	26000	13000	13000	-	-	-	-	-	-	-
Antimony	1.3	µg/g	1.3	40	0.99	<1.0	0.63	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	µg/g	18	12	18	3.899	3.899	2.207	2.438	2.131	2.259	1.484	1.79	2.818
Barium	220	µg/g	220	2000	180	92.733	92.733	20.793	36.753	21.926	46.247	14.61	19.821	55.592
Beryllium	2.5	µg/g	2.5	8	0.99	0.779	0.779	<0.200	0.285	0.211	0.426	<0.200	<0.200	<0.200
Boron, Total	36	µg/g	36	NV	26	13	13	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	1.4	1.4	0.6	0.75	1.05	0.78	0.8	0.8	0.9
Cadmium	1.2	µg/g	1.2	22	1.2	**6.464**	**6.464**	<0.200	<0.200	<0.200	0.234	<0.200	<0.200	**6.464**
Calcium	49000	µg/g	NV	NV	49000	30800	30800	-	-	-	-	-	-	-
Chromium (III) [b]	70	µg/g	70	87	63	25	25	-	-	-	-	-	-	-
Chromium (VI)	0.66	µg/g	0.66	1.4	NV	< 0.2	-	-	-	-	-	-	-	-
Chromium (Total)	70	µg/g	70	87	63	25	25	-	-	-	-	-	-	-
Chromium	70	µg/g	70	87	63	32.304	32.304	15.803	19.071	16.879	32.304	6.854	10.641	14.218
Cobalt	21	µg/g	21	300	17	7.606	7.606	5.65	4.825	6.16	6.549	2.555	2.677	3.287
Copper	91	µg/g	92	91	66	**120**	**120**	16.293	8.839	16.845	19.991	13.135	15.483	26.926
Iron	34000	µg/g	NV	NV	34000	16558.04	16558.04	8400	11400	8500	13000	5800	7900	10800
Lead	120	µg/g	120	600	1500	27.999	27.999	3.616	10.344	3.449	8.599	4.179	27.999	25.276

Table 92 Preliminary Screening for Soil of Metals at CL4

Location								**CL4-6**				**CL4-7**		
Sample ID														
Sample Depth (m)								**0.23**	**0.61**	**0.91**	**1.22**	**0.23**	**0.46**	**0.91**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**	**Units**	**MECP**	**CCME**	**Ontario**	**CL4**								
			Table 1 SCS [1]	**SQG** [2]	**OTR_{98}** [3]	**Maximum**	**Maximum Detected**							
Magnesium	15000	µg/g	NV	NV	15000	6200	6200	-	-	-	-	-	-	-
Manganese	1400	µg/g	NV	NV	1400	828.681	828.681	536.796	828.681	572.259	470.804	249.362	230.278	321.203
Mercury	0.27	µg/g	0.27	50	0.27	<0.250	0.119	<0.050	<0.050	<0.250	0.053	0.069	0.054	<0.050
Molybdenum	2	µg/g	2	40	1.3	**2.68**	**2.68**	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	1.817
Nickel	82	µg/g	82	89	50	25.317	25.317	7	8	7	11	5.326	7.505	14.674
Selenium	1.5	µg/g	1.5	2.9	1.1	1.1	1.1	<1.0	<1.0	<1.0	1	<1.0	<1.0	<1.0
Silver	0.5	µg/g	0.5	40	0.33	**2.597**	**2.597**	<0.250	<0.250	<0.250	<0.250	<0.250	**2.597**	**1.841**
Sodium	1000	µg/g	NV	NV	1000	**24000**	**24000**	400	367	406	525	370	436	455
Thallium	1	µg/g	1	1	NV	<0.500	0.14	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	µg/g	NV	NV	4700	922.075	922.075	525.021	607.838	601.75	922.075	172.625	141.584	169.588
Uranium	2.5	µg/g	2.5	300	1.9	**2.608**	**2.608**	0.581	0.621	0.813	1.64	0.44	0.434	0.453
Vanadium	86	µg/g	86	130	72	37.773	37.773	24.562	28.033	26.596	37.773	9.127	8.565	9.139
Zinc	290	µg/g	290	410	180	**350**	**350**	14.546	18.001	14.417	20.142	17.302	107.26	242.955
General Chemistry														
Cyanide (free)	0.051	µg/g	0.051	0.9	--	0.02	0.02	-	-	-	-	-	-	-
Conductivity	0.57	mS/cm	0.57	200	--	0.35	0.35	-	-	-	-	-	-	-
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	8.86	8.86	8.36	8.86	8.45	8.39	8.37	8.32	8.71
Sodium Adsorption Ratio	2.4	SAR	2.4	5	--	1	1	-	-	-	-	-	-	-

Table 92 Preliminary Screening for Soil of Metals at CL4

Location		**CL4-8**		**CL4-9**		**CL4-10**		**CL4-11**		**CL4**	**CL4-1**	**CL4-2**	**CL4-3**	**CL4-4**	**CL4-5**
Sample ID															
Sample Depth (m)		**0.06**	**0.46**	**0.06**	**0.46**	**0.06**	**0.46**	**0.06**	**0.46**	**0-0.1**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Nov-16**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**
Parameter	**Preliminary Benchmark**														
Aluminum	26000	-	-	-	-	-	-	-	-	-	5000	6100	12000	13000	7900
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.49	<0.20	<0.20	0.63	0.29	0.34
Arsenic	12	3	<1.000	2.886	2.492	3.899	1.922	2.857	1.827	1.7	1.2	1.9	2	1.8	1.1
Barium	220	74.576	38.471	92.733	27.875	92.116	29.029	85.333	32.665	59	21	23	61	62	31
Beryllium	2.5	0.476	0.303	0.6	<0.200	0.707	0.202	0.779	0.271	0.51	-	-	-	-	-
Boron, Total	36	-	-	-	-	-	-	-	-	13	9.9	5.4	12	13	8.4
Boron - Hot Water Ext. [a]	2	0.8	0.8	1.4	0.48	1.4	0.48	1.2	0.54	0.79	-	-	-	-	-
Cadmium	1.2	0.386	0.207	0.413	0.785	0.368	0.208	0.327	<0.200	0.4	0.2	0.17	0.34	0.32	0.19
Calcium	49000	-	-	-	-	-	-	-	-	30800	-	-	-	-	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	12	13	25	22	15
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	< 0.2	<0.18	<0.18	<0.18	<0.18	<0.18
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	12	13	25	22	15
Chromium	70	25.45	17.645	29.627	28.718	27.486	18.707	26.331	14.974	22	-	-	-	-	-
Cobalt	21	6.967	4.645	7.606	3.17	6.969	3.61	6.96	3.628	7.2	-	-	-	-	-
Copper	91	**104.796**	13.981	84.106	**113.862**	**119.569**	31.057	**96.186**	31.586	**120**	10	12	86	39	48
Iron	34000	16000	10000	16558.04	11323.05	16155.43	10450.53	15828.1	10519.46	-	9200	12000	15000	15000	10000
Lead	120	15.181	9.232	15.006	25.354	16.703	14.475	13.257	11.224	15	7.7	7.4	15	11	9.7

Table 92 Preliminary Screening for Soil of Metals at CL4

Location		**CL4-8**		**CL4-9**		**CL4-10**		**CL4-11**		**CL4**	**CL4-1**	**CL4-2**	**CL4-3**	**CL4-4**	**CL4-5**
Sample ID															
Sample Depth (m)		**0.06**	**0.46**	**0.06**	**0.46**	**0.06**	**0.46**	**0.06**	**0.46**	**0-0.1**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Nov-16**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**
Parameter	**Preliminary Benchmark**														
Magnesium	15000	-	-	-	-	-	-	-	-	6200	-	-	-	-	-
Manganese	1400	301.513	286.998	171.994	266.059	160.759	305.288	182.095	299.682	-	-	-	-	-	-
Mercury	0.27	0.119	0.092	0.081	0.069	0.086	0.115	0.095	0.07	0.055	<0.050	<0.050	0.057	<0.050	<0.050
Molybdenum	2	**2.612**	<1.000	1.411	**2.68**	1.704	<1.000	<1.000	<1.000	< 0.50	<0.50	<0.50	0.83	<0.50	<0.50
Nickel	82	19	14	25.317	16.105	20.912	14.866	18.031	5.094	20	9.9	7.9	20	17	12
Selenium	1.5	1.1	<1.0	1.1	<1.0	<1.0	<1.0	1	<1.0	0.63	<0.50	<0.50	0.56	<0.50	<0.50
Silver	0.5	<0.250	<0.250	<0.250	0.456	<0.250	<0.250	<0.250	<0.250	< 0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium	1000	500	450	310	295	365	300	310	290	**24000**	-	-	-	-	-
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	0.14	-	-	-	-	-
Titanium	4700	415.371	227.2	296.128	204.125	402.771	221.096	422.422	292.989	-	-	-	-	-	-
Uranium	2.5	**2.608**	1.004	2.133	0.988	2.498	0.791	1.786	0.816	1.1	0.64	0.44	0.9	1.2	0.78
Vanadium	86	30.793	20.967	29.533	12.497	32.045	18.809	30.383	17.042	27	15	23	25	27	19
Zinc	290	223.813	40.001	184.403	87.865	266.627	67.046	196.595	48.073	**350**	33	45	180	95	120
General Chemistry															
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	0.35	-	-	-	-	-
pH	5 to 9	7.92	8.09	6.89	7.56	6.82	7.54	6.82	7.45	6.97	-	-	-	-	-
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Table 92 Preliminary Screening for Soil of Metals at CL4

CL4 Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

b In absence of standards for Chromium (III), standards for Chromium (Total) were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 93 Preliminary Screening for Soil of PHCs at CL4

Location								CL4-6				CL4-7		
Sample ID								-	-	-	-	-	-	-
Sample Depth (m)								0.23	0.61	0.91	1.22	0.23	0.46	0.91
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	CL4								
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected							
F1 (C6-C10)	25	µg/g	25	240	NR	<20	-	-	-	-	-	-	-	-
F1 (C6-C10) - BTEX	25	µg/g	25	240	NR	<20	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	µg/g	10	260	NR	<10	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	µg/g	240	1700	NR	160	160	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	µg/g	120	3300	NR	80	80	-	-	-	-	-	-	-
Reached Baseline at C50	NA	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-
Organic C by LECO	NA	%	NA	NA	NA	3.94	3.94	-	-	-	-	0.98	0.63	1.06
TPH Light (C10-24)	10	µg/g	10	260	NR	<10	-	<10	<10	<10	<10	<10	<10	<10
TPH Heavy (C24-50)	120	µg/g	120	1700	NR	<100	-	<100	<100	<100	<100	<100	<100	<100

Table 93 Preliminary Screening for Soil of PHCs at CL4

Location		CL4-8		CL4-9		CL4-10		CL4-11		CL4	CL4-1	CL4-2	CL4-3	CL4-4	CL4-5
Sample ID		-	-	-	-	-	-	-	-						
Sample Depth (m)		0.06	0.46	0.06	0.46	0.06	0.46	0.06	0.46	0-0.1 m	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Nov-16	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	Preliminary Benchmark														
F1 (C6-C10)	25	-	-	-	-	-	-	-	-	-	<20	<20	<20	<10	<10
F1 (C6-C10) - BTEX	25	-	-	-	-	-	-	-	-	-	<20	<20	<20	<10	<10
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	<10	<10	<10	<10	<10
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	<50	<50	92	68	160
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	<50	<50	53	<50	80
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes	Yes
Organic C by LECO	NA	3.94	1.01	-	0.44	3.36	0.69	3.55	0.58	-	-	-	-	-	-
TPH Light (C10-24)	10	<10	<10	<10	<10	<10	<10	<10	<10	-	-	-	-	-	-
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	-	-	-	-	-	-

Table 93 Preliminary Screening for Soil of PHCs at CL4

CL4 PHC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 94 Preliminary Screening for Soil of Extractables at CL4

Location								CL4-8	CL4-9	CL4-10	CL4-11	CL4
Sample ID								-	-	-	-	-
Sample Depth (m)								0.46	0.46	0.46	0.46	0-0.1 m
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Nov-16
			MECP	CCME	Ontario	CL4						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
1- & 2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	0.03	0.03	-	-	-	-	0.03
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	<0.010	-	<0.010	<0.010	<0.010	<0.010	-
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	0.04	0.04	<0.004	0.04	<0.004	<0.004	< 0.0050
2,3,4,5-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	-
2,3,4,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	-
2,3,4-Trichlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2,3,5,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	-
2,3,5-Trichlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	<0.005	-	<0.005	<0.005	<0.005	<0.005	-
2,4-Dinitrophenol	2	µg/g	2	NV	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	-
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	<0.003	-	<0.003	<0.003	<0.003	<0.003	-
2,6-Dichlorophenol	5	µg/g	NV	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	<0.002	-	<0.002	<0.002	<0.002	<0.002	-
2-Chloronaphthalene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	-
2-Chlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	-
2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	0.14	0.14	<0.004	0.14	<0.004	<0.004	0.03
2-Methylphenol	NV	µg/g	NV	NV	NV	<0.004	-	<0.004	<0.004	<0.004	<0.004	-

Table 94 Preliminary Screening for Soil of Extractables at CL4

Location								**CL4-8**	**CL4-9**	**CL4-10**	**CL4-11**	**CL4**
Sample ID								-	-	-	-	**-**
Sample Depth (m)								**0.46**	**0.46**	**0.46**	**0.46**	**0-0.1 m**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Nov-16**
			MECP	**CCME**	**Ontario**	**CL4**						
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**					
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	<0.020	-	<0.020	<0.020	<0.020	<0.020	-
4-Bromophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	**0.01**	**0.01**	<0.003	**0.01**	<0.003	**0.01**	-
4-Chloro-3-methyl-phenol	NV	µg/g	NV	NV	NV	<0.015	-	<0.015	<0.015	<0.015	<0.015	-
4-Chlorophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	-
4-Nitrophenol	10	µg/g	NV	10	--	<0.020	-	<0.020	<0.020	<0.020	<0.020	-
Acenaphthene	0.072	µg/g	0.072	NV	NR	**0.48**	**0.48**	<0.002	**0.48**	<0.002	<0.002	< 0.0050
Acenaphthylene	0.093	µg/g	0.093	NV	NR	< 0.0050	-	<0.002	<0.002	<0.002	<0.002	< 0.0050
Anthracene	0.16	µg/g	0.16	32	NR	**1.2**	**1.2**	<0.002	**1.2**	0.005	<0.002	< 0.0050
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	**2.6**	**2.6**	<0.003	**2.6**	<0.003	<0.003	0.0054
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	**2.4**	**2.4**	<0.001	**2.4**	<0.001	<0.001	0.0082
Benzo(b)fluoranthene	0.47	µg/g	0.47	10	NR	**5**	**5**	<0.003	**5**	<0.003	<0.003	-
Benzo(b,j)fluoranthene	0.47	µg/g	0.47	10	NR	0.014	0.014	-	-	-	-	0.014
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	**1.7**	**1.7**	<0.003	**1.7**	<0.003	<0.003	0.01
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	0.44	0.44	<0.003	0.44	<0.003	<0.003	< 0.0050
Benzyl Butyl Phthalate	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	-
Biphenyl	0.05	µg/g	0.05	NV	NR	<0.010	-	<0.010	<0.010	<0.010	<0.010	-
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	<0.001	-	<0.001	<0.001	<0.001	<0.001	-
bis(2-chloroethoxy)methane	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005	<0.005	-
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	<0.003	-	<0.003	<0.003	<0.003	<0.003	-
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	0.05	0.05	<0.005	0.03	0.05	0.01	-
Chrysene	2.8	µg/g	2.8	NV	NR	2.3	2.3	<0.003	2.3	<0.003	<0.003	0.007
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	**0.79**	**0.79**	<0.003	**0.79**	<0.003	<0.003	< 0.0050
Diethyl phthalate	0.5	µg/g	0.5	NV	NR	<0.002	-	<0.002	<0.002	<0.002	<0.002	-
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	<0.002	-	<0.002	<0.002	<0.002	<0.002	-
Di-n-butyl Phthalate	NV	µg/g	NV	NV	NV	**0.11**	**0.11**	<0.005	**0.04**	**0.02**	**0.11**	-
di-n-octyl phthalate	NV	µg/g	NV	NV	NV	<0.006	-	<0.006	<0.006	<0.006	<0.006	-
Diphenylamines (total)	NV	µg/g	NV	NV	NV	<0.008	-	<0.008	<0.008	<0.008	<0.008	-

Table 94 Preliminary Screening for Soil of Extractables at CL4

Location								CL4-8	CL4-9	CL4-10	CL4-11	CL4
Sample ID								-	-	-	-	-
Sample Depth (m)								0.46	0.46	0.46	0.46	0-0.1 m
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Nov-16
			MECP	CCME	Ontario	CL4						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
Fluoranthene	0.56	µg/g	0.56	180	NR	**4.4**	**4.4**	<0.003	**4.4**	0.01	0.006	0.015
Fluorene	0.12	µg/g	0.12	NV	NR	< 0.0050	-	<0.002	<0.002	<0.002	<0.002	< 0.0050
Hexachlorobenzene	0.01	µg/g	0.01	10	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	-
Hexachlorobutadiene	0.01	µg/g	0.01	NV	--	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-
Hexachlorocyclopentadiene	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020	<0.020	-
Hexachloroethane	0.01	µg/g	0.01	NV	--	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	**1.7**	**1.7**	<0.006	**1.7**	<0.006	<0.006	0.0091
Isophorone	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001	<0.001	-
Naphthalene	0.013	µg/g	0.09	0.013	NR	**0.09**	**0.09**	<0.001	**0.09**	0.005	<0.001	< 0.0050
Nitrobenzene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	-
N-Nitrosodi-n-propylamine	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001	<0.001	-
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	<0.020	-	<0.020	<0.020	<0.020	<0.020	-
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	<0.010	-	<0.010	<0.010	<0.010	<0.010	-
Phenanthrene	0.046	µg/g	0.69	0.046	NR	**3.7**	**3.7**	<0.002	**3.7**	0.005	<0.002	0.0065
Phenol	0.5	µg/g	0.5	3.8	NR	<0.004	-	<0.004	<0.004	<0.004	<0.004	-
Pyrene	1	µg/g	1	100	NR	0.35	0.35	<0.002	0.35	<0.002	<0.002	0.012

Table 94 Preliminary Screening for Soil of Extractables at CL4

CL4 Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 95 Preliminary Screening for Soil of VOCs at CL4

Location								CL4-7		CL4-8	
Sample ID								-	-	-	-
Sample Depth (m)								0.23	0.46	0.06	0.46
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	CL4					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected				
1,1,1,2-Tetrachloroethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	µg/g	0.5	NV	NR	< 0.50	-	<0.105	<0.105	<0.105	<0.105
Benzene	0.02	µg/g	0.02	0.03	NR	*<0.040*	0.007	<0.002	<0.002	0.007	0.005
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003

Table 95 Preliminary Screening for Soil of VOCs at CL4

Location								CL4-7		CL4-8	
Sample ID								-	-	-	-
Sample Depth (m)								0.23	0.46	0.06	0.46
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	CL4					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected				
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Chloroethane	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	µg/g	0.05	50	NR	< 0.050	0.007	<0.003	<0.003	<0.003	0.007
Chloromethane	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	< 0.030	-	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
Dichloromethane	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	<0.040	-	<0.002	<0.002	<0.002	<0.002
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	< 0.50	0.05	<0.008	<0.008	0.04	0.05
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	< 0.50	-	<0.070	<0.070	<0.070	<0.070
Methyl t-Butyl Ether	0.05	µg/g	0.05	NV	NR	< 0.050	-	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	µg/g	0.05	6.5	NR	< 0.050	-	-	-	-	-
Styrene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	µg/g	0.2	0.37	NR	<0.040	-	<0.002	<0.002	<0.002	<0.002
trans-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	< 0.050	-	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	< 0.040	-	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.01	µg/g	0.05	0.01	NR	*< 0.050*	-	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	< 0.050	-	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	< 0.020	-	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	<0.080	-	<0.002	<0.002	<0.002	<0.002
o-xylene	NV	µg/g	NV	NV	NV	<0.040	-	<0.002	<0.002	<0.002	<0.002
Xylenes, Total	0.05	µg/g	0.05	11	NR	*<0.080*	-	-	-	-	-

Table 95 Preliminary Screening for Soil of VOCs at CL4

Location		CL4-9		CL4-10		CL4-11		CL4	CL4-1	CL4-2	CL4-3	CL4-4	CL4-5
Sample ID		-	-	-	-	-	-						
Sample Depth (m)		0.06	0.46	0.06	0.46	0.06	0.46	0-0.1 m	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Nov-16	Jun-21	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	**Preliminary Benchmark**												
1,1,1,2-Tetrachloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
1,1,2,2-Tetrachloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.050	-	-	-	-	-
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	< 0.050	-	-	-	-	-
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Acetone	0.5	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	< 0.50	-	-	-	-	-
Benzene	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	*<0.040*	*<0.040*	*<0.040*	<0.020	<0.020
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Chlorobenzene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-

Table 95 Preliminary Screening for Soil of VOCs at CL4

Location		**CL4-9**		**CL4-10**		**CL4-11**		**CL4**	**CL4-1**	**CL4-2**	**CL4-3**	**CL4-4**	**CL4-5**
Sample ID		-	-	-	-	-	-						
Sample Depth (m)		**0.06**	**0.46**	**0.06**	**0.46**	**0.06**	**0.46**	**0-0.1 m**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Nov-16**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**
Parameter	**Preliminary Benchmark**												
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Chloroethane	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-
Chloroform	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	-	-	-
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.030	-	-	-	-	-
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	< 0.050	-	-	-	-	-
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
Ethylbenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	<0.040	<0.040	<0.040	<0.020	<0.020
Methyl Ethyl Ketone	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	< 0.50	-	-	-	-	-
Methyl Isobutyl Ketone	0.5	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	< 0.50	-	-	-	-	-
Methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	< 0.050	-	-	-	-	-
n-Hexane	0.05	-	-	-	-	-	-	< 0.050	-	-	-	-	-
Styrene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.050	-	-	-	-	-
Toluene	0.2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	<0.040	<0.040	<0.040	<0.020	<0.020
trans-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.050	-	-	-	-	-
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.040	-	-	-	-	-
Trichloroethene	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	*< 0.050*	-	-	-	-	-
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	< 0.050	-	-	-	-	-
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.020	-	-	-	-	-
m-Xylene + p-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	<0.080	<0.080	<0.080	<0.040	<0.040
o-xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 0.020	<0.040	<0.040	<0.040	<0.020	<0.020
Xylenes, Total	0.05	-	-	-	-	-	-	< 0.020	*<0.080*	*<0.080*	*<0.080*	<0.040	<0.040

Table 95 Preliminary Screening for Soil of VOCs at CL4

CL4 VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.4 Fire Training Facility (FTF)

Table 96 Preliminary Screening for Soil of Metals at FTF

Location								FTF-1-00			
Sample ID								-	-	-	-
Sample Depth (m)								0.06	0.46	0.91	1.37
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FTF					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected				
Aluminum	26000	µg/g	NV	NV	26000	12000	12000	-	-	-	-
Antimony	1.3	µg/g	1.3	40	0.99	<1.0	0.51	<1.0	<1.0	<1.0	<1.0
Arsenic	12	µg/g	18	12	18	6.272	6.272	2.93	2.532	2.357	2.366
Barium	220	µg/g	220	2000	180	62	62	22.346	22.967	22.62	23.998
Beryllium	2.5	µg/g	2.5	8	0.99	0.54	0.54	<0.200	0.207	0.224	<0.200
Boron, Total	36	µg/g	36	NV	26	12	12	-	-	-	-
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	0.83	0.83	0.36	0.45	0.3	0.3
Cadmium	1.2	µg/g	1.2	22	1.2	0.61	0.61	<0.200	<0.200	<0.200	<0.200
Calcium	49000	µg/g	NV	NV	49000	34800	34800	-	-	-	-
Chromium	70	µg/g	70	87	63	22	22	11.012	12.169	9.772	7.694
Chromium (III) [b]	70	µg/g	70	87	63	21	21	-	-	-	-
Chromium (VI)	0.66	µg/g	0.66	1.4	NV	< 0.2	-	-	-	-	-
Chromium (Total)	70	µg/g	70	87	63	21	21	-	-	-	-
Cobalt	21	µg/g	21	300	17	7.9	7.9	3.74	4.813	4.007	3.998
Copper	91	µg/g	92	91	66	16.583	16.583	12.954	12.157	10.464	9.84
Iron	34000	µg/g	NV	NV	34000	18000	18000	7900	9400	7800	7200

Table 96 Preliminary Screening for Soil of Metals at FTF

Location								FTF-1-00			
Sample ID								-	-	-	-
Sample Depth (m)								0.06	0.46	0.91	1.37
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FTF					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected				
Lead	120	µg/g	120	600	1500	27	27	4.56	4.699	3.254	3.255
Magnesium	15000	µg/g	NV	NV	15000	11100	11100	-	-	-	-
Manganese	1400	µg/g	NV	NV	1400	1323.745	1323.745	287.522	263.688	244.572	292.247
Mercury	0.27	µg/g	0.27	50	0.27	0.18	0.18	0.018	0.031	<0.010	0.015
Molybdenum	2	µg/g	2	40	1.3	<1.000	0.84	<1.000	<1.000	<1.000	<1.000
Nickel	82	µg/g	82	89	50	17.844	17.844	<1.000	3.284	1.802	<1.000
Selenium	1.5	µg/g	1.5	2.9	1.1	1	1	<1.0	<1.0	<1.0	<1.0
Silver	0.5	µg/g	0.5	40	0.33	**1.284**	**1.28**	<0.250	<0.250	<0.250	<0.250
Sodium	1000	µg/g	NV	NV	1000	*< 5000*	**1400**	410	435	500	570
Thallium	1	µg/g	1	1	NV	<0.500	0.22	<0.500	<0.500	<0.500	<0.500
Titanium	4700	µg/g	NV	NV	4700	372.097	372.097	210.151	358.188	282.186	197.059
Uranium	2.5	µg/g	2.5	300	1.9	1.899	1.899	0.62	0.724	0.567	0.526
Vanadium	86	µg/g	86	130	72	52.59	52.59	12.832	17.573	12.703	10.676
Zinc	290	µg/g	290	410	180	**349.47**	**349.47**	66.445	34.596	35.829	26.331
Cyanide (free)	0.051	µg/g	0.051	0.9	-	0.03	0.03	-	-	-	-
Conductivity	0.57	mS/cm	0.57	200	-	0.19	0.19	-	-	-	-
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	**9.77**	**9.77**	8.46	8.17	8.53	8.48
Sodium Adsorption Ratio	2.4	SAR	2.4	5	-	0.24	0.24	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-2-00**			**FTF-4-00**						**FTF-6**			
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.46**	**0.91**	**0.06**	**0.06**	**0.46**	**0.46**	**0.91**	**0.91**	**0.06**	**0.46**	**0.91**	**1.37**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	2.049	1.034	3.157	1.507	2.035	1.888	1.874	1.958	1.969	1.722	1.74	1.872	1.722
Barium	220	15.936	<0.500	19.68	15.249	19.463	17.62	16.435	19.034	18.907	15.117	12.121	9.543	12.873
Beryllium	2.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Boron, Total	36	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.36	0.33	0.6	0.3	0.21	0.45	0.39	0.45	0.51	0.3	0.7	0.36	0.39
Cadmium	1.2	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	10.361	10.706	11.276	8.775	11.31	10.97	16.171	10.42	10.913	9.021	8.058	8.057	8.391
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	3.904	2.256	6.822	2.807	3.717	3.277	3.229	3.349	3.449	2.898	2.851	2.929	3.085
Copper	91	10.505	7.637	13.587	6.891	9.421	7.944	9.228	8.448	8.558	7.45	9.056	8.952	9.274
Iron	34000	6000	6266.03	10000	5900	7550	5250	6400	6800	6500	5800	5250	5500	5500

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		FTF-2-00			FTF-4-00						FTF-6			
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.46	0.91	0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark													
Lead	120	3.409	4.376	4.915	3.738	3.322	2.81	2.977	4.56	3.181	3.342	2.348	2.521	2.834
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	255.248	192.228	365.19	247.997	282.971	286.697	289.654	272.555	292.456	281.742	264.456	284.923	293.34
Mercury	0.27	0.011	<0.010	0.018	0.016	0.028	0.017	0.014	0.019	<0.010	0.021	0.018	0.026	0.026
Molybdenum	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	2.244	3.554	4.637	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	<0.250	**1.284**	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	377	488	339	790	850	365	390	400	395	**1050**	570	465	635
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	226.643	202.096	372.097	161.474	182.346	161.095	123.799	181.035	147.202	146.16	132.73	116.832	143.146
Uranium	2.5	0.531	0.802	0.564	0.549	0.651	0.663	0.643	0.684	0.683	0.586	0.506	0.375	0.527
Vanadium	86	13.218	9.941	16.837	10.382	12.832	12.272	10.664	12.246	11.579	15.192	9.532	9.532	10.038
Zinc	290	32.759	28.612	31.861	47.134	30.005	19.395	20.648	21.696	22.741	20.345	17.854	19.488	20.326
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.39	8.15	8.34	**9.16**	9	8.49	8.59	8.41	8.43	**9.77**	**9.33**	7.8	7.41
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-8**				**FTF-10**			**FTF-12**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.46**	**0.91**	**1.22**	**0.06**	**0.06**	**0.34**	**0.06**	**0.46**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**										
Aluminum	26000	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	1.785	2.429	2.395	2.799	2.144	<1.000	1.447	1.751	1.621	1.35
Barium	220	16.911	25.493	20.458	18.828	16.637	6.725	17.747	12.823	16.246	9.824
Beryllium	2.5	<0.200	0.225	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Boron, Total	36	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.3	0.45	0.6	0.42	0.24	0.15	0.3	0.24	0.24	0.15
Cadmium	1.2	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Calcium	49000	-	-	-	-	-	-	-	-	-	-
Chromium	70	9.223	11.439	10.636	11.234	11.201	8.278	9.039	7.345	8.542	7.036
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-
Cobalt	21	2.944	4.129	3.922	4.109	3.692	2.319	3.024	2.869	2.883	2.038
Copper	91	7.517	11.13	11.205	11.253	11.501	5.485	9.319	9.912	7.122	5.179
Iron	34000	5400	7400	8000	7800	7700	5400	5800	6150	6200	4800

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-8**				**FTF-10**			**FTF-12**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.46**	**0.91**	**1.22**	**0.06**	**0.06**	**0.34**	**0.06**	**0.46**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**										
Lead	120	5.188	3.869	4.185	4.586	5.555	3.711	3.215	3.448	5.064	7.679
Magnesium	15000	-	-	-	-	-	-	-	-	-	-
Manganese	1400	257.436	284.883	292.448	300.697	307.824	176.434	254.511	222.309	220.403	197.139
Mercury	0.27	0.01	0.035	0.02	0.031	<0.010	<0.010	0.024	<0.010	<0.010	<0.010
Molybdenum	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	<1.000	1.467	1.138	<1.000	3.33	1.08	<1.000	<1.000	<1.000	<1.000
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	475	637	930	1000	260	216	240	**1050**	**1150**	850
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	173.504	300.123	295.434	298.617	178.057	101.771	115.433	99.73	133.959	55.628
Uranium	2.5	0.708	0.607	0.698	0.643	0.582	0.547	0.635	0.482	0.66	0.528
Vanadium	86	10.677	14.904	13.505	14.415	17.296	8.738	10.459	8.554	8.988	6
Zinc	290	23.761	28.578	27.052	24.19	239.031	**349.47**	59.975	23.764	21.182	17.906
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.63	**9.04**	**9.19**	8.97	8.5	8.64	8.72	7.97	**9.09**	8.98
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-18**				**FTF-19**			**FTF-20**			
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.46**	**0.91**	**1.22**	**0.06**	**0.46**	**0.91**	**0.06**	**0.46**	**0.91**	**1.37**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**											
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	1.809	2.324	1.941	2.037	2.573	2.995	2.954	3.208	3.198	3.649	4.372
Barium	220	12.427	18.272	15.254	16.248	20.001	27.32	25.351	25.105	29.735	34.352	50.581
Beryllium	2.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.222	0.27	0.465
Boron, Total	36	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.3	0.3	0.3	0.21	0.3	0.3	0.2	0.36	0.3	0.42	0.45
Cadmium	1.2	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.2	0.227	0.486
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	7.311	7.906	8.484	7.239	8.694	11.014	10.309	11.293	12.664	14.125	16.482
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	3.198	3.527	3.618	3.688	2.901	4.411	4.279	3.532	4.326	6.263	6.996
Copper	91	8.43	10.761	12.224	12.739	9.626	11.634	11.675	9.692	10.633	13.069	12.95
Iron	34000	7300	7900	7000	7600	5400	10000	9500	8300	9200	12000	17000

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		FTF-18				FTF-19			FTF-20			
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.46	0.91	1.22	0.06	0.46	0.91	0.06	0.46	0.91	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**											
Lead	120	3.553	3.936	11.424	11.292	5.464	9.275	7.664	14.091	7.687	6.637	9.361
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	254.632	272.819	219.675	249.493	245.017	294.227	300.463	324.429	362.968	511.553	775.093
Mercury	0.27	<0.010	<0.010	0.012	<0.0010	0.018	<0.010	<0.010	0.028	0.028	0.02	0.041
Molybdenum	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Nickel	82	<1.000	<1.000	<1.000	2.23	<1.000	13.222	13.335	<1.000	1.869	16.916	17.081
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	378	370	350	365	289	315	320	350	385	330	365
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	150.129	159.588	131.717	144.983	132.309	168.707	166.413	168.671	207.316	291.794	194.025
Uranium	2.5	0.353	0.408	0.633	0.561	0.882	0.839	0.787	0.966	0.839	0.815	0.838
Vanadium	86	8.77	9.644	12.73	11.053	10.286	13.561	12.241	13.375	17.39	19.948	21.532
Zinc	290	27.825	29.335	34.648	44.255	29.115	49.278	36.744	57.69	39.106	45.434	77.958
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	7.84	8.42	7.74	7.97	8.05	8.19	8.46	7.61	7.56	7.65	7.58
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		FTF-21								FTF-22
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.23	0.23	0.61	0.61	0.91	0.91	1.22	1.22	0.30
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Jul-00
Parameter	Preliminary Benchmark									
Aluminum	26000	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Arsenic	12	3.594	3.336	1.569	1.572	2.194	2.19	2.574	1.798	-
Barium	220	44.757	47.342	14.721	12.101	28.048	24.765	28.027	20.889	-
Beryllium	2.5	0.243	0.324	<0.200	<0.200	<0.200	<0.200	0.209	<0.200	-
Boron, Total	36	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.8	0.8	0.8	0.6	0.36	0.5	0.66	0.81	-
Cadmium	1.2	0.331	0.32	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	-
Calcium	49000	-	-	-	-	-	-	-	-	-
Chromium	70	16.21	16.854	9.754	9.511	9.279	8.611	13.468	10.322	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-
Cobalt	21	5.04	5.444	3.617	3.439	3.348	3.154	4.948	4.586	-
Copper	91	9.247	9.317	6.681	4.96	16.038	14.398	10.62	16.583	-
Iron	34000	15000	18000	6400	6100	9300	8800	11700	9100	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		FTF-21								FTF-22
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.23	0.23	0.61	0.61	0.91	0.91	1.22	1.22	0.30
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Jul-00
Parameter	**Preliminary Benchmark**									
Lead	120	13.41	10.997	3.405	3.391	3.908	3.929	6.428	4.521	-
Magnesium	15000	-	-	-	-	-	-	-	-	-
Manganese	1400	704.655	1323.745	357.334	357.115	757.112	710.616	729.706	462.842	-
Mercury	0.27	0.089	0.089	0.058	<0.050	<0.050	<0.050	<0.050	<0.050	-
Molybdenum	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	-
Nickel	82	11	12	6	5	7	6	9	7	-
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1	<1.0	-
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	-
Sodium	1000	387	400	411	376	360	360	450	440	-
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-
Titanium	4700	355.132	358.435	187.374	206.209	197.261	193.761	301.44	243.057	-
Uranium	2.5	0.644	0.826	0.608	0.616	0.552	0.547	0.803	0.591	-
Vanadium	86	25.998	27.643	13.51	13.085	13.281	12.555	21.406	17.329	-
Zinc	290	35.543	44.743	10.201	9.034	10.787	10.505	22.663	18.586	-
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-
pH	5 to 9	7.69	8.41	7.99	8.48	-	8.52	8.56	8.71	8.02
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-23**			**FTF-24**			**FTF-25**		**FTF-26**	**FTF-27**	
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.30**	**0.91**	**1.22**	**0.30**	**0.91**	**1.22**	**0.30**	**0.91**	**0.30**	**0.30**	**0.91**
Date Sampled		**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**
Parameter	**Preliminary Benchmark**											
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	-	-	-	-	-	-	-	-	-	-	-
Arsenic	12	-	-	-	-	-	-	-	-	-	-	-
Barium	220	-	-	-	-	-	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-	-	-	-	-	-
Boron, Total	36	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-	-	-	-	-	-
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-	-	-	-	-	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-	-	-	-	-	-
Iron	34000	-	-	-	-	-	-	-	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		FTF-23			FTF-24			FTF-25		FTF-26	FTF-27	
Sample ID		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.30	0.91	1.22	0.30	0.91	1.22	0.30	0.91	0.30	0.30	0.91
Date Sampled		Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00
Parameter	Preliminary Benchmark											
Lead	120	-	-	-	-	-	-	-	-	-	-	-
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-	-	-	-	-	-
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.1	8.52	8.86	8	7.93	8.02	7.74	8.18	7.39	7.88	8.95
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-28**		**FTF**			**FTF-1-21**	**FTF-2-21**	**FTF-3-21**	**FTF-4-21**
Sample ID		**-**	**-**	**FTF-1-16**	**FTF-2-16**	**FTF-3-16**				
Sample Depth (m)		**0.30**	**0.91**	**0-0.1 m**	**0.2-0.3 m**	**0.4-0.45 m**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Jul-00**	**Jul-00**	**Oct-16**	**Oct-16**	**Oct-16**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**
Parameter	**Preliminary Benchmark**									
Aluminum	26000	-	-	-	-	-	6400	7300	5700	12000
Antimony	1.3	-	-	0.51	0.28	0.27	<0.20	<0.20	<0.20	<0.20
Arsenic	12	-	-	5.8	5.4	5.5	2.5	3.2	2.9	3.1
Barium	220	-	-	62	55	58	25	29	25	52
Beryllium	2.5	-	-	0.54	0.49	0.54				
Boron, Total	36	-	-	9	9.5	11	8.9	11	10	12
Boron - Hot Water Ext. [a]	2	-	-	0.83	0.67	0.51	-	-	-	-
Cadmium	1.2	-	-	0.61	0.55	0.56	0.21	0.13	0.14	0.24
Calcium	49000	-	-	30900	34800	21400	-	-	-	-
Chromium	70	-	-	21	21	22	-	-	-	-
Chromium (III) [b]	70	-	-	-	-	-	11	14	13	21
Chromium (VI)	0.66	-	-	< 0.2	< 0.2	< 0.2	<0.18	<0.18	<0.18	<0.18
Chromium (Total)	70	-	-	-	-	-	11	14	13	21
Cobalt	21	-	-	7.3	6.6	7.9	-	-	-	-
Copper	91	-	-	14	13	13	11	15	14	14
Iron	34000	-	-	-	-	-	11000	12000	11000	16000

Table 96 Preliminary Screening for Soil of Metals at FTF

Location		**FTF-28**		**FTF**			**FTF-1-21**	**FTF-2-21**	**FTF-3-21**	**FTF-4-21**
Sample ID		**-**	**-**	**FTF-1-16**	**FTF-2-16**	**FTF-3-16**				
Sample Depth (m)		**0.30**	**0.91**	**0-0.1 m**	**0.2-0.3 m**	**0.4-0.45 m**	**0-0.15**	**0-0.15**	**0-0.15**	**0-0.15**
Date Sampled		**Jul-00**	**Jul-00**	**Oct-16**	**Oct-16**	**Oct-16**	**Jun-21**	**Jun-21**	**Jun-21**	**Jun-21**
Parameter	**Preliminary Benchmark**									
Lead	120	-	-	24	27	21	7.1	7	5.6	10
Magnesium	15000	-	-	10100	11100	7700	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	0.12	0.18	0.085	<0.050	<0.050	<0.050	<0.050
Molybdenum	2	-	-	0.59	0.84	0.62	<0.50	<0.50	<0.50	<0.50
Nickel	82	-	-	16	15	16	8.1	12	12	16
Selenium	1.5	-	-	0.77	0.67	0.58	<0.50	<0.50	<0.50	<0.50
Silver	0.5	-	-	< 0.20	< 0.20	< 0.20	<0.20	<0.20	<0.20	<0.20
Sodium	1000	-	-	*< 5000*	*< 5000*	*< 5000*	-	-	-	-
Thallium	1	-	-	0.17	0.15	0.22	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	0.73	0.73	0.78	0.52	0.74	0.61	0.54
Vanadium	86	-	-	37	39	36	19	20	18	28
Zinc	290	-	-	100	86	66	35	50	92	66
Cyanide (free)	0.051	-	-	0.02	0.03	<0.01	-	-	-	-
Conductivity	0.57	-	-	0.19	0.19	0.14	-	-	-	-
pH	5 to 9	7.8	8.15	7.15	7.2	7.31	-	-	-	-
Sodium Adsorption Ratio	2.4	-	-	0.2	0.19	0.24	-	-	-	-

Table 96 Preliminary Screening for Soil of Metals at FTF

FTF Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

b In absence of standards for Chromium (III), standards for Chromium (Total) were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location								FTF-1-00				FTF-2-00			
Sample ID								-	-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FTF									
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected								
F1 (C6-C10 Hydrocarbons)	25	µg/g	25	240	NR	< 20	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	µg/g	25	240	NR	< 10	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	µg/g	10	260	NR	< 10	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	µg/g	240	1700	NR	90	90	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	µg/g	120	3300	NR	< 50	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	NA	NA	NA	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	µg/g	10	260	NR	**9676**	**9676**	**15**	**39**	**456**	**1196**	<10	**247**	<10	<10
TPH Heavy (C24-50)	120	µg/g	120	1700	NR	<100	-	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	µg/g	0.3	33	NR	< 0.010	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location		FTF-4-00						FTF-6				FTF-8				
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**															
F1 (C6-C10 Hydrocarbons)	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	**65**	**167**	<10	<10	<10	<10	**1501**	**17**	**3337**	**2924**	**334**	**75**	**173**	**746**	**329**
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location		FTF-10			FTF-12			FTF-14				FTF-15			FTF-16	
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.34	0.06	0.46	0.91	0.06	0.30	1.07	1.13	0.06	0.30	0.91	0.06	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark															
F1 (C6-C10 Hydrocarbons)	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	**354**	<10	**17**	**2895**	**3634**	**9676**	<10	<10	<10	<10	<10	**183**	<10	**30**	**631**
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location		FTF-10			FTF-12			FTF-14				FTF-15			FTF-16	
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.34	0.06	0.46	0.91	0.06	0.30	1.07	1.13	0.06	0.30	0.91	0.06	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**															
F1 (C6-C10 Hydrocarbons)	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	**354**	<10	**17**	**2895**	**3634**	**9676**	<10	<10	<10	<10	<10	**183**	<10	**30**	**631**
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location			**FTF-17**				**FTF-18**					**FTF-19**				
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.91**	**0.06**	**0.61**	**1.07**	**1.13**	**0.06**	**0.46**	**0.91**	**1.13**	**1.22**	**0.06**	**0.46**	**0.91**	**1.13**	**0.06**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**															
F1 (C6-C10 Hydrocarbons)	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	**72**	**815**	**40**	<10	**808**	**94**	**179**	**4174**	**3026**	**2647**	<10	<10	<10	<10	**180**
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location		**FTF-20**			**FTF-21**								**FTF-22**	**FTF-23**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.46**	**0.91**	**1.37**	**0.23**	**0.23**	**0.61**	**0.61**	**0.91**	**0.91**	**1.22**	**1.22**	**0.30**	**0.30**	**0.91**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Jul-00**	**Jul-00**	**Jul-00**	**Jul-00**
Parameter	**Preliminary Benchmark**															
F1 (C6-C10 Hydrocarbons)	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	**194**	<10	<10	**11**	<10	<10	<10	<10	<10	<10	<10	< 10	< 10	**183**	< 10
TPH Heavy (C24-50)	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	< 100	< 100	< 100	< 100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location		FTF-24			FTF-25		FTF-26	FTF-27		FTF-28	
Sample ID		-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.30	0.91	1.22	0.30	0.91	0.30	0.30	0.91	0.30	0.91
Date Sampled		Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00	Jul-00
Parameter	**Preliminary Benchmark**										
F1 (C6-C10 Hydrocarbons)	25	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10 Hydrocarbons)-BTEX	25	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	10	< 10	**12**	< 10	< 10	< 10	< 10	< 10	< 10	< 10
TPH Heavy (C24-50)	120	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

Location		FTF			FTF-1-21	FTF-2-21	FTF-3-21	FTF-4-21
Sample ID		FTF-1-16	FTF-2-16	FTF-3-16				
Sample Depth (m)		0-0.1 m	0.2-0.3 m	0.4-0.45 m	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	Preliminary Benchmark							
F1 (C6-C10 Hydrocarbons)	25	< 20	< 10	< 10	<10	<10	<10	<10
F1 (C6-C10 Hydrocarbons)-BTEX	25	< 10	< 10	< 10	<10	<10	<10	<10
F2 (C10-C16 Hydrocarbons)	10	< 10	< 10	< 10	<10	<10	<10	<10
F3 (C16-C34 Hydrocarbons)	240	< 50	< 50	< 50	64	90	58	60
F4 (C34-C50 Hydrocarbons)	120	< 50	< 50	< 50	<50	<50	<50	<50
Reached Baseline at C50	NA	YES	YES	YES	YES	YES	YES	YES
TPH Light (C10-24)	10	-	-	-	-	-	-	-
TPH Heavy (C24-50)	120	-	-	-	-	-	-	-
Aroclor 1242	NV	< 0.010	< 0.010	< 0.010	-	-	-	-
Aroclor 1248	NV	< 0.010	< 0.010	< 0.010	-	-	-	-
Aroclor 1254	NV	< 0.010	< 0.010	< 0.010	-	-	-	-
Aroclor 1260	NV	< 0.010	< 0.010	< 0.010	-	-	-	-
Polychlorinated Biphenyls	0.3	< 0.010	< 0.010	< 0.010	-	-	-	-

Table 97 Preliminary Screening for Soil of PHCs & PCBs at FTF

FTF PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location								FTF-1-00				FTF-2-00			
Sample ID								-	-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FTF									
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected								
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.1*	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
2,3,4,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
2,3,5,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-
2,3,4,5-Tetrachlorophenol	5	µg/g	NV	5	--	**32**	**32**	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
2,3,5-Trichlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-
2,3,4-Trichlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-
2,6-Dichlorophenol	5	µg/g	NV	5	NR	<0.003	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	*< 0.4*	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-
2,4-Dinitrophenol	2	µg/g	2	NV	NR	< 1	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-
2-Chloronaphthalene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
2-Chlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	< 0.06	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.007
2-Methylnapthalene	0.59	µg/g	0.59	NV	NR	< 0.06	-	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.007
1- & 2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.085	-	-	-	-	-	-	-	-	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location								**FTF-1-00**				**FTF-2-00**			
Sample ID								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)								**0.06**	**0.46**	**0.91**	**1.37**	**0.06**	**0.46**	**0.91**	**1.13**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**FTF**									
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**								
2-Methylphenol	NV	µg/g	NV	NV	NV	**16**	**16**	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	< 1	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-
4-Bromophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
4-Chloro-3-methyl-phenol	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
4-Chlorophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.015	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-
4-Nitrophenol	10	µg/g	NV	10	--	<0.003	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
Acenaphthene	0.072	µg/g	0.072	NV	NR	**0.41**	**0.41**	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004
Acenaphthylene	0.093	µg/g	0.093	NV	NR	**0.71**	**0.71**	<0.002	0.03	0.02	0.03	<0.002	<0.002	<0.002	<0.004
Anthracene	0.16	µg/g	0.16	32	NR	**0.47**	**0.47**	<0.002	0.01	0.02	0.02	<0.002	<0.002	<0.002	<0.004
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	**2.1**	**2.1**	<0.002	0.01	0.03	0.03	<0.002	<0.002	<0.002	<0.006
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	0.14	0.14	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(b)fluoranthene	0.47	µg/g	0.47	10	NR	0.12	0.12	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.004
Benzo(b,j)fluoranthene	0.47	µg/g	0.47	10	NR	< 0.2	0	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	< 0.2	0.17	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.004
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	0.23	0.23	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.008
Benzyl Butyl Phthalate	NV	µg/g	NV	NV	NV	**0.1**	**0.1**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
Biphenyl	0.05	µg/g	0.05	NV	NR	*< 0.1*	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
bis(2-chloroethoxy)methane	NV	µg/g	NV	NV	NV	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	< 2	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Chrysene	2.8	µg/g	2.8	NV	NR	0.4	0.4	0.02	0.03	0.01	0.02	<0.005	<0.005	<0.005	<0.005
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	**0.22**	**0.22**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	< 0.4	0.18	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location								FTF-1-00				FTF-2-00			
Sample ID								-	-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FTF									
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected								
Di-n-butyl Phthalate	NV	µg/g	NV	NV	NV	**0.06**	**0.06**	<0.002	**0.03**	**0.04**	**0.05**	<0.002	<0.002	<0.002	-
Di-n-octyl Phthalate	NV	µg/g	NV	NV	NV	**0.02**	**0.02**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Fluoranthene	0.56	µg/g	0.56	180	NR	0.1	0.1	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.003
Fluorene	0.12	µg/g	0.12	NV	NR	**0.95**	**0.95**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.007
Hexachlorobenzene	0.01	µg/g	0.01	10	--	**2.4**	**2.4**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
Hexachlorobutadiene	0.01	µg/g	0.01	NV	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Hexachlorocyclopentadiene	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
Hexachloroethane	0.01	µg/g	0.01	NV	--	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	< 0.2	0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004
Isophorone	NV	µg/g	NV	NV	NV	**0.13**	**0.13**	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-
Naphthalene	0.013	µg/g	0.09	0.013	NR	*< 0.06*	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.007
Nitrobenzene	NV	µg/g	NV	NV	NV	**4.5**	**4.5**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
N-Nitrosodi-n-propylamine	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	*< 0.2*	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
Phenanthrene	0.046	µg/g	0.69	0.046	NR	*< 0.1*	**0.08**	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.006
Phenol	0.5	µg/g	0.5	3.8	NR	**2.6**	**2.6**	<0.002	0.01	0.01	0.02	<0.002	<0.002	<0.002	-
Pyrene	1	µg/g	1	100	NR	0.28	0.28	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.002
Diphenylamines (total)	NV	µg/g	NV	NV	NV	**1.5**	**1.5**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-4-00						FTF-6				FTF-8				
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**															
1,2,4-Trichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
2,3,5,6-Tetrachlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
2,3,4,5-Tetrachlorophenol	5	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
2,3,5-Trichlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
2,3,4-Trichlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
2,6-Dichlorophenol	5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003
2,4-Dimethylphenol	0.2	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
2,4-Dinitrophenol	2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
2,4-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	<0.100
2,6-Dinitrotoluene	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
2-Chloronaphthalene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
2-Chlorophenol	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
1-Methylnapthalene	0.59	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.007	<0.002
2-Methylnaphthalene	0.59	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.007	<0.008
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-4-00						FTF-6				FTF-8				
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**															
2-Methylphenol	NV	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
3,3'-Dichlorobenzidine	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
4-Bromophenyl Phenyl Ether	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020
4-Chloro-3-methyl-phenol	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003
4-Chlorophenyl Phenyl Ether	NV	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	<0.015
4-Nitrophenol	10	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003
Acenaphthene	0.072	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	**0.41**	<0.020
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.4**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.06	<0.002
Anthracene	0.16	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.03	<0.002
Benzo(a)anthracene	0.36	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.006	<0.002
Benzo(a)pyrene	0.3	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.02	<0.003
Benzo(b)fluoranthene	0.47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.004	<0.001
Benzo(b,j)fluoranthene	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.004	<0.003
Benzo(k)fluoranthene	0.48	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.008	<0.003
Benzyl Butyl Phthalate	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003
Biphenyl	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
bis(2-chloroethoxy)methane	NV	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
bis(2-chloroethyl)ether	0.5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
bis(2-chlorisopropyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003
bis(2-ethylhexyl)phthalate	5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001
Chrysene	2.8	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-4-00						FTF-6				FTF-8				
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37	0.06	0.46	0.91	1.13	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark															
Di-n-butyl Phthalate	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
Di-n-octyl Phthalate	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
Fluoranthene	0.56	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.03	<0.006
Fluorene	0.12	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	**0.2**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.007	<0.003
Hexachlorobenzene	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.1**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
Hexachlorobutadiene	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005
Hexachlorocyclopentadiene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020
Hexachloroethane	0.01	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	*<0.020*
Indeno(1,2,3-cd)pyrene	0.23	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.02	<0.020
Isophorone	NV	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-	<0.006
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.007	<0.001
Nitrobenzene	NV	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001
N-Nitrosodi-n-propylamine	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
p-Chloroanaline	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001
Pentachlorophenol	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020
Phenanthrene	0.046	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	**0.08**	<0.010
Phenol	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002
Pyrene	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.18	<0.004
Diphenylamines (total)	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.4**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-10			FTF-12			FTF-14				FTF-15		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.34	0.06	0.46	0.91	0.06	0.30	1.07	1.13	0.06	0.30	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark													
1,2,4-Trichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
2,3,5,6-Tetrachlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008
2,3,4,5-Tetrachlorophenol	5	<0.004	<0.004	<0.004	0.43	**23**	**32**	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004
2,3,5-Trichlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008
2,3,4-Trichlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008
2,6-Dichlorophenol	5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003
2,4-Dimethylphenol	0.2	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008
2,4-Dinitrophenol	2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
2,4-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	<0.100	<0.100	<0.100
2,6-Dinitrotoluene	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008
2-Chloronaphthalene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
2-Chlorophenol	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
1-Methylnapthalene	0.59	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.007	<0.002	<0.002	<0.002
2-Methylnaphthalene	0.59	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.007	<0.008	<0.008	<0.008
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-10			FTF-12			FTF-14				FTF-15		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.34	0.06	0.46	0.91	0.06	0.30	1.07	1.13	0.06	0.30	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark													
2-Methylphenol	NV	<0.004	<0.004	<0.004	**0.29**	**12**	**16**	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004
3,3'-Dichlorobenzidine	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004
4-Bromophenyl Phenyl Ether	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020
4-Chloro-3-methyl-phenol	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003
4-Chlorophenyl Phenyl Ether	NV	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	<0.015	<0.015	<0.015
4-Nitrophenol	10	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003
Acenaphthene	0.072	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004	<0.020	<0.020	<0.020
Acenaphthylene	0.093	0.01	<0.002	<0.002	0.09	**0.4**	**0.71**	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	<0.002
Anthracene	0.16	0.01	0.02	<0.002	**0.47**	0.12	**0.18**	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	<0.002
Benzo(a)anthracene	0.36	0.04	0.01	<0.002	0.2	**1.8**	**2.1**	<0.002	<0.002	<0.002	<0.006	<0.002	<0.002	<0.002
Benzo(a)pyrene	0.3	<0.003	<0.003	<0.003	<0.003	0.07	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(b)fluoranthene	0.47	<0.001	0.02	<0.001	0.12	<0.001	<0.001	<0.001	<0.001	<0.001	<0.004	<0.001	<0.001	<0.001
Benzo(b,j)fluoranthene	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.68	0.03	0.07	<0.003	0.17	0.04	0.05	<0.003	<0.003	<0.003	<0.004	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	0.48	<0.003	0.14	<0.003	0.23	<0.003	<0.003	<0.003	<0.003	<0.003	<0.008	<0.003	<0.003	<0.003
Benzyl Butyl Phthalate	NV	**0.06**	**0.05**	<0.003	**0.1**	**0.03**	**0.03**	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003
Biphenyl	0.05	<0.002	<0.002	<0.002	<0.002	0.01	0.02	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
bis(2-chloroethoxy)methane	NV	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010
bis(2-chloroethyl)ether	0.5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
bis(2-chlorisopropyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003
bis(2-ethylhexyl)phthalate	5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Chrysene	2.8	<0.005	0.11	0.02	0.27	0.07	0.08	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibenzo(a,h)anthracene	0.1	0.03	0.08	<0.003	**0.22**	**0.13**	**0.2**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	<0.002	0.18	0.02	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		**FTF-10**			**FTF-12**			**FTF-14**				**FTF-15**		
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.06**	**0.34**	**0.06**	**0.46**	**0.91**	**0.06**	**0.30**	**1.07**	**1.13**	**0.06**	**0.30**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
Di-n-butyl Phthalate	NV	**0.01**	<0.002	<0.002	<0.002	<0.002	**0.05**	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
Di-n-octyl Phthalate	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
Fluoranthene	0.56	0.05	<0.006	<0.006	0.009	0.01	0.01	<0.006	<0.006	<0.006	<0.003	<0.006	<0.006	<0.006
Fluorene	0.12	0.05	**0.14**	<0.003	**0.95**	0.09	**0.13**	<0.003	<0.003	<0.003	<0.007	<0.003	<0.003	<0.003
Hexachlorobenzene	0.01	<0.002	<0.002	<0.002	**0.18**	**1.9**	**2.4**	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
Hexachlorobutadiene	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
Hexachlorocyclopentadiene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020
Hexachloroethane	0.01	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*
Indeno(1,2,3-cd)pyrene	0.23	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004	<0.020	<0.020	<0.020
Isophorone	NV	<0.006	**0.08**	<0.006	**0.13**	<0.006	<0.006	<0.006	<0.006	<0.006	-	<0.006	<0.006	<0.006
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.007	<0.001	<0.001	<0.001
Nitrobenzene	NV	**0.01**	**0.04**	<0.001	**0.23**	**3.1**	**4.5**	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
N-Nitrosodi-n-propylamine	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
p-Chloroanaline	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Pentachlorophenol	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020
Phenanthrene	0.046	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.006	<0.010	<0.010	<0.010
Phenol	0.5	0.02	0.01	<0.002	**1.1**	**2.1**	**2.6**	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
Pyrene	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.002	<0.004	<0.004	<0.004
Diphenylamines (total)	NV	**0.13**	**0.23**	<0.002	**1.5**	**0.74**	**0.82**	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		**FTF-16**			**FTF-17**				**FTF-18**				
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.61**	**0.91**	**0.06**	**0.61**	**1.07**	**1.13**	**0.06**	**0.46**	**0.91**	**1.13**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												
1,2,4-Trichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
2,3,5,6-Tetrachlorophenol	5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	-	<0.008
2,3,4,5-Tetrachlorophenol	5	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	**8.9**	-	0.13
2,3,5-Trichlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	-	<0.008
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	-	<0.008
2,3,4-Trichlorophenol	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	-	<0.008
2,6-Dichlorophenol	5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	-	<0.003
2,4-Dimethylphenol	0.2	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	-	<0.008
2,4-Dinitrophenol	2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
2,4-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	<0.100	<0.100	<0.100	-	<0.100
2,6-Dinitrotoluene	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	-	<0.008
2-Chloronaphthalene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002
2-Chlorophenol	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002
1-Methylnapthalene	0.59	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.007	<0.002	<0.002	<0.002	<0.007	<0.002
2-Methylnaphthalene	0.59	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.007	<0.008	<0.008	<0.008	<0.007	<0.008
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-	-	-	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		**FTF-16**			**FTF-17**				**FTF-18**				
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**0.61**	**0.91**	**0.06**	**0.61**	**1.07**	**1.13**	**0.06**	**0.46**	**0.91**	**1.13**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												
2-Methylphenol	NV	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	**8**	-	**0.17**
3,3'-Dichlorobenzidine	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	-	<0.004
4-Bromophenyl Phenyl Ether	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	-	<0.020
4-Chloro-3-methyl-phenol	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	-	<0.003
4-Chlorophenyl Phenyl Ether	NV	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	<0.015	<0.015	<0.015	-	<0.015
4-Nitrophenol	10	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	-	<0.003
Acenaphthene	0.072	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004	<0.020	<0.020	<0.020	<0.004	<0.020
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	**0.4**	0.04	0.06
Anthracene	0.16	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	**0.35**	0.05	0.06
Benzo(a)anthracene	0.36	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.006	<0.002	<0.002	**0.79**	<0.006	0.02
Benzo(a)pyrene	0.3	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.14	<0.003	<0.003
Benzo(b)fluoranthene	0.47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.004	<0.001	<0.001	0.01	0.01	<0.001
Benzo(b,j)fluoranthene	0.47	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.004	<0.003	<0.003	0.06	<0.004	0.04
Benzo(k)fluoranthene	0.48	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.008	<0.003	<0.003	0.05	0.01	<0.003
Benzyl Butyl Phthalate	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	**0.04**	-	<0.003
Biphenyl	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	0.01
bis(2-chloroethoxy)methane	NV	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	-	<0.010
bis(2-chloroethyl)ether	0.5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
bis(2-chlorisopropyl)ether	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	-	<0.003
bis(2-ethylhexyl)phthalate	5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001
Chrysene	2.8	0.1	<0.005	<0.005	0.1	<0.005	<0.005	<0.005	0.01	<0.005	0.13	0.04	0.03
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.09	<0.003	0.04
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	-	<0.003
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	0.07	-	0.04

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		**FTF-16**			**FTF-17**				**FTF-18**				
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.61**	**0.91**	**0.06**	**0.61**	**1.07**	**1.13**	**0.06**	**0.46**	**0.91**	**1.13**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												
Di-n-butyl Phthalate	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	**0.05**	-	**0.06**
Di-n-octyl Phthalate	NV	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
Fluoranthene	0.56	<0.006	<0.006	<0.006	0.1	<0.006	<0.006	<0.003	<0.006	<0.006	<0.006	0.09	<0.006
Fluorene	0.12	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.007	<0.003	<0.003	0.12	0.05	0.03
Hexachlorobenzene	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	**1.5**	-	**0.08**
Hexachlorobutadiene	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	-	<0.005
Hexachlorocyclopentadiene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	-	<0.020
Hexachloroethane	0.01	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	-	*<0.020*
Indeno(1,2,3-cd)pyrene	0.23	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.004	<0.020	<0.020	<0.020	<0.004	<0.020
Isophorone	NV	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-	<0.006	<0.006	**0.05**	-	<0.006
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.007	<0.001	<0.001	<0.001	<0.007	<0.001
Nitrobenzene	NV	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	**1.1**	-	<0.001
N-Nitrosodi-n-propylamine	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	-	<0.002
p-Chloroanaline	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001
Pentachlorophenol	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	-	<0.020
Phenanthrene	0.046	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.006	<0.010	<0.010	<0.010	**0.08**	<0.010
Phenol	0.5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	**0.95**	-	0.03
Pyrene	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.002	<0.004	<0.004	<0.004	0.28	<0.004
Diphenylamines (total)	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	**0.68**	-	**0.21**

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-19				FTF-20				FTF		
Sample ID		-	-	-	-	-	-	-	-	FTF-1-16	FTF-2-16	FTF-3-16
Sample Depth (m)		0.06	0.46	0.91	1.13	0.06	0.46	0.91	1.37	0-0.1 m	0.2-0.3 m	0.4-0.45 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark											
1,2,4-Trichlorobenzene	0.05	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	< 0.05	*< 0.1*	< 0.05
2,3,4,6-Tetrachlorophenol	5	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-	-
2,3,5,6-Tetrachlorophenol	5	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	<0.008	-	-	-
2,3,4,5-Tetrachlorophenol	5	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	-	-	-
2,3,5-Trichlorophenol	5	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-	-
2,4,6-Trichlorophenol	0.1	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	<0.008	< 0.1	*< 0.2*	< 0.1
2,4,5-Trichlorophenol	0.1	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	<0.008	< 0.08	*< 0.2*	< 0.08
2,3,4-Trichlorophenol	5	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-	-
2,4-Dichlorophenol	0.1	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	<0.008	< 0.1	*< 0.2*	< 0.1
2,6-Dichlorophenol	5	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-	-
2,4-Dimethylphenol	0.2	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	<0.008	< 0.2	*< 0.4*	< 0.2
2,4-Dinitrophenol	2	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	< 0.5	< 1	< 0.5
2,4-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	-	<0.100	<0.100	<0.100	<0.100	< 0.1	< 0.2	< 0.1
2,6-Dinitrotoluene	0.5	<0.008	<0.008	<0.008	-	<0.008	<0.008	<0.008	<0.008	< 0.1	< 0.2	< 0.1
2-Chloronaphthalene	NV	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-	-
2-Chlorophenol	0.1	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	< 0.08	*< 0.2*	< 0.08
1-Methylnapthalene	0.59	<0.002	<0.002	<0.002	<0.007	<0.002	<0.002	<0.002	<0.002	< 0.03	< 0.06	< 0.03
2-Methylnaphthalene	0.59	<0.008	<0.008	<0.008	<0.007	<0.008	<0.008	<0.008	<0.008	< 0.03	< 0.06	< 0.03
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	< 0.042	< 0.085	< 0.042

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-19				FTF-20				FTF		
Sample ID		-	-	-	-	-	-	-	-	FTF-1-16	FTF-2-16	FTF-3-16
Sample Depth (m)		0.06	0.46	0.91	1.13	0.06	0.46	0.91	1.37	0-0.1 m	0.2-0.3 m	0.4-0.45 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark											
2-Methylphenol	NV	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	-	-	-
3,3'-Dichlorobenzidine	1	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	< 0.5	< 1	< 0.5
4-Bromophenyl Phenyl Ether	NV	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	<0.020	-	-	-
4-Chloro-3-methyl-phenol	NV	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-	-
4-Chlorophenyl Phenyl Ether	NV	<0.015	<0.015	<0.015	-	<0.015	<0.015	<0.015	<0.015	-	-	-
4-Nitrophenol	10	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-	-
Acenaphthene	0.072	<0.020	<0.020	<0.020	<0.004	<0.020	<0.020	<0.020	<0.020	< 0.03	< 0.06	< 0.03
Acenaphthylene	0.093	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	<0.002	<0.002	< 0.05	*< 0.1*	< 0.05
Anthracene	0.16	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	<0.002	<0.002	< 0.03	< 0.06	< 0.03
Benzo(a)anthracene	0.36	<0.002	<0.002	<0.002	<0.006	<0.002	<0.002	<0.002	<0.002	< 0.05	< 0.1	< 0.05
Benzo(a)pyrene	0.3	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.05	< 0.1	< 0.05
Benzo(b)fluoranthene	0.47	<0.001	<0.001	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	-	-	-
Benzo(b,j)fluoranthene	0.47	-	-	-	-	-	-	-	-	< 0.1	< 0.2	< 0.1
Benzo(g,h,i)perylene	0.68	<0.003	<0.003	<0.003	<0.004	<0.003	<0.003	<0.003	<0.003	< 0.1	< 0.2	< 0.1
Benzo(k)fluoranthene	0.48	<0.003	<0.003	<0.003	<0.008	<0.003	<0.003	<0.003	<0.003	< 0.03	< 0.06	< 0.03
Benzyl Butyl Phthalate	NV	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-	-
Biphenyl	0.05	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	< 0.05	*< 0.1*	< 0.05
bis(2-chloroethoxy)methane	NV	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	-	-	-
bis(2-chloroethyl)ether	0.5	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	< 0.2	< 0.4	< 0.2
bis(2-chlorisopropyl)ether	0.5	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	<0.003	< 0.1	< 0.2	< 0.1
bis(2-ethylhexyl)phthalate	5	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	< 1	< 2	< 1
Chrysene	2.8	0.01	<0.005	<0.005	<0.005	0.4	0.2	<0.005	<0.005	< 0.05	< 0.1	< 0.05
Dibenzo(a,h)anthracene	0.1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.05	< 0.1	< 0.05
Diethyl Phthalate	0.5	<0.003	<0.003	<0.003	-	<0.003	<0.003	<0.003	<0.003	< 0.2	< 0.4	< 0.2
Dimethylphthalate	0.5	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	< 0.2	< 0.4	< 0.2

Table 98 Preliminary Screening for Soil of Extractables at FTF

Location		FTF-19				FTF-20				FTF		
Sample ID		-	-	-	-	-	-	-	-	FTF-1-16	FTF-2-16	FTF-3-16
Sample Depth (m)		0.06	0.46	0.91	1.13	0.06	0.46	0.91	1.37	0-0.1 m	0.2-0.3 m	0.4-0.45 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark											
Di-n-butyl Phthalate	NV	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-	-
Di-n-octyl Phthalate	NV	<0.005	**0.006**	**0.02**	-	<0.005	<0.005	<0.005	<0.005	-	-	-
Fluoranthene	0.56	<0.006	<0.006	<0.006	<0.003	<0.006	<0.006	<0.006	<0.006	< 0.05	< 0.1	< 0.05
Fluorene	0.12	<0.003	<0.003	<0.003	<0.007	<0.003	<0.003	<0.003	<0.003	< 0.03	< 0.06	< 0.03
Hexachlorobenzene	0.01	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-	-
Hexachlorobutadiene	0.01	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-	-
Hexachlorocyclopentadiene	NV	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	<0.020	-	-	-
Hexachloroethane	0.01	*<0.020*	*<0.020*	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	-	-
Indeno(1,2,3-cd)pyrene	0.23	<0.020	<0.020	<0.020	<0.004	<0.020	<0.020	<0.020	<0.020	< 0.08	< 0.2	< 0.08
Isophorone	NV	<0.006	<0.006	<0.006	-	<0.006	<0.006	<0.006	<0.006	-	-	-
Naphthalene	0.013	<0.001	<0.001	<0.001	<0.007	<0.001	<0.001	<0.001	<0.001	*< 0.03*	*< 0.06*	*< 0.03*
Nitrobenzene	NV	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	-	-	-
N-Nitrosodi-n-propylamine	NV	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-	-
p-Chloroanaline	0.5	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	< 0.2	< 0.4	< 0.2
Pentachlorophenol	0.1	<0.020	<0.020	<0.020	-	<0.020	<0.020	<0.020	<0.020	< 0.1	*< 0.2*	< 0.1
Phenanthrene	0.046	<0.010	<0.010	<0.010	<0.006	<0.010	<0.010	<0.010	<0.010	*< 0.05*	*< 0.1*	*< 0.05*
Phenol	0.5	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	< 0.09	< 0.2	< 0.09
Pyrene	1	<0.004	<0.004	<0.004	<0.002	<0.004	<0.004	<0.004	<0.004	< 0.05	< 0.1	< 0.05
Diphenylamines (total)	NV	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-	-

Table 98 Preliminary Screening for Soil of Extractables at FTF

FTF Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location								**FTF-1-00**				**FTF-2-00**		
Sample ID								**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)								**0.06**	**0.46**	**0.91**	**1.37**	**0.06**	**0.46**	**0.91**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**FTF**								
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**							
1,1,1,2-Tetrachloroethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	*< 0.10*	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.10*	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	µg/g	0.5	NV	NR	**1.8**	**1.8**	0.07	**0.56**	**1.1**	**0.81**	<0.105	0.1	**1.1**
Benzene	0.02	µg/g	0.02	0.03	NR	**0.42**	**0.42**	<0.002	**0.03**	0.02	0.02	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.10*	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location								FTF-1-00				FTF-2-00		
Sample ID								-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.46	0.91	1.37	0.06	0.46	0.91
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FTF								
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected							
Chloroethane	0.05	µg/g	0.05	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	µg/g	0.05	50	NR	**0.42**	**0.42**	0.02	**0.23**	<0.003	**0.12**	0.02	0.03	**0.42**
Chloromethane	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	*< 0.060*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	-	-	-	-	-	-	-
Dichloromethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	**1.5**	**1.5**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	**1.7**	**1.7**	0.05	**0.62**	0.36	0.41	0.05	0.08	**1.3**
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	*< 1.0*	-	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070
Methyl t-Butyl Ether	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	µg/g	0.05	6.5	NR	*< 0.10*	-	-	-	-	-	-	-	-
Purgeable Hydrocarbons (C5-C10)	25	µg/g	25	240	--	**222**	**222**	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300
Styrene	0.05	µg/g	0.05	50	NR	*< 0.10*	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	*< 0.10*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	µg/g	0.2	0.37	NR	**2.5**	**2.5**	<0.002	0.06	0.04	0.05	<0.002	<0.002	0.16
trans-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	*< 0.10*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	*< 0.080*	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.25	µg/g	0.25	NV	NR	< 0.10	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	< 0.10	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	*< 0.040*	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	**3.1**	**3.1**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	NV	µg/g	NV	NV	NV	**3.7**	**3.7**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes (Total)	0.05	µg/g	0.05	11	NR	**6.8**	**6.8**	-	-	-	-	-	-	-

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		FTF-4-00						FTF-6				FTF-8			
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37	0.06	0.91	1.22	0.46
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**														
1,1,1,2-Tetrachloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	0.35	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105
Benzene	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		**FTF-4-00**						**FTF-6**				**FTF-8**			
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.46	0.46	0.91	0.91	0.06	0.46	0.91	1.37	0.06	0.91	1.22	0.46
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**														
Chloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methyl Ethyl Ketone	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Methyl Isobutyl Ketone	0.5	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070
Methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purgeable Hydrocarbons (C5-C10)	25	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300
Styrene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
trans-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.25	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes (Total)	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		FTF-10			FTF-12			FTF-14			FTF-15			FTF-16		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.34	0.06	0.46	0.91	0.06	0.30	1.07	0.06	0.30	0.91	0.06	0.61	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark															
1,1,1,2-Tetrachloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	0.02	<0.002	<0.002	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	<0.105	<0.105	<0.105	<0.105	<0.105	**0.78**	0.2	0.22	0.25	<0.105	<0.105	0.1	**1.6**	**1.1**	**1.8**
Benzene	0.02	<0.002	<0.002	<0.002	**0.19**	**0.22**	**0.42**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		**FTF-10**			**FTF-12**			**FTF-14**			**FTF-15**			**FTF-16**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**0.06**	**0.34**	**0.06**	**0.46**	**0.91**	**0.06**	**0.30**	**1.07**	**0.06**	**0.30**	**0.91**	**0.06**	**0.61**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**															
Chloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	<0.003	<0.003	<0.003	**0.23**	**0.18**	**0.19**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	0.01	<0.002	<0.002	**0.08**	**0.87**	**1.5**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methyl Ethyl Ketone	0.5	<0.008	<0.008	<0.008	**1.2**	**1.1**	**1.3**	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	0.4	0.45	0.45
Methyl Isobutyl Ketone	0.5	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070
Methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purgeable Hydrocarbons (C5-C10)	25				**222**	**100**	**115**	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300
Styrene	0.05	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	<0.002	<0.002	<0.002	0.07	**1.3**	**2.5**	0.04	0.05	0.04	<0.002	<0.002	<0.002	0.08	0.1	0.14
trans-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.25	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	<0.002	<0.002	<0.002	<0.002	**1.8**	**3.1**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	NV	<0.002	<0.002	<0.002	<0.002	**2.1**	**3.7**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes (Total)	0.05	-	-	-	-	**3.9**	**6.8**	-	-	-	-	-	-	-	-	-

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		FTF-17			FTF-18				FTF-19			FTF-20			
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.61	1.07	0.06	0.46	0.91	1.22	0.06	0.46	0.91	0.06	0.46	0.91	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**														
1,1,1,2-Tetrachloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1,1-Trichloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2,2-Tetrachloroethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,1,2-Trichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethylene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dibromoethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichlorobenzene	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloropropane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	0.1	0.1	0.32	<0.105	<0.105	**0.75**	**1**	<0.105	<0.105	<0.105	**1.1**	**1.1**	<0.105	0.07
Benzene	0.02	<0.002	<0.002	<0.002	<0.002	<0.002	**0.06**	**0.08**	<0.002	<0.002	<0.002	**0.04**	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromoform	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bromomethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlorobenzene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chlorodibromomethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		**FTF-17**			**FTF-18**				**FTF-19**			**FTF-20**			
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.61**	**1.07**	**0.06**	**0.46**	**0.91**	**1.22**	**0.06**	**0.46**	**0.91**	**0.06**	**0.46**	**0.91**	**1.37**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**														
Chloroethane	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroform	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	**0.17**	**0.26**	<0.003	<0.003	<0.003	**0.28**	**0.27**	0.02	0.03
Chloromethane	NV	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
cis-1,3-Dichloropropene [a]	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dichlorodifluoromethane	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dichloromethane	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methyl Ethyl Ketone	0.5	<0.008	<0.008	<0.008	<0.008	<0.008	**1.2**	**1.7**	<0.008	<0.008	<0.008	**0.75**	**0.77**	0.06	0.06
Methyl Isobutyl Ketone	0.5	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070	<0.070
Methyl t-Butyl Ether	0.05	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
n-Hexane	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purgeable Hydrocarbons (C5-C10)	25	<1.300	<1.300	<1.300	9.6	5.3	**48**	17	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300	<1.300
Styrene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	0.2	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	0.08	<0.002	<0.002	<0.002	0.09	0.09	<0.002	<0.002
trans-1,2-Dichloroethene	0.05	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
trans-1,3-Dichloropropene [a]	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Trichloroethene	0.25	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorofluoromethane	0.25	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
m-Xylene + p-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	**0.02**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	NV	<0.002	<0.002	<0.002	<0.002	<0.002	**0.14**	**0.18**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes (Total)	0.05	-	-	-	-	-	**0.16**	**0.18**	-	-	-	-	-	-	-

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location			FTF		FTF-1-21	FTF-2-21	FTF-3-21	FTF-4-21
Sample ID		FTF-1-16	FTF-2-16	FTF-3-16				
Sample Depth (m)		0-0.1 m	0.2-0.3 m	0.4-0.45 m	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	**Preliminary Benchmark**							
1,1,1,2-Tetrachloroethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,1,1-Trichloroethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,1,2,2-Tetrachloroethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,1,2-Trichloroethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,1-Dichloroethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,1-Dichloroethylene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,2-Dibromoethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,2-Dichlorobenzene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,2-Dichloroethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,2-Dichloropropane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,3-Dichlorobenzene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,3-Dichloropropene, Total	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
1,4-Dichlorobenzene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Acetone	0.5	*< 1.0*	< 0.50	< 0.50	-	-	-	-
Benzene	0.02	*< 0.040*	< 0.020	< 0.020	<0.020	<0.020	< 0.020	<0.020
Bromodichloromethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Bromoform	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Bromomethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Carbon Tetrachloride	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Chlorobenzene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Chlorodibromomethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-

Table 99 Preliminary Screening for Soil of VOCs at FTF

Location		FTF			FTF-1-21	FTF-2-21	FTF-3-21	FTF-4-21
Sample ID		FTF-1-16	FTF-2-16	FTF-3-16				
Sample Depth (m)		0-0.1 m	0.2-0.3 m	0.4-0.45 m	0-0.15	0-0.15	0-0.15	0-0.15
Date Sampled		Oct-16	Oct-16	Oct-16	Jun-21	Jun-21	Jun-21	Jun-21
Parameter	**Preliminary Benchmark**							
Chloroethane	0.05	-	-	-	-	-	-	-
Chloroform	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Chloromethane	NV	-	-	-	-	-	-	-
cis-1,2-Dichloroethene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
cis-1,3-Dichloropropene [a]	0.05	*< 0.060*	< 0.030	< 0.030	-	-	-	-
Dichlorodifluoromethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Dichloromethane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Ethylbenzene	0.05	< 0.040	< 0.020	< 0.020	<0.020	<0.020	< 0.020	<0.020
Methyl Ethyl Ketone	0.5	*< 1.0*	< 0.50	< 0.50	-	-	-	-
Methyl Isobutyl Ketone	0.5	*< 1.0*	< 0.50	< 0.50	-	-	-	-
Methyl t-Butyl Ether	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
n-Hexane	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Purgeable Hydrocarbons (C5-C10)	25	-	-	-	-	-	-	-
Styrene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Tetrachloroethene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
Toluene	0.2	< 0.040	< 0.020	< 0.020	<0.020	<0.020	< 0.020	<0.020
trans-1,2-Dichloroethene	0.05	*< 0.10*	< 0.050	< 0.050	-	-	-	-
trans-1,3-Dichloropropene [a]	0.05	*< 0.080*	< 0.040	< 0.040	-	-	-	-
Trichloroethene	0.25	< 0.10	< 0.050	< 0.050	-	-	-	-
Trichlorofluoromethane	0.25	< 0.10	< 0.050	< 0.050	-	-	-	-
Vinyl Chloride	0.02	*< 0.040*	< 0.020	< 0.020	-	-	-	-
m-Xylene + p-Xylene	NV	<0.040	<0.020	< 0.020	<0.040	<0.040	<0.040	<0.040
o-Xylene	NV	<0.040	<0.020	< 0.020	<0.020	<0.020	< 0.020	<0.020
Xylenes (Total)	0.05	< 0.040	< 0.020	< 0.020	<0.040	<0.040	<0.040	<0.040

Table 99 Preliminary Screening for Soil of VOCs at FTF

FTF VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 100 Preliminary Screening for Soil of PFAS at FTF

Location								FTF		
Sample ID								FTF-1-16	FTF-2-16	FTF-3-16
Sample Depth (m)								0-0.1	0.2-0.3	0.4-0.45
Date Sampled								Oct-16	Oct-16	Oct-16
			MECP	CCME	Ontario	FTF				
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected			
Perfluoro-1-Octanesulfonate (PFOS)	10	µg/kg	NV	10	NV	4.7	4.7	4.7	2.6	1.1
perfluorobutane sulphonate	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorobutanoic acid	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorodecane Sulfonate	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorodecanoic Acid (PFDA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorododecanoic Acid (PFDoA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluoroheptane Sulfonate	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluoroheptanoic Acid (PFHpA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorohexane sulfonate (PFHXS)	10 [a]	µg/kg	NV	10 [a]	NV	1.3	1.3	1.3	< 1.0	< 1.0
Perfluorohexanoic Acid (PFHxA)	10 [a]	µg/kg	NV	10 [a]	NV	1.3	1.3	1.3	< 1.0	< 1.0
Perfluoro-n-octanoic acid (PFOA)	10 [a]	µg/kg	NV	10 [a]	NV	1.4	1.4	1.4	< 1.0	< 1.0
Perfluorononanoic Acid (PFNA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorooctane Sulfonamide (PFOSA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluoropentanoic Acid (PFPeA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorotetradecanoic Acid	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluorotridecanoic Acid	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0
Perfluoroundecanoic Acid (PFUnA)	NV	µg/kg	NV	NV	NV	< 1.0	-	< 1.0	< 1.0	< 1.0

Table 100 Preliminary Screening for Soil of PFAS at FTF

FTF PFAS Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

a - In absence of a guideline, the CCME SQG for PFOS was applied as a surrogate.

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.5 Former Sewage Lagoon (FSL)

Table 101 Preliminary Screening for Soil of Metals at FSL

Location								FSL-1-A		FSL-2-A			FSL-3-A		
Sample ID								-	-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.30	0.06	0.61	1.22	0.06	0.46	0.06
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FSL									
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected								
Aluminum	26000	μg/g	NV	NV	26000	6000	6000	-	-	-	-	-	-	-	-
Antimony	1.3	μg/g	1.3	40	0.99	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	μg/g	18	12	18	5	5	1.827	1.479	2.034	1.813	2.393	<1.000	1.154	1.216
Barium	220	μg/g	220	2000	180	98.957	98.957	26.21	22.83	27.286	50.5	24.837	23.304	85.984	50.861
Beryllium	2.5	μg/g	2.5	8	0.99	0.329	0.329	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Boron, Total	36	μg/g	36	NV	26	8.4	8.4	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	μg/g	2	NV	NV	1.2	1.2	0.48	0.54	0.3	0.51	0.3	0.1	0.2	0.18
Cadmium	1.2	μg/g	1.2	22	1.2	0.41	0.41	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Calcium	49000	μg/g	NV	NV	49000	**61200**	**61200**	-	-	-	-	-	-	-	-
Chromium	70	μg/g	70	87	63	11.852	11.852	8.174	5.644	10.005	6.164	9.553	4.703	3.792	2.692
Chromium (III) [b]	70	μg/g	70	87	63	11	11	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	μg/g	0.66	1.4	NV	< 0.2	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	μg/g	70	87	63	11	11	-	-	-	-	-	-	-	-
Cobalt	21	μg/g	21	300	17	4.994	4.994	3.385	2.579	3.775	2.719	4.087	2.291	2.432	1.913
Copper	91	μg/g	92	91	66	17.342	17.342	7.2	3.669	8.344	4.672	10.087	3.793	3.847	2.076

Table 101 Preliminary Screening for Soil of Metals at FSL

Location								**FSL-1-A**		**FSL-2-A**			**FSL-3-A**		
Sample ID								**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)								**0.06**	**0.30**	**0.06**	**0.61**	**1.22**	**0.06**	**0.46**	**0.06**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**FSL**									
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**								
Iron	34000	µg/g	NV	NV	34000	10300	10300	7200	3650	8700	3500	9300	2450	2150	1150
Lead	120	µg/g	120	600	1500	12.136	12.136	3.611	4.736	3.433	4.277	3.18	4.421	3.12	3.118
Magnesium	15000	µg/g	NV	NV	15000	11400	11400	-	-	-	-	-	-	-	-
Manganese	1400	µg/g	NV	NV	1400	393.985	393.985	231.628	114.479	316.593	155	348.125	102.287	99.801	48.733
Mercury	0.27	µg/g	0.27	50	0.27	<0.050	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum	2	µg/g	2	40	1.3	**2.572**	**2.572**	<1.000	<1.000	<1.000	1.238	<1.000	<1.000	1.08	1.412
Nickel	82	µg/g	82	89	50	14.954	14.954	6.059	2.638	10.651	3.739	10.289	1.764	2.348	<1.000
Selenium	1.5	µg/g	1.5	2.9	1.1	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	µg/g	0.5	40	0.33	**1.355**	**1.355**	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	µg/g	NV	NV	1000	*< 5000*	470	465	430	440	450	425	410	430	470
Thallium	1	µg/g	1	1	NV	<1	0.054	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	µg/g	NV	NV	4700	303.531	303.531	155.148	119.358	213.826	128.376	169.945	94.82	85.6	25.621
Uranium	2.5	µg/g	2.5	300	1.9	**3.597**	**3.597**	1.031	1.872	0.714	**2.527**	0.681	2.038	2.414	**2.576**
Vandium	86	µg/g	86	130	72	17	17	11.981	9.612	13.972	9.842	12.757	7.147	6.428	5.186
Zinc	290	µg/g	290	410	180	50.736	50.736	16.817	19.116	14.376	11.679	14.813	11.006	8.627	9.548
Cyanide (free)	0.051	µg/g	0.051	0.9	-	0.03	0.03	-	-	-	-	-	-	-	-
Conductivity	0.57	mS/cm	0.57	200	-	0.4	0.4	-	-	-	-	-	-	-	-
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	**9.21**	**9.21**	8.69	8.76	**9.12**	**9.15**	**9.21**	8.63	8.88	8.71
Sodium Adsorption Ratio	2.4	SAR	2.4	5	-	0.27	0.27	-	-	-	-	-	-	-	-

Table 101 Preliminary Screening for Soil of Metals at FSL

Location		FSL-4-A		FSL-5-A		FSL-6-A			FSL-7-A					
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.30	0.91	0.06	0.61	0.06	0.61	0.91	0.06	0.06	0.61	0.61	1.22	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**													
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	12	1.055	1.818	1.89	2.014	1.38	1.135	2.761	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Barium	220	98.957	27.936	17.229	21.84	14.603	78.088	37.713	19.972	37.355	39.701	41.184	21.025	28.431
Beryllium	2.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.251
Boron, Total	36	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	0.2	0.3	0.3	0.48	0.2	0.2	0.3	0.54	0.6	0.4	0.4	0.4	0.66
Cadmium	1.2	<0.200	<0.200	<0.200	<0.200	<0.200	0.41	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	2.408	8.228	5.143	5.449	6.676	2.818	11.852	5.178	3.73	4.103	3.73	10.199	10.775
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (VI)	0.66	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	1.999	3.841	2.507	2.597	2.355	2.143	4.994	1.413	1.06	1.135	<1.000	3.521	4.118
Copper	91	1.988	9.281	3.029	3.419	5.522	2.072	14.414	3.967	2.715	2.436	2.293	11.545	10.044

Table 101 Preliminary Screening for Soil of Metals at FSL

Location		**FSL-4-A**		**FSL-5-A**		**FSL-6-A**			**FSL-7-A**					
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.30**	**0.91**	**0.06**	**0.61**	**0.06**	**0.61**	**0.91**	**0.06**	**0.06**	**0.61**	**0.61**	**1.22**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
Iron	34000	1000	7800	3050	2800	5050	800	10300	2700	1800	1850	1300	8400	9000
Lead	120	2.67	2.97	4.979	5.973	12.136	5.164	4.786	4.06	4.082	5.439	4.098	3.223	3.55
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	50.748	340.667	106.08	94.333	170.768	38.632	393.985	125.755	78.003	75.435	41.982	363.163	382.228
Mercury	0.27	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum	2	1.294	<1.000	<1.000	<1.000	<1.000	**2.27**	<1.000	<1.000	1.278	1.705	**2.572**	<1.000	<1.000
Nickel	82	<1.000	7.28	1.607	1.235	4.045	2.184	14.954	3.5	4.5	4	4	7	8
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	**1.355**	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Sodium	1000	470	380	420	405	435	408	435	390	400	400	380	380	400
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Titanium	4700	25.072	155.988	69.474	68.765	128.427	22.382	207.749	140.8	80.859	81.516	33.619	201.827	230.198
Uranium	2.5	**2.741**	0.602	2.007	2.232	0.79	**3.597**	1.439	1.504	2.124	**2.585**	**3.484**	0.645	0.699
Vandium	86	4.601	11.234	8.299	8.215	8.797	5.224	16.276	7.805	6.23	6.692	5.886	13.384	14.042
Zinc	290	6.751	16.046	10.704	10.046	19.531	50.736	22.672	26.371	24.032	16.448	18.346	21.741	18.839
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.81	8.74	8.89	8.8	8.91	8.99	8.93	8.6	8.63	8.56	8.6	8.48	8.53
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 101 Preliminary Screening for Soil of Metals at FSL

Location		FSL-8-A			FSL-9-A			FSL-19	FSL-20	FSL-1		FSL
Sample ID		-	-	-	-	-	-	FSL-19	FSL-20	FSL-1	FSL-2	FSL
Sample Depth (m)		0.06	0.61	1.22	0.06	0.61	1.22	0.8 - 1.4	0.8 - 1.4	0-0.1 m	0.15-0.25 m	0-0.15
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	7-Jan-04	5-Apr-04	Oct-16	Oct-16	Jun-21
Parameter	**Preliminary Benchmark**											
Aluminum	26000	-	-	-	-	-	-	-	-	-	-	6000
Antimony	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	-	< 0.20	< 0.20	<0.20
Arsenic	12	<1.000	<1.000	<1.000	1.824	1.402	1.94	1	5	1.6	1.9	1.8
Barium	220	54.662	67.869	40.413	38.077	35.838	28.164	16.5	18.8	19	23	24
Beryllium	2.5	<0.200	<0.200	0.329	<0.200	<0.200	0.318	<0.1	0.2	< 0.20	< 0.20	-
Boron, Total	36	-	-	-	-	-	-	-	-	8.2	8	8.4
Boron - Hot Water Ext. [a]	2	0.6	0.6	0.8	1.2	0.33	0.45	-	-	0.31	0.052	-
Cadmium	1.2	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.4	<0.3	< 0.10	< 0.10	0.1
Calcium	49000	-	-	-	-	-	-	-	-	**61200**	21000	-
Chromium	70	5.713	4.854	11.723	10.37	3.339	11.238	1.7	5.4	7.4	9.5	-
Chromium (III) [b]	70	-	-	-	-	-	-	-	-	-	-	11
Chromium (VI)	0.66	-	-	-	-	-	-	<0.05	-	< 0.2	< 0.2	<0.18
Chromium (Total)	70	-	-	-	-	-	-	-	-	-	-	11
Cobalt	21	1.573	1.29	4.347	2.125	<1.000	3.433	0.8	3.3	2.8	3.1	
Copper	91	7.2	5.994	10.316	17.342	2.616	8.982	9.4	14.5	11	9.7	11

Table 101 Preliminary Screening for Soil of Metals at FSL

Location		FSL-8-A			FSL-9-A			FSL-19	FSL-20	FSL-1		FSL
Sample ID		-	-	-	-	-	-	FSL-19	FSL-20	FSL-1	FSL-2	FSL
Sample Depth (m)		0.06	0.61	1.22	0.06	0.61	1.22	0.8 - 1.4	0.8 - 1.4	0-0.1 m	0.15-0.25 m	0-0.15
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	7-Jan-04	5-Apr-04	Oct-16	Oct-16	Jun-21
Parameter	**Preliminary Benchmark**											
Iron	34000	3400	2550	9300	5800	1150	8100	-	-			10000
Lead	120	4.702	4.616	3.96	10.055	4.314	3.564	<2.5	3.1	6.5	3.1	5.9
Magnesium	15000	-	-	-	-	-	-	-	-	11400	3200	-
Manganese	1400	140.859	111.917	390.884	207.703	38.483	356.171	-	-	-	-	-
Mercury	0.27	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	< 0.050	< 0.050	<0.050
Molybdenum	2	1.202	1.303	<1.000	1.622	1.622	<1.000	<0.6	<0.6	< 0.50	< 0.50	<0.50
Nickel	82	4.5	3.5	8	<1.000	<1.000	<1.000	4	7	8.2	7.7	8.7
Selenium	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	-	< 0.50	< 0.50	<0.50
Silver	0.5	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	*<0.7*	*<0.7*	**0.52**	< 0.20	<0.20
Sodium	1000	395	420	450	420	405	380	-	-	*< 5000*	*< 5000*	-
Thallium	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<1	-	< 0.050	0.054	-
Titanium	4700	148.319	100.573	303.531	253.046	33.633	294.445	-	-	-	-	-
Uranium	2.5	1.723	2.341	0.785	1.595	**3.176**	0.805	-	-	0.58	0.54	0.47
Vandium	86	8.509	6.648	15.959	12.991	5.648	15.334	4.3	8.4	11	13	17
Zinc	290	17.456	14.732	17.607	39.001	15.513	16.919	14.7	20.3	29	18	32
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	0.03	< 0.01	-
Conductivity	0.57	-	-	-	-	-	-	-	-	0.4	0.15	-
pH	5 to 9	8.89	8.7	8.59	8.69	8.98	8.72	-	8.42	7.02	7.63	-
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	0.15	0.27	-

Table 101 Preliminary Screening for Soil of Metals at FSL

FSL Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

b In absence of standards for Chromium (III), standards for Chromium (Total) were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

Table 102 Preliminary Screening for Soil of PHCs at FSL

Location								**FSL-1-A**		**FSL-2-A**			**FSL-3-A**		
Sample ID								-	-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.30	0.06	0.61	1.22	0.06	0.46	0.06
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	**CCME**	**Ontario**	**FSL**									
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**								
F1 (C6-C10)	25	µg/g	25	240	NR	<10	-	-	-	-	-	-	-	-	-
F1 (C6-C10)-BTEX	25	µg/g	25	240	NR	<10	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	µg/g	10	260	NR	**24**	**24**	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	µg/g	240	1700	NR	60	60	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	µg/g	120	3300	NR	<50	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	µg/g	10	260	NR	<10.000	-	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-50)	120	µg/g	120	1700	NR	<100.000	-	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCB	0.3	µg/g	0.3	33	NR	<0.01	-	-	-	-	-	-	-	-	-

Table 102 Preliminary Screening for Soil of PHCs at FSL

Location		**FSL-4-A**		**FSL-5-A**		**FSL-6-A**			**FSL-7-A**					
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.30**	**0.91**	**0.06**	**0.61**	**0.06**	**0.61**	**0.91**	**0.06**	**0.06**	**0.61**	**0.61**	**1.22**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
F1 (C6-C10)	25	-	-	-	-	-	-	-	-	-	-	-	-	-
F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCB	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 102 Preliminary Screening for Soil of PHCs at FSL

Location		**FSL-8-A**			**FSL-9-A**			**FSL-20**	**FSL**
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**FSL-20**	**FSL**
Sample Depth (m)		**0.06**	**0.61**	**1.22**	**0.06**	**0.61**	**1.22**	**0.8-1.4**	**0-0.15**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**5-Apr-04**	**Jun-21**
Parameter	**Preliminary Benchmark**								
F1 (C6-C10)	25	-	-	-	-	-	-	-	<10
F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	<10
F2 (C10-C16 Hydrocarbons)	10	-	-	-	-	-	-	-	**24**
F3 (C16-C34 Hydrocarbons)	240	-	-	-	-	-	-	-	60
F4 (C34-C50 Hydrocarbons)	120	-	-	-	-	-	-	-	<50
Reached Baseline at C50	NA	-	-	-	-	-	-	-	Yes
TPH Light (C10-24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	-	-
TPH Heavy (C24-50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	-	-
PCB	0.3	-	-	-	-	-	-	<0.01	-

Table 102 Preliminary Screening for Soil of PHCs at FSL

FSL PHC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter;

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location								FSL-1-B		FSL-2-B			FSL-3-B	
Sample ID								-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.30	0.06	0.61	1.22	0.06	0.46
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FSL								
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected							
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,3,4,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,3,5,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,3,4,5-Tetrachloropheonol	5	µg/g	NV	5	--	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	< 0.3	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	< 0.8	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4-Dinitrophenol	2	µg/g	2	NV	NR	< 2	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chloronaphthalene	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chlorophenol	0.1	µg/g	0.1	5	NR	< 0.3	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1- & 2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.17	-	-	-	-	-	-	-	-
o-Cresol	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location								**FSL-1-B**		**FSL-2-B**			**FSL-3-B**	
Sample ID								-	-	-	-	-	-	-
Sample Depth (m)								**0.06**	**0.30**	**0.06**	**0.61**	**1.22**	**0.06**	**0.46**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**FSL**								
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**							
m,p-Cresol	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Methyl-4,6-dinitrophenol	1	µg/g	NV	10	NR	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
2-Nitrophenol	1	µg/g	NV	10	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	*< 2*	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
4-Bromophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
4-Chloro-3-methyl-phenol	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
4-Chlorophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
4-Nitrophenol	10	µg/g	NV	10	--	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acenaphthene	0.072	µg/g	0.072	NV	NR	*<0.100*	-	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Acenaphthylene	0.093	µg/g	0.093	NV	NR	*< 0.2*	-	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Anthracene	0.16	µg/g	0.16	32	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(b)fluoranthene	0.47	µg/g	0.47	10	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(b,j)fluoranthene	0.47	µg/g	0.47	10	NR	< 0.4	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzyl Butyl Phthalate	NV	µg/g	NV	NV	NV	<0.200	-	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Biphenyl	0.05	µg/g	0.05	NV	NR	*< 0.2*	-	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
bis(2-chloroethoxy)methane	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	*< 0.8*	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	< 4	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Chrysene	2.8	µg/g	2.8	NV	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location								FSL-1-B		FSL-2-B			FSL-3-B	
Sample ID								-	-	-	-	-	-	-
Sample Depth (m)								0.06	0.30	0.06	0.61	1.22	0.06	0.46
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	FSL								
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected							
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Diethyl Phthalate	0.5	µg/g	0.5	NV	NR	< 0.8	-	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	< 0.8	-	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Di-n-Butyl Phthalate	NV	µg/g	NV	NV	NV	<0.200	-	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Di-n-octyl phthalate	NV	µg/g	NV	NV	NV	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Fluoranthene	0.56	µg/g	0.56	180	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Fluorene	0.12	µg/g	0.12	NV	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Hexachlorobenzene	0.01	µg/g	0.01	10	--	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Hexachlorobutadiene	0.01	µg/g	0.01	NV	--	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Hexachlorocyclopentadiene	NV	µg/g	NV	NV	NV	<0.500	-	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Hexachloroethane	0.01	µg/g	0.01	NV	--	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	< 0.3	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Isophorone	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Naphthalene	0.013	µg/g	0.09	0.013	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nitrobenzene	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
N-Nitrosodiphenylamine	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
N-Nitrosodi-n-propylamine	NV	µg/g	NV	NV	NV	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	< 0.8	-	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	< 0.4	-	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Phenanthrene	0.046	µg/g	0.69	0.046	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Phenol	0.5	µg/g	0.5	3.8	NR	< 0.4	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Pyrene	1	µg/g	1	100	NR	< 0.2	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location		**FSL-4-B**			**FSL-5-B**		**FSL-6-B**			**FSL-7-B**				
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.30**	**0.91**	**0.06**	**0.61**	**0.06**	**0.61**	**0.91**	**0.06**	**0.06**	**0.61**	**0.61**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
1,2,4-Trichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
1,2-Dichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
1,3-Dichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
1,4-Dichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
2,3,4,6-Tetrachlorophenol	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,3,5,6-Tetrachlorophenol	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,3,4,5-Tetrachloropheonol	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4,6-Trichlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4,5-Trichlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4-Dichlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4-Dimethylphenol	0.2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,4-Dinitrophenol	2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,4-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2,6-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chloronaphthalene	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Chlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1-Methylnapthalene	0.59	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Methylnaphthalene	0.59	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	-	-	-	-	-	-
o-Cresol	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location		**FSL-4-B**			**FSL-5-B**		**FSL-6-B**			**FSL-7-B**				
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.30**	**0.91**	**0.06**	**0.61**	**0.06**	**0.61**	**0.91**	**0.06**	**0.06**	**0.61**	**0.61**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
m,p-Cresol	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
2-Methyl-4,6-dinitrophenol	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
2-Nitrophenol	1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
3,3'-Dichlorobenzidine	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
4-Bromophenyl Phenyl Ether	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
4-Chloro-3-methyl-phenol	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
4-Chlorophenyl Phenyl Ether	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
4-Nitrophenol	10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acenaphthene	0.072	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Acenaphthylene	0.093	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Anthracene	0.16	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(a)anthracene	0.36	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(a)pyrene	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(b)fluoranthene	0.47	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(b,j)fluoranthene	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.68	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzo(k)fluoranthene	0.48	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Benzyl Butyl Phthalate	NV	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Biphenyl	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
bis(2-chloroethoxy)methane	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
bis(2-chloroethyl)ether	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
bis(2-chlorisopropyl)ether	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
bis(2-ethylhexyl)phthalate	5	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Chrysene	2.8	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location		**FSL-4-B**			**FSL-5-B**		**FSL-6-B**			**FSL-7-B**				
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sample Depth (m)		**0.06**	**0.30**	**0.91**	**0.06**	**0.61**	**0.06**	**0.61**	**0.91**	**0.06**	**0.06**	**0.61**	**0.61**	**1.22**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
Dibenzo(a,h)anthracene	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Diethyl Phthalate	0.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Dimethylphthalate	0.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Di-n-Butyl Phthalate	NV	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Di-n-octyl phthalate	NV	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Fluoranthene	0.56	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Fluorene	0.12	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Hexachlorobenzene	0.01	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Hexachlorobutadiene	0.01	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Hexachlorocyclopentadiene	NV	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Hexachloroethane	0.01	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Indeno(1,2,3-cd)pyrene	0.23	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Isophorone	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Naphthalene	0.013	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Nitrobenzene	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
N-Nitrosodiphenylamine	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
N-Nitrosodi-n-propylamine	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
p-Chloroanaline	0.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Pentachlorophenol	0.1	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*
Phenanthrene	0.046	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*
Phenol	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Pyrene	1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location			FSL-8-B			FSL-9-B			FSL-1	
Sample ID		-	-	-	-	-	-	-	FSL-1	FSL-2
Sample Depth (m)		1.22	0.06	0.61	1.22	0.06	0.61	1.22	0-0.1 m	0.15-0.25 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16
Parameter	**Preliminary Benchmark**									
1,2,4-Trichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*< 0.2*	< 0.05
1,2-Dichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	-	-
1,3-Dichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	-	-
1,4-Dichlorobenzene	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	-	-
2,3,4,6-Tetrachlorophenol	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
2,3,5,6-Tetrachlorophenol	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
2,3,4,5-Tetrachloropheonol	5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
2,4,6-Trichlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.4*	< 0.1
2,4,5-Trichlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.3*	< 0.08
2,4-Dichlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.4*	< 0.1
2,4-Dimethylphenol	0.2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.8*	< 0.2
2,4-Dinitrophenol	2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	< 2	< 0.5
2,4-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.4	< 0.1
2,6-Dinitrotoluene	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.4	< 0.1
2-Chloronaphthalene	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
2-Chlorophenol	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.3*	< 0.08
1-Methylnapthalene	0.59	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.1	< 0.03
2-Methylnaphthalene	0.59	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.1	< 0.03
1- & 2-Methylnaphthalene	0.59	-	-	-	-	-	-	-	< 0.17	< 0.042
o-Cresol	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location			**FSL-8-B**			**FSL-9-B**			**FSL-1**	
Sample ID		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**FSL-1**	**FSL-2**
Sample Depth (m)		**1.22**	**0.06**	**0.61**	**1.22**	**0.06**	**0.61**	**1.22**	**0-0.1 m**	**0.15-0.25 m**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Oct-16**	**Oct-16**
Parameter	**Preliminary Benchmark**									
m,p-Cresol	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
2-Methyl-4,6-dinitrophenol	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	-
2-Nitrophenol	1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
3,3'-Dichlorobenzidine	1	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	*< 2*	< 0.5
4-Bromophenyl Phenyl Ether	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
4-Chloro-3-methyl-phenol	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
4-Chlorophenyl Phenyl Ether	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
4-Nitrophenol	10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-
Acenaphthene	0.072	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*< 0.1*	< 0.03
Acenaphthylene	0.093	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*< 0.2*	< 0.05
Anthracene	0.16	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.1	< 0.03
Benzo(a)anthracene	0.36	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.2	< 0.05
Benzo(a)pyrene	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.2	< 0.05
Benzo(b)fluoranthene	0.47	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
Benzo(b,j)fluoranthene	0.47	-	-	-	-	-	-	-	< 0.4	< 0.1
Benzo(g,h,i)perylene	0.68	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.4	< 0.1
Benzo(k)fluoranthene	0.48	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.1	< 0.03
Benzyl Butyl Phthalate	NV	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	-	-
Biphenyl	0.05	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*< 0.2*	< 0.05
bis(2-chloroethoxy)methane	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
bis(2-chloroethyl)ether	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.8*	< 0.2
bis(2-chlorisopropyl)ether	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.4	< 0.1
bis(2-ethylhexyl)phthalate	5	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	< 4	< 1
Chrysene	2.8	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.2	< 0.05

Table 103 Preliminary Screening for Soil of Extractables at FSL

Location			FSL-8-B			FSL-9-B			FSL-1	
Sample ID		-	-	-	-	-	-	-	FSL-1	FSL-2
Sample Depth (m)		1.22	0.06	0.61	1.22	0.06	0.61	1.22	0-0.1 m	0.15-0.25 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16
Parameter	Preliminary Benchmark									
Dibenzo(a,h)anthracene	0.1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.2*	< 0.05
Diethyl Phthalate	0.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	*< 0.8*	< 0.2
Dimethylphthalate	0.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	*< 0.8*	< 0.2
Di-n-Butyl Phthalate	NV	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	-	-
Di-n-octyl phthalate	NV	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	-
Fluoranthene	0.56	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.2	< 0.05
Fluorene	0.12	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.1	< 0.03
Hexachlorobenzene	0.01	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	-	-
Hexachlorobutadiene	0.01	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	-	-
Hexachlorocyclopentadiene	NV	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	-	-
Hexachloroethane	0.01	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	-	-
Indeno(1,2,3-cd)pyrene	0.23	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	*< 0.3*	< 0.08
Isophorone	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
Naphthalene	0.013	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*< 0.1*	*< 0.03*
Nitrobenzene	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
N-Nitrosodiphenylamine	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
N-Nitrosodi-n-propylamine	NV	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-
p-Chloroanaline	0.5	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	*< 0.8*	< 0.2
Pentachlorophenol	0.1	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*<0.200*	*< 0.4*	< 0.1
Phenanthrene	0.046	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*<0.100*	*< 0.2*	*< 0.05*
Phenol	0.5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.4	< 0.09
Pyrene	1	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	< 0.2	< 0.05

Table 103 Preliminary Screening for Soil of Extractables at FSL

FSL Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter;

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

Table 104 Preliminary Screening for Soil of VOCs at FSL

Location								FSL
Sample ID								FSL
Sample Depth (mbgs)								0-0.15
Date Sampled								10-Jun-21
			MECP	CCME	Ontario	FSL		
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected	
Benzene	0.02	µg/g	0.02	0.03	NR	<0.020	-	<0.020
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	<0.020	-	<0.020
o-Xylene	NV	µg/g	NV	NV	NV	<0.020	-	<0.020
p+m-Xylene	NV	µg/g	NV	NV	NV	<0.040	-	<0.040
Toluene	0.2	µg/g	0.2	0.37	NR	<0.020	-	<0.020
Xylene (Total)	0.05	µg/g	0.05	11	NR	<0.040	-	<0.040

Table 104 Preliminary Screening for Soil of VOCs at FSL

FSL VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.6 Distribution Station #1 (DS1)

Table 105 Preliminary Screening for Soil of Metals at DS1

Location								DS1-1-00					
Sample ID								DS1-1-0.2-B	DS1-1-0.2-B Dup	DS1-1-2-B	DS1-1-2-B Dup	DS1-1-4-B	DS1-1-4-B Dup
Sample Depth (m)								0.06	0.06	0.61	0.61	1.22	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS1							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Antimony	1.3	µg/g	1.3	40	0.99	<1.0	0.36	-	-	-	-	-	-
Arsenic	12	µg/g	18	12	18	10	10	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
Barium	220	µg/g	220	2000	180	90.728	90.728	-	-	-	-	-	-
Beryllium	2.5	µg/g	2.5	8	0.99	0.73	0.73	-	-	-	-	-	-
Boron, Total	36	µg/g	36	NV	26	< 5.0	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	0.69	0.69	-	-	-	-	-	-
Cadmium	1.2	µg/g	1.2	22	1.2	<0.200	0.11	-	-	-	-	-	-
Calcium	49000	µg/g	NV	NV	49000	17500	17500	-	-	-	-	-	-
Chromium	70	µg/g	70	87	63	33.348	33.348	-	-	-	-	-	-
Hexavalent Chrmium	0.66	µg/g	0.66	1.4	NV	< 0.2	-	-	-	-	-	-	-
Cobalt	21	µg/g	21	300	17	10.125	10.125	-	-	-	-	-	-
Copper	91	µg/g	92	91	66	16.164	16.164	-	-	-	-	-	-
Iron	3400	µg/g	NV	NV	34000	**23676.3**	**23676.3**	-	-	-	-	-	-
Lead	120	µg/g	120	600	1500	8.748	8.748	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location								DS1-1-00					
Sample ID								DS1-1-0.2-B	DS1-1-0.2-B Dup	DS1-1-2-B	DS1-1-2-B Dup	DS1-1-4-B	DS1-1-4-B Dup
Sample Depth (m)								0.06	0.06	0.61	0.61	1.22	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS1							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Magnesium	15000	µg/g	NV	NV	15000	4400	4400	-	-	-	-	-	-
Manganese	1400	µg/g	NV	NV	1400	417.272	417.272	-	-	-	-	-	-
Mercury	0.27	µg/g	0.27	50	0.27	< 0.050	-	-	-	-	-	-	-
Molybdenum	2	µg/g	2	40	1.3	<1.000	-	-	-	-	-	-	-
Nickel	82	µg/g	82	89	50	25.201	25.201	-	-	-	-	-	-
Selenium	1.5	µg/g	1.5	2.9	1.1	<1.0	-	-	-	-	-	-	-
Silver	0.5	µg/g	0.5	40	0.33	<0.250	-	-	-	-	-	-	-
Sodium	1000	µg/g	NV	NV	1000	*< 5000*	530	-	-	-	-	-	-
Thallium	1	µg/g	1	1	NV	<0.500	-	-	-	-	-	-	-
Titanium	4700	µg/g	NV	NV	4700	289.677	289.677	-	-	-	-	-	-
Uranium	2.5	µg/g	2.5	300	1.9	1.044	1.044	-	-	-	-	-	-
Vanadium	86	µg/g	86	130	72	28.997	28.997	-	-	-	-	-	-
Zinc	290	µg/g	290	410	180	42.259	42.259	-	-	-	-	-	-
Cyanide (free)	0.051	µg/g	0.051	0.9	-	< 0.01	-	-	-	-	-	-	-
Conductivity	0.57	mS/cm	0.57	200	-	0.085	0.085	-	-	-	-	-	-
pH	5 to 9	units	5 to 9	6 to 8	7.5	**9.34**	**9.34**	-	-	-	-	-	-
Sodium Adsorption Ratio	2.4	SAR	2.4	5	-	0.3	0.3	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-2-00			DS1-3			DS1-4		DS1-5			
Sample ID		DS1-2-0.2-B	DS1-2-0.2-B Dup	DS1-2-4-B	DS1-3-0.2-B	DS1-3-2-B	DS1-3-4-B	DS1-4-0.2-B	DS1-4-2.5-B	DS1-5-0.5-A	DS1-5-1-A	DS1-5-GP1-2.2-A	DS1-5-GP1-4.5-A
Sample Depth (m)		0.06	0.06	1.22	0.06	0.61	1.22	0.06	0.76	0.15	0.30	0.67	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Antimony	1.3	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	12	1	<1.000	<1.000	<1.000	<1.000	1	1	<1.000	1	<1.000	<1.000	3
Barium	220	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Boron, Total	36	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-	-	-	-	-	-	-
Hexavalent Chrmium	0.66	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-	-	-	-	-	-	-
Iron	3400	-	-	-	-	-	-	-	-	-	-	-	-
Lead	120	-	-	-	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-2-00			DS1-3			DS1-4		DS1-5			
Sample ID		DS1-2-0.2-B	DS1-2-0.2-B Dup	DS1-2-4-B	DS1-3-0.2-B	DS1-3-2-B	DS1-3-4-B	DS1-4-0.2-B	DS1-4-2.5-B	DS1-5-0.5-A	DS1-5-1-A	DS1-5-GP1-2.2-A	DS1-5-GP1-4.5-A
Sample Depth (m)		0.06	0.06	1.22	0.06	0.61	1.22	0.06	0.76	0.15	0.30	0.67	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	-	-	-	-	-	-	-	-	8.8	8.62	8.53	**9.34**
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-6				DS1-7				DS1-8			
Sample ID		DS1-6-0.33-A	DS1-6-1-A	DS1-6-GP1-2.4-A	DS1-6-GP1-4.5-A	DS1-7-0.33-A	DS1-7-1-A	DS1-7-GP1-2.1-A	DS1-7-GP1-4.5-A	DS1-8-0.33-A	DS1-8-1-A	DS1-8-GP1-2.5-A	DS1-8-GP1-4.5-A
Sample Depth (m)		0.10	0.30	0.73	1.37	0.10	0.30	0.64	1.37	0.10	0.30	0.76	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Antimony	1.3	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	12	2	<1.000	1	3	1	2	3	1	1	1	1	1
Barium	220	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Boron, Total	36	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	49000	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-	-	-	-	-	-	-
Hexavalent Chrmium	0.66	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-	-	-	-	-	-	-
Iron	3400	-	-	-	-	-	-	-	-	-	-	-	-
Lead	120	-	-	-	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-6				DS1-7				DS1-8			
Sample ID		DS1-6-0.33-A	DS1-6-1-A	DS1-6-GP1-2.4-A	DS1-6-GP1-4.5-A	DS1-7-0.33-A	DS1-7-1-A	DS1-7-GP1-2.1-A	DS1-7-GP1-4.5-A	DS1-8-0.33-A	DS1-8-1-A	DS1-8-GP1-2.5-A	DS1-8-GP1-4.5-A
Sample Depth (m)		0.10	0.30	0.73	1.37	0.10	0.30	0.64	1.37	0.10	0.30	0.76	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Magnesium	15000	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.55	8.79	8.04	8.94	8.94	8.58	7.94	**9.07**	8.51	8.57	8.61	**9.17**
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-9			DS1-10			DS1-11		
Sample ID		DS1-9-0.33-A	DS1-9-GP1-2.6-A	DS1-9-GP1-3.6-A	DS1-10-0.33-A	DS1-10-GP1-1.5-A	DS1-10-GP1-4-A	DS1-11-0.33-A	DS1-11-GP1-2.3-A	DS1-11-GP1-3.5-A
Sample Depth (m)		0.10	0.79	1.10	0.10	0.46	1.22	0.10	0.70	1.07
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
Antimony	1.3	-	-	-	-	-	-	-	-	-
Arsenic	12	1	1	<1.000	10	1	1	2	2	<1.000
Barium	220	-	-	-	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-	-	-	-
Boron, Total	36	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-	-	-	-
Calcium	49000	-	-	-	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-	-	-	-
Hexavalent Chrmium	0.66	-	-	-	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-	-	-	-
Iron	3400	-	-	-	-	-	-	-	-	-
Lead	120	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-9			DS1-10			DS1-11		
Sample ID		DS1-9-0.33-A	DS1-9-GP1-2.6-A	DS1-9-GP1-3.6-A	DS1-10-0.33-A	DS1-10-GP1-1.5-A	DS1-10-GP1-4-A	DS1-11-0.33-A	DS1-11-GP1-2.3-A	DS1-11-GP1-3.5-A
Sample Depth (m)		0.10	0.79	1.10	0.10	0.46	1.22	0.10	0.70	1.07
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
Magnesium	15000	-	-	-	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-	-	-	-
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.69	8.8	**9.07**	8.91	8.12	**9.25**	8.57	8.44	**9.09**
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-12			DS1-13			DS1-14		
Sample ID		DS1-12-0.25-A	DS1-12-GP1-2.3-A	DS1-12-GP1-3.5-A	DS1-13-0.33-A	DS1-13-GP1-2.5-A	DS1-13-GP2-2.5-A	DS1-14-0.33-A	DS1-14-GP1-2.5-A	DS1-14-GP1-3.5-A
Sample Depth (m)		0.08	0.70	1.07	0.10	0.76	1.07	0.10	0.76	1.07
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
Antimony	1.3	-	-	-	-	-	-	-	-	-
Arsenic	12	2	2	2	<1.000	1	1	1	<1.000	2
Barium	220	-	-	-	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-	-	-	-
Boron, Total	36	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-	-	-	-
Calcium	49000	-	-	-	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-	-	-	-
Hexavalent Chrmium	0.66	-	-	-	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-	-	-	-
Iron	3400	-	-	-	-	-	-	-	-	-
Lead	120	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-12			DS1-13			DS1-14		
Sample ID		DS1-12-0.25-A	DS1-12-GP1-2.3-A	DS1-12-GP1-3.5-A	DS1-13-0.33-A	DS1-13-GP1-2.5-A	DS1-13-GP2-2.5-A	DS1-14-0.33-A	DS1-14-GP1-2.5-A	DS1-14-GP1-3.5-A
Sample Depth (m)		0.08	0.70	1.07	0.10	0.76	1.07	0.10	0.76	1.07
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**									
Magnesium	15000	-	-	-	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-	-	-	-
Cyanide (free)	0.051	-	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.33	8.31	8.82	7.99	7.97	8.12	8.08	8.29	8.67
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	-	-

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		DS1-15			DS1-16				DS1	
Sample ID		DS1-15-0-A	DS1-15-GP1-1-A	DS1-15-GP1-3.5-A	DS1-16-0.2-A	DS1-16-1.5-A	DS1-16-2.5-A	DS1-16-4-A	DS1-1-16	DS1-2-16
Sample Depth (m)		0.00	0.30	1.07	0.06	0.46	0.76	1.22	0-0.1 m	0.3-0.4 m
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16
Parameter	Preliminary Benchmark									
Antimony	1.3	-	-	-	<1.0	<1.0	<1.0	<1.0	0.36	< 0.20
Arsenic	12	4	1	<1.000	1.564	2.001	4.246	2.36	2	1.1
Barium	220	-	-	-	16.945	19.256	90.728	60.29	14	7.6
Beryllium	2.5	-	-	-	0.202	<0.200	0.73	0.518	< 0.20	< 0.20
Boron, Total	36	-	-	-	-	-	-	-	< 5.0	< 5.0
Boron - Hot Water Ext. [a]	2	-	-	-	0.24	0.69	0.55	0.66	0.15	< 0.050
Cadmium	1.2	-	-	-	<0.200	<0.200	<0.200	<0.200	0.11	< 0.10
Calcium	49000	-	-	-	-	-	-	-	17500	16800
Chromium	70	-	-	-	7.694	10.276	33.348	20.024	6.3	5.5
Hexavalent Chrmium	0.66	-	-	-	-	-	-	-	< 0.2	< 0.2
Cobalt	21	-	-	-	1.985	2.327	10.125	5.473	2.2	1.6
Copper	91	-	-	-	2.31	5.032	16.164	12.071	4.3	2.4
Iron	3400	-	-	-	**7679.127**	**9519.678**	**23676.3**	**14015.37**	-	-
Lead	120	-	-	-	2.9	2.698	8.748	5.062	4	1.7

Table 105 Preliminary Screening for Soil of Metals at DS1

Location		**DS1-15**			**DS1-16**				**DS1**	
Sample ID		**DS1-15-0-A**	**DS1-15-GP1-1-A**	**DS1-15-GP1-3.5-A**	**DS1-16-0.2-A**	**DS1-16-1.5-A**	**DS1-16-2.5-A**	**DS1-16-4-A**	**DS1-1-16**	**DS1-2-16**
Sample Depth (m)		**0.00**	**0.30**	**1.07**	**0.06**	**0.46**	**0.76**	**1.22**	**0-0.1 m**	**0.3-0.4 m**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Oct-16**	**Oct-16**
Parameter	**Preliminary Benchmark**									
Magnesium	15000	-	-	-	-	-	-	-	4400	2400
Manganese	1400	-	-	-	103.727	255.79	417.272	324.354	-	-
Mercury	0.27	-	-	-	<0.01	<0.01	<0.01	<0.01	< 0.050	< 0.050
Molybdenum	2	-	-	-	<1.000	<1.000	<1.000	<1.000	< 0.50	< 0.50
Nickel	82	-	-	-	5.311	3.304	25.201	11.389	4.7	3.6
Selenium	1.5	-	-	-	<1.0	<1.0	<1.0	<1.0	< 0.50	< 0.50
Silver	0.5	-	-	-	<0.250	<0.250	<0.250	<0.250	< 0.20	< 0.20
Sodium	1000	-	-	-	233	530	500	460	*< 5000*	*< 5000*
Thallium	1	-	-	-	<0.500	<0.500	<0.500	<0.500	< 0.050	< 0.050
Titanium	4700	-	-	-	111.929	289.677	207.652	208.632	-	-
Uranium	2.5	-	-	-	0.307	0.656	0.951	1.044	0.26	0.24
Vanadium	86	-	-	-	8.475	14.479	28.997	21.364	9.1	7.7
Zinc	290	-	-	-	29.584	14.194	42.259	22.682	38	10
Cyanide (free)	0.051	-	-	-	-	-	-	-	< 0.01	< 0.01
Conductivity	0.57	-	-	-	-	-	-	-	0.085	0.08
pH	5 to 9	7.59	7.62	8.54	-	-	-	-	7.42	7.74
Sodium Adsorption Ratio	2.4	-	-	-	-	-	-	-	0.28	0.3

Table 105 Preliminary Screening for Soil of Metals at DS1

DS1 Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location								DS1-1-00					
Sample ID								DS1-1-0.2-A	DS1-1-0.2-A Dup	DS1-1-2-A	DS1-1-2-A Dup	DS1-1-4-A	DS1-1-4-A Dup
Sample Depth (m)								0.06	0.06	0.61	0.61	1.22	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS1							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Petroleum Hydrocarbons - F1 (C6-C10)	25	µg/g	25	240	NR	< 10	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	µg/g	25	240	NR	< 10	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	µg/g	10	260	NR	< 10	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	µg/g	240	1700	NR	< 50	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	µg/g	120	3300	NR	< 50	-	-	-	-	-	-	-
Reached Baseline at C50	NA	NA	NA	NA	NA	-	-	-	-	-	-	-	-
Organic C by LECO	NA	%	NA	NA	NA	0.81	0.81	-	-	-	-	-	-
TPH Light (C10-C24)	10	µg/g	10	260	NR	**384**	**384**	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	µg/g	120	1700	NR	<100.00	-	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00
Hydrocarbon Material C50-C100	120	µg/g	120	3300	NR	<1000	-	-	-	-	-	-	-
Aroclor 1242	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Aroclor 1248	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Aroclor 1254	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Aroclor 1260	NV	µg/g	NV	NV	NV	< 0.010	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	µg/g	0.3	33	NR	< 0.010	-	-	-	-	-	-	-
PCB in soil	0.3	µg/g	0.3	33	NR	**0.38**	**0.38**	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location		DS1-2-00			DS1-3			DS1-4	
Sample ID		DS1-2-0.2-A	DS1-2-2-A	DS1-2-4-A	DS1-3-0.2-A	DS1-3-2-A	DS1-3-4-A	DS1-4-0.2-A	DS1-4-2.5-A
Sample Depth (m)		0.06	0.61	1.22	0.06	0.61	1.22	0.06	0.76
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark								
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-
Organic C by LECO	NA	-	-	-	-	-	-	-	-
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.00	<100.00	<100.000	<100.00	<100.00	<100.00	<100.00	<100.00
Hydrocarbon Material C50-C100	120	-	-	-	-	-	-	-	-
Aroclor 1242	NV	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location		DS1-5				DS1-6			
Sample ID		DS1-5-0.5-A	DS1-5-1-A	DS1-5-GP1-2.2	DS1-5-GP1-4.5-A	DS1-6-0.33-A	DS1-6-1-A	DS1-6-GP1-2.4-A	DS1-6-GP1-4.5-A
Sample Depth (m)		0.15	0.30	0.67	1.37	0.10	0.30	0.73	1.37
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**								
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-
Organic C by LECO	NA	-	-	-	-	-	-	-	-
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00
Hydrocarbon Material C50-C100	120	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*
Aroclor 1242	NV	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location		**DS1-7**				**DS1-8**			
Sample ID		**DS1-7-0.33-A**	**DS1-7-1-A**	**DS1-7-GP1-2.1-A**	**DS1-7-GP1-4.5-A**	**DS1-8-0.33-A**	**DS1-8-1-A**	**DS1-8-GP1-2.5-A**	**DS1-8-GP1-4.5-A**
Sample Depth (m)		**0.10**	**0.30**	**0.64**	**1.37**	**0.10**	**0.30**	**0.76**	**1.37**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**								
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-
Organic C by LECO	NA	-	-	-	-	-	-	-	-
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00
Hydrocarbon Material C50-C100	120	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*	*<1000*
Aroclor 1242	NV	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location		DS1-9			DS1-10			DS1-11		
Sample ID		DS1-9-0.33-A	DS1-9-GP1-2.6-A	DS1-9-GP1-3.5-A	DS1-10-0.33-A	DS1-10-GP1-1.3-A	DS1-10-GP1-4-A	DS1-11-0.33-A	DS1-11-GP1-2.3-A	DS1-11-GP1-3.5-A
Sample Depth (m)		0.10	0.79	1.07	0.10	0.40	1.22	0.10	0.70	1.07
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**									
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-	-	-
Organic C by LECO	NA	-	-	-	-	-	-	-	-	-
TPH Light (C10-C24)	10	**228**	**326**	**189**	**384**	**348**	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.00	<100.00	<100.00	<100.00	<100.00	<100.00	<100.000	<100.000	<100.000
Hydrocarbon Material C50-C100	120	*<1000*	*<1000*	*<1000*	-	-	-	-	-	-
Aroclor 1242	NV	-	-	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	-	-
PCB in soil	0.3	**0.366**	**0.378**	<0.100	**0.38**	0.265	<0.100	<0.100	<0.100	<0.100

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location		DS1-12			DS1-13		DS1-14	
Sample ID		DS1-12-0.25-A	DS1-12-GP1-2.3-A	DS1-12-GP1-3.5-A	DS1-13-0.33-A	DS1-13-GP1-2.5-A	DS1-14-0.33-A	DS1-14-GP1-2.5-A
Sample Depth (m)		0.08	0.70	1.07	0.10	0.76	0.10	0.76
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**							
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-
Reached Baseline at C50	NA	-	-	-	-	-	-	-
Organic C by LECO	NA	-	-	-	-	-	-	-
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
Hydrocarbon Material C50-C100	120	-	-	-	-	-	-	-
Aroclor 1242	NV	-	-	-	-	-	-	-
Aroclor 1248	NV	-	-	-	-	-	-	-
Aroclor 1254	NV	-	-	-	-	-	-	-
Aroclor 1260	NV	-	-	-	-	-	-	-
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

Location		**DS1-15**			**DS1-16**				**DS1**	
Sample ID		**DS1-15-0-A**	**DS1-15-GP1-1-A**	**DS1-15-GP1-3.5-A**	**DS1-16-0.2-A**	**DS1-16-1.5-A**	**DS1-16-2.5-A**	**DS1-16-4-A**	**DS1-1-16**	**DS1-2-16**
Sample Depth (m)		**0.00**	**0.30**	**1.07**	**0.06**	**0.46**	**0.76**	**1.22**	**0-0.1 m**	**0.3-0.4 m**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Oct-16**	**Oct-16**
Parameter	**Preliminary Benchmark**									
Petroleum Hydrocarbons - F1 (C6-C10)	25	-	-	-	-	-	-	-	< 10	< 10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	-	-	-	-	-	-	-	< 10	< 10
Petroleum Hydrocarbons - F2 (C10-C16)	10	-	-	-	-	-	-	-	< 10	< 10
Petroleum Hydrocarbons - F3 (C16-C34)	240	-	-	-	-	-	-	-	< 50	< 50
Petroleum Hydrocarbons - F4 (C34-C50)	120	-	-	-	-	-	-	-	< 50	< 50
Reached Baseline at C50	NA	-	-	-	-	-	-	-	YES	YES
Organic C by LECO	NA	-	-	-	0.81	0.29	0.42	0.47	-	-
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	-	-
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	-	-
Hydrocarbon Material C50-C100	120	-	-	-	-	-	-	-	-	-
Aroclor 1242	NV	-	-	-	-	-	-	-	< 0.010	< 0.010
Aroclor 1248	NV	-	-	-	-	-	-	-	< 0.010	< 0.010
Aroclor 1254	NV	-	-	-	-	-	-	-	< 0.010	< 0.010
Aroclor 1260	NV	-	-	-	-	-	-	-	< 0.010	< 0.010
Polychlorinated Biphenyls	0.3	-	-	-	-	-	-	-	< 0.010	< 0.010
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	-	-

Table 106 Preliminary Screening for Soil of PHCs & PCBs at DS1

DS1 PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 107 Preliminary Screening for Soil of Extractables at DS1

Location								DS1-16				DS1	
Sample ID								DS1-16-0.2-C	DS1-16-1.5-C	DS1-16-2.5-C	DS1-16-4-C	DS1-1-16	DS1-2-16
Sample Depth (m)								0.06	0.46	0.76	1.22	0-0.1 m	0.3-0.4 m
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16
			MECP	CCME	Ontario	DS1							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.05	-	<0.010	<0.010	<0.010	<0.010	< 0.05	< 0.05
2,3,4,6-Tetrachlorophenol	5	µg/g	NV	5	–	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-
2,3,5,6-Tetrachlorophenol	5	µg/g	NV	5	–	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-
2,3,4,5-Tetrachlorophonol	5	µg/g	NV	5	–	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-
2,3,5-Trichlorophenol	5	µg/g	NV	5	–	<0.008	-	<0.008	<0.008	<0.008	<0.008	-	-
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	< 0.1	-	<0.008	<0.008	<0.008	<0.008	< 0.1	< 0.1
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	< 0.08	-	<0.008	<0.008	<0.008	<0.008	< 0.08	< 0.08
2,3,4-Trichlorophenol	5	µg/g	NV	5	–	<0.008	-	<0.008	<0.008	<0.008	<0.008	-	-
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	< 0.1	-	<0.008	<0.008	<0.008	<0.008	< 0.1	< 0.1
2,6-Dichlorophenol	5	µg/g	NV	5	NR	<0.008	-	<0.008	<0.008	<0.008	<0.008	-	-
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	< 0.2	-	<0.005	<0.005	<0.005	<0.005	< 0.2	< 0.2
2,4-Dinitrophenol	2	µg/g	2	NV	NR	< 0.5	-	<0.100	<0.100	<0.100	<0.100	< 0.5	< 0.5
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.1	-	<0.003	<0.003	<0.003	<0.003	< 0.1	< 0.1
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.1	-	<0.002	<0.002	<0.002	<0.002	< 0.1	< 0.1
2-Chloronaphthalene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-
2-Chlorophenol	0.1	µg/g	0.1	5	NR	< 0.08	-	<0.008	<0.008	<0.008	<0.008	< 0.08	< 0.08
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	< 0.03	-	<0.004	<0.004	<0.004	<0.004	< 0.03	< 0.03
2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.03	-	<0.004	<0.004	<0.004	<0.004	< 0.03	< 0.03
1- & 2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.042	-	-	-	-	-	< 0.042	< 0.042
2-Methylphenol	NV	µg/g	NV	NV	NV	<0.004	-	<0.004	<0.004	<0.004	<0.004	-	-
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	< 0.5	-	<0.020	<0.020	<0.020	<0.020	< 0.5	< 0.5
4-bromophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-
4-Chloro-3-methyl-phenol	NV	µg/g	NV	NV	NV	<0.015	-	<0.015	<0.015	<0.015	<0.015	-	-
4-Chlorophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-
4-Nitrophenol	10	µg/g	NV	10	–	<0.020	-	<0.020	<0.020	<0.020	<0.020	-	-
Acenaphthene	0.072	µg/g	0.072	NV	NR	< 0.03	-	<0.002	<0.002	<0.002	<0.002	< 0.03	< 0.03
Acenaphthylene	0.093	µg/g	0.093	NV	NR	< 0.05	-	<0.002	<0.002	<0.002	<0.002	< 0.05	< 0.05
Anthracene	0.16	µg/g	0.16	32	NR	< 0.03	-	<0.002	<0.002	<0.002	<0.002	< 0.03	< 0.03

Table 107 Preliminary Screening for Soil of Extractables at DS1

Location								DS1-16				DS1	
Sample ID								DS1-16-0.2-C	DS1-16-1.5-C	DS1-16-2.5-C	DS1-16-4-C	DS1-1-16	DS1-2-16
Sample Depth (m)								0.06	0.46	0.76	1.22	0-0.1 m	0.3-0.4 m
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Oct-16	Oct-16
			MECP	CCME	Ontario	DS1							
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected						
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	< 0.05	-	<0.003	<0.003	<0.003	<0.003	< 0.05	< 0.05
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	< 0.05	-	<0.001	<0.001	<0.001	<0.001	< 0.05	< 0.05
Benzo(b)fluoranthene	0.47	µg/g	0.47	10	NR	<0.003	-	<0.003	<0.003	<0.003	<0.003	-	-
Benzo(b,j)fluoranthene	0.47	µg/g	0.47	10	NR	< 0.1	-	-	-	-	-	< 0.1	< 0.1
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	< 0.1	-	<0.003	<0.003	<0.003	<0.003	< 0.1	< 0.1
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	< 0.03	-	<0.003	<0.003	<0.003	<0.003	< 0.03	< 0.03
Benzyl butyl phthalate	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-
Biphenyl	0.05	µg/g	0.05	NV	NR	< 0.05	-	<0.010	<0.010	<0.010	<0.010	< 0.05	< 0.05
bis(2-chloroethoxy)methane	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.003	<0.003	<0.003	<0.003	< 0.2	< 0.2
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	< 0.1	-	<0.001	<0.001	<0.001	<0.001	< 0.1	< 0.1
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	< 1	-	<0.005	<0.005	<0.005	<0.005	< 1	< 1
Chrysene	2.8	µg/g	2.8	NV	NR	< 0.05	-	<0.003	<0.003	<0.003	<0.003	< 0.05	< 0.05
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	< 0.05	-	<0.003	<0.003	<0.003	<0.003	< 0.05	< 0.05
Diethyl phthalate	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.002	<0.002	<0.002	<0.002	< 0.2	< 0.2
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.002	<0.002	<0.002	<0.002	< 0.2	< 0.2
Di-n-butyl Phthalate	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-
Di-n-octyl Phthalate	NV	µg/g	NV	NV	NV	<0.006	-	<0.006	<0.006	<0.006	<0.006	-	-
Fluoranthene	0.56	µg/g	0.56	180	NR	< 0.05	-	<0.003	<0.003	<0.003	<0.003	< 0.05	< 0.05
Fluorene	0.12	µg/g	0.12	NV	NR	< 0.03	-	<0.002	<0.002	<0.002	<0.002	< 0.03	< 0.03
Hexachlorobenzene	0.01	µg/g	0.01	10	–	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-
Hexachlorobutadiene	0.01	µg/g	0.01	NV	–	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	-
Hexachlorocyclopentadiene	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020	<0.020	-	-
Hexachloroethane	0.01	µg/g	0.01	NV	–	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*	*<0.020*	-	-
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	< 0.08	-	<0.006	<0.006	<0.006	<0.006	< 0.08	< 0.08
Isophorone	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001	<0.001	-	-
Naphthalene	0.013	µg/g	0.09	0.013	NR	*< 0.03*	-	<0.001	<0.001	<0.001	<0.001	*< 0.03*	*< 0.03*
Nitrobenzene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002	<0.002	-	-
N-Nitrosodi-n-propylamine	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001	<0.001	-	-
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	< 0.2	-	<0.020	<0.020	<0.020	<0.020	< 0.2	< 0.2
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	< 0.1	-	<0.010	<0.010	<0.010	<0.010	< 0.1	< 0.1
Phenanthrene	0.046	µg/g	0.69	0.046	NR	*< 0.05*	-	<0.002	<0.002	<0.002	<0.002	*< 0.05*	*< 0.05*
Phenol	0.5	µg/g	0.5	3.8	NR	< 0.09	-	<0.004	<0.004	<0.004	<0.004	< 0.09	< 0.09
Pyrene	1	µg/g	1	100	NR	< 0.05	-	<0.002	<0.002	<0.002	<0.002	< 0.05	< 0.05
Diphenylamines (total)	NV	µg/g	NV	NV	NV	<0.008	-	<0.008	<0.008	<0.008	<0.008	-	-

Table 107 Preliminary Screening for Soil of Extractables at DS1

DS1 Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MOECC Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 108 Preliminary Screening for Soil of VOCs at DS1

Location								DS1-16			
Sample ID								DS1-16-0.2-C	DS1-16-1.5-C	DS1-16-2.5-C	DS1-16-4-C
Sample Depth (m)								0.06	0.46	0.76	1.22
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS1					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected				
1,1,1,2-Tetrachlroethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
1,1,1-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,2-Dibromoethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
1,3-Dichloropropene, Total	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	<0.002	<0.002	<0.002	<0.002
Acetone	0.5	µg/g	0.5	NV	NR	< 0.50	-	-	-	-	-
Benzene	0.02	µg/g	0.02	0.03	NR	< 0.020	-	-	-	-	-
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
Bromoform	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
Bromomethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
Chlorobenzene	0.05	µg/g	0.05	10	NR	< 0.050	-	-	-	-	-

Table 108 Preliminary Screening for Soil of VOCs at DS1

Location								**DS1-16**			
Sample ID								**DS1-16-0.2-C**	**DS1-16-1.5-C**	**DS1-16-2.5-C**	**DS1-16-4-C**
Sample Depth (m)								**0.06**	**0.46**	**0.76**	**1.22**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**DS1**					
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**				
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
Chloroform	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	< 0.030	-	-	-	-	-
Dichlorodifluoromethane	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
Dichloromethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	< 0.020	-	-	-	-	-
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	< 0.50	-	-	-	-	-
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	< 0.50	-	-	-	-	-
methyl t-Butyl Ether	0.05	µg/g	0.05	NV	NR	< 0.050	-	-	-	-	-
n-Hexane	0.05	µg/g	0.05	6.5	NR	< 0.050	-	-	-	-	-
Styrene	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	< 0.050	-	-	-	-	-
Toluene	0.2	µg/g	0.2	0.37	NR	< 0.020	-	-	-	-	-
trans-1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.050	-	-	-	-	-
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	< 0.040	-	-	-	-	-
Trichloroethene	0.01	µg/g	0.05	0.01	NR	*< 0.050*	-	-	-	-	-
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	< 0.050	-	-	-	-	-
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	< 0.020	-	-	-	-	-
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	< 0.020	-	-	-	-	-
o-Xylene	NV	µg/g	NV	NV	NV	< 0.020	-	-	-	-	-
Xylenes, Total	0.05	µg/g	0.05	11	NR	< 0.020	-	-	-	-	-

Table 108 Preliminary Screening for Soil of VOCs at DS1

Location		DS1	
Sample ID		DS1-1-16	DS1-2-16
Sample Depth (m)		0-0.1 m	0.3-0.4 m
Date Sampled		Oct-16	Oct-16
Parameter	Preliminary Benchmark		
1,1,1,2-Tetrachlroethane	0.05	< 0.050	< 0.050
1,1,1-Trichloroethane	0.05	< 0.050	< 0.050
1,1,2,2-Tetrachloroethane	0.05	< 0.050	< 0.050
1,1,2-Trichloroethane	0.05	< 0.050	< 0.050
1,1-Dichloroethane	0.05	< 0.050	< 0.050
1,1-Dichloroethylene	0.05	< 0.050	< 0.050
1,2-Dibromoethane	0.05	< 0.050	< 0.050
1,2-Dichlorobenzene	0.05	< 0.050	< 0.050
1,2-Dichloroethane	0.05	< 0.050	< 0.050
1,2-Dichloropropane	0.05	< 0.050	< 0.050
1,3-Dichlorobenzene	0.05	< 0.050	< 0.050
1,3-Dichloropropene, Total	0.05	< 0.050	< 0.050
1,4-Dichlorobenzene	0.05	< 0.050	< 0.050
Acetone	0.5	< 0.50	< 0.50
Benzene	0.02	< 0.020	< 0.020
Bromodichloromethane	0.05	< 0.050	< 0.050
Bromoform	0.05	< 0.050	< 0.050
Bromomethane	0.05	< 0.050	< 0.050
Carbon Tetrachloride	0.05	< 0.050	< 0.050
Chlorobenzene	0.05	< 0.050	< 0.050

Table 108 Preliminary Screening for Soil of VOCs at DS1

Location		DS1	
Sample ID		DS1-1-16	DS1-2-16
Sample Depth (m)		0-0.1 m	0.3-0.4 m
Date Sampled		Oct-16	Oct-16
Parameter	Preliminary Benchmark		
Chlorodibromomethane	0.05	< 0.050	< 0.050
Chloroform	0.05	< 0.050	< 0.050
cis-1,2-Dichloroethene	0.05	< 0.050	< 0.050
cis-1,3-Dichloropropene [a]	0.05	< 0.030	< 0.030
Dichlorodifluoromethane	0.05	< 0.050	< 0.050
Dichloromethane	0.05	< 0.050	< 0.050
Ethylbenzene	0.05	< 0.020	< 0.020
Methyl Ethyl Ketone	0.5	< 0.50	< 0.50
Methyl Isobutyl Ketone	0.5	< 0.50	< 0.50
methyl t-Butyl Ether	0.05	< 0.050	< 0.050
n-Hexane	0.05	< 0.050	< 0.050
Styrene	0.05	< 0.050	< 0.050
Tetrachloroethene	0.05	< 0.050	< 0.050
Toluene	0.2	< 0.020	< 0.020
trans-1,2-Dichloroethane	0.05	< 0.050	< 0.050
trans-1,3-Dichloropropene [a]	0.05	< 0.040	< 0.040
Trichloroethene	0.01	*< 0.050*	*< 0.050*
Trichlorofluoromethane	0.25	< 0.050	< 0.050
Vinyl Chloride	0.02	< 0.020	< 0.020
m-Xylene + p-Xylene	NV	< 0.020	< 0.020
o-Xylene	NV	< 0.020	< 0.020
Xylenes, Total	0.05	< 0.020	< 0.020

Table 108 Preliminary Screening for Soil of VOCs at DS1

DS1 VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.7 Distribution Station #2 (DS2)

Table 109 Preliminary Screening for Soil of Metals at DS2

Location								DS2-1			DS2-2		DS2-3			
Sample ID								-	-	-	-	-	-	-	DS2-3-GP1	
Sample Depth (m)								0.06	0.30	0.61	0.06	0.30	0.06	0.61	0.91	1.40
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS2										
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	MOE OTR_{98} [3]	Maximum	Maximum Detected									
Arsenic	12	µg/g	18	12	18	2	2	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	2	1
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	8.87	8.87	8.81	8.71	-	8.78	8.74	8.75	8.68	-	-

Location		DS2-4						DS2-5			DS2-6				
Sample ID		-	-	-	-	-	-	-	-	-	-	-	DS2-6-GP1		
Sample Depth (m)		0.06	0.06	0.76	0.76	1.22	1.22	0.06	0.30	0.61	0.06	0.30	0.61	0.91	1.40
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark														
Arsenic	12	-	1	2	2	2	2	1.548	<1.000	1.142	<1.000	<1.000	<1.000	1	2
pH	5 to 9	-	8.87	8.26	8.26	8.44	8.44	8.45	8.4	8.56	8.3	8.56	-	-	-

Table 109 Preliminary Screening for Soil of Metals at DS2

Location		**DS2-7**				**DS2-8**				**DS2-9**				
Sample ID		-	-	**DS2-7-GP1**		-	-	**DS2-8-GP1**		-	-	**DS2-9-GP1**		
Sample Depth (m)		**0.06**	**0.46**	**0.85**	**1.40**	**0.06**	**0.61**	**1.01**	**1.40**	**0.06**	**0.30**	**0.61**	**0.98**	**1.40**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
Arsenic	12	<1.000	<1.000	1	1	<1.000	<1.000	2	1	-	<1.000	2	2	1
pH	5 to 9	8.2	8.51	-	-	8.39	8.12	-	-	8.18	8.59	-	-	-

Table 109 Preliminary Screening for Soil of Metals at DS2

DS2 Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

r; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 110 Preliminary Screening for Soil of PHCs & PCBs at DS2

Location								DS2-1			DS2-2	
Sample ID								-	-	-	-	-
Sample Depth (m)								0.06	0.30	0.61	0.06	0.30
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS2						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
TPH Light (C10-C24)	10	µg/g	10	260	NR	<10.000	-	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	µg/g	120	1700	NR	<100.000	-	<100.000	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	µg/g	0.3	33	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100

Location		DS2-3				DS2-4						DS2-5		
Sample ID		-	-	DS2-3-GP1		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.61	0.91	1.40	0.06	0.06	0.76	0.76	1.22	1.22	0.06	0.30	0.61
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark													
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 110 Preliminary Screening for Soil of PHCs & PCBs at DS2

Location		**DS2-6**					**DS2-7**				**DS2-8**			
Sample ID		-	-	**DS2-6-GP1**			-	-	**DS2-7-GP1**		-	-	**DS2-8-GP1**	
Sample Depth (m)		**0.06**	**0.30**	**0.61**	**0.91**	**1.40**	**0.06**	**0.46**	**0.85**	**1.40**	**0.06**	**0.61**	**1.01**	**1.40**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**													
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Location		**DS2-9**				
Sample ID		-	-	**DS2-9-GP1**		
Sample Depth (m)		**0.06**	**0.30**	**0.61**	**0.98**	**1.40**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**					
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100

Table 110 Preliminary Screening for Soil of PHCs & PCBs at DS2

DS2 PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.8 Distribution Station #4 (DS4)

Table 111 Preliminary Screening for Soil of Metals at DS4

Table 111 Preliminary Screening for Soil of Metals at DS4

Location								DS4-1				
Sample ID								-	-	-	DS4-1-GP1	
Sample Depth (m)								0.06	0.30	0.61	0.91	1.37
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS4						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
Antimony	1.3	µg/g	1.3	40	0.99	<1.0	-	-	-	-	-	-
Arsenic	12	µg/g	18	12	18	2.949	2.949	<1.000	2	<1.000	<1.000	<1.000
Barium	220	µg/g	220	2000	180	33.612	33.612	-	-	-	-	-
Beryllium	2.5	µg/g	2.5	8	0.99	0.255	0.255	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	0.57	0.57	-	-	-	-	-
Cadmium	1.2	µg/g	1.2	22	1.2	<0.200	-	-	-	-	-	-
Chromium	70	µg/g	70	87	63	14.444	14.444	-	-	-	-	-
Cobalt	21	µg/g	21	300	17	4.749	4.749	-	-	-	-	-
Copper	91	µg/g	92	91	66	10.938	10.938	-	-	-	-	-
Iron	34000	µg/g	NV	NV	34000	11000	11000	-	-	-	-	-
Lead	120	µg/g	120	600	1500	8.359	8.359	-	-	-	-	-
Manganese	1400	µg/g	NV	NV	1400	422.457	422.457	-	-	-	-	-
Mercury	0.27	µg/g	0.27	50	0.27	0.016	0.016	-	-	-	-	-
Molybdenum	2	µg/g	2	40	1.3	<1.000	-	-	-	-	-	-
Nickel	82	µg/g	82	89	50	12.352	12.352	-	-	-	-	-
Selenium	1.5	µg/g	1.5	2.9	1.1	<1.0	-	-	-	-	-	-
Silver	0.5	µg/g	0.5	40	0.33	<0.250	-	-	-	-	-	-
Sodium	1000	µg/g	NV	NV	1000	310	310	-	-	-	-	-
Thallium	1	µg/g	1	1	NV	<0.500	-	-	-	-	-	-
Titanium	4700	µg/g	NV	NV	4700	199.141	199.141	-	-	-	-	-
Uranium	2.5	µg/g	2.5	300	1.9	0.657	0.657	-	-	-	-	-
Vanadium	86	µg/g	86	130	72	17.454	17.454	-	-	-	-	-
Zinc	290	µg/g	290	410	180	45.754	45.754	-	-	-	-	-
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	8.75	8.75	8.21	8.22	7.97	-	-

Table 111 Preliminary Screening for Soil of Metals at DS4

Location		DS4-2				DS4-3				DS4-4			
Sample ID		-	-	DS4-2-GP1		-	-	DS4-3-GP1		-	-	DS4-4-GP1	
Sample Depth (m)		0.06	0.61	0.91	1.40	0.06	0.91	1.07	1.40	0.06	0.46	0.91	1.40
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**												
Antimony	1.3	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	12	<1.000	<1.000	2	2	2	<1.000	1	1	<1.000	<1.000	2	1
Barium	220	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-	-	-	-	-	-	-
Iron	34000	-	-	-	-	-	-	-	-	-	-	-	-
Lead	120	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-	-	-	-	-	-	-
pH	5 to 9	8.36	8.24	-	-	8.4	8.45	-	-	8.22	8.25	-	-

Table 111 Preliminary Screening for Soil of Metals at DS4

Location		DS4-5				DS4-6	
Sample ID		-	-	DS4-5-GP1		-	-
Sample Depth (m)		0.06	0.61	0.91	1.40	0.30	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	**Preliminary Benchmark**						
Antimony	1.3	-	-	-	-	-	-
Arsenic	12	<1.000	<1.000	1	1	<1.000	<1.000
Barium	220	-	-	-	-	-	-
Beryllium	2.5	-	-	-	-	-	-
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-
Cadmium	1.2	-	-	-	-	-	-
Chromium	70	-	-	-	-	-	-
Cobalt	21	-	-	-	-	-	-
Copper	91	-	-	-	-	-	-
Iron	34000	-	-	-	-	-	-
Lead	120	-	-	-	-	-	-
Manganese	1400	-	-	-	-	-	-
Mercury	0.27	-	-	-	-	-	-
Molybdenum	2	-	-	-	-	-	-
Nickel	82	-	-	-	-	-	-
Selenium	1.5	-	-	-	-	-	-
Silver	0.5	-	-	-	-	-	-
Sodium	1000	-	-	-	-	-	-
Thallium	1	-	-	-	-	-	-
Titanium	4700	-	-	-	-	-	-
Uranium	2.5	-	-	-	-	-	-
Vanadium	86	-	-	-	-	-	-
Zinc	290	-	-	-	-	-	-
pH	5 to 9	8.69	8.75	-	-	8.59	8.53

Table 111 Preliminary Screening for Soil of Metals at DS4

Location		DS4-7			DS4-8			DS4-BG		
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.30	0.91	0.06	0.61	0.91	0.06	0.61	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
Antimony	1.3	-	-	-	-	-	-	<1.0	<1.0	<1.0
Arsenic	12	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	2.949	2.428	2.112
Barium	220	-	-	-	-	-	-	33.612	23.394	21.054
Beryllium	2.5	-	-	-	-	-	-	0.252	<0.200	0.255
Boron - Hot Water Ext. [a]	2	-	-	-	-	-	-	0.57	0.48	0.33
Cadmium	1.2	-	-	-	-	-	-	<0.200	<0.200	<0.200
Chromium	70	-	-	-	-	-	-	14.444	9.116	9.737
Cobalt	21	-	-	-	-	-	-	4.749	3.613	3.53
Copper	91	-	-	-	-	-	-	10.938	8.961	8.277
Iron	34000	-	-	-	-	-	-	11000	9200	9300
Lead	120	-	-	-	-	-	-	8.359	6.045	5.431
Manganese	1400	-	-	-	-	-	-	422.457	360.991	242.949
Mercury	0.27	-	-	-	-	-	-	0.016	0.011	0.011
Molybdenum	2	-	-	-	-	-	-	<1.000	<1.000	<1.000
Nickel	82	-	-	-	-	-	-	12.352	8.796	9.123
Selenium	1.5	-	-	-	-	-	-	<1.0	<1.0	<1.0
Silver	0.5	-	-	-	-	-	-	<0.250	<0.250	<0.250
Sodium	1000	-	-	-	-	-	-	310	310	310
Thallium	1	-	-	-	-	-	-	<0.500	<0.500	<0.500
Titanium	4700	-	-	-	-	-	-	199.141	176.491	192.393
Uranium	2.5	-	-	-	-	-	-	0.639	0.657	0.601
Vanadium	86	-	-	-	-	-	-	17.454	12.65	12.365
Zinc	290	-	-	-	-	-	-	45.754	30.405	31.475
pH	5 to 9	8.06	8.37	8.59	8.02	8.53	7.65	8.13	8.5	8.2

Table 111 Preliminary Screening for Soil of Metals at DS4

DS4 Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter;

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 112 Preliminary Screening for Soil of PHCs & PCBs at DS4

Location								**DS4-1**				
Sample ID								-	-	-	**DS4-1-GP1**	
Sample Depth (m)								**0.06**	**0.30**	**0.61**	**0.91**	**1.37**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**DS4**						
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**					
Organic C by LECO	NA	%	NA	NA	NA	0.41	0.41	-	-	-	-	-
TPH Light (C10-C24)	10	µg/g	10	260	NR	**12**	**12**	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	µg/g	120	1700	NR	<100.000	-	<100.000	<100.000	<100.000	<100.000	<100.000
PCB in soil	0.3	µg/g	0.3	33	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100	<0.100

Location		**DS4-2**				**DS4-3**				**DS4-4**			
Sample ID		-	-	**DS4-2-GP1**		-	-	**DS4-3-GP1**		-	-	**DS4-4-GP1**	
Sample Depth (m)		**0.06**	**0.61**	**0.91**	**1.40**	**0.06**	**0.91**	**1.07**	**1.40**	**0.06**	**0.46**	**0.91**	**1.40**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												
Organic C by LECO	NA	-	-	-	-	-	-	-	-	-	-	-	-
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 112 Preliminary Screening for Soil of PHCs & PCBs at DS4

Location		**DS4-5**				**DS4-6**		**DS4-7**			**DS4-8**			**DS4-BG**		
Sample ID		-	-	**DS4-5-GP1**		-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**0.61**	**0.91**	**1.40**	**0.30**	**0.91**	**0.06**	**0.30**	**0.91**	**0.06**	**0.61**	**0.91**	**0.06**	**0.61**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**															
Organic C by LECO	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	0.41	0.34
TPH Light (C10-C24)	10	**11**	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	**12**	**12**	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCB in soil	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 112 Preliminary Screening for Soil of PHCs & PCBs at DS4

DS4 PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

Table 113 Preliminary Screening for Soil of Extractables at DS4

Location								DS4-BG		
Sample ID								DS4-BG-0.2-D	DS4-BG-2-D	DS4-BG-3-D
Sample Depth (m)								0.06	0.61	0.91
Date Sampled								Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS4				
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected			
Phenol	0.5	µg/g	0.5	3.8	NR	<0.004	-	<0.004	<0.004	<0.004
2-Chlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008
2-Methylphenol	NV	µg/g	NV	NV	NV	<0.004	-	<0.004	<0.004	<0.004
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	<0.005	-	<0.005	<0.005	<0.005
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008
2,6-Dichlorophenol	5	µg/g	NV	5	NR	<0.008	-	<0.008	<0.008	<0.008
4-Chloro-3-methyl-phenol	NV	µg/g	NV	NV	NV	<0.015	-	<0.015	<0.015	<0.015
2,3,5-Trichlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	<0.008	-	<0.008	<0.008	<0.008
2,3,4-Trichlorophenol	5	µg/g	NV	5	--	<0.008	-	<0.008	<0.008	<0.008
2,4-Dinitrophenol	2	µg/g	2	NV	NR	<0.100	-	<0.100	<0.100	<0.100
4-Nitrophenol	10	µg/g	NV	10	--	<0.020	-	<0.020	<0.020	<0.020
2,3,4,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005
2,3,5,6-Tetrachlorophenol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005
2,3,4,5-Tetrachloropheonol	5	µg/g	NV	5	--	<0.005	-	<0.005	<0.005	<0.005
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	<0.010	-	<0.010	<0.010	<0.010
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	<0.003	-	<0.003	<0.003	<0.003
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	<0.001	-	<0.001	<0.001	<0.001

Table 113 Preliminary Screening for Soil of Extractables at DS4

Location								DS4-BG		
Sample ID								DS4-BG-0.2-D	DS4-BG-2-D	DS4-BG-3-D
Sample Depth (m)								0.06	0.61	0.91
Date Sampled								Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS4				
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected			
N-Nitrosodi-n-propylamine	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001
Hexachloroethane	0.01	µg/g	0.01	NV	--	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*
Nitrobenzene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002
Isophorone	NV	µg/g	NV	NV	NV	<0.001	-	<0.001	<0.001	<0.001
bis(2-chloroethoxy)methane	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	<0.010	-	<0.010	<0.010	<0.010
Naphthalene	0.013	µg/g	0.09	0.013	NR	<0.001	-	<0.001	<0.001	<0.001
Hexachlorobutadiene	0.01	µg/g	0.01	NV	--	*<0.020*	-	*<0.020*	*<0.020*	*<0.020*
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	<0.004	-	<0.004	<0.004	<0.004
2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	<0.004	-	<0.004	<0.004	<0.004
Hexachlorocyclopentadiene	NV	µg/g	NV	NV	NV	<0.020	-	<0.020	<0.020	<0.020
2-Chloronaphthalene	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002
Biphenyl	0.05	µg/g	0.05	NV	NR	<0.010	-	<0.010	<0.010	<0.010
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	<0.003	-	<0.003	<0.003	<0.003
Acenaphthylene	0.093	µg/g	0.093	NV	NR	<0.002	-	<0.002	<0.002	<0.002
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	<0.002	-	<0.002	<0.002	<0.002
Acenaphthene	0.072	µg/g	0.072	NV	NR	<0.002	-	<0.002	<0.002	<0.002
Fluorene	0.12	µg/g	0.12	NV	NR	<0.002	-	<0.002	<0.002	<0.002
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	<0.002	-	<0.002	<0.002	<0.002
Diethyl Phthalate	0.5	µg/g	0.5	NV	NR	<0.002	-	<0.002	<0.002	<0.002
4-Chlorophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003
4-Bromophenyl Phenyl Ether	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003

Table 113 Preliminary Screening for Soil of Extractables at DS4

Location								DS4-BG		
Sample ID								DS4-BG-0.2-D	DS4-BG-2-D	DS4-BG-3-D
Sample Depth (m)								0.06	0.61	0.91
Date Sampled								Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS4				
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected			
Hexachlorobenzene	10	µg/g	0.01	10	--	<0.005	-	<0.005	<0.005	<0.005
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	<0.020	-	<0.020	<0.020	<0.020
Phenanthrene	0.046	µg/g	0.69	0.046	NR	<0.002	-	<0.002	<0.002	<0.002
Anthracene	0.16	µg/g	0.16	32	NR	<0.002	-	<0.002	<0.002	<0.002
Diphenylamines (total)	NV	µg/g	NV	NV	NV	<0.008	-	<0.008	<0.008	<0.008
Di-n-butyl Phthalate	NV	µg/g	NV	NV	NV	<0.005	-	<0.005	<0.005	<0.005
Fluoranthene	0.56	µg/g	0.56	180	NR	<0.003	-	<0.003	<0.003	<0.003
Pyrene	1	µg/g	1	100	NR	<0.002	-	<0.002	<0.002	<0.002
Benzyl Butyl Phthalate	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	<0.003	-	<0.003	<0.003	<0.003
Chrysene	2.8	µg/g	2.8	NV	NR	<0.003	-	<0.003	<0.003	<0.003
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	<0.005	-	<0.005	<0.005	<0.005
Di-n-octyl phthalate	NV	µg/g	NV	NV	NV	<0.006	-	<0.006	<0.006	<0.006
Benzo(b)fluoranthene	0.47	µg/g	0.47	10	NR	<0.003	-	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	<0.003	-	<0.003	<0.003	<0.003
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	<0.001	-	<0.001	<0.001	<0.001
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	<0.020	-	<0.020	<0.020	<0.020
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	<0.006	-	<0.006	<0.006	<0.006
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	<0.003	-	<0.003	<0.003	<0.003
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	<0.003	-	<0.003	<0.003	<0.003

Table 113 Preliminary Screening for Soil of Extractables at DS4

DS4 Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 114 Preliminary Screening for Soil of VOCs at DS4

Location								**DS4-BG**		
Sample ID								**DS4-BG-0.2-A**	**DS4-BG-2-A**	**DS4-BG-3-A**
Sample Depth (m)								**0.06**	**0.61**	**0.91**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**DS4**				
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**			
Chloromethane	NV	µg/g	NV	NV	NV	<0.003	-	<0.003	<0.003	<0.003
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	<0.003	-	<0.003	<0.003	<0.003
Bromomethane	0.05	µg/g	0.05	NV	NR	<0.003	-	<0.003	<0.003	<0.003
Chloroethane	NV	µg/g	NV	NV	NV	<0.002	-	<0.002	<0.002	<0.002
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	<0.004	-	<0.004	<0.004	<0.004
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002
Acetone	0.5	µg/g	0.5	NV	NR	<0.105	-	<0.105	<0.105	<0.105
Dichloromethane	0.05	µg/g	0.05	50	NR	<0.003	-	<0.003	<0.003	<0.003
trans-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	<0.003	-	<0.003	<0.003	<0.003
Methyl t-Butyl-Ether	0.05	µg/g	0.05	NV	NR	<0.015	-	<0.015	<0.015	<0.015
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	<0.003	-	<0.003	<0.003	<0.003
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	<0.008	-	<0.008	<0.008	<0.008
Chloroform	0.05	µg/g	0.05	50	NR	<0.003	-	<0.003	<0.003	<0.003
1,1,1-Trichloroethane	0.05	µg/g	0.05	50	NR	<0.003	-	<0.003	<0.003	<0.003
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002
Benzene	0.02	µg/g	0.02	0.03	NR	<0.002	-	<0.002	<0.002	<0.002
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002

Table 114 Preliminary Screening for Soil of VOCs at DS4

Location								**DS4-BG**		
Sample ID								**DS4-BG-0.2-A**	**DS4-BG-2-A**	**DS4-BG-3-A**
Sample Depth (m)								**0.06**	**0.61**	**0.91**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**DS4**				
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**			
Trichloroethene	0.01	µg/g	0.05	0.01	NR	<0.003	-	<0.003	<0.003	<0.003
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	<0.002	-	<0.002	<0.002	<0.002
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	<0.003	-	<0.003	<0.003	<0.003
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	<0.070	-	<0.070	<0.070	<0.070
Toluene	0.2	µg/g	0.2	0.37	NR	0.01	0.01	0.01	0.01	0.01
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	<0.002	-	<0.002	<0.002	<0.002
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	<0.002	-	<0.002	<0.002	<0.002
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	**0.08**	**0.08**	**0.08**	<0.002	<0.002
1,2-Dibromoethane	0.05	µg/g	0.05	NV	NR	<0.002	-	<0.002	<0.002	<0.002
Chlorobenzene	0.05	µg/g	0.05	10	NR	<0.003	-	<0.003	<0.003	<0.003
1,1,1,2-Tetrachlroethane	0.05	µg/g	0.05	NV	NR	<0.002	-	<0.002	<0.002	<0.002
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	0.01	0.01	0.01	0.01	<0.002
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	**0.07**	**0.07**	**0.07**	**0.04**	**0.02**
o-Xylene	NV	µg/g	NV	NV	NV	**0.04**	**0.04**	**0.04**	**0.03**	**0.01**
Xylenes, Total	0.05	µg/g	0.05	11	NR	**0.11**	**0.11**	**0.11**	**0.07**	0.03
Styrene	0.05	µg/g	0.05	50	NR	<0.002	-	<0.002	<0.002	<0.002
Bromoform	0.05	µg/g	0.05	NV	NR	<0.002	-	<0.002	<0.002	<0.002
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	<0.003	-	<0.003	<0.003	<0.003
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	<0.002	-	<0.002	<0.002	<0.002
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	0.01	0.01	0.01	<0.002	<0.002
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	0.02	0.02	0.02	<0.001	<0.001

Table 114 Preliminary Screening for Soil of VOCs at DS4

DS4 VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.9 Distribution Station #5 (DS5)

Table 115 Preliminary Screening for Soil of Metals at DS5

Location								DS5-1		
Sample ID								-	-	-
Sample Depth (m)								0.06	0.30	0.61
Date Sampled								Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS5				
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected			
Arsenic	12	µg/g	18	12	18	2	2	1.194	<1.000	1.083
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	**9.05**	**9.05**	8.17	8.08	7.93

Location		DS5-2						DS5-3			DS5-4		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.30	0.30	0.61	0.61	1.07	1.07	0.06	0.61	0.91	0.06	0.61	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
Arsenic	12	1.507	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	1.329	1.143	1.568	1.348	1.082
pH	5 to 9	8.72	8.82	8.17	8.61	8.04	7.63	6.96	6.96	**9.05**	8.27	8.37	8.69

Table 115 Preliminary Screening for Soil of Metals at DS5

Location		DS5-5								DS5-6		DS5-7			DS5-8		
Sample ID		-	-	-	-	DS5-5-GP1				-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.30	0.91	1.22	1.07	1.40	0.06	0.06	0.06	0.30	0.06	0.61	1.22	0.06	0.46	0.91
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark																
Arsenic	12	1.519	1.008	1.635	<1.000	1	2	1.344	1.39	1.46	1.311	1.192	<1.000	<1.000	<1.000	<1.000	<1.000
pH	5 to 9	7.92	8.26	8.06	8.47	-	-	8.48	8.69	8.5	8.42	8.43	8.65	8.86	7.96	8.36	8.71

Table 115 Preliminary Screening for Soil of Metals at DS5

DS5 Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 116 Preliminary Screening for Soil of PHCs & PCBs at DS5

Location								DS5-1		
Sample ID								-	-	-
Sample Depth (m)								0.06	0.30	0.61
Date Sampled								Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS5				
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected			
TPH Light (C10-C24)	10	µg/g	10	260	NR	<10.000	-	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	µg/g	120	1700	NR	<100.000	-	<100.000	<100.000	<100.000
Hydrocarbon Material C50-100	120	µg/g	120	3300	NR	*<1000*	-	-	-	-
PCBs	0.3	µg/g	0.3	33	NR	<0.100	-	<0.100	<0.100	<0.100

Location		DS5-2						DS5-3			DS5-4		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.30	0.30	0.61	0.61	1.07	1.07	0.06	0.61	0.91	0.06	0.61	1.22
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark												
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
Hydrocarbon Material C50-100	120	-	-	-	-	-	-	-	-	-	-	-	-
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 116 Preliminary Screening for Soil of PHCs & PCBs at DS5

Location		**DS5-5**								**DS5-6**		**DS5-7**			**DS5-8**		
Sample ID		-	-	-	-	**DS5-5-GP1**				-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**0.30**	**0.91**	**1.22**	**1.07**	**1.40**	**0.06**	**0.06**	**0.06**	**0.30**	**0.06**	**0.61**	**1.22**	**0.06**	**0.46**	**0.91**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**																
TPH Light (C10-C24)	10	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
Hydrocarbon Material C50-100	120	-	-	-	-	*<1000*	*<1000*	-	-	-	-	-	-	-	-	-	-
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 116 Preliminary Screening for Soil of PHCs & PCBs at DS5

DS5 PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter

SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.1.10 Distribution Station #8 (DS8)

Table 117 Preliminary Screening for Soil of Metals at DS8

Location								**DS8-1**		**DS8-2**		**DS8-3**		**DS8-4**		
Sample ID								-	-	-	-	-	-	-	-	-
Sample Depth (m)								**0.06**	**0.91**	**0.06**	**0.91**	**0.06**	**0.91**	**0.06**	**0.30**	**0.76**
Date Sampled								**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
			MECP	**CCME**	**Ontario**	**DS8**										
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**									
Arsenic	12	µg/g	18	12	18	2.74	2.74	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	1.896	1.403	<1.000
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	**9.28**	**9.28**	8.91	8.47	8.83	**9.12**	8.83	8.6	8.01	8.36	8.81

Location		**DS8-5**			**DS8-6**						**DS8-7**		
Sample ID		-	-	-	-	-	-	-	-	-	-	-	-
Sample Depth (m)		**0.06**	**0.30**	**0.76**	**0.06**	**0.06**	**0.30**	**0.30**	**0.76**	**0.76**	**0.06**	**0.30**	**0.76**
Date Sampled		**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**	**Apr-00**
Parameter	**Preliminary Benchmark**												#
Arsenic	12	1.377	1.292	<1.000	1.879	1.849	2.162	2.74	<1.000	<1.000	1.531	2.173	1.855
pH	5 to 9	8.09	8.04	8.64	7.83	7.79	8.43	8.36	**9.24**	**9.28**	7.9	8.06	8.5

Table 117 Preliminary Screening for Soil of Metals at DS8

DS8 Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 118 Preliminary Screening for Soil of PHCs & PCBs at DS8

Location								DS8-1		DS8-2	
Sample ID								-	-	-	-
Sample Depth (m)								0.06	0.91	0.06	0.91
Date Sampled								Apr-00	Apr-00	Apr-00	Apr-00
			MECP	CCME	Ontario	DS8					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected				
TPH Light (C10-C24)	10	µg/g	10	260	NR	**50**	**50**	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	µg/g	120	1700	NR	<100.000	-	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	µg/g	0.3	33	NR	<0.100	-	<0.100	<0.100	<0.100	<0.100

Location		DS8-3		DS8-4			DS8-5		
Sample ID		-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.91	0.06	0.30	0.76	0.06	0.30	0.76
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark								
TPH Light (C10-C24)	10	<10.000	<10.000	**24**	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 118 Preliminary Screening for Soil of PHCs & PCBs at DS8

Location		DS8-6						DS8-7		
Sample ID		-	-	-	-	-	-	-	-	-
Sample Depth (m)		0.06	0.06	0.30	0.30	0.76	0.76	0.06	0.30	0.76
Date Sampled		Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00	Apr-00
Parameter	Preliminary Benchmark									
TPH Light (C10-C24)	10	**23**	**50**	**28**	<10.000	<10.000	<10.000	<10.000	<10.000	<10.000
TPH Heavy (C24-C50)	120	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000	<100.000
PCBs	0.3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Table 118 Preliminary Screening for Soil of PHCs & PCBs at DS8

DS8 PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

In absence of guidelines for TPH, guidelines for PHC were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

5.1.11 General Soil Samples (BPS/SS)

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

Location								**BPS-01-07**	**BPS-02-07**	**BPS-04-07**	**BPS-05-07**
Sample ID								**-**	**-**	**-**	**-**
Sample Depth (m)								**0-0.1 m**	**0-0.1 m**	**0-0.1 m**	**0-0.1 m**
Date Sampled								**3-Aug-07**	**3-Aug-07**	**3-Aug-07**	**3-Aug-07**
			MECP	**CCME**	**Ontario**	**BPS**					
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS** [1]	**CCME SQG** [2]	**OTR_{98}** [3]	**Maximum**	**Maximum Detected**	**Location** [1]	**Location** [1]	**Location** [1]	**Location** [1]
Metals											
Aluminum	26000	µg/g	NV	NV	26000	8100	8100	2700	3000	1900	8100
Antimony	1.3	µg/g	1.3	40	0.99	0.8	0.8	0.8	<0.2	0.5	0.2
Arsenic	12	µg/g	18	12	18	5	5	5	2	4	4
Barium	220	µg/g	220	2000	180	65	65	38	18	41	62
Beryllium	2.5	µg/g	2.5	8	0.99	0.61	0.61	<0.2	<0.2	<0.2	0.4
Boron, Total	36	µg/g	36	NV	26	15	15	-	-	-	-
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	**6.56**	**6.56**	0.58	0.39	**6.56**	1.04
Cadmium	1.2	µg/g	1.2	22	1.2	**1.5**	**1.5**	1	<0.1	**1.5**	0.7
Calcium	49000	µg/g	NV	NV	49000	**96000**	**96000**	41000	**76000**	26000	38000
Chromium	70	µg/g	70	87	63	26	26	5	9	4	15
Hexavalent Chromium	0.66	µg/g	0.66	1.4	NV	< 0.2	-	-	-	-	-
Cobalt	21	µg/g	21	300	17	9.7	9.7	1.2	2.8	2.4	6.2
Copper	91	µg/g	92	91	66	49	49	13	5.9	49	15
Iron	34000	µg/g	NV	NV	34000	16000	16000	4000	7200	6700	16000
Lead	120	µg/g	120	600	1500	59	59	59	4	26	20
Magnesium	15000	µg/g	NV	NV	15000	**38000**	**38000**	13000	**21000**	3000	**21000**
Manganese	1400	µg/g	NV	NV	1400	770	770	170	220	210	770
Mercury	0.27	µg/g	0.27	50	0.27	0.27	0.27	0.27	<0.05	0.24	0.06
Molybdenum	2	µg/g	2	40	1.3	1.8	1.8	0.5	<0.5	1.8	<0.5

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

Location								**BPS-01-07**	**BPS-02-07**	**BPS-04-07**	**BPS-05-07**
Sample ID								**-**	**-**	**-**	**-**
Sample Depth (m)								**0-0.1 m**	**0-0.1 m**	**0-0.1 m**	**0-0.1 m**
Date Sampled								**3-Aug-07**	**3-Aug-07**	**3-Aug-07**	**3-Aug-07**
			MECP	**CCME**	**Ontario**	**BPS**					
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**	**Location [1]**	**Location [1]**	**Location [1]**	**Location [1]**
Nickel	82	µg/g	82	89	50	20	20	7.8	6	12	12
Phosphorus	1500	µg/g	NV	NV	1500	1100	1100	510	330	1100	600
Potassium	4900	µg/g	NV	NV	4900	**1300**	1300	330	380	290	960
Selenium	1.5	µg/g	1.5	2.9	1.1	**2.8**	**2.8**	1.4	<0.5	**2.8**	0.6
Silver	0.5	µg/g	0.5	40	0.33	0.3	0.3	0.3	<0.2	0.3	0.2
Sodium	1000	µg/g	NV	NV	1000	**25000**	**25000**	<100	260	<100	<100
Strontium	77	µg/g	NV	NV	77	**110**	**110**	**92**	**110**	51	30
Thallium	1	µg/g	1	1	NV	0.13	0.13	0.1	<0.05	0.09	0.12
Titanium	4700	µg/g	NV	NV	4700	260	260	230	220	68	260
Uranium	2.5	µg/g	2.5	300	1.9	**13**	**13**	0.45	0.35	**13**	0.46
Vanadium	86	µg/g	86	130	72	31	31	13	13	29	25
Zinc	290	µg/g	290	410	180	110	110	81	27	95	110
Inorganics											
Total Ammonia-N	NV	µg/g	NV	NV	NV	<25	-	<25	<25	<25	<25
Conductivity	0.57	mS/cm	0.57	200	--	**1.07**	**1.07**	0.5	**0.725**	**1.07**	0.32
Orthophosphate	NV	µg/g	NV	NV	NV	**17**	**17**	**10**	**0.9**	**17**	**3.2**
Available (CaCl2) pH	5 to 9	pH	5 to 9	6 to 8	7.5	7.69	7.69	6.6	7.3	5.8	6.9
Fluoride	2000	µg/g	NV	2000	--	<10	-	<10	<10	<10	<10
Nitrite	NV	µg/g	NV	NV	NV	**1.8**	**1.8**	<0.5	<0.5	**1**	<0.5
Chloride	130	µg/g	NA	NV	130	**392**	**392**	**185**	**253**	**392**	28
Nitrate	NV	µg/g	NV	NV	NV	**77**	**77**	<2	<2	**77**	<2
Nitrate + Nitrite	NV	µg/g	NV	NV	NV	**78**	**78**	<3	<3	**78**	<3
Bromide	NV	µg/g	NV	NV	NV	<20	-	<20	<20	<20	<20
Sulphate	NV	µg/g	NV	NV	NV	**22600**	**22600**	**58**	**115**	**22600**	<20
Cyanide (free)	0.051	µg/g	0.051	0.9	-	**0.07**	**0.07**	-	-	-	-
Conductivity	0.57	mS/cm	0.57	200	-	0.32	0.32	-	-	-	-
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	7.69	7.69	-	-	-	-
Sodium Adsorption Ratio	2.4	SAR	2.4	5	-	1.1	1.1	-	-	-	-

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

Location		BPS-06-07	BPS-07-07	BPS-08-07	BPS-01-16		BPS-02-16		BPS-04-16	
Sample ID		-	-	-	BPS-01-01	BPS-01-02	BPS-02-01	DUP2-1	BPS-04-1	BPS-04-2
Sample Depth (m)		0-0.1 m	0-0.1 m	0-0.1 m	0-0.1 m	0.15-0.25 m	0-0.1 m	0-0.1 m	0-0.1 m	0.2-0.35 m
Date Sampled		3-Aug-07	3-Aug-07	3-Aug-07	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16
Parameter	Preliminary Benchmark	Location [1]	Location [1]	Location [1]	Off access road in middle of EWC				Off roadway in EWC, within poplar forest	
Metals										
Aluminum	26000	4000	6400	1200	-	-	-	-	-	-
Antimony	1.3	<0.2	<0.2	<0.2	< 0.20	< 0.20	< 0.20	< 0.20	0.27	0.22
Arsenic	12	3	3	<1	1.5	1.2	1.8	1.2	3.1	2.1
Barium	220	27	40	4	11	19	23	21	27	11
Beryllium	2.5	0.2	0.3	<0.2	< 0.20	< 0.20	< 0.20	< 0.20	0.32	< 0.20
Boron, Total	36	-	-	-	7.3	9.1	8.5	8.1	6.6	8
Boron - Hot Water Ext. [a]	2	1.39	1.16	0.06	0.24	0.59	0.3	0.29	0.28	0.16
Cadmium	1.2	0.4	0.2	<0.1	0.21	0.47	0.11	0.17	0.37	< 0.10
Calcium	49000	47000	**96000**	46000	**53000**	**49900**	28700	30000	41100	15600
Chromium	70	10	15	4	6.1	2.7	8.8	8	12	10
Hexavalent Chromium	0.66	-	-	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Cobalt	21	3.4	5.4	1.2	1.8	0.95	3.2	2.9	5.2	2.2
Copper	91	12	14	2.3	6.6	5.4	11	9.2	8.8	3.7
Iron	34000	8300	13000	3500	-	-	-	-	-	-
Lead	120	13	9	2	4.8	18	7.2	8.2	16	4.5
Magnesium	15000	**25000**	**38000**	**26000**	**19400**	**15600**	4300	4300	14300	4400
Manganese	1400	330	600	140	-	-	-	-	-	-
Mercury	0.27	0.05	<0.05	<0.05	< 0.050	0.061	< 0.050	< 0.050	< 0.050	< 0.050
Molybdenum	2	<0.5	<0.5	<0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

Location		BPS-06-07	BPS-07-07	BPS-08-07	BPS-01-16		BPS-02-16		BPS-04-16	
Sample ID		-	-	-	BPS-01-01	BPS-01-02	BPS-02-01	DUP2-1	BPS-04-1	BPS-04-2
Sample Depth (m)		0-0.1 m	0-0.1 m	0-0.1 m	0-0.1 m	0.15-0.25 m	0-0.1 m	0-0.1 m	0-0.1 m	0.2-0.35 m
Date Sampled		3-Aug-07	3-Aug-07	3-Aug-07	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16
Parameter	**Preliminary Benchmark**	**Location [1]**	**Location [1]**	**Location [1]**	**Off access road in middle of EWC**				**Off roadway in EWC, within poplar forest**	
Nickel	82	7.2	11	2.4	5.7	4.3	7.9	7.3	9.1	4.6
Phosphorus	1500	600	640	190	-	-	-	-	-	-
Potassium	4900	630	1300	<200	-	-	-	-	-	-
Selenium	1.5	0.6	0.6	<0.5	< 0.50	< 0.50	< 0.50	< 0.50	0.52	< 0.50
Silver	0.5	<0.2	<0.2	<0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Sodium	1000	<100	140	<100	*< 5000*	*< 5000*	**21000**	**25000**	**8000**	**5000**
Strontium	77	44	72	22	-	-	-	-	-	-
Thallium	1	0.06	0.09	<0.05	< 0.050	0.053	0.055	0.058	0.095	< 0.050
Titanium	4700	140	240	110	-	-	-	-	-	-
Uranium	2.5	0.87	0.55	0.19	0.32	0.68	0.51	0.5	0.45	0.57
Vanadium	86	15	20	9	9	7.3	12	12	29	17
Zinc	290	46	42	12	29	39	29	28	55	13
Inorganics					-	-	-	-	-	-
Total Ammonia-N	NV	<25	<25	<25	-	-	-	-	-	-
Conductivity	0.57	0.2	0.285	0.12	-	-	-	-	-	-
Orthophosphate	NV	**2.5**	**1.3**	**1.3**	-	-	-	-	-	-
Available (CaCl2) pH	5 to 9	7.1	7.3	7.6	6.87	7.04	7.16	7.16	6.94	7.33
Fluoride	2000	<10	<10	<10	-	-	-	-	-	-
Nitrite	NV	<0.5	**1.8**	<0.5	-	-	-	-	-	-
Chloride	130	28	33	72	-	-	-	-	-	-
Nitrate	NV	<2	**25**	<2	-	-	-	-	-	-
Nitrate + Nitrite	NV	<3	**27**	<3	-	-	-	-	-	-
Bromide	NV	<20	<20	<20	-	-	-	-	-	-
Sulphate	NV	<20	<20	**72**	-	-	-	-	-	-
Cyanide (free)	0.051	-	-	-	0.03	0.03	< 0.01	0.01	0.04	< 0.01
Conductivity	0.57	-	-	-	0.32	0.3	0.24	0.24	0.29	0.11
pH	5 to 9	-	-	-	6.87	7.04	7.16	7.16	6.94	7.33
Sodium Adsorption Ratio	2.4	-	-	-	0.15	0.16	0.98	1.1	0.28	0.3

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

Location		BPS-05-16		BPS-06-16		BPS-07-16		BPS-08-16	
Sample ID		**BPS-05-1**	**BPS-05-2**	**BPS-06-1**	**BPS-06-2**	**BPS-07-1**	**BPS-07-2**	**BPS-08-1**	**BPS-08-2**
Sample Depth (m)		**0-0.1 m**	**0.2-0.35 m**	**0-0.1 m**	**0.15-0.25 m**	**0-0.1 m**	**0.3-0.4 m**	**0-0.1 m**	**0.3-0.4 m**
Date Sampled		**26-Oct-16**	**26-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**26-Oct-16**	**26-Oct-16**
Parameter	**Preliminary Benchmark**	**Disturbed area located under a powerline**		**Laydown area / old storage area**		**Near north guard shack**		**Location [1]**	**Location [1]**
Metals									
Aluminum	26000	-	-	-	-	-	-	-	-
Antimony	1.3	< 0.20	< 0.20	0.23	0.5	0.26	< 0.20	< 0.20	0.41
Arsenic	12	1.4	1.1	2	1.8	3.1	1.3	1.5	2.1
Barium	220	23	6.6	12	14	65	12	41	57
Beryllium	2.5	0.23	< 0.20	< 0.20	< 0.20	0.61	< 0.20	0.39	0.43
Boron, Total	36	6.5	< 5.0	5.9	5.5	15	< 5.0	12	15
Boron - Hot Water Ext. [a]	2	0.49	0.051	0.3	0.25	0.38	0.052	0.75	0.18
Cadmium	1.2	0.2	< 0.10	0.14	0.14	0.22	0.1	0.27	< 0.10
Calcium	49000	35400	16700	20100	24100	46100	21300	37700	24000
Chromium	70	13	7.5	9.8	9.9	26	8.2	17	23
Hexavalent Chromium	0.66	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Cobalt	21	4	2.2	4.3	2.8	9.7	2.6	5.3	7.4
Copper	91	10	6.5	11	13	15	7.9	22	17
Iron	34000	-	-	-	-	-	-	-	-
Lead	120	9.1	2.1	7.8	5.7	13	3.6	7.9	5.7
Magnesium	15000	5200	3000	3500	4500	10700	5300	8700	4300
Manganese	1400	-	-	-	-	-	-	-	-
Mercury	0.27	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Molybdenum	2	< 0.50	< 0.50	0.7	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

Location		BPS-05-16		BPS-06-16		BPS-07-16		BPS-08-16	
Sample ID		**BPS-05-1**	**BPS-05-2**	**BPS-06-1**	**BPS-06-2**	**BPS-07-1**	**BPS-07-2**	**BPS-08-1**	**BPS-08-2**
Sample Depth (m)		**0-0.1 m**	**0.2-0.35 m**	**0-0.1 m**	**0.15-0.25 m**	**0-0.1 m**	**0.3-0.4 m**	**0-0.1 m**	**0.3-0.4 m**
Date Sampled		**26-Oct-16**	**26-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**26-Oct-16**	**26-Oct-16**
Parameter	**Preliminary Benchmark**	**Disturbed area located under a powerline**		**Laydown area / old storage area**		**Near north guard shack**		**Location [1]**	**Location [1]**
Nickel	82	11	5.3	7.3	8.4	20	6.9	14	18
Phosphorus	1500	-	-	-	-	-	-	-	-
Potassium	4900	-	-	-	-	-	-	-	-
Selenium	1.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.55	< 0.50
Silver	0.5	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Sodium	1000	*< 5000*	*< 5000*	*< 5000*	*< 5000*	**7000**	**10000**	*< 5000*	*< 5000*
Strontium	77	-	-	-	-	-	-	-	-
Thallium	1	0.075	< 0.050	< 0.050	< 0.050	0.13	0.051	0.07	0.097
Titanium	4700	-	-	-	-	-	-	-	-
Uranium	2.5	0.42	0.3	0.49	0.45	0.58	0.45	1.7	0.72
Vanadium	86	19	15	12	14	31	13	23	25
Zinc	290	63	20	96	49	61	36	40	30
Inorganics		-	-	-	-	-	-	-	-
Total Ammonia-N	NV	-	-	-	-	-	-	-	-
Conductivity	0.57	-	-	-	-	-	-	-	-
Orthophosphate	NV	-	-	-	-	-	-	-	-
Available (CaCl2) pH	5 to 9	7.02	7.53	7.06	7.29	7.08	7.69	7.17	7.66
Fluoride	2000	-	-	-	-	-	-	-	-
Nitrite	NV	-	-	-	-	-	-	-	-
Chloride	130	-	-	-	-	-	-	-	-
Nitrate	NV	-	-	-	-	-	-	-	-
Nitrate + Nitrite	NV	-	-	-	-	-	-	-	-
Bromide	NV	-	-	-	-	-	-	-	-
Sulphate	NV	-	-	-	-	-	-	-	-
Cyanide (free)	0.051	0.02	< 0.01	0.01	< 0.01	0.02	< 0.01	**0.07**	< 0.01
Conductivity	0.57	0.2	0.081	0.12	0.13	0.26	0.13	0.23	0.17
pH	5 to 9	7.02	7.53	7.06	7.29	7.08	7.69	7.17	7.66
Sodium Adsorption Ratio	2.4	0.21	0.3	0.27	0.25	0.23	0.49	0.19	0.25

Table 119 Preliminary Screening for Soil of Metals at BPS Sites

BPS Metal & Inorganic Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

1 - This location is considered to represent suitable ecological habitat

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no Tier 1 Benchmark
1 (shaded)	Denotes detected concentration exceeding Tier 1 Benchmark
<0.05 (shaded)	Denotes detection limit exceeding Tier 1 Benchmark

Table 120 Preliminary Screening for Soil of Metals at SS Sites

Location								**SS-1**		**SS-2**		**SS-3**
Sample ID								**SS1-1**	**SS1-2**	**SS2-1**	**SS2-2**	**SS3-1**
Date Sampled								**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**
			MECP	**CCME**	**Ontario**	**SS**						
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**					
Antimony	1.3	µg/g	1.3	40	0.99	0.58	0.58	< 0.20	< 0.20	0.39	0.21	< 0.20
Arsenic	12	µg/g	18	12	18	6	6	1.8	5	6	5.3	4.9
Barium	220	µg/g	220	2000	180	50	50	13	48	49	34	43
Beryllium	2.5	µg/g	2.5	8	0.99	0.5	0.5	< 0.20	0.5	0.45	0.42	0.36
Boron, Total	36	µg/g	36	NV	26	12	12	7.3	11	10	10	8.1
Boron - Hot Water Ext. [a]	2	µg/g	2	NV	NV	0.74	0.74	0.43	0.21	0.66	0.26	0.35
Cadmium	1.2	µg/g	1.2	22	1.2	0.61	0.61	0.15	0.39	0.61	0.33	0.25
Calcium	49000	µg/g	NV	NV	49000	41300	41300	41300	28100	31200	26300	35800
Chromium	70	µg/g	70	87	63	21	21	5.8	21	20	17	15
Hexavalent Chromium	0.66	µg/g	0.66	1.4	NV	< 0.2	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Cobalt	21	µg/g	21	300	17	8.3	8.3	2.3	7	7.8	6.9	8.3
Copper	91	µg/g	92	91	66	16	16	7.3	13	16	13	10
Lead	120	µg/g	120	600	1500	**130**	**130**	4.8	11	19	9	14
Magnesium	15000	µg/g	NV	NV	15000	**16200**	**16200**	9500	4800	11400	7600	6600
Mercury	0.27	µg/g	0.27	50	0.27	0.091	0.091	< 0.050	0.091	0.09	0.067	< 0.050
Molybdenum	2	µg/g	2	40	1.3	0.67	0.67	< 0.50	0.67	< 0.50	< 0.50	< 0.50
Nickel	82	µg/g	82	89	50	18	18	5.1	15	18	15	11
Selenium	1.5	µg/g	1.5	2.9	1.1	0.51	0.51	< 0.50	< 0.50	0.51	< 0.50	< 0.50
Silver	0.5	µg/g	0.5	40	0.33	0.22	0.22	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Sodium	1000	µg/g	NV	NV	1000	*< 5000*	-	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*
Thallium	1	µg/g	1	1	NV	0.17	0.17	0.081	0.16	0.17	0.15	0.13
Uranium	2.5	µg/g	2.5	300	1.9	0.91	0.91	0.91	0.85	0.67	0.72	0.5
Vanadium	86	µg/g	86	130	72	36	36	10	36	34	31	24
Zinc	290	µg/g	290	410	180	89	89	22	65	89	58	60
Cyanide (free)	0.051	µg/g	0.051	0.9	-	0.03	0.03	0.02	< 0.01	0.03	< 0.01	0.01
Conductivity	0.57	mS/cm	0.57	200	-	0.27	0.27	0.27	0.16	0.22	0.16	0.19
pH	5 to 9	pH units	5 to 9	6 to 8	7.5	7.55	7.55	7.3	7.36	7.26	7.43	7.36
Sodium Adsorption Ratio	2.4	SAR	2.4	5	-	0.36	0.36	0.18	0.23	0.19	0.22	0.2

Table 120 Preliminary Screening for Soil of Metals at SS Sites

Location		**SS-4**				**SS-5**		**SS-6**		**SS-7**		**SS-8**	
Sample ID		**DUP3-1**	**DUP3-2**	**SS4-1**	**SS4-2**	**SS5-1**	**SS5-2**	**SS6-1**	**SS6-2**	**SS7-1**	**SS7-2**	**SS8-1**	**SS8-2**
Date Sampled		**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**	**Oct-16**
Parameter	**Preliminary Benchmark**												
Antimony	1.3	0.58	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	0.24	< 0.20	< 0.20	< 0.20	0.28	< 0.20
Arsenic	12	1.8	1.7	2.3	1.5	1.7	2.4	2.4	2.1	1.7	1.6	1.6	< 1.0
Barium	220	14	9.7	16	7.3	13	45	36	13	22	50	6.7	4.1
Beryllium	2.5	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	0.34	0.21	< 0.20	< 0.20	0.4	< 0.20	< 0.20
Boron, Total	36	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	12	6.9	7.8	5.9	11	< 5.0	< 5.0
Boron - Hot Water Ext. [a]	2	0.68	0.15	0.74	0.14	0.5	0.15	0.45	0.12	0.49	0.11	0.3	0.091
Cadmium	1.2	0.12	< 0.10	0.12	< 0.10	< 0.10	< 0.10	0.27	< 0.10	0.21	< 0.10	0.13	< 0.10
Calcium	49000	23500	13700	27100	14900	28400	26100	29000	18200	30300	18500	24300	9200
Chromium	70	7.2	6.5	7.9	6.3	5.3	16	11	9.8	9.8	21	4.8	5.3
Hexavalent Chromium	0.66	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Cobalt	21	2.1	1.9	2.3	1.9	1.6	5.2	3.2	3	2.7	6.2	1.6	1.3
Copper	91	4.1	4.3	5	4.1	2	12	8.9	5.9	6.5	10	3	1
Lead	120	5.9	2.6	7	2.5	2.1	5.3	**130**	5.6	11	5.4	13	1.6
Magnesium	15000	6900	3400	7100	3900	4500	3000	5200	3000	**16200**	4400	8400	3200
Mercury	0.27	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Molybdenum	2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Nickel	82	4.6	4.3	5.2	4.3	5.1	13	6.9	6.6	6.9	16	4.1	3.3
Selenium	1.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Silver	0.5	0.22	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Sodium	1000	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*	*< 5000*
Thallium	1	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.076	0.073	< 0.050	0.054	0.094	< 0.050	< 0.050
Uranium	2.5	0.23	0.27	0.25	0.31	0.28	0.57	0.34	0.37	0.33	0.43	0.22	0.21
Vanadium	86	11	9.7	12	10	7.8	20	15	15	13	22	7.3	6.3
Zinc	290	23	15	27	13	14	25	76	19	31	24	16	7.3
Cyanide (free)	0.051	0.02	< 0.01	0.02	< 0.01	0.03	< 0.01	0.02	< 0.01	0.03	< 0.01	0.03	< 0.01
Conductivity	0.57	0.15	0.059	0.18	0.068	0.19	0.16	0.16	0.092	0.22	0.13	0.17	0.061
pH	5 to 9	6.95	7.19	6.95	7.29	7.26	7.38	7.36	7.55	7.11	7.54	7.15	7.2
Sodium Adsorption Ratio	2.4	0.23	0.31	0.22	0.3	0.23	0.25	0.22	0.29	0.18	0.27	0.22	0.36

Table 120 Preliminary Screening for Soil of Metals at SS Sites

SS Metal Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

a In absence of Table 1 SCS, Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Coarse Textured Soils for Industrial/Commercial/Community Property Use were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1 (shaded)	Denotes detected concentration exceeding preliminary benchmark
<0.05 (shaded)	Denotes detection limit exceeding preliminary benchmark

Table 121 Preliminary Screening for Soil of PHCs & PCBs at BPS Sites

Location								**BPS-01-07**	**BPS-02-07**	**BPS-04-07**
Sample ID								**BPS 01**	**BPS 02**	**BPS 04**
Sample Depth (m)								**0-0.1 m**	**0-0.1 m**	**0-0.1 m**
Date Sampled								**3-Aug-07**	**3-Aug-07**	**3-Aug-07**
			MECP	**CCME**	**Ontario**	**BPS**				
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**CCME SQG [2]**	**OTR_{98} [3]**	**Maximum**	**Maximum Detected**	**Location [1]**	**Location [1]**	**Location [1]**
Petroleum Hydrocarbons										
Benzene	0.02	µg/g	0.02	0.03	NR	*<0.1*	-	<0.02	<0.02	*<0.1*
Toluene	0.2	µg/g	0.2	0.37	NR	<0.1	-	<0.02	<0.02	<0.1
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	*<0.1*	-	<0.02	<0.02	*<0.1*
o-Xylene	NV	µg/g	NV	NV	NV	<0.1	-	<0.02	<0.02	<0.1
p+m-Xylene	NV	µg/g	NV	NV	NV	<0.2	-	<0.04	<0.04	<0.2
Total Xylenes	0.05	µg/g	0.05	11	NR	*<0.2*	-	<0.04	<0.04	*<0.2*
F1 (C6-C10)	25	µg/g	25	240	NR	*<50*	12	<10	<10	*<50*
F1 (C6-C10) - BTEX	25	µg/g	25	240	NR	*<50*	12	<10	<10	*<50*
F2 (C10-C16 Hydrocarbons)	10	µg/g	10	260	NR	**500**	**500**	**500**	<10	*<50*
F3 (C16-C34 Hydrocarbons)	240	µg/g	240	1700	NR	**1500**	**1500**	**1500**	14	**480**
F4 (C34-C50 Hydrocarbons)	120	µg/g	120	3300	NR	**1400**	**1400**	**1400**	<10	**150**
Petroleum Hydrocarbons - F4 Gravimetric	120	µg/g	120	3300	NR	**490**	**490**	-	-	-
Reached Baseline at C50	NA	µg/g	NA	NA	NA	-	-	No	Yes	Yes

Table 121 Preliminary Screening for Soil of PHCs & PCBs at BPS Sites

Location		**BPS-05-07**	**BPS-06-07**	**BPS-07-07**	**BPS-08-07**	**BPS-01-16**		**BPS-02-16**		**BPS-04-16**	
Sample ID		**BPS 05**	**BPS 06**	**BPS 07**	**BPS 08**	**BPS-01-01**	**BPS-01-02**	**BPS-02-01**	**DUP2-1**	**BPS-04-1**	**BPS-04-2**
Sample Depth (m)		**0-0.1 m**	**0-0.1 m**	**0-0.1 m**	**0-0.1 m**	**0-0.1 m**	**0.15-0.25 m**	**0-0.1 m**	**0-0.1 m**	**0-0.1 m**	**0.2-0.35 m**
Date Sampled		**3-Aug-07**	**3-Aug-07**	**3-Aug-07**	**3-Aug-07**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**	**27-Oct-16**
Parameter	**Preliminary Benchmark**	**Location [1]**	**Location [1]**	**Location [1]**	**Location [1]**	**Off access road in middle of EWC**				**Off roadway in EWC, within poplar forest**	
Petroleum Hydrocarbons											
Benzene	0.02	<0.02	<0.02	<0.02	<0.02	*< 0.040*	< 0.020	< 0.020	< 0.020	*< 0.040*	< 0.020
Toluene	0.2	<0.02	<0.02	<0.02	<0.02	< 0.040	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
Ethylbenzene	0.05	<0.02	<0.02	<0.02	<0.02	< 0.040	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
o-Xylene	NV	<0.02	<0.02	<0.02	<0.02	< 0.040	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
p+m-Xylene	NV	<0.04	<0.04	<0.04	<0.04	< 0.080	< 0.040	< 0.040	< 0.040	< 0.080	< 0.040
Total Xylenes	0.05	<0.04	<0.04	<0.04	<0.04	*< 0.080*	< 0.040	< 0.040	< 0.040	*< 0.080*	< 0.040
F1 (C6-C10)	25	12	<10	<10	<10	< 20	< 10	< 10	< 10	< 20	< 10
F1 (C6-C10) - BTEX	25	12	<10	<10	<10	< 20	< 10	< 10	< 10	< 20	< 10
F2 (C10-C16 Hydrocarbons)	10	**28**	<10	<10	<10	**80**	**31**	< 10	< 10	**35**	< 10
F3 (C16-C34 Hydrocarbons)	240	140	68	29	<10	180	54	< 50	< 50	110	< 50
F4 (C34-C50 Hydrocarbons)	120	57	26	<10	<10	87	< 50	< 50	< 50	52	< 50
Petroleum Hydrocarbons - F4 Gravimetric	120	-	-	-	-	**490**	-	-	-	-	-
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	NO	YES	YES	YES	YES	YES

Table 121 Preliminary Screening for Soil of PHCs & PCBs at BPS Sites

Location		BPS-05-16		BPS-06-16		BPS-07-16		BPS-08-16	
Sample ID		BPS-05-1	BPS-05-2	BPS-06-1	BPS-06-2	BPS-07-1	BPS-07-2	BPS-08-1	BPS-08-2
Sample Depth (m)		0-0.1 m	0.2-0.35 m	0-0.1 m	0.15-0.25 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m
Date Sampled		26-Oct-16	26-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16	27-Oct-16	26-Oct-16	26-Oct-16
Parameter	**Preliminary Benchmark**	**Disturbed area located under a powerline**		**Laydown area / old storage area**		**Near north guard shack**		**Location [1]**	**Location [1]**
Petroleum Hydrocarbons									
Benzene	0.02	*< 0.040*	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Toluene	0.2	< 0.040	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Ethylbenzene	0.05	< 0.040	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
o-Xylene	NV	< 0.040	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
p+m-Xylene	NV	< 0.080	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040
Total Xylenes	0.05	*< 0.080*	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040
F1 (C6-C10)	25	< 20	< 10	< 10	< 10	< 10	< 10	< 10	< 10
F1 (C6-C10) - BTEX	25	< 20	< 10	< 10	< 10	< 10	< 10	< 10	< 10
F2 (C10-C16 Hydrocarbons)	10	< 10	< 10	**21**	< 10	10	< 10	< 10	< 10
F3 (C16-C34 Hydrocarbons)	240	< 50	< 50	88	< 50	55	< 50	< 50	< 50
F4 (C34-C50 Hydrocarbons)	120	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Petroleum Hydrocarbons - F4 Gravimetric	120	-	-	-	-	-	-	-	-
Reached Baseline at C50	NA	YES	YES	YES	YES	YES	YES	YES	YES

Table 121 Preliminary Screening for Soil of PHCs & PCBs at BPS Sites

BPS PHC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

- = not analyzed

1 - This location is considered to represent suitable ecological habitat and thought to be free of industrial activity.

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no Tier 1 Benchmark
1	Denotes detected concentration exceeding Tier 1 Benchmark
<0.05	Denotes detection limit exceeding Tier 1 Benchmark

Table 122 Preliminary Screening for Soil of PHCs & PCBs at SS Sites

Location								SS-1		SS-2		SS-3
Sample ID								SS1-1	SS1-2	SS2-1	SS2-2	SS3-1
Sample Depth (m)								0-0.1 m	0.2-0.3 m	0-0.1 m	0.3-0.4 m	0-0.1 m
Date Sampled								Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
			MECP	CCME	Ontario	SS						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
Petroleum Hydrocarbons - F1 (C6-C10)	25	µg/g	25	240	NR	< 20	-	< 10	< 10	< 10	< 10	< 10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	µg/g	25	240	NR	< 10	-	< 10	< 10	< 10	< 10	< 10
Petroleum Hydrocarbons - F2 (C10-C16)	10	µg/g	10	260	NR	**150**	**150**	**32**	**12**	< 10	< 10	< 10
Petroleum Hydrocarbons - F3 (C16-C34)	240	µg/g	240	1700	NR	110	110	56	< 50	< 50	< 50	57
Petroleum Hydrocarbons - F4 (C34-C50)	120	µg/g	120	3300	NR	< 100	-	< 50	< 50	< 50	< 50	< 50
Reached Baseline at C50	NA	NA	NA	NA	NA	-	-	YES	YES	YES	YES	YES
Aroclor 1242	NV	µg/g	NV	NV	NV	< 0.020	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Aroclor 1248	NV	µg/g	NV	NV	NV	< 0.020	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Aroclor 1254	NV	µg/g	NV	NV	NV	< 0.020	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Aroclor 1260	NV	µg/g	NV	NV	NV	< 0.020	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCBs	0.3	µg/g	0.3	33	NR	< 0.020	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

Table 122 Preliminary Screening for Soil of PHCs & PCBs at SS Sites

Location		SS-4				SS-5		SS-6		SS-7		SS-8	
Sample ID		DUP3-1	DUP3-2	SS4-1	SS4-2	SS5-1	SS5-2	SS6-1	SS6-2	SS7-1	SS7-2	SS8-1	SS8-2
Sample Depth (m)		0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.25-0.35 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.2-0.3 m
Date Sampled		Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark												
Petroleum Hydrocarbons - F1 (C6-C10)	25	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20	< 10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	25	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Petroleum Hydrocarbons - F2 (C10-C16)	10	< 10	< 10	< 10	< 10	< 10	< 10	**20**	< 10	**150**	< 10	*< 20*	< 10
Petroleum Hydrocarbons - F3 (C16-C34)	240	59	< 50	< 50	< 50	< 50	< 50	57	< 50	110	< 50	< 100	< 50
Petroleum Hydrocarbons - F4 (C34-C50)	120	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 100	< 50
Reached Baseline at C50	NA	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Aroclor 1242	NV	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010
Aroclor 1248	NV	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010
Aroclor 1254	NV	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010
Aroclor 1260	NV	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010
PCBs	0.3	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020	< 0.010

Table 122 Preliminary Screening for Soil of PHCs & PCBs at SS Sites

SS PHC & PCB Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 123 Preliminary Screening for Soil of Extractables at SS Sites

Location								SS-1		SS-2		SS-3
Sample ID								SS1-1	SS1-2	SS2-1	SS2-2	SS3-1
Sample Depth (m)								0-0.1 m	0.2-0.3 m	0-0.1 m	0.3-0.4 m	0-0.1 m
Date Sampled								Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
			MECP	CCME	Ontario	SS						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
1,2,4-Trichlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.1*	-	< 0.05	< 0.05	*< 0.1*	< 0.05	< 0.05
2,4,6-Trichlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	< 0.1	< 0.1	*< 0.2*	< 0.1	< 0.1
2,4,5-Trichlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	< 0.08	< 0.08	*< 0.2*	< 0.08	< 0.08
2,4-Dichlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	< 0.1	< 0.1	*< 0.2*	< 0.1	< 0.1
2,4-Dimethylphenol	0.2	µg/g	0.2	NV	NR	*< 0.4*	-	< 0.2	< 0.2	*< 0.4*	< 0.2	< 0.2
2,4-Dinitrophenol	2	µg/g	2	NV	NR	< 1	-	< 0.5	< 0.5	< 1	< 0.5	< 0.5
2,4-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.2	-	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
2,6-Dinitrotoluene	0.5	µg/g	0.5	NV	NR	< 0.2	-	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
2-Chlorophenol	0.1	µg/g	0.1	5	NR	*< 0.2*	-	< 0.08	< 0.08	*< 0.2*	< 0.08	< 0.08
1-Methylnapthalene	0.59	µg/g	0.59	NV	NR	< 0.06	-	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03
2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.06	-	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03
1- & 2-Methylnaphthalene	0.59	µg/g	0.59	NV	NR	< 0.085	-	< 0.042	< 0.042	< 0.085	< 0.042	< 0.042
3,3'-Dichlorobenzidine	1	µg/g	1	NV	NR	< 1	-	< 0.5	< 0.5	< 1	< 0.5	< 0.5
Acenaphthene	0.072	µg/g	0.072	NV	NR	< 0.06	-	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03
Acenaphthylene	0.093	µg/g	0.093	NV	NR	*< 0.1*	-	< 0.05	< 0.05	*< 0.1*	< 0.05	< 0.05
Anthracene	0.16	µg/g	0.16	32	NR	< 0.06	-	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03
Benzo(a)anthracene	0.36	µg/g	0.36	10	NR	< 0.1	-	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05

Table 123 Preliminary Screening for Soil of Extractables at SS Sites

Location								SS-1		SS-2		SS-3
Sample ID								SS1-1	SS1-2	SS2-1	SS2-2	SS3-1
Sample Depth (m)								0-0.1 m	0.2-0.3 m	0-0.1 m	0.3-0.4 m	0-0.1 m
Date Sampled								Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
			MECP	CCME	Ontario	SS						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
Benzo(a)pyrene	0.3	µg/g	0.3	72	NR	< 0.1	-	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05
Benzo(b,j)fluoranthene	0.47	µg/g	0.47	10	NR	< 0.2	-	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Benzo(g,h,i)perylene	0.68	µg/g	0.68	NV	NR	< 0.2	-	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Benzo(k)fluoranthene	0.48	µg/g	0.48	10	NR	< 0.06	-	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03
Biphenyl	0.05	µg/g	0.05	NV	NR	*< 0.1*	-	< 0.05	< 0.05	*< 0.1*	< 0.05	< 0.05
bis(2-chloroethyl)ether	0.5	µg/g	0.5	NV	NR	< 0.4	-	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2
bis(2-chlorisopropyl)ether	0.5	µg/g	0.5	NV	NR	< 0.2	-	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
bis(2-ethylhexyl)phthalate	5	µg/g	5	NV	NR	< 2	-	< 1	< 1	< 2	< 1	< 1
Chrysene	2.8	µg/g	2.8	NV	NR	< 0.1	-	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05
Dibenzo(a,h)anthracene	0.1	µg/g	0.1	10	NR	< 0.1	-	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05
Diethyl phthalate	0.5	µg/g	0.5	NV	NR	< 0.4	-	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2
Dimethylphthalate	0.5	µg/g	0.5	NV	NR	< 0.4	-	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2
Fluoranthene	0.56	µg/g	0.56	180	NR	< 0.1	-	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05
Fluorene	0.12	µg/g	0.12	NV	NR	< 0.06	-	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03
Indeno(1,2,3-cd)pyrene	0.23	µg/g	0.23	10	NR	< 0.2	-	< 0.08	< 0.08	< 0.2	< 0.08	< 0.08
Naphthalene	0.013	µg/g	0.09	0.013	NR	*< 0.06*	-	*< 0.03*	*< 0.03*	*< 0.06*	*< 0.03*	*< 0.03*
p-Chloroanaline	0.5	µg/g	0.5	NV	NR	< 0.4	-	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2
Pentachlorophenol	0.1	µg/g	0.1	7.6	NR	*< 0.2*	-	< 0.1	< 0.1	*< 0.2*	< 0.1	< 0.1
Phenanthrene	0.046	µg/g	0.69	0.046	NR	*< 0.1*	-	*< 0.05*	*< 0.05*	*< 0.1*	*< 0.05*	*< 0.05*
Phenol	0.5	µg/g	0.5	3.8	NR	< 0.2	-	< 0.09	< 0.09	< 0.2	< 0.09	< 0.09
Pyrene	1	µg/g	1	100	NR	< 0.1	-	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05

Table 123 Preliminary Screening for Soil of Extractables at SS Sites

Location		SS-4				SS-5		SS-6		SS-7		SS-8	
Sample ID		DUP3-1	DUP3-2	SS4-1	SS4-2	SS5-1	SS5-2	SS6-1	SS6-2	SS7-1	SS7-2	SS8-1	SS8-2
Sample Depth (m)		0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.25-0.35 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.2-0.3 m
Date Sampled		Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark												
1,2,4-Trichlorobenzene	0.05	< 0.05	< 0.05	< 0.05	< 0.05	*< 0.1*	< 0.05	< 0.05	< 0.05	*< 0.1*	< 0.05	*< 0.1*	< 0.05
2,4,6-Trichlorophenol	0.1	< 0.1	< 0.1	< 0.1	< 0.1	*< 0.2*	< 0.1	< 0.1	< 0.1	*< 0.2*	< 0.1	*< 0.2*	< 0.1
2,4,5-Trichlorophenol	0.1	< 0.08	< 0.08	< 0.08	< 0.08	*< 0.2*	< 0.08	< 0.08	< 0.08	*< 0.2*	< 0.08	*< 0.2*	< 0.08
2,4-Dichlorophenol	0.1	< 0.1	< 0.1	< 0.1	< 0.1	*< 0.2*	< 0.1	< 0.1	< 0.1	*< 0.2*	< 0.1	*< 0.2*	< 0.1
2,4-Dimethylphenol	0.2	< 0.2	< 0.2	< 0.2	< 0.2	*< 0.4*	< 0.2	< 0.2	< 0.2	*< 0.4*	< 0.2	*< 0.4*	< 0.2
2,4-Dinitrophenol	2	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 1	< 0.5	< 1	< 0.5
2,4-Dinitrotoluene	0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.2	< 0.1
2,6-Dinitrotoluene	0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.2	< 0.1
2-Chlorophenol	0.1	< 0.08	< 0.08	< 0.08	< 0.08	*< 0.2*	< 0.08	< 0.08	< 0.08	*< 0.2*	< 0.08	*< 0.2*	< 0.08
1-Methylnapthalene	0.59	< 0.03	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.06	< 0.03
2-Methylnaphthalene	0.59	< 0.03	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.06	< 0.03
1- & 2-Methylnaphthalene	0.59	< 0.042	< 0.042	< 0.042	< 0.042	< 0.085	< 0.042	< 0.042	< 0.042	< 0.085	< 0.042	< 0.085	< 0.042
3,3'-Dichlorobenzidine	1	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 1	< 0.5	< 1	< 0.5
Acenaphthene	0.072	< 0.03	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.06	< 0.03
Acenaphthylene	0.093	< 0.05	< 0.05	< 0.05	< 0.05	*< 0.1*	< 0.05	< 0.05	< 0.05	*< 0.1*	< 0.05	*< 0.1*	< 0.05
Anthracene	0.16	< 0.03	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.06	< 0.03
Benzo(a)anthracene	0.36	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.1	< 0.05

Table 123 Preliminary Screening for Soil of Extractables at SS Sites

Location		SS-4				SS-5		SS-6		SS-7		SS-8	
Sample ID		DUP3-1	DUP3-2	SS4-1	SS4-2	SS5-1	SS5-2	SS6-1	SS6-2	SS7-1	SS7-2	SS8-1	SS8-2
Sample Depth (m)		0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.25-0.35 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.2-0.3 m
Date Sampled		Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
Parameter	**Preliminary Benchmark**												
Benzo(a)pyrene	0.3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.1	< 0.05
Benzo(b,j)fluoranthene	0.47	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.2	< 0.1
Benzo(g,h,i)perylene	0.68	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.2	< 0.1
Benzo(k)fluoranthene	0.48	< 0.03	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.06	< 0.03
Biphenyl	0.05	< 0.05	< 0.05	< 0.05	< 0.05	*< 0.1*	< 0.05	< 0.05	< 0.05	*< 0.1*	< 0.05	*< 0.1*	< 0.05
bis(2-chloroethyl)ether	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.4	< 0.2
bis(2-chlorisopropyl)ether	0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.2	< 0.1
bis(2-ethylhexyl)phthalate	5	< 1	< 1	< 1	< 1	< 2	< 1	< 1	< 1	< 2	< 1	< 2	< 1
Chrysene	2.8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.1	< 0.05
Dibenzo(a,h)anthracene	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.1	< 0.05
Diethyl phthalate	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.4	< 0.2
Dimethylphthalate	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.4	< 0.2
Fluoranthene	0.56	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.1	< 0.05
Fluorene	0.12	< 0.03	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.03	< 0.03	< 0.06	< 0.03	< 0.06	< 0.03
Indeno(1,2,3-cd)pyrene	0.23	< 0.08	< 0.08	< 0.08	< 0.08	< 0.2	< 0.08	< 0.08	< 0.08	< 0.2	< 0.08	< 0.2	< 0.08
Naphthalene	0.013	*< 0.03*	*< 0.03*	*< 0.03*	*< 0.03*	*< 0.06*	*< 0.03*	*< 0.03*	*< 0.03*	*< 0.06*	*< 0.03*	*< 0.06*	*< 0.03*
p-Chloroanaline	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.4	< 0.2
Pentachlorophenol	0.1	< 0.1	< 0.1	< 0.1	< 0.1	*< 0.2*	< 0.1	< 0.1	< 0.1	*< 0.2*	< 0.1	*< 0.2*	< 0.1
Phenanthrene	0.046	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.1*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.1*	*< 0.05*	*< 0.1*	*< 0.05*
Phenol	0.5	< 0.09	< 0.09	< 0.09	< 0.09	< 0.2	< 0.09	< 0.09	< 0.09	< 0.2	< 0.09	< 0.2	< 0.09
Pyrene	1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.1	< 0.05

Table 123 Preliminary Screening for Soil of Extractables at SS Sites

SS Extractables Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 124 Preliminary Screening for Soil of VOCs at SS Sites

Location								SS-1		SS-2		SS-3
Sample ID								SS1-1	SS1-2	SS2-1	SS2-2	SS3-1
Sample Depth (m)								0-0.1 m	0.2-0.3 m	0-0.1 m	0.3-0.4 m	0-0.1 m
Date Sampled								Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
			MECP	CCME	Ontario	SS						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
1,1,1,2-Tetrachlroethane	0.05	µg/g	0.05	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,1,1-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,1,2,2-Tetrachloroethane	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,1,2-Trichloroethane	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,1-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,1-Dichloroethylene	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,2-Dibromoethane	0.05	µg/g	0.05	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,2-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,2-Dichloropropane	0.05	µg/g	0.05	50	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,3-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,3-Dichloropropene, Total	0.05	µg/g	0.05	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
1,4-Dichlorobenzene	0.05	µg/g	0.05	10	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Acetone	0.5	µg/g	0.5	NV	NR	**1.1**	**1.1**	**0.84**	< 0.50	< 0.50	< 0.50	< 0.50
Benzene	0.02	µg/g	0.02	0.03	NR	< 0.040	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Bromodichloromethane	0.05	µg/g	0.05	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Bromoform	0.05	µg/g	0.05	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Bromomethane	0.05	µg/g	0.05	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050

Table 124 Preliminary Screening for Soil of VOCs at SS Sites

Location								SS-1		SS-2		SS-3
Sample ID								SS1-1	SS1-2	SS2-1	SS2-2	SS3-1
Sample Depth (m)								0-0.1 m	0.2-0.3 m	0-0.1 m	0.3-0.4 m	0-0.1 m
Date Sampled								Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
			MECP	CCME	Ontario	SS						
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	CCME SQG [2]	OTR_{98} [3]	Maximum	Maximum Detected					
Carbon Tetrachloride	0.05	µg/g	0.05	50	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Chlorobenzene	0.05	µg/g	0.05	10	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Chlorodibromomethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Chloroform	0.05	µg/g	0.05	50	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
cis-1,2-Dichloroethene	0.05	µg/g	0.05	50	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
cis-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	*< 0.060*	-	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030
Dichlorodifluoromethane	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Dichloromethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Ethylbenzene	0.05	µg/g	0.05	0.082	NR	< 0.040	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Methyl Ethyl Ketone	0.5	µg/g	0.5	NV	NR	*< 1.0*	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Methyl Isobutyl Ketone	0.5	µg/g	0.5	NV	NR	*< 1.0*	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
methyl t-Butyl Ether	0.05	µg/g	0.05	NV	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
n-Hexane	0.05	µg/g	0.05	6.5	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Styrene	0.05	µg/g	0.05	50	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Tetrachloroethene	0.05	µg/g	0.05	0.6	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Toluene	0.2	µg/g	0.2	0.37	NR	< 0.040	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
trans-1,2-Dichloroethane	0.05	µg/g	0.05	50	NR	*< 0.10*	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
trans-1,3-Dichloropropene [a]	0.05	µg/g	0.05	NV	NR	*< 0.080*	-	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040
Trichloroethene	0.01	µg/g	0.05	0.01	NR	*< 0.10*	-	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*
Trichlorofluoromethane	0.25	µg/g	0.25	NV	NR	< 0.10	-	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Vinyl Chloride	0.02	µg/g	0.02	NV	NR	*< 0.040*	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
m-Xylene + p-Xylene	NV	µg/g	NV	NV	NV	< 0.040	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
o-Xylene	NV	µg/g	NV	NV	NV	< 0.040	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Xylenes, Total	0.05	µg/g	0.05	11	NR	< 0.040	-	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020

Table 124 Preliminary Screening for Soil of VOCs at SS Sites

Location		SS-4				SS-5		SS-6		SS-7		SS-8	
Sample ID		DUP3-1	DUP3-2	SS4-1	SS4-2	SS5-1	SS5-2	SS6-1	SS6-2	SS7-1	SS7-2	SS8-1	SS8-2
Sample Depth (m)		0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.25-0.35 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.2-0.3 m
Date Sampled		Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
Parameter	Preliminary Benchmark												
1,1,1,2-Tetrachlroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,1,1-Trichloroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,1,2,2-Tetrachloroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,1,2-Trichloroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,1-Dichloroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,1-Dichloroethylene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,2-Dibromoethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,2-Dichlorobenzene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,2-Dichloroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,2-Dichloropropane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,3-Dichlorobenzene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,3-Dichloropropene, Total	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
1,4-Dichlorobenzene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Acetone	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	**1.1**	< 0.50	*< 1.0*	< 0.50
Benzene	0.02	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	*< 0.040*	< 0.020
Bromodichloromethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Bromoform	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Bromomethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050

Table 124 Preliminary Screening for Soil of VOCs at SS Sites

Location		SS-4				SS-5		SS-6		SS-7		SS-8	
Sample ID		DUP3-1	DUP3-2	SS4-1	SS4-2	SS5-1	SS5-2	SS6-1	SS6-2	SS7-1	SS7-2	SS8-1	SS8-2
Sample Depth (m)		0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.25-0.35 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.3-0.4 m	0-0.1 m	0.2-0.3 m
Date Sampled		Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16	Oct-16
Parameter	**Preliminary Benchmark**												
Carbon Tetrachloride	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Chlorobenzene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Chlorodibromomethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Chloroform	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
cis-1,2-Dichloroethene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
cis-1,3-Dichloropropene [a]	0.05	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	*< 0.060*	< 0.030
Dichlorodifluoromethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Dichloromethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Ethylbenzene	0.05	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
Methyl Ethyl Ketone	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	*< 1.0*	< 0.50
Methyl Isobutyl Ketone	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	*< 1.0*	< 0.50
methyl t-Butyl Ether	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
n-Hexane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Styrene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Tetrachloroethene	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
Toluene	0.2	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
trans-1,2-Dichloroethane	0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*< 0.10*	< 0.050
trans-1,3-Dichloropropene [a]	0.05	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	*< 0.080*	< 0.040
Trichloroethene	0.01	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.050*	*< 0.10*	*< 0.050*
Trichlorofluoromethane	0.25	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.10	< 0.050
Vinyl Chloride	0.02	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	*< 0.040*	< 0.020
m-Xylene + p-Xylene	NV	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
o-Xylene	NV	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020
Xylenes, Total	0.05	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.040	< 0.020

Table 124 Preliminary Screening for Soil of VOCs at SS Sites

SS VOC Notes

Data shown for soil sampled at depths between 0 and 1.5 metres below ground surface (mbgs).

[a] In absence of standards for cis- and trans-1,3-Dichloropropene, standards for Total 1,3-Dichloropropene were applied.

NV = no value; NR = not required; NA = not applicable

m = metres; µg/g = micrograms per gram; mS/cm = millisiemens per centimeter; SAR = sodium adsorption ratio; % = percent

< = less than the reportable detection limit

\- = not analyzed

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use. April 15, 2011

2 - Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial. Last updated 2021.

3 - Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR_{98} for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Preliminary Benchmark = lower of the MECP Table 1 and CCME Industrial CSQG (where no values for either, use Ontario OTR98 for old urban parkland)

1	Denotes detected concentration with no preliminary benchmark
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.2 Groundwater

Table 125 Preliminary Screening for Groundwater of Metals at FSL and BASC

Monitoring Well												FSL-16A			
Sample ID												FSL-16A	FSL-16A	FSL-DUP1	FSL-18*
Source												2	3	3	2
Date Sampled												Sep-17	Oct-18	Oct-18	Sep-17
Time Sampled												10:25	10:40	10:40	8:05
ALS Sample ID												L2000077-1	L2180186-12	L2180186-14	L2000077-2
Groundwater Depth (mbgs)												1.14	0.79	0.79	0.72
Date Elevation Measured												Sep-17	Oct-18	Oct-18	Sep-17
			MECP	FCSAP	Ontario	Health Canada	MECP	FSL		BASC					
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	FIGQG Table 3 Tier 1 [2]	DWS MAC (unless otherwise indicated) [3]	CDWQ MAC (unless otherwise indicated) [4]	PGMIS Background 97.5th% [5d]	Maximum	Maximum Detected	Maximum	Maximum Detected				
Antimony	0.0015	mg/L	0.0015	2	0.006	0.006	NR	<0.001	0.00042	<0.001	0.0004	<0.0001	<0.0001	<0.0001	<0.001
Arsenic	0.005	mg/L	0.013	0.005	0.01	0.01	NR	0.0021	0.0021	<0.001	0.00083	0.00075	0.00072	0.00071	0.0021
Barium	0.5	mg/L	0.61	0.5	1	2	NR	0.262	0.262	0.0826	0.0826	0.225	0.253	0.262	0.023
Beryllium	0.0005	mg/L	0.0005	0.0053	-	-	NR	*<0.001*	-	*<0.001*	-	<0.0001	<0.0001	<0.0001	*<0.001*
Boron	1.5	mg/L	1.7	1.5	5	5	NR	0.21	0.21	0.493	0.493	0.025	0.028	0.027	0.17
Cadmium	0.00015	mg/L	0.0005	0.00015[a]	0.005	0.007	NR	<0.0001	0.000017	<0.0001	0.000012	<0.00001	<0.00001	<0.00001	<0.0001
Chromium	0.0089	mg/L	0.011	0.0089	0.05	0.05	NR	<0.005	-	<0.005	-	<0.0005	<0.0005	<0.0005	<0.005
Cobalt	0.0038	mg/L	0.0038	-	-	-	NR	**0.0062**	**0.0062**	<0.001	-	<0.0001	<0.0001	<0.0001	<0.001
Copper	0.00216	mg/L	0.005	0.00216[a]	-	2	NR	**0.0038**	**0.0038**	**0.0052**	**0.0052**	0.00023	0.00036	<0.0002	<0.002
Lead	0.00278	mg/L	0.0019	0.00278[a]	0.01	0.005	NR	<0.0005	-	<0.0005	-	<0.00005	<0.00005	<0.00005	<0.0005
Molybdenum	0.023	mg/L	0.023	0.073	-	-	NR	0.0086	0.0086	0.0113	0.0113	0.00173	0.00163	0.00168	0.0061
Nickel	0.014	mg/L	0.014	0.0882[a]	-	-	NR	0.00551	0.00551	<0.005	0.00077	<0.0005	<0.0005	<0.0005	<0.005
Selenium	0.001	mg/L	0.005	0.001	0.05	0.05	NR	**0.00106**	**0.00106**	0.000613	0.000613	0.000107	**0.00105**	**0.00106**	<0.0005
Silver	0.0003	mg/L	0.0003	0.025	-	NR	NR	*<0.0005*	-	*<0.0005*	-	<0.00005	<0.00005	<0.00005	*<0.0005*
Sodium	200	mg/L	490	-	-	AO : ≤ 200	NR	132	132	142	142	71.6	74.6	73.8	90.8
Thallium	0.0005	mg/L	0.0005	0.0008	-	-	NR	0.00018	0.00018	<0.0001	-	<0.00001	<0.00001	<0.00001	<0.0001
Uranium	0.0089	mg/L	0.0089	0.015	0.02	0.02	NR	**0.0115**	**0.0115**	0.0039	0.0039	0.000435	0.000405	0.000419	0.00441
Vanadium	0.0039	mg/L	0.0039	-	-	-	NR	*<0.005*	0.00052	*<0.005*	0.00213	<0.0005	<0.0005	<0.0005	*<0.005*
Zinc	0.01	mg/L	0.16	0.01	-	AO : ≤ 5	NR	*<1.0*	0.0058	**0.015**	**0.015**	0.0014	<0.001	<0.001	<0.01
Chloride	120	mg/L	790	120	-	AO : ≤ 250	NR	**194**	**194**	**213**	**213**	**121**	-	-	17.3
Sulphate	100	mg/L	-	100	-	AO : ≤ 500	NR	**396**	**396**	**484**	**484**	74.2	-	-	**396**
Bromide	0.01	mg/L	-	-	0.01	0.01[b]	NR	*<0.10*	-	*<0.10*	-	*<0.10*	-	-	*<0.10*
Fluoride	0.12	mg/L	-	0.12	1.5	1.5	NR	**1.86**	**1.86**	**1.33**	**1.33**	**1.1**	-	-	**1.6**
Nitrate	2.86	mg/L as NO_3	-	13	10	10	NR	0.166	0.166	1.21	1.21	<0.020	-	-	-
Nitrite	0.06	mg/L as NO_3	-	0.266[c]	1	1	NR	<0.010	-	<0.010	-	<0.010	-	-	-
Orthophosphate	NV	mg/L	-	-	-	-	NR	**0.008**	**0.008**	**0.0056**	**0.0056**	-	-	-	<0.0030

Table 125 Preliminary Screening for Groundwater of Metals at FSL and BASC

Monitoring Well		FSL-18		FSL-19		
Sample ID		FSL-18	FSL-18	FSL-19*	FSL-DUP 1*	FSL-19
Source		3	4	2	2	3
Date Sampled		Oct-18	Oct-19	Sep-17	Sep-17	Oct-18
Time Sampled		9:05	8:08	8:15	8:15	9:15
ALS Sample ID		L2182914-1	L2360295-9	L2000077-3	L2000077-6	L2182914-2
Groundwater Depth (mbgs)		0.46	1.35	1.25	1.25	0.97
Date Elevation Measured		Oct-18	Sep-19	Sep-17	Sep-17	Oct-18
Parameter	Preliminary Benchmark					
Antimony	0.0015	<0.001	<0.001	0.00041	0.00042	<0.001
Arsenic	0.005	<0.001	0.001	0.00029	0.00027	<0.001
Barium	0.5	0.023	0.0219	0.116	0.112	0.0979
Beryllium	0.0005	*<0.001*	*<0.001*	<0.0001	<0.0001	*<0.001*
Boron	1.5	0.21	0.14	0.016	0.017	<0.1
Cadmium	0.00015	<0.00005	<0.00005	-	0.000014	<0.00005
Chromium	0.0089	<0.005	<0.005	<0.0005	<0.0005	<0.005
Cobalt	0.0038	<0.001	<0.001	<0.0001	<0.0001	<0.001
Copper	0.00216	<0.002	<0.002	**0.0022**	0.00178	<0.002
Lead	0.00278	<0.0005	<0.0005	<0.00005	<0.00005	<0.0005
Molybdenum	0.023	0.0086	0.00594	0.0077	0.0079	0.0072
Nickel	0.014	<0.005	<0.005	0.0042	0.00421	<0.005
Selenium	0.001	<0.0005	<0.0005	0.00055	0.000475	0.00068
Silver	0.0003	*<0.0005*	*<0.0005*	<0.00005	<0.00005	*<0.0005*
Sodium	200	132	85.5	126	127	110
Thallium	0.0005	<0.0001	<0.0001	0.000176	0.00018	0.00017
Uranium	0.0089	0.00658	0.00448	**0.00964**	**0.00982**	0.00879
Vanadium	0.0039	*<0.005*	*<0.005*	<0.0005	<0.0005	*<0.005*
Zinc	0.01	<0.01	<0.01	0.0027	*<1.0*	<0.01
Chloride	120	-	-	**194**	**194**	-
Sulphate	100	-	-	36.9	34.2	-
Bromide	0.01	-	-	*<0.10*	*<0.10*	-
Fluoride	0.12	-	-	**1.37**	**1.38**	-
Nitrate	2.86	-	-	0.164	0.166	-
Nitrite	0.06	-	-	<0.010	<0.010	-
Orthophosphate	NV	-	-	**0.0071**	**0.008**	-

Table 125 Preliminary Screening for Groundwater of Metals at FSL and BASC

Monitoring Well		FSL-20		FSL-21			BASC-16		BASC-22	BASC-23	BASC-24
Sample ID		FSL-20	FSL-20	FSL-21*	FSL-21	FSL-21	BASC-16	BASC-16-DUP1	BASC-22	BASC-23	BASC-24
Source		2	3	2	3	4	2	2	2	2	2
Date Sampled		Sep-17	Oct-18	Sep-17	Oct-18	Oct-19	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		7:45	8:55	7:35	9:05	8:12	9:46:00 AM	9:46:00 AM	2:10:00 PM	2:20:00 PM	9:40:00 AM
ALS Sample ID		L2000077-4	L2182914-3	L2000077-5	L2180186-13	L2360295-10	L1996022-1	L1996022-3	L1998896-1	L1998896-2	L1996022-2
Groundwater Depth (mbgs)		1.44	1.08	0.57	0.47	1.12	1.43	1.43	-0.26	-0.19	0.96
Date Elevation Measured		Sep-17	Oct-18	Sep-17	Oct-18	Sep-19	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	**Preliminary Benchmark**										
Antimony	0.0015	<0.0001	<0.0001	<0.001	0.00038	<0.001	<0.001	<0.001	0.00016	0.00022	0.0004
Arsenic	0.005	0.00031	0.00027	<0.001	0.00031	<0.001	<0.001	<0.001	0.00031	0.00083	0.00044
Barium	0.5	0.0283	0.0257	<0.11	0.152	0.136	0.0826	0.0752	0.0168	0.0164	0.0388
Beryllium	0.0005	<0.0001	<0.0001	*<0.001*	<0.0001	*<0.001*	*<0.001*	*<0.001*	<0.0001	<0.0001	<0.0001
Boron	1.5	0.026	0.026	<0.1	0.012	<0.1	<0.1	<0.1	0.493	0.48	0.452
Cadmium	0.00015	<0.00001	<0.00001	<0.0001	0.000017	<0.00005	<0.0001	<0.0001	<0.00001	0.000011	0.000012
Chromium	0.0089	<0.0005	<0.0005	<0.005	<0.0005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.0005
Cobalt	0.0038	0.0003	<0.0001	**0.0062**	0.00245	0.0015	<0.001	<0.001	<0.0001	<0.0001	<0.0001
Copper	0.00216	0.00069	0.00072	**0.0038**	**0.00326**	**0.0034**	**0.0052**	**0.0045**	0.00067	0.00084	0.00064
Lead	0.00278	<0.00005	<0.00005	<0.0005	<0.00005	<0.0005	<0.0005	<0.0005	<0.00005	<0.00005	<0.00005
Molybdenum	0.023	0.00311	0.00306	0.00434	0.0042	0.00355	0.00151	0.00136	0.00853	0.00939	0.0113
Nickel	0.014	0.00136	0.00124	<0.005	0.00551	<0.005	<0.005	<0.005	0.00057	0.00057	0.00077
Selenium	0.001	0.000239	0.000333	<0.0005	0.00048	0.00087	<0.0005	<0.0005	0.000613	0.000481	0.000294
Silver	0.0003	<0.00005	<0.00005	*<0.0005*	<0.00005	*<0.0005*	*<0.0005*	*<0.0005*	<0.00005	<0.00005	<0.00005
Sodium	200	37.1	42.8	<5	0.95	1.91	142	131	63.6	57.3	77.8
Thallium	0.0005	0.000023	0.000016	<0.0001	0.000019	<0.0001	<0.0001	<0.0001	<0.00001	<0.00001	<0.00001
Uranium	0.0089	**0.0106**	**0.0111**	**0.0115**	0.00592	**0.00927**	0.00128	0.00117	0.00132	0.00125	0.0039
Vanadium	0.0039	0.00052	<0.0005	*<0.005*	<0.0005	*<0.005*	*<0.005*	*<0.005*	<0.0005	0.00213	0.00128
Zinc	0.01	0.0018	0.002	<0.01	0.0058	<0.01	**0.015**	**0.012**	<0.001	<0.001	<0.001
Chloride	120	14.9	-	<0.50	-	-	**210**	**213**	7.23	6.52	7.19
Sulphate	100	**274**	-	38.7	-	-	42.3	37.1	**484**	**388**	**417**
Bromide	0.01	*<0.10*	-	*<0.10*	-	-	*<0.10*	*<0.10*	*<0.10*	*<0.10*	*<0.10*
Fluoride	0.12	**1.86**	-	**1.42**	-	-	**1.31**	**1.33**	**0.516**	**0.437**	**0.839**
Nitrate	2.86	<0.020	-	<0.020	-	-	<0.020	0.041	0.84	1.21	0.197
Nitrite	0.06	<0.010	-	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Orthophosphate	NV	<0.0030	-	<0.0030	-	-	<0.0030	<0.0030	**0.0032**	**0.0056**	**0.0037**

Table 125 Preliminary Screening for Groundwater of Metals at FSL and BASC

Metal Notes

Data shown for groundwater depths between 0 and 1.5 metres below ground surface (mbgs). Negative groundwater depth (i.e., negative mbgs) represents an above ground groundwater level as the monitoring well was likely a stick-up.

AO = aesthetic objective; MAC = maximum acceptable concentration; NR = not required; NV = no value; mbgs = metres below ground surface

mg/L = miligrams per litre

< = less than the reportable detection limit

a - Based on minimum hardness of 90 mg/L $CaCO_3$ measured in receiving water body, Lake Huron. This hardness results in the most conservative guideline.

b - Value for bromate used

c - Applied conversion factor for nitrate-N to nitrate total of 4.43

d - Ontario MECP PGMIS only required if there were no screening guidelines from other jurisdictions

* Detection limits in this sample adjusted for sample matrix effects

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Generic Site Condition Standards (SCS) - Groundwater (µg/L) All Types of Property Uses. April 15, 2011

2 - Federal Contaminated Sites Action Plan (FCSAP), 2016. Federal Interim Groundwater Quality Guidelines (FIGQGs). Table 3 FIGQGs for Commercial and Industrial Land Uses (mg/L), Tier 1 Guidelines, coarse-textured soils. June 2016, Version 4.

3 - Ontario Regulation (O.Reg.) 169/03: Ontario Drinking Water Standards (ODWS). Last amendment: O.Reg. 327/08. http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm.

4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.

5 - Ontario MECP, 2011. Rationale for the Development of Soil and Ground Water Standard for Use at Contaminated Sites in Ontario. Table 8.4 - Provincial Groundwater Monitoring Information System (PGMIS) 97.5th% Background Groundwater Concentrations. April 15, 2011

Data Sources:

(2) CH2M HILL Canada Limited. 2018. 2017 Groundwater Monitoring and Sampling Program, Prepared for Bruce Power, Dated October 26, 2018. B-REP-07010-00067.pdf

(3) Jacobs Engineering Group Inc. 2019. Groundwater Monitoring and Sampling Program, 2018 Groundwater Monitoring and Sampling Report, Prepared for Bruce Power, Dated June 2019. 2018_BPGW_Final_e-Deliverable.pdf

(4) Jacobs Engineering Group Inc. 2020. Groundwater Monitoring and Sampling Program, 2019 Groundwater Monitoring and Sampling Report, Prepared for Bruce Power, Dated February 2020. 2019_BPGW_LowRes.pdf

(5) Jacobs Engineering Group Inc. 2021. 2020 Groundwater Annual Program Summary, Bruce Power Annual Groundwater Monitoring Program. Prepared for Bruce Power, Dated February 5, 2021. 2020 Annual GWMP Report_DRAFT.pdf

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

Monitoring Well									
Sample ID									
Source									
Date Sampled									
Time Sampled									
ALS Sample ID									
Groundwater Depth (mbgs)									
Date Elevation Measured									
			MECP	FCSAP	Ontario	Health Canada	MECP	FSL	BASC
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	FIGQG Table 3 Tier 1 [2]	DWS MAC (unless otherwise indicated) [3]	CDWQ MAC (unless otherwise indicated) [4]	PGMIS Background 97.5th% [5b]	Maximum	Maximum
Acetone	2700	µg/L	2700	13000	-	-	NR	<30	<30
Benzene	0.5	µg/L	0.5	690	1	5	NR	<0.50	<0.50
Bromodichloromethane	2	µg/L	2	8500	-	100[a]	NR	<2.0	<2.0
Bromoform	5	µg/L	5	3700	-	100[a]	NR	<5.0	<5.0
Bromomethane	0.89	µg/L	0.89	33	-	-	NR	<0.50	<0.50
Carbon Tetrachloride	0.2	µg/L	0.2	6.8	2	2	NR	<0.20	<0.20
Chlorobenzene	0.5	µg/L	0.5	1.3	80	80	NR	<0.50	<0.50
Dibromochloromethane	2	µg/L	2	10000	-	-	NR	<2.0	<2.0
Chloroform	1.8	µg/L	2	1.8	-	100[a]	NR	<1.0	<1.0
1,2-Dibromoethane	0.2	µg/L	0.2	5.1	-	-	NR	<0.20	<0.20
1,2-Dichlorobenzene	0.5	µg/L	0.5	0.7	200	200	NR	<0.50	<0.50
1,3-Dichlorobenzene	0.5	µg/L	0.5	42	-	-	NR	<0.50	<0.50
1,4-Dichlorobenzene	0.5	µg/L	0.5	26	5	5	NR	<0.50	<0.50
Dichlorodifluoromethane	590	µg/L	590	-	-	-	NR	<2.0	<2.0
1,1-Dichloroethane	0.5	µg/L	0.5	6600	-	-	NR	<0.50	<0.50
1,2-Dichloroethane	0.5	µg/L	0.5	100	5	5	NR	<0.50	<0.50
1,1-Dichloroethylene	0.5	µg/L	0.5	490	14	14	NR	<0.50	<0.50
cis-1,2-Dichloroethylene	1.6	µg/L	1.6	30	-	-	NR	<0.50	<0.50
trans-1,2-Dichloroethylene	1.6	µg/L	1.6	30	-	-	NR	<0.50	<0.50

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

Monitoring Well									
Sample ID									
Source									
Date Sampled									
Time Sampled									
ALS Sample ID									
Groundwater Depth (mbgs)									
Date Elevation Measured									
			MECP	FCSAP	Ontario	Health Canada	MECP	FSL	BASC
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	FIGQG Table 3 Tier 1 [2]	DWS MAC (unless otherwise indicated) [3]	CDWQ MAC (unless otherwise indicated) [4]	PGMIS Background 97.5th% [5b]	Maximum	Maximum
1,2-Dichloropropane	0.5	µg/L	0.5	330	-	-	NR	<0.50	<0.50
cis-1,3-Dichloropropene	0.5	µg/L	0.5	100	-	-	NR	<0.30	<0.30
trans-1,3-Dichloropropene	0.5	µg/L	0.5	100	-	-	NR	<0.30	<0.30
1,3-Dichloropropene (cis & trans)	0.5	µg/L	0.5	100	-	-	NR	<0.50	<0.50
Ethylbenzene	0.5	µg/L	0.5	11000	140	140	NR	<0.50	<0.50
n-Hexane	5	µg/L	5	-	-	-	NR	<0.50	<0.50
Methyl Ethyl Ketone	400	µg/L	400	150000	-	-	NR	<20	<20
Methyl Isobutyl Ketone	640	µg/L	640	58000	-	-	NR	<20	<20
MTBE	15	µg/L	15	4300	-	-	NR	<2.0	<2.0
Methylene Chloride	5	µg/L	5	98	50	50	NR	<5.0	<5.0
Styrene	0.5	µg/L	0.5	72	-	-	NR	<0.50	<0.50
1,1,1,2-Tetrachloroethane	1.1	µg/L	1.1	66	-	-	NR	<0.50	<0.50
1,1,2,2-Tetrachloroethane	0.5	µg/L	0.5	63	-	-	NR	<0.50	<0.50
Tetrachloroethylene	0.5	µg/L	0.5	110	10	10	NR	<0.50	<0.50
Toluene	0.8	µg/L	0.8	83	60	60	NR	<0.50	<0.50
1,1,1-Trichloroethane	0.5	µg/L	0.5	1100	-	-	NR	<0.50	<0.50
1,1,2-Trichloroethane	0.5	µg/L	0.5	91	-	-	NR	<0.50	<0.50
Trichloroethylene	0.5	µg/L	0.5	29	5	5	NR	<0.50	<0.50
Trichlorofluoromethane	150	µg/L	150	-	-	-	NR	<5.0	<5.0
Vinyl Chloride	0.5	µg/L	0.5	13	1	2	NR	<0.50	<0.50
o-Xylene	NV	µg/L	-	-	-	-	NV	<0.30	<0.30
m+p-Xylenes	NV	µg/L	-	-	-	-	NV	<0.40	<0.40
Xylenes (Total)	72	µg/L	72	18000	90	90	NR	<0.50	<0.50

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

Monitoring Well		FSL-16A	FSL-18	FSL-19		FSL-20	FSL-21
Sample ID		FSL-16A	FSL-18	FSL-19	FSL-DUP 1	FSL-20	FSL-21
Source		2	2	2	2	2	2
Date Sampled		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		10:25:00 AM	8:05:00 AM	8:15:00 AM	8:15:00 AM	7:45:00 AM	7:35:00 AM
ALS Sample ID		L2000077-1	L2000077-2	L2000077-3	L2000077-6	L2000077-4	L2000077-5
Groundwater Depth (mbgs)		1.14	0.72	1.25	1.25	1.44	0.57
Date Elevation Measured		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	**Preliminary Benchmark**						
Acetone	2700	<30	<30	<30	<30	<30	<30
Benzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bromodichloromethane	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Bromoform	5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bromomethane	0.89	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Carbon Tetrachloride	0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dibromochloromethane	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroform	1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dibromoethane	0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,3-Dichlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,4-Dichlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichlorodifluoromethane	590	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,1-Dichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,2-Dichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1-Dichloroethylene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
cis-1,2-Dichloroethylene	1.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
trans-1,2-Dichloroethylene	1.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

Monitoring Well		FSL-16A	FSL-18	FSL-19		FSL-20	FSL-21
Sample ID		FSL-16A	FSL-18	FSL-19	FSL-DUP 1	FSL-20	FSL-21
Source		2	2	2	2	2	2
Date Sampled		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		10:25:00 AM	8:05:00 AM	8:15:00 AM	8:15:00 AM	7:45:00 AM	7:35:00 AM
ALS Sample ID		L2000077-1	L2000077-2	L2000077-3	L2000077-6	L2000077-4	L2000077-5
Groundwater Depth (mbgs)		1.14	0.72	1.25	1.25	1.44	0.57
Date Elevation Measured		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	Preliminary Benchmark						
1,2-Dichloropropane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
cis-1,3-Dichloropropene	0.5	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
trans-1,3-Dichloropropene	0.5	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
1,3-Dichloropropene (cis & trans)	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
n-Hexane	5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Methyl Ethyl Ketone	400	<20	<20	<20	<20	<20	<20
Methyl Isobutyl Ketone	640	<20	<20	<20	<20	<20	<20
MTBE	15	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Methylene Chloride	5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Styrene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1,2-Tetrachloroethane	1.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tetrachloroethylene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Toluene	0.8	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1-Trichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2-Trichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichloroethylene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichlorofluoromethane	150	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Vinyl Chloride	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
o-Xylene	NV	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
m+p-Xylenes	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Xylenes (Total)	72	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

Monitoring Well		BASC-16		BASC-22	BASC-23	BASC-24
Sample ID		BASC-16	BASC-16-DUP1	BASC-22	BASC-23	BASC-24
Source		2	2	2	2	2
Date Sampled		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		9:46:00 AM	9:46:00 AM	2:10:00 PM	2:20:00 PM	9:40:00 AM
ALS Sample ID		L1996022-1	L1996022-3	L1998896-1	L1998896-2	L1996022-2
Groundwater Depth (mbgs)		1.43	1.43	-0.26	-0.19	0.96
Date Elevation Measured		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	**Preliminary Benchmark**					
Acetone	2700	<30	<30	<30	<30	<30
Benzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Bromodichloromethane	2	<2.0	<2.0	<2.0	<2.0	<2.0
Bromoform	5	<5.0	<5.0	<5.0	<5.0	<5.0
Bromomethane	0.89	<0.50	<0.50	<0.50	<0.50	<0.50
Carbon Tetrachloride	0.2	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Dibromochloromethane	2	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroform	1.8	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dibromoethane	0.2	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,3-Dichlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,4-Dichlorobenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Dichlorodifluoromethane	590	<2.0	<2.0	<2.0	<2.0	<2.0
1,1-Dichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,2-Dichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,1-Dichloroethylene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
cis-1,2-Dichloroethylene	1.6	<0.50	<0.50	<0.50	<0.50	<0.50
trans-1,2-Dichloroethylene	1.6	<0.50	<0.50	<0.50	<0.50	<0.50

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

Monitoring Well		BASC-16		BASC-22	BASC-23	BASC-24
Sample ID		BASC-16	BASC-16-DUP1	BASC-22	BASC-23	BASC-24
Source		2	2	2	2	2
Date Sampled		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		9:46:00 AM	9:46:00 AM	2:10:00 PM	2:20:00 PM	9:40:00 AM
ALS Sample ID		L1996022-1	L1996022-3	L1998896-1	L1998896-2	L1996022-2
Groundwater Depth (mbgs)		1.43	1.43	-0.26	-0.19	0.96
Date Elevation Measured		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	Preliminary Benchmark					
1,2-Dichloropropane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
cis-1,3-Dichloropropene	0.5	<0.30	<0.30	<0.30	<0.30	<0.30
trans-1,3-Dichloropropene	0.5	<0.30	<0.30	<0.30	<0.30	<0.30
1,3-Dichloropropene (cis & trans)	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
n-Hexane	5	<0.50	<0.50	<0.50	<0.50	<0.50
Methyl Ethyl Ketone	400	<20	<20	<20	<20	<20
Methyl Isobutyl Ketone	640	<20	<20	<20	<20	<20
MTBE	15	<2.0	<2.0	<2.0	<2.0	<2.0
Methylene Chloride	5	<5.0	<5.0	<5.0	<5.0	<5.0
Styrene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1,2-Tetrachloroethane	1.1	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Tetrachloroethylene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Toluene	0.8	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1-Trichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2-Trichloroethane	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Trichloroethylene	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Trichlorofluoromethane	150	<5.0	<5.0	<5.0	<5.0	<5.0
Vinyl Chloride	0.5	<0.50	<0.50	<0.50	<0.50	<0.50
o-Xylene	NV	<0.30	<0.30	<0.30	<0.30	<0.30
m+p-Xylenes	NV	<0.40	<0.40	<0.40	<0.40	<0.40
Xylenes (Total)	72	<0.50	<0.50	<0.50	<0.50	<0.50

Table 126 Preliminary Screening for Groundwater of VOCs at FSL and BASC

VOC Notes

mbgs) represents an above ground groundwater level as the monitoring well was likely a stick-up.
MAC = maximum acceptable concentration; NR = not required; NV = no value; mbgs = metres below ground surface
µg/L = micrograms per litre
< = less than the reportable detection limit
a - Value for trihalomethanes applied
b - Ontario MECP PGMIS only required if there were no screening guidelines from other jurisdictions

References:
1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Generic Site Condition Standards (SCS) - Groundwater (µg/L) All Types of Property Uses. April 15, 2011
2 - Federal Contaminated Sites Action Plan (FCSAP), 2016. Federal Interim Groundwater Quality Guidelines (FIGQGs). Table 3 FIGQGs for Commercial and Industrial Land Uses (mg/L), Tier 1 Guidelines, coarse-textured soils. June 2016, Version 4.
3 - Ontario Regulation (O.Reg.) 169/03: Ontario Drinking Water Standards (ODWS). Last amendment: O.Reg. 327/08. http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm.
4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.
5 - Ontario MECP, 2011. Rationale for the Development of Soil and Ground Water Standard for Use at Contaminated Sites in Ontario. Table 8.4 - Provincial Groundwater Monitoring Information System (PGMIS) 97.5th% Background Groundwater Concentrations. April 15, 2011

Data Sources:
(2) CH2M HILL Canada Limited. 2018. 2017 Groundwater Monitoring and Sampling Program, Prepared for Bruce Power, Dated October 26, 2018. B-REP-07010-00067.pdf
Report, Prepared for Bruce Power, Dated June 2019. 2018_BPGW_Final_e-Deliverable.pdf
(4) Jacobs Engineering Group Inc. 2020. Groundwater Monitoring and Sampling Program, 2019 Groundwater Monitoring and Sampling Report, Prepared for Bruce Power, Dated February 2020. 2019_BPGW_LowRes.pdf
(5) Jacobs Engineering Group Inc. 2021. 2020 Groundwater Annual Program Summary, Bruce Power Annual Groundwater Monitoring Program. Prepared for Bruce Power, Dated February 5, 2021. 2020 Annual GWMP Report_DRAFT.pdf

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 127 Preliminary Screening for Groundwater of PHCs at FSL and BASC

Monitoring Well										FSL-16A	FSL-18
Sample ID										FSL-16A	FSL-18
Source										2	2
Date Sampled										Sep-17	Sep-17
Time Sampled										10:25:00 AM	8:05:00 AM
ALS Sample ID										L2000077-1	L2000077-2
Groundwater Depth (mbgs)										1.14	0.72
Date Elevation Measured										Sep-17	Sep-17
			MECP	FCSAP	Ontario	Health Canada	MECP	FSL	BASC		
Parameter	Preliminary Benchmark	Units	Table 1 SCS [1]	FIGQG Table 3 Tier 1 [2]	DWS MAC (unless otherwise indicated) [3]	CDWQ MAC (unless otherwise indicated) [4]	PGMIS Background 97.5th% [5a]	Maximum	Maximum		
F1 (C6-C10)	420	µg/L	420	9100	-	-	NR	<25	<25	<25	<25
F1-BTEX	420	µg/L	420	9100	-	-	NR	<25	<25	<25	<25
F2 (C10-C16)	150	µg/L	150	1300	-	-	NR	<100	<100	<100	<100
F3 (C16-C34)	500	µg/L	500	-	-	-	NR	<250	<250	<250	<250
F4 (C34-C50)	500	µg/L	500	-	-	-	NR	<250	<250	<250	<250

Table 127 Preliminary Screening for Groundwater of PHCs at FSL and BASC

Monitoring Well		FSL-19		FSL-20	FSL-21	BASC-16		BASC-22	BASC-23	BASC-24
Sample ID		FSL-19	FSL-DUP 1	FSL-20	FSL-21	BASC-16	BASC-16-	BASC-22	BASC-23	BASC-24
Source		2	2	2	2	2	2	2	2	2
Date Sampled		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		8:15:00 AM	8:15:00 AM	7:45:00 AM	7:35:00 AM	9:46:00 AM	9:46:00 AM	2:10:00 PM	2:20:00 PM	9:40:00 AM
ALS Sample ID		L2000077-3	L2000077-6	L2000077-4	L2000077-5	L1996022-1	L1996022-3	L1998896-1	L1998896-2	L1996022-2
Groundwater Depth (mbgs)		1.25	1.25	1.44	0.57	1.43	1.43	-0.26	-0.19	0.96
Date Elevation Measured		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	**Preliminary Benchmark**									
F1 (C6-C10)	420	<25	<25	<25	<25	<25	<25	<25	<25	<25
F1-BTEX	420	<25	<25	<25	<25	<25	<25	<25	<25	<25
F2 (C10-C16)	150	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34)	500	<250	<250	<250	<250	<250	<250	<250	<250	<250
F4 (C34-C50)	500	<250	<250	<250	<250	<250	<250	<250	<250	<250

Table 127 Preliminary Screening for Groundwater of PHCs at FSL and BASC

PAH Notes

Data shown for groundwater depths between 0 and 1.5 metres below ground surface (mbgs). Negative groundwater depth (i.e., negative mbgs) represents an above ground groundwater level as the monitoring well was likely a stick-up.
MAC = maximum acceptable concentration; NR = not required; mbgs = metres below ground surface
µg/L = micrograms per litre
< = less than the reportable detection limit
a - Ontario MECP PGMIS only required if there were no screening guidelines from other jurisdictions

References:
Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Generic Site Condition Standards (SCS) - Groundwater (µg/L) All

2 - Federal Contaminated Sites Action Plan (FCSAP), 2016. Federal Interim Groundwater Quality Guidelines (FIGQGs). Table 3 FIGQGs for Commercial and Industrial Land Uses (mg/L), Tier 1 Guidelines, coarse-textured soils. June 2016, Version 4.
laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm.
4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.
Ontario. Table 8.4 - Provincial Groundwater Monitoring Information System (PGMIS) 97.5th% Background Groundwater

Data Sources:
(2) CH2M HILL Canada Limited. 2018. 2017 Groundwater Monitoring and Sampling Program, Prepared for Bruce Power, Dated October 26, 2018. B-REP-07010-00067.pdf
Sampling Report, Prepared for Bruce Power, Dated June 2019. 2018_BPGW_Final_e-Deliverable.pdf
Sampling Report, Prepared for Bruce Power, Dated February 2020. 2019_BPGW_LowRes.pdf
Monitoring Program. Prepared for Bruce Power, Dated February 5, 2021. 2020 Annual GWMP Report_DRAFT.pdf

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 128 Preliminary Screening for Groundwater of PAHs at FSL and BASC

Monitoring Well										**FSL-16A**
Sample ID										**FSL-16A**
Source										**2**
Date Sampled										**Sep-17**
Time Sampled										**10:25:00 AM**
ALS Sample ID										**L2000077-1**
Groundwater Depth (mbgs)										**1.14**
Date Elevation Measured										**Sep-17**
			MECP	**FCSAP**	**Ontario**	**Health Canada**	**MECP**	**FSL**	**BASC**	
Parameter	**Preliminary Benchmark**	**Units**	**Table 1 SCS [1]**	**FIGQG Table 3 Tier 1 [2]**	**DWS MAC (unless otherwise indicated) [3]**	**CDWQ MAC (unless otherwise indicated) [4]**	**PGMIS Background 97.5th% [5a]**	**Maximum**	**Maximum**	
Acenaphthene	4.1	µg/L	4.1	5.8	-	-	NR	<0.020	<0.020	<0.020
Acenaphthylene	1	µg/L	1	46	-	-	NR	<0.020	<0.020	<0.020
Anthracene	0.012	µg/L	0.1	0.012	-	-	NR	<0.020	<0.020	<0.020
Benzo(a)anthracene	0.018	µg/L	0.2	0.018	-	-	NR	<0.020	<0.020	<0.020
Benzo(a)pyrene	0.01	µg/L	0.01	0.015	0.01	0.04	NR	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	0.1	µg/L	0.1	0.48	-	-	NR	<0.020	<0.020	<0.020
Benzo(k)fluoranthene	0.1	µg/L	0.1	0.48	-	-	NR	<0.020	<0.020	<0.020
Benzo(g,h,i)perylene	0.17	µg/L	0.2	0.17	-	-	NR	<0.020	<0.020	<0.020
Chrysene	0.1	µg/L	0.1	1.4	-	-	NR	<0.020	<0.020	<0.020
Dibenzo(a,h)anthracene	0.2	µg/L	0.2	0.26	-	-	NR	<0.020	<0.020	<0.020
Fluoranthene	0.04	µg/L	0.4	0.04	-	-	NR	<0.020	<0.020	<0.020
Fluorene	3	µg/L	120	3	-	-	NR	<0.020	<0.020	<0.020
Indeno(1,2,3-cd)pyrene	0.2	µg/L	0.2	0.21	-	-	NR	<0.020	<0.020	<0.020
1-Methylnaphthalene	2	µg/L	2	180	-	-	NR	<0.020	<0.020	<0.020
2-Methylnaphthalene	2	µg/L	2	180	-	-	NR	<0.020	<0.020	<0.020
1+2-Methylnaphthalenes	2	µg/L	2	180	-	-	NR	<0.028	<0.028	<0.028
Naphthalene	1.1	µg/L	7	1.1	-	-	NR	<0.050	<0.050	<0.050
Phenanthrene	0.1	µg/L	0.1	0.4	-	-	NR	<0.020	<0.020	<0.020
Pyrene	0.025	µg/L	0.2	0.025	-	-	NR	<0.020	<0.020	<0.020

Table 127 Preliminary Screening for Groundwater of PHCs at FSL and BASC

Monitoring Well		FSL-18	FSL-19		FSL-20	FSL-21	BASC-16		BASC-22	BASC-23
Sample ID		FSL-18	FSL-19	FSL-DUP 1	FSL-20	FSL-21	BASC-16	BASC-16-	BASC-22	BASC-23
Source		2	2	2	2	2	2	2	2	2
Date Sampled		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Time Sampled		8:05:00 AM	8:15:00 AM	8:15:00 AM	7:45:00 AM	7:35:00 AM	7:35:00 AM		2:10:00 PM	2:20:00 PM
ALS Sample ID		L2000077-2	L2000077-3	L2000077-6	L2000077-4	L2000077-5	L2000077-5		L1998896-1	L1998896-2
Groundwater Depth (mbgs)		0.72	1.25	1.25	1.44	0.57	1.43	1.43	-0.26	-0.19
Date Elevation Measured		Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17	Sep-17
Parameter	**Preliminary Benchmark**									
Acenaphthene	4.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Acenaphthylene	1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Anthracene	0.012	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(a)anthracene	0.018	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(a)pyrene	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(k)fluoranthene	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Benzo(g,h,i)perylene	0.17	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Chrysene	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Dibenzo(a,h)anthracene	0.2	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Fluoranthene	0.04	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Fluorene	3	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Indeno(1,2,3-cd)pyrene	0.2	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
1-Methylnaphthalene	2	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
2-Methylnaphthalene	2	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
1+2-Methylnaphthalenes	2	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028
Naphthalene	1.1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phenanthrene	0.1	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Pyrene	0.025	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020

Table 127 Preliminary Screening for Groundwater of PHCs at FSL and BASC

Monitoring Well		BASC-24
Sample ID		BASC-24
Source		2
Date Sampled		Sep-17
Time Sampled		9:40:00 AM
ALS Sample ID		L1996022-2
Groundwater Depth (mbgs)		0.96
Date Elevation Measured		Sep-17
Parameter	**Preliminary Benchmark**	
Acenaphthene	4.1	<0.020
Acenaphthylene	1	<0.020
Anthracene	0.012	<0.020
Benzo(a)anthracene	0.018	<0.020
Benzo(a)pyrene	0.01	<0.010
Benzo(b)fluoranthene	0.1	<0.020
Benzo(k)fluoranthene	0.1	<0.020
Benzo(g,h,i)perylene	0.17	<0.020
Chrysene	0.1	<0.020
Dibenzo(a,h)anthracene	0.2	<0.020
Fluoranthene	0.04	<0.020
Fluorene	3	<0.020
Indeno(1,2,3-cd)pyrene	0.2	<0.020
1-Methylnaphthalene	2	<0.020
2-Methylnaphthalene	2	<0.020
1+2-Methylnaphthalenes	2	<0.028
Naphthalene	1.1	<0.050
Phenanthrene	0.1	<0.020
Pyrene	0.025	<0.020

Table 127 Preliminary Screening for Groundwater of PHCs at FSL and BASC

PHC Notes

mbgs) represents an above ground groundwater level as the monitoring well was likely a stick-up.
MAC = maximum acceptable concentration; NR = not required; mbgs = metres below ground surface
µg/L = micrograms per litre
< = less than the reportable detection limit
a - Ontario MECP PGMIS only required if there were no screening guidelines from other jurisdictions
FSL-16B and FSL-17 were decommissioned in 2012

References:
Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Generic Site Condition Standards (SCS) - Groundwater (µg/L) All Types of
2 - Federal Contaminated Sites Action Plan (FCSAP), 2016. Federal Interim Groundwater Quality Guidelines (FIGQGs). Table 3 FIGQGs for Commercial and Industrial Land Uses (mg/L), Tier 1 Guidelines, coarse-textured soils. June 2016, Version 4.
laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm.
4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.
Table 8.4 - Provincial Groundwater Monitoring Information System (PGMIS) 97.5th% Background Groundwater Concentrations. April 15,

Data Sources:
26, 2018. B-REP-07010-00067.pdf
(3) Jacobs Engineering Group Inc. 2019. Groundwater Monitoring and Sampling Program, 2018 Groundwater Monitoring and Sampling Report, Prepared for Bruce Power, Dated June 2019. 2018_BPGW_Final_e-Deliverable.pdf
Report, Prepared for Bruce Power, Dated February 2020. 2019_BPGW_LowRes.pdf
(5) Jacobs Engineering Group Inc. 2021. 2020 Groundwater Annual Program Summary, Bruce Power Annual Groundwater Monitoring Program. Prepared for Bruce Power, Dated February 5, 2021. 2020 Annual GWMP Report_DRAFT.pdf

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.3 Surface Water

Table 129 Preliminary Screening for Surface Water of Metals

Location						
Sample ID						
Sample Date						
			PWQO [1]	**CCME** [2]	**Ontario** [3]	**Health Canada** [4]
Parameter	**Preliminary Benchmark**	**Units**		**WQG - Long Term**	**ODWS (MAC)**	**CDWQGs (MAC, unless otherwise specified)**
Field Observations						
Specific Conductivity	NA	µS/cm	-	-	-	-
pH	6.5-8.5	pH	6.5 - 8.5	6.5-9	-	7-10.5
Temperature	NA	°C	-	-	-	-
DO (mg/L)	6	mg/L	6 [o]	-	-	-
General Chemistry						
Total Ammonia-N	NA	mg/L	Refer to Ammonia/Un-ionized Ammonia			Not required [b]
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	mg/L	0.016	0.016	-	-
Ammonium (NH4+-N)	NA	mg/L	Refer to Ammonia			
Total Phosphorous	0.02	mg/L	0.02[a]	-	-	-
Total Dissolved Solids (TDS)	NA	mg/L	-	-	-	AO: < 500
Hardness ($CaCO_3$)	NA	mg/L	-	-	-	Not required
Dissolved Organic Carbon (DOC)	NA	mg/L	-	-	-	-
Total Suspended Solids (TSS)	NA	mg/L	-	-	-	-
Alkalinity (Total as CaCO3)	NA	mg/L	Narrative[c]	-	-	-
Nitrite (N)	0.06	mg/L	-	0.06	2.9	2.9
Chloride (Cl)	120	mg/L	-	120	-	AO: <250
Nitrate (N)	10	mg/L	-	13	10	10
Sulphate (SO_4^{2-})	NA	mg/L	-	-	-	AO: <500
Fluoride (F-)	0.12	mg/L	-	0.12	1.5	1.5

Table 129 Preliminary Screening for Surface Water of Metals

Location						
Sample ID						
Sample Date						
			PWQO [1]	**CCME [2]**	**Ontario [3]**	**Health Canada [4]**
Parameter	**Preliminary Benchmark**	**Units**		**WQG - Long Term**	**ODWS (MAC)**	**CDWQGs (MAC, unless otherwise specified)**
Metals						
Total Aluminum (Al)	75 - 100	µg/L	d	e	-	OG : <100[f]
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	µg/L	*PWQO and CWQG calculated on a per sample basis using pH measured at time of sampling event.*			
Aluminum CWQG		µg/L				
Minimum Al guideline		µg/L				
Total Antimony (Sb)	6	µg/L	20	-	6	6
Total Arsenic (As)	5	µg/L	5	5	10	10
Total Barium (Ba)	1000	µg/L	-	-	1000	2000
Total Boron (B)	200	µg/L	200	1500	5000	5000
Total Cadmium (Cd)	0.09 - 0.37	µg/L	g	h	5	7
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	µg/L	*PWQO and CWQG calculated on a per sample basis using hardness measured at time of sampling event.*			
Cadmium CWQG		µg/L				
Minimum Cd guideline		µg/L				
Total Chromium (Cr)	50	µg/L	-	-	50	50
Chromium (+3)	8.9	µg/L	8.9	8.9	-	-
Chromium (VI)	1	µg/L	1	1	50	50
Total Copper (Cu)	2 - 4	µg/L	i	j	-	2000
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	µg/L	*PWQO and CWQG calculated on a per sample basis using hardness measured at time of sampling event.*			
Copper CWQG		µg/L				
Minimum Cu guideline		µg/L				

Table 129 Preliminary Screening for Surface Water of Metals

Location						
Sample ID						
Sample Date						
			PWQO [1]	**CCME** [2]	**Ontario** [3]	**Health Canada** [4]
Parameter	**Preliminary Benchmark**	**Units**		**WQG - Long Term**	**ODWS (MAC)**	**CDWQGs (MAC, unless otherwise specified)**
Total Iron (Fe)	300	µg/L	300	300	-	AO : ≤300
Total Lead (Pb)	1 - 5	µg/L	k	l	10	5
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	µg/L	*PWQO and CWQG calculated on a per sample basis using hardness measured at time of sampling event.*			
Lead CWQG		µg/L				
Minimum Pb guideline		µg/L				
Total Mercury (Hg)	0.026	µg/L	0.2	0.026	1	1
Total Molybdenum (Mo)	40	µg/L	40	73	-	-
Total Nickel (Ni)	25	µg/L	25	m	-	-
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	µg/L	*CWQG calculated on a per sample basis using hardness measured at time of sampling event.*			
Nickel CWQG		µg/L				
Minimum Ni guideline		µg/L				
Total Selenium (Se)	1	µg/L	100	1	50	50
Total Uranium (U)	5	µg/L	5	15	20	20
Total Vanadium (V)	6	µg/L	6	-	-	-
Total Zinc (Zn)	2.4 - 30	µg/L	30	n	-	AO: ≤5000
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	µg/L	*CWQG calculated on a per sample basis using hardness, pH, and DOC measured at the time of sampling event.*			
Zinc CWQG		µg/L				
Minimum Zn guideline		µg/L				

Table 129 Preliminary Screening for Surface Water of Metals

Location									
Sample ID									
Sample Date									
	Preliminary Benchmark	**Lake Water Quality**		**On-Site Stream C U/S**		**On-Site Stream C D/S**		**On-Site Permanent Drainage Feature**	
Parameter		**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**
Field Observations									
Specific Conductivity	NA	615	615	635	635	800	800	1675	1675
pH	6.5-8.5	**8.84**	**8.84**	8.33	8.33	8.1	8.1	9.54	9.54
Temperature	NA	30.67	30.67	19.03	19.03	20.3	20.3	23.27	23.27
DO (mg/L)	6	6.7 (min)	6.7	**5.95 (min)**	**5.95**	**4.41 (min)**	**4.41**	**4.3**	**4.3**
General Chemistry									
Total Ammonia-N	NA	0.91	0.91	22	22	12	12	0.3	0.3
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	**0.30**	**0.30**	**1.61**	**1.61**	**0.296**	**0.29551**	*<0.038512*	**0.023660562**
Ammonium (NH4+-N)	NA	0.84	0.84	21.82	21.82	11.90	11.90	0.29754796185	0.297547962
Total Phosphorous	0.02	**0.028**	**0.028**	**0.08**	**0.08**	**0.06**	**0.06**	**0.23**	**0.23**
Total Dissolved Solids (TDS)	NA	216	216	332	332	358	358	790	790
Hardness ($CaCO_3$)	NA	99	99	322	322	298	298	230	230
Dissolved Organic Carbon (DOC)	NA	-	-	7.33	7.33	6.93	6.93	6.49	6.49
Total Suspended Solids (TSS)	NA	<10	4.2	25	25	23	23	43	43
Alkalinity (Total as CaCO3)	NA	87	87	290	290	280	280	237	237
Nitrite (N)	0.06	<0.05	-	<0.03	-	<0.03	-	<0.01	0
Chloride (Cl)	120	8.9	8.9	30	30	38	38	**360**	**360**
Nitrate (N)	10	0.81	0.81	0.63	0.63	0.46	0.46	0.183	0.183
Sulphate (SO_4^{2-})	NA	20	20	11	11	10	10	19	19
Fluoride (F-)	0.12	**0.15**	**0.15**	**0.37**	**0.37**	**0.46**	**0.46**	**0.66**	**0.66**

Table 129 Preliminary Screening for Surface Water of Metals

Location										
Sample ID										
Sample Date										
		Lake Water Quality		**On-Site Stream C U/S**		**On-Site Stream C D/S**		**On-Site Permanent Drainage Feature**		
Parameter	**Preliminary Benchmark**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**
Metals									
Total Aluminum (Al)	75 - 100	62	62	**1630**	**1630**	**1540**	**1540**	**775**	**775**
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*PWQO and CWQG calculated on a per sample basis using pH measured at time of sampling event.*							
Aluminum CWQG									
Minimum Al guideline									
Total Antimony (Sb)	6	-	-	<0.50	-	<0.50	-	<0.50	0.14
Total Arsenic (As)	5	<1.0	0.55	<1.0	0.43	<1.0	0.4	<1.0	0.3
Total Barium (Ba)	1000	-	-	19.6	19.6	19.8	19.8	51	51
Total Boron (B)	200	21	21	15	15	21	21	63	63
Total Cadmium (Cd)	0.09 - 0.37	<0.10	-	<0.10	0.018	<0.10	0.019	<0.090	0.0094
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*PWQO and CWQG calculated on a per sample basis using hardness measured at time of sampling event.*							
Cadmium CWQG									
Minimum Cd guideline									
Total Chromium (Cr)	50	<5.0	-	11.5	11.5	<5.0	2.20	<5.0	-
Chromium (+3)	8.9	-	-	**11.2**	**11.2**	<5	2.20	<5	-
Chromium (VI)	1	<0.99	0.58	<0.50	0.40	0.5	0.50	<0.50	-
Total Copper (Cu)	2 - 4	2.1	2.1	**8.9**	**8.9**	2	2	**4.8**	**4.8**
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*PWQO and CWQG calculated on a per sample basis using hardness measured at time of sampling event.*							
Copper CWQG									
Minimum Cu guideline									

Table 129 Preliminary Screening for Surface Water of Metals

Location									
Sample ID									
Sample Date									
		Lake Water Quality		**On-Site Stream C U/S**		**On-Site Stream C D/S**		**On-Site Permanent Drainage Feature**	
Parameter	**Preliminary Benchmark**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**
Total Iron (Fe)	300	<100	-	**1300**	**1300**	**1360**	**1360**	**370**	**370**
Total Lead (Pb)	1 - 5	0.71	0.71	0.68	0.68	0.59	0.59	<0.50	0.091
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*PWQO and CWQG calculated on a per sample basis using hardness measured at time of sampling event.*							
Lead CWQG									
Minimum Pb guideline									
Total Mercury (Hg)	0.026	*<0.1*	-	*<0.1*	-	<0.1	-	*<0.10*	-
Total Molybdenum (Mo)	40	-	-	<0.50	0.28	2	2	1.2	1.2
Total Nickel (Ni)	25	6.8	6.8	1.9	1.9	2	2	1.3	1.3
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*CWQG calculated on a per sample basis using hardness measured at time of sampling event.*							
Nickel CWQG									
Minimum Ni guideline									
Total Selenium (Se)	1	-	-	*<2.0*	0.10	<2.0	1	*<2.0*	0.14
Total Uranium (U)	5	-	-	0.75	0.75	0.75	0.75	1.2	1.2
Total Vanadium (V)	6	-	-	2.72	2.72	2.47	2.47	**20.5**	**20.5**
Total Zinc (Zn)	2.4 - 30	**130**	**130**	6	6	14	14	**8.70**	**8.70**
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event*	*CWQG calculated on a per sample basis using hardness, pH, and DOC measured at the time of sampling event.*							
Zinc CWQG									
Minimum Zn guideline									

Table 129 Preliminary Screening for Surface Water of Metals

Location		MacGregor Point							Loscombe Bank
Sample ID		LWQ7	LWQ7	LWQ7	LWQ7	LWQ7	LWQ7	LWQ7	LWQ6
Sample Date		9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20	9-Jun-21	15-Aug-21	9-Jun-17
Parameter	Preliminary Benchmark								
Field Observations									
Specific Conductivity	NA	-	201	-	606	-	-	226	-
pH	6.5-8.5	-	8.03	7.78	8.43	7.68	**8.69**	8.35	-
Temperature	NA	-	20.57	1.84	4.53	10.7	15.2	22.24	-
DO (mg/L)	6	-	8.91	18.71	6.70	-	10.79	8.43	-
General Chemistry									
Total Ammonia-N	NA	<0.05	0.54	<0.05	0.62	<0.05	0.06	<0.01	<0.05
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	<0.0068	**0.023**	<0.00029	**0.019**	<0.00047	0.0067	<0.00094	<0.0068
Ammonium (NH4+-N)	NA	<0.0432	0.52	<0.04971	0.60	<0.04953	0.05	<0.00906	<0.0432
Total Phosphorous	0.02	<0.004	<0.004	<0.004	<0.02	<0.02	<0.02	-	<0.004
Total Dissolved Solids (TDS)	NA	94.00	158.00	85.00	120.00	145.00	70.00	-	106.00
Hardness ($CaCO_3$)	NA	92.00	96.00	94.00	-	-	94.00	-	95.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<1	<1	1.00	<10	<10	<10	-	<1
Alkalinity (Total as CaCO3)	NA	81.00	85.00	86.00	80.00	83.00	80.00	-	82.00
Nitrite (N)	0.06	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	-	<0.01
Chloride (Cl)	120	7.70	7.10	7.70	7.70	8.80	7.70	-	7.00
Nitrate (N)	10	0.28	0.30	0.30	0.40	0.25	0.20	-	0.29
Sulphate (SO_4^{2-})	NA	16.00	16.00	15.00	15.00	16.00	16.00	-	15.00
Fluoride (F-)	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	-	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		**MacGregor Point**							**Loscombe Bank**
Sample ID		**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ6**
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**15-Aug-21**	**9-Jun-17**
Parameter	**Preliminary Benchmark**								
Metals									
Total Aluminum (Al)	75 - 100	<5.0	7.1	29	12	14	18	-	11
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	16.00	12.00	13.00	15.00	15.00	11.00	-	14.00
Total Cadmium (Cd)	0.09 - 0.37	<0.10	<0.10	<0.10	<0.10	<0.09	<0.09	-	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-	<5.0
Chromium (+3)	8.9	-	-	-	-	-	<5.0	-	-
Chromium (VI)	1	<0.50	<0.50	<0.50	<0.50	0.54	<0.99	-	<0.50
Total Copper (Cu)	2 - 4	<1.0	<1.0	<1.0	<1.0	1.80	<0.90	-	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.20*	*2.28*	*2.24*	*2.16*	*2.16*	*2.24*	*2.16*	*2.26*
Minimum Cu guideline		*2.20*	*2.28*	*2.24*	*2.16*	*2.16*	*2.24*	*2.16*	*2.26*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**MacGregor Point**							**Loscombe Bank**
Sample ID		**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ6**
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**15-Aug-21**	**9-Jun-17**
Parameter	**Preliminary Benchmark**								
Total Iron (Fe)	300	<100	<100	<100	<100	<100	<100	-	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*2.86*	*3.02*	*2.94*	*2.78*	*2.78*	*2.94*	*2.78*	*2.98*
Minimum Pb guideline		*2.86*	*3.02*	*2.94*	*2.78*	*2.78*	*2.94*	*2.78*	*2.98*
Total Mercury (Hg)	0.026	<0.01	*<0.1*	*<0.1*	*<0.1*	*<0.1*	<0.01	-	<0.01
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	<1.0	<1.0	<1.0	1.00	<1.0	-	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*90*	*93*	*91*	*88*	*88*	*91*	*88*	*92*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	<5.0	<5.0	**27.00**	5.90	6.40	-	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*21*	*14*	*17*	*10*	*18*	*8*	*10*	*22*
Minimum Zn guideline		*21*	*14*	*17*	*10*	*18*	*8*	*10*	*22*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Loscombe Bank**		**Baie du Dore**		**Baie du Dore**			
Sample ID		**LWQ6**	**LWQ6**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**
Sample Date		**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**9-Jun-17**	**16-Aug-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**
Parameter	**Preliminary Benchmark**								
Field Observations									
Specific Conductivity	NA	195	-	-	-	210	-	-	615
pH	6.5-8.5	7.97	7.9	-	-	**8.55**	-	-	8.29
Temperature	NA	19.44	2.9	-	-	22.7	-	-	7.34
DO (mg/L)	6	9.29	17.91	-	-	8.52	-	-	9.54
General Chemistry									
Total Ammonia-N	NA	0.37	<0.05	<0.05	<0.05	0.16	0.35	<0.05	0.20
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	0.01	<0.00041	<0.0068	<0.0068	**0.023**	0.005	<0.0004	0.006
Ammonium (NH4+-N)	NA	0.36	<0.04959	<0.0432	<0.0432	0.14	0.30	<0.0496	0.19
Total Phosphorous	0.02	<0.004	0.01	<0.004	<0.004	<0.004	<0.004	<0.004	<0.02
Total Dissolved Solids (TDS)	NA	164.00	110.00	108.00	106.00	172.00	160.00	80.00	110.00
Hardness ($CaCO_3$)	NA	99.00	93.00	96.00	91.00	97.00	93.00	95.00	-
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	1.00	<1	<1	1.00	<1	<1	1.00	<10
Alkalinity (Total as CaCO3)	NA	84.00	86.00	86.00	81.00	86.00	85.00	86.00	84.00
Nitrite (N)	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05
Chloride (Cl)	120	6.90	7.50	7.60	7.60	7.00	7.70	7.30	8.30
Nitrate (N)	10	0.32	0.31	0.19	0.28	0.26	0.26	0.33	0.44
Sulphate (SO_4^{2-})	NA	15.00	15.00	15.00	16.00	15.00	16.00	13.00	15.00
Fluoride (F-)	0.12	<0.1	<0.1	<0.1	<0.1	**0.15**	<0.1	<0.1	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		Loscombe Bank		Baie du Dore		Baie du Dore			
Sample ID		LWQ6	LWQ6	LWQ5	LWQ5	LWQ5	LWQ5	LWQ5	LWQ5
Sample Date		16-Aug-17	18-Dec-17	9-Jun-17	9-Jun-17	16-Aug-17	16-Aug-17	18-Dec-17	12-Dec-18
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	6.2	34	11	5	7.6	8	34	22
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	12.00	13.00	16.00	15.00	12.00	12.00	13.00	14.00
Total Cadmium (Cd)	0.09 - 0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.16*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	-	-	-	-	-	-	-
Chromium (VI)	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<1.0	<1.0	1.50	<1.0	<1.0	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.34*	*2.22*	*2.28*	*2.18*	*2.30*	*2.22*	*2.26*	*2.16*
Minimum Cu guideline		*2.34*	*2.22*	*2.28*	*2.18*	*2.30*	*2.22*	*2.26*	*2.16*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Loscombe Bank		Baie du Dore		Baie du Dore			
Sample ID		LWQ6	LWQ6	LWQ5	LWQ5	LWQ5	LWQ5	LWQ5	LWQ5
Sample Date		16-Aug-17	18-Dec-17	9-Jun-17	9-Jun-17	16-Aug-17	16-Aug-17	18-Dec-17	12-Dec-18
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	<100	<100	<100	<100	<100	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*3.14*	*2.90*	*3.02*	*2.82*	*3.06*	*2.90*	*2.98*	*2.78*
Minimum Pb guideline		*3.14*	*2.90*	*3.02*	*2.82*	*3.06*	*2.90*	*2.98*	*2.78*
Total Mercury (Hg)	0.026	*<0.1*	*<0.1*	<0.01	<0.01	*<0.1*	*<0.1*	*<0.1*	*<0.1*
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*95*	*90*	*93*	*89*	*93*	*90*	*92*	*88*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*15*	*15*	*22*	*21*	*9*	*22*	*22*	*11*
Minimum Zn guideline		*15*	*15*	*22*	*21*	*9*	*22*	*22*	*11*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Baie du Dore					Bruce A Discharge Channel		
Sample ID		LWQ5	LWQ5	LWQ5	BPS01-20	BPF02-20	LWQ1	LWQ1	LWQ1
Sample Date		25-Oct-20	9-Jun-21	15-Aug-21	18-Sep-20	18-Sep-20	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	Preliminary Benchmark								
Field Observations									
Specific Conductivity	NA	-	-	305	-	-	-	223	-
pH	6.5-8.5	7.92	**8.59**	8.45	-	-	-	8.47	8.01
Temperature	NA	12.8	21.02	24.97	-	-	-	25.43	10.33
DO (mg/L)	6	-	9.97	8.09	-	-	-	8.41	15.45
General Chemistry									
Total Ammonia-N	NA	0.12	<0.05	0.01	<0.01	0.012	<0.05	0.34	0.13
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	0.002	<0.00712	0.002	<0.00125	0.0015	<0.00681	**0.05**	0.002
Ammonium (NH4+-N)	NA	0.12	<0.04288	0.01	<0.00875	0.0105	<0.04319	0.29	0.13
Total Phosphorous	0.02	<0.02	<0.02	-	0.01	0.01	<0.004	<0.004	<0.004
Total Dissolved Solids (TDS)	NA	140.00	95.00	-	-	-	110.00	160.00	65.00
Hardness ($CaCO_3$)	NA	-	96.00	-	-	-	94.00	96.00	95.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<10	<10	-	4.20	<3.0	<1	1.00	1.00
Alkalinity (Total as CaCO3)	NA	84.00	79.00	-	-	-	81.00	86.00	84.00
Nitrite (N)	0.06	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride (Cl)	120	8.80	7.90	-	-	-	7.30	6.90	7.70
Nitrate (N)	10	0.26	0.21	-	-	-	0.28	0.31	0.81
Sulphate (SO_4^{2-})	NA	16.00	19.00	-	-	-	16.00	15.00	15.00
Fluoride (F-)	0.12	<0.1	<0.1	-	-	-	<0.1	<0.1	**0.13**

Table 129 Preliminary Screening for Surface Water of Metals

Location		Baie du Dore					Bruce A Discharge Channel		
Sample ID		LWQ5	LWQ5	LWQ5	BPS01-20	BPF02-20	LWQ1	LWQ1	LWQ1
Sample Date		25-Oct-20	9-Jun-21	15-Aug-21	18-Sep-20	18-Sep-20	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	30	17	-	<5	<5	6	5.7	45
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	-	0.54	0.53	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	15.00	16.00	-	14.00	14.00	16.00	12.00	13.00
Total Cadmium (Cd)	0.09 - 0.37	<0.09	<0.09	-	<0.005	<0.005	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	-	<0.5	<0.5	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	<5.0	-	-	-	-	-	-
Chromium (VI)	1	<0.50	<0.99	-	-	-	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<0.90	1.30	-	0.33	0.32	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.16*	*2.28*	*2.16*	*2.16*	*2.16*	*2.24*	*2.28*	*2.26*
Minimum Cu guideline		*2.16*	*2.28*	*2.16*	*2.16*	*2.16*	*2.24*	*2.28*	*2.26*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Baie du Dore					Bruce A Discharge Channel		
Sample ID		LWQ5	LWQ5	LWQ5	BPS01-20	BPF02-20	LWQ1	LWQ1	LWQ1
Sample Date		25-Oct-20	9-Jun-21	15-Aug-21	18-Sep-20	18-Sep-20	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	**Preliminary Benchmark**								
Total Iron (Fe)	300	<100	<100	-	<10	<10	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	-	<0.05	<0.05	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*2.78*	*3.02*	*2.78*	*2.78*	*2.78*	*2.94*	*3.02*	*2.98*
Minimum Pb guideline		*2.78*	*3.02*	*2.78*	*2.78*	*2.78*	*2.94*	*3.02*	*2.98*
Total Mercury (Hg)	0.026	*<0.1*	<0.01	-	<0.005	<0.005	<0.01	*<0.1*	*<0.1*
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	<1.0	-	<0.5	<0.5	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*88*	*93*	*88*	*88*	*88*	*91*	*93*	*92*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	**9.30**	-	<0.2	0.50	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*15*	*9*	*10*	*21*	*21*	*22*	*10*	*14*
Minimum Zn guideline		*15*	*9*	*10*	*21*	*21*	*22*	*10*	*14*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Bruce A Discharge Channel				Bruce B Discharge Channel			
Sample ID		LWQ1	LWQ1	LWQ1	LWQ1	LWQ2	LWQ2	LWQ2	LWQ2
Sample Date		12-Dec-18	25-Oct-20	9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18
Parameter	Preliminary Benchmark								
Field Observations									
Specific Conductivity	NA	581	-	-	230	-	240	-	564
pH	6.5-8.5	8.22	7.96	**8.58**	8.45	-	**8.84**	7.98	8.13
Temperature	NA	11.51	20.2	21.94	30.4	-	28.55	13.33	11.41
DO (mg/L)	6	11.04	-	9.23	7.86	-	8.21	14.32	10.86
General Chemistry									
Total Ammonia-N	NA	0.28	0.12	<0.05	0.02	<0.05	0.91	<0.05	0.09
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	0.009	0.004	<0.00739	0.003	<0.00681	**0.30**	<0.00112	0.002
Ammonium (NH4+-N)	NA	0.27	0.12	<0.04261	0.01	<0.04319	0.61	<0.04888	0.08
Total Phosphorous	0.02	<0.02	**0.021**	<0.02	-	<0.004	<0.004	0.00	**0.021**
Total Dissolved Solids (TDS)	NA	90.00	140.00	90.00	-	128.00	116.00	35.00	115.00
Hardness ($CaCO_3$)	NA	-	-	94.00	-	92.00	97.00	90.00	-
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<10	<10	<10	-	<1	1.00	<1	<10
Alkalinity (Total as CaCO3)	NA	79.00	82.00	81.00	-	81.00	84.00	84.00	78.00
Nitrite (N)	0.06	<0.05	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.05
Chloride (Cl)	120	7.40	8.70	7.60	-	7.00	7.10	7.80	7.40
Nitrate (N)	10	0.32	0.25	0.24	-	0.28	0.30	0.25	0.33
Sulphate (SO_4^{2-})	NA	15.00	16.00	16.00	-	15.00	16.00	15.00	15.00
Fluoride (F-)	0.12	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		Bruce A Discharge Channel				Bruce B Discharge Channel			
Sample ID		LWQ1	LWQ1	LWQ1	LWQ1	LWQ2	LWQ2	LWQ2	LWQ2
Sample Date		12-Dec-18	25-Oct-20	9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	11	12	16	-	<5.0	11	30	12
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	15.00	16.00	21.00	-	15.00	12.00	14.00	14.00
Total Cadmium (Cd)	0.09 - 0.37	<0.10	<0.09	<0.09	-	<0.10	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	-	<5.0	-	-	-	-	-
Chromium (VI)	1	<0.50	0.55	<0.99	-	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<1.0	<0.90	1.50	-	<1.0	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.16*	*2.16*	*2.24*	*2.16*	*2.20*	*2.30*	*2.16*	*2.16*
Minimum Cu guideline		*2.16*	*2.16*	*2.24*	*2.16*	*2.20*	*2.30*	*2.16*	*2.16*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Bruce A Discharge Channel				Bruce B Discharge Channel			
Sample ID		LWQ1	LWQ1	LWQ1	LWQ1	LWQ2	LWQ2	LWQ2	LWQ2
Sample Date		12-Dec-18	25-Oct-20	9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	<100	<100	<100	-	<100	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*2.78*	*2.78*	*2.94*	*2.78*	*2.86*	*3.06*	*2.78*	*2.78*
Minimum Pb guideline		*2.78*	*2.78*	*2.94*	*2.78*	*2.86*	*3.06*	*2.78*	*2.78*
Total Mercury (Hg)	0.026	*<0.1*	*<0.1*	<0.01	-	<0.01	*<0.1*	*<0.1*	*<0.1*
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	<1.0	<1.0	-	<1.0	<1.0	6.80	1.90
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*88*	*88*	*91*	*88*	*90*	*93*	*88*	*88*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	<5.0	**27.00**	-	<5.0	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*12*	*14*	*9*	*10*	*21*	*7*	*14*	*12*
Minimum Zn guideline		*12*	*14*	*9*	*10*	*21*	*7*	*14*	*12*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Bruce B Discharge Channel**				**Off Bruce B Discharge Channel**			**MacPherson Bay**
Sample ID		**LWQ2**	**LWQ2**	**LWQ2**	**LWQ2**	**LWQ11**	**LWQ11**	**LWQ11**	**LWQ3**
Sample Date		**25-Oct-20**	**9-Jun-21**	**9-Jun-21**	**15-Aug-21**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**
Parameter	**Preliminary Benchmark**								
Field Observations									
Specific Conductivity	NA	-	-	-	219	-	201	-	-
pH	6.5-8.5	7.89	8.42	8.42	8.4	-	7.78	7.9	-
Temperature	NA	19.5	21.07	21.07	30.67	-	20.66	3.46	-
DO (mg/L)	6	-	8.56	8.56	8.20	-	9.10	17.83	-
General Chemistry									
Total Ammonia-N	NA	0.18	<0.05	<0.05	0.01	<0.05	0.86	<0.05	0.06
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	0.005	<0.00506	<0.00506	0.002	<0.0068	**0.02**	<0.00043	0.009
Ammonium (NH4+-N)	NA	0.17	<0.04494	<0.04494	0.01	<0.0432	0.84	<0.04957	0.055
Total Phosphorous	0.02	<0.02	<0.02	<0.02	-	<0.004	<0.004	<0.004	<0.004
Total Dissolved Solids (TDS)	NA	110.00	85.00	80.00	-	130.00	160.00	30.00	94.00
Hardness ($CaCO_3$)	NA	-	94.00	94.00	-	91.00	96.00	93.00	94.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<10	<10	<10	-	<1	<1	2.00	<1
Alkalinity (Total as CaCO3)	NA	81.00	78.00	80.00	-	81.00	84.00	86.00	82.00
Nitrite (N)	0.06	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
Chloride (Cl)	120	8.30	7.70	7.80	-	7.20	7.00	6.50	7.20
Nitrate (N)	10	0.25	0.24	0.24	-	0.28	0.31	0.28	0.29
Sulphate (SO_4^{2-})	NA	16.00	20.00	17.00	-	16.00	15.00	14.00	15.00
Fluoride (F-)	0.12	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		Bruce B Discharge Channel				Off Bruce B Discharge Channel			MacPherson Bay
Sample ID		LWQ2	LWQ2	LWQ2	LWQ2	LWQ11	LWQ11	LWQ11	LWQ3
Sample Date		25-Oct-20	9-Jun-21	9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	13	18	17	-	7.4	6	35	9.1
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	16.00	16.00	12.00	-	15.00	12.00	12.00	15.00
Total Cadmium (Cd)	0.09 - 0.37	<0.09	<0.09	<0.09	-	<0.10	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	<5.0	<5.0	-	-	-	-	-
Chromium (VI)	1	0.58	<0.99	<0.99	-	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<0.90	2.10	1.30	-	<1.0	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.16*	*2.24*	*2.24*	*2.16*	*2.18*	*2.28*	*2.22*	*2.24*
Minimum Cu guideline		*2.16*	*2.24*	*2.24*	*2.16*	*2.18*	*2.28*	*2.22*	*2.24*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Bruce B Discharge Channel				Off Bruce B Discharge Channel			MacPherson Bay
Sample ID		LWQ2	LWQ2	LWQ2	LWQ2	LWQ11	LWQ11	LWQ11	LWQ3
Sample Date		25-Oct-20	9-Jun-21	9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	<100	<100	<100	-	<100	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.50	-	0.71	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*2.78*	*2.94*	*2.94*	*2.78*	*2.82*	*3.02*	*2.90*	*2.94*
Minimum Pb guideline		*2.78*	*2.94*	*2.94*	*2.78*	*2.82*	*3.02*	*2.90*	*2.94*
Total Mercury (Hg)	0.026	*<0.1*	<0.01	<0.01	-	<0.01	*<0.1*	*<0.1*	<0.01
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	1.50	<1.0	<1.0	-	1.60	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*88*	*91*	*91*	*88*	*89*	*93*	*90*	*91*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	**16.00**	**130.00**	-	<5.0	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*15*	*10*	*10*	*10*	*21*	*17*	*15*	*22*
Minimum Zn guideline		*15*	*10*	*10*	*10*	*21*	*17*	*15*	*22*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**MacPherson Bay**					**Gunn Point**		
Sample ID		**LWQ3**	**LWQ3**	**LWQ3**	**LWQ3**	**LWQ3**	**LWQ4**	**LWQ4**	**LWQ4**
Sample Date		**9-Jun-17**	**16-Aug-17**	**16-Aug-17**	**18-Dec-17**	**18-Dec-17**	**9-Jun-17**	**9-Jun-17**	**16-Aug-17**
Parameter	**Preliminary Benchmark**								
Field Observations									
Specific Conductivity	NA	-	194	188	-	-	-	-	200
pH	6.5-8.5	-	8.09	7.65	8.02	8.14	-	-	7.74
Temperature	NA	-	19.07	18.04	2.75	2.81	-	-	20.09
DO (mg/L)	6	-	9.28	9.55	17.66	17.17	-	-	9.01
General Chemistry									
Total Ammonia-N	NA	<0.05	0.64	0.21	<0.05	<0.05	<0.05	0.10	0.28
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	<0.00681	**0.03**	0.003	<0.00054	<0.00071	<0.00681	0.014	0.01
Ammonium (NH4+-N)	NA	<0.04319	0.61	0.21	<0.04946	<0.04929	<0.04319	0.086	0.27
Total Phosphorous	0.02	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Total Dissolved Solids (TDS)	NA	104.00	166.00	162.00	85.00	60.00	108.00	92.00	160.00
Hardness ($CaCO_3$)	NA	92.00	96.00	97.00	93.00	94.00	92.00	91.00	95.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<1	<1	<1	<1	1.00	<1	<1	<1
Alkalinity (Total as CaCO3)	NA	80.00	84.00	83.00	85.00	85.00	78.00	80.00	85.00
Nitrite (N)	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride (Cl)	120	7.70	6.80	6.90	7.70	7.80	7.00	7.10	7.00
Nitrate (N)	10	0.28	0.31	0.31	0.27	0.28	0.28	0.29	0.30
Sulphate (SO_4^{2-})	NA	15.00	15.00	15.00	14.00	15.00	15.00	16.00	15.00
Fluoride (F-)	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	0.10	<0.1	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		MacPherson Bay					Gunn Point		
Sample ID		LWQ3	LWQ3	LWQ3	LWQ3	LWQ3	LWQ4	LWQ4	LWQ4
Sample Date		9-Jun-17	16-Aug-17	16-Aug-17	18-Dec-17	18-Dec-17	9-Jun-17	9-Jun-17	16-Aug-17
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	<5.0	7.1	5.7	35	28	<5.0	5.2	7.9
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	15.00	13.00	13.00	15.00	14.00	14.00	15.00	12.00
Total Cadmium (Cd)	0.09 - 0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	-	-	-	-	-	-	-
Chromium (VI)	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.20*	*2.28*	*2.30*	*2.22*	*2.24*	*2.20*	*2.18*	*2.26*
Minimum Cu guideline		*2.20*	*2.28*	*2.30*	*2.22*	*2.24*	*2.20*	*2.18*	*2.26*

Table 129 Preliminary Screening for Surface Water of Metals

Location		MacPherson Bay					Gunn Point		
Sample ID		LWQ3	LWQ3	LWQ3	LWQ3	LWQ3	LWQ4	LWQ4	LWQ4
Sample Date		9-Jun-17	16-Aug-17	16-Aug-17	18-Dec-17	18-Dec-17	9-Jun-17	9-Jun-17	16-Aug-17
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	<100	<100	<100	<100	<100	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*2.86*	*3.02*	*3.06*	*2.90*	*2.94*	*2.86*	*2.82*	*2.98*
Minimum Pb guideline		*2.86*	*3.02*	*3.06*	*2.90*	*2.94*	*2.86*	*2.82*	*2.98*
Total Mercury (Hg)	0.026	<0.01	*<0.1*	*<0.1*	*<0.1*	*<0.1*	<0.01	<0.01	*<0.1*
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*90*	*93*	*93*	*90*	*91*	*90*	*89*	*92*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*21*	*14*	*20*	*14*	*13*	*21*	*21*	*18*
Minimum Zn guideline		*21*	*14*	*20*	*14*	*13*	*21*	*21*	*18*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Gunn Point			McRae Point			McRae Point	
Sample ID		LWQ4	LWQ4	LWQ4	LWQ8	LWQ8	LWQ8	LWQ8	LWQ8
Sample Date		16-Aug-17	18-Dec-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20
Parameter	Preliminary Benchmark								
Field Observations									
Specific Conductivity	NA	191	-	-	-	200	-	550	-
pH	6.5-8.5	7.48	7.86	8.25	-	7.81	7.83	8.45	7.93
Temperature	NA	18.45	2.86	2.82	-	20.13	2.18	4.5	10.7
DO (mg/L)	6	9.28	17.16	16.96	-	9.30	17.79	8.07	-
General Chemistry									
Total Ammonia-N	NA	0.41	<0.05	0.08	<0.05	0.34	<0.05	0.12	<0.05
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	0.004	<0.00038	0.001	<0.0068	0.01	<0.00033	0.004	<0.00082
Ammonium (NH4+-N)	NA	0.41	<0.04962	0.08	<0.0432	0.33	<0.04967	0.12	<0.04918
Total Phosphorous	0.02	<0.004	0.01	0.01	<0.004	<0.004	<0.004	**0.028**	<0.02
Total Dissolved Solids (TDS)	NA	174.00	55.00	30.00	114.00	172.00	115.00	125.00	140.00
Hardness ($CaCO_3$)	NA	96.00	93.00	92.00	91.00	97.00	95.00	-	-
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<1	<1	1.00	<1	<1	2.00	<10	<10
Alkalinity (Total as CaCO3)	NA	84.00	85.00	85.00	80.00	85.00	86.00	87.00	82.00
Nitrite (N)	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01
Chloride (Cl)	120	6.90	7.70	6.50	7.20	6.80	7.60	7.90	8.90
Nitrate (N)	10	0.32	0.27	0.28	0.26	0.30	0.31	0.66	0.25
Sulphate (SO_4^{2-})	NA	15.00	14.00	15.00	16.00	15.00	16.00	15.00	16.00
Fluoride (F-)	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		Gunn Point			McRae Point			McRae Point	
Sample ID		LWQ4	LWQ4	LWQ4	LWQ8	LWQ8	LWQ8	LWQ8	LWQ8
Sample Date		16-Aug-17	18-Dec-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	6.4	39	34	14	9.1	29	62	15
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	13.00	16.00	13.00	15.00	12.00	13.00	13.00	14.00
Total Cadmium (Cd)	0.09 - 0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.09
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	-	-	-	-	-	-	-
Chromium (VI)	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<1.0	<1.0	<1.0	<1.0	1.20	<1.0	<1.0	0.96
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.28*	*2.22*	*2.20*	*2.18*	*2.30*	*2.26*	*2.16*	*2.16*
Minimum Cu guideline		*2.28*	*2.22*	*2.20*	*2.18*	*2.30*	*2.26*	*2.16*	*2.16*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Gunn Point			McRae Point			McRae Point	
Sample ID		LWQ4	LWQ4	LWQ4	LWQ8	LWQ8	LWQ8	LWQ8	LWQ8
Sample Date		16-Aug-17	18-Dec-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	<100	<100	<100	<100	<100	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*3.02*	*2.90*	*2.86*	*2.82*	*3.06*	*2.98*	*2.78*	*2.78*
Minimum Pb guideline		*3.02*	*2.90*	*2.86*	*2.82*	*3.06*	*2.98*	*2.78*	*2.78*
Total Mercury (Hg)	0.026	*<0.1*	*<0.1*	*<0.1*	<0.01	*<0.1*	*<0.1*	*<0.1*	*<0.1*
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	<1.0	<1.0	<1.0	1.20	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*93*	*90*	*90*	*89*	*93*	*92*	*88*	*88*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*22*	*16*	*11*	*21*	*17*	*17*	*10*	*15*
Minimum Zn guideline		*22*	*16*	*11*	*21*	*17*	*17*	*10*	*15*

Table 129 Preliminary Screening for Surface Water of Metals

Location		McRae Point		Holmes Bay			Inverhuron Bay		
Sample ID		LWQ8	LWQ8	LWQ9	LWQ9	LWQ9	LWQ10	LWQ10	LWQ10
Sample Date		9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	Preliminary Benchmark								
Field Observations									
Specific Conductivity	NA	-	221	-	200	-	-	200	-
pH	6.5-8.5	**8.63**	8.38	-	7.65	7.67	-	7.79	7.83
Temperature	NA	15.5	22.03	-	20.09	1.95	-	20.02	1.83
DO (mg/L)	6	11.00	8.50	-	9.04	18.24	-	9.16	18.10
General Chemistry									
Total Ammonia-N	NA	<0.05	0.02	<0.05	<0.05	0.06	<0.05	0.10	<0.05
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	<0.00539	0.0018	<0.0068	<0.00087	0.0003	<0.0068	0.002	<0.00032
Ammonium (NH4+-N)	NA	<0.04461	0.02	<0.0432	<0.04913	0.06	<0.0432	0.10	<0.04968
Total Phosphorous	0.02	<0.02	-	<0.004	<0.004	0.004	<0.004	<0.004	<0.004
Total Dissolved Solids (TDS)	NA	75.00	-	114.00	158.00	115.00	216.00	176.00	90.00
Hardness ($CaCO_3$)	NA	96.00	-	92.00	94.00	96.00	93.00	94.00	93.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<10	-	<1	<1	2.00	<1	1.00	2.00
Alkalinity (Total as CaCO3)	NA	82.00	-	81.00	85.00	87.00	81.00	85.00	85.00
Nitrite (N)	0.06	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride (Cl)	120	7.60	-	7.70	7.10	6.60	7.40	7.10	7.20
Nitrate (N)	10	0.21	-	0.28	0.30	0.29	0.27	0.30	0.30
Sulphate (SO_4^{2-})	NA	16.00	-	16.00	16.00	14.00	16.00	16.00	14.00
Fluoride (F-)	0.12	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 129 Preliminary Screening for Surface Water of Metals

Location		McRae Point		Holmes Bay			Inverhuron Bay		
Sample ID		LWQ8	LWQ8	LWQ9	LWQ9	LWQ9	LWQ10	LWQ10	LWQ10
Sample Date		9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	15	-	<5.0	8.8	47	9.2	10	38
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	-	-	-	-	-	-	-
Total Arsenic (As)	5	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	-	-	-	-	-	-	-	-
Total Boron (B)	200	11.00	-	14.00	12.00	13.00	15.00	12.00	13.00
Total Cadmium (Cd)	0.09 - 0.37	<0.09	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Cadmium CWQG		*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
Minimum Cd guideline		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total Chromium (Cr)	50	<5.0	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	<5.0	-	-	-	-	-	-	-
Chromium (VI)	1	<0.99	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	<0.90	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.28*	*2.16*	*2.20*	*2.24*	*2.28*	*2.22*	*2.24*	*2.22*
Minimum Cu guideline		*2.28*	*2.16*	*2.20*	*2.24*	*2.28*	*2.22*	*2.24*	*2.22*

Table 129 Preliminary Screening for Surface Water of Metals

Location		McRae Point		Holmes Bay			Inverhuron Bay		
Sample ID		LWQ8	LWQ8	LWQ9	LWQ9	LWQ9	LWQ10	LWQ10	LWQ10
Sample Date		9-Jun-21	15-Aug-21	9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	<100	-	<100	<100	<100	<100	<100	<100
Total Lead (Pb)	1 - 5	<0.50	-	0.58	<0.50	<0.50	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*3.02*	*2.78*	*2.86*	*2.94*	*3.02*	*2.90*	*2.94*	*2.90*
Minimum Pb guideline		*3.02*	*2.78*	*2.86*	*2.94*	*3.02*	*2.90*	*2.94*	*2.90*
Total Mercury (Hg)	0.026	<0.01	-	<0.01	*<0.1*	*<0.1*	<0.01	*<0.1*	*<0.1*
Total Molybdenum (Mo)	40	-	-	-	-	-	-	-	-
Total Nickel (Ni)	25	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*93*	*88*	*90*	*91*	*93*	*90*	*91*	*90*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	-	-	-	-	-	-	-
Total Uranium (U)	5	-	-	-	-	-	-	-	-
Total Vanadium (V)	6	-	-	-	-	-	-	-	-
Total Zinc (Zn)	2.4 - 30	**21.00**	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*9*	*10*	*21*	*19*	*19*	*22*	*17*	*16*
Minimum Zn guideline		*9*	*10*	*21*	*19*	*19*	*22*	*17*	*16*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Inverhuron Bay	Stream C - Upstream (Background)						
Sample ID		IHS01-20	SW1	SW1	SW1	SW1	SW1	SW1	SW1
Sample Date		18-Sep-20	8-Jun-17	17-Aug-17	18-Dec-17	18-Dec-17 (Dup)	26-Aug-20	11-Nov-20	23-Dec-20
Parameter	Preliminary Benchmark								OPG RA Data
Field Observations									
Specific Conductivity	NA	-	-	422	-	-	583	554	496.4
pH	6.5-8.5	-	-	6.65	7.54	7.54	7.87	7.88	7.5
Temperature	NA	-	-	15.43	-0.13	-0.13	18.3	12.1	-
DO (mg/L)	6	-	-	**5.95**	15.48	15.48	6.09	6.35	8.42
General Chemistry									
Total Ammonia-N	NA	<0.01	<0.05	<0.05	0.11	0.41	<0.1	<0.1	-
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	<0.00125	<0.000981	<0.000063	0.000310	0.001155	<0.002526	<0.001632	-
Ammonium (NH4+-N)	NA	<0.00875	<0.049019	<0.049937	0.10969	0.408845	<0.097474	<0.098368	-
Total Phosphorous	0.02	0.0033	**0.024**	**0.026**	**0.022**	0.01	*<0.03*	*<0.03*	-
Total Dissolved Solids (TDS)	NA	-	258.00	332.00	250.00	230.00	320.00	323.00	275.00
Hardness ($CaCO_3$)	NA	-	250.00	250.00	250.00	260.00	291.00	322.00	-
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	-
Total Suspended Solids (TSS)	NA	<3.0	5.00	8.00	10.00	17.00	5.00	2.00	<4
Alkalinity (Total as CaCO3)	NA	-	240.00	260.00	260.00	270.00	284.00	254.00	240.00
Nitrite (N)	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	-
Chloride (Cl)	120	-	14.00	16.00	18.00	30.00	-	-	-
Nitrate (N)	10	-	<0.10	<0.10	0.63	0.36	<0.06	0.14	-
Sulphate (SO_4^{2-})	NA	-	8.60	4.30	8.10	11.00	-	-	-
Fluoride (F-)	0.12	-	**0.32**	**0.30**	**0.31**	**0.29**	**0.37**	**0.34**	-

Table 129 Preliminary Screening for Surface Water of Metals

Location		Inverhuron Bay	Stream C - Upstream (Background)						
Sample ID		IHS01-20	SW1	SW1	SW1	SW1	SW1	SW1	SW1
Sample Date		18-Sep-20	8-Jun-17	17-Aug-17	18-Dec-17	18-Dec-17 (Dup)	26-Aug-20	11-Nov-20	23-Dec-20
Parameter	Preliminary Benchmark								OPG RA Data
Metals									
Total Aluminum (Al)	75 - 100	<5	61	66	**96**	**76**	26	65	**131**
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	<0.50	<0.50	<0.50	<0.50	-	-	<0.03
Total Arsenic (As)	5	0.55	<1.0	<1.0	<1.0	<1.0	-	-	0.25
Total Barium (Ba)	1000	-	11.00	13.00	15.00	14.00	19.10	19.00	14.40
Total Boron (B)	200	13.00	14.00	12.00	<10	10.00	-	-	<13
Total Cadmium (Cd)	0.09 - 0.37	<0.005	<0.10	<0.10	<0.10	<0.10	0.00	0.01	<0.004
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.10*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*
Cadmium CWQG		*0.15*	*0.34*	*0.34*	*0.34*	*0.35*	*0.37*	*0.37*	*0.34*
Minimum Cd guideline		*0.1*	*0.34*	*0.34*	*0.34*	*0.35*	*0.37*	*0.37*	*0.34*
Total Chromium (Cr)	50	<0.5	<5.0	<5.0	<5.0	<5.0	11.50	0.16	<0.2
Chromium (+3)	8.9	-	<5	<5	<5	<5	**11.20**	<5	-
Chromium (VI)	1	-	<0.50	<0.50	<0.50	<0.50	0.30	0.40	<0.24
Total Copper (Cu)	2 - 4	0.29	<1.0	**8.90**	<1.0	<1.0	0.40	0.80	0.54
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*2.16*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*
Minimum Cu guideline		*2.16*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Inverhuron Bay**	**Stream C - Upstream (Background)**						
Sample ID		**IHS01-20**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**
Sample Date		**18-Sep-20**	**8-Jun-17**	**17-Aug-17**	**18-Dec-17**	**18-Dec-17 (Dup)**	**26-Aug-20**	**11-Nov-20**	**23-Dec-20**
Parameter	**Preliminary Benchmark**								**OPG RA Data**
Total Iron (Fe)	300	<10	**570.00**	**480.00**	**420.00**	230.00	**904.00**	**419.00**	282.00
Total Lead (Pb)	1 - 5	<0.05	<0.50	<0.50	<0.50	<0.50	<0.01	0.06	<0.09
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*2.78*	*7.00*	*7.00*	*7.00*	*7.00*	*7.00*	*7.00*	*7.00*
Minimum Pb guideline		*2.78*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*
Total Mercury (Hg)	0.026	<0.005	*<0.1*	*<0.1*	*<0.1*	*<0.1*	<0.01	<0.01	<0.003
Total Molybdenum (Mo)	40	-	<0.50	<0.50	<0.50	<0.50	0.15	0.26	<0.2
Total Nickel (Ni)	25	<0.5	<1.0	<1.0	<1.0	<1.0	0.30	0.30	<0.4
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*88*	*150*	*150*	*150*	*150*	*150*	*150*	*150*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	*<2.0*	*<2.0*	*<2.0*	*<2.0*	-	-	0.10
Total Uranium (U)	5	-	0.30	0.24	0.57	0.75	0.21	0.46	0.46
Total Vanadium (V)	6	-	<0.50	<0.50	<0.50	<0.50	0.28	0.33	<0.2
Total Zinc (Zn)	2.4 - 30	<0.2	<5.0	<5.0	<5.0	<5.0	2.00	6.00	<1.1
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*21*	*109*	*109*	*53*	*55*	*46*	*51*	*54*
Minimum Zn guideline		*21*	*30*	*30*	*30*	*30*	*30*	*30*	*30*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Stream C - Upstream (Background)**			**Stream C - Downstream**			**Stream C - Downstream**	
Sample ID		**SW1**	**SW1**	**SW1**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**
Sample Date		**12-Mar-21**	**22-Jul-21**	**17-Nov-21**	**24-Feb-17**	**5-May-17**	**8-Jun-17**	**8-Jun-17**	**17-Aug-17**
Parameter	**Preliminary Benchmark**								
Field Observations									
Specific Conductivity	NA	-	573	635	-	-	-	-	479
pH	6.5-8.5	8.11	8.33	8.16	7.79	7.73	-	-	7.26
Temperature	NA	-	19.03	4.13	-	-	-	-	17.03
DO (mg/L)	6	-	7.83	11.50	-	-	-	-	**4.41**
General Chemistry									
Total Ammonia-N	NA	<0.1	22.00	0.11	-	-	<0.05	<0.05	0.10
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	<0.001050	**1.61**	0.00	-	-	<0.000981	<0.000981	0.000575
Ammonium (NH4+-N)	NA	<0.098950	21.82	0.11	-	-	<0.049019	<0.049019	0.099425
Total Phosphorous	0.02	**0.08**	**0.03**	**0.05**	**0.05**	<0.02	0.01	0.01	0.02
Total Dissolved Solids (TDS)	NA	206.00	285.00	238.00	-	-	288.00	288.00	348.00
Hardness ($CaCO_3$)	NA	160.00	280.00	202.00	-	-	250.00	250.00	270.00
Dissolved Organic Carbon (DOC)	NA	-	-	7.33	-	-	-	-	-
Total Suspended Solids (TSS)	NA	25.00	<10	4.50	23.00	<2	2.00	1.00	2.00
Alkalinity (Total as CaCO3)	NA	124.00	290.00	198.00	-	-	240.00	240.00	270.00
Nitrite (N)	0.06	<0.03	<0.01	<0.01	-	-	<0.01	<0.01	<0.01
Chloride (Cl)	120	-	16.00	12.50	-	-	25.00	25.00	23.00
Nitrate (N)	10	0.61	<0.1	0.32	-	-	<0.10	<0.10	<0.10
Sulphate (SO_4^{2-})	NA	-	<1.0	4.96	-	-	4.60	4.70	2.10
Fluoride (F-)	0.12	**0.21**	**0.35**	**0.17**	-	-	**0.32**	**0.33**	**0.36**

Table 129 Preliminary Screening for Surface Water of Metals

Location		Stream C - Upstream (Background)			Stream C - Downstream			Stream C - Downstream	
Sample ID		SW1	SW1	SW1	SW2	SW2	SW2	SW2	SW2
Sample Date		12-Mar-21	22-Jul-21	17-Nov-21	24-Feb-17	5-May-17	8-Jun-17	8-Jun-17	17-Aug-17
Parameter	Preliminary Benchmark								
Metals									
Total Aluminum (Al)	75 - 100	**1630**	18	**1010**	**281**	68	14	16	17
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	-	<0.50	<0.1	-	-	<0.50	<0.50	<0.50
Total Arsenic (As)	5	-	<1.0	0.43	0.30	0.40	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	19.60	17.00	16.20	1.60	14.00	12.00	13.00	16.00
Total Boron (B)	200	-	15.00	13.00	-	18.00	15.00	17.00	16.00
Total Cadmium (Cd)	0.09 - 0.37	0.02	<0.090	0.01	-	-	<0.10	<0.10	<0.10
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*
Cadmium CWQG		*0.23*	*0.37*	*0.28*	*0.34*	*0.34*	*0.34*	*0.34*	*0.36*
Minimum Cd guideline		*0.23*	*0.37*	*0.28*	*0.34*	*0.34*	*0.34*	*0.34*	*0.36*
Total Chromium (Cr)	50	2.40	<5.0	1.60	2.00	1.00	<5.0	<5.0	<5.0
Chromium (+3)	8.9	2.40	<5	1.60	-	-	<5	<5	<5
Chromium (VI)	1	<0.2	<0.50	<0.5	-	-	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	2.40	<0.90	1.40	1.00	2.00	<1.0	<1.0	<1.0
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*3.53*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*
Minimum Cu guideline		*3.53*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Stream C - Upstream (Background)**			**Stream C - Downstream**			**Stream C - Downstream**	
Sample ID		**SW1**	**SW1**	**SW1**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**
Sample Date		**12-Mar-21**	**22-Jul-21**	**17-Nov-21**	**24-Feb-17**	**5-May-17**	**8-Jun-17**	**8-Jun-17**	**17-Aug-17**
Parameter	**Preliminary Benchmark**								
Total Iron (Fe)	300	**1300.00**	**870.00**	**1150.00**	206.00	75.00	110.00	120.00	150.00
Total Lead (Pb)	1 - 5	0.68	<0.50	0.40	0.10	-	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*5.79*	*7.00*	*7.00*	*7.00*	*7.00*	*7.00*	*7.00*	*7.00*
Minimum Pb guideline		*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*
Total Mercury (Hg)	0.026	<0.01	*<0.10*	<0.005	-	-	*<0.1*	*<0.1*	*<0.1*
Total Molybdenum (Mo)	40	0.28	<0.50	0.23	2.00	0.50	<0.50	<0.50	<0.50
Total Nickel (Ni)	25	1.90	<1.0	1.45	2.00	2.00	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Nickel CWQG		*137*	*150*	*150*	*150*	*150*	*150*	*150*	*150*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	-	*<2.0*	0.10	1.00	-	*<2.0*	*<2.0*	*<2.0*
Total Uranium (U)	5	0.35	0.21	0.43	0.60	0.50	0.50	0.51	0.18
Total Vanadium (V)	6	2.72	<0.50	1.75	1.00	0.70	<0.50	<0.50	<0.50
Total Zinc (Zn)	2.4 - 30	6.00	<5.0	4.30	2.00	2.00	<5.0	<5.0	<5.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*22*	*31*	*26*	*43*	*45*	*109*	*109*	*71*
Minimum Zn guideline		*22*	*30*	*26*	*30*	*30*	*30*	*30*	*30*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Stream C - Downstream							
Sample ID		SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
Sample Date		17-Aug-17	18-Dec-17	26-Aug-20	11-Nov-20	23-Dec-20	12-Mar-21	22-Jul-21	17-Nov-21
Parameter	Preliminary Benchmark					OPG RA Data			
Field Observations									
Specific Conductivity	NA	479	-	579	552	512.7	-	641	800
pH	6.5-8.5	7.26	7.93	8.1	7.93	7.73	8.1	7.8	7.61
Temperature	NA	17.03	-0.23	20.3	11.5	-	-	20.14	4.71
DO (mg/L)	6	**4.41**	14.82	8.23	9.02	9.98	-	8.10	10.40
General Chemistry									
Total Ammonia-N	NA	0.073	0.43	<0.1	<0.1	-	<0.1	12.00	0.12
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	0.000420	0.002938	<0.004850	<0.001746	-	<0.001027	**0.30**	0.00
Ammonium (NH4+-N)	NA	0.072580	0.427062	<0.095150	<0.098254	-	<0.098973	11.90	0.12
Total Phosphorous	0.02	0.01	0.01	*<0.03*	*<0.03*	-	**0.06**	**0.03**	0.02
Total Dissolved Solids (TDS)	NA	358.00	255.00	311.00	337.00	295.00	169.00	285.00	264.00
Hardness ($CaCO_3$)	NA	260.00	260.00	269.00	298.00	-	149.00	270.00	224.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	-	-	-	-	6.93
Total Suspended Solids (TSS)	NA	2.00	7.00	7.00	3.00	<5	11.00	<10	4.20
Alkalinity (Total as CaCO3)	NA	280.00	270.00	231.00	257.00	240.00	122.00	280.00	219.00
Nitrite (N)	0.06	<0.01	<0.01	<0.03	<0.03	-	<0.03	<0.01	<0.01
Chloride (Cl)	120	23.00	29.00	-	-	-	-	38.00	19.40
Nitrate (N)	10	<0.10	0.41	<0.03	<0.03	-	0.46	0.16	0.19
Sulphate (SO_4^{2-})	NA	1.90	10.00	-	-	-	-	<1.0	5.68
Fluoride (F-)	0.12	**0.37**	**0.28**	**0.46**	**0.32**	-	**0.15**	**0.37**	**0.22**

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Stream C - Downstream**							
Sample ID		**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**
Sample Date		**17-Aug-17**	**18-Dec-17**	**26-Aug-20**	**11-Nov-20**	**23-Dec-20**	**12-Mar-21**	**22-Jul-21**	**17-Nov-21**
Parameter	**Preliminary Benchmark**					**OPG RA Data**			
Metals									
Total Aluminum (Al)	75 - 100	16	59	16	40	**216**	**1540**	8	**502**
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*75*	*75*
Total Antimony (Sb)	6	<0.50	<0.50	-	-	<0.05	-	<0.50	<0.1
Total Arsenic (As)	5	<1.0	<1.0	-	-	0.27	-	<1.0	0.37
Total Barium (Ba)	1000	16.00	14.00	19.80	17.10	15.00	18.40	16.00	14.90
Total Boron (B)	200	17.00	10.00	-	-	<14	-	21.00	14.00
Total Cadmium (Cd)	0.09 - 0.37	<0.10	<0.10	<0.003	0.01	<0.004	0.02	<0.090	0.01
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*
Cadmium CWQG		*0.35*	*0.35*	*0.36*	*0.37*	*0.34*	*0.22*	*0.36*	*0.31*
Minimum Cd guideline		*0.35*	*0.35*	*0.36*	*0.37*	*0.34*	*0.22*	*0.36*	*0.31*
Total Chromium (Cr)	50	<5.0	<5.0	0.23	0.13	<0.4	2.20	<5.0	0.80
Chromium (+3)	8.9	<5	<5	<5	<5	<0	2.20	<5	<1.0
Chromium (VI)	1	<0.50	<0.50	0.30	0.50	<0.3	<0.2	<0.50	<0.5
Total Copper (Cu)	2 - 4	<1.0	<1.0	0.70	1.10	0.70	1.80	1.10	<0.001
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*3.32*	*4.00*	*4.00*
Minimum Cu guideline		*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*3.32*	*4.00*	*4.00*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Stream C - Downstream							
Sample ID		SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
Sample Date		17-Aug-17	18-Dec-17	26-Aug-20	11-Nov-20	23-Dec-20	12-Mar-21	22-Jul-21	17-Nov-21
Parameter	Preliminary Benchmark					OPG RA Data			
Total Iron (Fe)	300	150.00	180.00	170.00	187.00	297.00	**1360.00**	<100	**479.00**
Total Lead (Pb)	1 - 5	<0.50	<0.50	<0.01	0.06	<0.13	0.59	<0.50	0.21
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Lead CWQG		*7.00*	*7.00*	*7.00*	*7.00*	*7.00*	*5.29*	*7.00*	*7.00*
Minimum Pb guideline		*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*
Total Mercury (Hg)	0.026	*<0.1*	*<0.1*	< 0.01	< 0.01	<0.001	<0.01	*<0.10*	<0.005
Total Molybdenum (Mo)	40	<0.50	<0.50	0.27	0.33	<0.3	0.21	<0.50	0.32
Total Nickel (Ni)	25	<1.0	<1.0	0.50	0.40	<0.8	1.80	<1.0	0.85
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*150*	*150*	*150*	*150*	*150*	*129*	*150*	*150*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	*<2.0*	*<2.0*	-	-	<0.09	-	*<2.0*	0.11
Total Uranium (U)	5	0.17	0.75	0.22	0.56	0.60	0.25	0.47	0.60
Total Vanadium (V)	6	<0.50	<0.50	0.23	0.22	<0.3	2.47	<0.50	1.01
Total Zinc (Zn)	2.4 - 30	<5.0	<5.0	<2	4.00	<1.6	7.00	14.00	<3.0
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event.*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*69*	*40*	*36*	*45*	*45*	*20*	*46*	*45*
Minimum Zn guideline		*30*	*30*	*30*	*30*	*30*	*20*	*30*	*30*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Eastern Drainage Ditch				B31 Pond	B16 Pond	Former Sewage Lagoon (FSL)	
Sample ID		SW3	SW3	SW3	SW3	B31-Pond	B16-Pond	FSL-1	FSL-2
Sample Date		24-Feb-17	5-May-17	22-Jul-21	17-Nov-21	22-Jul-21	22-Jul-21	22-Jul-21	22-Jul-21
Parameter	Preliminary Benchmark								
Field Observations									
Specific Conductivity	NA	-	-	1675	1563	492	1040	111	111
pH	6.5-8.5	7.84	7.86	8.3	8.1	7.73	7.64	**9.54**	**9.54**
Temperature	NA	-	-	21.1	6.56	23.27	22.9	23.05	23.05
DO (mg/L)	6	-	-	6.10	8.20	**5.59**	**4.30**	7.94	7.94
General Chemistry									
Total Ammonia-N	NA	-	-	0.30	0.22	0.099	<0.061	<0.061	0.062
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	-	-	**0.02**	0.004	0.0008	<0.001274	*<0.038512*	0.0005
Ammonium (NH4+-N)	NA	-	-	0.30	0.22	0.0982	<0.059726	<0.022488	0.0615
Total Phosphorous	0.02	**0.028**	<0.02	<0.02	0.01	**0.07**	**0.03**	**0.23**	**0.22**
Total Dissolved Solids (TDS)	NA	-	-	790.00	514.00	200.00	485.00	70.00	70.00
Hardness ($CaCO_3$)	NA	230	230	230.00	230.00	80.00	160.00	58.00	53.00
Dissolved Organic Carbon (DOC)	NA	-	-	-	6.49	-	-	-	-
Total Suspended Solids (TSS)	NA	13.1	<2	<10	<3.0	10.00	<10	35.00	43.00
Alkalinity (Total as CaCO3)	NA	-	-	230.00	237.00	63.00	140.00	59.00	57.00
Nitrite (N)	0.06	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride (Cl)	120	-	-	**360.00**	**164.00**	96.00	**210.00**	2.60	1.80
Nitrate (N)	10	-	-	<0.1	0.18	<0.1	<0.1	<0.1	<0.1
Sulphate (SO_4^{2-})	NA	-	-	19.00	9.48	8.40	17.00	<1.0	<1.0
Fluoride (F-)	0.12	-	-	**0.66**	**0.48**	**0.37**	**0.38**	**0.43**	**0.41**

Table 129 Preliminary Screening for Surface Water of Metals

Location		**Eastern Drainage Ditch**				**B31 Pond**	**B16 Pond**	**Former Sewage Lagoon (FSL)**	
Sample ID		**SW3**	**SW3**	**SW3**	**SW3**	**B31-Pond**	**B16-Pond**	**FSL-1**	**FSL-2**
Sample Date		**24-Feb-17**	**5-May-17**	**22-Jul-21**	**17-Nov-21**	**22-Jul-21**	**22-Jul-21**	**22-Jul-21**	**22-Jul-21**
Parameter	**Preliminary Benchmark**								
Metals									
Total Aluminum (Al)	75 - 100	**775**	37	13	**90.1**	**210**	7.3	86	98
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*	*75*	*75*	*75*	*-*	*-*
Aluminum CWQG		*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*	*75*	*75*	*75*	*100*	*100*
Total Antimony (Sb)	6	0.3	0.1	<0.50	0.14	<0.50	<0.50	<0.50	<0.50
Total Arsenic (As)	5	0.7	0.4	<1.0	0.30	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	1000	52.0	37.0	51.00	32.10	12.00	19.00	21.00	22.00
Total Boron (B)	200	27.0	34.0	45.00	22.00	63.00	19.00	12.00	10.00
Total Cadmium (Cd)	0.09 - 0.37	<0.1	<0.1	<0.090	0.009	<0.090	<0.090	<0.090	<0.090
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.50*	*0.50*	*0.50*	*0.50*	*0.10*	*0.50*	*0.10*	*0.10*
Cadmium CWQG		*0.32*	*0.32*	*0.32*	*0.32*	*0.13*	*0.23*	*0.10*	*0.09*
Minimum Cd guideline		*0.32*	*0.32*	*0.32*	*0.32*	*0.10*	*0.23*	*0.10*	*0.09*
Total Chromium (Cr)	50	25	<0.1	<5.0	<0.5	<5.0	<5.0	<5.0	<5.0
Chromium (+3)	8.9	-	-	<5	<1.0	<5	<5	<5	<5
Chromium (VI)	1	-	-	<0.50	<0.5	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	2 - 4	4.00	2	2.40	1.20	**4.80**	<0.90	**2.80**	1.40
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Copper CWQG		*4*	*4*	*4.00*	*4.00*	*2.00*	*3.53*	*2.00*	*2.00*
Minimum Cu guideline		*4*	*4*	*4.00*	*4.00*	*2.00*	*3.53*	*2.00*	*2.00*

Table 129 Preliminary Screening for Surface Water of Metals

Location		Eastern Drainage Ditch				B31 Pond	B16 Pond	Former Sewage Lagoon (FSL)	
Sample ID		SW3	SW3	SW3	SW3	B31-Pond	B16-Pond	FSL-1	FSL-2
Sample Date		24-Feb-17	5-May-17	22-Jul-21	17-Nov-21	22-Jul-21	22-Jul-21	22-Jul-21	22-Jul-21
Parameter	Preliminary Benchmark								
Total Iron (Fe)	300	**1310**	58	<100	129.00	**310.00**	**370.00**	150.00	150.00
Total Lead (Pb)	1 - 5	1	<0.1	<0.50	0.09	<0.50	<0.50	<0.50	<0.50
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*	*5*	*3*	*5*	*3*	*3*
Lead CWQG		*7*	*7*	*7.00*	*7.00*	*2.39*	*5.79*	*1.00*	*1.00*
Minimum Pb guideline		*5*	*5*	*5.00*	*5.00*	*2.39*	*5.00*	*1.00*	*1.00*
Total Mercury (Hg)	0.026	*<0.1*	*<0.1*	*<0.10*	<0.005	*<0.10*	*<0.10*	*<0.10*	*<0.10*
Total Molybdenum (Mo)	40	4	1	1.20	0.88	0.62	<0.50	<0.50	0.55
Total Nickel (Ni)	25	4	2	1.30	1.06	<1.0	<1.0	<1.0	<1.0
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25
Nickel CWQG		*150*	*150*	*150*	*150*	*81*	*137*	*25*	*25*
Minimum Ni guideline		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Total Selenium (Se)	1	1	<1	*<2.0*	0.14	*<2.0*	*<2.0*	*<2.0*	*<2.0*
Total Uranium (U)	5	1	0.8	1.20	1.08	0.31	0.14	0.15	0.14
Total Vanadium (V)	6	4	<0.1	**7.30**	**20.50**	1.30	<0.50	0.50	0.53
Total Zinc (Zn)	2.4 - 30	**34**	17	16.00	14.00	12.00	<5.0	**8.70**	*<5.0*
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
Zinc CWQG		*38*	*38*	*26*	*31*	*15*	*32*	*3*	*2*
Minimum Zn guideline		*30*	*30*	*26*	*30*	*15*	*30*	*3*	*2*

Table 129 Preliminary Screening for Surface Water of Metals

Location		**South Railway Ditch (near new COS Soil Mgmt Area (South))**	**South Railway Ditch (near new COS Soil Mgmt Area (NE))**	**Stream C Confluence**
Sample ID		**SRD-4**	**SRD-5**	**Stream C Confluence**
Sample Date		**23-Dec-20**	**23-Dec-20**	**23-Dec-20**
Parameter	**Preliminary Benchmark**	**OPG Lands Presented for Informational Purposes Only**		
Field Observations				
Specific Conductivity	NA	781.3	748.9	528.9
pH	6.5-8.5	7.72	7.82	7.73
Temperature	NA	-	-	-
DO (mg/L)	6	6.72	8.88	9.77
General Chemistry				
Total Ammonia-N	NA	-	-	-
Ammonia (NH3-N) / Un-ionized Ammonia	0.016	-	-	-
Ammonium (NH4+-N)	NA	-	-	-
Total Phosphorous	0.02	-	-	-
Total Dissolved Solids (TDS)	NA	410.00	380.00	300.00
Hardness ($CaCO_3$)	NA	-	-	-
Dissolved Organic Carbon (DOC)	NA	-	-	-
Total Suspended Solids (TSS)	NA	<2	<4	<7
Alkalinity (Total as CaCO3)	NA	210.00	210.00	240.00
Nitrite (N)	0.06	-	-	-
Chloride (Cl)	120	-	-	-
Nitrate (N)	10	-	-	-
Sulphate (SO_4^{2-})	NA	-	-	-
Fluoride (F-)	0.12	-	-	-

Table 129 Preliminary Screening for Surface Water of Metals

Location		South Railway Ditch (near new COS Soil Mgmt Area (South))	South Railway Ditch (near new COS Soil Mgmt Area (NE))	Stream C Confluence
Sample ID		SRD-4	SRD-5	Stream C Confluence
Sample Date		23-Dec-20	23-Dec-20	23-Dec-20
Parameter	**Preliminary Benchmark**	**OPG Lands Presented for Informational Purposes Only**		
Metals				
Total Aluminum (Al)	75 - 100	9.7	11.8	**225**
Aluminum PWQO	*Calculated on a per sample basis using pH measured at time of sampling event.*	*75*	*75*	*75*
Aluminum CWQG		*100*	*100*	*100*
Minimum Al guideline		*75*	*75*	*75*
Total Antimony (Sb)	6	<0.11	<0.12	<0.03
Total Arsenic (As)	5	0.17	0.18	0.24
Total Barium (Ba)	1000	17.90	16.70	14.70
Total Boron (B)	200	<23	<22	<13
Total Cadmium (Cd)	0.09 - 0.37	<0.002	<0.002	<0.005
Cadmium PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*0.50*	*0.50*	*0.50*
Cadmium CWQG		*0.09*	*0.09*	*0.09*
Minimum Cd guideline		*0.09*	*0.09*	*0.09*
Total Chromium (Cr)	50	<0.1	<0.1	<0.4
Chromium (+3)	8.9	-	-	-
Chromium (VI)	1	<0.36	<0.4	<0.3
Total Copper (Cu)	2 - 4	0.51	0.52	0.76
Copper PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*5*	*5*	*5*
Copper CWQG		*2.00*	*2.00*	*2.00*
Minimum Cu guideline		*2.00*	*2.00*	*2.00*

Table 129 Preliminary Screening for Surface Water of Metals

Location		South Railway Ditch (near new COS Soil Mgmt Area (South))	South Railway Ditch (near new COS Soil Mgmt Area (NE))	Stream C Confluence
Sample ID		SRD-4	SRD-5	Stream C Confluence
Sample Date		23-Dec-20	23-Dec-20	23-Dec-20
Parameter	Preliminary Benchmark	OPG Lands Presented for Informational Purposes Only		
Total Iron (Fe)	300	45.00	37.00	295
Total Lead (Pb)	1 - 5	<0.02	<0.02	<0.14
Lead PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	*3*	*3*	*3*
Lead CWQG		*1.00*	*1.00*	*1.00*
Minimum Pb guideline		*1.00*	*1.00*	*1.00*
Total Mercury (Hg)	0.026	<0.002	<0.001	<0.001
Total Molybdenum (Mo)	40	<0.4	<0.5	<0.3
Total Nickel (Ni)	25	<0.4	<0.4	<0.6
Nickel PWQO	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25
Nickel CWQG		*25*	*25*	*25*
Minimum Ni guideline		*25*	*25*	*25*
Total Selenium (Se)	1	<0.09	<0.08	<0.09
Total Uranium (U)	5	0.48	0.50	0.61
Total Vanadium (V)	6	<0.1	<0	<0.3
Total Zinc (Zn)	2.4 - 30	**16.60**	**10.60**	<1.5
Zinc PWQO	*Calculated on a per sample basis using hardness, pH, and DOC measured at time of sampling event*	*30*	*30*	*30*
Zinc CWQG		*10*	*10*	*10*
Minimum Zn guideline		*10*	*10*	*10*

Table 129 Preliminary Screening for Surface Water of Metals

Metal Notes

AO = aesthetic objective; MAC = maximum acceptable concentration; NR = not required; NV = no value; OG = operational guideline

µS/cm = microsiemens per centimeter; °C = degrees celsius; mg/L = miligrams per litre; µg/L = micrograms per litre

< = less than the reportable detection limit

a - The PWQO is dependant on the type of waterbody. To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 0.02 mg/L

b - A guideline value is not necessary as it is produced in the body and efficiently metabolized in healthy people

c - Alkalinity should not be decreased by more than 25% of the natural concentration

d - For PWQO, if pH < 6.5 the guideline is 15 µg/L and if pH > 6.5 to 9.0 the guideline is 75 µg/L. When pH is over 9.0, CCME CWQG is applied.

e - For CCME CWQG, if pH ≥6.5, guideline is 100 µg/L and if pH<6.5, guideline is 5 µg/L.

f - Based on conventional treatment of aluminum

g - For PWQO, if hardness 0-100 mg/L CaCO3, guideline is 0.1 µg/L. If hardness is >100 mg/L CaCO3, guideline is 0.5 µg/L. If hardness was not measured during the sampling event, the lowest measured hardness for the water body was assumed.

h - For CCME CWQG, if hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L. At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation:CWQG (µg/L) = 10{0.83(log[hardness])

i - For PWQO, if hardness 0-20 mg/L CaCO3, guideline is 1 µg/L. If hardness is > 20, guideline is 5 µg/L.

j - For CCME CWQG, if hardness is 0 to < 82 mg/L, the guideline is 2 µg/L. At hardness ≥82 to ≤180 mg/L the CWQG is calculated using this equation:CWQG (µg/L) = 0.2 * e{0.8545[ln(hardness)]-

k - For PWQO, if hardness is 30 to 80 mg/L CaCO3, guideline is 3 µg/L. If hardness is >80 mg/L CaCO3, guideline is 5 µg/L. If hardness was not measured at the sampling event, the lowest

l - For CCME CWQG, when the hardness is 0 to ≤ 60 mg/L, the guideline is 1 µg/L. At hardness >60 to ≤ 180 mg/L the CWQG is calculated using this equation: CWQG (µg/L)= e{1.273[ln(hardness)]-

m - For CCME CWQG, when the hardness is 0 to ≤ 60 mg/L, the guideline is 25 µg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation:CWQG (µg/L) =

n - Equation based on hardness, pH and DOC: CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). If hardness was not measured at the sampling event, the

o - Dissolved oxygen concentrations should not be less than the indicated value. PWQO is temperature dependent, where a temperature of 15°C was considered.

References:

1 - Ministry of the Environment and Energy (MOEE), 1994. Water Management: Policies, Guidelines, Provincial Water Quality Objectives (PWQO) (MOEE, 1994). Last updated August 16, 2021.

2 - Canadian Council of Ministers of the Environment (CCME), 2019. Water Quality Guidelines (WGQ) for the Protection of Aquatic Life, Freshwater, Long Term. Last updated 2019.

3 - Ontario Regulation (O.Reg.) 169/03, 2020. Ontario Drinking Water Standards (ODWS) (O.Reg., 2020). Last amendment: O.Reg. 327/08. http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm. Last updated January 1, 2020.

4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location													
Sample ID													
Sample Depth													
Sample Date													
			PWQO [1]	**CCME [2]**	**Ontario [3]**	**Health Canada [4]**	**On-Site Stream C**		**Lake Water Quality**		**On-Site Permanent Drainage Feature**	
Parameter	**Preliminary Benchmark**	**Units**		**WQG - Long Term**	**DWS (MAC)**	**CDWQGs (MAC, unless otherwise specified)**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**	**Maximum**	**Maximum Detected**
Petroleum Hydrocarbons												
F1 (C6-C10)	NV	µg/L	a	-	-	-	<25	-	<25	-	<25	-
F1 (C6-C10) - BTEX	NV	µg/L	-	-	-	-	<25	-	<25	-	<25	-
F2 (C10-C16 Hydrocarbons)	NV	µg/L	-	-	-	-	<100	-	<100	-	<100	-
F3 (C16-C34 Hydrocarbons)	NV	µg/L	-	-	-	-	<250	-	<200	-	<250	**200**
F4 (C34-C50 Hydrocarbons)	NV	µg/L	-	-	-	-	<250	-	<200	-	<250	-
Reached Baseline at C50	NA						Yes	Yes	Yes	Yes	Yes	Yes
Other												
Morpholine	0.004	mg/L	0.004	-	-	-	-	-	<0.004	-	-	-
Hydrazine	0.026	mg/L	-	0.026[b]	-	-	-	-	<0.005	-	-	-

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**MacGregor Point**						
Sample ID		**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**	**LWQ7**
Sample Depth		**1m below Surface**			**1m below Surface**	**1m below Surface**	**1m below Surface**	***resample for hydrazine only, 1 m**
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**11-Jul-21**
Parameter	**Preliminary Benchmark**							
Petroleum Hydrocarbons								
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25	
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25	<25	<25	
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	Yes	Yes	
Other								
Morpholine	0.004	<0.004	<0.004	<0.004	<0.004		<0.004	
Hydrazine	0.026	<0.0002	<0.0002		<0.005	<0.005	<0.00314	<0.00314

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**Baie du Dore**									**Loscombe Bank**		
Sample ID		**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ6**	**LWQ6**	**LWQ6**
Sample Depth		**1m below Surface**		**1m below Surface**			**1m below Surface**	**1m below Surface**	**1m below Surface**	***resample for hydrazine only, 1 m**	**1m below Surface**		
Sample Date		**9-Jun-17**	**16-Aug-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**11-Jul-21**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**
Parameter	**Preliminary Benchmark**												
Petroleum Hydrocarbons													
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	<100	<100		<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200	<200		<200	<200	<200
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200	<200		<200	<200	<200
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
Other													
Morpholine	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004		<0.004		<0.004	<0.004	<0.004
Hydrazine	0.026	<0.0002	<0.0002	<0.0002	<0.0002		<0.005	<0.005	<0.00314	<0.00314	<0.0002	<0.0002	

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**Bruce A Discharge Channel**							
Sample ID		**LWQ1**	**LWQ1**	**LWQ1**	**LWQ1**	**LWQ1**	**LWQ1**	**LWQ1**	**LWQ1**
Sample Depth		**1m below Surface**			**1m below Surface**	**1m below Surface**	**1m below Surface**	***resample for hydrazine only, 1 m**	***resample for hydrazine only, 1 m**
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**11-Jul-21**	**11-Jul-21**
Parameter	**Preliminary Benchmark**								
Petroleum Hydrocarbons									
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25		
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25	<25	<25		
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100		
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200		
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200		
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	Yes	Yes		
Other									
Morpholine	0.004	<0.004	<0.004	<0.004	<0.004		<0.004		
Hydrazine	0.026	<0.0002	<0.0002		<0.005	<0.005	<0.00314	<0.00314	<0.00314

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**Bruce B Discharge Channel**								**Off Bruce B Discharge Channel**		
Sample ID		**LWQ2**	**LWQ2**	**LWQ2**	**LWQ2**	**LWQ2**	**LWQ2**	**LWQ2**	**LWQ2**	**LWQ11**	**LWQ11**	**LWQ11**
Sample Depth		**1m below Surface**			**1m below Surface**	**1m below Surface**	**1m below Surface**	**1m below Surface**	***resample for hydrazine only, 1 m**	**1m below Surface**		
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**9-Jun-21**	**11-Jul-21**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**
Parameter	**Preliminary Benchmark**											
Petroleum Hydrocarbons												
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25	<25	<25	<25		<25	<25	<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	<100		<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200		<200	<200	<200
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200		<200	<200	<200
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
Other												
Morpholine	0.004	<0.004	<0.004	<0.004	<0.004		<0.004	<0.004		<0.004	<0.004	<0.004
Hydrazine	0.026	<0.0002	<0.0002		<0.005	<0.005	<0.00314	<0.00314	<0.00314	<0.0002	<0.0002	

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**McRae Point**							**MacPherson Bay**					
Sample ID		**LWQ8**	**LWQ8**	**LWQ8**	**LWQ8**	**LWQ8**	**LWQ8**	**LWQ8**	**LWQ3**			**LWQ3**		
Sample Depth		**1m below Surface**			**1m below Surface**	**1m below Surface**	**1m below Surface**	***resample for hydrazine only, 1 m**	**1m below Surface**			**10m below Surface**		
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**12-Dec-18**	**25-Oct-20**	**9-Jun-21**	**11-Jul-21**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**
Parameter	**Preliminary Benchmark**													
Petroleum Hydrocarbons														
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25		<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25	<25	<25		<25	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100		<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200		<200	<200	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200		<200	<200	<200	<200	<200	<200
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Other														
Morpholine	0.004	<0.004	<0.004	<0.004	<0.004		<0.004		<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hydrazine	0.026	<0.0002	<0.0002		<0.005	<0.005	<0.00314	<0.00314	<0.0002	<0.0002		<0.0002	<0.0002	

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**Gunn Point**						**Holmes Bay**			**Inverhuron Bay**		
Sample ID		**LWQ4**			**LWQ4**			**LWQ9**			**LWQ10**		
Sample Depth		**1m below Surface**			**20m below Surface**			**1m below Surface**			**1m below Surface**		
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**
Parameter	**Preliminary Benchmark**												
Petroleum Hydrocarbons													
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other													
Morpholine	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hydrazine	0.026	<0.0002	<0.0002		<0.0002	<0.0002		<0.0002	<0.0002		<0.0002	<0.0002	

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**Stream C Upstream**								
Sample ID		**SW1**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**	**SW1**
Sample Depth										
Sample Date		**8-Jun-17**	**17-Aug-17**	**18-Dec-17**	**18-Dec-17**	**26-Aug-20**	**11-Nov-20**	**12-Mar-21**	**22-Jul-21**	**17-Nov-21**
Parameter	**Preliminary Benchmark**									
Petroleum Hydrocarbons										
F1 (C6-C10)	NV	<25	<25	<25	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NV	<25	<25	<25	<25				<25	<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200	<200	<250
F4 (C34-C50 Hydrocarbons)	NV	<200	<200	<200	<200	<200	<200	<200	<200	<250
Reached Baseline at C50	NA	Yes	Yes	Yes	Yes				Yes	Yes
Other										
Morpholine	0.004									
Hydrazine	0.026									

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		**Stream C Downstream**										
Sample ID		**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**
Sample Depth												
Sample Date		**24-Feb-17**	**5-May-17**	**8-Jun-17**	**17-Aug-17**	**18-Dec-17**	**8-Jun-17**	**17-Aug-17**	**26-Aug-20**	**11-Nov-20**	**12-Mar-21**	**22-Jul-21**
Parameter	**Preliminary Benchmark**											
Petroleum Hydrocarbons												
F1 (C6-C10)	NV	<20	<20	<25	<25	<25	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NV			<25	<25	<25	<25	<25				<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<100	<100	<200	<200	<200	<200	<200	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	NV	<100	<100	<200	<200	<200	<200	<200	<200	<200	<200	<200
Reached Baseline at C50	NA			Yes	Yes	Yes	Yes	Yes				Yes
Other												
Morpholine	0.004											
Hydrazine	0.026											

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

Location		Eastern Drainage Ditch					B31 Pond	B16 Pond	Former Sewage Lagoon (FSL)	
Sample ID		SW2	SW3	SW3	SW3	SW3	B31-Pond	B16 Pond	FSL-1	FSL-2
Sample Depth										
Sample Date		17-Nov-21	24-Feb-17	5-May-17	22-Jul-21	17-Nov-21	22-Jul-21	22-Jul-21	22-Jul-21	22-Jul-21
Parameter	Preliminary Benchmark									
Petroleum Hydrocarbons										
F1 (C6-C10)	NV	<25	<20	<20	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NV	<25			<25	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	NV	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NV	<250	<100	<100	<200	<250	<200	<200	**200**	<200
F4 (C34-C50 Hydrocarbons)	NV	<250	<100	<100	<200	<250	<200	<200	<200	<200
Reached Baseline at C50	NA	Yes			Yes	Yes	Yes	Yes	Yes	Yes
Other										
Morpholine	0.004									
Hydrazine	0.026									

Table 130 Preliminary Screening for Surface Water of PHCs, Morpholine and Hydrazine

PHCs, Misc Notes

MAC = maximum acceptable concentration; NV = no value; NA = not applicable

µg/L = micrograms per litre; mg/L = miligrams per litre

< = less than the reportable detection limit

a - 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.

b - Hydrazine guideline is based on the Federal Environmental Quality Guidelines (FEQG), as cited at: https://canadagazette.gc.ca/rp-pr/p1/2018/2018-11-10/html/sup1-eng.html.

References:

1 - Ministry of the Environment and Energy (MOEE), 1994. Water Management: Policies, Guidelines, Provincial Water Quality Objectives (PWQO) (MOEE, 1994). Last updated August 16, 2021.

2 - Canadian Council of Ministers of the Environment (CCME), 2019. Water Quality Guidelines (WGQ) for the Protection of Aquatic Life, Freshwater, Long Term. Last updated 2019.

3 - Ontario Regulation (O.Reg.) 169/03, 2020. Ontario Drinking Water Standards (ODWS) (O.Reg., 2020). Last amendment: O.Reg. 327/08. http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm. Last updated January 1, 2020.

4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 131 Preliminary Screening for Surface Water of BTEX

Location												
Sample ID												
Sample Depth												
Sample Date												
	Preliminary Benchmark		PWQO [1]	CCME [2]	Ontario [3]	Health Canada [4]	On-Site Stream C		Lake Water Quality		On-Site Permanent Drainage Feature	
Parameter		Units		WQG - Long Term	DWS (MAC)	CDWQGs (MAC, unless otherwise specified)	Maximum	Maximum Detected	Maximum	Maximum Detected	Maximum	Maximum Detected
Benzene	1	µg/L	100	370	1	5	<0.50	-	<0.20	-	<0.50	-
Ethylbenzene	8	µg/L	8	90	140	140	<0.50	-	<0.20	-	<0.50	-
o-Xylene	NV	µg/L	-	-	-	-	<0.5	-	<0.20	-	<0.30	-
p+m-Xylene	NV	µg/L	-	-	-	-	<0.5	-	<0.40	-	<0.40	-
Toluene	0.8	µg/L	0.8	2	60	60	<0.50	-	<0.40	-	<0.50	0.35
Xylene (Total)	2	µg/L	2[a]	-	90	90	<0.50	-	<0.40	-	<0.50	-

Table 131 Preliminary Screening for Surface Water of BTEX

Location		Bruce A Discharge Channel						Bruce B Discharge Channel					
Sample ID		LWQ1	LWQ1	LWQ1	LWQ1	LWQ1	LWQ1	LWQ2	LWQ2	LWQ2	LWQ2	LWQ2	LWQ2
Sample Depth		1m below Surface			1m below Surface	1m below Surface	1m below Surface	1m below Surface			1m below Surface	1m below Surface	1m below Surface
Sample Date		9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20	9-Jun-21	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20	9-Jun-21
Parameter	Preliminary Benchmark												
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		**Bruce B Discharge Channel**	**Off Bruce B Discharge Channel**			**MacPherson Bay**					
Sample ID		**LWQ2**	**LWQ11**	**LWQ11**	**LWQ11**	**LWQ3**			**LWQ3**		
Sample Depth		**1m below Surface**	**1m below Surface**			**1m below Surface**			**10m below Surface**		
Sample Date		**9-Jun-21**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**
Parameter	**Preliminary Benchmark**										
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		**Gunn Point**						**Baie du Dore**				
Sample ID		**LWQ4**			**LWQ4**			**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**	**LWQ5**
Sample Depth		**1m below Surface**			**20m below Surface**			**1m below Surface**		**1m below Surface**		
Sample Date		**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**	**9-Jun-17**	**16-Aug-17**	**9-Jun-17**	**16-Aug-17**	**18-Dec-17**
Parameter	**Preliminary Benchmark**											
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		Baie du Dore			Loscombe Bank			MacGregor Point		
Sample ID		LWQ5	LWQ5	LWQ5	LWQ6	LWQ6	LWQ6	LWQ7	LWQ7	LWQ7
Sample Depth		1m below Surface	1m below Surface	1m below Surface	1m below Surface			1m below Surface		
Sample Date		12-Dec-18	25-Oct-20	9-Jun-21	9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17
Parameter	Preliminary Benchmark									
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		MacGregor Point			McRae Point					
Sample ID		LWQ7	LWQ7	LWQ7	LWQ8	LWQ8	LWQ8	LWQ8	LWQ8	LWQ8
Sample Depth		1m below Surface	1m below Surface	1m below Surface	1m below Surface			1m below Surface	1m below Surface	1m below Surface
Sample Date		12-Dec-18	25-Oct-20	9-Jun-21	9-Jun-17	16-Aug-17	18-Dec-17	12-Dec-18	25-Oct-20	9-Jun-21
Parameter	Preliminary Benchmark									
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		Holmes Bay			Inverhuron Bay			Stream C - Upstream (Background)			
Sample ID		LWQ9			LWQ10			SW1	SW1	SW1	SW1
Sample Depth		1m below Surface			1m below Surface						
Sample Date		9-Jun-17	16-Aug-17	18-Dec-17	9-Jun-17	16-Aug-17	18-Dec-17	8-Jun-17	17-Aug-17	18-Dec-17	18-Dec-17
Parameter	Preliminary Benchmark										
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		**Stream C - Upstream (Background)**				
Sample ID		**SW1**	**SW1**	**SW1**	**SW1**	**SW1**
Sample Depth						
Sample Date		**26-Aug-20**	**11-Nov-20**	**12-Mar-21**	**22-Jul-21**	**17-Nov-21**
Parameter	**Preliminary Benchmark**					
Benzene	1	<0.5	<0.5	<0.5	<0.20	<0.50
Ethylbenzene	8	<0.5	<0.5	<0.5	<0.20	<0.50
o-Xylene	NV	<0.5	<0.5	<0.5	<0.20	<0.30
p+m-Xylene	NV	<0.5	<0.5	<0.5	<0.40	<0.40
Toluene	0.8	<0.5	<0.5	<0.5	<0.20	<0.50
Xylene (Total)	2	<0.5	<0.5	<0.5	<0.40	<0.50

Table 131 Preliminary Screening for Surface Water of BTEX

Location		**Stream C - Downstream**								
Sample ID		**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**	**SW2**
Sample Depth										
Sample Date		**8-Jun-17**	**17-Aug-17**	**18-Dec-17**	**8-Jun-17**	**17-Aug-17**	**26-Aug-20**	**11-Nov-20**	**12-Mar-21**	**22-Jul-21**
Parameter	**Preliminary Benchmark**									
Benzene	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.5	<0.5	<0.5	<0.20
Ethylbenzene	8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.5	<0.5	<0.5	<0.20
o-Xylene	NV	<0.20	<0.20	<0.20	<0.20	<0.20	<0.5	<0.5	<0.5	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.5	<0.5	<0.5	<0.40
Toluene	0.8	<0.20	<0.20	<0.20	<0.20	<0.20	<0.5	<0.5	<0.5	<0.20
Xylene (Total)	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.5	<0.5	<0.5	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

Location		Stream C - Downstream	Eastern Drainage Ditch		B31	B16 Pond	Former Sewage Lagoon	
Sample ID		SW2	SW3	SW3	B31-Pond	B16-Pond	FSL-1	FSL-2
Sample Depth								
Sample Date		17-Nov-21	22-Jul-21	17-Nov-21	22-Jul-21	22-Jul-21	22-Jul-21	22-Jul-21
Parameter	Preliminary Benchmark							
Benzene	1	<0.50	<0.20	<0.50	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	8	<0.50	<0.20	<0.50	<0.20	<0.20	<0.20	<0.20
o-Xylene	NV	<0.30	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NV	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	<0.50	<0.20	<0.50	<0.20	<0.20	0.32	0.35
Xylene (Total)	2	<0.50	<0.40	<0.50	<0.40	<0.40	<0.40	<0.40

Table 131 Preliminary Screening for Surface Water of BTEX

BTEX Notes

MAC = maximum acceptable concentration; NV = no value
µg/L = micrograms per litre
< = less than the reportable detection limit
a - Based on most conservative guideline of the o, m and p-xylene isomers

References:

1 - Ministry of the Environment and Energy (MOEE), 1994. Water Management: Policies, Guidelines, Provincial Water Quality
2 - Canadian Council of Ministers of the Environment (CCME), 2019. Water Quality Guidelines (WGQ) for the Protection of Aquatic Life, Freshwater, Long Term. Last updated 2019.
3 - Ontario Regulation (O.Reg.) 169/03, 2020. Ontario Drinking Water Standards (ODWS) (O.Reg., 2020). Last amendment: O.Reg.
4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 132 Preliminary Screening for Surface Water of Extractables

Location									
Sample ID									
Sample Depth									
Sample Date									
	Preliminary Benchmark		PWQO [1]	CCME [2]	Ontario [3]	Health Canada [4]	Lake Water Quality	On-Site Stream C	On-Site Permanent Drainage Feature
Parameter		Units		WQG - Long Term	DWS (MAC)	CDWQGs (MAC, unless otherwise specified)	Maximum	Maximum	Maximum
Acid & Base Neutral Extractables									
Phenol	1	µg/L	1	4	-	-	<1	<1	<1

Table 132 Preliminary Screening for Surface Water of Extractables

Location		Bruce A Discharge Channel	Bruce B Discharge Channel		Baie du Dore	MacGregor Point	McRae Point	Stream C US	Stream C DS	Eastern Drainage Ditch
Sample ID		LWQ1	LWQ2		LWQ5	LWQ7	LWQ8	SW1	SW2	SW3
Sample Depth		1m below Surface	1m below Surface	1m below Surface	1m below Surface	1m below Surface	1m below Surface			
Sample Date		9-Jun-21	9-Jun-21	9-Jun-21	9-Jun-21	9-Jun-21	9-Jun-21	17-Nov-21	17-Nov-21	17-Nov-21
Parameter	Preliminary Benchmark									
Acid & Base Neutral Extractables										
Phenol	1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 132 Preliminary Screening for Surface Water of Extractables

Extractables Notes

MAC = maximum acceptable concentration
µg/L = micrograms per litre
< = less than the reportable detection limit

References:
1 - Ministry of the Environment and Energy (MOEE), 1994. Water Management: Policies, Guidelines, Provincial Water Quality Objectives (PWQO) (MOEE, 1994). Last updated August 16, 2021.
2 - Canadian Council of Ministers of the Environment (CCME), 2019. Water Quality Guidelines (WGQ) for the Protection of Aquatic Life, Freshwater, Long Term. Last updated 2019.

3 - Ontario Regulation (O.Reg.) 169/03, 2020. Ontario Drinking Water Standards (ODWS) (O.Reg., 2020). Last amendment: O.Reg. 327/08. http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm. Last updated January 1, 2020.
4 - Health Canada, 2020. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. September 2020.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

5.4 Sediment

Table 133 Preliminary Screening for Sediment of Metals

Location							
Sample ID							
Sample Depth							
Sampling Date							
Source							
			MECP	CCME	Thompson et al.	MECP	Ontario
Parameter	Preliminary Benchmark	Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]	Table 1 SCS - Soil [4]	OTR98 - Old Urban Parkland [5]
General							
Total Organic Carbon	NA	µg/g	-	-	-		
Moisture	NA	%	-	-	-		
pH	NA	pH	-	-	-		
Metals							
Aluminum	26000	µg/g	-	-	-	-	26000
Antimony	1.30	µg/g	-	-	-	1.30	NR
Arsenic	5.90	µg/g	6	5.90	9.30	NR	NR
Barium	220	µg/g	-	-	-	220	NR
Boron	36	µg/g	-	-	-	36	NR
Cadmium	0.60	µg/g	1	0.60	-	NR	NR
Chromium (III) [(a)]	26	µg/g	-	-	-	-	-
Chromium (VI)	0.70	µg/g	-	-	-	0.70	NR
Chromium	26	µg/g	26	37.30	36.70	NR	NR
Copper	12	µg/g	16	35.70	12.00	NR	NR
Iron	34000	µg/g	-	-	-	-	34000
Lead	27.7	µg/g	31	35.00	27.70	NR	NR
Mercury	0.17	µg/g	0	0.17	-	NR	NR
Molybdenum	8.30	µg/g	-	-	8.30	NR	NR
Nickel	16.00	µg/g	16	-	21.00	NR	NR
Selenium	0.90	µg/g	-	-	0.90	NR	NR
Silver	0.50	µg/g	1	-	-	NR	NR
Uranium	32	µg/g	-	-	32.00	NR	NR
Vanadium	27.3	µg/g	-	-	27.30	NR	NR
Zinc	120	µg/g	120	123.00	-	NR	NR

Table 133 Preliminary Screening for Sediment of Metals

Location									
Sample ID									
Sample Depth									
Sampling Date									
Source									
		Lake Huron		On-Site Stream C U/S		On-Site Stream C D/S		Permenant Drainage Features	
Parameter	Preliminary Benchmark	Maximum	Maximum Detected	Maximum	Maximum Detected	Maximum	Maximum Detected	Maximum	Maximum Detected
General									
Total Organic Carbon	NA	-	-	43000	43000	74000	74000	-	-
Moisture	NA	-	-	47	47	65	65	-	-
pH	NA	-	-	6.95	6.95	6.79	6.79	-	-
Metals							0		
Aluminum	26000	1800	1800	4000	4000	4200	4200	22000	22000
Antimony	1.30	<0.20	-	<0.20	0.06	<0.20	0.03	**11**	**11**
Arsenic	5.90	1.5	1.5	2.9	2.9	1.8	1.8	3.3	3.3
Barium	220	7.7	7.7	41	41	34	34	62	62
Boron	36	7.5	7.5	7.2	7.2	7.4	7.4	13	13
Cadmium	0.60	0.15	0.15	0.2	0.2	0.16	0.16	**2**	**2**
Chromium (III) [(a)]	26	11	11	8	8	7	7	**37**	**37**
Chromium (VI)	0.70	<0.36	-	0.2	0.2	0.3	0.3	<0.18	0
Chromium	26	11	11	7.5	7.5	11	11	**37**	**37**
Copper	12	4.3	4.3	7.2	7.2	11	11	**210**	**210**
Iron	34000	8100	8100	11000	11000	9300	9300	18000	18000
Lead	27.7	2.4	2.4	3.8	3.8	7.3	7.3	**50**	**50**
Mercury	0.17	<0.050	-	<0.050	0.016	<0.050	0.005	**0.61**	**0.61**
Molybdenum	8.30	1	1	<0.50	0.11	<0.50	0.13	3	3
Nickel	16.00	7.8	7.8	5.6	5.6	8.1	8.1	**22**	**22**
Selenium	0.90	<0.50	-	<0.50	0.48	<0.50	0.18	**1.1**	**1.1**
Silver	0.50	<0.20	-	<0.20	0.01	<0.20	0.01	**54**	**54**
Uranium	32	0.49	0.49	0.47	0.47	0.59	0.59	1.8	1.8
Vanadium	27.3	19	19	12	12	12	12	**100**	**100**
Zinc	120	27	27	30	30	43	43	**390**	**390**

Table 133 Preliminary Screening for Sediment of Metals

Location		Sauble Beach	Inverhuron (Also known as Little Sauble River)	Bruce A Discharge Channel	Bruce B Discharge Channel	Bruce B Discharge Channel	Scott's Point	Southampton
Sample ID		Sauble Beach	BR32	BA	BB	DUP BB	Scott's Point	Southampton
Sample Depth								
Sampling Date		2021/06/17	2021/07/05	2021/07/11	2021/07/11	2021/07/11	2021/07/11	2021/06/17
Source		Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary
Parameter	Preliminary Benchmark							
General								
Total Organic Carbon	NA	-	-	-	-	-	-	-
Moisture	NA	-	-	-	-	-	-	-
pH	NA	-	-	-	-	-	-	-
Metals								
Aluminum	26000	1200	1300	1600	1700	1800	1500	1700
Antimony	1.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	5.90	1	<1.0	<1.0	<1.0	1.1	<1.0	1.5
Barium	220	3	3.7	5.6	6	7.6	7.7	6.5
Boron	36	<5.0	<5.0	<5.0	5.6	<5.0	7.5	7.1
Cadmium	0.60	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium (III) [(a)]	26	4	4	6	7	6	11	5
Chromium (VI)	0.70	<0.18	<0.18	<0.18	<0.18	<0.18	<0.36	<0.18
Chromium	26	3.7	3.9	6.2	7.1	6.4	11	5
Copper	12	0.63	1	4.1	3.2	4.3	2.7	2.6
Iron	34000	3000	2900	5400	5000	4600	6000	5200
Lead	27.7	1.1	<1.0	2.4	1.6	1.8	2	1.9
Mercury	0.17	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum	8.30	<0.50	<0.50	<0.50	<0.50	<0.50	1	<0.50
Nickel	16.00	2	2.8	4.3	4.9	4.8	7.8	3
Selenium	0.90	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver	0.50	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium	32	0.23	0.19	0.49	0.39	0.36	0.31	0.34
Vanadium	27.3	<5.0	<5.0	8.7	9.6	8	12	6
Zinc	120	5.9	6.2	11	14	14	12	16

Table 133 Preliminary Screening for Sediment of Metals

Location		Baie du Dore	Baie du Dore	Baie du Dore	Stream C - Upstream	Stream C - Upstream	Stream C - Upstream	Stream C - downstream
Sample ID		SPAR5	SPAR 6	SPAR 103	SW1	SW1	SW1	SW2
Sample Depth							-	
Sampling Date		2021/07/11	2021/07/11	2021/07/11	2020/11/04	2021/06/24	2017/01/20	2020/11/04
Source		Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	B715788V1-R2017	Sediment Summary
Parameter	Preliminary Benchmark				OPG RA Data			OPG RA Data
General								
Total Organic Carbon	NA	-	-	-	-	-	43000	-
Moisture	NA	-	-	-	-	-	47	-
pH	NA	-	-	-	-	-	6.95	-
Metals								
Aluminum	26000	1600	1600	1800	3500	4000	3400	2100
Antimony	1.30	<0.20	<0.20	<0.20	0.06	<0.20	<0.20	0.03
Arsenic	5.90	<1.0	1.1	<1.0	2.9	1.9	1.4	0.8
Barium	220	5.7	4.2	7.4	41	35	30	10
Boron	36	<5.0	<5.0	<5.0	5	7.2	<5.0	3.5
Cadmium	0.60	<0.10	<0.10	0.15	0.2	0.16	0.14	0.05
Chromium (III) [(a)]	26	5	9	7	8	7	-	7
Chromium (VI)	0.70	<0.18	<0.18	<0.18	0	<0.18	0.2	0
Chromium	26	5.1	8.7	6.7	7.5	7.4	7.3	6.9
Copper	12	1.8	1.7	3.4	6.8	7.2	6.9	3.1
Iron	34000	4300	8100	5100	11000	8400	8100	5400
Lead	27.7	1.1	1.6	2.2	3.6	3.8	3.8	2.9
Mercury	0.17	<0.050	<0.050	<0.050	0.016	<0.050	<0.050	0.005
Molybdenum	8.30	<0.50	<0.50	<0.50	0.11	<0.50	<0.50	0.13
Nickel	16.00	3.6	4	4.9	5.5	5.6	5.3	4
Selenium	0.90	<0.50	<0.50	<0.50	0.48	<0.50	<0.50	0.18
Silver	0.50	<0.20	<0.20	<0.20	0.01	<0.20	<0.20	0.01
Uranium	32	0.27	0.36	0.33	0.4	0.45	0.47	0.36
Vanadium	27.3	8.4	19	9.2	12	12	11	10
Zinc	120	8.2	8	27	30	25	24	16

Table 133 Preliminary Screening for Sediment of Metals

Location		Stream C - downstream	Stream C - downstream	Eastern Drainage Ditch	Former Sewage Lagoons (FSL)		B16 Pond	B31 Pond
Sample ID		SW2	SW2	SW3	FSL1	FSL2	B16	B31 Pond
Sample Depth								
Sampling Date		2021/06/24	2017/01/20	2021/06/24	2021/06/30	2021/06/30	2021/07/06	2021/07/06
Source		Sediment Summary	B715788V1-R2017	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary
Parameter	Preliminary Benchmark		Stream C					
General								
Total Organic Carbon	NA	-	74000	-	-	-	-	-
Moisture	NA	-	65	-	-	-	-	-
pH	NA	-	6.79	-	-	-	-	-
Metals								
Aluminum	26000	2400	4200	5500	22000	5800	2600	14000
Antimony	1.30	<0.20	<0.20	0.29	**11**	<0.20	<0.20	0.59
Arsenic	5.90	1.8	1.5	3	3.3	1.7	1.2	2.5
Barium	220	12	34	60	57	23	9.7	62
Boron	36	7	7.4	13	7.3	9.6	5.3	12
Cadmium	0.60	<0.10	0.16	**0.74**	**2**	<0.10	<0.10	0.47
Chromium (III) [(a)]	26	6	-	14	**37**	11	7	25
Chromium (VI)	0.70	<0.18	0.3	<0.18	<0.18	<0.18	<0.18	<0.18
Chromium	26	5.7	11	14	**37**	11	6.6	25
Copper	12	8.2	11	**37**	**210**	**13**	5.2	**150**
Iron	34000	8100	9300	9200	9300	10000	6500	18000
Lead	27.7	2.6	7.3	16	**50**	3.9	2.9	16
Mercury	0.17	<0.050	<0.050	0.075	**0.61**	<0.050	<0.050	0.11
Molybdenum	8.30	<0.50	<0.50	1.1	3	<0.50	<0.50	1.1
Nickel	16.00	5.2	8.1	**17**	**17**	8.4	5.1	**22**
Selenium	0.90	<0.50	<0.50	**1.1**	0.68	<0.50	<0.50	**1**
Silver	0.50	<0.20	<0.20	**4.4**	**54**	**0.86**	<0.20	<0.20
Uranium	32	0.49	0.59	1.4	1.8	0.49	0.38	1.6
Vanadium	27.3	9.6	12	**100**	17	14	9.8	27
Zinc	120	35	43	**390**	**310**	23	19	**360**

Table 133 Preliminary Screening for Sediment of Metals

Location		South Railway Ditch	South Railway Ditch	South Railway Ditch	South Railway Ditch	South Railway Ditch
Sample ID		SRD-1	SRD-2	SRD-3	SRD-4	SRD-5
Sample Depth						
Sampling Date		2020/11/02	2020/11/03	2020/11/03	2020/11/03	2020/11/03
Source		Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary
Parameter	Preliminary Benchmark	OPG - showing in RA for Informational Purposes				
General						
Total Organic Carbon	NA	-	-	-	-	-
Moisture	NA	-	-	-	-	-
pH	NA	-	-	-	-	-
Metals						
Aluminum	26000	4800	5100	5000	3500	5100
Antimony	1.30	0.48	0.06	0.18	0.15	0.1
Arsenic	5.90	2.9	2.3	2	2	2.1
Barium	220	52	25	25	31	23
Boron	36	7.9	8.3	8.4	7.5	9.3
Cadmium	0.60	0.48	0.07	0.21	0.31	0.08
Chromium (III) [(a)]	26	11	11	10	8	12
Chromium (VI)	0.70	0	0.02	0	0.04	0.01
Chromium	26	11	11	10	7.8	12
Copper	12	**140**	11	11	**19**	11
Iron	34000	12000	11000	10000	11000	12000
Lead	27.7	15	3.7	5.5	6.7	4.4
Mercury	0.17	0.019	<0.0098	<0.018	0.017	<0.021
Molybdenum	8.30	1.6	0.24	0.32	0.39	0.21
Nickel	16.00	15	9.5	9	8.3	9.4
Selenium	0.90	0.6	0.09	0.23	0.36	0.17
Silver	0.50	0.09	0.01	0.03	0.02	0.02
Uranium	32	1.1	0.49	0.51	0.48	0.46
Vanadium	27.3	24	15	17	13	18
Zinc	120	**450**	37	**180**	**420**	69

Table 133 Preliminary Screening for Sediment of Metals

Metal & Inorganic Notes

NR = not required, soil background criteria applied in absence of sediment criteria; NA = not applicable
µg/g = mircograms per grams; % = percent
- = Not analyzed
< = less than the reportable detection limit
a - Tier 1 benchmark for total chromium applied to chromium (III)
ISQG = Interim Sediment Quality Guideline
LEL = Lowest Effect Level

References:
1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use. April 15, 2011
2 - Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for the Protection of Aquatic
3 - Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of

4 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards: Soil: Industrial Property Use. April 15, 2011.
5 - Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, Ontario Ministry of environment and Energy, December 1993.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 134 Preliminary Screening for Sediment of PHCs

Location						
Sample ID						
Sample Depth						
Sampling Date						
Source						
	Preliminary Benchmark		MECP	CCME	Thompson et al.	MECP
Parameter		Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]	Table 1 SCS - Soil [4]
Benzene	0.02	µg/g	-	-	-	0.02
Toluene	0.2	µg/g	-	-	-	0.2
Ethylbenzene	0.05	µg/g	-	-	-	0.05
Total Xylenes	0.05	µg/g	-	-	-	0.05
F1 (C6-C10)	25	µg/g	-	-	-	25
F1 (C6-C10) - BTEX	25	µg/g	-	-	-	25
F2 (C10-C16 Hydrocarbons)	10	µg/g	-	-	-	10
F3 (C16-C34 Hydrocarbons)	240	µg/g	-	-	-	240
F4 (C34-C50 Hydrocarbons)	120	µg/g	-	-	-	120

Table 134 Preliminary Screening for Sediment of PHCs

Location									
Sample ID									
Sample Depth									
Sampling Date									
Source									
		Lake Huron		On-Site Stream C U/S		On-Site Stream C D/S		Permenant Drainage	
Parameter	Preliminary Benchmark	Maximum	Maximum Detected	Maximum	Maximum Detected	Maximum	Maximum Detected	Maximum	Maximum Detected
Benzene	0.02	*<0.040*	-	*<0.040*	-	<0.020	-	<0.20	-
Toluene	0.2	**0.59**	**0.59**	<0.040	-	<0.020	-	**0.28**	**0.28**
Ethylbenzene	0.05	<0.040	-	<0.040	-	<0.020	-	<0.20	-
Total Xylenes	0.05	*<0.080*	0.043	*<0.080*	-	<0.040	-	*<0.40*	-
F1 (C6-C10)	25	<20	-	<20	-	<20	-	*<100*	-
F1 (C6-C10) - BTEX	25	<20	-	<20	-	<20	-	*<100*	-
F2 (C10-C16 Hydrocarbons)	10	*<20*	-	*<20*	-	**35**	**35**	*<70*	-
F3 (C16-C34 Hydrocarbons)	240	200	200	<100	-	**290**	**290**	**1100**	**1100**
F4 (C34-C50 Hydrocarbons)	120	<100	-	<100	-	*<150*	-	*<350*	**230**

Table 134 Preliminary Screening for Sediment of PHCs

Location		**Inverhuron (also known as Little Sauble River)**	**Southampton**	**Sauble Beach**	**Bruce A Discharge Channel**	**Bruce B Discharge Channel**	**Bruce B Discharge Channel**
Sample ID		**BR32**	**Southampton**	**Sauble Beach**	**BA**	**BB**	**DUP BB**
Sample Depth							
Sampling Date		**Jul-21**	**Jun-21**	**Jun-21**	**Jul-21**	**Jul-21**	**Jul-21**
Source		**Sediment Summary**	**Sediment Summary**	**Sediment Summary**	**Sediment Summary**	**Sediment Summary**	**Sediment Summary**
Parameter	**Preliminary Benchmark**						
Benzene	0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Toluene	0.2	<0.020	<0.020	<0.020	<0.020	**0.59**	0.15
Ethylbenzene	0.05	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Xylenes	0.05	<0.040	<0.040	<0.040	<0.040	0.043	<0.040
F1 (C6-C10)	25	<10	<10	<10	<10	<10	<10
F1 (C6-C10) - BTEX	25	<10	<10	<10	<10	<10	<10
F2 (C10-C16 Hydrocarbons)	10	<10	<10	<10	<10	<10	*<20*
F3 (C16-C34 Hydrocarbons)	240	<50	<50	<50	74	120	200
F4 (C34-C50 Hydrocarbons)	120	<50	<50	<50	<50	<50	<100

Table 134 Preliminary Screening for Sediment of PHCs

Location		Baie du Dore			Scott's Point	Stream C - upstream	
Sample ID		SPAR 5	SPAR 6	SPAR 103	Scott's Point	SW1	SW1
Sample Depth							
Sampling Date		Jul-21	Jul-21	Jul-21	Jul-21	Jun-21	Jan-17
Source		Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	B715788V1-R2017
Parameter	Preliminary Benchmark						
Benzene	0.02	<0.020	<0.020	<0.020	*<0.040*	*<0.040*	-
Toluene	0.2	<0.020	<0.020	<0.020	0.053	<0.040	-
Ethylbenzene	0.05	<0.020	<0.020	<0.020	<0.040	<0.040	-
Total Xylenes	0.05	<0.040	<0.040	<0.040	*<0.080*	*<0.080*	-
F1 (C6-C10)	25	<10	<10	<10	<20	<20	<10
F1 (C6-C10) - BTEX	25	<10	<10	<10	<20	<20	<10
F2 (C10-C16 Hydrocarbons)	10	<10	<10	<10	*<20*	*<20*	*<20*
F3 (C16-C34 Hydrocarbons)	240	85	<50	74	<100	<100	<100
F4 (C34-C50 Hydrocarbons)	120	<50	<50	<50	<100	<100	<100

Table 134 Preliminary Screening for Sediment of PHCs

Location		Stream C - downstream		Eastern Drainage Ditch		Former Sewage Lagoons (FSL)		B16 Pond	B31 Pond
Sample ID		SW2	SW2	SW3	SW3-Dup	FSL1	FSL2	B16 Pond	B31 Pond
Sample Depth									
Sampling Date		Jun-21	Jan-17	6/24/2021	Jun-21	Jun-21	Jun-21	Jul-21	Jul-21
Source		Sediment Summary	B715788V1-R2017	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary	Sediment Summary
Parameter	Preliminary Benchmark								
Benzene	0.02	<0.020	-	*<0.20*	*<0.20*	*<0.060*	<0.020	*<0.040*	*<0.060*
Toluene	0.2	<0.020	-	**0.28**	**0.26**	0.13	<0.020	0.041	<0.060
Ethylbenzene	0.05	<0.020	-	*<0.20*	*<0.20*	*<0.060*	<0.020	<0.040	*<0.060*
Total Xylenes	0.05	<0.040	-	*<0.40*	*<0.40*	*<0.12*	<0.040	*<0.080*	*<0.12*
F1 (C6-C10)	25	<10	<20	*<100*	*<100*	*<30*	<10	<20	*<30*
F1 (C6-C10) - BTEX	25	<10	<20	*<100*	*<100*	*<30*	<10	<20	*<30*
F2 (C10-C16 Hydrocarbons)	10	<10	**35**	*<70*	-	*<20*	<10	*<20*	*<30*
F3 (C16-C34 Hydrocarbons)	240	62	**290**	**500**	-	**1100**	<50	<100	<150
F4 (C34-C50 Hydrocarbons)	120	<50	*<150*	*<350*	-	**230**	<50	<100	*<150*

Table 134 Preliminary Screening for Sediment of PHCs

PHC Notes

NR = not required, soil background criteria applied in absence of sediment criteria; NA = not applicable
µg/g = mircograms per grams
- = Not analyzed
< = less than the reportable detection limit
ISQG = Interim Sediment Quality Guideline
LEL = Lowest Effect Level

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use. April 15, 2011
2 - Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for the Protection of Aquatic Life, Freshwater. Last updated 2002.
3 - Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk
4 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards: Soil: Industrial Property Use. April 15, 2011.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 135 Preliminary Screening for Sediment of VOCs

Location								Stream C - Upstream	Stream C - Downstream
Sample ID								SW1	SW2
Sample Depth								-	-
Sampling Date								20-Jan-17	20-Jan-17
			MECP	CCME	Thompson et al.	MECP	On-Site		
Parameter	Preliminary Benchmark	Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]	Table 1 SCS - Soil [4]	Maximum		
Acetone (2-Propanone)	0.5	µg/g	-	-	-	0.5	**1.2**	<0.50	**1.2**
Benzene	NV	µg/g	-	-	-	NR	<0.012	<0.0060	<0.012
Bromodichloromethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Bromoform	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Bromomethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Carbon Tetrachloride	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Chlorobenzene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Chloroform	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Dibromochloromethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,2-Dichlorobenzene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,3-Dichlorobenzene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,4-Dichlorobenzene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Dichlorodifluoromethane (FREON 12)	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,1-Dichloroethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,2-Dichloroethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,1-Dichloroethylene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
cis-1,2-Dichloroethylene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
trans-1,2-Dichloroethylene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,2-Dichloropropane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
cis-1,3-Dichloropropene	NV	µg/g	-	-	-	NR	<0.060	<0.030	<0.060
trans-1,3-Dichloropropene	NV	µg/g	-	-	-	NR	<0.080	<0.040	<0.080

Table 135 Preliminary Screening for Sediment of VOCs

Location								Stream C - Upstream	Stream C - Downstream
Sample ID								SW1	SW2
Sample Depth								-	-
Sampling Date								20-Jan-17	20-Jan-17
			MECP	CCME	Thompson et al.	MECP	On-Site		
Parameter	Preliminary Benchmark	Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]	Table 1 SCS - Soil [4]	Maximum		
Ethylbenzene	NV	µg/g	-	-	-	NR	<0.020	<0.010	<0.020
Ethylene Dibromide	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Hexane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Methylene Chloride (Dichloromethane)	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Methyl Isobutyl Ketone	NV	µg/g	-	-	-	NR	<1.0	<0.50	<1.0
Methyl Ethyl Ketone (2-Butanone)	NV	µg/g	-	-	-	NR	<1.0	<0.50	<1.0
Methyl t-butyl ether (MTBE)	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Styrene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,1,1,2-Tetrachloroethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,1,2,2-Tetrachloroethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Tetrachloroethylene	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Toluene	NV	µg/g	-	-	-	NR	<0.040	<0.020	<0.040
1,1,1-Trichloroethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
1,1,2-Trichloroethane	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10
Trichloroethylene	NV	µg/g	-	-	-	NR	<0.020	<0.010	<0.020
Vinyl Chloride	NV	µg/g	-	-	-	NR	<0.040	<0.020	<0.040
p+m-Xylene	NV	µg/g	-	-	-	NR	<0.040	<0.020	<0.040
o-Xylene	NV	µg/g	-	-	-	NR	<0.040	<0.020	<0.040
Total Xylenes	NV	µg/g	-	-	-	NR	<0.040	<0.020	<0.040
Chloroethane	NV	µg/g	-	-	-	NR	<0.40	<0.20	<0.40
Chloromethane	NV	µg/g	-	-	-	NR	<0.80	<0.40	<0.80
Trichlorofluoromethane (FREON 11)	NV	µg/g	-	-	-	NR	<0.10	<0.050	<0.10

Table 135 Preliminary Screening for Sediment of VOCs

VOC Notes

NR = not required, soil background criteria applied in absence of sediment criteria; NV = no value, no standard is available
µg/g = mircograms per grams
- = Not analyzed
< = less than the reportable detection limit
ISQG = Interim Sediment Quality Guideline
LEL = Lowest Effect Level

References:

1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use. April 15, 2011
2 - Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for the Protection of Aquatic Life, Freshwater. Last updated 2002.
3 - Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk
4 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards: Soil: Industrial Property Use. April 15, 2011.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 136 Preliminary Screening for Sediment of PAHs

Location								Scott's Point
Sample ID								Scott's Point
Sample Depth								
Sampling Date								11-Jul-21
			MECP	CCME	Thompson et al.	Lake Huron		
Parameter	Preliminary Benchmark	Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]	Maximum	Maximum Detected	
1-Methylnaphthalene	NV	µg/g	-	-	-	<0.10	-	<0.10
2-Methylnaphthalene	0.0202	µg/g	-	0.0202	-	*<0.10*	-	*<0.10*

Table 136 Preliminary Screening for Sediment of PAHs

PAH Notes
NV = no value, no standard is available
µg/g = mircograms per grams
- = Not analyzed
< = less than the reportable detection limit
ISQG = Interim Sediment Quality Guideline
LEL = Lowest Effect Level

References:
1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use. April 15, 2011
2 - Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for
3 - Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Milling Activities in Canada. Environmental Monitoring and Assessment. 110: 71-85.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 137 Preliminary Screening for Sediment of PCBs

Location						Stream C - Upstream	Stream C - Downstream
Sample ID						SW1	SW2
Sampling Date						2017/01/20	2017/01/20
	Preliminary Benchmark		MECP	CCME	Thompson et al.		
Parameter		Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]		
Aroclor 1262	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1016	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1221	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1232	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1242	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1248	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1254	0.06	µg/g	-	0.06	-	<0.02	<0.03
Aroclor 1260	NV	µg/g	-	-	-	<0.02	<0.03
Aroclor 1268	NV	µg/g	-	-	-	<0.02	<0.03
Total PCB	0.03	µg/g	0.07	0.03	-	<0.02	<0.03

Table 137 Preliminary Screening for Sediment of PCBs

PCB Notes
NV = no value, no standard is available
µg/g = mircograms per grams
- = Not analyzed
< = less than the reportable detection limit
ISQG = Interim Sediment Quality Guideline
LEL = Lowest Effect Level

References:
1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use. April 15, 2011
2 - Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for the Protection of Aquatic Life, Freshwater. Last updated 2002.
3 - Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Milling Activities in Canada. Environmental Monitoring and Assessment. 110: 71-85.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

Table 138 Preliminary Screening for Sediment of Phenolics

Location								Bruce A Discharge Channel	Bruce B Discharge Channel	Bruce B Discharge Channel
Sample ID								BA	BB	DUP BB
Sample Depth								-	-	-
Sampling Date								Jul-21	Jul-21	Jul-21
	Preliminary Benchmark		MECP	CCME	Thompson et al.	MECP	Lake Huron			
Parameter		Units	Table 1 SCS - Sediment [1]	ISQG [2]	LEL [3]	Table 1 SCS - Soil [4]	Maximum			
Phenolics	0.5	µg/g	-	-	-	0.5	0.35	0.35	<0.04	<0.04

Location		Baie du Dore			Scott's Point
Sample ID		SPAR 5	SPAR 6	SPAR 103	Scott's Point
Sample Depth		-	-	-	-
Sampling Date		Jul-21	Jul-21	Jul-21	Jul-21
Parameter	Preliminary Benchmark				
Phenolics	0.5	<0.04	<0.04	<0.04	<0.04

Table 138 Preliminary Screening for Sediment of Phenolics

OTH Notes
NR = not required, soil background criteria applied in absence of sediment criteria; NA = not applicable
µg/g = mircograms per grams
\- = Not analyzed
< = less than the reportable detection limit
ISQG = Interim Sediment Quality Guideline
LEL = Lowest Effect Level

References:
1 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use. April 15, 2011
2 - Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for the Protection of Aquatic Life, Freshwater. Last updated 2002.
3 - Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk
4 - Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards: Soil: Industrial Property Use. April 15, 2011.

1	Denotes detected concentration with no screening value
1	Denotes detected concentration exceeding preliminary benchmark
<0.05	Denotes detection limit exceeding preliminary benchmark

6.0 APPENDIX F: ECOLOGICAL RISK ASSESSMENT FOR CHEMICALS – EXPOSURE AND RISK TABLES

The exposure and risk estimates are provided below for each evaluated media and valued ecosystem component (VEC).

6.1 Air

No COPCs were identified in air; therefore, exposure and risk estimates were not calculated.

6.2 Soil

6.2.1 Plants and Soil Invertebrates

The exposure and risk estimates for plants and soil invertebrates from direct contact with soil are provided in Table 139.

Table 139 Exposure and Risk Estimates for Plants and Soil Invertebrates from Soil COPCs

COPC	Toxicological Benchmark (µg/g)	Max EPC (µg/g)	Average / 95th Percentile EPC (µg/g)	Max HQ	Average / 95th Percentile HQ
BASC					
Boron (HWS)	1.5	6.3	0.92	**4.2**	0.6
Chromium VI	8	1	1	0.1	0.1
Zinc	120	520	86	**4.3**	0.7
PHC F3	300	340	114	**1.1**	0.4
BBED					
None					
CL4					
Copper	70	120	49	**1.7**	0.7
Zinc	120	350	113	**2.9**	0.9
Acenaphthene	29	0.48	0.48	0.02	0.02
Benzo(a)anthracene	18	2.6	2.1	0.1	0.1
Benzo(b)fluoranthene	18	5	5	0.3	0.3
Dibenzo(a,h)anthracene	18	0.79	0.79	0.04	0.04
Indeno(1,2,3-cd)pyrene	18	1.7	1.4	0.1	0.1
4-Bromophenyl Phenyl Ether	nv	0.01	0.006	NC	NC
Di-n-butyl Phthalate	160	0.11	0.043	0.0007	0.0003
FTF					
TPH Light	150	9676	534	**65**	**3.6**
Purgeable Hydrocarbons (C5-C10)	210	222	84	**1.1**	0.4
Acenaphthene	29	0.41	0.03	0.01	0.001
Acenaphthylene	29	0.71	0.4	0.02	0.01
Benzo(a)anthracene	18	2.1	0.26	0.1	0.01

Table 139 Exposure and Risk Estimates for Plants and Soil Invertebrates from Soil COPCs

COPC	Toxicological Benchmark (µg/g)	Max EPC (µg/g)	Average / 95th Percentile EPC (µg/g)	Max HQ	Average / 95th Percentile HQ
Dibenzo(a,h)anthracene	18	0.22	0.1	0.01	0.01
Acetone	NV	1.8	1.1	NC	NC
Benzyl butyl phthalate	NV	0.1	0.04	NC	NC
Di-n-octyl Phthalate	160	0.02	0.005	0.0001	0.00003
Di-n-butyl Phthalate	160	0.06	0.05	0.0004	0.0003
Hexachlorobenzene	10	2.4	0.9	0.2	0.1
Nitrobenzene	2.2	4.5	0.7	**2.0**	0.3
Diphenylamines (total)	nv	1.5	0.7	NC	NC
2,3,4,5-Tetrachlorophenol	nv	32	5.1	NC	NC
2-methylphenol	nv	16	4.5	NC	NC
Isophorone	nv	0.13	0.05	NC	NC
FSL					
None					
DS1					
TPH Light	150	384	267	**2.6**	**1.8**
DS#2/4/5					
None					
DS#8					
None					
BPS / SS					
Boron (HWS)	1.5	6.56	NA	**4.4**	NA
Selenium	0.52	2.8	NA	**5.4**	NA
PHC F2	150	500	NA	**3.3**	NA
PHC F3	300	1500	NA	**5.0**	NA
Acetone	NV	1.1	NA	NC	NA

Notes:
NV – No TRV identified
NC – Not calculated
NA – Not Applicable
Bold indicates HQ>1

6.2.2 Terrestrial Wildlife

The exposure and risk estimates for terrestrial wildlife from soil exposure pathways (bioconcentration into vegetation, soil inverts and prey; sediment ingestion) is provided below for each assessed area and VEC. The maximum and average / 95th percentile COPC concentration was applied as the exposure point concentration for each assessed area.

6.2.2.1 Bruce A Storage Compound (BASC)

The maximum and average / 95th percentile COPC concentrations were applied as the exposure point concentration in Table 140 and Table 141.

Table 140 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within BASC Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Zinc	9.5E-01	5.1E+01	NA	NA	5.2E+01	0.3
Northern Short-tailed Shrew						
Zinc	1.7E+00	1.2E+01	3.2E+02	5.9E+00	3.3E+02	**2.0**
White-Tailed Deer						
Zinc	3.1E-01	2.0E+01	NA	NA	2.0E+01	0.1
Red Fox						
Zinc	3.5E-01	2.1E+00	1.5E+01	6.6E+00	2.4E+01	0.1
Mourning Dove						
Zinc	9.2E+00	1.3E+02	NA	NA	1.4E+02	**2.1**
American Woodcock						
Zinc	6.9E+00	1.2E+01	4.6E+02	NA	4.7E+02	**7.2**
Short-Eared Owl						
Zinc	NA	NA	NA	3.1E+01	3.1E+01	0.5
Common Gartersnake						
Zinc	8.5E-02	NA	6.0E+00	2.6E+00	8.6E+00	0.1
Wood Frog						
Zinc	4.0E-01	NA	1.6E+02	NA	1.6E+02	**2.4**

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

Table 141 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within BASC Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Zinc	1.6E-01	1.9E+01	NA	NA	1.9E+01	0.1
Northern Short-tailed Shrew						
Zinc	2.8E-01	4.4E+00	1.7E+02	5.2E+00	1.8E+02	**1.1**
White-Tailed Deer						
Zinc	5.2E-02	7.4E+00	NA	NA	7.5E+00	0.04
Red Fox						
Zinc	5.8E-02	7.7E-01	8.3E+00	5.8E+00	1.5E+01	0.1
Mourning Dove						
Zinc	1.5E+00	4.7E+01	NA	NA	4.9E+01	0.7
American Woodcock						
Zinc	1.1E+00	4.3E+00	2.5E+02	NA	2.6E+02	**3.9**
Short-Eared Owl						
Zinc	NA	NA	NA	2.7E+01	2.7E+01	0.4
Common Gartersnake						
Zinc	1.4E-02	NA	3.3E+00	2.3E+00	5.6E+00	0.1
Wood Frog						
Zinc	6.5E-02	NA	8.8E+01	NA	8.8E+01	**1.3**

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

6.2.2.2 Construction Landfill #4 (CL4)

The maximum and average / 95th percentile COPC concentrations were applied as the exposure point concentration in Table 142 and Table 143.

Table 142 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Cadmium	1.2E-02	5.7E-01	NA	NA	5.8E-01	7.6E-02
Silver	4.7E-03	1.8E-03	NA	NA	6.5E-03	1.1E-04
Zinc	6.4E-01	4.1E+01	NA	NA	4.2E+01	2.4E-01
Benzo(a)pyrene	4.4E-03	2.1E-02	NA	NA	2.5E-02	8.3E-03
Benzo(g,h,i)perylene	3.1E-03	1.5E-02	NA	NA	1.8E-02	6.0E-03
Dibenzo(a,h)anthracene	1.4E-03	7.2E-03	NA	NA	8.7E-03	2.9E-03
Fluoranthene	8.0E-03	3.7E-02	NA	NA	4.5E-02	1.4E-04
Indeno(1,2,3-cd)pyrene	3.1E-03	1.5E-02	NA	NA	1.8E-02	6.0E-03
4-Bromophenyl Phenyl Ether	1.8E-05	2.6E-05	NA	NA	4.5E-05	NC
Di-n-butyl Phthalate	2.0E-04	4.7E-04	NA	NA	6.7E-04	5.0E-07
Northern Short-tailed Shrew						
Cadmium	2.1E-02	1.3E-01	1.7E+01	3.3E-02	1.8E+01	**2.3**
Silver	8.5E-03	4.3E-04	4.0E-01	1.6E-04	4.1E-01	6.8E-03
Zinc	1.1E+00	9.7E+00	2.8E+02	5.7E+00	2.9E+02	**1.7**
Benzo(a)pyrene	7.9E-03	4.9E-03	4.7E-01	NA	4.9E-01	1.6E-01
Benzo(g,h,i)perylene	5.6E-03	3.5E-03	3.4E-01	NA	3.4E-01	1.1E-01
Dibenzo(a,h)anthracene	2.6E-03	1.7E-03	1.6E-01	NA	1.6E-01	5.3E-02
Fluoranthene	1.4E-02	8.7E-03	1.0E+00	NA	1.0E+00	3.2E-03
Indeno(1,2,3-cd)pyrene	5.6E-03	3.5E-03	3.4E-01	NA	3.4E-01	1.1E-01
4-Bromophenyl Phenyl Ether	3.3E-05	6.2E-06	1.3E-03	1.4E-06	1.3E-03	NC
Di-n-butyl Phthalate	3.6E-04	1.1E-04	1.3E-02	6.9E-06	1.4E-02	1.0E-05
White-Tailed Deer						
Cadmium	3.9E-03	2.3E-01	NA	NA	2.3E-01	3.0E-02
Silver	1.6E-03	7.1E-04	NA	NA	2.3E-03	3.8E-05
Zinc	2.1E-01	1.6E+01	NA	NA	1.6E+01	9.6E-02
Benzo(a)pyrene	1.4E-03	8.2E-03	NA	NA	9.6E-03	3.2E-03
Benzo(g,h,i)perylene	1.0E-03	5.9E-03	NA	NA	6.9E-03	2.3E-03
Dibenzo(a,h)anthracene	4.7E-04	2.9E-03	NA	NA	3.3E-03	1.1E-03
Fluoranthene	2.6E-03	1.4E-02	NA	NA	1.7E-02	5.2E-05
Indeno(1,2,3-cd)pyrene	1.0E-03	5.9E-03	NA	NA	6.9E-03	2.3E-03

Table 142 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
4-Bromophenyl Phenyl Ether	6.0E-06	1.0E-05	NA	NA	1.6E-05	NC
Di-n-butyl Phthalate	6.6E-05	1.9E-04	NA	NA	2.5E-04	1.9E-07
Red Fox						
Cadmium	4.4E-03	2.3E-02	8.3E-01	3.7E-02	8.9E-01	1.2E-01
Silver	1.7E-03	7.4E-05	1.9E-02	1.8E-04	2.1E-02	3.5E-04
Zinc	2.4E-01	1.7E+00	1.3E+01	6.4E+00	2.1E+01	1.3E-01
Benzo(a)pyrene	1.6E-03	8.5E-04	2.2E-02	NA	2.5E-02	8.3E-03
Benzo(g,h,i)perylene	1.1E-03	6.1E-04	1.6E-02	NA	1.8E-02	5.9E-03
Dibenzo(a,h)anthracene	5.3E-04	3.0E-04	7.4E-03	NA	8.2E-03	2.7E-03
Fluoranthene	3.0E-03	1.5E-03	4.8E-02	NA	5.3E-02	1.6E-04
Indeno(1,2,3-cd)pyrene	1.1E-03	6.1E-04	1.6E-02	NA	1.8E-02	5.9E-03
4-Bromophenyl Phenyl Ether	6.7E-06	1.1E-06	5.9E-05	1.6E-06	6.9E-05	NC
Di-n-butyl Phthalate	7.4E-05	1.9E-05	6.2E-04	7.7E-06	7.2E-04	5.4E-07
Mourning Dove						
Cadmium	1.1E-01	1.4E+00	NA	NA	1.5E+00	0.7
Silver	4.6E-02	4.5E-03	NA	NA	5.0E-02	2.5E-02
Zinc	6.2E+00	1.0E+02	NA	NA	1.1E+02	**1.6**
Benzo(a)pyrene	4.2E-02	5.2E-02	NA	NA	9.4E-02	4.7E-01
Benzo(g,h,i)perylene	3.0E-02	3.7E-02	NA	NA	6.7E-02	3.4E-01
Dibenzo(a,h)anthracene	1.4E-02	1.8E-02	NA	NA	3.2E-02	1.6E-01
Fluoranthene	7.8E-02	9.2E-02	NA	NA	1.7E-01	1.0E-03
Indeno(1,2,3-cd)pyrene	3.0E-02	3.7E-02	NA	NA	6.7E-02	3.4E-01
4-Bromophenyl Phenyl Ether	1.8E-04	6.6E-05	NA	NA	2.4E-04	NC
Di-n-butyl Phthalate	1.9E-03	1.2E-03	NA	NA	3.1E-03	2.2E-02
American Woodcock						
Cadmium	8.6E-02	1.3E-01	2.5E+01	NA	2.5E+01	**12**
Silver	3.4E-02	4.1E-04	5.8E-01	NA	6.2E-01	3.1E-01
Zinc	4.6E+00	9.4E+00	4.0E+02	NA	4.1E+02	**6.3**
Benzo(a)pyrene	3.2E-02	4.8E-03	6.8E-01	NA	7.2E-01	**3.6**
Benzo(g,h,i)perylene	2.2E-02	3.4E-03	4.8E-01	NA	5.1E-01	**2.5**
Dibenzo(a,h)anthracene	1.0E-02	1.7E-03	2.2E-01	NA	2.4E-01	**1.2**
Fluoranthene	5.8E-02	8.4E-03	1.5E+00	NA	1.5E+00	9.3E-03
Indeno(1,2,3-cd)pyrene	2.2E-02	3.4E-03	4.8E-01	NA	5.1E-01	**2.5**

Table 142 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
4-Bromophenyl Phenyl Ether	1.3E-04	6.1E-06	1.8E-03	NA	1.9E-03	NC
Di-n-butyl Phthalate	1.5E-03	1.1E-04	1.9E-02	NA	2.0E-02	1.5E-01
Short-Eared Owl						
Cadmium	NA	NA	NA	1.7E-01	1.7E-01	8.2E-02
Silver	NA	NA	NA	8.3E-04	8.3E-04	4.1E-04
Zinc	NA	NA	NA	3.0E+01	3.0E+01	4.5E-01
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	7.3E-06	7.3E-06	NC
Di-n-butyl Phthalate	NA	NA	NA	3.6E-05	3.6E-05	2.6E-04
Common Gartersnake						
Cadmium	1.1E-03	NA	3.3E-01	1.4E-02	3.5E-01	1.6E-01
Silver	4.2E-04	NA	7.7E-03	7.0E-05	8.2E-03	4.0E-03
Zinc	5.7E-02	NA	5.3E+00	2.5E+00	7.8E+00	1.2E-01
Benzo(a)pyrene	3.9E-04	NA	9.0E-03	NA	9.4E-03	4.7E-02
Benzo(g,h,i)perylene	2.8E-04	NA	6.4E-03	NA	6.6E-03	3.3E-02
Dibenzo(a,h)anthracene	1.3E-04	NA	3.0E-03	NA	3.1E-03	1.5E-02
Fluoranthene	7.2E-04	NA	1.9E-02	NA	2.0E-02	1.2E-04
Indeno(1,2,3-cd)pyrene	2.8E-04	NA	6.4E-03	NA	6.6E-03	3.3E-02
4-Bromophenyl Phenyl Ether	1.6E-06	NA	2.4E-05	6.1E-07	2.6E-05	NC
Di-n-butyl Phthalate	1.8E-05	NA	2.5E-04	3.0E-06	2.7E-04	1.9E-03
Wood Frog						
Cadmium	4.9E-03	NA	8.7E+00	NA	8.7E+00	**4.2**
Silver	2.0E-03	NA	2.0E-01	NA	2.0E-01	1.0E-01
Zinc	2.7E-01	NA	1.4E+02	NA	1.4E+02	**2.1**
Benzo(a)pyrene	1.8E-03	NA	2.4E-01	NA	2.4E-01	**1.2**
Benzo(g,h,i)perylene	1.3E-03	NA	1.7E-01	NA	1.7E-01	8.5E-01
Dibenzo(a,h)anthracene	6.0E-04	NA	7.8E-02	NA	7.9E-02	3.9E-01
Fluoranthene	3.3E-03	NA	5.1E-01	NA	5.1E-01	3.1E-03
Indeno(1,2,3-cd)pyrene	1.3E-03	NA	1.7E-01	NA	1.7E-01	8.5E-01

Table 142 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
4-Bromophenyl Phenyl Ether	7.6E-06	NA	6.3E-04	NA	6.3E-04	NC
Di-n-butyl Phthalate	8.4E-05	NA	6.5E-03	NA	6.6E-03	4.7E-02

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

Table 143 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Average/95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Cadmium	1.0E-03	1.5E-01	NA	NA	1.5E-01	1.9E-02
Silver	3.3E-03	1.2E-03	NA	NA	4.5E-03	7.5E-05
Zinc	2.0E-01	2.2E+01	NA	NA	2.2E+01	1.3E-01
Benzo(a)pyrene	3.5E-03	1.7E-02	NA	NA	2.0E-02	6.7E-03
Benzo(g,h,i)perylene	2.6E-03	1.2E-02	NA	NA	1.5E-02	5.0E-03
Dibenzo(a,h)anthracene	1.4E-03	7.2E-03	NA	NA	8.7E-03	2.9E-03
Fluoranthene	6.4E-03	3.0E-02	NA	NA	3.6E-02	1.1E-04
Indeno(1,2,3-cd)pyrene	2.5E-03	1.2E-02	NA	NA	1.5E-02	4.8E-03
4-Bromophenyl Phenyl Ether	1.1E-05	1.6E-05	NA	NA	2.7E-05	NC
Di-n-butyl Phthalate	7.8E-05	1.8E-04	NA	NA	2.6E-04	2.0E-07
Northern Short-tailed Shrew						
Cadmium	1.8E-03	3.5E-02	2.4E+00	1.0E-02	2.5E+00	3.2E-01
Silver	5.9E-03	2.9E-04	2.8E-01	1.1E-04	2.9E-01	4.7E-03
Zinc	3.7E-01	5.1E+00	1.9E+02	5.3E+00	2.0E+02	**1.2**
Benzo(a)pyrene	6.2E-03	3.9E-03	3.7E-01	NA	3.8E-01	1.3E-01
Benzo(g,h,i)perylene	4.6E-03	2.9E-03	2.8E-01	NA	2.8E-01	9.4E-02
Dibenzo(a,h)anthracene	2.6E-03	1.7E-03	1.6E-01	NA	1.6E-01	5.3E-02
Fluoranthene	1.1E-02	7.0E-03	8.1E-01	NA	8.3E-01	2.5E-03

Table 143 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Average/95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Indeno(1,2,3-cd)pyrene	4.5E-03	2.9E-03	2.7E-01	NA	2.8E-01	9.2E-02
4-Bromophenyl Phenyl Ether	2.0E-05	3.7E-06	7.5E-04	8.4E-07	7.8E-04	NC
Di-n-butyl Phthalate	1.4E-04	4.4E-05	5.1E-03	2.7E-06	5.3E-03	3.9E-06
White-Tailed Deer						
Cadmium	3.3E-04	5.9E-02	NA	NA	5.9E-02	7.6E-03
Silver	1.1E-03	4.9E-04	NA	NA	1.6E-03	2.6E-05
Zinc	6.7E-02	8.6E+00	NA	NA	8.7E+00	5.1E-02
Benzo(a)pyrene	1.1E-03	6.5E-03	NA	NA	7.7E-03	2.6E-03
Benzo(g,h,i)perylene	8.4E-04	4.9E-03	NA	NA	5.7E-03	1.9E-03
Dibenzo(a,h)anthracene	4.7E-04	2.9E-03	NA	NA	3.3E-03	1.1E-03
Fluoranthene	2.1E-03	1.2E-02	NA	NA	1.4E-02	4.2E-05
Indeno(1,2,3-cd)pyrene	8.2E-04	4.8E-03	NA	NA	5.6E-03	1.9E-03
4-Bromophenyl Phenyl Ether	3.6E-06	6.3E-06	NA	NA	9.9E-06	NC
Di-n-butyl Phthalate	2.6E-05	7.3E-05	NA	NA	9.9E-05	7.4E-08
Red Fox						
Cadmium	3.7E-04	6.1E-03	1.2E-01	1.2E-02	1.3E-01	1.7E-02
Silver	1.2E-03	5.1E-05	1.3E-02	1.2E-04	1.5E-02	2.4E-04
Zinc	7.5E-02	8.9E-01	9.0E+00	5.9E+00	1.6E+01	9.3E-02
Benzo(a)pyrene	1.3E-03	6.8E-04	1.8E-02	NA	2.0E-02	6.6E-03
Benzo(g,h,i)perylene	9.4E-04	5.1E-04	1.3E-02	NA	1.5E-02	4.8E-03
Dibenzo(a,h)anthracene	5.3E-04	3.0E-04	7.4E-03	NA	8.2E-03	2.7E-03
Fluoranthene	2.4E-03	1.2E-03	3.8E-02	NA	4.2E-02	1.3E-04
Indeno(1,2,3-cd)pyrene	9.1E-04	4.9E-04	1.3E-02	NA	1.4E-02	4.7E-03
4-Bromophenyl Phenyl Ether	4.0E-06	6.5E-07	3.6E-05	9.4E-07	4.1E-05	NC
Di-n-butyl Phthalate	2.9E-05	7.5E-06	2.4E-04	3.0E-06	2.8E-04	2.1E-07
Mourning Dove						
Cadmium	9.7E-03	3.7E-01	NA	NA	3.8E-01	1.8E-01
Silver	3.2E-02	3.1E-03	NA	NA	3.5E-02	1.7E-02
Zinc	2.0E+00	5.4E+01	NA	NA	5.6E+01	8.5E-01
Benzo(a)pyrene	3.4E-02	4.1E-02	NA	NA	7.5E-02	3.8E-01
Benzo(g,h,i)perylene	2.5E-02	3.1E-02	NA	NA	5.6E-02	2.8E-01

Table 143 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Average/95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Dibenzo(a,h)anthracene	1.4E-02	1.8E-02	NA	NA	3.2E-02	1.6E-01
Fluoranthene	6.2E-02	7.4E-02	NA	NA	1.4E-01	8.2E-04
Indeno(1,2,3-cd)pyrene	2.4E-02	3.0E-02	NA	NA	5.4E-02	2.7E-01
4-Bromophenyl Phenyl Ether	1.1E-04	4.0E-05	NA	NA	1.5E-04	NC
Di-n-butyl Phthalate	7.6E-04	4.6E-04	NA	NA	1.2E-03	8.7E-03
American Woodcock						
Cadmium	7.3E-03	3.4E-02	3.5E+00	NA	3.6E+00	**1.7**
Silver	2.4E-02	2.9E-04	4.0E-01	NA	4.3E-01	2.1E-01
Zinc	1.5E+00	5.0E+00	2.8E+02	NA	2.8E+02	**4.3**
Benzo(a)pyrene	2.5E-02	3.8E-03	5.4E-01	NA	5.7E-01	**2.8**
Benzo(g,h,i)perylene	1.8E-02	2.9E-03	4.0E-01	NA	4.2E-01	**2.1**
Dibenzo(a,h)anthracene	1.0E-02	1.7E-03	2.2E-01	NA	2.4E-01	**1.2**
Fluoranthene	4.6E-02	6.8E-03	1.2E+00	NA	1.2E+00	7.4E-03
Indeno(1,2,3-cd)pyrene	1.8E-02	2.8E-03	3.9E-01	NA	4.1E-01	**2.0**
4-Bromophenyl Phenyl Ether	7.9E-05	3.6E-06	1.1E-03	NA	1.2E-03	NC
Di-n-butyl Phthalate	5.7E-04	4.2E-05	7.4E-03	NA	8.0E-03	5.7E-02
Short-Eared Owl						
Cadmium	NA	NA	NA	5.4E-02	5.4E-02	2.6E-02
Silver	NA	NA	NA	5.8E-04	5.8E-04	2.9E-04
Zinc	NA	NA	NA	2.7E+01	2.7E+01	4.1E-01
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	4.4E-06	4.4E-06	NC
Di-n-butyl Phthalate	NA	NA	NA	1.4E-05	1.4E-05	1.0E-04
Common Gartersnake						
Cadmium	9.0E-05	NA	4.6E-02	4.5E-03	5.1E-02	2.4E-02
Silver	2.9E-04	NA	5.3E-03	4.8E-05	5.6E-03	2.8E-03
Zinc	1.8E-02	NA	3.6E+00	2.3E+00	5.9E+00	9.0E-02

Table 143 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within CL4 Based on Average/95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Benzo(a)pyrene	3.1E-04	NA	7.1E-03	NA	7.4E-03	3.7E-02
Benzo(g,h,i)perylene	2.3E-04	NA	5.2E-03	NA	5.5E-03	2.7E-02
Dibenzo(a,h)anthracene	1.3E-04	NA	3.0E-03	NA	3.1E-03	1.5E-02
Fluoranthene	5.7E-04	NA	1.5E-02	NA	1.6E-02	9.6E-05
Indeno(1,2,3-cd)pyrene	2.2E-04	NA	5.1E-03	NA	5.3E-03	2.7E-02
4-Bromophenyl Phenyl Ether	9.8E-07	NA	1.4E-05	3.7E-07	1.6E-05	NC
Di-n-butyl Phthalate	7.0E-06	NA	9.7E-05	1.2E-06	1.0E-04	7.5E-04
Wood Frog						
Cadmium	4.2E-04	NA	1.2E+00	NA	1.2E+00	5.8E-01
Silver	1.4E-03	NA	1.4E-01	NA	1.4E-01	7.0E-02
Zinc	8.5E-02	NA	9.5E+01	NA	9.6E+01	**1.4**
Benzo(a)pyrene	1.4E-03	NA	1.9E-01	NA	1.9E-01	9.5E-01
Benzo(g,h,i)perylene	1.1E-03	NA	1.4E-01	NA	1.4E-01	7.0E-01
Dibenzo(a,h)anthracene	6.0E-04	NA	7.8E-02	NA	7.9E-02	3.9E-01
Fluoranthene	2.7E-03	NA	4.0E-01	NA	4.1E-01	2.5E-03
Indeno(1,2,3-cd)pyrene	1.0E-03	NA	1.3E-01	NA	1.4E-01	6.8E-01
4-Bromophenyl Phenyl Ether	4.6E-06	NA	3.8E-04	NA	3.8E-04	NC
Di-n-butyl Phthalate	3.3E-05	NA	2.6E-03	NA	2.6E-03	1.8E-02

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

6.2.2.3 Fire Training Facility (FTF)

The maximum and average / 95th percentile COPC concentrations were applied as the exposure point concentration in Table 144 and Table 145.

Table 144 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Acenaphthylene	1.3E-03	6.5E-03	NA	NA	7.8E-03	2.4E-05
Dibenzo(a,h)anthracene	4.0E-04	2.2E-03	NA	NA	2.6E-03	8.5E-04
Benzyl butyl phthalate	1.8E-04	3.0E-04	NA	NA	4.8E-04	3.0E-06
Di-n-octyl Phthalate	3.6E-05	6.6E-07	NA	NA	3.7E-05	2.8E-08
Di-n-butyl Phthalate	1.1E-04	2.6E-04	NA	NA	3.7E-04	2.7E-07
Hexachlorobenzene	4.4E-03	2.4E-03	NA	NA	6.7E-03	9.5E-04
Nitrobenzene	8.2E-03	7.4E-01	NA	NA	7.4E-01	1.1E-01
Diphenylamines (total)	2.7E-03	2.7E-02	NA	NA	3.0E-02	NC
2,3,4,5-Tetrachlorophenol	5.8E-02	2.2E-01	NA	NA	2.8E-01	NC
2-methylphenol	2.9E-02	6.8E-01	NA	NA	7.1E-01	3.2E-03
Isophorone	2.4E-04	2.6E-02	NA	NA	2.6E-02	NC
Northern Short-tailed Shrew						
Acenaphthylene	2.3E-03	1.5E-03	1.6E-01	NA	1.7E-01	5.1E-04
Dibenzo(a,h)anthracene	7.2E-04	5.1E-04	4.3E-02	NA	4.5E-02	1.5E-02
Benzyl butyl phthalate	3.3E-04	7.0E-05	1.2E-02	1.1E-05	1.3E-02	8.0E-05
Di-n-octyl Phthalate	6.5E-05	1.6E-07	3.8E-03	6.1E-03	9.9E-03	7.4E-06
Di-n-butyl Phthalate	2.0E-04	6.1E-05	7.1E-03	3.7E-06	7.4E-03	5.5E-06
Hexachlorobenzene	7.9E-03	5.6E-04	3.4E-01	2.4E-03	3.5E-01	4.9E-02
Nitrobenzene	1.5E-02	1.7E-01	2.5E-01	2.3E-07	4.4E-01	6.3E-02
Diphenylamines (total)	4.9E-03	6.4E-03	1.4E-01	5.9E-06	1.5E-01	NC
2,3,4,5-Tetrachlorophenol	1.0E-01	5.2E-02	3.5E+00	7.5E-04	3.7E+00	NC
2-methylphenol	5.2E-02	1.6E-01	1.3E+00	1.2E-05	1.5E+00	6.8E-03
Isophorone	4.3E-04	6.1E-03	6.8E-03	4.4E-09	1.3E-02	NC
White-Tailed Deer						
Acenaphthylene	4.3E-04	2.6E-03	NA	NA	3.0E-03	9.2E-06
Dibenzo(a,h)anthracene	1.3E-04	8.5E-04	NA	NA	9.8E-04	3.3E-04
Benzyl butyl phthalate	6.0E-05	1.2E-04	NA	NA	1.8E-04	1.1E-06
Di-n-octyl Phthalate	1.2E-05	2.6E-07	NA	NA	1.2E-05	9.1E-09
Di-n-butyl Phthalate	3.6E-05	1.0E-04	NA	NA	1.4E-04	1.0E-07
Hexachlorobenzene	1.4E-03	9.4E-04	NA	NA	2.4E-03	3.4E-04

Table 144 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Nitrobenzene	2.7E-03	2.9E-01	NA	NA	2.9E-01	4.2E-02
Diphenylamines (total)	9.0E-04	1.1E-02	NA	NA	1.2E-02	NC
2,3,4,5-Tetrachlorophenol	1.9E-02	8.8E-02	NA	NA	1.1E-01	NC
2-methylphenol	9.6E-03	2.7E-01	NA	NA	2.8E-01	1.3E-03
Isophorone	7.8E-05	1.0E-02	NA	NA	1.0E-02	NC
Red Fox						
Acenaphthylene	4.8E-04	2.7E-04	7.8E-03	NA	8.5E-03	2.6E-05
Dibenzo(a,h)anthracene	1.5E-04	8.8E-05	2.1E-03	NA	2.3E-03	7.6E-04
Benzyl butyl phthalate	6.7E-05	1.2E-05	5.9E-04	1.2E-05	6.8E-04	4.3E-06
Di-n-octyl Phthalate	1.3E-05	2.7E-08	1.8E-04	6.8E-03	7.0E-03	5.2E-06
Di-n-butyl Phthalate	4.0E-05	1.1E-05	3.4E-04	4.2E-06	3.9E-04	2.9E-07
Hexachlorobenzene	1.6E-03	9.7E-05	1.6E-02	2.7E-03	2.0E-02	2.9E-03
Nitrobenzene	3.0E-03	3.0E-02	1.2E-02	2.6E-07	4.5E-02	6.5E-03
Diphenylamines (total)	1.0E-03	1.1E-03	6.7E-03	6.6E-06	8.8E-03	NC
2,3,4,5-Tetrachlorophenol	2.1E-02	9.1E-03	1.7E-01	8.4E-04	2.0E-01	NC
2-methylphenol	1.1E-02	2.8E-02	6.1E-02	1.4E-05	9.9E-02	4.5E-04
Isophorone	8.7E-05	1.1E-03	3.2E-04	4.9E-09	1.5E-03	NC
Mourning Dove						
Acenaphthylene	1.3E-02	1.6E-02	NA	NA	2.9E-02	1.7E-04
Dibenzo(a,h)anthracene	3.9E-03	5.4E-03	NA	NA	9.3E-03	4.6E-02
Benzyl butyl phthalate	1.8E-03	7.4E-04	NA	NA	2.5E-03	NC
Di-n-octyl Phthalate	3.5E-04	1.7E-06	NA	NA	3.6E-04	2.5E-03
Di-n-butyl Phthalate	1.1E-03	6.4E-04	NA	NA	1.7E-03	1.2E-02
Hexachlorobenzene	4.2E-02	5.9E-03	NA	NA	4.8E-02	9.7E-03
Nitrobenzene	8.0E-02	1.8E+00	NA	NA	1.9E+00	NC
Diphenylamines (total)	2.7E-02	6.8E-02	NA	NA	9.5E-02	7.0E-03
2,3,4,5-Tetrachlorophenol	5.7E-01	5.6E-01	NA	NA	1.1E+00	NC
2-methylphenol	2.8E-01	1.7E+00	NA	NA	2.0E+00	NC
Isophorone	2.3E-03	6.5E-02	NA	NA	6.7E-02	NC
American Woodcock						
Acenaphthylene	9.4E-03	1.5E-03	2.4E-01	NA	2.5E-01	1.5E-03
Dibenzo(a,h)anthracene	2.9E-03	5.0E-04	6.3E-02	NA	6.6E-02	3.3E-01
Benzyl butyl phthalate	1.3E-03	6.8E-05	1.8E-02	NA	1.9E-02	NC

Table 144 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Di-n-octyl Phthalate	2.6E-04	1.5E-07	5.4E-03	NA	5.7E-03	4.1E-02
Di-n-butyl Phthalate	7.9E-04	5.9E-05	1.0E-02	NA	1.1E-02	7.9E-02
Hexachlorobenzene	3.2E-02	5.5E-04	4.9E-01	NA	5.2E-01	1.0E-01
Nitrobenzene	5.9E-02	1.7E-01	3.6E-01	NA	5.9E-01	NC
Diphenylamines (total)	2.0E-02	6.3E-03	2.0E-01	NA	2.3E-01	1.7E-02
2,3,4,5-Tetrachlorophenol	4.2E-01	5.1E-02	5.1E+00	NA	5.6E+00	NC
2-methylphenol	2.1E-01	1.6E-01	1.8E+00	NA	2.2E+00	NC
Isophorone	1.7E-03	6.0E-03	9.8E-03	NA	1.7E-02	NC
Short-Eared Owl						
Acenaphthylene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzyl butyl phthalate	NA	NA	NA	5.8E-05	5.8E-05	NC
Di-n-octyl Phthalate	NA	NA	NA	3.2E-02	3.2E-02	2.3E-01
Di-n-butyl Phthalate	NA	NA	NA	2.0E-05	2.0E-05	1.4E-04
Hexachlorobenzene	NA	NA	NA	1.2E-02	1.2E-02	2.5E-03
Nitrobenzene	NA	NA	NA	1.2E-06	1.2E-06	NC
Diphenylamines (total)	NA	NA	NA	3.1E-05	3.1E-05	2.3E-06
2,3,4,5-Tetrachlorophenol	NA	NA	NA	3.9E-03	3.9E-03	NC
2-methylphenol	NA	NA	NA	6.3E-05	6.3E-05	NC
Isophorone	NA	NA	NA	2.3E-08	2.3E-08	NC
Common Gartersnake						
Acenaphthylene	1.2E-04	NA	3.1E-03	NA	3.2E-03	2.0E-05
Dibenzo(a,h)anthracene	3.6E-05	NA	8.2E-04	NA	8.6E-04	4.3E-03
Benzyl butyl phthalate	1.6E-05	NA	2.3E-04	4.9E-06	2.6E-04	NC
Di-n-octyl Phthalate	3.3E-06	NA	7.1E-05	2.7E-03	2.7E-03	2.0E-02
Di-n-butyl Phthalate	9.8E-06	NA	1.4E-04	1.6E-06	1.5E-04	1.0E-03
Hexachlorobenzene	3.9E-04	NA	6.4E-03	1.0E-03	7.9E-03	1.6E-03
Nitrobenzene	7.3E-04	NA	4.8E-03	1.0E-07	5.5E-03	NC
Diphenylamines (total)	2.4E-04	NA	2.7E-03	2.6E-06	2.9E-03	2.2E-04
2,3,4,5-Tetrachlorophenol	5.2E-03	NA	6.7E-02	3.3E-04	7.2E-02	NC
2-methylphenol	2.6E-03	NA	2.4E-02	5.3E-06	2.7E-02	NC
Isophorone	2.1E-05	NA	1.3E-04	1.9E-09	1.5E-04	NC
Wood Frog						

Table 144 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Acenaphthylene	5.4E-04	NA	8.2E-02	NA	8.3E-02	5.0E-04
Dibenzo(a,h)anthracene	1.7E-04	NA	2.2E-02	NA	2.2E-02	1.1E-01
Benzyl butyl phthalate	7.6E-05	NA	6.2E-03	NA	6.3E-03	NC
Di-n-octyl Phthalate	1.5E-05	NA	1.9E-03	NA	1.9E-03	1.4E-02
Di-n-butyl Phthalate	4.6E-05	NA	3.6E-03	NA	3.6E-03	2.6E-02
Hexachlorobenzene	1.8E-03	NA	1.7E-01	NA	1.7E-01	3.4E-02
Nitrobenzene	3.4E-03	NA	1.3E-01	NA	1.3E-01	NC
Diphenylamines (total)	1.1E-03	NA	7.1E-02	NA	7.2E-02	5.3E-03
2,3,4,5-Tetrachlorophenol	2.4E-02	NA	1.8E+00	NA	1.8E+00	NC
2-methylphenol	1.2E-02	NA	6.4E-01	NA	6.5E-01	NC
Isophorone	9.9E-05	NA	3.4E-03	NA	3.5E-03	NC

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

Table 145 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Acenaphthylene	7.3E-04	3.8E-03	NA	NA	4.5E-03	1.4E-05
Dibenzo(a,h)anthracene	1.8E-04	1.0E-03	NA	NA	1.2E-03	4.0E-04
Benzyl butyl phthalate	7.3E-05	1.2E-04	NA	NA	1.9E-04	1.2E-06
Di-n-octyl Phthalate	9.1E-06	1.7E-07	NA	NA	9.3E-06	6.9E-09
Di-n-butyl Phthalate	9.1E-05	2.1E-04	NA	NA	3.1E-04	2.3E-07
Hexachlorobenzene	1.6E-03	8.9E-04	NA	NA	2.5E-03	3.6E-04
Nitrobenzene	1.3E-03	1.1E-01	NA	NA	1.2E-01	1.7E-02
Diphenylamines (total)	1.3E-03	1.3E-02	NA	NA	1.4E-02	NC
2,3,4,5-Tetrachlorophenol	9.3E-03	3.5E-02	NA	NA	4.5E-02	NC

Table 145 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
2-methylphenol	8.2E-03	1.9E-01	NA	NA	2.0E-01	9.1E-04
Isophorone	9.1E-05	1.0E-02	NA	NA	1.0E-02	NC
Northern Short-tailed Shrew						
Acenaphthylene	1.3E-03	9.0E-04	9.2E-02	NA	9.4E-02	2.9E-04
Dibenzo(a,h)anthracene	3.3E-04	2.4E-04	2.0E-02	NA	2.0E-02	6.7E-03
Benzyl butyl phthalate	1.3E-04	2.8E-05	4.9E-03	4.4E-06	5.1E-03	3.2E-05
Di-n-octyl Phthalate	1.6E-05	3.9E-08	9.4E-04	1.5E-03	2.5E-03	1.8E-06
Di-n-butyl Phthalate	1.6E-04	5.1E-05	5.9E-03	3.1E-06	6.1E-03	4.6E-06
Hexachlorobenzene	2.9E-03	2.1E-04	1.3E-01	8.9E-04	1.3E-01	1.8E-02
Nitrobenzene	2.3E-03	2.7E-02	3.9E-02	3.6E-08	6.8E-02	9.9E-03
Diphenylamines (total)	2.3E-03	3.0E-03	6.6E-02	2.7E-06	7.1E-02	NC
2,3,4,5-Tetrachlorophenol	1.7E-02	8.4E-03	5.6E-01	1.2E-04	5.9E-01	NC
2-methylphenol	1.5E-02	4.5E-02	3.6E-01	3.4E-06	4.2E-01	1.9E-03
Isophorone	1.6E-04	2.4E-03	2.6E-03	1.7E-09	5.1E-03	NC
White-Tailed Deer						
Acenaphthylene	2.4E-04	1.5E-03	NA	NA	1.7E-03	5.3E-06
Dibenzo(a,h)anthracene	6.0E-05	4.0E-04	NA	NA	4.6E-04	1.5E-04
Benzyl butyl phthalate	2.4E-05	4.7E-05	NA	NA	7.1E-05	4.5E-07
Di-n-octyl Phthalate	3.0E-06	6.5E-08	NA	NA	3.1E-06	2.3E-09
Di-n-butyl Phthalate	3.0E-05	8.5E-05	NA	NA	1.1E-04	8.6E-08
Hexachlorobenzene	5.4E-04	3.5E-04	NA	NA	8.9E-04	1.3E-04
Nitrobenzene	4.2E-04	4.5E-02	NA	NA	4.6E-02	6.6E-03
Diphenylamines (total)	4.2E-04	5.0E-03	NA	NA	5.4E-03	NC
2,3,4,5-Tetrachlorophenol	3.1E-03	1.4E-02	NA	NA	1.7E-02	NC
2-methylphenol	2.7E-03	7.6E-02	NA	NA	7.8E-02	3.6E-04
Isophorone	3.0E-05	3.9E-03	NA	NA	4.0E-03	NC
Red Fox						
Acenaphthylene	2.7E-04	1.5E-04	4.4E-03	NA	4.8E-03	1.5E-05
Dibenzo(a,h)anthracene	6.7E-05	4.2E-05	9.4E-04	NA	1.0E-03	3.5E-04
Benzyl butyl phthalate	2.7E-05	4.9E-06	2.3E-04	5.0E-06	2.7E-04	1.7E-06
Di-n-octyl Phthalate	3.4E-06	6.8E-09	4.5E-05	1.7E-03	1.8E-03	1.3E-06
Di-n-butyl Phthalate	3.4E-05	8.8E-06	2.8E-04	3.5E-06	3.3E-04	2.4E-07
Hexachlorobenzene	6.0E-04	3.6E-05	6.0E-03	1.0E-03	7.7E-03	1.1E-03

Table 145 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Nitrobenzene	4.7E-04	4.7E-03	1.9E-03	4.1E-08	7.0E-03	1.0E-03
Diphenylamines (total)	4.7E-04	5.2E-04	3.1E-03	3.1E-06	4.1E-03	NC
2,3,4,5-Tetrachlorophenol	3.4E-03	1.4E-03	2.7E-02	1.3E-04	3.2E-02	NC
2-methylphenol	3.0E-03	7.8E-03	1.7E-02	3.8E-06	2.8E-02	1.3E-04
Isophorone	3.4E-05	4.1E-04	1.2E-04	1.9E-09	5.7E-04	NC
Mourning Dove						
Acenaphthylene	7.1E-03	9.5E-03	NA	NA	1.7E-02	1.0E-04
Dibenzo(a,h)anthracene	1.8E-03	2.6E-03	NA	NA	4.3E-03	2.2E-02
Benzyl butyl phthalate	7.1E-04	3.0E-04	NA	NA	1.0E-03	NC
Di-n-octyl Phthalate	8.8E-05	4.1E-07	NA	NA	8.9E-05	6.3E-04
Di-n-butyl Phthalate	8.8E-04	5.4E-04	NA	NA	1.4E-03	1.0E-02
Hexachlorobenzene	1.6E-02	2.2E-03	NA	NA	1.8E-02	3.6E-03
Nitrobenzene	1.2E-02	2.9E-01	NA	NA	3.0E-01	NC
Diphenylamines (total)	1.2E-02	3.2E-02	NA	NA	4.4E-02	3.3E-03
2,3,4,5-Tetrachlorophenol	9.0E-02	8.8E-02	NA	NA	1.8E-01	NC
2-methylphenol	8.0E-02	4.8E-01	NA	NA	5.6E-01	NC
Isophorone	8.8E-04	2.5E-02	NA	NA	2.6E-02	NC
American Woodcock						
Acenaphthylene	5.3E-03	8.7E-04	1.3E-01	NA	1.4E-01	8.4E-04
Dibenzo(a,h)anthracene	1.3E-03	2.3E-04	2.8E-02	NA	3.0E-02	1.5E-01
Benzyl butyl phthalate	5.3E-04	2.7E-05	7.1E-03	NA	7.7E-03	NC
Di-n-octyl Phthalate	6.6E-05	3.8E-08	1.4E-03	NA	1.4E-03	1.0E-02
Di-n-butyl Phthalate	6.6E-04	4.9E-05	8.6E-03	NA	9.3E-03	6.6E-02
Hexachlorobenzene	1.2E-02	2.1E-04	1.8E-01	NA	2.0E-01	3.9E-02
Nitrobenzene	9.2E-03	2.6E-02	5.6E-02	NA	9.2E-02	NC
Diphenylamines (total)	9.2E-03	2.9E-03	9.5E-02	NA	1.1E-01	8.0E-03
2,3,4,5-Tetrachlorophenol	6.7E-02	8.1E-03	8.1E-01	NA	8.8E-01	NC
2-methylphenol	5.9E-02	4.4E-02	5.2E-01	NA	6.2E-01	NC
Isophorone	6.6E-04	2.3E-03	3.8E-03	NA	6.7E-03	NC
Short-Eared Owl						
Acenaphthylene	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA
Benzyl butyl phthalate	NA	NA	NA	2.3E-05	2.3E-05	NC

Table 145 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Di-n-octyl Phthalate	NA	NA	NA	7.9E-03	7.9E-03	5.7E-02
Di-n-butyl Phthalate	NA	NA	NA	1.6E-05	1.6E-05	1.2E-04
Hexachlorobenzene	NA	NA	NA	4.6E-03	4.6E-03	9.3E-04
Nitrobenzene	NA	NA	NA	1.9E-07	1.9E-07	NC
Diphenylamines (total)	NA	NA	NA	1.4E-05	1.4E-05	1.1E-06
2,3,4,5-Tetrachlorophenol	NA	NA	NA	6.2E-04	6.2E-04	NC
2-methylphenol	NA	NA	NA	1.8E-05	1.8E-05	NC
Isophorone	NA	NA	NA	8.8E-09	8.8E-09	NC
Common Gartersnake						
Acenaphthylene	6.5E-05	NA	1.8E-03	NA	1.8E-03	1.1E-05
Dibenzo(a,h)anthracene	1.6E-05	NA	3.7E-04	NA	3.9E-04	2.0E-03
Benzyl butyl phthalate	6.5E-06	NA	9.4E-05	1.9E-06	1.0E-04	NC
Di-n-octyl Phthalate	8.2E-07	NA	1.8E-05	6.7E-04	6.8E-04	4.9E-03
Di-n-butyl Phthalate	8.2E-06	NA	1.1E-04	1.4E-06	1.2E-04	8.7E-04
Hexachlorobenzene	1.5E-04	NA	2.4E-03	3.9E-04	2.9E-03	5.9E-04
Nitrobenzene	1.1E-04	NA	7.4E-04	1.6E-08	8.6E-04	NC
Diphenylamines (total)	1.1E-04	NA	1.3E-03	1.2E-06	1.4E-03	1.0E-04
2,3,4,5-Tetrachlorophenol	8.3E-04	NA	1.1E-02	5.2E-05	1.2E-02	NC
2-methylphenol	7.3E-04	NA	6.8E-03	1.5E-06	7.6E-03	NC
Isophorone	8.2E-06	NA	5.0E-05	7.4E-10	5.8E-05	NC
Wood Frog						
Acenaphthylene	3.0E-04	NA	4.6E-02	NA	4.7E-02	2.8E-04
Dibenzo(a,h)anthracene	7.6E-05	NA	9.9E-03	NA	1.0E-02	5.0E-02
Benzyl butyl phthalate	3.0E-05	NA	2.5E-03	NA	2.5E-03	NC
Di-n-octyl Phthalate	3.8E-06	NA	4.7E-04	NA	4.7E-04	3.4E-03
Di-n-butyl Phthalate	3.8E-05	NA	3.0E-03	NA	3.0E-03	2.1E-02
Hexachlorobenzene	6.8E-04	NA	6.4E-02	NA	6.4E-02	1.3E-02
Nitrobenzene	5.3E-04	NA	2.0E-02	NA	2.0E-02	NC
Diphenylamines (total)	5.3E-04	NA	3.3E-02	NA	3.4E-02	2.5E-03
2,3,4,5-Tetrachlorophenol	3.9E-03	NA	2.8E-01	NA	2.8E-01	NC
2-methylphenol	3.4E-03	NA	1.8E-01	NA	1.8E-01	NC
Isophorone	3.8E-05	NA	1.3E-03	NA	1.3E-03	NC

Table 145 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FTF Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

6.2.2.4 Former Sewage Lagoon (FSL)

The maximum and average / 95th percentile COPC concentrations were applied as the exposure point concentration in Table 146 and Table 147.

Table 146 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FSL Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Silver	2.6E-03	2.8E-03	NA	NA	5.4E-03	9.0E-05
Northern Short-tailed Shrew						
Silver	4.6E-03	6.7E-04	2.4E-01	2.1E-02	2.7E-01	4.5E-03
White-Tailed Deer						
Silver	8.4E-04	1.1E-03	NA	NA	2.0E-03	3.3E-05
Red Fox						
Silver	9.4E-04	1.2E-04	1.1E-02	2.4E-02	3.6E-02	6.0E-04
Mourning Dove						
Silver	2.5E-02	7.1E-03	NA	NA	3.2E-02	1.6E-02
American Woodcock						
Silver	1.8E-02	6.5E-04	3.5E-01	NA	3.7E-01	1.8E-01
Short-Eared Owl						
Silver	NA	NA	NA	1.1E-01	1.1E-01	5.4E-02
Common Gartersnake						
Silver	2.3E-04	NA	4.6E-03	9.2E-03	1.4E-02	6.9E-03
Wood Frog						
Silver	1.1E-03	NA	1.2E-01	NA	1.2E-01	6.0E-02

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

Table 147 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within FSL Based on Average / 95th Percentile Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Silver	1.3E-03	1.4E-03	NA	NA	2.7E-03	4.5E-05
Northern Short-tailed Shrew						
Silver	2.3E-03	3.4E-04	1.2E-01	1.3E-02	1.4E-01	2.3E-03
White-Tailed Deer						
Silver	4.2E-04	5.6E-04	NA	NA	9.8E-04	1.6E-05
Red Fox						
Silver	4.7E-04	5.8E-05	5.7E-03	1.4E-02	2.0E-02	3.4E-04
Mourning Dove						
Silver	1.2E-02	3.6E-03	NA	NA	1.6E-02	7.9E-03
American Woodcock						
Silver	9.2E-03	3.3E-04	1.7E-01	NA	1.8E-01	9.1E-02
Short-Eared Owl						
Silver	NA	NA	NA	6.6E-02	6.6E-02	3.3E-02
Common Gartersnake						
Silver	1.1E-04	NA	2.3E-03	5.5E-03	7.9E-03	3.9E-03
Wood Frog						
Silver	5.3E-04	NA	6.1E-02	NA	6.1E-02	3.0E-02

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

6.2.2.5 General Soil Samples (BPS/SS)

The maximum COPC concentrations were applied as the exposure point concentration in Table 148. No average concentrations were used because of the spatially separate nature of the sampling sites.

Table 148 Exposure and Risk Estimates for Terrestrial Wildlife from Soil COPCs within BPS/SS Based on Maximum Concentrations

COPC	Soil Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Invert Ingestion (mg/kg-d)	Prey Ingestion (mg/kg-d)	Soil Total Exposure (mg/kg-d)	Soil HQ
Meadow Vole						
Lead	2.4E-01	1.2E+00	NA	NA	1.4E+00	0.2
Selenium	5.1E-03	5.2E-01	NA	NA	5.3E-01	**2.5**
Northern Short-tailed Shrew						
Lead	4.3E-01	2.9E-01	1.9E+01	3.8E-01	2.0E+01	**2.3**
Selenium	9.2E-03	1.2E-01	9.4E-01	4.7E-02	1.1E+00	**5.2**
White-Tailed Deer						
Lead	7.8E-02	4.8E-01	NA	NA	5.6E-01	0.1
Selenium	1.7E-03	2.1E-01	NA	NA	2.1E-01	1.0
Red Fox						
Lead	8.7E-02	5.0E-02	9.2E-01	4.3E-01	1.5E+00	0.2
Selenium	1.9E-03	2.1E-02	4.4E-02	5.2E-02	1.2E-01	0.6
Mourning Dove						
Lead	2.3E+00	3.0E+00	NA	NA	5.3E+00	**3.3**
Selenium	4.9E-02	1.3E+00	NA	NA	1.4E+00	**4.7**
American Woodcock						
Lead	1.7E+00	2.8E-01	2.8E+01	NA	3.0E+01	**18**
Selenium	3.7E-02	1.2E-01	1.3E+00	NA	1.5E+00	**5.2**
Short-Eared Owl						
Lead	NA	NA	NA	2.0E+00	2.0E+00	**1.2**
Selenium	NA	NA	NA	2.4E-01	2.4E-01	0.8
Common Gartersnake						
Lead	2.1E-02	NA	3.7E-01	1.7E-01	5.6E-01	0.3
Selenium	4.6E-04	NA	1.8E-02	2.0E-02	3.9E-02	0.1
Wood Frog						
Lead	9.9E-02	NA	9.7E+00	NA	9.8E+00	**6.0**
Selenium	2.1E-03	NA	4.7E-01	NA	4.7E-01	**1.6**

Notes:
NA – VEC does not consume dietary item
NC – Not calculated, no TRV identified
Bold indicates HQ>1

6.3 Groundwater

No COPCs were retained for further assessment in groundwater; therefore, exposure and risk estimates were not calculated.

6.4 Sediment

6.4.1 Aquatic Communities

The exposure and risk estimates for benthic invertebrates from direct contact with sediment are provided in Table 149.

Table 149 Exposure and Risk Estimates for Aquatic Communities from Sediment COPCs

COPC	Toxicological Benchmark (µg/g)	Max EPC (µg/g)	Average / 95th Percentile EPC (µg/g)	Max HQ	Average / 95th Percentile HQ
LAKE HURON					
None	-	-	-	-	-
STREAM C					
None	-	-	-	-	-
FSL					
Copper	197	210	-	**1.1**	-
Mercury	0.49	0.61	-	**1.2**	-
B16 POND					
None	-	-	-	-	-
B31 POND					
Copper	197	150	-	7.6E-01	-
Selenium	NV	1	-	NC	-
Zinc	315	360	-	**1.1**	-
PHC F3	110	1100	-	**10**	
PHC F4	190	230	-	**1.2**	
EDD					
Selenium	NV	1.1	-	NC	-
Vanadium	NV	100	-	NC	-
Zinc	315	390	-	**1.2**	-
Toluene	6.1	0.26	-	4.3E-02	-
PHC F3	110	500	-	**4.5**	-

Notes:
NV – No TRV identified
NC – Not calculated
Bold indicates HQ>1

6.4.2 Semi-Aquatic Wildlife

The exposure and risk estimates for semi-aquatic wildlife from sediment exposure pathways (bioconcentration into vegetation and benthics; sediment ingestion) are provided below for each assessed area and VEC. The maximum COPC concentration was applied as the exposure point concentration given the limited data available for each assessed area.

6.4.2.1 Former Sewage Lagoon (FSL)

The exposure and risk estimates for semi-aquatic wildlife from sediment exposure pathways are provided in Table 150.

Table 150 Exposure and Risk Estimates for Semi-Aquatic Wildlife from Sediment COPCs within FSL

COPC	Sediment Ingestion (mg/kg-d)	Vegetation ingestion (mg/kg-d)	Benthic Ingestion (mg/kg-d)	Sediment Total Exposure (mg/kg-d)	Sediment HQ
Muskrat					
Cadmium	2.8E-03	4.4E-02	4.8E-01	5.3E-01	0.1
Lead	7.0E-02	1.1E-01	2.2E+00	2.4E+00	0.3
Mink					
Cadmium	1.3E-03	0.0E+00	3.3E-01	3.3E-01	0.04
Lead	3.3E-02	0.0E+00	1.5E+00	1.5E+00	0.2
Green-winged Teal					
Cadmium	6.4E-03	2.2E-02	3.9E-01	4.2E-01	0.2
Lead	1.6E-01	9.0E-02	1.8E+00	2.1E+00	**1.3**
Spotted Sandpiper					
Cadmium	7.2E-03	3.0E-03	8.1E-01	8.2E-01	0.4
Lead	1.8E-01	1.9E-02	3.7E+00	3.9E+00	**2.4**
Belted Kingfisher					
Cadmium	5.0E-03	0.0E+00	5.2E-01	5.3E-01	0.3
Lead	1.2E-01	0.0E+00	2.4E+00	2.5E+00	**1.6**
Snapping Turtle					
Cadmium	1.0E-04	2.8E-03	3.3E-02	3.6E-02	0.02
Lead	2.5E-03	1.7E-02	1.5E-01	1.7E-01	0.1
Northern Watersnake					
Cadmium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00
Lead	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00

Notes:
Bold indicates HQ>1

6.4.2.2 B31 Pond

The exposure and risk estimates for semi-aquatic wildlife from sediment exposure pathways are provided in Table 151.

Table 151 Exposure and Risk Estimates for Semi-Aquatic Wildlife from Sediment COPCs within B31 Pond

COPC	Sediment Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Benthic Ingestion (mg/kg-d)	Sediment Total Exposure (mg/kg-d)	Sediment HQ
Muskrat					
Zinc	5.0E-01	6.2E+00	1.4E+01	2.1E+01	0.1
Mink					
Zinc	2.3E-01	0.0E+00	9.8E+00	1.0E+01	0.1
Green-winged Teal					
Zinc	1.2E+00	3.1E-02	1.2E+01	1.3E+01	0.2
Spotted Sandpiper					
Zinc	1.3E+00	2.9E-03	2.4E+01	2.6E+01	0.4
Belted Kingfisher					
Zinc	9.0E-01	0.0E+00	1.6E+01	1.7E+01	0.3
Snapping Turtle					
Zinc	1.8E-02	2.8E-03	9.8E-01	1.0E+00	0.0
Northern Watersnake					
Zinc	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0

Notes:
Bold indicates HQ>1

6.4.2.3 Eastern Drainage Ditch (EDD)

The exposure and risk estimates for semi-aquatic wildlife from sediment exposure pathways are provided in Table 152.

Table 152 Exposure and Risk Estimates for Semi-Aquatic Wildlife from Sediment COPCs within EDD

COPC	Sediment Ingestion (mg/kg-d)	Vegetation ingestion (mg/kg-d)	Benthic Ingestion (mg/kg-d)	Sediment Total Exposure (mg/kg-d)	Sediment HQ
Muskrat					
Vanadium	1.4E-01	7.9E-02	7.1E+00	7.3E+00	0.9
Zinc	5.5E-01	6.4E+00	1.6E+01	2.3E+01	0.1
Mink					
Vanadium	6.5E-02	0.0E+00	4.8E+00	4.9E+00	0.6
Zinc	2.5E-01	0.0E+00	1.1E+01	1.1E+01	0.1
Green-winged Teal					
Vanadium	3.2E-01	3.0E-01	5.8E+00	6.4E+00	**19**
Zinc	1.2E+00	3.3E-02	1.3E+01	1.4E+01	0.2
Spotted Sandpiper					
Vanadium	3.6E-01	2.8E-01	1.2E+01	1.3E+01	**36**
Zinc	1.4E+00	3.2E-03	2.6E+01	2.8E+01	0.4
Belted Kingfisher					
Vanadium	2.5E-01	0.0E+00	7.7E+00	7.9E+00	**23**
Zinc	9.7E-01	0.0E+00	1.7E+01	1.8E+01	0.3
Snapping Turtle					
Vanadium	5.0E-03	2.6E-01	4.8E-01	7.4E-01	**2.2**
Zinc	1.9E-02	3.0E-03	1.1E+00	1.1E+00	0.0
Northern Watersnake					
Vanadium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0
Zinc	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0

Notes:
Bold indicates HQ>1

6.5 Surface Water

6.5.1 Aquatic Communities

The exposure and risk estimates for aquatic communities (plants, algae, invertebrates, and fish) from direct contact with surface water are provided in Table 153.

Table 153 Exposure and Risk Estimates for Aquatic Communities from Surface Water COPCs

COPC	TRV (µg/L)	Max EPC (µg/L)	Average EPC (µg/L)	Max HQ	Average HQ
LAKE HURON					
Zinc	13	130	21	**10**	**1.6**
Ammonia	16	300	11	**19**	0.7
FSL					
Copper	2	2.8	-	**1.4**	-
Zinc	2.5	8.7	-	**3.5**	-
B16 POND					
Iron	604	370	-	0.6	-
B31 POND					
Aluminum	426	210	-	0.5	-
Copper	2	4.8	-	**2.4**	-
Iron	604	310	-	0.5	-
EDD					
Vanadium	20	20.5	-	1.0	-

Notes:
Bold indicates HQ>1

6.5.2 Semi-Aquatic Wildlife

The exposure and risk estimates for semi-aquatic wildlife from the applicable surface water exposure pathways (bioconcentration into fish and surface water ingestion) are provided below for each assessed area and VEC. The maximum COPC concentration was applied as the exposure point concentration given the limited data available for each assessed area.

6.5.2.1 Former Sewage Lagoon (FSL)

The exposure and risk estimates for semi-aquatic wildlife from the applicable surface water exposure pathways are provided in Table 154.

Table 154 Exposure and Risk Estimates for Semi-Aquatic Wildlife from Surface Water COPCs within FSL

COPC	Fish Ingestion (mg/kg-d)	Surface Water ingestion (mg/kg-d)	Surface Water Total Exposure (mg/kg-d)	Surface Water HQ
Muskrat				
Cadmium	7.1E-05	9.0E-06	8.0E-05	2.8E-05
Lead	3.9E-08	5.0E-05	5.0E-05	6.3E-07
Mink				
Cadmium	4.3E-04	2.7E-06	4.3E-04	1.5E-04
Lead	2.4E-07	1.5E-05	1.5E-05	1.9E-07
Green-winged Teal				
Cadmium	NA	7.2E-06	7.2E-06	4.9E-06
Lead	NA	4.0E-05	4.0E-05	3.5E-05
Spotted Sandpiper				
Cadmium	NA	1.5E-05	1.5E-05	1.0E-05
Lead	NA	8.5E-05	8.5E-05	7.5E-05
Belted Kingfisher				
Cadmium	2.2E-03	1.3E-05	2.2E-03	1.5E-03
Lead	1.2E-06	7.0E-05	7.1E-05	6.3E-05
Snapping Turtle				
Cadmium	NA	NA	NA	NA
Lead	NA	NA	NA	NA
Northern Watersnake				
Cadmium	2.9E-04	NA	2.9E-04	1.9E-04
Lead	1.6E-07	NA	1.6E-07	1.4E-07

Notes:
NA – not applicable; VEC does not consume dietary item or for the case of reptile exposure to SW there are insufficient methods to quantitatively evaluate exposure
Bold indicates HQ>1

6.5.2.2 B31 Pond

The exposure and risk estimates for semi-aquatic wildlife from the applicable surface water exposure pathways are provided in Table 155.

Table 155 Exposure and Risk Estimates for Semi-Aquatic Wildlife from Surface Water COPCs within B31 Pond

COPC	Fish Ingestion (mg/kg-d)	SW ingestion (mg/kg-d)	SW Total Exposure (mg/kg-d)	SW HQ
Muskrat				
Zinc	1.5E-03	1.2E-03	2.7E-03	8.4E-06
Mink				
Zinc	9.0E-03	3.6E-04	9.4E-03	2.9E-05
Green-winged Teal				
Zinc	NA	9.6E-04	9.6E-04	6.6E-05
Spotted Sandpiper				
Zinc	NA	2.0E-03	2.0E-03	1.4E-04
Belted Kingfisher				
Zinc	4.5E-02	1.7E-03	4.7E-02	3.2E-03
Snapping Turtle				
Zinc	NA	NA	NA	NA
Northern Watersnake				
Zinc	6.0E-03	NA	6.0E-03	4.1E-04

Notes:
NA – not applicable; VEC does not consume dietary item or for the case of reptile exposure to SW there are insufficient methods to quantitatively evaluate exposure
Bold indicates HQ>1

6.5.2.3 Eastern Drainage Ditch (EDD)

The exposure and risk estimates for semi-aquatic wildlife from the applicable surface water exposure pathways are provided in Table 156.

Table 156 Exposure and Risk Estimates for Semi-Aquatic Wildlife from Surface Water COPCs within EDD

COPC	Fish Ingestion (mg/kg-d)	Surface Water ingestion (mg/kg-d)	Surface Water Total Exposure (mg/kg-d)	Surface Water HQ
Muskrat				
Vanadium	1.8E-05	2.1E-03	2.1E-03	9.8E-04
Zinc	2.0E-03	1.6E-03	3.6E-03	1.1E-05
Mink				
Vanadium	1.1E-04	6.2E-04	7.2E-04	3.4E-04
Zinc	1.2E-02	4.8E-04	1.3E-02	3.9E-05
Green-winged Teal				
Vanadium	NA	1.6E-03	1.6E-03	4.3E-03
Zinc	NA	1.3E-03	1.3E-03	8.8E-05
Spotted Sandpiper				
Vanadium	NA	3.5E-03	3.5E-03	9.2E-03
Zinc	NA	2.7E-03	2.7E-03	1.9E-04
Belted Kingfisher				
Vanadium	5.4E-04	2.9E-03	3.4E-03	9.0E-03
Zinc	6.0E-02	2.2E-03	6.3E-02	4.3E-03
Snapping Turtle				
Vanadium	NA	NA	NA	NA
Zinc	NA	NA	NA	NA
Northern Watersnake				
Vanadium	7.2E-05	NA	7.2E-05	1.9E-04
Zinc	8.0E-03	NA	8.0E-03	5.5E-04

Notes:
NA – not applicable; VEC does not consume dietary item or for the case of reptile exposure to SW there are insufficient methods to quantitatively evaluate exposure
Bold indicates HQ>1

6.6 Drinking Water

No COPCs were identified in drinking water; therefore, exposure and risk estimates were not calculated.

7.0 APPENDIX G: TOXICOLOGICAL EVALUATION OF CHEMICALS WITH SITE-SPECIFIC DISCHARGE LIMITS

This appendix provides a toxicological evaluation of the chemicals that are monitored under the Bruce Nuclear Facility's Environmental Compliance Approval for Water (ECA) and Municipal and Industrial Strategy for Abatement (MISA) requirements to determine if the MISA limits established for these chemicals are protective of human health and the environment (i.e., aquatic life). MISA requirements were rolled into the ECA requirements in 2021.These include chemicals measured at the condensed circulating water (CCW), which represents end of pipe at the Bruce A discharge channel, and several other locations upstream within the Bruce A facility. Chemicals monitored at the CCW include boron (total), ammonia (unionized), pH, morpholine, and hydrazine.

For aquatic life, the discharge limits were compared to environmental quality guidelines for long-term or chronic effects, including both provincial and federal water quality guidelines for the protection of freshwater aquatic life, as well as primary chronic toxicity data in absence of published guidelines. Comparison of the discharge limits to chronic benchmarks is considered to be a conservative approach because aquatic life would be exposed to concentrations in the discharges on a short-term basis as the discharges mix with the water of Lake Huron. If it was determined the discharge limits were greater than chronic benchmarks, the limits were compared to available acute benchmarks for aquatic life.

7.1 Ammonia (unionized)

The MISA limit for ammonia (unionized) is <20 µg/L. The maximum concentration measured in the last five years of monitoring data (i.e., Q1 2017 to Q2 2021) is 2.2 µg/L.

7.1.1 Aquatic Life Toxicology

The Ontario Ministry of the Environment [currently known as the Ministry of the Environment Conservation and Parks (MECP)] derived a Provincial Water Quality Objective (PWQO) for unionized ammonia of 20 µg/L [R-16]. The Canadian Council of Ministers of the Environment (CCME) provides a Canadian Water Quality Guideline for the Protection of Freshwater Aquatic Life (CWQG-PAL) for unionized ammonia of 19 µg/L [R-264]. The maximum measured unionized ammonia concentration measured in the last five years of monitoring data is well below the PWQO and CWQG-PAL. This indicates that the MISA limit is considered protective of aquatic life and there are no potential risks to aquatic life from ammonia in the discharges.

7.1.2 Human Health Toxicology

Health Canada [R-206] has not derived a Canadian Drinking Water Quality Guideline (CDWG) for ammonia given that it is produced naturally by humans and it is metabolized efficiently in healthy individuals. There are no toxicity reference values (TRVs) available for ammonia. Given that the maximum measured concentration of ammonia from the past five years is below the MISA limit of 20 µg/L, no health concerns are associated with ammonia. The MISA limit is considered protective of human health.

7.2 Boron (total as B)

The MISA limit for boron (total) is 5,000 µg/L. The maximum concentration measured in the last five years of monitoring data (i.e., Q1 2017 to Q2 2021) is 180 µg/L. Boron is not used at Bruce B and at Units 1 and 2 at Bruce A. The use of boron will be discontinued at Bruce A following the Unit 3 and 4 MCRs.

7.2.1 Aquatic Life Toxicology

The MECP provides a PWQO for boron of 200 µg/L [R-16]. The CCME provides a long-term CWQG-PAL of 1,500 µg/L [R-264]. The discharge limit is above the PWQO and CWQG-PAL; however, the maximum measured concentration of boron in the last five years of monitoring data is below the provincial and federal guidelines.

The CCME provides a short-term (acute) guideline for boron of 29,000 µg/L. The MISA limit and maximum measured concentration is well below acute effect concentrations for aquatic life.

7.2.2 Human Health Toxicology

The CDWG for boron is 5,000 µg/L [R-206], which is equivalent to its MISA limit. Given that concentrations of boron have met their limit in the last five years of monitoring data, no health concerns are associated with boron. The MISA limit is considered protective of human health.

7.3 Hydrazine

The MISA limit for hydrazine is 100 µg/L. The maximum concentration measured in the last five years of monitoring data (i.e., Q1 2017 to Q2 2021) is 73 µg/L.

7.3.1 Aquatic Life Toxicology

The MECP and CCME do not provide a PWQO/CWQG-PAL for hydrazine [R-16][R-264]. Environment Canada derived a chronic federal water quality guideline (FWQG) for the protection of freshwater aquatic life from adverse effects of hydrazine of 2.6 µg/L [R-265]. The FWQG was derived using a species sensitivity distribution (SSD) based on acute toxicity data for five fish, three invertebrates, one amphibian, and one algal species. An HC_5 (hazardous concentration for 5% of species) of 26 µg/L was derived based on the SSD. Given the lack of chronic toxicity data for this chemical, an application factor of 10 was applied to the acute HC_5 to yield the FWQG of 2.6 µg/L. The FWQG represents a concentration below which no or only a low likelihood of adverse effects on freshwater aquatic life would be expected [R-265]. However, for discharges to the Great Lakes a limit of 26 µg/L is permitted [R-266]. The maximum measured concentration and the discharge limit for hydrazine is greater than the allowable discharge limit to the Great Lakes.

Based on the information provided in Environment Canada [R-265], acute toxicity data for fish (96-hour LC_{50}) range from 610 to 5,980 µg/L, with the most sensitive species being the common guppy (*Lebistes reticulatus*); however, the common guppy is a tropical fish species that does not occur in Lake Huron. The next most sensitive species is the channel catfish

(*Ictalurus punctatus*) with a 96-hour LC_{50} of 1,000 µg/L. This species has been caught near the Site. Acute toxicity data for invertebrates range from a 48-hour LC_{50} of 40 µg/L for the amphipod *Hyalella azteca* to a 72-hour LC_{50} of 1,300 µg/L for an isopod (*Asillidae* spp.). Amphipoda was the dominant group in the nearshore areas while naidids were the dominant group in the Bruce A discharge channel [R-49]. In the Bruce B discharge channel, the benthic community was dominated by oligochaetes in the shallow water and chironomids were the major species in deeper waters. The discharge limit and the maximum measured concentration of hydrazine is greater than the acute toxicity value for *Hyalella Azteca*, but below for all other fish and invertebrate species.

Despite concentrations measured within the discharge above some of the aquatic toxicity thresholds, hydrazine was found to pose negligible risk to aquatic life in surface water in the EcoRA as concentrations were measured below detection limits within Lake Huron.

7.3.2 Human Health Toxicology

While there is no CDWG for hydrazine [R-206], the US EPA Regional Screening Level (RSL) for the ingestion of tap water is 0.026 µg/L [R-267]. The tap water RSL is based upon the potential carcinogenicity of hydrazine using a cancer slope factor of 3.0 per mg/kg-day from the US EPA's Integrated Risk Information System (IRIS) and a target cancer risk level of 1 in 1,000,000. The MISA limit and the maximum measured concentration for hydrazine does not meet the US EPA RSL.

People are not expected to be exposed to surface water at end of pipe of the Bruce A or B discharge channel. Any transient exposure at this location would be short-term and infrequent and as a result, concentrations within the discharge are not considered to pose a potential risk to human health. Further, hydrazine was found to pose negligible risk to humans in surface water in the HHRA as concentrations were measured below detection limits within Lake Huron.

7.4 Morpholine

The MISA limit for morpholine is 2,500 µg /L. The maximum concentration measured in the last five years of monitoring data (i.e., Q1 2017 to Q2 2021) is 770 µg/L.

7.4.1 Aquatic Life Toxicology

The MECP provides a PWQO for morpholine of 4 µg/L [R-16] and the CCME does not provide a CWQG-PAL [R-264]. The toxicological basis of the PWQO is unavailable.

Based on a review of the US EPA ECOTOX database [R-268], the lowest reported acute toxicity data in the literature for morpholine is a 96-hour LC_{50} for *Danio rerio* of greater than 1,000 µg/L. Fish of the same family as *Danio rerio* (family *Cyprinidae*) have been identified on the Site. However, there is some uncertainty in this toxicity value because it represents an unbounded value (i.e., toxicity could occur anywhere above 1,000 µg/L). Acute toxicity data (as LC_{50}) for morpholine for fish range upwards from 180,000 µg/L for test species such as rainbow trout. Reported lowest observed effect concentrations (LOECs) for sensitive algal species for sublethal endpoints (i.e., growth) ranged upwards of 5,000 µg/L. The discharge limit and maximum measured concentrations for morpholine is well below acute effects concentrations for aquatic receptors.

Further, morpholine was found to pose negligible risk to aquatic receptors in the ERA as concentrations were measured below detection limits within Lake Huron.

7.4.2 Human Health Toxicology

There is no CDWG [R-206] or tap water RSL [R-267] for morpholine. The toxicological basis of the PWQO is unavailable. Currently, the only TRV available for morpholine was developed by Health Canada for the purpose of evaluating exposure to morpholine as a component of apple wax coating [R-269]. An acceptable daily intake of 0.48 mg/kg-day was derived. If the same approach to deriving tap water RSLs is used, this TRV would be associated with a tap water RSL of 3,600 µg /L. The MISA limit and the maximum measured concentration for morpholine are below this value. As such, health effects are considered to be negligible for people potentially consuming water directly from the discharge channel and the MISA limit is considered protective of human health.

7.5 pH

The MISA limit for pH is a range of 6.0 to 9.5. The range of measured pH in the last five years of monitoring data (i.e., Q1 2017 to Q2 2021) was 6.8 to 8.5.

7.5.1 Aquatic Life Toxicology

The MECP provides a PWQO of 6.5 to 8.5 to protect aquatic life [R-16]. The CCME provides a guideline of 6.5 to 9.0 to protect aquatic life [R-264]. The MISA limit is within these ranges and is thus considered protective of aquatic life. The range of measured pH in the last five years of monitoring data is also within the ranges provided by the MECP and CCME, and pH of the discharges is considered to pose negligible risk to aquatic life.

7.5.2 Human Health Toxicology

The CDWG for pH is a range of 6.5 to 8.5 for its influence on water treatment technology efficiency and formation of treatment byproducts [R-206] The MISA limit is within this range and is thus considered protective of human health. Given that the measured range of pH values from the past five years is within this range, there is little potential for health effects associated with water from the discharge channel.

8.0 APPENDIX H: EVALUATION OF POINT OF IMPINGEMENT LIMITS FOR AIR EMISSIONS

The 2021 Emission Summary and Dispersion Modelling Report [R-215] provides estimates of air quality at ground level at the fenceline of the property line. This location is termed the Maximum Point of Impingement (MPOI) as defined by Ontario Regulation 419/05 [R-216]. All significant sources of chemicals from the Bruce operations are included in the emission sources and consider that all eight units of Bruce A and Bruce B are operational. A summary of the predicted MPOI concentrations are shown in Table 157 below.

Table 157 Emissions at Maximum Point of Impingement (POI) and comparison to Ministry of the Environment and Climate Change (MECP) POI Limits

Contaminant	**Averaging Period** (h)	**Maximum POI Concentration** (μg/m^3)	**MOE POI Limit** (μg/m^3)	**Limiting Effect**	**Reg. Sch. No.**	**% of MOE POI Limit**
Ethyl Benzene	24	1.66E+00	1000	Health	3	0.2%
	10 min	4.61E+01	1900	Odour	G	2%
Nitrogen Oxides [1]	0.5	1.29E+03 ***	1880	-	EGC	68%
Nitrogen Oxides [2]	24	1.03E+02	200	Health	3	52%
	1	3.61E+02 ***	400	Health	3	90%
Morpholine	24	1.95E+01	200	Health	SL-JSL	10%
2-Butoxy Ethanol	10 min	4.61E+01	500	Odour	G	9%
	24	1.66E+00	2400	Health	G	0.07%
Butyl Acetate	1	1.17E+02	15000	Health	G	1%
	10 min	1.93E+02	1000	Odour	G	19%
Ferric Oxide	24	6.23E-01	25	Soiling	3	2%
Xylene	24	9.98E+00	730	Health	3	1%
	10 min	2.77E+02	3000	Odour	G	9%
Ethanolamine	24	1.46E+00	35	Health	SL-JSL	4%
Ethyl Acetate	1	1.68E+02	19000	Odour	G	1%
Hydrazine	24	1.69E-01	0.143	-	MGLC	≤ MGLC
	annual	2.14E-02+	-	-	-	-
Propylene Glycol	24	3.80E-01	120	Particulate	G	0.3%
Ethanol	1	1.93E+00	19000	Odour	G	0.01%
n-Butyl Alcohol	24	1.74E+00	920	Health	3	0.2%
	10 min	4.82E+01	2100	Odour	G	2%
Manganese	24	1.16E-01	0.4	Health	3	29%
Hexavalent Chromium	annual	3.34E-06 **	0.00014	Health	3	2%
Sulphur Dioxide	24	1.23E+01	275	Health & Vegetation	3	4%
	1	5.30E+01	690	Health & Vegetation	3	8%
Methylamine	24	1.59E+00	25	Odour	G	6%
Sodium Bisulphite	24	0.00E+00	120	Part. & Health	G	<0.01%

Table 157 Emissions at Maximum Point of Impingement (POI) and comparison to Ministry of the Environment and Climate Change (MECP) POI Limits

Contaminant	**Averaging Period** (h)	**Maximum POI Concentration** (µg/m^3)	**MOE POI Limit** (µg/m^3)	**Limiting Effect**	**Reg. Sch. No.**	**% of MOE POI Limit**
Hydrogen Chloride	24	8.01E-01	20	Health	3	4%
Ammonia	24	1.12E+01	100	Health	3	11%
Methyl Ethyl Ketone	24	3.04E+01	1000	Health	3	3%
Glycolic Acid	24	1.31E-02	20	Health	SL-JSL	0%
2-(2 aminoethoxyl)ethanol	24	3.31E-01	19	Health	SL-JSL	2%
Particulate Matter	24	1.31E+01	120	Visibility	3	11%
Mineral Spirits [3]	24	4.53E+01	2600	Health	3	2%

NOTE: This assessment was completed using AERMOD/AERMET version 19191.
[1] Nitrogen Oxides emissions from all significant combustion sources.
[2] Nitrogen Oxides emissions from all significant non-emergency combustion sources.
[3] Includes emissions from Aliphatic Naphtha (CAS #64742-88-7) and Stoddard Solvent (CAS #8052-41-3).
**5-year annual average result was increased by a factor of 140% to account for potential variability between the overall 5-year annual average versus the maximum annual result per individual year.
*** After removal of highest 8 hours per meteorological year.
+ Maximum annual (not average) concentration presented. Value was multiplied by 2 to provide flexibility.
Reg. Sch. or Regulation Schedule: 3 Standard - Schedule 3 of Reg. 419
G Guideline - Summary of Standards and Guidelines to support O.Reg.419: Air Pollution - Local Air Quality, April 2012
SL-** Screening Level-JSL, MD, PA, ACB List January 2018 (JSL)
MGLC Maximum Ground Level Concentration as approved by the MOE for the facility for ECA No. 7477-8PGMTZ. EGC Emergency Generator Checklist limit, November 2010

All reported MPOI concentrations were below MECP POI limits. The following chemicals met their health-based O. Reg. 419/05 Schedule 3 limits or guidelines:

- Ethyl Benzene (24-hour);
- Oxides of Nitrogen (1-hour and 24-hour averaging periods);
- 2-Butoxy Ethanol (24-hour);
- Butyl Acetate (1-hour);
- Xylene (24-hour);
- n-Butyl Alcohol (24-hour);
- Manganese (24-hour);
- Hexavalent Chromium (Annual);
- Sulphur Dioxide (1-hour and 24-hour);

- Hydrogen Chloride (24-hour);
- Ammonia (24-hour);
- Methyl Ethyl Ketone (24-hour); and
- Mineral Spirits (24-hour).

The following chemicals met their health-based Jurisdictional Screening Levels (JSLs):

- Morpholine (24-hour);
- Ethanolamine (24-hour);
- Glycolic Acid (24-hour); and,
- 2-(2 aminoethoxyl) ethanol.

The limits used for each of the chemicals and averaging times above are protective of effects to health. The POI limits were confirmed with the original sources and were checked that the values had not since been updated.

There were several chemicals for which their MECP guideline values were based on a limiting effect other than health:

- Ethyl Benzene (10-minutes, odour);
- 2-Butoxy Ethanol (10-minutes, odour);
- Butyl Acetate (10-minutes, odour);
- Ferric Oxide (24-hour, soiling);
- Xylene (10-minutes, odour);
- Ethyl Acetate (1-hour, odour);
- Propylene Glycol (24-hour, particulate);
- Ethanol (1-hour, odour);
- n-Butyl Alcohol (10-minutes, odour);
- Sulphur Dioxide (1-hour and 24-hour, vegetation);
- Methylamine (24-hour, odour);

- Sodium Bisulphite (24-hour, particulate); and,
- Particulate Matter (24-hour, visibility).

In standards setting, the MECP considers several endpoints including health, odour, vegetation, soiling, visibility, corrosion, or other effects. When selecting the final value for the standard, the most sensitive endpoint is selected. Therefore, the guidelines for each of the chemicals above has considered health as an endpoint in its derivation, but another endpoint was considered to be the limiting effect and thus drives the selected value of the guideline. As a result, the POI limit was considered to be health protective and health effects would not be expected at concentrations higher than the guidelines. As a result, no further assessment of these chemicals for these averaging times was required in the HHRA.

Hydrazine

Hydrazine does not have a MECP POI, but hydrazine was included using "Supporting Information for Maximum Ground Level Concentration Acceptability Request for Compounds with No Ministry POI Limit, Supplement to Application for Approval, EPA S.9." The facility ECA Maximum Ground Level Concentration (MGLC) is 0.143 µg/m^3.

The maximum modelled concentration of hydrazine at the MPOI for a 24-hour averaging period is 0.169 µg/m^3, which is less than its facility ECA MGLC. In 2011, a review of available 24-hour air thresholds from other jurisdictions was carried out to confirm that the maximum concentrations from the predicted emissions are acceptable with respect to health. In 2022, it was determined this review was up-to-date.

The Massachusetts Department of Environmental Protection (MassDEP) [R-270] and North Carolina Department of Environment and Natural Resources Division (NCDENR) of Air Quality [R-271] provide 24-hour thresholds for hydrazine. However, neither of the values derived by these agencies is considered to be appropriate for comparison purposes following review of their derivation.

A 24-hour Threshold Effects Exposure Limit (TEL) of 0.04 µg/m^3 was derived by MassDEP [R-272] from the chronic (annual average) Reference Exposure Level (REL) of 0.2 µg/m^3 from California Environmental Protection Agency (CalEPA), and incorporates a Relative Source Contribution (RSC) factor of 0.2. The chronic REL is intended for comparison to predicted annual average concentrations and not 24-hour maximum concentrations. The chronic REL was derived from a key study (Vernot et al. 1985) in which hamsters were exposed to hydrazine in air 6 hours per day, 5 days per week for one year. A lowest-observed adverse effect level (LOAEL) of 0.33 mg/m^3 was adjusted for continuous exposure and an uncertainty factor of 300 was applied to account for extrapolation from animals to humans, human variability, and use of a LOAEL (rather than a no-observed adverse effect level or NOAEL) to derive the chronic REL of 0.2 µg/m^3. Therefore, this value is protective of long-term, continuous exposure, and comparison of predicted 24-hour concentrations to this value would be overly conservative.

The RSC factor of 0.2 was applied to the REL to account for exposure from soil, food, water, and indoor air (i.e., assumes that 80% of exposure may come from other sources). An RSC factor is not typically used in the derivation of ambient air guidelines and as such, the MADEP values are not directly comparable to guidelines derived by other jurisdictions. By removing the RSC factor, the 24-hour value becomes 0.2 µg/m^3, which is still considered to be conservative as it is equivalent to the CalEPA chronic REL, which is intended for comparison to a predicted annual average concentration.

The NCDENR [R-271] provides an Acceptable Ambient Level (AAL) of 0.6 µg/m^3 for a 24-hour period. This value was derived from a 1977 American Conference for Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 0.1 ppm (or 0.1 mg/m^3). Uncertainty factors totaling 160 (i.e., 10 for human variability, 4 for adjustment to continuous exposure, 2 for experimental uncertainty, and 2 for severity of effect) were applied to the TLV. Given that the TLV is nearly 40 years old and the toxicological data that the TLV is based upon are unknown, the confidence in this guideline is low.

Texas Commission on Environmental Quality (TCEQ) provides interim short-term (1-hour) and long-term (annual) Effects Screening Levels (ESL) for hydrazine of 0.13 µg/m^3 and 0.013 µg/m^3, respectively [R-273]. The short- and long-term ESLs for hydrazine were based on ACGIH TLV of 0.013 mg/m^3 by applying a safety factor of 100 and 1000, respectively.

The ATSDR (1997) provides an intermediate-duration (15 to <365 days) Minimum Reference Level (MRL) of 0.004 ppm (or 5.2 µg/m^3); note that ATSDR was unable to derive acute and chronic MRLs [R-274]. The intermediate MRL is based upon a LOAEL of 0.2 ppm for hepatic effects in female mice (Haun and Kinkead 1973). Mice were exposed to 0, 0.2 or 1.0 ppm for 6 hours per day, 5 days per week for 6 months. The LOAEL was adjusted for continuous exposure and an uncertainty factor of 300 was applied to account for human variability, extrapolation from animals to humans, and the use of a LOAEL.

To ascertain whether the predicted 24-hour maximum concentration of 0.169 µg/m^3 could be associated with health effects, comparison with the conservative benchmarks of 0.2 µg/m^2 (from MADEP, which is protective of long-term exposures that may span many years) and 5.2 µg/m^3 (from ATSDR, which is protective of exposures from 15 to 365 days) suggests that health effects are unlikely, given that the predicted 24-hour concentration meets two benchmarks derived for longer durations that are supported by scientific studies.

9.0 APPENDIX I: THERMAL RISK ASSESSMENT

9.1 Definitions

Term	Definition
Chronic Lethal Maximum (CLM)	The CLM is similar to the CTM, except that the rate of temperature change is slower (1-2°C/day). The rate is slow enough that the fish constantly acclimatize to the changing temperature [R-275].
Correlation Coefficient	The Pearson product-moment correlation coefficient (also referred to as Pearson's *r*) is a measure of the linear correlation between an effect site and a reference site (under non-operational conditions), where a value of +1 or -1 is a perfect correlation and a value of 0 indicates no correlation. The general formula for the correlation coefficient is: $$r = \frac{\sum\left(x_{o,i} - \overline{x_o}\right)\left(x_{c,i} - \overline{x_c}\right)}{\sqrt{\sum\left(x_{o,i} - \overline{x_o}\right)^2 \sum\left(x_{c,i} - \overline{x_c}\right)^2}} \quad (2)$$ Where; $x_{o,i}$ measured value at time *i*, $\bar{x}_o$ mean of measured values, $x_{c,i}$ predicted value at time *i*, and $\bar{x}_c$ mean of measured values.
Critical Thermal Maximum (CTM)	This presents the upper limit of the “thermal tolerance zone”[R-276]. To determine CTM, the temperature is changed at a constant rate(i.e., 1°C/min or 1°C/hour) and behaviour is observed until locomotory movement becomes disorganized and the animal loses its ability to escape from conditions that may ultimately lead to its death (i.e. loss of equilibrium) [R-277][R-278]. Lethality occurs if the fish are maintained at CTM or temperature above CTM for extended periods of time [R-277].
Hazard Quotient (HQ)	For the purposes of thermal risk assessment, HQs are calculated by dividing the temperature aggregation by the thermal benchmark: $$HQ = \frac{Temperature\ Aggregation}{Benchmark\ Value}$$ HQs above 1.0 indicate the potential for thermal effects and the need for more detailed analysis.

Term	Definition
Local Study Area (LSA)	Area assessed for thermal effect delineated by the 95th percentile of the 1°C difference between modelled Operational and Non-Operational conditions (i.e., Bruce Power in operation and not in operation) for April 1, 2016 to March 31, 2021.
Maximum Temperature for Embryos (MTE)	The Maximum Temperature for Embryos (MTE) represents a temperature below which successful incubation and hatching are expected [R-278].
Maximum Weekly Average Temperature (MWAT)	The preferred temperature (Tpref) plus one-third of the difference between the UILT and Tpref temperatures (MWAT=Tpref+((UILT-Tpref)/3))[R-278].
Preferred Temperature (Tpref)	The temperature towards which fish are attracted to when exposed to a broad temperature gradient which is specific to the species and life stage [R-277][R-279].
Root Mean Square Error (RMSE)	A weighted indication of difference between the temperature at the reference site and the effect site if Bruce Power was not operating. This metric provides an indication of the weighted average absolute error and, thus, a measure of similarity between reference sites and effect sites over time.

$$RMSE = \sqrt{\frac{1}{M}\sum\left(x_{o,i} - x_{c,i}\right)^2} \quad (1)$$

Where; M number of observations (time steps),
$x_{o,i}$ observed value at time *i*, and
$x_{c,i}$ predicted value at time *i*.

Term	Definition
Short Term Maximum (STmax)	The maximum temperature where the fish can cope without experiencing adverse effects or mortality for a short-term exposure (24 hours) and which is greater than the seven day UILT minus 2°C [R-278][R-280].
Upper Incipient Lethal Temperature (UILT)	The temperature which is lethal to 50% of the test population when exposed for a sustained period [R-277][R-278], which can be standardized as a 7 day exposure period [R-276]. After acclimation, the fish are abruptly transferred to water in a range of lethal test temperatures and the time to mortality is recorded [R-276].

9.2 Introduction

The Site uses the cold water from Lake Huron in once-through cooling systems, in which water is drawn in at deep, offshore intakes and then pumped through a series of condensers before being returned to the lake via discharge channels. The once-through cooling system at each station supplies continuous circulation of water that cools and condenses steam from the turbines which are generating electricity. Through this process, the lake water is warmed, as the steam system is cooled, before being discharged to the lake. The maximum design flow of water into Bruce A and Bruce B is 175 m^3/s and 193 m^3/s, respectively.

Limits on the effluent temperature and difference between effluent and intake temperature are set by Ontario's Ministry of the Environment, Conservation and Parks (MECP) in Environmental Compliance Approvals (ECAs). The limits stipulated in the Bruce A and Bruce B ECAs are shown in Table 158. The higher temperature difference value (i.e., difference between effluent and intake temperature) during the winter months (13°C) is to allow for recirculation of the discharge waters to avoid frazzle ice formation in the forebay. This temperature difference value is based on condenser efficiency and is dependent on the operational status of each unit and the number of pumps running.

Table 158 ECA Limits for Bruce A and Bruce B

Station	Parameter	Calendar Period	Daily (24hr) Average Temperature Limit
Bruce A	Effluent Temperature	Jun 15 to Sept 30	34.5ºC **
		Oct 1 to Jun 14	32.2ºC
	Temperature Difference (effluent minus intake)	Dec 15 to Apr 14	13.0ºC
		Apr 15 to Dec 14	11.1ºC
Bruce B	Effluent Temperature	Entire Year	No Limit
	Temperature Difference (effluent minus intake)	Dec 15 to Apr 14	13ºC
		Apr 15 to Dec 14	11ºC

** During this Operational Flexibility window, Bruce A shall be allowed to go beyond the Daily (24 hour) average effluent temperature limit of 32.2°C for no more than 30 aggregate days in this window and no more than 15 consecutive days for each event.

The thermal risk assessment is completed to fulfill requirements of N288.6-12, Clause 7.2.5.4.5 stating that thermal stressors "should be identified as stressors of concern at nuclear power plants and carried forward to be assessed in the ERA".[R-5]

9.2.1 Thermal Effects Guidance

This section provides an overview of guidance for the assessment of thermal discharges in the CSA N288 series, regulatory acts, objectives and guidance documents [R-5][R-16][R-235][R-280][R-281] used to complete the thermal risk assessment.

The CSA N288 series provides guidance on the collection of thermal monitoring data and the thermal risk assessment process. N288.4 Clause 7.4.4 states that thermal measurements obtained from the EMP program should be made in a manner that supports the calculation of temperature metrics that are used as evaluation criteria in the ERA. [R-235] N288.6 Clause 7.4.4 states that thermal benchmarks should be used for direct thermal effects on the growth, survival and reproduction of aquatic biota. Thermal benchmarks vary by species and life stage. The Maximum Weekly Average Temperature (MWAT – see Definitions) represents the temperature at which juvenile growth is expected to be appreciably reduced. The Maximum Temperature for Embryos (MTE – see Definitions) is used to assess thermal conditions during spawning and embryonic development in the spring or fall/winter and represents a temperature below which successful incubation and hatching are expected. Seasonal advance of hatch should be considered as a potential effect. Temperatures above the Upper Incipient Lethal Temperature (UILT – see Definitions) may result in thermal incapacitation and these temperatures may exist in the discharge channel during the warmest summer months. N288.6 Clause 7.4.4.4 states "Turnpenny and Liney (2006) suggest that a maximum allowable ΔT of 3°C should be protective in most waters against potential effects of both hatch advance and thermal fronts interfering with fish movements."[R-5] N288.6 Clause 7.5.4 states that the Hazard Quotients (HQs – see Definitions) based on thermal benchmarks should be presented in the ERA. [R-5] An HQ>1 indicates that temperatures are higher than the thermal benchmark and that further risk characterization is required.

Federal guidance for the assessment of freshwater thermal discharges is provided by Environment and Climate Change Canada (ECCC) in *Guidance Document: Environmental Effects Assessment of Freshwater Thermal Discharges (2019)*. This document states that "Facilities proponents and operators should evaluate and regulate their thermal discharges on the basis of site-specific environmental impact assessment rather than using fixed, detailed numerical standards for broad areas, such as water quality standards for whole provinces. This type of assessment is likely to result in numerical limits for the facility (e.g. maximum discharge temperature), with the benefit that the numerical limit would be based on the site-specific aquatic water environment and its biological community. This is in contrast to making decisions based <u>almost exclusively on a single most thermally sensitive species or life stage</u>." National guidelines for water temperatures are provided by the Canadian Council of Ministers of the Environment (CCME).[R-280]

In Ontario, the Ontario Provincial Water Quality Objective (PWQOs)[R-16] for temperature consists of the following guidelines:

1. General: Natural thermal regime is not to be so altered as to impair and cause significant change to the diversity, distribution and abundance of plant and animal life.

2. Waste Health Discharge:

    a) Ambient Temperature Change: Temperature at edge of mixing zone not to exceed temperature at representative control location by more than 10°C, or as specified by the Ontario Ministry of the Environment (MOE). Nature of mixing zone and representative control location to be determined by the MOE.

    b) Discharge Temperature Permitted: Maximum temperature of the receiving body of water, at any point outside the mixing zone, shall not exceed 30°C or the temperature of the representative control location plus 10°C, whichever is lesser. Continuous temperature records are required with daily measurements recorded.

    c) Taking and Discharging of Cooling Water: Mixing zones are not to be used as an alternative to reasonable and practical treatment and should not interfere with other water uses or cause irreversible environmental damage, risk to ecosystem integrity or risk to human health.

Additional guidance is found in the *Fisheries Act*, Subsection 36(3) specifying that, unless authorized by federal regulation, no person shall deposit or permit the deposit of deleterious substances of any type in water frequented by fish. Deleterious substances are described as including heat. No exception is made for a mixing or dilution zone.[R-282]

The thermal risk assessment presented here is the result of analysis of Bruce Power’s thermal monitoring results completed by Bruce Power with review by Golder Associates Ltd and thermal modeling completed by Golder Associates Ltd using the validated MIKE3 Huron Hydrothermal (HHT) model of Lake Huron.[R-92] Thermal modelling is widely used as an adjunct to thermal monitoring in thermal risk assessments.[R-280][R-283]

9.3 Methods

This section presents the detailed methods used in the thermal risk assessment. These methods were developed using the guidance in the documents described in Section 9.2.1, methods used to complete the thermal risk assessment in the 2017 ERA and supplemented with novel uses of the MIKE3 HHT model.[R-231][R-284]–[R-287]

9.3.1 Thermal Monitoring

Bruce Power deployed temperature loggers throughout the water column in the spring, summer and fall (surface to bottom) and in the winter (lake bottom only) at several thermal monitoring sites near Bruce Power (Figure 59). Severe weather and ice coverage in the winter prevented deployment of loggers at surface or within the water column. Data collected from April 1, 2016 to March 31st, 2021 were used for the 2022 ERA. For the assessment of Lake and Round Whitefish embryos only, data from April 1, 2021 to May 31, 2021 was included to enable full assessment of five incubation seasons. An Acoustic Doppler Current Profiler (ADCP) deployed at 8 m depth off of Gunn Point (south of Bruce B) monitored year-round water currents (speed and direction) throughout the water column. Available data from thermal loggers deployed in support of the bass nesting program were also used, as well as thermal monitoring data collected from the Coastal Waters Monitoring Program (CWMP) conducted by SON.

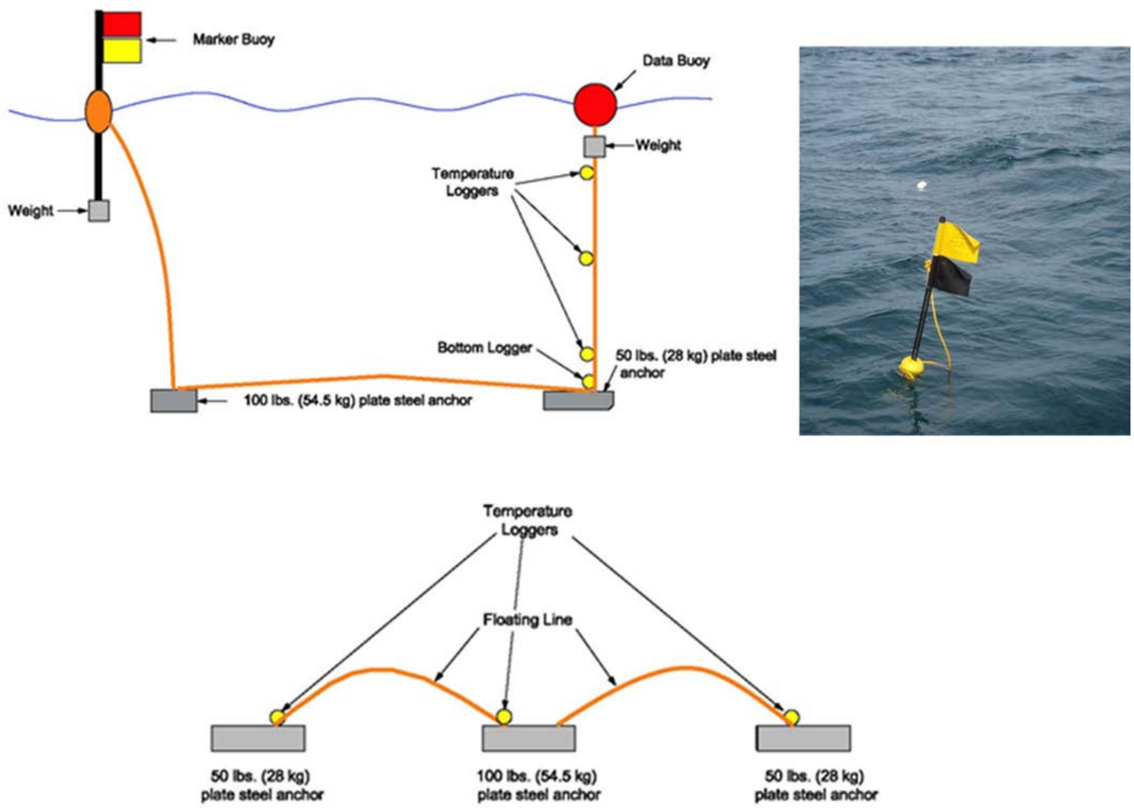

Figure 59 Drawing and photo of summer logger set up (top) and winter logger set up (bottom).

Temperature and current results were downloaded after each monitoring season and data QA/QC was performed prior to use in the thermal data analysis. Data was cleaned to remove outlier measurements at the beginning and end of each deployment when loggers were not deployed under water at their specified locations. QA/QC consisted of comparisons between duplicate loggers at the same location and depth, and data were accepted when duplicate measurements were within ±1°C for 95% of the data. The ±1°C criteria is based on a reasonable temperature difference to be expected between the duplicate loggers given the instruments have a ±0.2°C specified accuracy and there is potential for small localized temperature differences to exist within a site as loggers and substrate shift slightly under harsh environmental conditions. Where the temperature difference between loggers was >1°C but <3°C, and this difference comprised <5% of the total data for a site, the data was retained. If the data with >1°C difference between loggers comprise >5% of the measurements for a given site, the data points >1°C different were discarded. Data points with >3°C difference were discarded based on a biologically relevant temperature difference, as suggested by Turnpenny and Linney (2006)[R-5]. All data used in the risk assessment was cleaned and met the QA/QC criteria. No data was discarded because of failed QA/QC.

Water temperature and HQ data were presented using four site groups:

1. Reference Sites: All sites outside the Local Study Area (LSA), defined as the 95th percentile of the 1°C isopleth of the modelled difference between operational and non-operational conditions from April 2, 2016 to March 31, 2021, including CWMP sites.

2. Local Study Area Sites: Sites within the LSA but not within Baie du Doré, defined as the 95th percentile of the 1°C isopleth of the modelled difference between operational and non-operational conditions in April 1, 2016 to March 31, 2021, including CWMP sites in Inverhuron.

3. Baie du Doré Sites: Sites within Baie du Doré, including loggers from the bass nesting program, the thermal monitoring program and the CWMP. This included thermal monitoring program sites 14, 17, 18, 33, bass nesting logger BDD1, and CWMP program sites BDL01, BDL02, BDL03, BDL1 and BDL2. Baie du Doré sites are considered LSA sites for the purposes of the thermal risk assessment. Temperature data for Baie du Doré sites is presented separately to illustrate the warmer temperature occurring in a localized manner in this shallow (<3m depth) embayment (Figure 60).

Figure 60 Local area showing Baie du Doré, a shallow (<3m depth) embayment north of Bruce A

4. Discharge Sites: Sites within the Bruce A and Bruce B discharges will be used for water temperature data presentation only.

Additionally, an ADCP has been stationed outside the facility to collect current direction and speed. This current monitoring data has enabled Bruce Power to model the thermal plume in both the summer and winter months.

9.3.1.1 Thermal Monitoring Site Water Column Location

Where multiple depths were available for each site (i.e., during the spring, summer and fall deployments), the available depths were divided into surface and bottom sites depending on the overall depth of the site (Table 159). The upper 50% of available depths for a given site were assigned as surface sites. The lower 50% of available depths were assigned as bottom sites. Substrate sites were assigned as bottom sites regardless of depth. At shallow 3m and 5m substrate logger depth sites, this generally meant that the 1m logger depth was designated as the surface location. At sites with substrate logger depths of greater than 10m, this generally meant that logger depths of greater than 5m were designated as bottom locations and depths of 1m to 5m were designated as surface locations.

Table 159 Temperature Logger Depth Location Designation by Site

Site	Surface Depths (Metres Below Surface)	Bottom Depths (Metres Below Surface)
1	1, 5	10, 15, 19, 20
2	--	10
3	1	4,5
4	1,5	10, 14, 15, 19, 20
5	1	5, 10
6	1, 5	10, 14, 15
7	1,5	10, 14, 15
8	1,5	10, 14, 15
9	1	5
10	1	10
11	1,5	9, 10
12	1,5	10
13	1,5	10, 14, 15
14	--	3
15	--	15
16	--	10
17	2	3
18	1	3
19	1,5	9, 10
20	1,5	9, 10
21	1,5	9, 10
22	1	4,5
23	--	5
24	1,5,8	10, 15, 19, 20
25	1	5
26	1,5	9, 10
27	1,5	10, 14, 15
29	1,5	10, 15, 19, 20
30	1	5
31	1	4,5
32	--	10
33	1	--
34	--	5
35	1,5	9, 10
37	1,5	10, 15, 19, 20
38	1,5	10, 14, 15
39	1,5	9, 10
40	1	4, 5
41	1,5	9, 10
BA1, BB1, BDD1, BDL1, BDL2, FIL3, INL1, JHL01, PBL1, SBL01, SBL1, SBL2, SCL1	1	--
CPL01, CPL03, FIL1, FIS01, FIS03, HVL1, IHL01, BDL03	2	--

Site	Surface Depths (Metres Below Surface)	Bottom Depths (Metres Below Surface)
FIL2	3	
CPL02, JHL02, SBL03, SBL04	--	4
BDL01, BDL02, FSL02, IHL01, LI1	--	5
LI2	--	8
B	--	10

9.3.1.2 Thermal Monitoring Site Risk Characterization

Accurate risk characterization of the extent of thermal exceedances within the LSA requires a spatial assessment of the extent of the exceedance. This is particularly important given the higher density of sites near the thermal discharge at Bruce A, where each logger represents a smaller proportion of LSA temperatures than in other areas of the LSA. In order to deal with the variable density of logger locations within the LSA, the MIKE3 HHT model was used to assist in the characterization of the spatial extent of thermal exceedances with the LSA Remapping Tool as described in Section 9.4.3.4

9.3.1.3 Thermal Monitoring Site Selection

Generally speaking, loggers have remained in current locations since 2019 for consistency over time but there have been adjustments to locations based on safety considerations, substrate changes, retrieval rates, thermal modelling information and risk assessment outcomes. Temperature loggers in future ERAs will continue to be positioned practicably to capture the greatest temperature variation possible while still ensuring safe and sufficient retrieval potential. All available thermal monitoring data were used in this thermal risk assessment.

9.3.1.4 Data Analysis

Initial data analysis of the thermal monitoring data consisted of selecting temperature data within individual loggers and depths for the calculation of chronic and acute HQs. For example, a thermal logger set-up with loggers at depths of 10m, 5m, and 1m recording hourly temperature values would have three separate daily maximum, rolling weekly maximum and rolling weekly average temperatures per day (one for each depth), for a total of nine temperature values for each day (three for each depth). For each individual temperature logger and depth, temperature data was aggregated as follows:

1. Chronic temperature aggregation:

    a) Rolling weekly average daily temperature (i.e. average of last seven daily average hourly temperatures, including the current day)

    b) Rolling weekly maximum daily temperature (i.e. average of last seven daily maximum hourly temperatures, including the current day)

2. Acute temperature aggregation:

    a) Daily maximum hourly temperature (i.e. maximum hourly average temperature in a given day)

Trends or abnormalities were noted and investigated further by examining nearby temperature monitors and as otherwise required. Violin plots [R-288] were created to demonstrate the density, range, median, first quartile, third quartile and outliers in the data by site group to enhance visualization and facilitate understanding of the effect of the thermal effluent on water temperature.

9.3.2 VEC Selection

A selection of fish species were used for each of the cold, cool and warm water guilds based on use in the 2017 ERA, known presence in the local area, physiology and environmental preferences, discussion with regulators (CNSC/ECCC) and First Nations and Métis communities, and stakeholder interest including recreational and commercial fisheries.[R-231] These included Lake Whitefish, Round Whitefish, Deepwater Sculpin, Chinook Salmon, Rainbow Trout, Lake Trout, Emerald Shiner, Gizzard Shad, Smallmouth Bass, Walleye, White Sucker, Yellow Perch, Brown Bullhead, Channel Catfish, Common Carp, Freshwater Drum and White Bass. The biology of each of the 17 fish species was examined to determine the timing and length of each life stage.

Each calendar month was assessed individually. Potential presence in the nearshore for the 5 life stages (i.e. spawning, egg incubation, larvae, juvenile/growth, and parent/adult) of each of the 17 fish species was laid onto the calendar months. This took into consideration the typical timing of each life stage and length of each life stage according to Scott and Crossman [R-289], with a focus on Lake Huron timing, and supplemented with additional local knowledge and information. Species and life stages not anticipated to be in the nearshore environment were eliminated from further assessment.

In the summer months, when there are temperature loggers available throughout the water column, both the bottom and sub-surface temperatures were examined where appropriate for a particular species/life stage (see Table 160).

Table 160 Location of Species and Life Stages Assessed in Bruce Power Nearshore Environment

Species	Life Stage*	Location
Lake Whitefish$^{\alpha}$	Eggs/Larvae/Growth	Bottom
Round Whitefish$^{\alpha}$	Eggs/Larvae	Bottom
Deepwater Sculpin	Larvae	Surface/Bottom
Chinook Salmon	Larvae/Growth	Surface/Bottom
Rainbow Trout	Growth	Surface/Bottom
Lake Trout$^{\alpha}$	Eggs/Larvae Growth	Bottom Surface/Bottom
Emerald Shiner	Eggs/Larvae/Growth	Surface/Bottom
Gizzard Shad	Eggs Larvae/Growth	Surface/Bottom Bottom
Smallmouth Bass	Parent/Eggs/Larvae/Growth	Surface/Bottom
Walleye	Eggs/Growth Larvae	Bottom Surface
White Sucker	Larvae/Growth	Bottom
Yellow Perch	Eggs Larvae/Growth	Bottom Surface/Bottom
Brown Bullhead	Parent/Eggs/Larvae/Growth	Bottom
Channel Catfish	Parent/Eggs/Larvae/Growth	Bottom
Common Carp	Eggs/Larvae/Growth	Bottom
Freshwater Drum	Eggs/Larvae/Growth	Bottom
White Bass	Eggs Larvae/Growth	Bottom Surface/Bottom

*Life stages that occur outside the LSA are not included in the thermal risk assessment.

$^{\alpha}$ Egg stages for Lake Trout, Lake and Round Whitefish are not assessed in Baie du Doré.

Species and life stages were not constrained to specific portions of the LSA unless a biological characteristic of the life stage required narrowing the habitat utilization and there was an enhancement to the risk assessment achieved by narrowing the habitat considered. Specific portions of the LSA were utilized in the assessment of the egg stage for Lake Trout, Lake Whitefish and Round Whitefish as described below.

9.3.2.1 Egg Stage Considerations

The egg stages of cold water species with long overwinter incubation periods on the lake bottom was subject to some depth and location restrictions in the thermal risk assessment. Lake Trout eggs were assessed at depths of greater than 12m only. Lake and Round Whitefish were assessed at depths between 4m and 10m, excluding Baie du Doré.

Baie du Doré is not a suitable spawning ground for Lake and Round Whitefish because of its shallow depths, fraction of cobble/boulder substrate, frequency of ice formation, tendency of ice scour, and lack of species presence in the bay. The bathymetry of the bay was measured in the spring of 2014 and 2015, and at the time of the survey the average water level was 176.6 meters above sea level (masl). In general the bay was typically 2 meters deep, with a few deeper pockets being 3-6 meters. Average depths vary each year with changes in surface water elevation, and lower lake levels result in shallower depths. Substrates in the bay range from sand/silt to gravel, cobble, boulder and bedrock. Most of the available substrate suitable for whitefish spawning, i.e. cobble and boulder, is located on the outer edge of the bay. This area has little or no emergent vegetation which strongly suggests that it is exposed to considerable wind/wave action and ice scour. Baie du Doré is susceptible to ice formation and in turn more prone to have ice thick enough to scour the bottom. Temperature loggers located in the bay during the winter months are consistently damaged or lost each year due to ice. Ice scouring would have detrimental impacts to the survival rate of whitefish eggs and yolk sac larvae. Compared to other sites in Lake Huron, larval densities near Bruce Power are generally low and fail to show the high peak densities associated with known spawning grounds [R-285]. Recent investigations by Overdyk (2015) of Lake Whitefish larval distribution and abundance in Lake Huron near the Site collected only one single larvae in Baie du Doré, whereas the majority (98%) were collected south of Douglas Point in the region of Inverhuron and Holmes Bays [R-290]. The author noted several factors that would limit the spawning habitat for Whitefish in Baie du Doré, including lack of internal or adjacent spawning grounds/activity, lack of appropriate currents to transport free embryos or larvae into the bay, inhospitable environmental conditions for survival (e.g., temperature, dissolved oxygen), lack of appropriate zooplankton prey and excessive predation. The research noted that Inverhuron and Holmes Bays are more closely associated with low temperature and high dissolved oxygen, whereas Baie du Doré is generally higher in temperature and lower in dissolved oxygen because it is much shallower and its hydraulic connections with Lake Huron are restricted [R-290]. Previous studies have identified water temperature as an important factor in embryonic development, recruitment and feeding among larval Whitefish [R-285]. However, Overdyk (2015) did not find that water temperature was a significant environmental condition explaining the variation in the distribution of larval Lake Whitefish near the Site [R-290]. Further, thermal modelling studies completed on the Bruce A discharge demonstrate there is very little interaction with Baie du Doré that could link elevated thermal conditions to Site activities [R-291]. Instead, it is thought that thermal conditions in Baie du Doré are dominated by physical conditions that typically define shallow embayments (solar warming, shallow depths, and restricted flow/exchange between Lake Huron and Baie du Doré).

9.3.3 Thermal Modelling

A third-party contractor, Golder Associates Ltd., has completed thermal modelling of the thermal effluent from the Bruce Power site using a lake-wide model. Details of the MIKE3 Flexible Mesh (FM) Huron Hydrothermal (HHT) model, including validation work, are documented elsewhere [R-92][R-93]. Thermal models provide valuable spatial and temporal information about temperatures at various locations potentially affected by thermal effluent that cannot be adequately quantified with point source temperature loggers.[R-283]

Thermal modelling results were used to:

1. Delineate the Local Study Area (LSA) as described in Section 9.3.4;
2. Determine appropriate primary and secondary reference sites for each LSA site and depth, as described in Section 9.3.4.1;
3. Incorporate a spatial assessment into the chronic thermal risk assessment as described in Section 9.3.7.1; and,
4. Complete the spatial component of the risk characterization of thermal exceedances as described in 9.3.8.2.

Temperatures at bottom and at 1m below the surface were extracted with and without the effects of Bruce Power operations from April 1, 2016 to March 31, 2021. Thermal modelling was not completed to align with species-specific life stages, except for Block 1 Round Whitefish embryo development to fulfill a regulatory request for such modelling for this thermally sensitive immobile life stage [R-292]. Round Whitefish Block 1 for egg development is currently defined as 30 days from the date that the rolling weekly reference site average drops below and remains under 5.5°C for 7 consecutive days, based on work by Griffiths (1980) [R-293][R-294].

9.3.4 Local Study Area

In the ECCC *Guidance Document: Environmental Effects Assessment of Freshwater Thermal Discharge (2019),* local study areas were usually limited to the described extent of the thermal plume.[R-280]

Historically, the Bruce Power thermal plume under warm water conditions (i.e. lake water above 4°C, in the spring, fall and summer) was described as extending alongshore to the northeast beyond 23km from Bruce A, to the southwest beyond 15km from Bruce B and offshore up to 3km. Under cold water conditions (i.e. lake water below 4°C in the winter), the Bruce Power thermal plume is described as extending approximately 10km northeast and up to 8km offshore. Overlap of the Bruce A and Bruce B lake surface plumes is estimated to occur less than 8% of the time.[R-280]

The Lake Huron shoreline presents similar habitat along the full length of the shoreline extending from Goderich to Tobermory, available to all fish species examined in this analysis. During past ERAs, the thermal risk assessments had a focus on potentially more sensitive cold water fish species such as Lake and Round Whitefish. To further support the broad availability of habitat along the coastline, Bruce Power funded research to examine genetic and ecological groupings of Lake and Round Whitefish near Bruce Power and throughout Lake Huron for Lake Whitefish. Genetic and ecological analysis of Lake and Round Whitefish near the Bruce Power site did not identify distinct genetic populations or ecological niches [R-295]. Additional genetic and ecological analysis of the lake-wide population of Lake Whitefish identified a lack of genetic diversity or ecological niches, indicating extensive mixing of the Lake Whitefish populations in the Main Basin of Lake Huron [R-296]. Details of these research results can be found in [R-285]. A lack of Round Whitefish samples from various locations in Lake Huron because of the absence of commercial value prevented a similar lake-wide analysis for Round Whitefish.

In the absence of defined habitat- or population- based boundaries for a local study area for the purpose of thermal effects assessment, the maximum extent of the thermal plume was used to define the local study area. In order to ensure that the assessment captured the entire potential thermal output from Bruce Power, a single Local Study Area (LSA) was delineated as the 95th percentile of the 1°C isopleth of the modelled difference between operational and non-operational conditions at the lake surface and lake bottom from April 1, 2016 to March 31, 2021. This time period was selected to correspond to the years used in this 2022 thermal risk assessment. Using thermal modeling to define the LSA at the 95th percentile of the 1°C difference between operational and non-operational conditions can be repeated in future assessments as required, rendering the definition adaptive to changes in the size of the local study area with meteorological and climate change driven alterations in lake temperature and current patterns.

9.3.4.1 Reference Site Selection

The ECCC technical guidance states that it is now common in research programs to use a large number of reference sites. Studies "using a gradient approach and multiple reference sites are statistically stronger than studies that depend on a single reference site" (see pg. 3-4 of [R-297], referenced by [R-280]). Advantages of multiple reference sites include improved ability to evaluate:

- Natural variability
- Ecological relevance
- Confounding factors
- Adequacy of the chosen reference site

To support the use of multiple reference sites, two reference sites outside the LSA were selected for each site inside the LSA during each logger deployment period. Non-operational model scenario temperature outputs were examined to characterize the difference in temperature between reference sites and sites within the LSA if Bruce Power was not operating. This ensured that the baseline temperature profile of the reference sites was as similar as possible to the temperature profile of the LSA site without the addition of thermal effluent.

Each individual site and depth combination within the LSA was independently matched to a Primary and Secondary Reference site and depth outside the LSA, based only on statistical criteria to obtain the most similar temperature profiles under non-operational conditions. For example, Site 20 at 10m depth has a Primary and Secondary Reference site and depth that are selected in a completely independent process from Site 20 at 5m depth.

Specific statistical evaluation criteria (Table 161) were used to select reference sites based on similarities between non-operational temperature profiles (i.e., similarities between sites and depths if Bruce Power was not producing thermal effluent).

Table 161 Reference Site Selection Criteria

	RMSE	R^2	Maximum Error
Reference Site Evaluation Criteria	Smallest	Closest to 1.0	Closest to zero

The reference site selection criteria included:

1. Root Mean Square Error (RMSE): a weighted indication of difference between the temperature at the reference site and the effect site if Bruce Power was not operating. This metric provides an indication of the weighted average absolute error and, thus, is a measure of similarity between reference sites and effect sites over time.

$$RMSE = \sqrt{\frac{1}{M}\sum\left(x_{o,i} - x_{c,i}\right)^2} \qquad (1)$$

Where; M number of observations (time steps),

$x_{o,i}$ observed value at time *i*, and

$x_{c,i}$ predicted value at time *i*.

2. Correlation Coefficient: The Pearson product-moment correlation coefficient (also referred to as Pearson's *r*) is a measure of the linear correlation between an effect site and a reference site (under non-operational conditions), where a value of 1 is a perfect correlation and a value of 0 indicates no correlation. The general formula for the correlation coefficient is:

$$r = \frac{\sum\left(x_{o,i} - \overline{x_o}\right)\left(x_{c,i} - \overline{x_c}\right)}{\sqrt{\sum\left(x_{o,i} - \overline{x_o}\right)^2 \sum\left(x_{c,i} - \overline{x_c}\right)^2}} \qquad (2)$$

Where; $x_{o,i}$ measured value at time *i*,

$\bar{x}_o$ mean of measured values,

$x_{c,i}$ predicted value at time *i*, and

$\bar{x}_c$ mean of measured values.

3. Maximum Error (Negative and Positive): the maximum temperature difference between an effect site and a reference site over the period of examination if Bruce Power was not operating.

In order to strengthen thermal monitoring data analysis, at least two reference sites were selected:

1. Primary Reference Site: The optimal Primary Reference Site and depth was selected using the following process:

    a) All potential reference sites and depths with RMSE above 3 at the surface or bottom were discarded.

    b) Two or three candidate sites and depths were selected based on the lowest RMSE at the surface and bottom for each primary reference site.

    c) The R^2 of each candidate reference site and depth was evaluated to identify the highest value.

    d) The maximum negative and positive error of each candidate reference site and depth was evaluated to identify the lowest values.

2. Secondary Reference Site: The Secondary Reference Site and depth was selected based on the second-best available reference site from the Primary Reference Site selection process (above).

For the risk assessment, only scenarios where the Primary and Secondary Reference sites are lower than the applicable thermal benchmark will be retained for further analysis.

9.3.5 Thermal Impacts to Fish

Available thermal assessment endpoints in fish are described in Table 162 [R-280].

Table 162 Thermal Assessment Endpoints in Fish, adapted from [R-280]

Time	Endpoint	Description	Duration	Effect	Rate of Temperature Change	Statistic
Acute	UILT or LT50 (Upper Incipient Lethal Temperature)	Temperature lethal to 50% of the test population for a sustained period. The fish is placed in a range of temperatures and the time to mortality is recorded. Endpoint for acute toxicity test	Several days to one week	Lethal	Abrupt	Dose-response curve for multiple treatments

Time	Endpoint	Description	Duration	Effect	Rate of Temperature Change	Statistic
	CTM (Critical Thermal Maximum)	Temperature at which locomotory movement becomes disorganized and animal loses its ability to escape from conditions that may ultimately lead to its death. Temperature is changed at a constant rate (i.e. 1°C/min or 1°C/hour) and behaviour observed. Acute toxicity test.	Several hours to one day	Lethal	Constant	Descriptive statistics (i.e. mean)
Chronic	CLM (Chronic Lethal Maximum)	Similar to CT Max but temperature change is slower (i.e. 1-2°C/day). Allows for acclimation and measurement of sublethal effects, such as reduced feeding rates, weight loss or development changes.	Several days to multiple weeks	Non-Lethal Locomotory Change	Constant	Descriptive statistics (i.e. mean)
	MWAT (Maximum Weekly Average Temperature	The Maximum Weekly Average Temperature (MWAT) is defined at the growth optimum (GO) temperature plus one-third of the difference between the ultimate upper incipient lethal (UUIL) and GO temperatures and represents the temperature at which juvenile growth is expected to be appreciably reduced. Calculated as the average of the maximum water temperature for 7 days.				

The temperatures for these endpoints for the same species are usually UILT<CLMax<CTMax (Figure 61). The CLM test is likely a more realistic representation of temperature tolerance and less likely to be seasonally affected than CTM, although no CLMs were found for the species considered in the thermal risk assessment. Where available, the CTM was used as a first choice acute benchmark, followed by the UILT. When other acute benchmarks were not available, the short-term maximum was used and this was defined as the maximum temperature for short-term exposures (i.e., 24 hours) [R-298]. MWAT was used as the chronic thermal benchmark throughout the thermal risk assessment.

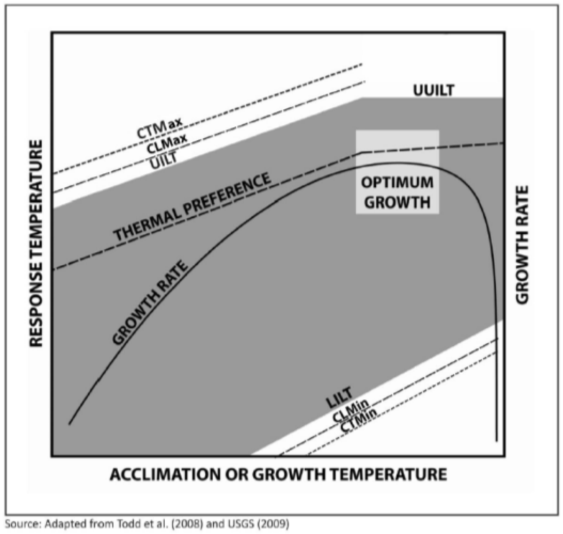

Figure 61 Temperature Relations of Fish, taken directly from [R-280]

Research has shown that acclimation is possible for individual organisms and species to both seasonal changes in temperature or to ranges of temperatures that they may encounter when the acclimation period extends for an adequate duration.[R-297]

The ECCC *Guidance Document: Environmental Effects Assessment of Freshwater Thermal Discharge (2019)* states that “Numerous laboratory or theoretical studies have suggested that thermal discharges have a potential to negatively influence the aquatic environment. Most field studies, however, have demonstrated that any negative effect on freshwater communities or water use is localized and dependent on the specific physical characteristics of the site and the groups of aquatic communities that normally inhabit it.”[R-280].

In order to fully assess the potential thermal impacts to cold water species, additional modelling efforts were used to determine thermal benchmarks missing from the literature (see Section 9.3.6.1).

9.3.6 Preliminary Screening of Temperatures within the LSA

All Hazard Quotients (HQs) calculated for the 2022 ERA are presented in plots over time by benchmark and violin plots [R-288] by site group. Where an HQ was greater than 1.0 during the Preliminary Screening stages, the species and life stage moved on to the Secondary Screening stage (Section 9.3.7).

9.3.6.1 Step 1: Thermal Benchmarks

Thermal benchmarks were updated from the 2017 ERA using available scientific research available in the literature. Scientific articles and grey literature found during these searches were reviewed for relevance and included for consideration in establishing thermal benchmarks for the 2022 ERA (Table 163).

Table 163 Thermal Benchmark Search Description

Databases Searched	Search Terms
Biosis previews (Web of Science), Pubmed and Jstor, Google, Google scholar	species name + “thermal tolerance”, “temperature tolerance”, “critical temperature”, “thermal limit”, “preferred temperature”, “thermal ecology”, “thermal stress”, “critical thermal max”, “reproductive ecology”, “seasonal habitat selection”, “juvenile distribution”, “egg incubation”, “distribution”, “habitat preference”.

The results of the literature search demonstrated that several high quality thermal benchmark reviews were completed in recent years, including reviews by Manderville et al. (2019) [R-299] Hasnain et al. (2013) [R-300], Yoder (2012) [R-301], and Teletchea et al. (2009) [R-302]. For some species, recent thermal research provided additional information regarding thermal tolerance.

In light of the availability of recent thermal benchmark reviews, the following hierarchy was used to determine thermal benchmarks for species evaluated in the 2022 ERA:

1. **Level 1** –thermal benchmark compilations using summary statistics for multiple experiments for a thermal benchmark (i.e. mean of CTM across several experiments wherever multiple experiment results were available). Thermal benchmark compilations considered included:
   - Mandeville et al. (2019) [R-299]
   - Hasnain et al. (2013) [R-300]
   - Teletchea et al. (2009) [R-302]
2. **Level 2** – where no Level 1 evidence exists, thermal benchmarks from a single study completed in a lab or field setting were used. This includes thermal benchmark reviews by Wismer and Christie (1987) [R-276] and Yoder (2012) [R-301] as thermal benchmarks from multiple studies were not aggregated in these reviews.
3. **Level 3** – where no Level 1 or Level 2 thermal benchmark literature exists, modelled thermal benchmarks from Hasnain et al. (2018) [R-303] or from additional modelling work were used. MWATs were calculated for species and life stages where both a thermal preference and an UILT were available but no published MWAT was found during the literature review. MWATs were calculated using the equation: MWAT=Tpref+((UILT-Tpref)/3), based on the method used by Manderville et al. (2019) [R-299] and described in CWQCC (2011) [R-304].

Modelling of Missing Cold Water Benchmarks

Using peer reviewed methods described in Hasnain et al. (2018) [R-303], additional thermal benchmark modelling was completed for missing preferred temperature and UILT benchmarks for select cold water species.

The Tpref, UILT, and CTMax for all Salmonid species listed in Wismer and Christie [R-276] were compiled. These included Chinook Salmon, Lake Trout, Lake Whitefish, Rainbow Trout and Round Whitefish for spawning (preferred temperature only), egg development/incubation, larvae, juvenile (growth or YOY), and adults. A correlation analysis was carried out for each metric and life stage by calculating Spearman rank correlation coefficient with pairwise complete observations. Pairs of either metric or life stage with a spearman coefficient greater than 0.5 or less than -0.5 were considered to be associated with each other.

Following the correlation analysis, linear models were constructed for each associated pair of life stages within each metric or metrics for each life stage. The metric or life stage with the greatest number of unknown values was set as the response variable and was estimated by metric or life stage with the most known values in each pair. Models were visually assessed for normality and homoscedasticity of variances. For models where points of influence were detected, robust regression methodology with MM type estimators was used to reduce the effect of these points on model fit [R-305]. Intercepts and slopes were recorded for all models.

For models where a statistically significant ($p<0.05$) relationship was detected between the response and explanatory variable, the slope and intercept were used to construct a Bayesian model to obtain estimates for unknown values. For models where statistically significant relationships were not detected, the slope and intercept were also used to construct Bayesian models. However, the prior for the variance parameter (tau) for the metric or life stage of interest were set to be two orders of magnitude wider in order to account for a lack of strong fit. For all Bayesian models, three Markov Chain Monte Carlo (MCMC) chains [R-306] were run for 10,000 iterations each with the first 5,000 iterations discarded as a burn-in period. The Gibbs sampling algorithm was used for MCMC procedures [R-307]. Convergence of all MCMC chains for each model were assessed visually and using the Gelman-Rubin diagnostic, which assesses the differences between within chain and between chain variances for each model parameter [R-307]–[R-310]. Estimates for unknown metrics across different life stages for each species were determined by averaging across every 100th sample in each MCMC chain (known as the thinning period). For each unknown metric estimates, a credible region (CR) was also provided. All thermal benchmark modelling analyses were performed by a third party consultant using R version 4.1.1 [R-311].

The modelled preferred temperature and UILT benchmarks were then used to calculate missing MWAT values using the equation: MWAT=Tpref+((UILT-Tpref)/3), based on the method used by Manderville et al. (2019) [R-299] and described in CWQCC (2011) [R-304].

Final Thermal Benchmark Compilations

The final thermal benchmarks used to complete the thermal risk assessment are listed in Table 164, Table 165 and Table 166 for cold, cool and warm water species, respectively.

Table 164 Thermal Benchmarks for Coldwater Fish Species in the 2022 ERA

Species[µ]	Life Stage	Tpref (°C)	CTM (°C)	UILT (°C)	MWAT (°C)
Chinook Salmon	Spawning[NA]	8.5[Ω]	-	-	-
	Egg/Incubation[NA]	7.5 [Ω]	29.6 (10) 30.4 (14)[2]	10 (STmax)[13] 9.9 (CR:-10.8-30.3)[µ]	8.3*
	Larvae[B/S]	9.5 [Ω]	28.4 (10) 29.4 (14)[2]	21.4 (CR:14.8-28.0)[µ]	13.5*
	Growth/YOY/Juvenile[B/S]	14.3±2.0[α]	28.6 (11.6)[3]	21.5 (5) 24.3 (10) 25 (15) 25.1 (20/24)[14]	18.7[1]
	Adult[NA]	13.8±2.5[α]	25.1[α]	23.5±1.8[α]	17.0*
Lake Trout	Spawning[NA]	8.0[¥]	-	-	-
	Egg/Incubation[B]	5.7[¥]	-	10.0 (CR:-10.7–20.8)[µ]	7.1*
	Larvae[B]	9.2-10.8[11]	27.5 (CR:24.3-30.8)[µ]	21.5 (CR: 14.1-28.0)[µ]	13.8*
	Growth/YOY/Juvenile[B/S]	10.0[α]	26.0-26.2 (8) 26.2-26.5 (11) 28.1-28.3 (15) 28.7-29.1 (19)[4]	23.5 (15/20)[14]	19.4[1]
	Adult[NA]	11.8±1.5[α]	26.6[¥]	24.3±1.1[α]	16.0*
Lake Whitefish	Spawning[NA]	3.3[α]	-	-	-
	Egg/Incubation[B]	5.0[α]	-	10 (STmax)[1] 10.0 (CR:-10.5-30.1)[µ]	7[1] 6.7*
	Larvae[B]	8.5[Ω]	27.8 (CR:24.6-31.0)[µ]	21.4 (CR:15.1-28.1)[µ]	12.8*
	Growth/YOY/Juvenile[B]	14.7[α]	24 (6)[5] 25 (12)[5] 29.3 (14)[6] 26 (18)[5]	20.6 (5) 22.7 (10) 25.8 (15) 26.6 (20/22.5)[9]	16.7 (5) 17.4 (10) 18.4 (15) 18.7 (20/22.5)*
	Adult[NA]	12.7[α]	26.8[¥]	23.9[α]	16.4*
Rainbow Trout	Spawning[NA]	7.0[α]	-	-	9[15]
	Egg/Incubation	8.9[α]	-	<15[16]	10.9*
	Larvae[B/S]	11[Ω]	28.2 (10) 27.6 (22)[7]	23.7 (5) 24.2 (9) 25.2 (13) 25.7 (17) 26.2 (21/24.5)[17]	15.2 (5) 15.4 (9) 15.7 (13) 15.9 (17) 16.1 (21/24.5)*
	Growth/YOY/Juvenile[B/S]	15.6±2.4[α]	28.4-30.9 (13)[8]	26.2[10]	19[16]
	Adult[NA]	15.5±3.5[α]	22.1±6.5[α]	25.0±2.3[α]	19.3[β]
Round Whitefish	Spawning[NA]	3.8±1.1[α]	-	-	-
	Egg/Incubation[B]	3.0[α]	-	10 (x6 hrs)[12] 10.1 (CR:-10.5-30.1)[µ]	5.4*
	Larvae[B]	5.4 (CR:3.4-7.5)[µ]	27.5 (CR:24.2-30.9)[µ]	21.5 (CR:14.8-28.0)[µ]	10.8*
	Growth/YOY/Juvenile[B]	16.7[¥]	27.0 (CR:22.8-31.2)[µ]	24.8 (CR:23.5-26.2)[µ]	19.4*
	Adult[NA]	8.3±8.0[α]	26.9[¥]	22.8[¥]	13.1*
Deepwater Sculpin	Larvae[B/S]	5.4[18]	-	-	-

Level 1 Sources: [α]Hasnain et al. (2013)[R-300] [β]Manderville et al. (2019)[R-299] [Ω]Teletchea et al. (2009)[R-302]

Level 2 Sources: [1]Wismer and Christie (1987): WC[R-276] [2]Del Rio et al. (2019)[R-312] [3]Baird et al. (2018)[R-313] [4]Kelly et al. (2014)[R-314] [5]Zak et al. (2018)[R-315] [6]Whitehouse et al. (2018)[R-316] [7]Blair and Glover (2019)[R-317] [8]Shi et al. (2018)[R-318] [9]Spotila et al. (1979)[R-319] [10]Brinkman and Crockett (2013) in ECCC (2019) [R-280] [11]Peterson et al. (1979)[R-320] in Holmes et al. (2002)[R-321] [12]Griffiths (1980)[R-294] [13]Cravens et al. (1983) in WC[R-276] [14]Brown (1974) in WC[R-276] [15]EPA (1974) in WC[R-276] [16]Spotila et al. (1974) in WC[R-276] [17]Houston (1982) in WC[R-276] [18]Mansfield et al. (1983)[R-81]

Level 3 Sources: [¥]Modelled temperatures from Hasnain et al. (2018)[R-303] [µ]Modelled temperatures with 95% Credible Interval (CR) calculated using methods based on Hasnain et al. (2018), see Section 9.3.6.1 for details.*MWAT calculated using MWAT=Tpref+((UILT-Tpref)/3). Some MWAT input values are based on modelled values.

B: Benchmark assessed at bottom sites. S: Benchmark assessed at surface sites. B/S: Benchmark assessed at surface and bottom sites.

NA: Life stage not assessed in thermal risk assessment.

Table 165 Thermal Benchmarks for Coolwater Fish Species in the 2022 ERA

Species	Life Stage	Tpref (°C)	CTM (°C)	UILT (°C)	MWAT (°C)
Emerald Shiner	Spawning[NA]	24.0[α]	-	-	23 (Jun-Aug)[19]
	Egg/Incubation[B/S]	23.9[α]	-	-	-
	Larvae[B/S]	23[2]	-	35.2[5]	27.1*
	Growth/YOY/Juvenile[B/S]	25.7±1.8[α]	35.2 (20)[3]	30.7 (25)[18]	30[19]
	Adult[NA]	19.3±8.9[α]	30.1[β]	27.4 ± 3.2[α]	28.9[β]
Gizzard Shad	Spawning[NA]	22.0[α]	-	-	22[1]
	Egg/Incubation[B/S]	22.2[α]	-	33.3[¥] (heat shock)[18]	25.9*
	Larvae[B]	16-26[4]	-	35.6[¥] (25-35)[18]	25.9*
	Growth/YOY/Juvenile[B]	17.0[α]	31.0[5]	31.7 (15.9)[9]	23.2[1]
	Adult[NA]	20.7 ± 7.6[α]	31.7[α]	35.5 ± 1.3[α]	30.7[β]
Smallmouth Bass	Spawning[B/S]	18.0[α]	-	-	17[20]
	Egg/Incubation[B]	21.0[α]	-	29 (19)[18]	23.7*
	Larvae[B/S]	20.5[Ω]	-	38[6]	26.3*
	Growth/YOY/Juvenile[B/S]	26.0[α]	36.9 (26)[6]	35 (33)[6]	33[21]
	Adult[NA]	25.0±6.0[α]	36.3[α]	36.0±1.4[α]	28.9[β]
Walleye	Spawning[NA]	7.7±1.0[α]	-	19.2 (spring)[8]	8.9[1]
	Egg/Incubation[B]	12.2±1.7[α]	-	20[23]	14.8*
	Larvae[S]	15.5[Ω]	-	19.2 (spring)[8]	16.7*
	Growth/YOY/Juvenile[B]	22.1[α]	34.8-35 (23)[11]	34.1 (28)[12]	25[1]
	Adult[NA]	22.5±2.5[α]	23.4[α]	29.7±1.1[α]	26.0[β]
White Sucker	Spawning[NA]	15.8[α]	-	<24.1 (STmax)[13]	10 (Apr-Jun)[19]
	Egg/Incubation	15[α]	-	24.1 (STmax)[13]	-
	Larvae[B]	26.9[13]	37 (23)[15]	28-32 (9-21)[14]	28[19]
	Growth/YOY/Juvenile[B]	25.5[α]	40.6 (26.3-28)[16]	26.6-27 (23)[17]	26.0*
	Adult[NA]	23.4[α]	31.6[α]	27.8[α]	27.7[β]
Yellow Perch	Spawning[NA]	9.1±2.7[α]	-	-	12[19]
	Egg/Incubation[B]	15.0[α]	-	19.9[8]	16.6*
	Larvae[B/S]	15.5[Ω]	-	28 (18)[22]	19.7*
	Growth/YOY/Juvenile[B/S]	25.4±2.4[α]	-	33-34 (28)[8]	22[19]
	Adult[NA]	17.6±6.0[α]	35.0[α]	25.6±4.7[α]	25.0[β]

Level 1 Sources: [α]Hasnain et al. (2013)[R-300] [β]Manderville et al. (2019)[R-299] [Ω]Teletchea et al. (2009)[R-302]

Level 2 Sources: [1]Wismer and Christie (1987):WC[R-276] [2]Cochran et al. (2017)[R-322] [3]McCormick and Kleiner (1976)[R-323] in Yoder (2012): Y [R-301][4]Michaletz et al. (2014)[R-324] [5]Talmage et al. (1978) in ECCC (2019):ECCC/WC[R-276][R-280] [6]EPRI (2011) in ECCC[R-280] [8]Hokanson et al. (1977) in ECCC/WC[R-276] [9]Reutter and Herdendorff (1976) in Y[R-301] [10]Koesnt and Smith (1976) in Y[R-301] [11]Perterson (1993) in Y[R-301] [12]Hokanson and Koenst (1986) in Y[R-301] [13]McCormick et al. (1977) in Y/WC[R-276][R-301] [14]McCormick (1977) in Moyano et al. (2017)[R-325] [15]Tatarko et al. (1966) in Y[R-301] [16]Horoszewica et al. (1973) in Y[R-301] [17]Black et al. 1953 in Y[R-301] [18]Brown (1974) in WC[R-276] [19]EPA (1974) in WC[R-276] [20]Wrenn (1984) in WC[R-276] [21]Wrenn (1980) in WC[R-276] [22]Hokanson and Kleiner (1974) and Hokanson (1977) in Moyano (2017)[R-325] [23]Griffiths (1981) [R-326] in WC[R-276]

Level 3 Sources: *MWAT calculated using MWAT=Tpref+((UILT-Tpref)/3). If UILT presented as a range, mid-range value was used. [¥]Average value calculated according to the methods in Hasnain et al. (2013) [R-300]

B: Benchmark assessed at bottom sites. S: Benchmark assessed at surface sites. B/S: Benchmark assessed at surface and bottom sites.
NA: Life stage not assessed in thermal risk assessment.

Table 166 Thermal Benchmarks for Warmwater Fish Species in the 2022 ERA

Species	Life Stage	Tpref (°C)	CTM (°C)	UILT (°C)	MWAT (°C)
Brown Bullhead	Spawning[B]	21.1±1.3[α]	-	-	21.1[1]
	Egg/Incubation[B]	22.8[α]	-	25 (STmax)[1]	-
	Larvae[B]	24.5[Ω]	-	38.2 (25)[7]	29.1*
	Growth/YOY/Juvenile[B]	30.0±1.9[α]	-	32 (20) 34 (26) 36 (31.2) 37 (36)[2]	30.7 (20) 31.3 (26) 32.0 (31.2) 32.3 (36)*
	Adult[NA]	26.2±2.6[α]	37.9±0.1[α]	33.4±3.3[α]	32[1]
Channel Catfish	Spawning[B]	25.0±2.2[α]	-	-	-
	Egg/Incubation[B]	22.9±1.0[α]	-	29 (STmax)[1]	27[1]
	Larvae[B]	25.5[Ω]	-	-	-
	Growth/YOY/Juvenile[B]	29.5±0.7[α]	39.0 (30±1)[3]	35.8 (20) 37.6 (24) 39.2 (28) 41.2 (32)[4]	32[1]
	Adult[NA]	27.3±5.8[α]	36.7±2.7[α]	32.9±1.7[α]	32.4[β]
Common Carp	Spawning[NA]	24.0[α]	-	-	21[8]
	Egg/Incubation[B]	21.0[α]	40.6[9]	31-35 (25)[9]	25*
	Larvae[B]	22.5[Ω]	-	36.4 (16-21) 38.8 (19-27)[10]	27.1 (16-27) 27.9 (19-27)*
	Growth/YOY/Juvenile[B]	27.3[α]	-	39.7 (25) 40.6 (30) 42.9 (35)[5]	34[1]
	Adult[NA]	27.7[α]	39.0[α]	34.5[α]	29.8[β]
Freshwater Drum	Spawning[NA]	21.0[α]	-	-	21[8]
	Egg/Incubation[B]	23.9[α]	-	26 (STmax)[8]	-
	Larvae[B]	-	-	-	-
	Growth/YOY/ Juvenile[B]	22.0[α]	-	32.8 (su)[7]	25.6[1]
	Adult[NA]	24.6±6.2[α]	34.0[α]	32.8[α]	30.2[β]
White Bass	Spawning[NA]	15.5[α]	-	24 (STmax)[8]	19[8]
	Egg/Incubation[B/S]	17.5[α]	-	26 (STmax)[12]	-
	Larvae[B/S]	20.5[Ω]	-	31.7-30.6 (14-26)[12]	24.1*
	Growth/YOY/Juvenile[B/S]	28.3[¥]	35.3 (21.7)[11]	33.5 (su)[6]	26.7[1]
	Adult[NA]	27.3±6.5[α]	35.3[α]	33.5[α]	29.4*

Level 1 Sources: [α]Hasnain et al. (2013)[R-300] [β]Manderville et al. (2019)[R-299] [Ω]Teletchea et al. (2009)[R-302]
Level 2 Sources: [1]Wismer and Christie (1987): WC[R-276] [2]Brett et al. (1944) in Yoder (2012): Y[R-301] [3]Stewart and Allen (2014)[R-327] [4]Cheethan et al. (1976) in Y[R-301] [5]Chatterjee et al. (2004)[R-328] [6]Cvancara et al. (1977) in ECCC (2019)[R-280] [7]Jinks et al. (1981) in WC[R-276] [8]EPA (1974) in WC[R-276] [9]Brown (1974) in WC[R-276] [10]Talmage (1978) in WC[R-276] [11]Reutter & Herdendorf (1976) in WC[R-276] [12]McCormick (1978) in WC[R-276]
Level 3 Sources: [¥]Modelled temperatures from Hasnain et al. (2018)[R-303] [Ω] Estimated temperatures from Teletchea et al. (2009)[R-302]
*MWAT calculated using MWAT=Tpref+((UILT-Tpref)/3).If UILT presented as a range, the mid-range value was used.
B: Benchmark assessed at bottom sites. S: Benchmark assessed at surface sites. B/S: Benchmark assessed at surface and bottom sites.
NA: Life stage not assessed in thermal risk assessment.

Presence of each species and life stage by season and calendar month was determined. Species and life stages that were only present on the Bruce Power site in Stream C were excluded from further thermal risk assessment. Stream C is not impacted by thermal effluent and therefore these species and life stages do not require further thermal risk assessment. Species and life stages present in Stream C were included in the risk assessment for exposure to conventional and radiological contaminants. Species and life stages that were expected to occur only in offshore environments not impacted by thermal effluent were also excluded from the thermal risk assessment.

Where multiple depths were available at a single thermal monitoring site, depths were assigned to surface and bottom locations according to Table 159 (Section 9.3.1). The maximum calculated HQ within available surface locations and within available bottom locations was included in the risk characterization. Fish species and life stages were assigned to surface or bottom sites or both according to Table 160 (Section 9.3.2).

9.3.6.2 Step 2: Chronic Hazard Quotient Calculation

Hazard Quotients (HQs) were calculated, where benchmarks were available, for each species and life stage for each month using the 7-day rolling daily average (or maximum, for cold water guild species) temperature at available surface and/or bottom thermal monitoring sites according to the species distribution in Table 160.

Two chronic assessment metrics were used:

1. Chronic embryonic assessment (embryonic life stage only): HQ of 7-day rolling average temperature divided by the embryo MWAT. (N288.6-12, Clause 7.4.4.3 [R-5])

2. Chronic growth assessment (larval/growth life stage only): HQ of 7-day rolling daily average temperature divided by the MWAT for cool and warm water thermal guilds. HQ of 7-day rolling daily maximum temperature divided by the MWAT for cold water thermal guilds. (N288.6-12, Clause 7.4.4.2 [R-5]).

Warm and Cool Water Guilds

$$HQ = \frac{Weekly\ Rolling\ Daily\ Average\ Tem}{MWAT}$$

Cold Water Guild

$$HQ = \frac{Weekly\ Rolling\ Daily\ Maximum\ Tem}{MWAT}$$

9.3.6.3 Step 3: Acute Hazard Quotient Calculation

Acute HQs were calculated for each species at the embryonic stage for each month using the daily maximum hourly temperature at each available thermal monitoring site available at surface and/or bottom according to the species distribution in Table 160. In the 2017 ERA [R-231], the acute assessment consisted of the calculation of the HQ of daily maximum hourly temperature divided by the CTM or STmax. This approach was also used for the 2022 ERA, where the CTM was used as the preferred acute thermal benchmark. If not available, the UILT or STmax was used as the acute thermal benchmark as available. Although the CLM test is likely a more realistic representation of temperature tolerance and less likely to be seasonally affected than CTM, very few CLM thermal benchmarks exist and these were not considered in the 2022 ERA thermal assessment. As additional CLM benchmarks become available, they will be considered for future ERAs.

$$HQ = \frac{Daily\ Maximum\ Temperature}{Acute\ Benchmark}$$

9.3.6.4 Step 4: HQ Calculation Window and Hatch Advance for Embryos

Thermally sensitive Lake and Round Whitefish embryos have a long immobile incubation period on the substrate and have been identified as potentially at risk of effects from thermal effluent. A detailed assessment of Lake and Round Whitefish was completed that examines several temperature benchmarks and hatch advance in Lake Whitefish embryos.

Lake and Round Whitefish

Due to the highly temperature dependent and variable timing of spawning each year, Lake and Round Whitefish embryos have specific HQ calculation and assessment criteria. The thermal risk assessment started each year on the day the rolling 7-day weekly average temperature was below 8°C for Lake Whitefish embryos and below 5.5°C for Round Whitefish embryos at 5m and 10m depth reference sites and remained below 8°C or 5.5°C for 7 days.[R-292]

The assessment continued until the calculated last day of 50% hatch for Lake Whitefish using the following equation [R-292]:

$$D = e^{5.353 - 0.108T - 0.00432T^2}$$

Where D was number of days to 50% hatch and T was the daily average temperature.

The model for Lake Whitefish hatch timing was used for Round Whitefish as there is no available model for Round Whitefish hatch timing. Round Whitefish embryo incubation time starts later at cooler temperatures and is shorter than for Lake Whitefish and this model ensured that the entirety of the Round Whitefish incubation period was assessed. Hatch is triggered by warming water in the spring for both species.

Hatch advance for Lake Whitefish was considered as the difference between the estimated number of days to 50% hatch between the Primary reference site and other thermal monitoring sites (N288.6-12, Clause 7.4.4.4 [R-5]). Changes in Round Whitefish embryo incubation time were captured in this hatch advance assessment as the time period covered by Lake Whitefish incubation encompasses the Round Whitefish embryo incubation period. Round and Lake Whitefish exhibit similar temperature-dependent incubation periods.[R-329][R-330]

Hatch advance was assessed against a 30-day hatch advance compared to the reference location. Experimental data for Lake and Round Whitefish hatch advance supports the 30-day hatch advance criteria proposed by Griffiths (Table 167).[R-294][R-331] The mean within-experiment increase in 30-day mortality of larval Lake and Round Whitefish relative to the baseline 2°C comparison groups for experiments with hatch advances of ≥30 days

(30-80 days) is 24.5% versus those with hatch advances of <30 days (3-26 days) of 3.3%. For Lake Whitefish only, the mean within-experiment increase in 30-day larval mortality relative to the baseline 2°C comparison groups for experiments with hatch advances of >30 days is 8.8% versus a single experiment with a hatch advance of <30 days of 3.5%. For Round Whitefish only, the mean within-experiment increase in 30-day mortality relative to the baseline 2°C comparison groups for experiments with hatch advances of >30 days is 32.3% versus those with hatch advances of <30 days of 3.2%. The higher mortality in the >30 day hatch advance group for Round Whitefish was likely related to their reduced tolerance for high incubation temperature (i.e., constant 8°C) compared to Lake Whitefish [[R-329] and personal communication, M. Fuzzen to K. Gaudreau 20AUG2020].

Table 167 Mean within-experiment relative 30-day mortality of larval Lake and Round Whitefish compared to constant or seasonal 2°C embryonic incubation groups by 50% hatch advance group under laboratory conditions

Species	Hatch advance			
	0-29 days		30+ days	
	Mean relative larval mortality	Range of relative larval mortality	Mean relative larval mortality	Range of relative larval mortality
Lake Whitefish	3.5%	Not Applicable	8.8%	1.8% to 12.7%
Round Whitefish	3.2%	-31.9% to 16.2%	32.3%	-24.3% to 74.1%

Other Species

Relevant biological knowledge regarding optimal spawning temperature and embryo development times may be applied to other species if significant hatch advance effects are anticipated in future ERAs, as applicable and as additional information becomes available.

9.3.6.5 Step 5: Thermal Effects Assessment for Lake and Round Whitefish Embryos

Lake and Round Whitefish embryos were assessed using the same methodology as used in the 2017 ERA, with the exceptions of the new definition for the LSA [R-293]. New modelled thermal benchmarks were also used to complete a thermal risk assessment using the standard methodology used for other species and life stages within this risk assessment. Results of the approach used in the 2017 ERA and from the modelled benchmarks are both presented in the 2022 ERA.

Round Whitefish Block 1 embryo thermal exceedances were evaluated over the duration of Block 1. Block 1 is defined as 30 days after the first day a temperature logger at a 5m or 10m depth reference site drops below a rolling weekly average of 5.5°C and remains below 5.5°C for at least 7 days. [R-292]

In the absence of acute or chronic thermal benchmarks for Round Whitefish embryos, the following criteria were used during Block 1:

1. Chronic assessment: average temperature for the duration of Block 1 was less than 6°C.
2. Sub-acute assessment: rolling weekly average temperature during Block 1 was less than 8.5°C.
3. Acute assessment: temperatures above 10°C have a duration of less than 6 hours.
4. Spatial assessment: extent of the LSA area that is affected by a 3°C difference between modelled operational and non-operational temperatures was less than 10% at the 25th, 50th and 75th percentiles for the duration of Block 1.

Additionally, the following criteria was applied for the entire Lake and Round Whitefish incubation period from the start of Lake Whitefish incubation and Round Whitefish Block 1 to the last date of calculated 50% hatch for Lake Whitefish embryos (in the absence of a hatch timing model for Round Whitefish embryos):

1. Chronic assessment criteria: 7-day rolling daily average temperature <3°C different from Primary Reference Site conditions. Lake and Round Whitefish chronic thermal exceedances were defined as exceedances of the 3°C difference between thermal monitoring sites and Primary Reference Site.

Exceedances of the above criteria were considered equivalent to an HQ above 1.

9.3.7 Secondary Screening of Temperatures within the LSA

When HQs were calculated to be above 1.0 during the Preliminary Screening stage (Section 9.3.6), these were further screened for spatial extent, reference site exceedances and duration of the exceedance. Following this examination, HQ exceedances that were considered significant were retained for the consideration (see Section 9.3.7.5).

9.3.7.1 Step 1: Thermal Modelling Maps Used to Determine Significant Chronic Exceedances

Chronic HQs for the growth and embryonic stages were only considered significant where chronic thermal benchmark exceedances affected 10% or more of the local study area in a given month and year. Thermal modelling maps were used to determine significant chronic thermal exceedances during the embryonic and growth stages using the following steps:

1. The 75th percentile of thermal HHT model temperatures for the entire ERA assessment period was calculated for each calendar month indicating absolute substrate and sub-surface (1m below surface) temperatures to the nearest degree Celsius. Using the 75th percentile ensures a conservative approach to incorporating the spatial extent of chronic thermal exceedances into the thermal risk assessment.
2. The percent of the local study area associated with each degree Celsius contour was calculated.

3. The percent of the LSA within each degree Celsius contour was compared to the chronic thermal benchmark for each calendar month where a species and life stage is present. Where the percent of the LSA that encompassed temperatures above the chronic thermal benchmark was >10% of the LSA, the HQ exceedance was retained as a significant chronic HQ exceedance. Where the percent of the LSA that encompassed temperatures above the chronic thermal benchmark was ≤10% of the LSA, the HQ exceedance was excluded as a non-significant thermal exceedance.

This step does not apply to acute temperature benchmarks. Round and Lake Whitefish egg temperature criteria that were not MWAT and acute UILT thresholds were considered in a separate assessment (see Section 9.3.6.5).

9.3.7.2 Step 2: HQ Results Compared to Primary and Secondary Reference Site Results

Primary and Secondary Reference Site HQ results were compared to HQ results within the LSA. HQ exceedances at LSA sites with corresponding HQ exceedances at the Primary or Secondary references sites were discarded from further evaluation as these indicated that the HQ exceedances were driven by high ambient lake temperatures rather than by thermal effluent.

9.3.7.3 Step 3: Determine the Frequency of the HQ Exceedance

The number of days in the month where an HQ exceedance occurred was determined. All HQ exceedances with a frequency ≤10% of the duration of the calendar month were discarded from further evaluation. Intermittent HQ exceedances that occurred on 10% or fewer of the calendar days in a month (i.e. up to any 3 days per month) were not carried forward as significant HQ exceedances. Intermittent thermal benchmark exceedances, especially of chronic benchmarks, are unlikely to have an effect on the overall survival of the species and life stage within the LSA. The focus of the thermal risk assessment is on identifying ongoing, long term increases in rolling weekly average temperature that limit the success of species and life stages within the LSA.

9.3.7.4 Step 4: Consideration of Cold Shock

The potential for cold shock was previously considered and assessed during the last four unit outage. Fish left the discharge channel at Bruce B with no ill effects noted. The primary species at risk for cold shock effects near Bruce Power is the Gizzard Shad.

Gizzard Shad (*Dorosoma cepedianum*) is a fragile species that is highly sensitive to temperature changes (a.k.a. cold shock) and Viral Hemorrhagic Septicemia. High winter mortality of Gizzard Shad often occurs because natural stressors often result in large-lake-wide die-offs that reduce populations by >75% [R-332]. Studies have shown that periods of high Gizzard Shad impingement often correspond to episodes of high winter mortality [R-333].

To date, thermal effluent from Bruce Power operations is not interrelated with Gizzard Shad impingement. Instead, it is a lake-wide phenomenon, and there are several reports up and down the coast of Lake Huron (USA and Canada) of Gizzard Shad washing up on the shorelines.

Dr. Charles C. Coutant (Oak Ridge National Laboratory), an international expert in freshwater ecology and the effects of power plants on aquatic life published the following summary (verbatim) on natural die-offs in aquatic environments [R-334]:

> "It is also quite normal for certain populations of organisms to undergo occasional and sometimes massive die offs, often as a result of natural phenomena. Because cooling water intakes draw these moribund or dead individuals into the intake, the power station is often unjustifiably pinpointed as the cause. For example, Gizzard Shad in the North latitudes of the US and Threadfin Shad in more Southern latitudes are highly sensitive to cold (reference therein). Sudden autumn weather fronts or progressive winter cooling in a cold year will cause these fish to become lethargic and they often die in great numbers. They commonly appear on power station intake screens at these times. The fish, however, have a high capacity for recovery of populations because of high natural reproductive rate (reference therein). Episodes of high impingement 'mortalities' under these circumstances are thus quite normal for both the population and the ecosystem. The greatest problem may not be ecological but for power station operators in dealing with the massive influx of fish bodies that can damage screens."

A relatively large number of Gizzard Shad are impinged annually at the Bruce Power site, averaging 29% of all impinged fish from 2013 to 2021. The majority of episodes of high Gizzard Shad impingement (i.e. fish run of greater than 30 individual fish) occurred between November and May in all years (Figure 62) when lake temperatures were very cold and natural lake turnover at this time of year resulted in a temperature 'shock' for Gizzard Shad. Vacuums Building and Station Containment Outages that involve removing all four units at either Bruce A or Bruce B were not associated with an increase in Gizzard Shad impingement (grey areas on Figure 62).

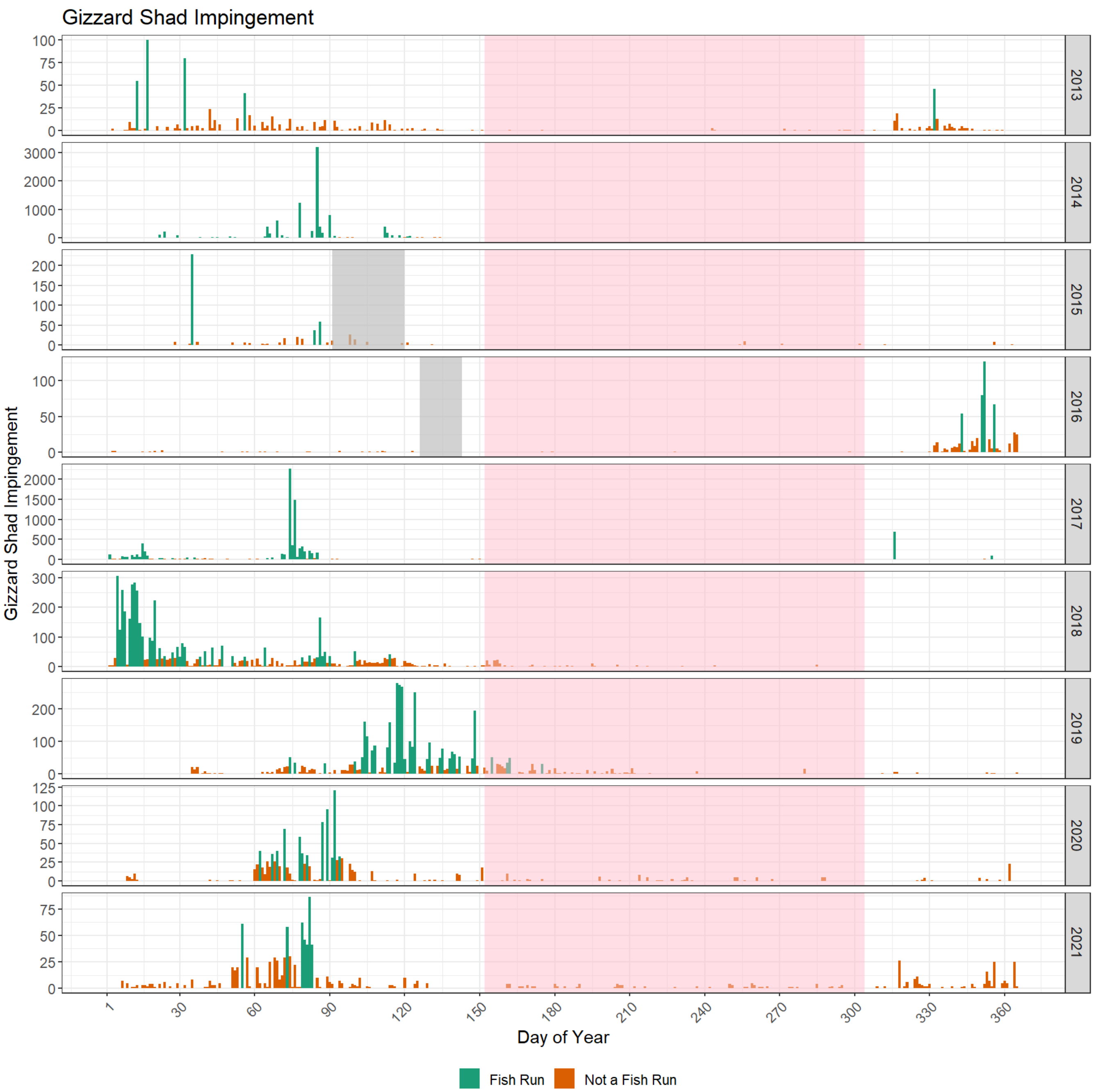

Figure 62 Gizzard Shad Impingement, 2013-2021. Fish runs (n>30) shown in green and non-fish runs (n<30) shown in orange. The majority of the Gizzard Shad fish runs occur after November 1st and before May 31st of each year (white background). Few Gizzard Shad runs occur between June 1st and October 31st (pink background). Grey shaded area in April 2015 and May 2016 indicates last VBO and SCO at Bruce A and B where all 4 units were offline.

Figure 63 examines the relationship between daily average temperatures for January to June within the LSA and from the Bruce A and B discharges. There are no consistent patterns between drops in daily average temperatures within the LSA or from the Bruce A or B discharge channels and episodes of high Gizzard Shad impingement (i.e., fish runs). Anytime there are reports of fish die-offs in the nearby area or when there are high numbers of Gizzard Shad impinged, Bruce Power performs an immediate investigation to identify if there are any abnormal operations that could be the cause. This includes: a review of intake and outfall temperatures and if there have been any changes to unit operations that may affect outfall temperatures; a walk down of discharge channels to observe fish presence, specifically the presence of Gizzard Shad; a walk down of local shorelines in neighbouring areas to observe fish; a review of station effluents to determine if there were any abnormal discharges; increased frequency of observations of pump house fish baskets; and weather observations. Bruce Power operations do not result in abrupt temperature changes to thermal effluent, rather there would be gradual changes in temperature. Higher numbers of Gizzard Shad are observed during the colder winter months, times when power is in demand, and thus power production is generally consistent at this time as are the thermal outputs. As a result, acute minimum thermal benchmarks from ECCC *Guidance Document: Environmental Effects Assessment of Freshwater Thermal Discharge* [R-280] were not considered in this assessment.

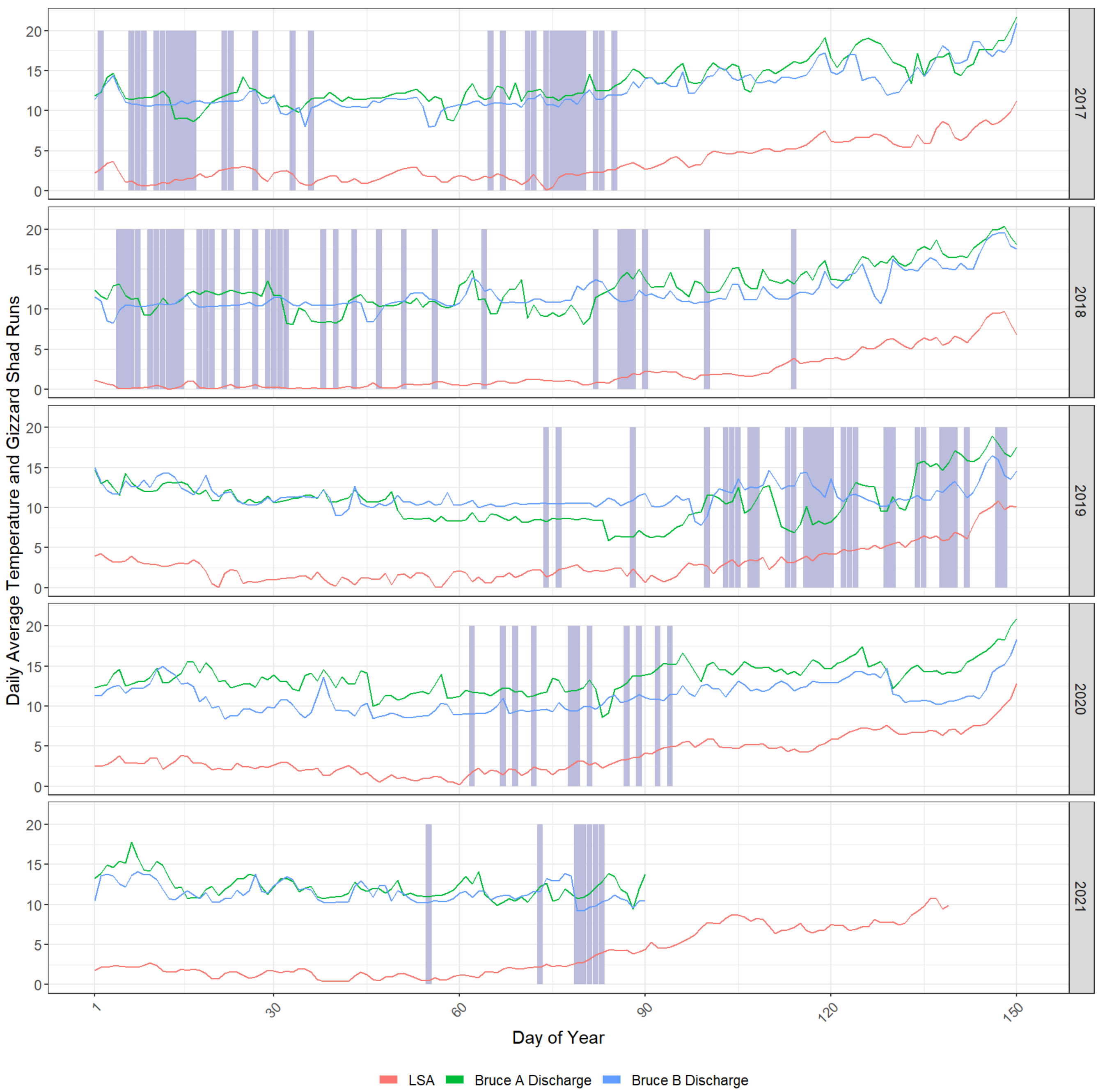

Figure 63 Average temperatures within the LSA (bottom pink line) excluding Baie du Doré and in the Bruce A (green) and Bruce B (blue) discharge channels compared to episodes of Gizzard Shad fish runs of over 30 fish (purple bars) from January 1st to June 1st for 2017 to 2021.

9.3.7.5 Step 5: Thermal Risk Assessment Criteria

HQs above 1.0 indicate the potential for thermal effects and the need for more detailed analysis. HQs below or equal to 1.0 were considered as no unreasonable risk to the species and life stage and were not discussed further.

HQs greater than1.0 assessed as non-significant during the secondary screening were excluded from the Thermal Risk Assessment (TRA) based on the following criteria:

2. Short Duration: HQ>1.0 lasted for 10% or less of the calendar month. This criterion is used to ensure that thermal exceedances are of sufficient duration to have a substantial effect on fish, based on the justification for low risk discussed in Section 9.3.8.5, prior to being further assessed.

3. Reference Site HQ: Exceedance (HQ>1.0) at Primary or Secondary reference site on the same calendar date. This criterion is used to ensure that thermal exceedances are not the result of warm ambient temperatures in Lake Huron prior to being further assessed.

4. Small spatial extent (chronic benchmarks only): MIKE3 HHT 75th percentile operational temperature modelling by calendar month indicated that the spatial extent of temperatures generating the HQ>1.0 was less than or equal to 10% of the LSA. This criterion is used to ensure that thermal exceedances encompass a sufficient spatial extent within the LSA to meet the threshold for low risk prior to being further assessed.

All other significant HQs above 1.0 were retained for TRA assessment. The few species and life stages without thermal benchmarks were assessed using overlapping life stages of the same species if available (Table 168). Deepwater Sculpin larvae acute benchmarks were not assessed due to a lack of any thermal research on the species and life stage.

Table 168 Assessment of Species and Life Stages without Benchmarks in the 2022 ERA

Species	Life Stage	Missing Benchmark Type	Proxy Assessment
Deepwater Sculpin	Larvae	Acute and Chronic	No thermal research available on this species for the larval life stage. Acute benchmark not assessed. Chronic benchmarks assessed using maximum water temperatures of larval capture.
Emerald Shiner	Egg	Acute and Chronic	Assessed using acute and chronic larval benchmarks due to egg incubation period of less than 7 days and overlapping calendar months of assessment with larval stage.
Brown Bullhead	Egg	Chronic	Assessed using the parent benchmarks due to the parental care provided, the lengthy spawning season and the short incubation of less than 7 days.
White Bass	Egg	Chronic	Assessed using the spawning benchmarks due to the short incubation of 2 days.
Channel Catfish	Larvae	Acute and Chronic	The larval stage for Channel Catfish was not assessed given that the preferred larval

			temperature of 25.5°C lies between the preferred egg incubation temperature of 22.9°C and the preferred adult temperature of 27.3°C and that both the egg and parent stages are assessed for acute and chronic benchmarks

Exceedance of the Lake or Round Whitefish temperature, hatch advance or spatial extent criteria were considered equivalent to a HQ above 1.0 and were retained for the TRA.

Secondary screening results are presented in the form of a table for each species assessed. These tables indicate the number of significant HQ exceedances for LSA and Baie du Doré sites. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. For each HQ exceedance value presented, the total number of HQs calculated in the LSA, Baie du Doré and Reference areas are presented for context as to the proportion of all the calculated HQs presented that exceed one. All significant HQs within the LSA and Baie du Doré are advanced to the TRA.

9.3.8 Thermal Risk Assessment (TRA)

9.3.8.1 Inclusion in the Thermal Risk Assessment

Significant HQs above 1.0 within the LSA and Baie du Doré were retained for the TRA. The TRA consisted of the identification and characterization of significant thermal benchmark exceedances. The species for which the HQ exceedances applied were listed and the frequency, duration and extent of the thermal benchmark exceedance were described. Species and life stages without existing thermal benchmarks were discussed qualitatively using thermal benchmarks from related species as appropriate. Sites within the LSA and Baie du Doré are assessed together in the TRA, unless otherwise specified.

9.3.8.2 Characterization of Significant Thermal Exceedances

Using existing thermal research literature, the potential impact of the significant HQ exceedances was described in terms of:

1. Size: percent of the LSA and Baie du Doré affected.

2. Extent: frequency of the exceedances over the thermal risk assessment period based on number of years where significant thermal exceedances occurred.

3. Biological relevance: species life stage mobility, research regarding tolerance of short-term thermal exceedances, acclimation temperature used in determining the benchmark.

4. Ecological relevance: population size, availability of nearby equivalent habitat, knowledge of local populations, SAR status.

LSA Risk Characterization

For each day of the thermal risk assessment, HQs were calculated for each grid node within the LSA and Baie du Doré using the same methodology as used for measured data. The percent of the nodes with HQs above 1.0 was calculated based on the number of nodes assessed, providing an estimate of the extent of the LSA and Baie du Doré involved in the thermal exceedance. Section XX (4.3.4) provides details on the development of grid nodes based on modelled temperatures corrected for measured temperatures using the LSA Remapping Tool. The median and interquartile ranges are presented on a monthly basis to enable an understanding of the extent of the thermal benchmark exceedances for a given species and life stage.

9.3.8.3 Climate Change

A third-party contractor, Golder Associates Ltd., prepared an assessment of future climate conditions at the Bruce Power site [R-90] and these results are summarized in Section 9.5.4.

Available results include baseline, average, extreme warm and extreme cold climatic scenarios at all locations, Baie du Doré surface and the Bruce A and Bruce B intakes:

- Modelled changes in temperature between current operational conditions and future operational conditions
- Modelled changes in temperature between current non-operational and future non-operational conditions

This information can be used to determine the potential impact of climate change on the ERA. Any overlay of climate change on current operational conditions needs to consider the following:

- Trends in water temperature changes associated with climate change will be gradual over time. Sudden changes in water temperature trends are not predicted.
- Acclimation temperature is an important component of thermal benchmarks.[R-280] The acclimation temperature of all species in Lake Huron will gradually increase as the overall lake temperature increases. This will likely result in changes to the thermal benchmarks used to assess risk related to thermal effluent.
- The ERA is reviewed and re-assessed at a minimum frequency of 5 years. Lake temperature changes related to climate change will be captured with repeat assessments of temperature over time. Thermal monitoring data and corresponding thermal modelling results will directly capture meteorological and hydrological changes related to climate change.

9.3.8.4 Statistical Analysis

Statistical data analysis of thermal monitoring data, including the calculation of HQs and HQ equivalents (i.e., delta T thresholds, hatch advance and Block 1 Round Whitefish benchmark comparisons) was completed using R version 3.6.0 [R-335].

Violin plots have been used to represent data throughout the thermal risk assessment. Violin plots are a combination of a box plot and a kernel density plot that improve data visualization, particularly with large datasets (Figure 64).[R-336][R-337] The boxplot indicates the median, 1st quartile, 3rd quartile and adjacent range. Kernel density plots provide a visual of the distribution of values. Kernel density plots are created based on the probability of data being of a given value, with short wide plots indicating that most of data is clustered around a small range of values and tall thin plots indicating that the data is spread over a large range of values. Kernel density plots can be visualized as being an approximation of a balanced histogram on either side of the boxplot. Kernel density plots with multiple wider areas indicate that there are two clusters of data where there is a greater frequency of values. Violin plots are ideally suited to non-normal data as they do not make any assumptions about the distribution of the data.

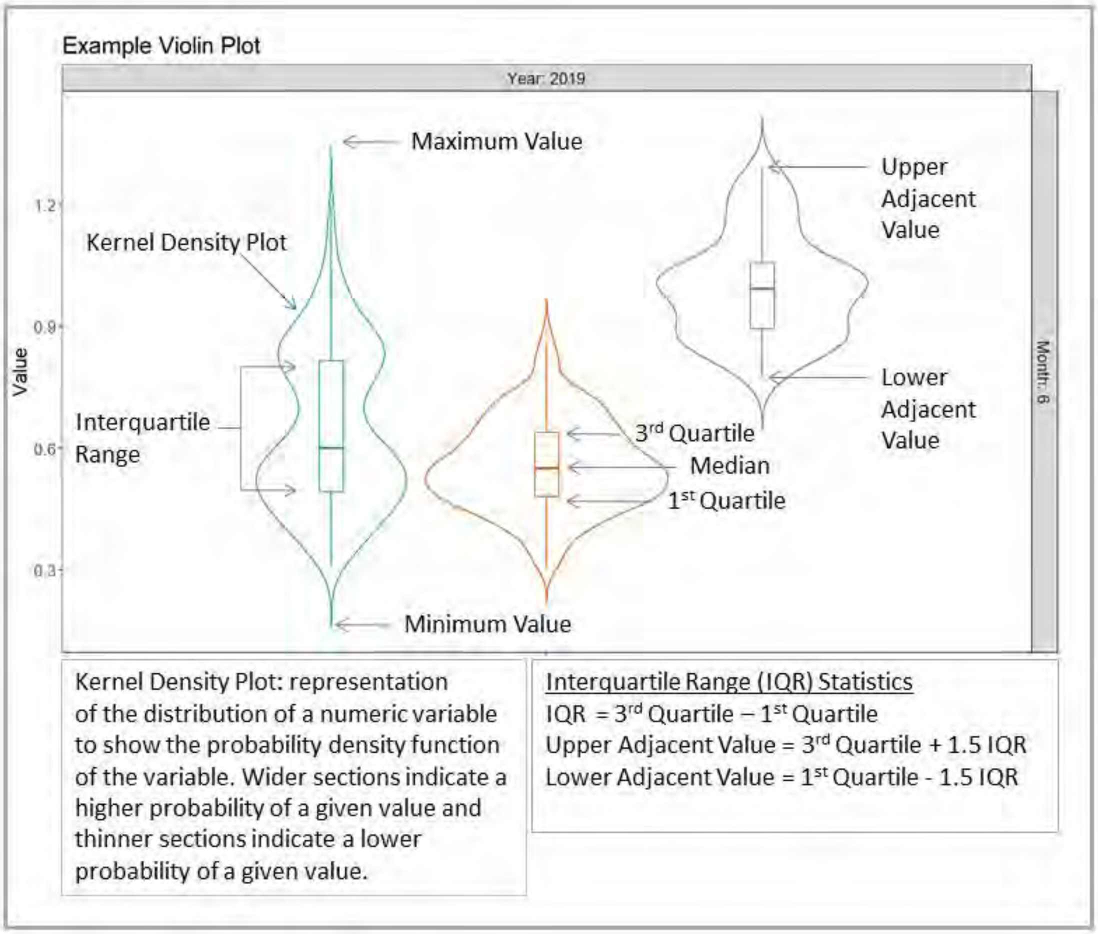

Figure 64 Violin Plot Components [R-336][R-337]

9.3.8.5 Overall Thermal Risk Characterization

The ECCC *Guidance Document: Environmental Effects Assessment of Freshwater Thermal Discharge (2019)* states that the assessment of potential effects of a thermal plume on fish, other biological resources and water use is based on the:

- Facility design/operational information
- Data on the thermal and limnological/hydrological regime of the intake and receiving water areas
- Thermal plume modelling results

- Site-specific information on benthic macroinvertebrate communities (shoreline discharge only)
- Site-specific information on fisheries resources and fish habitat
- Available information on other biological resources and nearby water uses
- Thermal tolerance and resistance of specific endemic species, particularly VECs. [R-297]

Literature reviews have characterized critical effect sizes as approximately 25%, or two standard deviations, for many biological or ecological monitoring endpoints. [R-338] This 25% value has been described as reasonable for use in a wide variety of monitoring programs and with a wide variety of endpoints and has been supported for use by ECCC in the metal mining and pulp and paper mill industry and in ECCC's guidance on the assessment of thermal discharges.[R-280][R-297][R-338]

In a reviewed environmental assessment, Husky Oil offers a more specific definition of predicted effect level in a marine aquatic environment "In evaluating the predicted residual environmental effects of the project, an effect is rated as significant, not significant or positive. For fish and fish habitat, marine birds, and marine mammals and sea turtles, a significant effect is defined as one having a high or medium magnitude for a duration of greater than one year, over an area greater than 100 km². Magnitude was defined as follows (effects can be outright mortality, sublethal or exclusion due to disturbance):

- **Low:** Affects 0 to 10 percent of individuals in the area determined to be affected.
- **Medium:** Affects 10 to 25 percent of individuals in the area determined to be affected.
- **High:** Affects greater than 25 percent of individuals in the area determined to be affected."[R-339]

The State of Oregon provides the only US Ecological Risk Assessment guidance document with critical effects thresholds and it indicates that risk is acceptable when either 1) the chance of exposure exceeding the toxicity reference value is <10% regardless of the fraction of the population exposed or 2) the chance of exposure exceeding the TRV is >10% for an individual organism but <20% of the local population is exposed. Additionally, Menzie et al. (2008) support the use of a relative survival threshold of 90%.[R-340][R-341]

Barnthouse and Coutant (2021) describe appreciable harm to an ecosystem as occurring if thermal effluent:

1. Impacts a sufficiently large space extent that may threaten sustainability of key ecosystem components considering the temporal patterns of the impacts.
2. Blocks migration corridors essential to water shed connectivity.

3. Increase the potential for a shift to an alternative, less desirable, ecological shift.[R-283]

Using the above sources as benchmarks, Bruce Power characterized the overall thermal risk assessment as no unreasonable risk, low or moderate risk:

No Unreasonable Risk: There are no significant thermal exceedances encompassing greater than 10% of the LSA.

Low Risk: The criteria for low risk thermal exceedances is encompassing greater than 10% of the LSA but less than 25% for at least 1 year of the thermal risk assessment, according to the criteria from the State of Oregon and Menzie et al (2008)[R-340][R-341]. Biological and/or ecological considerations were also applied to determine the final risk characterization as low or moderate.

Moderate Risk: The criteria for moderate risk is based on the criteria presented in Munkittrick at al. (2009) and accepted by ECCC for pulp and paper mills [R-280][R-297][R-338]. This moderate risk criterion will consist of thermal exceedances encompassing more than 25% of the LSA in 2 or more years of the thermal risk assessment. Both the duration (i.e. 2+ years) and the spatial extent criteria must be met to increase the risk categorization. Where the life stage exists at the surface and bottom and has sufficient mobility, exceedances are required at both surface and bottom to increase the risk categorization. Biological and/or ecological considerations were also applied to determine the final risk characterization as low or moderate.

9.4 Thermal Risk Assessment Inputs

9.4.1 Local Study Area

The local study area was delineated based on the modelled 95th percentile of the 1°C isopleth difference between operational and non-operational conditions from April 1, 2016 to March 31, 2021 at both the lake bottom and lake surface. Resulting lake bottom and lake surface contours were combined to develop a total representative LSA that accommodates the full areal extents of both surface and bottom contours (Figure 65 and Figure 66). Figure 65 shows the location of surface thermal monitoring locations used in the risk assessment. Figure 66 shows the location of bottom thermal monitoring locations. The local study area for the 2022 ERA thermal assessment extends along the shore approximately from McRae Point at its south end to the mouth of the Saugeen River on its north end. The local study area extends less than 4km offshore and covers an area of 82.2 km^2.

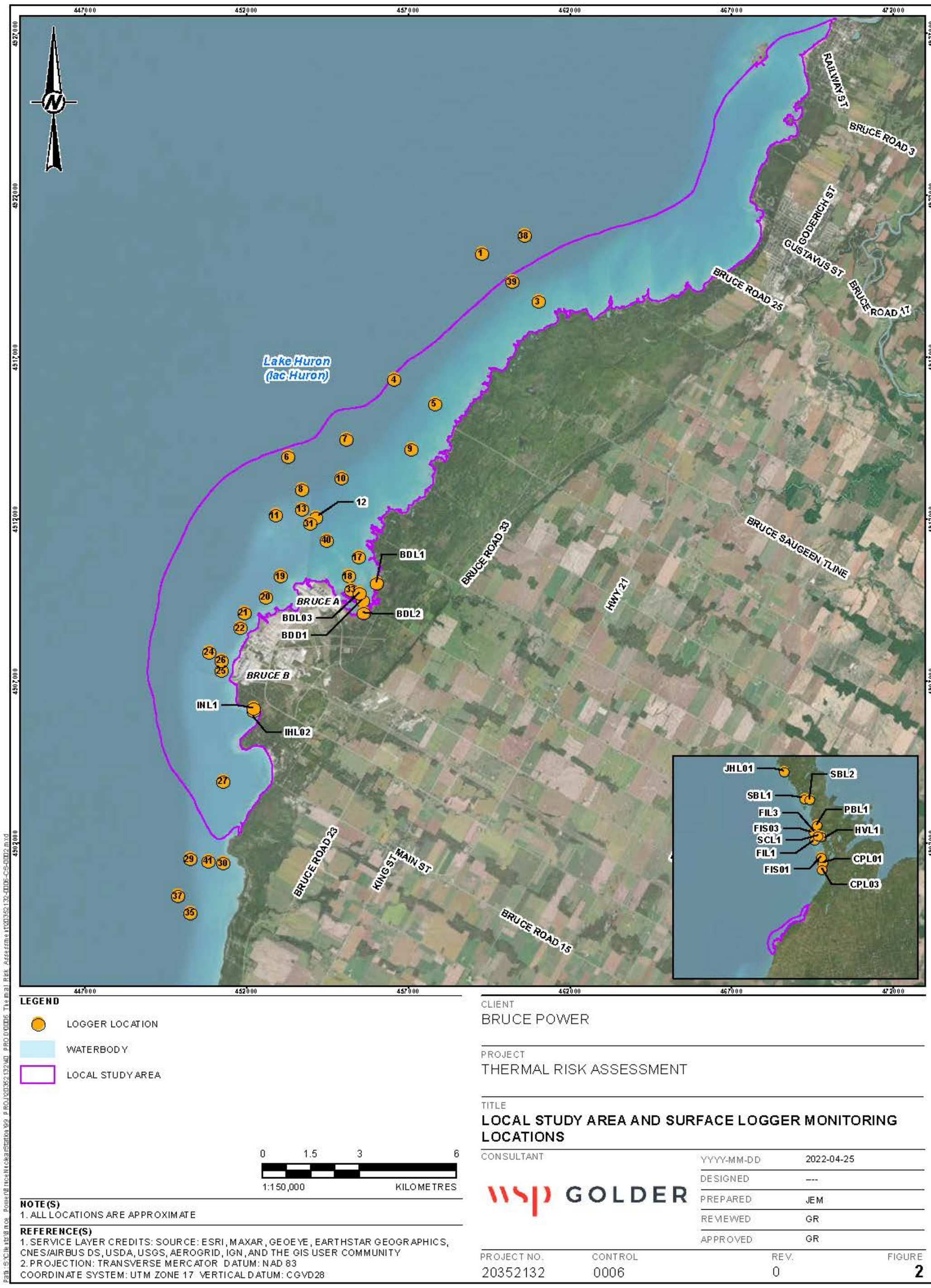

Figure 65 Local study area (LSA, purple line) for the 2022 ERA and surface thermal monitoring site locations used in the 2022 thermal risk assessment.

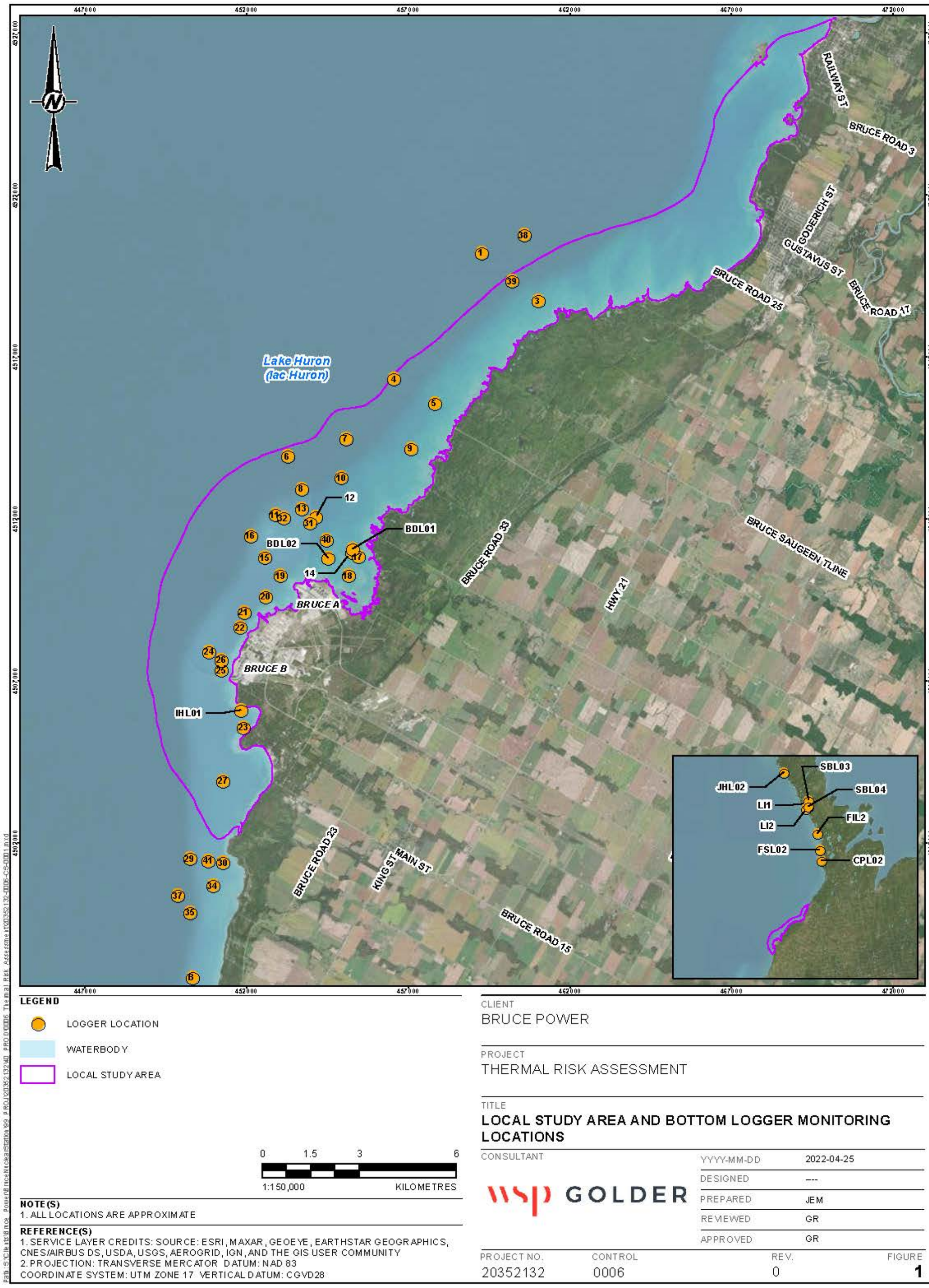

Figure 66 Local study area (LSA, purple line) for the 2022 ERA and bottom thermal monitoring site locations used in the 2022 thermal risk assessment.

From 2016 to 2021, the location, distribution and number of thermal loggers deployed during each monitoring season (i.e., throughout the water column in the spring, summer and fall and on the bottom in the winter) has changed. Most of the location changes occurred in 2017 and 2018. These changes have been implemented primarily to improve retrieval and enhance coverage of the LSA while maintaining a reasonable level of effort for field execution.

Historical thermal monitoring sites that are no longer regularly deployed as of Fall 2021 are shown in red in Figure 67. Although Figure 67 only shows the logger distribution between 2016 and 2021 relevant to this thermal risk assessment, logger locations from 2012 to 2016 were consistent with those deployed in 2017 and 2018. Further information about historical logger deployments not relevant to the current thermal risk assessment is extensively described in [R-285].

Thermal loggers located north of Bruce B (formerly Sites 24 and 25) were shifted slightly further north to Sites 42 and 43 in 2021 to enhance safety during deployment and improve substrate conditions for retrieval. Additional reference sites were deployed during the winter of 2020-21 (Sites A-F), with successful retrieval only for Site B in the spring of 2021. The new reference site locations are based on the objective of locating reference sites outside of the local study area and in water depths of depths of 5m, 10m and 20m to north and south (A-C and D-F, respectively). The new northern reference sites are located significantly further north to avoid thermal influences from Chantry Island and the Saugeen River.

Retrieval of temperature loggers in Lake Huron can be very difficult due to the inhospitable conditions and frequent disappearance of the loggers, particularly during the winters. Current Bruce Power thermal monitoring program active sites are indicated in Figure 67. These active site locations are subject to changes without notice based on safety considerations, substrate changes, retrieval rates, thermal modelling information and risk assessment outcomes.

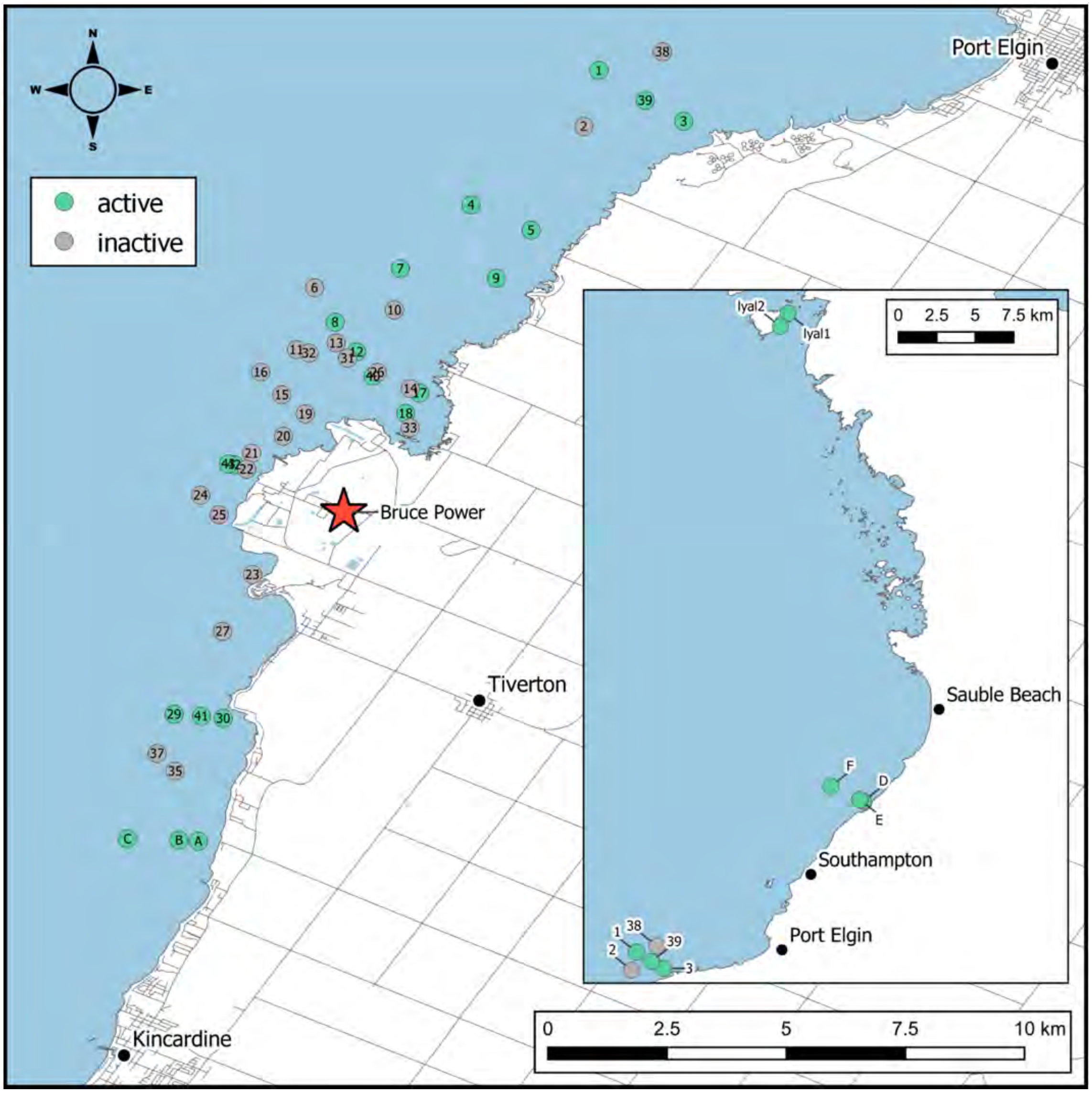

Figure 67 Bruce Power active (green) as of May 2022 and historical (grey) thermal monitoring locations from 2016-2021.

9.4.2 Thermal Monitoring

Thermal logger sites successfully retrieved from April 1, 2016 to March 31, 2021 are listed in Figure 68. All available temperature data obtained between those dates were used for the 2022 thermal ERA, including data from the bass nesting program, the thermal monitoring program and SON-operated CWMP program. Bass nesting program loggers include the discharge channel loggers (BA1 and BB1) and a logger in Baie du Doré (BDD1). CWMP loggers included sites in Baie du Doré (BDL1, BDL2, BDL03, BDL01 and BDL02) and sites in the LSA (IHL02, IHL01 and INL1). CWMP loggers were also used as reference loggers, including FIL3, JHL01, PBL1, SBL1, SCL1, SBL01, FIL1, HVL1, CPL01, CPL03, FIS01,

FIS03, FIL2, CPL02, JHL02, SBL03, SBL04 and FSL02. All other thermal monitoring sites are part of the Bruce Power thermal monitoring program.

Sites located in the LSA and included in the Baie du Doré site group included thermal monitoring program sites 14, 17, 18, 33, bass nesting logger BDD1, and CWMP program sites BDL01, BDL02, BDL03, BDL1 and BDL2.

All data included in the thermal risk assessment met the QA/QC criteria (Section 9.3.1). Discarded data were limited to periods at the beginning and end of deployments when the loggers were physically not in the water and the temperatures were clearly not water temperatures. No data were discarded due to failed QA/QC.

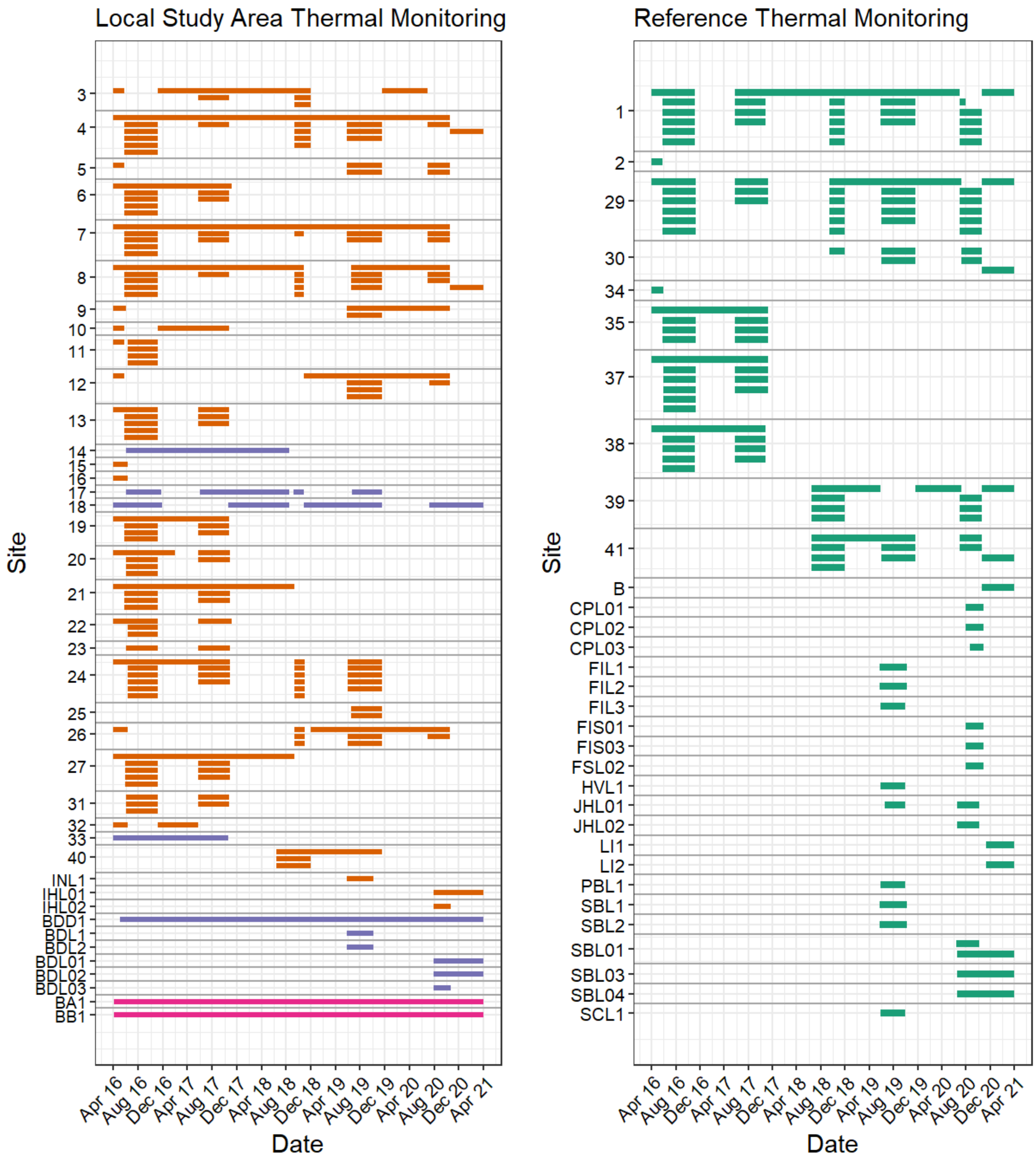

Figure 68 Thermal Monitoring Sites Retrieved and Used in the 2022 ERA. Each bar indicates when the logger was in the field and data was available for the thermal risk assessment. Seasons where multiple bars are listed for a single location indicate that data for multiple depths was obtained and used in the thermal risk assessment. Color indicates site group LSA (orange), Baie du Doré (purple), Discharge (pink) and Reference (green).

9.4.2.1 Rolling Weekly Average of Daily Average Temperature

The rolling weekly average of the daily average temperature was calculated as described in Section 9.3.1.4 and presented in Figure 69 and Figure 70. Each facet of the plots shows the rolling weekly average temperature data for a given month and year considered in the 2022 thermal risk assessment. Figure 69 shows a faceted violin plot of each month of temperature data by site group, including Reference Sites, LSA Sites, Baie du Doré Sites and Discharge Channel Sites. The interpretation of violin plots as a method of visualizing non-normal data with overlaid kernel density and boxplots on the same graph is described in detail in Section 9.3.8.4. Figure 70 shows the same rolling weekly average temperature data as a dot plot of each rolling weekly average data point faceted by month and year.

There is limited evidence of high-level differences between rolling weekly average LSA site temperatures and reference site temperatures in any given month where sufficient data is available, as indicated by visual comparison between the similar orange and green violin plots on Figure 69. There is a clear gradient of warming rolling weekly average temperatures, with temperatures increasing from the similar LSA and Reference site groups to the Baie du Doré site group and finally to the discharge group also in Figure 69. Warmer temperatures are expected in Baie du Doré compared to the LSA site group given the sheltered and shallow nature of this embayment. The violin density plots of the temperature data clearly indicate the non-normal nature of this data, with several higher density areas apparent in many of the facets of the graph (i.e., December 2016). There is also considerable variability between years in the temperature of the site groups in the same month (i.e., September 2016 versus September 2018), although this variability is considerably reduced during the cold winter months (January to April). Figure 70 shows the seasonal changes in lake temperature, upwelling events (i.e., September 2018) and changes in operational conditions (i.e., 4-unit outage in May 2016, start of Unit 6 MCR in January 2020).

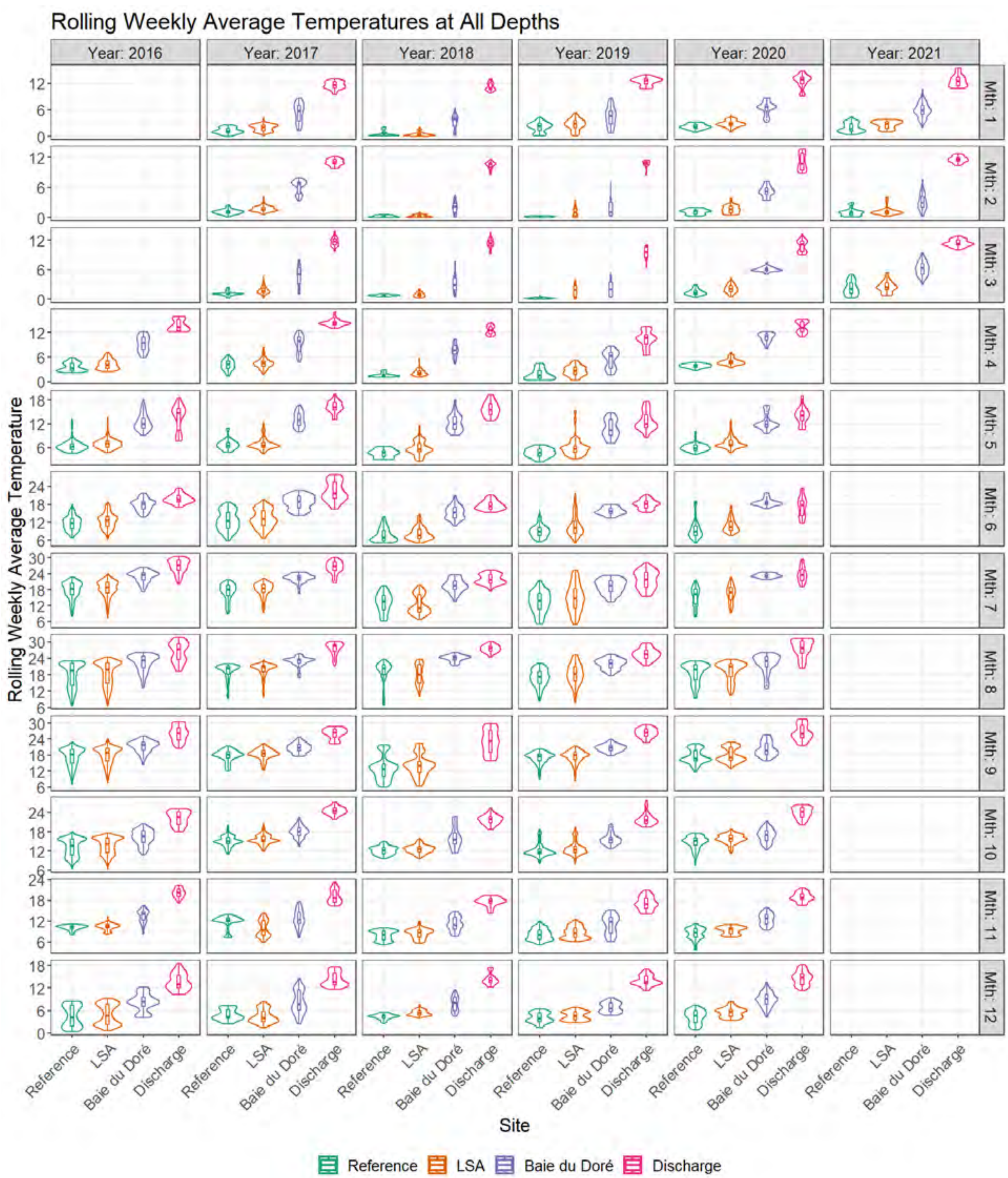

Figure 69 Rolling Weekly Average of All Thermal Monitoring Data used in the Thermal Risk Assessment by Site Group. Outer lines around each site indicate density of temperature data and boxplot inside each site indicate median and interquartile range.

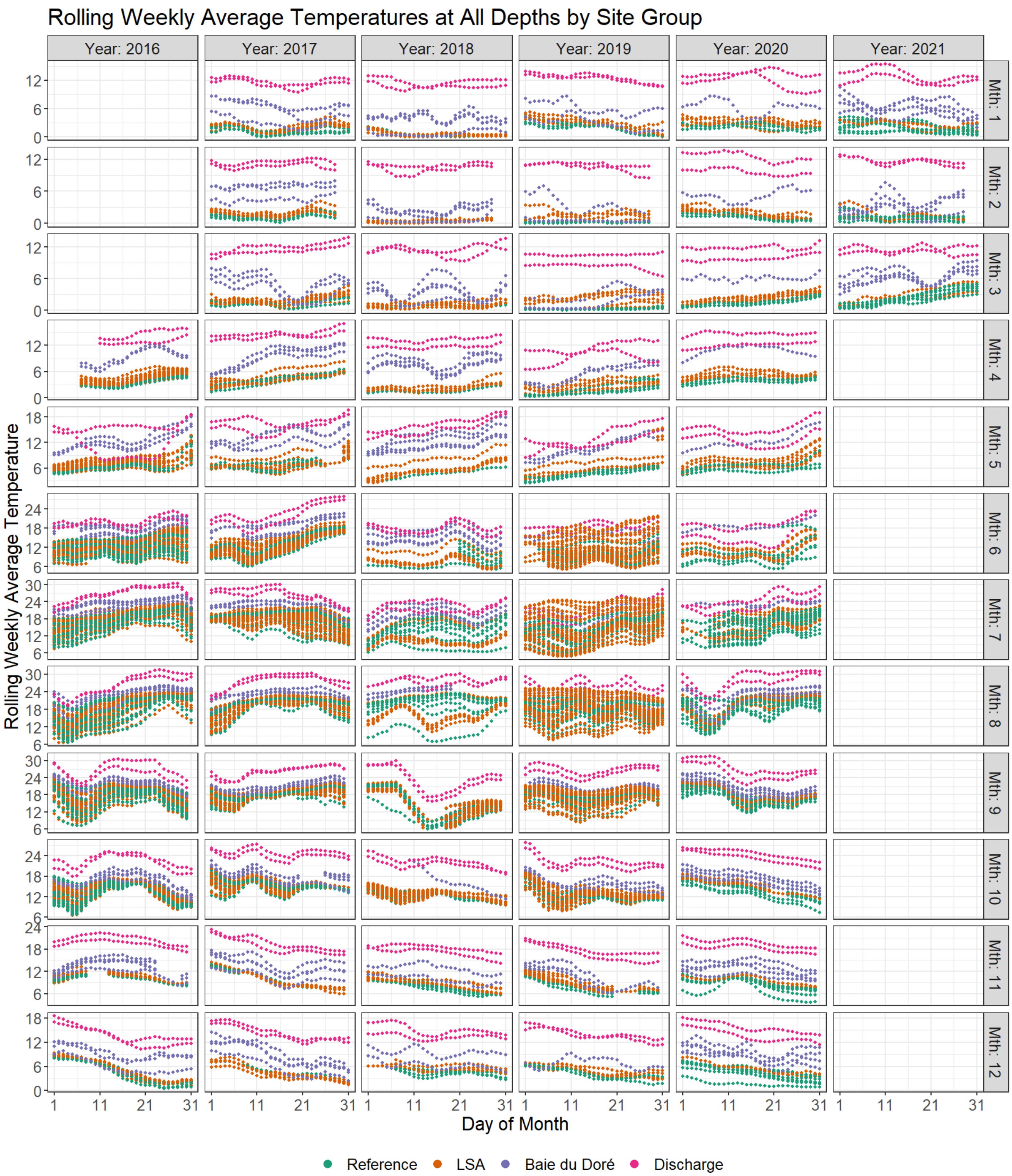

Figure 70 Rolling Weekly Average of Temperatures used in the Thermal Risk Assessment by Year and Month

9.4.2.2 Rolling Weekly Average of Daily Maximum Temperature

The rolling weekly average of the daily maximum temperature was calculated as described in the methods (Section 9.3.1.4) and is presented in Figure 71 and Figure 72. Each facet of the plots shows the rolling weekly maximum temperature data for a given month and year considered in the 2022 thermal risk assessment. Figure 71 shows a faceted violin plot of each month of temperature data by site group, including Reference Sites, LSA Sites, Baie du Doré Sites and Discharge Channel Sites. The interpretation of violin plots is described in detail in Section 9.3.8.4. Figure 72 shows the same rolling weekly maximum temperature data as a dot plot of each rolling weekly maximum data point faceted by month and year.

There is limited evidence of high-level differences between rolling weekly maximum LSA site temperatures and reference site temperatures in any given month where sufficient data is available, as indicated by visual comparison between the similar orange and green violin plots on Figure 71. There is a clear gradient of warming rolling weekly maximum temperatures, with temperatures increasing from the similar LSA and reference site groups to the Baie du Doré site group and finally to the discharge group. Warmer temperatures are expected in Baie du Doré compared to the LSA site group given the sheltered and shallow nature of this embayment. The violin density plots of the temperature data clearly indicate the non-normal nature of this data, with several higher density areas apparent in many of the facets of the graph (i.e., September 2020). There is also considerable variability between years in the temperature of the site groups in the same month (i.e., June 2017 versus June 2018), although this variability is reduced during the cold winter months (January to April). Figure 72 shows the seasonal changes in lake temperature, upwelling events (i.e., September 2018) and changes in operational conditions (i.e., 4-unit outage in May 2016, start of Unit 6 MCR in January 2020).

Figure 71 Rolling Weekly Maximum of All Thermal Monitoring Data used in the Thermal Risk Assessment by Site Group. Outer lines around each site indicate density of temperature data and boxplot inside each site indicate median and interquartile range.

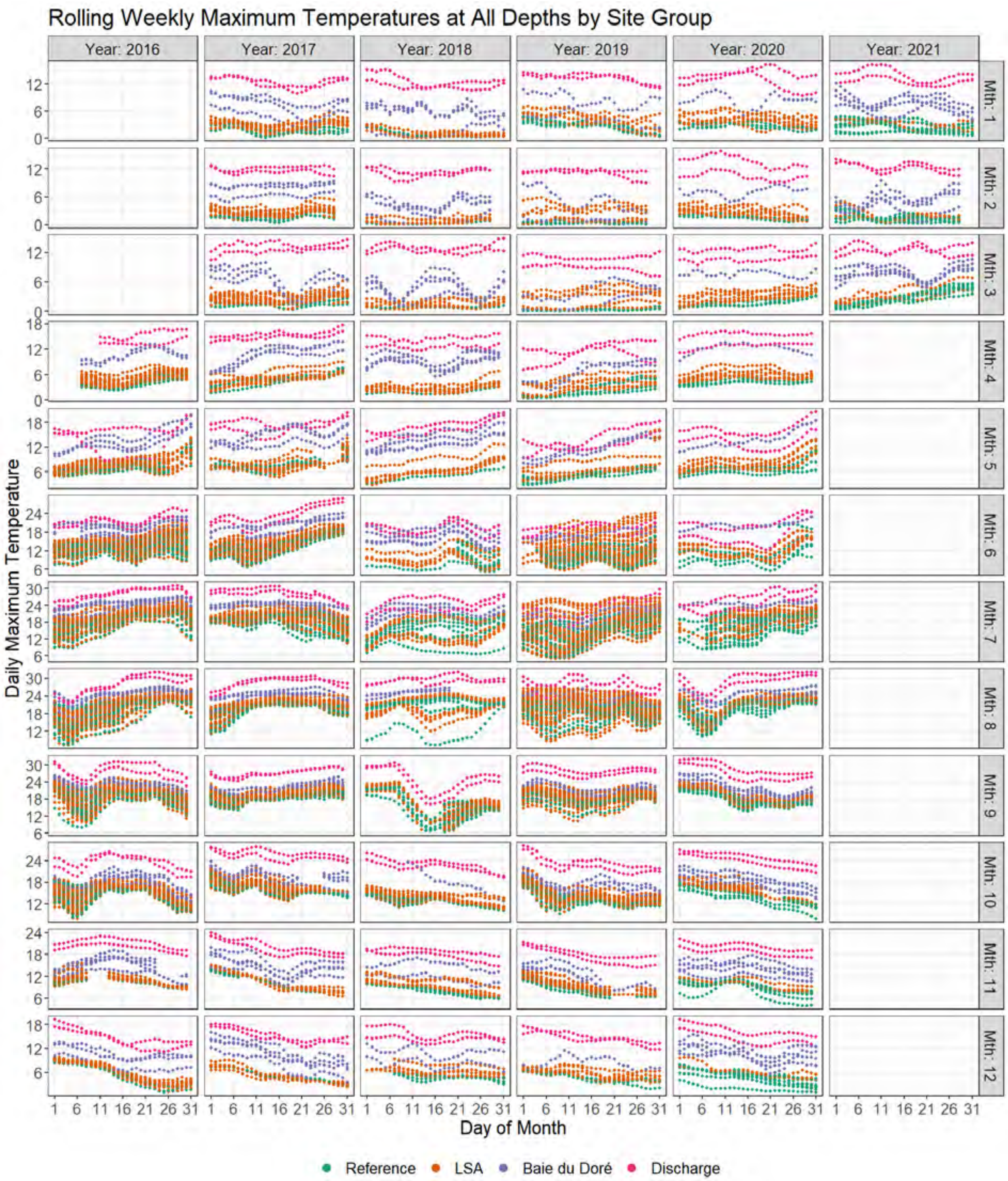

Figure 72 Rolling Weekly Maximum of Temperatures used in the Thermal Risk Assessment by Year and Month

9.4.2.3 Daily Maximum Temperature

The maximum daily temperature was calculated as described in the methods (Section 9.3.1.4) and is presented in Figure 73 and Figure 74. Each facet of the plots shows the daily maximum temperature data for a given month and year considered in the 2022 thermal risk assessment. Figure 73 shows a faceted violin plot of each month of temperature data by site group, including Reference Sites, LSA Sites, Baie du Doré Sites and Discharge Channel Sites. The interpretation of violin plots is described in detail in Section 9.3.8.4. Figure 74 shows the same daily maximum temperature data as a dot plot of each daily maximum data point faceted by month and year.

There is limited evidence of high-level differences between daily maximum LSA site temperatures and reference site temperatures in any given month where sufficient data is available, as indicated by visual comparison between the similar orange and green violin plots (Figure 73). There is a clear gradient of warming daily maximum temperatures, with temperatures increasing from the similar LSA/reference site groups to the Baie du Doré site group and finally to the discharge group in Figure 73. Warmer temperatures are expected in Baie du Doré compared to the LSA site group given the sheltered and shallow nature of this embayment. The violin density plots of the temperature data clearly indicate the non-normal nature of this data, with several higher density areas apparent in many of the facets of the graph (i.e., June 2018). There is also some variability between years in the temperature of the site groups in the same month although this variability is reduced compared to the rolling weekly average and rolling weekly daily maximum. Figure 74 shows the high variability in daily maximum temperatures and represents an excellent visual of upwelling events, indicated by sudden drops in maximum temperature across multiple locations (i.e., September 2018).

Figure 73 Daily Maximum Temperature of All Thermal Monitoring Data used in the Thermal Risk Assessment by Site Group. Outer lines around each site indicate density of temperature data and boxplot inside each site indicate median and interquartile range.

Figure 74 Daily Maximum of Temperatures used in the Thermal Risk Assessment by Year and Month

9.4.3 Thermal Modelling

MIKE3 HHT Thermal modelling was completed for April 1, 2016 to March 31, 2021 for use in the 2022 thermal risk assessment. A full description of the MIKE3 HHT model set-up and validation are available in [R-92].

9.4.3.1 Model Validation

Validation of the MIKE3 FM HHT model was addressed in a model validation report, where criteria for model validation were established. Model performance for thermal modelling used in the thermal risk assessment was evaluated against literature-derived acceptance criteria of a monthly average RMSE ≤3.65°C for temperature and ≤0.1 m/s for current speed and an annual correlation coefficient of ≥0.8 for temperatures and ≥0.25 for currents in cases where RMSE for these parameters is found to exceed two-thirds of the target RMSE.[R-92][R-342] The findings of the HHT model validation, based on comparisons of field measurements and simulation predictions for the 2017 calendar year, concluded that the current version of the HHT model met the established validation criteria and was fit for simulating the behavior of operational thermal discharges in the receiving environment and represented a substantial improvement over the regulatory-approved but recently retired RMA10 model.

9.4.3.2 Spatial Extent

Chronic Monthly Spatial Extent

For each calendar month from April 1, 2016 to March 31, 2021, the extent of the LSA at each 1°C temperature contour was delineated using the HHT temperature results at the 75th percentile. All chronic benchmark exceedances that had a spatial extent of less than 10% of the LSA area were eliminated during the secondary screening. This ensures that HQ exceedances retained for thermal risk assessment extend to 10% or more of the LSA and have the potential to be significant to the species and life stage [R-338].

Round Whitefish Block 1 Spatial Extent

The extent of the 3°C difference between operational (i.e., Bruce Power in operation) and non-operational (i.e. Bruce Power not operating) HHT simulations was determined during Round Whitefish Block 1 at the 25th, 50th and 75th percentiles. This assessment provides spatial extent context for the absolute thermal benchmarks assessed during Round Whitefish Block 1.

9.4.3.3 Reference Site Selection

Reference site and depth selection is based on the RMSE between effect and reference sites under modelled non-operational conditions (i.e. Bruce Power is not producing thermal effluent). Non-operational conditions are used to pair the thermal logger site and depth within the LSA with the closest temperature match at a reference site and depth located outside of the LSA. This ensures that the ambient temperatures at the site and depth within the LSA and at the Reference Site and depth are as similar as possible in a given deployment. The site and depth with the two lowest RMSE are selected as the Primary and Secondary reference sites. An RMSE of 3.0°C or less is required to be considered as a reference and all RMSEs for selected reference sites used in this report are less than 2.41°C, with all but 6 sites having an RMSE of less than 1.85°C. Where the RMSE for all potential reference sites was above 3.0°C, then the LSA site within the LSA remained without a designated reference site and all HQ exceedances at that site were carried forward as significant thermal exceedances. This occurred only at Site 5 in April and May of 2016. Additionally, there were time periods where the effect site was deployed but the designated reference site was not deployed. During these periods, all HQ exceedances at the LSA sites were carried forward to the secondary screening. This conservative approach ensures that all HQs without paired reference sites are carried forward for secondary screening.

9.4.3.4 LSA Risk Characterization with the LSA Remapping Tool

The LSA risk characterization carried out with the LSA Remapping Tool was used to determine the spatial extent of significant thermal exceedances in the Thermal Risk Assessment (TRA). The LSA Remapping Tool used HHT model outputs corrected using thermal monitoring temperatures to generate a daily average and daily maximum temperature across the LSA for each date included in the thermal risk assessment. These monitoring data-corrected HHT modelling outputs were used for the entire thermal risk assessment period (April 1, 2016 to March 31, 2021) at a daily time step, to develop the LSA risk characterization.

First, the entire LSA and Baie du Doré was divided into regularly spaced square grid nodes at 100m intervals, creating 8,815 nodes across the LSA and Baie du Doré at the lake surface and lake bottom. Daily temperature values for each grid node were estimated using a 2D interpolation of model-predicted values according to modelled values provided for the nearest HHT model nodes. Generally, the MIKE3 HHT model nodes were within 70m of grid nodes. Then, all available thermal logger data were used to determine a logger-weighting matrix to generate thermal model corrections for the square grid nodes on each day at surface and bottom. The thermal model corrections generated using the thermal monitoring data were then applied to the daily average and daily maximum of the model grid node temperatures to generate final corrected daily average and daily maximum temperatures across the full LSA and Baie du Doré. The corrected daily average and daily maximum temperatures were used to calculate the spatial extent of thermal exceedances across the LSA and Baie du Doré using the same methodology applied to the measured temperature data. The number of nodes exceeding the thermal benchmark on each day where a significant measured thermal exceedance existed were used to determine the spatial extent of the thermal exceedance within the LSA and Baie du Doré. For species and life stages assessed at the surface, all 8,815 grid nodes were used. For species and life stages assessed at the bottom, the depth was limited to greater than 2m, where there might be significant differences between surface and bottom temperatures. This left 7,696 grid nodes included in the calculation of the spatial extent of bottom exceedances.

Depth consideration for cold water species at the egg stage (i.e. Lake Trout, Lake Whitefish and Round Whitefish – see Section 9.3.2.1) was applied to the LSA risk characterization. For Lake and Round Whitefish eggs, this meant that the spatial extent was assessed for depths between 4m and 10m within the LSA, leaving 3,284 grid nodes. For Lake Trout eggs, this meant that the spatial extent was assessed for depths of 12m or greater within the LSA, leaving 2,460 grid nodes. This effectively eliminated Baie du Doré from consideration for the egg stage for Lake Whitefish, Round Whitefish and Lake Trout due to the shallow depth (≤3m) of the bay.

9.5 Results

The thermal risk assessment for each species is discussed below. Some species and life stages did not have benchmarks available and these instances are highlighted and surrogate benchmarks and species suggested.

9.5.1 Cold Water Fish Species

Acute and chronic thermal benchmarks were assessed for six cold water fish species present in the LSA, generally between October and June of each year. Table 169 and Table 170 list the thermal benchmarks used in the calculation of HQs by month. Sources for the thermal benchmarks are described in Section 9.3.6.1.

Table 169 Acute thermal benchmarks (˚C) by month for cold water fish species considered in thermal risk assessment

Acute ONLY (Hierarchy of CTM > UILT > STmax)												
Species	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook Salmon	Eggs: Stream C		Eggs: Stream C Larvae 28.4		Growth 28.6				Parent & Eggs: Stream C		Eggs: Stream C	
Rainbow Trout				Eggs & Larvae: Stream C		Eggs & Larvae: Stream C	Larvae: Stream C, Growth 30.9					
Lake Trout	Eggs 10		Eggs 10, Larvae 27.5	Larvae 27.5, Growth 28.3	Growth 28.3					Eggs 10		
Lake Whitefish	Eggs 10$^{\beta}$			Eggs 10$^{\beta}$, Larvae 27.8	Larvae 27.8, Growth 29.3	Larvae 27.8, Growth 29.3					Eggs 10$^{\beta}$	
Round Whitefish	Eggs: 10.1$^{\alpha}$			Eggs 10.1$^{\alpha}$, Larvae 27.5	Larvae 27.5							Eggs 10.1/ 10$^{\alpha}$
Deepwater Sculpin				Larvae: N/A								

$^{\alpha}$Temperature-based start date set as the date the rolling weekly average drops below 5.5°C for minimum of 7 days. End date defined as last date of median hatch for Lake Whitefish. Block 1 defined as first 30 days of incubation. Alternate acute threshold of 10°C for 6 hours also assessed during Block 1.
$^{\beta}$Temperature-based start date set as the date the rolling weekly average drops below 8.0°C for minimum of 7 days. End date defined as last date of median hatch for Lake Whitefish.
Note: Overall most sensitive thermal benchmark for all thermal guilds in each month in red. Species listed as not available (N/A) in yellow. Grey cells indicate species are expected to be offshore.

Table 170 Chronic MWAT thermal benchmarks (˚C) by month for cold water fish species

Chronic ONLY (MWAT)												
Species	**Month**											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chinook Salmon	Eggs: Stream C		Eggs: Stream C, Larvae 13.5	Larvae 13.5	Growth 18.7				Parent & Eggs: Stream C		Eggs: Stream C	
Rainbow Trout				Eggs: Stream C	Eggs & Larvae: Stream C	Eggs & Larvae: Stream C	Larvae: Stream C, Growth 19					
Lake Trout	Eggs 7.1		Eggs 7.1, Larvae 13.8	Larvae: 13.8, Growth: 19.4	Growth 19.4					Eggs 7.1		
Lake Whitefish	Eggs 6.7/Δ3°C^{β} + HA			Eggs 6.7/ Δ3°C^{β} + HA, Larvae 12.8	Larvae 12.8, Growth 18.4						Eggs 6.7/ Δ3°C^{β} + HA	Eggs 6.7/ Δ3°C^{β} + HA
Round Whitefish	Eggs 5.4$^{£}$/Δ3°C^{β}			Eggs 5.4 Larvae 10.8	Larvae 10.8, Growth 19.4	Growth 19.4						Eggs 5.4/ Δ3°C^{β}
Deepwater Sculpin				Larvae 9^{μ}	Larvae 11.8^{μ}	Larvae 11.8^{μ}						

^{μ}Notes regarding the use of 9°C chronic threshold for Deepwater Sculpin larvae in April and 11.8°C in May and June in Section 9.5.1.6.
^{β}Temperature-based start date set as the date the rolling weekly average drops below 8.0°C for minimum of 7 days. End date defined as last date of median hatch for Lake Whitefish. Delta of 3°C from the selected reference sites and Hatch Advance (HA) also assessed – see Section 9.3.6.5.
$^{£}$ Temperature-based start date set as the date the rolling weekly average drops below 5.5°C for minimum of 7 days. End date defined as last date of median hatch for Lake Whitefish. Block 1 defined as first 30 days of incubation. Specific additional criteria used for Round Whitefish Block 1 thermal assessment, including a chronic threshold of 6.0°C for 30 days and a sub-acute threshold of an 8.5°C rolling weekly average. Delta of 3°C from the selected reference sites also assessed. – see Section 9.3.6.5.
Note: Overall most sensitive thermal benchmark for all thermal guilds in each month in red. Grey cells indicate species are expected to be offshore.

9.5.1.1 Chinook Salmon

Chinook Salmon, a non-native species, spawn in rivers with gravel and cobble substrates. Spawning is variable by location, but is typically September or October in the Great Lakes. Adults make a nest in gravel and after spawning the female covers the nest with gravel and guards the nest for up to 2 weeks. Eggs incubate in the gravel substrate until March. After hatch alevins stay in the nest for 2-3 weeks absorbing yolk before emerging from the gravel and making their way to the open water of the lake.[R-289]

In the local area, spawning adults may be present in Stream C in September or October to lay eggs; the female remains for an additional 1-2 weeks after spawning. Eggs may be present in Stream C for 5-6 months from September through March, followed by larvae in March or April for a period of 2-3 weeks. As Stream C is excluded from the thermal risk assessment, the egg and larvae stage in Stream C are removed from further consideration. Larvae then travel towards the open water of Lake Huron and may be present throughout the water column in the nearshore in March and April. The growth stage may be present throughout the water column in inshore areas during May and June.

Chinook Salmon are a sought after game species for local anglers based on creel survey data and local fishing derby information. This species is also identified as an important species for MNO and HSM (see Appendix A Section 1.8.7).

Preliminary Screening

HQs were calculated as described in the methodology and are presented using violin plots by site group in Figure 75 and Figure 76 and over time in Figure 77.

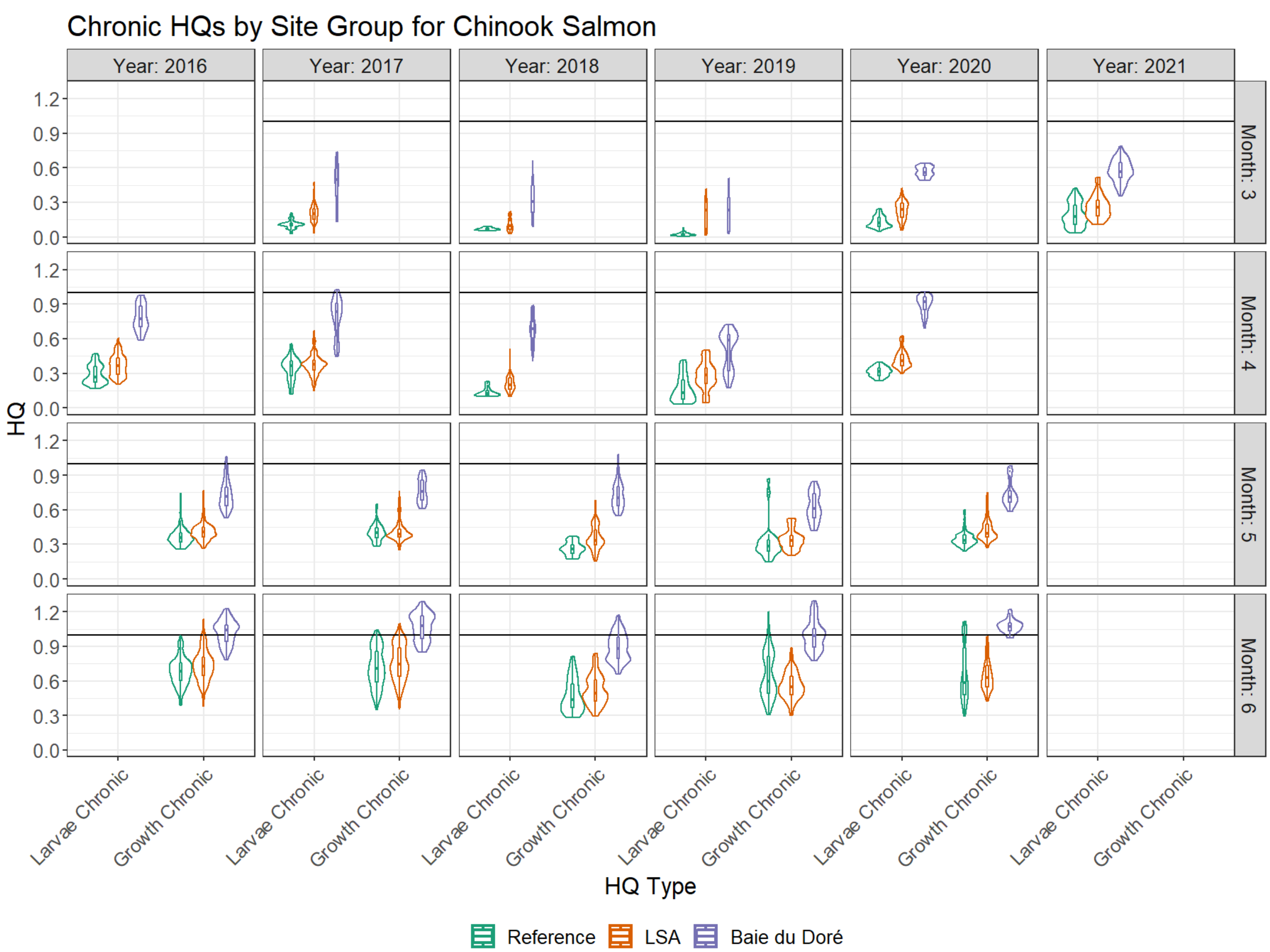

Figure 75 Chronic HQs for Chinook Salmon by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

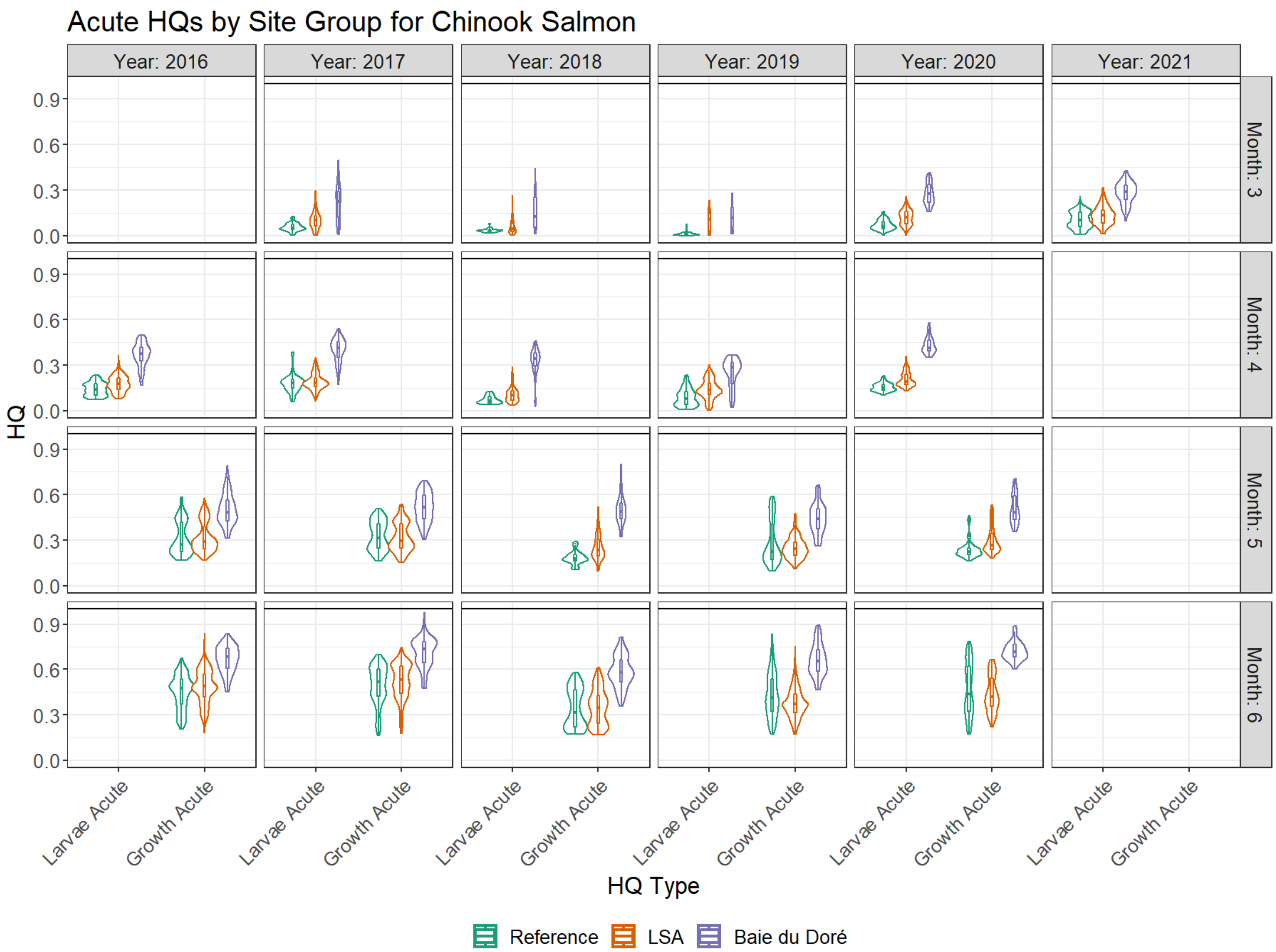

Figure 76 Acute HQs for Chinook Salmon by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

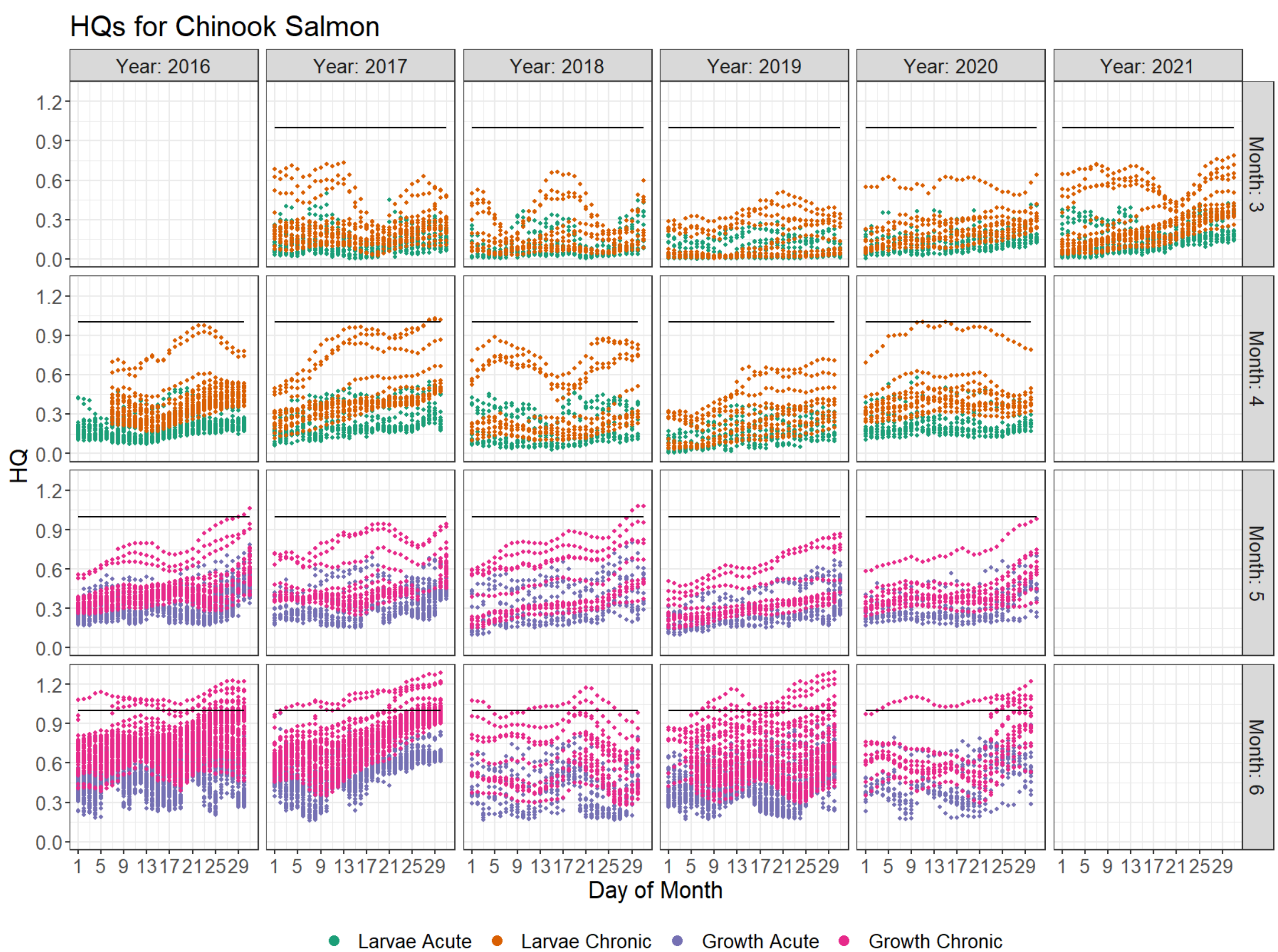

Figure 77 HQs for Acute and Chronic Larval and Growth stage Chinook Salmon by Benchmark. Black line indicates HQ of 1.0.

No acute larval threshold exceedance occurred. Thermal exceedances occurred almost exclusively in Baie du Doré for the chronic growth threshold of 18.7°C at the end of May and during the month of June over the 5 years of the thermal risk assessment.

Assessment of the chronic growth benchmark is retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment of acute or chronic larval or acute growth Chinook Salmon benchmarks is required.

<u>Secondary Screening</u>

Secondary screening results are presented in the form of a table for each species assessed. These tables indicate the number of significant HQ exceedances for LSA and Baie du Doré sites. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. For each HQ exceedance value presented, the total number of HQs calculated in the LSA, Baie du Doré and Reference areas are presented for context as to the proportion of all the calculated HQs presented that exceed one. All significant HQs within the LSA and Baie du Doré are advanced to the TRA.

A count of significant HQ exceedances is presented in Table 171 according to the criteria described in Section 9.3.8.1. As expected due to higher surface temperatures, a higher number of significant LSA and Baie du Doré exceedances occurred at surface locations. Given the presence of significant thermal exceedances of the chronic growth benchmark, the growth stage in Baie du Doré and the LSA is retained for assessment in the TRA.

Table 171 Number of significant HQs s above 1.0 and total number of HQs calculated by year and site group for Chinook Salmon in June

Chinook Salmon (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Growth (Bottom)										
Baie du Doré*	25	104	13	78	-	183	-	59	-	-
LSA*	-	992	5	648	-	315	-	379	-	427
Reference	-	333	-	226	-	81	-	220	18	207
Growth (Surface)										
Baie du Doré*	52	110	48	117	20	61	49	113	27	61
LSA*	30	333	19	435	-	71	-	220	-	-
Reference	-	146	6	153	-	20	16	345	8	18

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month or 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

<u>Thermal Risk Assessment</u>

The extent of the significant thermal exceedances in Baie du Doré and the LSA for the chronic threshold of Chinook Salmon at the growth stage is presented in Table 172.

Table 172 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) affected by chronic HQ exceedances for Chinook Salmon in June

Chinook Salmon (Chronic)	2016	2017	2018	2019	2020
Growth (Bottom)	1 (0-1)	**31 (13-35)**	--	--	--
Growth (Surface)	**23 (3-30)**	**22 (9-32)**	2 (1-5)	3 (2-3)	**79 (64-86)**

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

Temperature exceedances were above 10% at both the surface and bottom in 2017 only, although the extent of the LSA and Baie du Doré impacted was above 10% at the surface only in 2016 and 2020. Given the mobility of the growth stage of Chinook Salmon required for the larvae to be able to relocate from the nest at 1-2 weeks of age [R-289], exceedances at both the surface and bottom were considered to be required together for risk categorization purposes. Chinook Salmon have exhibited thermoregulatory behaviour at approximately 7-9 months of age [R-343] and it is reasonable to expect that this capability would be present at 3-5 months of age. It is likely that Chinook Salmon at the growth stage are able to relocate out of the LSA (and particularly Baie du Doré) by the end of June in order to access other favorable conditions or have acclimated to the temperatures present.

As a result, thermal effluent generally poses a low risk to growth stage Chinook Salmon in the LSA, and no unreasonable risk to the population success of Chinook Salmon near Bruce Power.

9.5.1.2 Rainbow Trout

Rainbow Trout spawn in the spring, mainly in mid-April to late June, at water temperatures of 10.0-15.5°C. Spawning occurs in small tributaries or inlet/outlet streams of lakes in gravel in areas with riffles or shallow runs. Eggs are deposited in nests and then covered with gravel for the 4-7 week incubation period. Larvae spend 3-7 days absorbing yolk before emerging from the nest approximately 15 days after hatching, in mid-June to mid-August, and travel to the open water body at approximately 1 year of age.[R-289]

Near Bruce Power, Rainbow Trout may spawn in Stream C in April, May or June depending on the water temperature. Eggs remain in the gravel substrate for 1-2 months in April through June. Larvae spend up to 2 weeks near the nest after hatch. As Stream C is excluded from the thermal risk assessment, the egg and larvae stage in Stream C are removed from further consideration. The juvenile/growth stage may be present in the nearshore in July and August. Rainbow Trout are a species of interest to MNO and HSM and adults are known to be present near the Bruce Power site based on impingement monitoring and creel survey data (see Appendix A Section 1.8.7 and 1.8.6).

Preliminary Screening

HQs for Rainbow Trout were calculated as described in the methodology and are presented using violin plots by site group in Figure 78 and over time in Figure 79.

Figure 78 Acute and Chronic HQs for Rainbow Trout by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

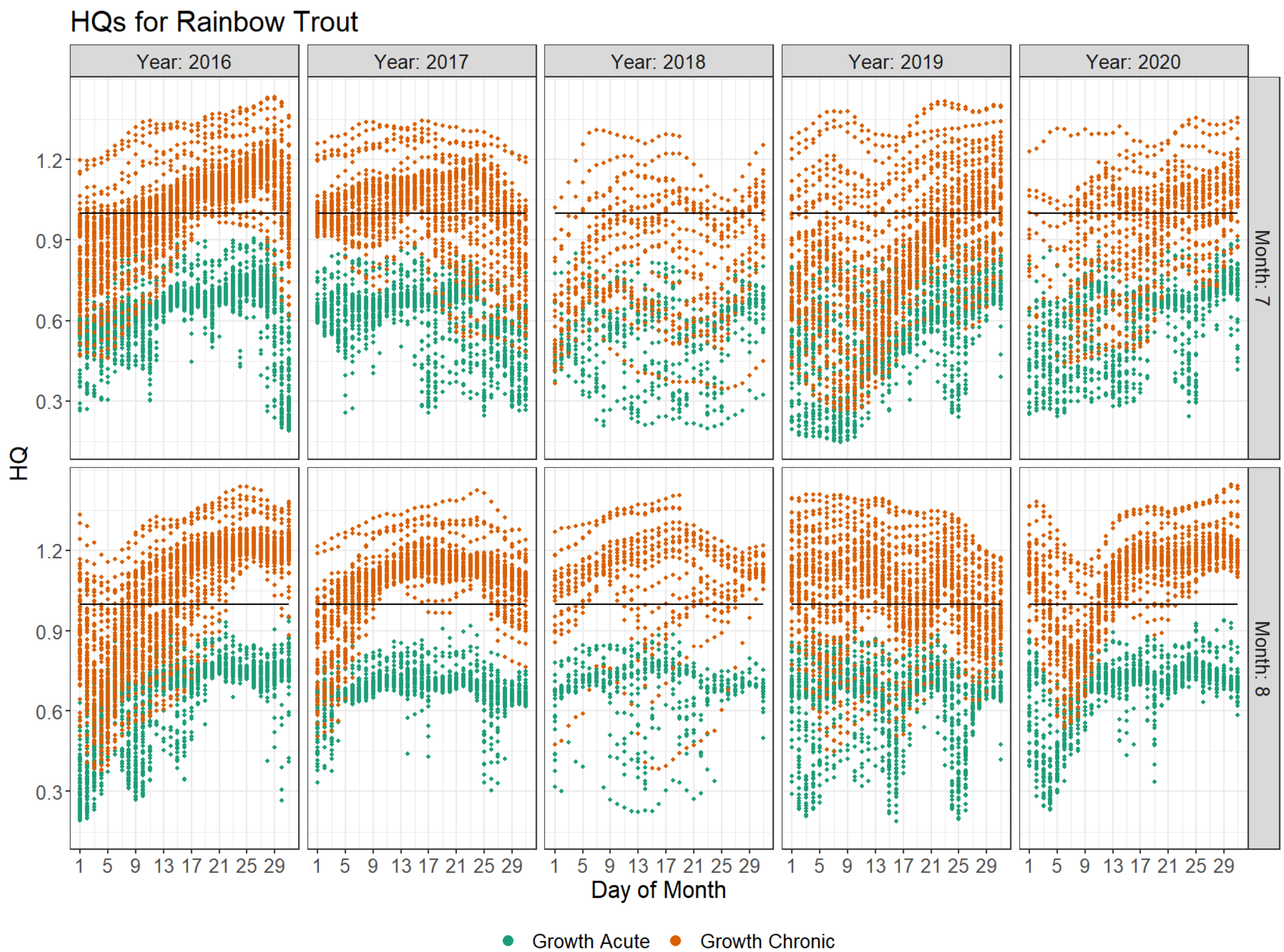

Figure 79 HQs for Rainbow Trout by Benchmark. Black line indicates HQ of 1.0.

Widespread chronic growth HQ exceedances occurred for all months assessed in Baie du Doré, the LSA and at Reference sites, with the magnitude of the exceedance and the number of HQ exceedances increasing through July and August. Assessment of the chronic growth benchmark is retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment of the acute growth Rainbow Trout benchmark is required.

Secondary Screening

A count of significant HQ exceedances is presented in Table 173 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Once the criteria for determining significant thermal exceedances were applied, there was a significant reduction in the number of chronic growth HQ exceedances in Baie du Doré and the LSA for Rainbow Trout, primarily because of HQ exceedances at reference sites on the corresponding date. Significant thermal exceedances for the growth stage in the LSA and Baie du Doré in all years assessed were carried forward for further assessment in the TRA.

Table 173 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Rainbow Trout

Rainbow Trout (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Growth (Bottom)										
Baie du Doré*	34	186	-	124	64	150	36	124	-	58
LSA*	25	868	112	744	88	372	69	620	242	421
Reference	170	310	156	310	62	186	73	248	284	465
Growth (Surface)										
Baie du Doré*	35	124	-	124	10	19	-	186	89	139
LSA*	74	806	-	868	52	124	89	620	269	353
Reference	249	310	291	310	83	124	614	806	383	488

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of growth stage Rainbow Trout are presented in Table 174.

Table 174 Median (25^{th} - 75^{th} percentile) extent of LSA including Baie du Doré (%) affected by chronic HQ exceedances for Rainbow Trout

Rainbow Trout (Chronic)	2016	2017	2018	2019	2020
Growth (Bottom)					
July	3 (2 – 30)	**53 (29-67)**	8 (5-12)	**43 (33-44)**	**35 (21-61)**
August	**20 (1-25)**	**69 (54-83)**	**64 (57-72)**	**50 (45-58)**	**78 (75-84)**
Growth (Surface)					
July	**28 (24-41)**	--	**70 (42-80)**	**33 (21-38)**	**60 (37-78)**
August	**71 (48-86)**	--	**99 (99-99)**	**41 (28-47)**	**99 (97-100)**

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

Exceedances of the criteria for no unreasonable risk (i.e. occurring at ≤10% LSA) occurred in all years assessed for the growth stage of Rainbow Trout. Despite these quantitative exceedances of the criteria for no unreasonable risk, the overall risk to the growth stage of non-native Rainbow Trout in the LSA is likely low because of the biological and ecological context for this species and life stage. Rainbow Trout with a mean length of 246mm and a mean weight of 158g exhibited thermoregulatory behaviour during the summer months, actively seeking thermal refuges of colder water within a river system [R-344]. Within the same study, young of the year (age-0) Rainbow Trout that were too small for the implanted temperature loggers were observed to use similar and slightly deeper habitat than the Rainbow Trout demonstrating thermoregulatory behaviour [R-344].

Early Rainbow Trout life stages are occurring in rivers and near site in Stream C are unaffected by thermal effluent. By the time the growth stage of Rainbow Trout leaves Stream C and other rivers at approximately 1 year of age, they are highly mobile and will roam based on available food sources. Observations of local Rainbow Trout indicate that the highly mobile growth stage is purposely seeking food near the site in temperature conditions that exceed the thermal benchmarks evaluated in this risk assessment. This may indicate that acclimation to temperatures within the LSA is occurring in favour of obtaining access to additional food sources.

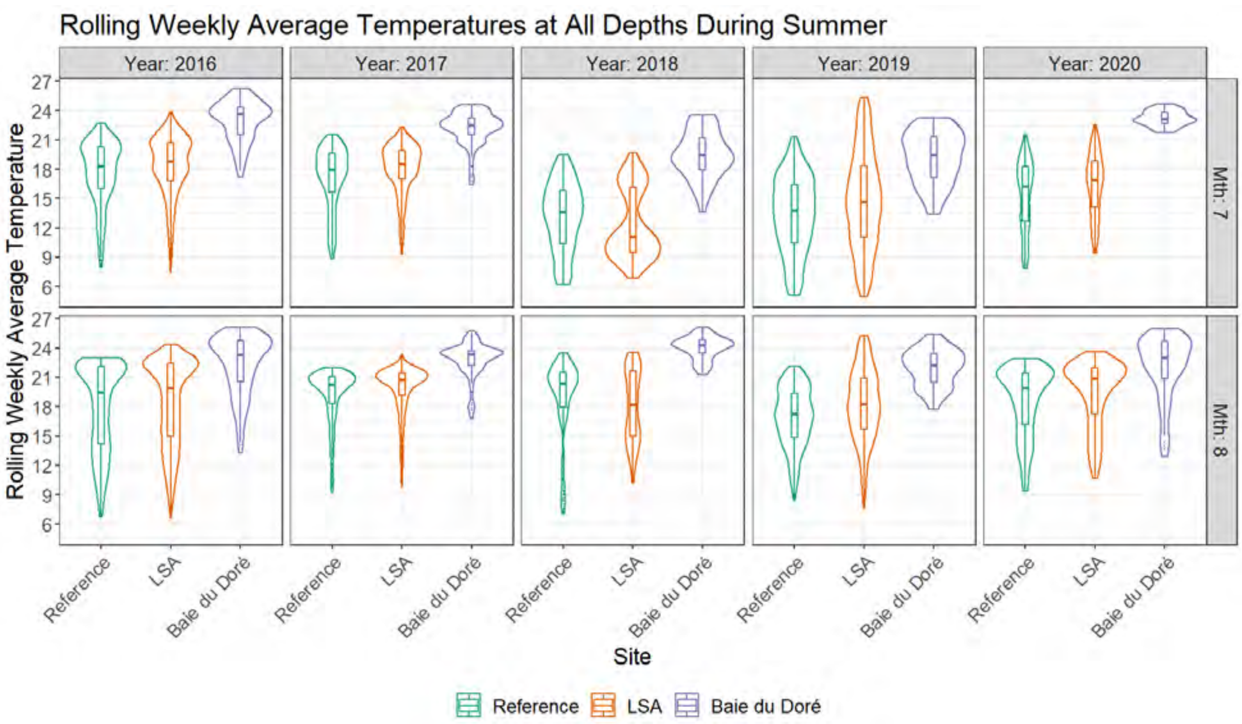

Figure 80 Rolling Weekly Average Water Temperatures during Rainbow Trout Growth Stage presence in the LSA

Overall, this indicates that the thermal benchmark used for growth stage Rainbow Trout may be too low for the LSA, particularly given that Hasnain et al. (2013) gives a preferred temperature range from aggregate studies for the growth stage of 15.6 ± 2.4°C [R-300], with the upper end of this preferred temperature range resulting in a chronic MWAT of 20.7°C rather than 19°C. Even with the use of an MWAT of 20.7°C, the results of the overall risk characterization remain unchanged as the percent of the LSA affected drops in all years but not sufficiently to change the outcome of the risk assessment. Heat tolerant Rainbow Trout in Australia have shown that growth from ~15g to 40-60g continues in a normal pattern at acclimation temperatures of 15°C to 23°C and only becomes appreciably reduced at an average temperature of 25°C [R-345]. The CTM of heat-tolerant Rainbow Trout acclimated to 23°C temperatures increased to 31.1°C compared to a CTM of 29.0°C for Rainbow Trout acclimated to 15°C [R-345]. Figure 80 shows that rolling weekly average temperature during the growth stage in the LSA and demonstrates that temperatures within the LSA are generally suitable for heat-tolerant Rainbow Trout. Temperatures within Baie du Doré are generally higher than would be well-tolerated by growth Rainbow Trout. Given the use of deeper pools described in [R-344], it is unlikely that growth stage Rainbow Trout are utilizing the shallow (1-2m depth) areas of Baie du Doré during the growth stage.

Given the biological and ecological context of high mobility, the likelihood of thermoregulatory behaviour, the potential for acclimation to higher average temperatures while maintaining a normal growth trajectory and local observations, the thermal HQ exceedances described here pose a low risk to the growth stages of Rainbow Trout and no unreasonable risk to the overall population of Rainbow Trout in the LSA.

9.5.1.3 Lake Trout

Lake Trout spawn in the autumn when the lake temperature is 8.9-13.9°C. The timing is variable by lake, in September to the north and November to the south, but most commonly in October. Spawning occurs in a single night over large boulders or rubble substrates at depths of 12-36m. Eggs incubate in rock crevices for 4-5 months and larvae hatch in March or April. After about a month, the larvae seek deeper water.[R-289]

In the local area, Lake Trout may spawn in the rocky substrate at depths >12m in the month of October. Eggs would incubate from October through March (5 months). Larvae would remain near the bottom in the LSA for approximately 1 month in March or April and then move offshore to deeper water. This species is of interest to MNO and HSM (see Appendix A Section 1.8.7).

<u>Preliminary Screening</u>

Egg, larval and growth HQs for Lake Trout were calculated as described in the methodology and are presented using violin plots by site group in Figure 81, Figure 83 and Figure 84 and over time in Figure 82 and Figure 85.

Figure 81 HQs for Lake Trout Eggs by Site Group at Depths ≥12m. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

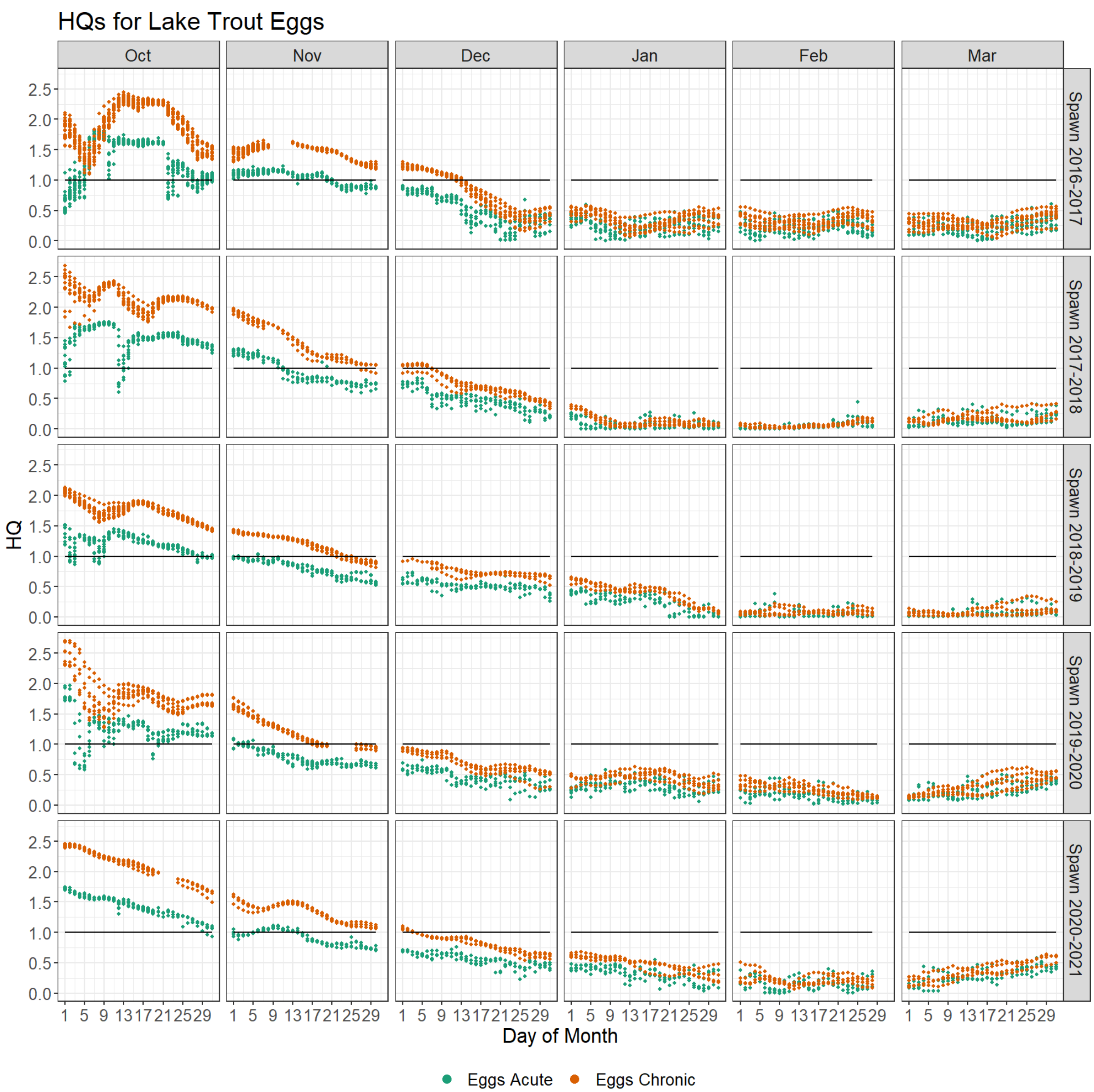

Figure 82 HQs for Lake Trout Eggs by Benchmark at depths ≥ 12m. Black line indicates HQ of 1.0.

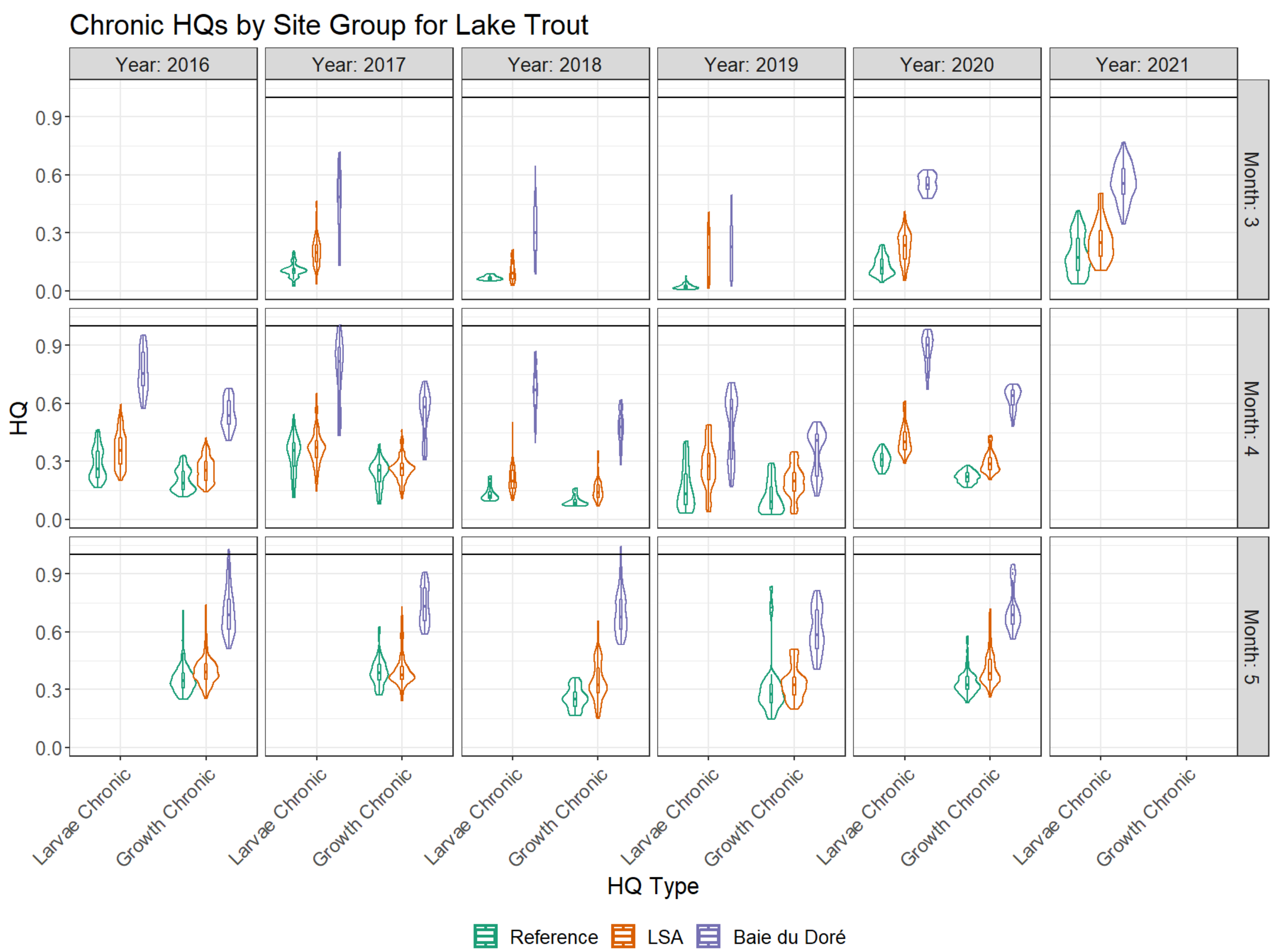

Figure 83 Chronic HQs for Lake Trout Larvae and Growth stage by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

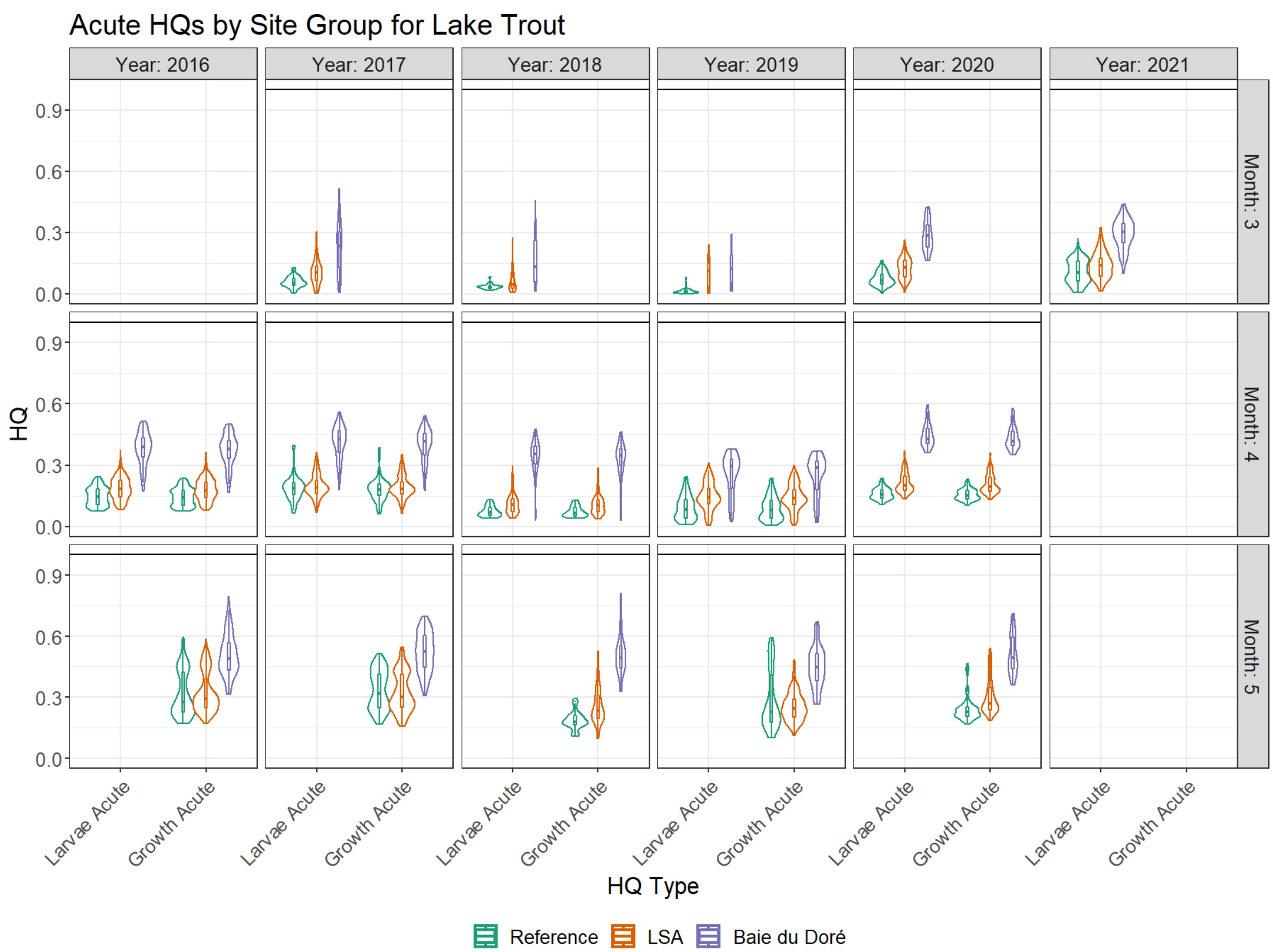

Figure 84 Acute HQs for Lake Trout Larvae and Growth stage by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

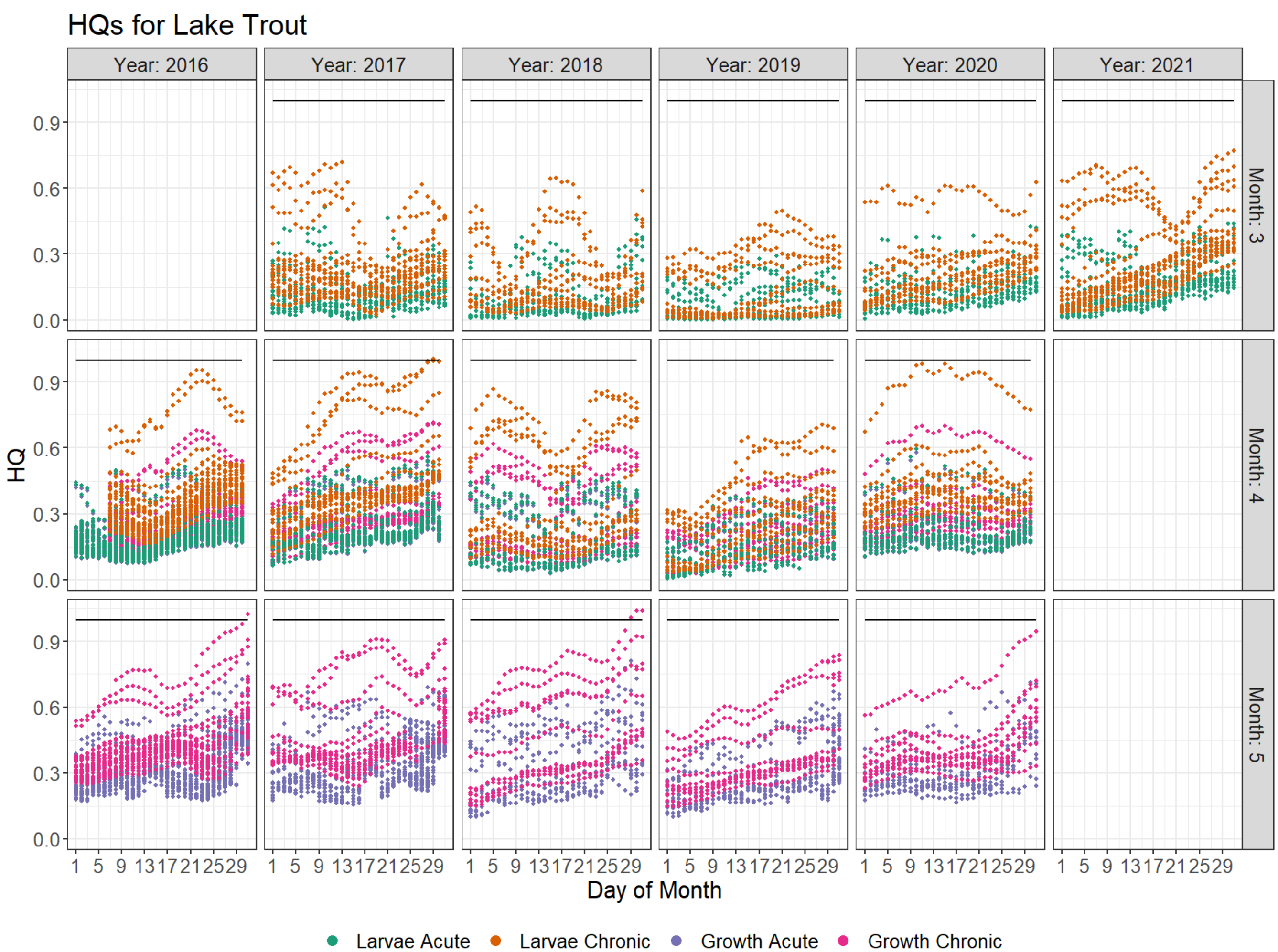

Figure 85 HQs for Lake Trout Larvae and Growth stage by Benchmark. Black line indicates HQ of 1.0.

Lake Trout acute and chronic egg benchmarks and chronic growth benchmarks were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment of acute and chronic larval or acute growth Lake Trout benchmarks is required.

<u>Secondary Screening</u>

A count of significant HQ exceedances in the LSA at depths greater than 12m is presented in Table 175 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Lake Trout eggs had acute and chronic thermal benchmark exceedances throughout October, November and early December in all years assessed. Temperatures at reference sites were very similar to those within the LSA and extensive benchmark exceedances also occurred at reference sites (Figure 81 and Figure 82). Assessment of the Lake Trout egg thermal exceedances in the LSA was carried forward to the TRA.

A very limited number of chronic growth exceedances occurred in Baie du Doré at the end of May in 2016 and 2018. None of these exceedances met the criteria for significant HQ exceedance according to the criteria described in Section 9.3.8.1. Due to a lack of significant thermal exceedances, no further assessment is required for the growth stages of Lake Trout.

Table 175 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Lake Trout eggs at depths greater than 12m.

Lake Trout (Bottom)	2016-17		2017-18		2018-19		2019-20		2020-21	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Chronic)[β]										
LSA*	30	1,100	129	715	-	411	-	532	95	378
Reference	212	431	158	279	106	352	97	356	114	356
Eggs (Acute)[β]										
LSA*	16	1,133	57	744	-	422	-	550	72	384
Reference	152	441	140	284	54	364	62	366	78	364

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.
[β]Differences in total number of HQs calculated for acute and chronic results are related to the use of 7-day moving averages for chronic temperature data aggregation (i.e., no HQs calculated for the first 6 days of a deployment).

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of Lake Trout eggs is presented in Table 176.

Table 176 Median (25^{th} - 75^{th} percentile) extent of LSA with depth ≥ 12m (%) with significant thermal exceedances for Lake Trout embryos

Lake Trout (Bottom)	2016-17	2017-18	2018-19	2019-20	2020-21
Eggs (Chronic)					
October	--	**100 (100-100)**	--	--	**100 (100-100)**
November	**100 (100-100)**	**100 (93-100)**	--	--	**87 (71-99)**
December	**100 (96-100)**	--	--	--	--
March	--	--	--	--	--
April	--	--	--	--	--
Eggs (Acute)					
October	**16 (6-28)**	**100 (100-100)**	--	--	**100 (100-100)**
November	**99 (90-100)**	**100 (92-100)**	--	--	**49 (36-53)**

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as "--"in the table.

As a result of the extensive thermal exceedances in the reference areas and the very similar HQ profile at both reference sites and sites within the LSA (Figure 81 and Figure 82), the risk to Lake Trout eggs incubating in the LSA is assessed to be low.

As a result, thermal effluent generally poses a low risk to the egg stage and no unreasonable risk to the larval or growth stage of Lake Trout in the LSA, and no unreasonable risk to the population success of Lake Trout near Bruce Power.

9.5.1.4 Lake Whitefish

The spawning period of Lake Whitefish is November or December when water temperatures are <7.8°C. Spawning occurs in depths <7.6m over hard cobble/boulder/bedrock. Eggs incubate in the crevices between rocks for a period of approximately 4-5 months and hatch in spring with ice break up in late March or early April. Larvae form aggregations along steep shore lines and remain in the nearshore April through June, at which time they move to deeper waters. The larval or juvenile growth stage leaves inshore waters in early summer [R-289].

Near Bruce Power, Lake Whitefish eggs may be present in the shallow shoals beginning in November or December until March or April the following year. Given the extended immobile incubation of this cold water species on the substrate, Bruce Power has funded substantial research into the thermal tolerance and ecological and genetic population of Lake Whitefish near Bruce Power and across Lake Huron. Results of this research are summarized elsewhere [R-71][R-285].

Larval presence has been observed in the nearshore in April, May and June from entrainment monitoring. The growth stage is expected to be offshore but may be present in May and June. Lake Whitefish have historically been one of Lake Huron's most valuable commercial fish and are an important part of the SON commercial fishery and serve as an important traditional fishery for SON, HSM and MNO (see Appendix A Section 1.8.7).

A specific chronic MWAT temperature for Lake Whitefish eggs of 6.7°C is available. The application of the chronic MWAT for Lake Whitefish eggs requires some modification given the lengthy incubation period that encompasses significant seasonal changes by spanning from the late fall to early spring [R-330]. Early incubation exceedances of the chronic benchmark are expected. Assessment of chronic temperatures during the egg stage of Lake Whitefish is assessed using 1) modelled acute, 2) calculated chronic benchmarks and 3) throughout incubation using a rolling 7-day average of a 3°C difference between selected Reference Site temperatures and other thermal monitoring site temperatures starting on the day the rolling weekly average drops below 8°C for at least 7 days at the selected Reference Site (see Section 9.3.6.5 for details).

Baie du Doré is a shallow embayment northwest of Bruce A and is not considered a suitable spawning ground for whitefish for a variety of factors. The bathymetry of the bay is shallow, at approximately 2 meters deep, with a few deeper pockets at 3-6 meters. Substrates range from sand/silt in depositional areas to gravel, cobble, boulder and bedrock. Most of the available substrate suitable for whitefish spawning, i.e. cobble and boulder, is located on the outer edge of the bay and this area has little or no emergent vegetation, suggesting that it is exposed to considerable wind/wave action and ice scour. Baie du Doré is susceptible to ice formation and in turn more prone to have ice thick enough to scour the bottom. Ice scouring would have detrimental impacts to the survival rate of whitefish eggs and yolk sac larvae. Two larval tow studies conducted in Baie du Doré, one in 2008 [R-26] and one in 2014 [R-26] found only a single lake whitefish embryo in the bay. In summary, Baie du Doré is not considered suitable spawning habitat for whitefish because of its shallow depths, small fraction of cobble/boulder substrate, lack of species presence within the bay, and high frequency of ice formation and ice scour. Therefore, the temperature monitoring sites located within the bay (i.e. Sites BDD1, BDL1, BDL2, BDL01, BDL02, BDL03, 14, 17, 18 and 33) are not considered further in determining the potential environment experienced by whitefish embryos.

<u>Preliminary Screening</u>

Embryos

Temperatures during Lake Whitefish egg incubation are presented in Figure 86 and Figure 87 by site group. When there is a sufficient number of sites (denoted by the density of the violin plot), there are limited biologically relevant differences between LSA and reference sites in the median temperature and distribution of temperatures in a specific month, particularly early in the Lake Whitefish incubation period. Lake Whitefish incubation is defined as starting on the first date the rolling weekly average dropping below 8°C at a 5m or 10m depth reference site and remaining below 8°C for at least 7 days, to the last date of calculated median hatch based on the methodology in Section 9.3.6.4 (Table 177).

Table 177 Lake Whitefish Egg Incubation Periods, 2016-2021

Season	Incubation Start Date	Incubation End Date
Spawn 2016-2017	December 1, 2016	April 30, 2017
Spawn 2017-2018	November 21, 2017	April 27, 2018
Spawn 2018-2019	November 6, 2018	April 9, 2019
Spawn 2019-2020	November 6, 2019	April 23, 2020
Spawn 2020-2021	November 18, 2020	April 16, 2021

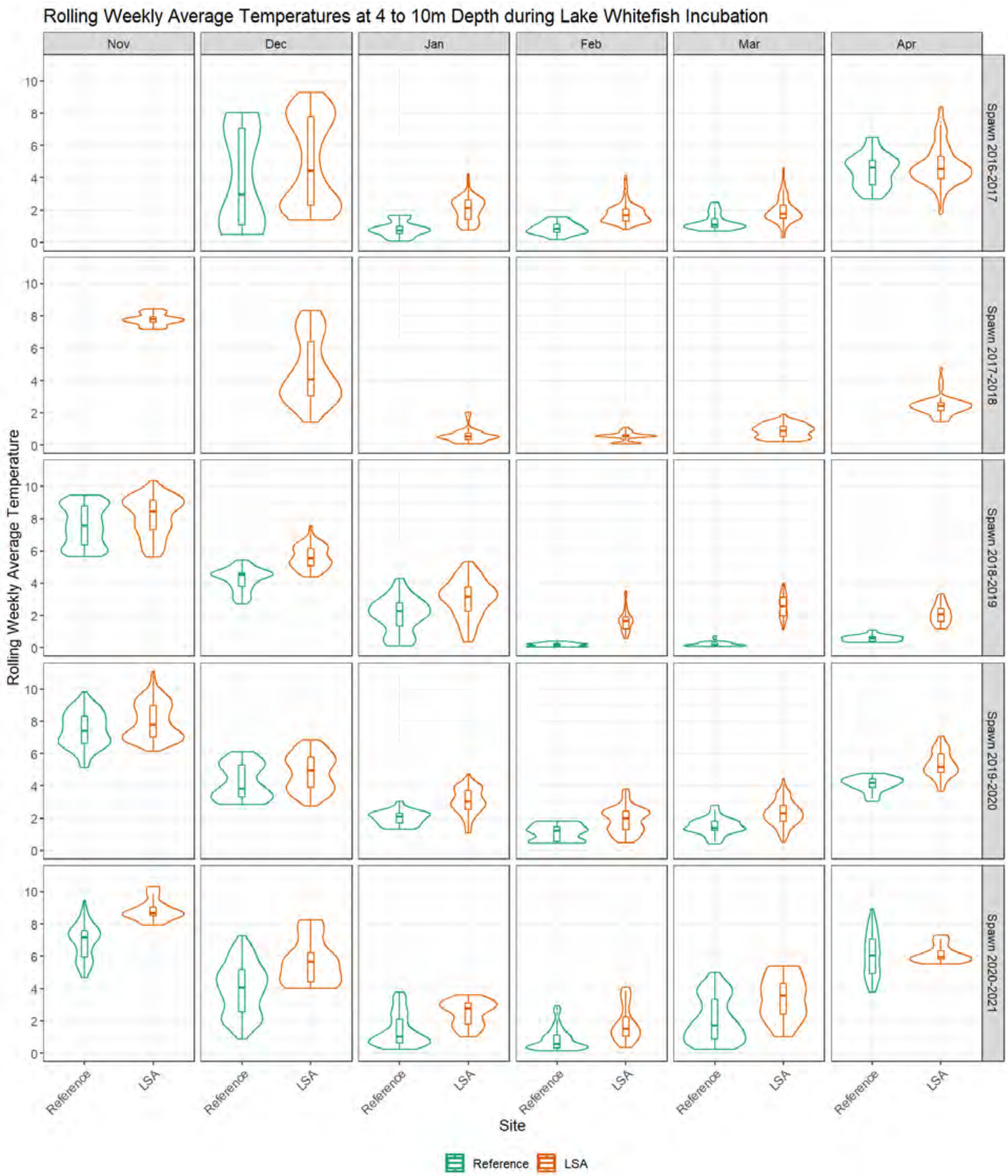

Figure 86 Rolling Weekly Average Temperatures (˚C) by Month for Reference and LSA sites, excluding sites located in Baie du Doré, for Lake Whitefish egg incubation period. Outer lines around each site group indicate density of HQ data and boxplot inside each site indicate median and interquartile range.

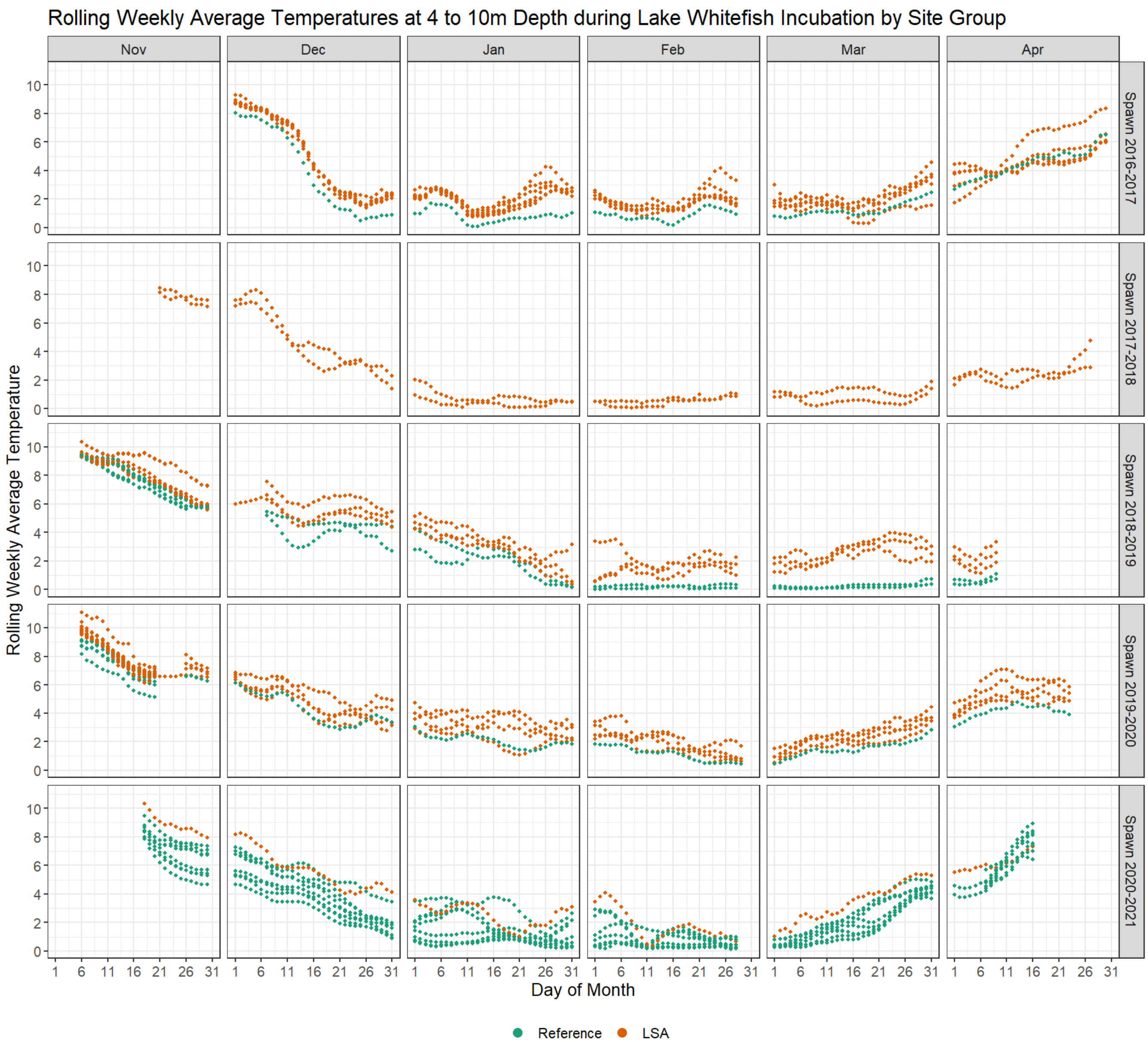

Figure 87 Rolling Weekly Average Temperature (˚C) during Lake Whitefish Egg Incubation by Site Group, excluding sites located in Baie du Doré

Acute and chronic HQs for Lake Whitefish embryos were calculated as described in the methodology and are presented using violin plots by site group in Figure 88 and over time in Figure 89.

Figure 88 HQs for Lake Whitefish Egg Incubation by Site Group, excluding sites located in Baie du Doré. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

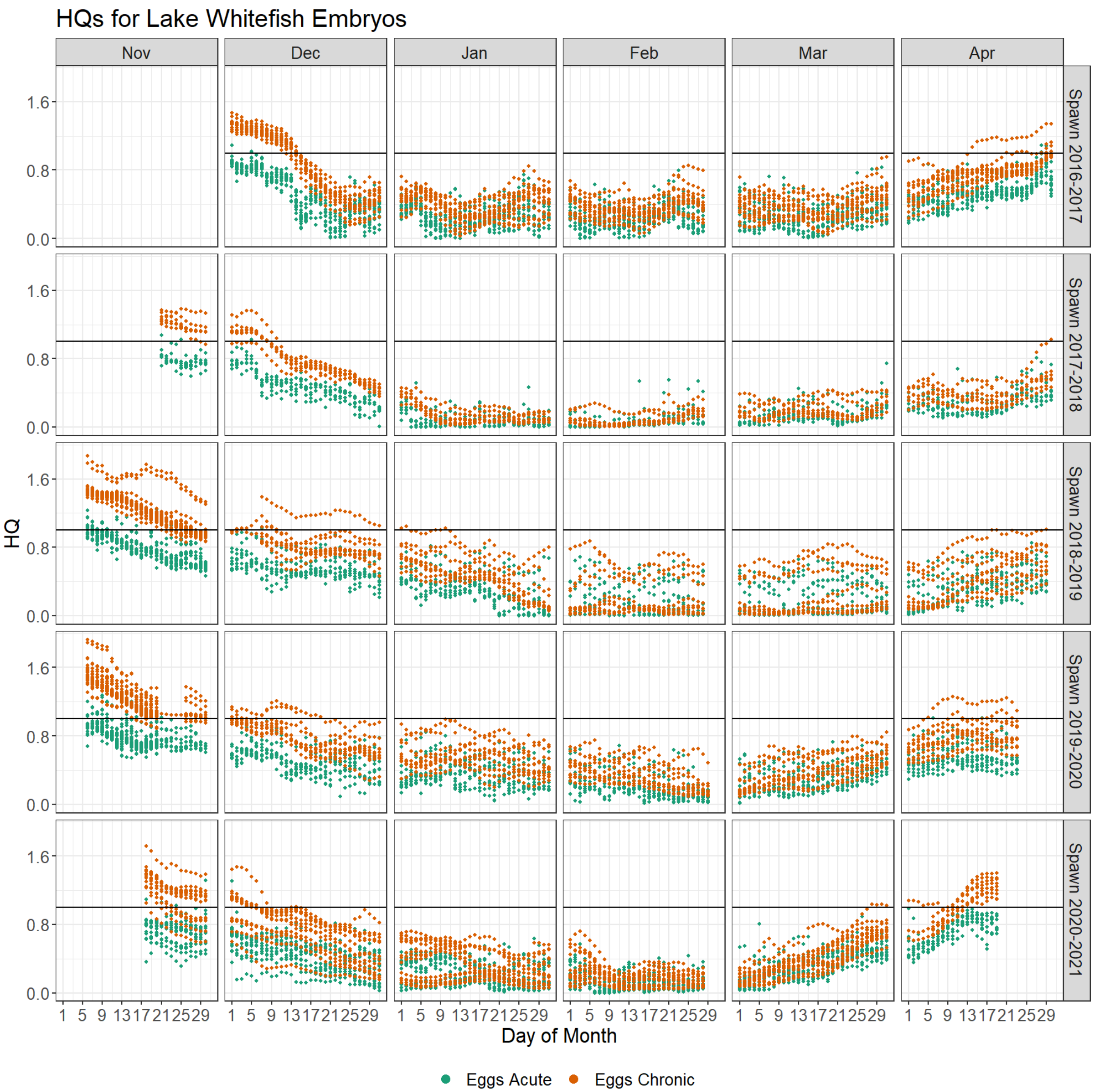

Figure 89 HQs for Lake Whitefish Eggs, excluding sites located in Baie du Doré. Black line indicates HQ of 1.0

Acute exceedances are clustered near the beginning of the incubation period, which is expected due to the small difference between the temperature threshold for the start of incubation (rolling weekly average of <8°C for at least 7 days at a reference site) and the acute benchmark of 10°C. Chronic exceedances are also clustered near the beginning of the incubation period due to the MWAT benchmark of 6.7°C being less than the rolling weekly average of 8°C that trigger the start of the incubation period. All LSA and Reference sites are showing chronic exceedances in the early portion of incubation, indicating that some portion of these exceedances are likely driven more by ambient lake temperatures than by operational effects. This is further supported by results of the Delta T threshold assessment below, where the temperature difference between LSA and Reference sites remains <3°C for the majority of the sites and dates assessed early in the incubation period.

<u>Lake Whitefish Embryos - Chronic Delta T Assessment (≤3°C Difference from Reference Site)</u>

The Primary and Secondary reference site for each LSA site was determined using the RMSE of the difference between sites within the LSA and reference sites under modelled non-operational conditions (see Sections 9.3.4.1 and 9.3.7.2 for details). The Delta T threshold of 3°C was exceeded for short periods of time in all years except 2017-2018 (Figure 90).

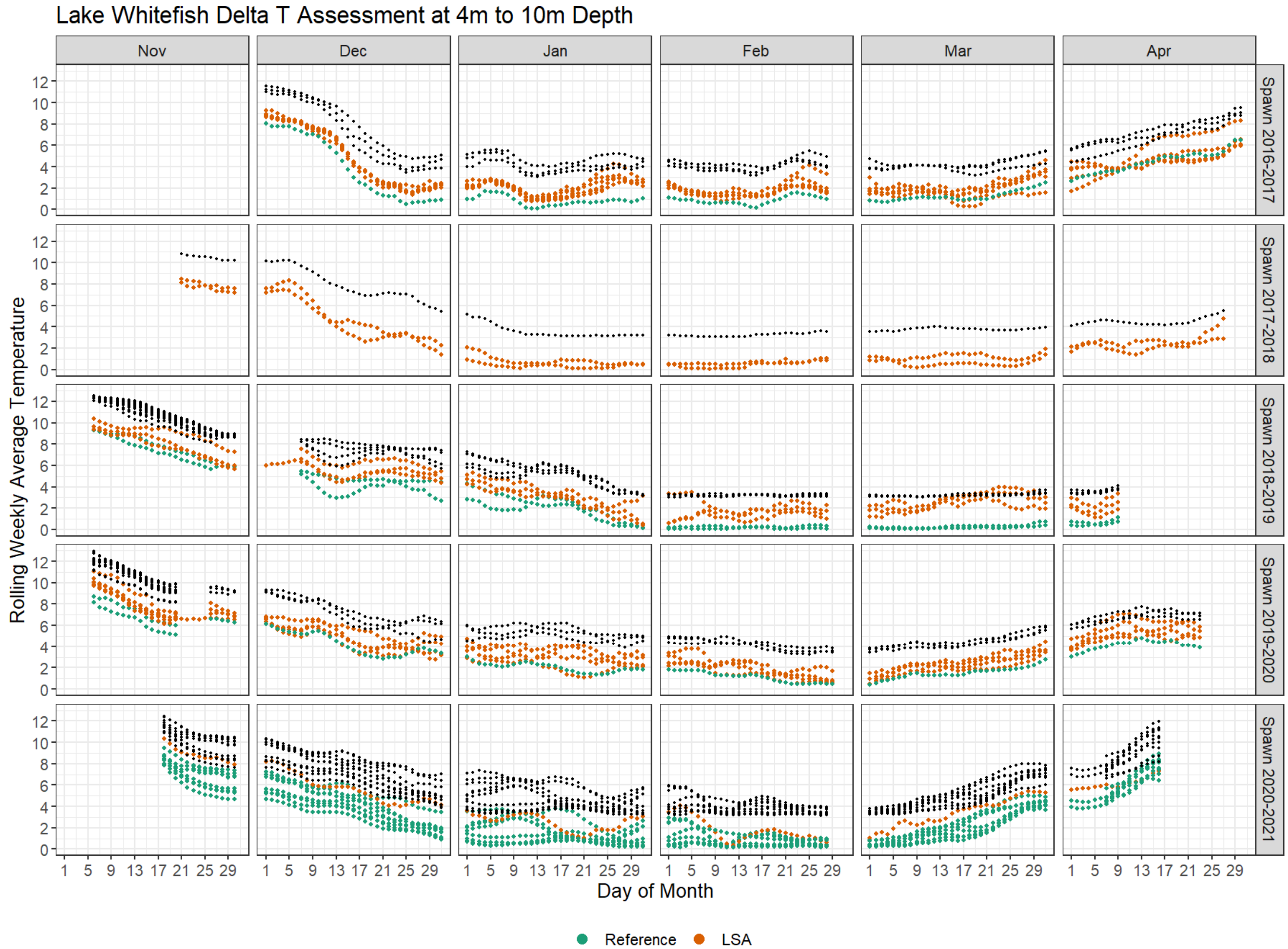

Figure 90 Delta T Assessment for Lake Whitefish Embryos for LSA (orange) and Reference (green) sites between 4m and 10m depth only. Black dotted lines indicate delta T threshold, with criteria of the reference site temperature plus 3°C for reference sites identified according to lowest RMSE. Each LSA site and depth has an assigned primary and secondary reference site and depth, resulting in multiple black dotted lines for most years assessed. Reference site depth may be <4m or >10m and green reference site temperature plots are only shown if depths are between 4m and 10m (resulting in more black lines than green lines in some years). In 2017-2018, there was no available reference site between 4m and 10m depth and a deeper reference site was used to create the black dotted reference line.

<u>Lake Whitefish Embryos – Hatch Advance</u>

Hatch advance for Lake Whitefish embryos was calculated for all applicable monitoring sites as described in the methodology in Section 9.3.6.4 and is presented in Table 178. Hatch was advanced by more than 30 days in 2018-19 at two sites and 2019-20 at three sites and this is equivalent to a HQ above 1.0.

To provide some context for the calculated hatch advance as compared to a single reference site, hatch advance outside the depths of Lake Whitefish egg incubation was examined. Hatch advance calculated for reference sites 1 and 20 at 20m depth in 2018-19 and 2019-20 also showed hatch advances of 4-15 days in 2018-19 and 22-26 days in 2019-20. This indicates that hatch at the selected reference sites in 2018-19 and 2019-20 may have been delayed compared to the remainder of the lake and that the hatch advance at sites 9, 12, 26 and 40 may have been less than 30 days if an alternative reference site had been available and was selected. The calculated hatch advance presented in this assessment represents the worst case scenario because the latest median hatch at a reference site was used as the reference site. The actual hatch advance occurring within the LSA is likely less than presented here.

Table 178 Lake Whitefish Median Hatch and Hatch Advance by Site and Year at depths of 4m to 10m

Spawn	Site	Site Group	Depth	Median Hatch	Hatch Advance
Spawn 2016-2017	21	LSA	10	April 22	8
	10	LSA	10	April 19	11
	3	LSA	5	April 22	11
	19	LSA	10	April 21	9
	32	LSA	10	April 21	9
	35	Reference	10	April 30	0
Spawn 2017-2018	3	LSA	5	April 22	5[α]
	21	LSA	5	April 22	5[α]
Spawn 2018-2019[β]	**40**	**LSA**	**5**	**February 15**	**53**
	12	**LSA**	**10**	**February 28**	**40**
	26	LSA	10	April 29	-20
	41	Reference	10	April 9	0
	39	Reference	10	March 28	12
Spawn 2019-2020[Ω]	**9**	**LSA**	**5**	**March 6**	**48**
	26	**LSA**	**10**	**March 9**	**45**
	12	**LSA**	**10**	**March 8**	**46**
	3	LSA	5	April 16	7
	39	Reference	10	April 23	0
Spawn 2020-2021	IHL01	LSA	5	March 19	28
	LI1	Reference	5	April 16	0
	LI2	Reference	8	April 19	-3
	B	Reference	10	April 11	5
	39	Reference	10	March 31	16
	41	Reference	10	April 8	8
	30	Reference	5	April 10	6
	SBL03	Reference	4	April 14	2

Spawn	Site	Site Group	Depth	Median Hatch	Hatch Advance
	SBL04	Reference	4	April 16	0

[α]Site 1 at 20m depth used as reference site for Spawn 2017-2018.
[β]Hatch advance occurred at other Reference Sites in 2018-2019 as well, including: Site 1 (North of LSA at 20m depth): **15 days** and Site 29 (South of LSA at 20m depth): **4 days**.
[Ω]Hatch advance occurred at other Reference Sites in 2019-2020 as well, including: Site 1 (North of LSA at 20m depth): **26 days**, Site 29 (South of LSA at 20m depth): **22 days**.
Green shading indicates reference site used for each year.
Bold grey shading indicates an exceedance of the 30 day hatch advance threshold.

Lake Whitefish acute, chronic, delta T and hatch advance egg benchmarks were retained for secondary screening.

Larvae and Growth

HQs for larval and growth stage Lake Whitefish were calculated as described in the methodology and are presented using violin plots by site group in Figure 91 and Figure 92 and over time in Figure 93.

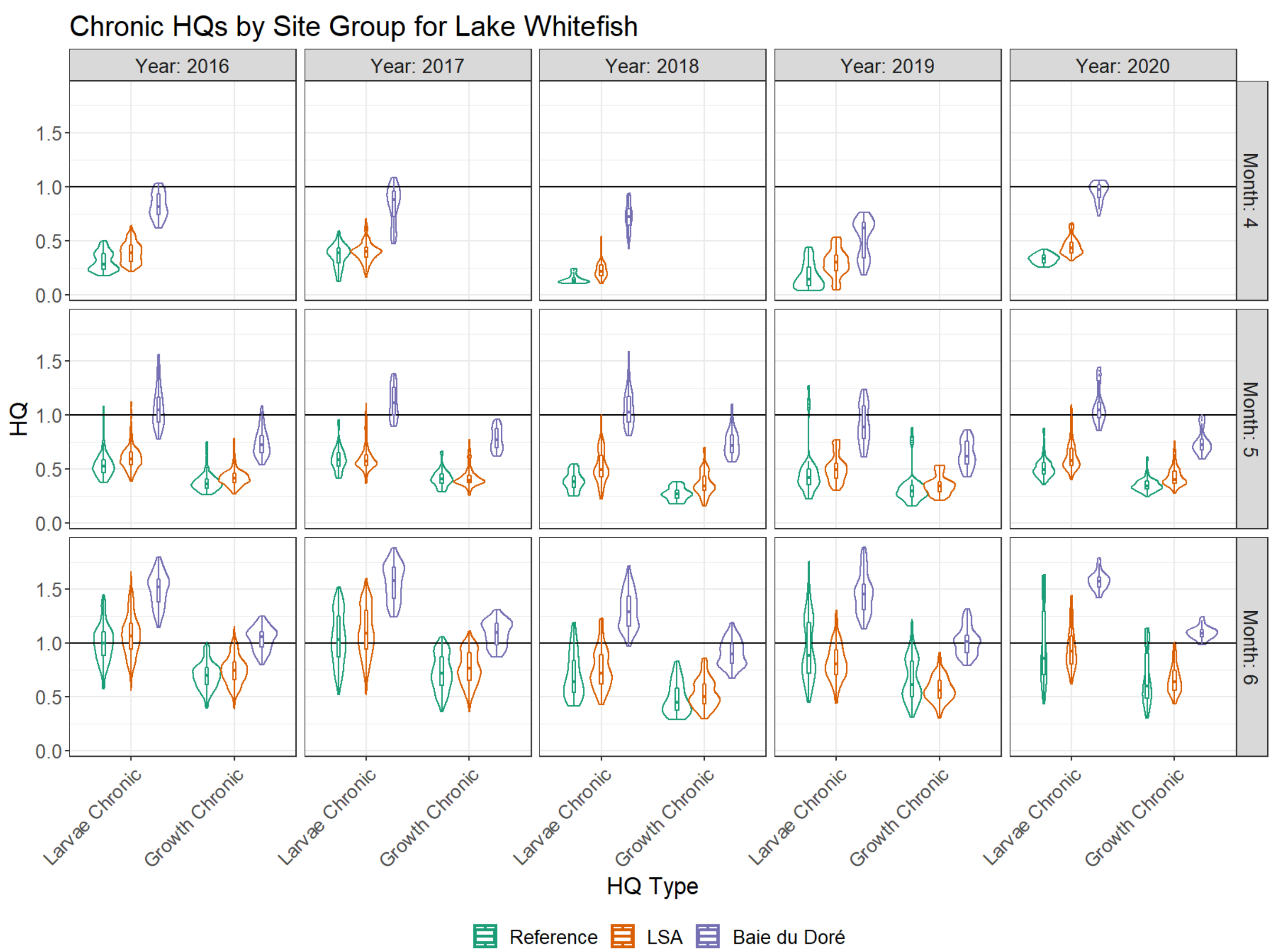

Figure 91 Chronic HQs for Lake Whitefish Larvae and Growth stages by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

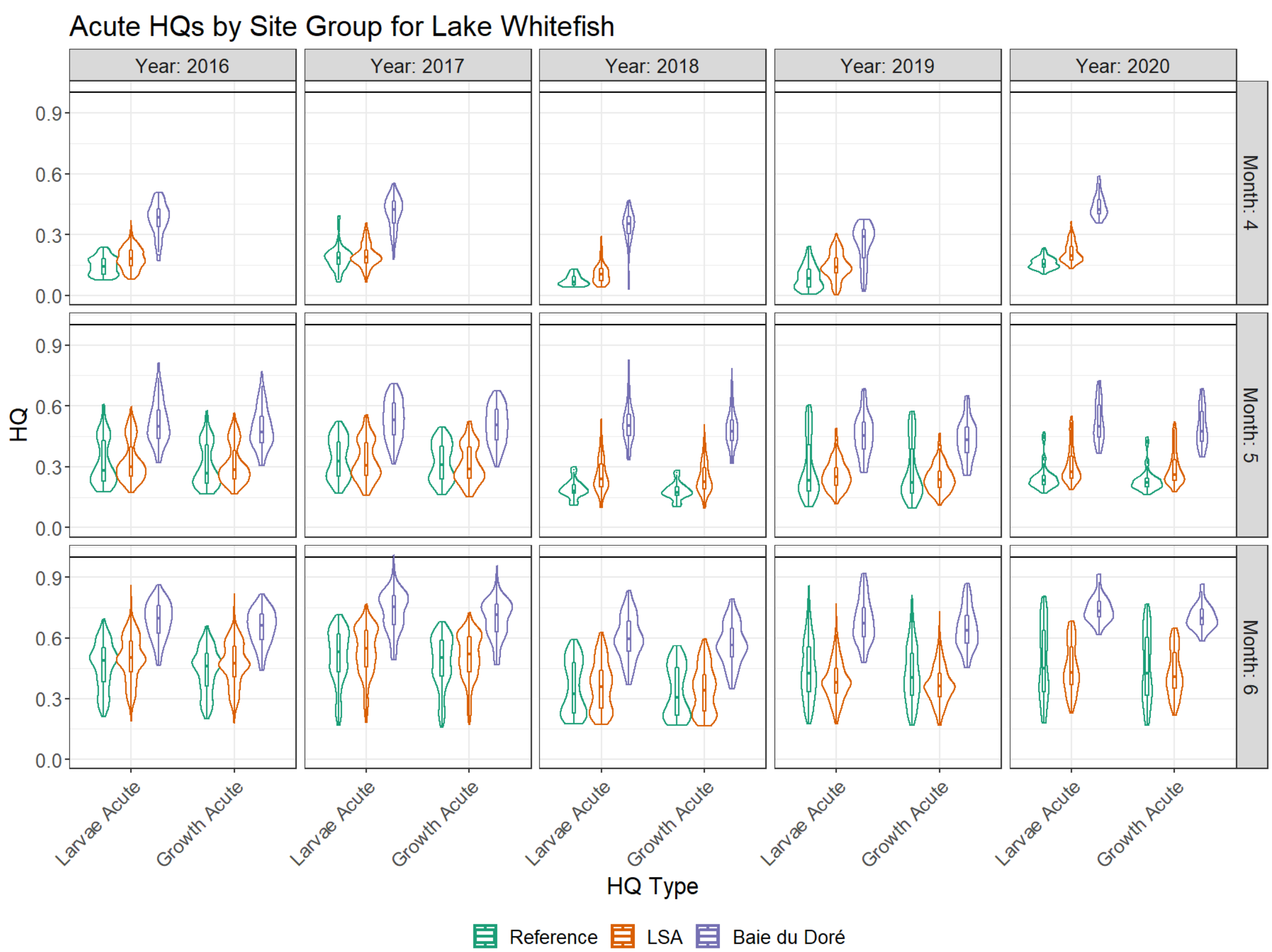

Figure 92 Acute HQs for Lake Whitefish Larval and Growth stage by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

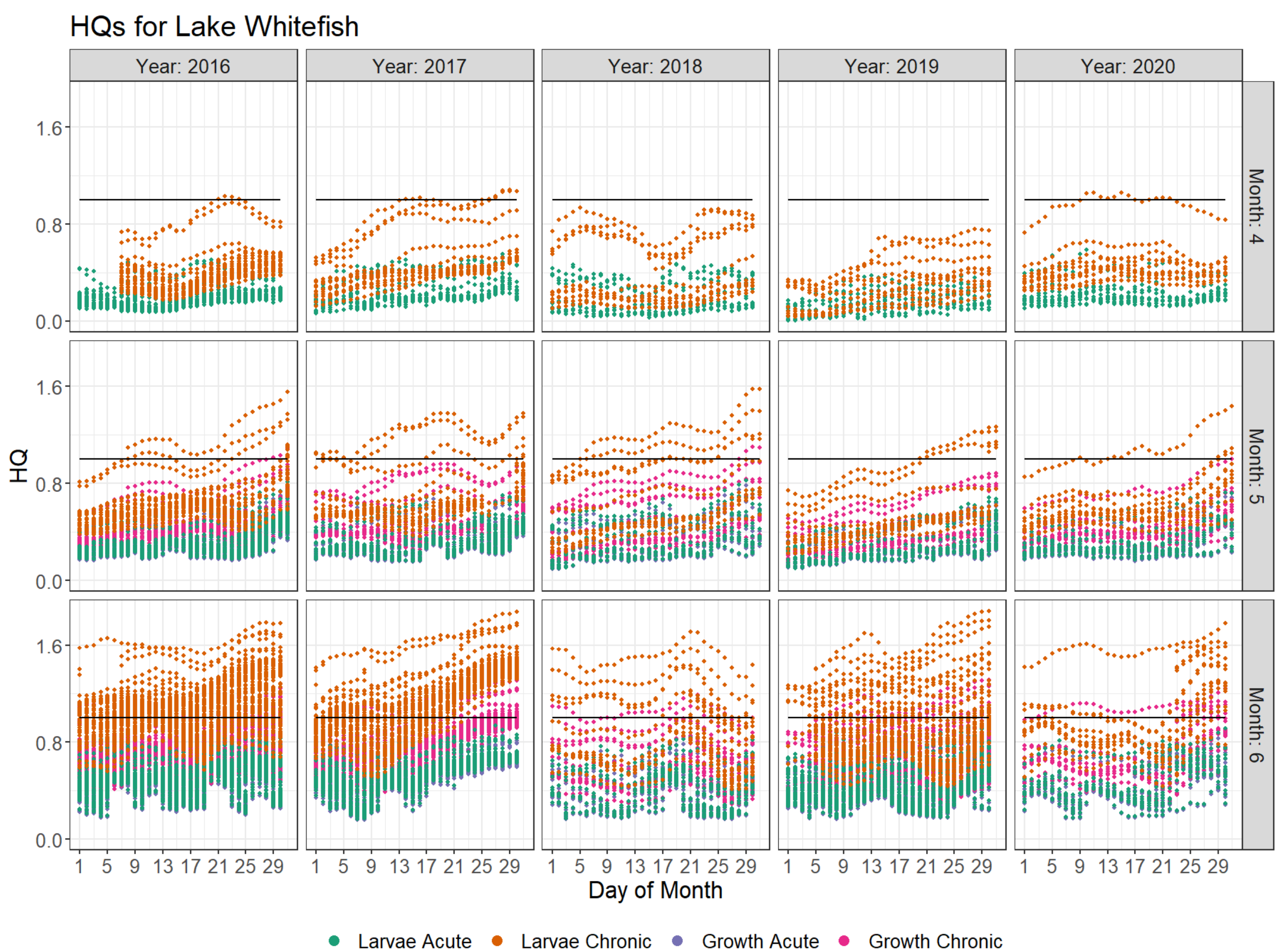

Figure 93 HQs for Lake Whitefish Larval and Growth Stage by Benchmark. Black line indicates HQ of 1.0.

Widespread chronic larval and growth HQ exceedances occurred for all months assessed in Baie du Doré. Intermittent chronic larval and growth exceedances occurred in the LSA and at Reference sites, with the magnitude and number of the HQ exceedances increasing in June of each year. Lake Whitefish chronic larval and growth benchmarks were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment of acute larval or growth Lake Whitefish benchmarks is required.

<u>Secondary Screening</u>

Embryos

Hatch advance occurred in two of the five years considered and was retained for assessment in the TRA.

There were no exceedances of the delta T threshold in 2017-2018 (Table 179) calculated as per the methodology described in Section 9.3.6.5. The delta T assessment shows infrequent exceedances of the 3°C threshold in 2016-2017 and 2019-2020. In 2018-2019, there were 22 exceedances in March of 2019, with 3 occurring at Site 26, 6 occurring at Site 12 and 13 occurring at Site 40. In 2020-21, there were a number of exceedances in November and December, all of which occurred at IHL01 near Inverhuron. Delta T exceedances in the LSA were retained for assessment in the TRA.

Table 179 Number of exceedances of Primary and Secondary Delta T threshold of 3°C by site group for Lake Whitefish Embryos at depths of 4m to 10m

Lake Whitefish (Bottom)		2016-17		2017-18		2018-19		2019-20		2020-21	
		T>Δ 3°C	Total	T>Δ 3°C	Total	T>Δ 3°C	Total	T>Δ 3°C	Total	T>Δ 3°C	Total
Eggs (Chronic)											
LSA	Nov	NA	NA	-	10	6	118	4	185	13	52
	Dec	-	155	-	31	1	84	4	136	29	118
	Jan	3	164	-	31	1	96	1	127	-	31
	Feb	-	140	-	28	6	90	-	116	4	40
	Mar	2	161	-	31	22	111	-	124	-	31
	Apr	3	159	-	27	-	27	7	113	-	16
NA: Not Applicable because the spawn did not start in November of 2016.											

A count of significant acute HQ exceedances for the egg stage is presented in Table 180 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. These limited number of significant exceedances occurred in the early part of incubation period, when the acute threshold of 10°C is only 2°C higher than the rolling weekly average temperature of 8°C. All of the acute LSA site exceedances occurred during the month of November.

Chronic HQ exceedances were concentrated in November and December as the lake cooled from the 8°C egg incubation starting temperature to the egg MWAT benchmark of 6.7°C. Chronic egg stage exceedances also occurred in the spring mainly in April, but these were likely after the lake warming process had triggered hatch for any eggs present. Chronic and acute egg benchmark exceedances in the LSA were retained for assessment in the TRA.

Table 180 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Lake Whitefish Embryos at depths of 4m to 10m

Lake Whitefish (Bottom)		2016-17		2017-18		2018-19		2019-20		2020-21	
		HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Chronic)[β]											
LSA*	Nov	-	-	10	10	20	100	11	171	-	13
	Dec	68	155	10	31	34	81	32	124	-	31
	Mar	-	155	-	31	-	93	-	124	4	31
	Apr	21	150	-	30	-	87	26	92	15[μ]	19

Lake Whitefish (Bottom)		2016-17		2017-18		2018-19		2019-20		2020-21	
		HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Ref.	Nov	-	-	-	-	77	100	44	50	67	104
	Dec	11	31	-	-	-	50	-	31	24	248
	Mar	-	31	-	-	-	62	-	31	-	248
	Apr	-	30	-	-	-	58	-	23	144	210
Eggs (Acute) [β]											
LSA*	Nov	-	-	-	10	12	100	6	189	5	13
Ref.	Nov	-	-	-	-	-	100	-	56	-	104

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA. For April 2021 only, all thermal exceedances are presented.
[β]Differences in total number of HQs calculated for acute and chronic results are related to the use of 7-day moving averages for chronic temperature data aggregation (i.e., no HQs calculated for the first 6 days of a deployment).
[μ] Only duration considered for thermal exceedances in April 2021. No consideration of reference site exceedances or spatial extent, resulting in additional thermal benchmark exceedances included.
Ref.: Reference Site

Larvae and Growth

A count of significant HQ exceedances for chronic larval and growth stages is presented in Table 181 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Thermal exceedances occurred mainly in Baie du Doré, but also intermittently in the LSA and at reference sites. Chronic larval and growth exceedances in Baie du Doré and the LSA were retained for assessment in the TRA.

Table 181 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Larval and Growth Lake Whitefish

Lake Whitefish (Bottom)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Larvae (Chronic)										
Baie du Doré*	13	128	4	108	123	273	37	89	-	-
LSA*	34	1,496	45	978	9	465	9	529	70	637
Reference	75	501	64	316	1	111	10	340	35	297
Growth (Chronic)										
Baie du Doré*	29	104	12	78	-	183	1	59	-	-
LSA*	-	992	7	648	-	315	-	379	2	427
Reference	-	333	1	226	-	81	-	220	71	122

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

Embryos

The delta T assessment shows no exceedances in 2017-2018 and limited exceedances in other years of a difference of greater than 3°C between reference sites selected based on the lowest RMSE and sites within the LSA, excluding those in Baie du Doré. There were 22 exceedances in March of 2019 at Sites 12, 26 and 40. Given the hatch advance estimated to have occurred at these sites (Table 178), any embryos incubating there would already have hatched and not likely exposed to these thermal conditions. In 2020-21, there were a number of delta T exceedances in November and December, all of which occurred at IHL01. Despite these exceedances, hatch advance at this site remained below the threshold (<30 days advanced).

The extents of the significant thermal exceedances for the acute and chronic threshold for Lake Whitefish embryos are presented in Table 182 according to the criteria described in Section 9.3.8.1. Significant chronic HQ exceedances in November 2017, 2018 and 2019 and December of 2016 and 2017 encompass a large portion of the LSA, however, they are concentrated in the first several weeks after the start of the spawning period when the starting temperature threshold of 10°C is only 2°C higher than the rolling weekly average temperature of 8°C. Lim et al. (2017) incubated Lake Whitefish embryos under a seasonal regime starting at 8°C and decreasing by 1°C per week for 6 weeks with 3°C 1-hour heat shock every 2 to 3 days (i.e., reaching temperatures of up to 11°C) and achieved similar survival results to Lake Whitefish embryos incubated under a constant 2°C regime or under a seasonal regime without heat shocks.[R-330] The success of the seasonal regime with heat shocks used by Lim et al. (2017) suggests that embryos exposed to the thermal conditions near Bruce Power will develop and hatch successfully.

Table 182 Median (25^{th} - 75^{th} percentile) extent of LSA (%) at 4m to 10m depth with significant thermal exceedances for Lake Whitefish embryos

Lake Whitefish (Bottom)	2016-17	2017-18	2018-19	2019-20	2020-21
Eggs (Chronic)					
November	NA	**100 (100-100)**	**62 (33-71)**	**71 (59-75)**	--
December	**100 (74-100)**	**98 (78-98)**	10 (6-26)	8 (5-15)	--
January	--	--	--	--	--
February	--	--	--	--	--
March	--	--	--	--	8 (8-9)
April	**51 (43-54)**	--	--	**13 (10-18)**	NA
Eggs (Acute)					
November	NA	--	**20 (9-29)**	10 (6-15)	**18 (7-19)**

Shading indicates median extent of LSA is greater than 10%.
NA: Not applicable due to 1) December start date in 2016 and 2) LSA risk characterization not completed for April of 2021.
Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as "--"in the table.

Hatch advance of greater than 30 days occurred in 2018-2019 and 2019-2020. In both of the years with significant hatch advance, the selection of the reference site logger influenced the calculated hatch advance significantly. In 2018-19, hatch advance at the remaining reference sites were advanced by 12, 15 and 4 days at Sites 39 (10m depth), 1 (20m depth) and 29 (20m depth) compared to Site 41 (10m depth). In 2019-20, hatch advance at the remaining reference sites was advanced by 22 and 26 days at Site 29 (20m depth) and Site 1 (20 m depth) compared to Site 39 (10m depth). Using a different reference site would have rendered the hatch advance to be <30 days at all sites except Site 40 in 2018-2019. As a result, the risk related to advance hatch is assessed as low given the hatch advance occurring at other reference sites.

Information from industry and academic research is available to provide ecological context to these risk assessment results. Several years of gill netting during spawning season as well as a larger mark and recapture study demonstrated that spawning whitefish were not abundant in the vicinity of the site.[R-285] Spawning Lake and Round Whitefish likely use a much broader local area during spawning season. Work by Graham et al. (2016) and Eberts et al. (2017) from the University of Regina supports this with both ecological and genetic analyses failing to find small local Lake Whitefish populations near Bruce Power.[R-295][R-296] Extensive mixing of Lake Whitefish populations occurred from summer to fall throughout Lake Huron.[R-296] If Bruce Power were to use genetic and ecological niche research to delineate the local population of Lake Whitefish, the local area would encompass the entire eastern coastline of Lake Huron.

Given the overall findings of the thermal risk assessment for Lake Whitefish embryos, including delta T and hatch advance exceedances in small areas of the LSA and the ecological context for Lake Whitefish spawning behaviour, thermal effluent from Bruce Power likely poses a low risk to the development, survival and reproductive success for the low abundance of embryos likely to be incubating near Bruce Power and no unreasonable risk to the reproductive success of Lake Whitefish in the main basin of Lake Huron.

Larvae and Growth

The extent of the significant thermal exceedances for the chronic threshold of larval and growth stage Lake Whitefish are presented in Table 183 according to the criteria described in Section 9.3.8.1.

Table 183 Median (25th - 75th percentile) extent of LSA (%) with significant thermal exceedances for larval and growth stage Lake Whitefish

Lake Whitefish (Bottom)	2016	2017	2018	2019	2020
Growth (Chronic)					
June	1 (0-1)	**30 (9-38)**	--	--	--
Larvae (Chronic)					
May	--	--	1 (1-9)	--	--
June	**40 (32-44)**	**30 (9-77)**	5 (3-16)	**32 (23-39)**	**43 (30-78)**
Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.					

By June, when all of the HQ exceedances encompassing over 10% of the LSA occur, larvae are approximately 2 months of age and will tolerate water temperatures of 16 to 19°C with low mortality, based on work by Patrick et al. (2014).[R-346] Given the long larval development period, and similar to the embryonic stage, larval Lake Whitefish likely have an increased thermal tolerance as they age. Given this biological context for tolerance of water temperatures above the assessed thermal benchmark, the overall risk to larval Lake Whitefish posed by thermal effluent from the Bruce Power site is low.

Lake Whitefish in the growth stage have greater mobility than their larval counterparts and are able to seek deeper waters and/or alternative feeding locations. Additionally, a study examining growth of Lake Whitefish in Lake Huron modelled increased growth with warming water temperature under a climate change scenario with high prey consumption but decreased growth if prey availability was reduced.[R-347] Given the single year of the exceedance in the five years assessed, the mobility of the life stage, and the similarities between the temperature profiles at LSA and Reference sites, the risk to the growth stage of Lake Whitefish is low.

Thermal effluent in the LSA poses an overall low risk to egg, larval and growth stage Lake Whitefish in the LSA and no unreasonable risk to the overall Lake Whitefish population in the main basin of Lake Huron.

9.5.1.5 Round Whitefish

Round Whitefish spawn in mid-November to mid-December when lake temperatures are 4.5°C. Spawning occurs over gravel/cobble/boulder shallows at depths of 4-15m and eggs incubate for a period of 4-5 months and hatch in the spring in March to April.[R-289] Adults are known to be present near the Bruce Power site from impingement monitoring. Round Whitefish are not a sought after sport or commercial species.

In the local area, Round Whitefish may utilize the same spawning grounds as Lake Whitefish which are the shallow, rocky shoals at depths <15m. Eggs may be present for 4-5 months from December through March or April. Given the extended immobile incubation of this cold water species on the substrate, Bruce Power has funded substantial research into the thermal tolerance and ecological and genetic population of Round Whitefish near Bruce Power. Results of this research are summarized elsewhere [R-71][R-285].

Larvae could be in the nearshore in April through May, at which time they move to deeper waters. The growth stage is not expected to be in the nearshore.

A specific chronic MWAT temperature for Round Whitefish eggs has been modelled at 5.4°C. The application of the modelled MWAT requires some modification given the lengthy incubation period that encompasses significant seasonal changes by spanning from the late fall to early spring [R-329]. Exceedances of the modelled MWAT value are expected early in incubation. Assessment of chronic temperatures during the egg stage of Round Whitefish is covered by specific Block 1 Round Whitefish criteria in the first 30 days and throughout incubation using a rolling 7-day average of a 3°C difference between the non-operational

RMSE-based reference site temperatures and the LSA site temperatures (sees 9.3.6.5 for details).

Preliminary Screening

Embryos

The time period assessed for Round Whitefish embryos in each year is listed in Table 184 and determined by a start date of the first day the rolling weekly average falls below 5.5°C at a 5m or 10m depth reference site and remains there for at least 7 days. The duration of Block 1 is set at 30 days from the start date. The incubation end date is based on the last median hatch date calculated for Lake Whitefish, due to the slightly shorter incubation period of Round Whitefish and the lack of a suitable hatch timing model for Round Whitefish.

Table 184 Round Whitefish Egg Incubation Period Start Dates for 2022 ERA Thermal Risk Assessment

Season	Start Date Site	Start Date	Block 1 End Date	Incubation End Date
2016-2017	35	December 11, 2016	January 10, 2017	April 30, 2017
2017-2018	3*	December 10, 2017	January 9, 2018	April 27, 2018
2018-2019	39	December 6, 2018	January 5, 2019	April 9, 2019
2019-2020	30	December 4, 2019	January 3, 2019	April 23, 2020
2020-2021	30	December 7, 2020	January 6, 2021	April 16, 2021

*No reference site available to use as start date in 2017-2018. Site 3 chosen as the farthest available site from the source of thermal effluent at a depth of between 4m and 10m.

Round Whitefish Embryos Block 1 – Chronic Benchmark Assessment (6°C Average)

Temperatures at thermal monitoring sites located at 5m and 10m depth did not exceed the Round Whitefish embryo Block 1 chronic criteria of 6°C (Table 185).

Table 185 Round Whitefish Egg Incubation Average Temperature during Block 1 for thermal monitoring sites at 4m to 10m depth, excluding those in Baie due Doré

Season	Site Group	Site	Depth	Average Temperature (°C)
2016-17	LSA	3	5	2.4
		10	10	2.2
		19	10	2.3
		20	5	2.3
		21	10	2.4
		32	10	2.2
	Reference	35	10	1.2
2017-18	LSA	3	5	1.9
		21	5	2.6
2018-19	LSA	12	10	4.7
		26	10	4.9
		40	5	5.8

Season	Site Group	Site	Depth	Average Temperature (°C)
	Reference	39	10	4.4
		41	10	3.2
2019-20	LSA	3	5	4.1
		9	5	5.1
		12	10	3.9
		26	10	4.4
	Reference	39	10	3.6
2020-21	LSA	IHL01	5	4.4
	Reference	SBL03	4	1.7
		SBL04	4	2.0
		30	5	3.0
		39	10	4.6
		41	10	3.5
		LI1	5	2.6
		LI2	8	2.2
		B	10	3.3

Round Whitefish Embryos Block 1 – Sub-Chronic Benchmark Assessment (8.5°C Rolling Weekly Average)

No exceedances of the Round Whitefish embryo Block 1 sub-chronic criteria were found at any of the 4-10m thermal monitoring sites (Figure 94).

Figure 94 Round Whitefish Block 1 Sub-Chronic Assessment showing Rolling Weekly Average Temperatures for Sites at 4m to 10m Depth, excluding Sites in Baie du Doré. Black lines indicate sub-chronic threshold of 8.5°C.

<u>Round Whitefish Embryos Block 1 – Acute Benchmark Assessment (10°C for 6 hours)</u>

No exceedances were found of the Round Whitefish embryo Block 1 assessment criteria of 10°C for 6 hours (Figure 95). Over 5 years of thermal monitoring during Block 1, the hourly temperatures during Block 1 exceeded 10°C for a single hour on December 7, 2018 at 5:00 AM. The seasonal plus heat shock regime used by Lim et al. (2018) reached temperatures of up to 11°C and achieved similar survival results (26% versus 30%) to Round Whitefish embryos incubated under a constant 2°C regime or under a seasonal regime without heat shocks [R-329]. No impact on Round Whitefish embryos survival is expected based on the results presented.

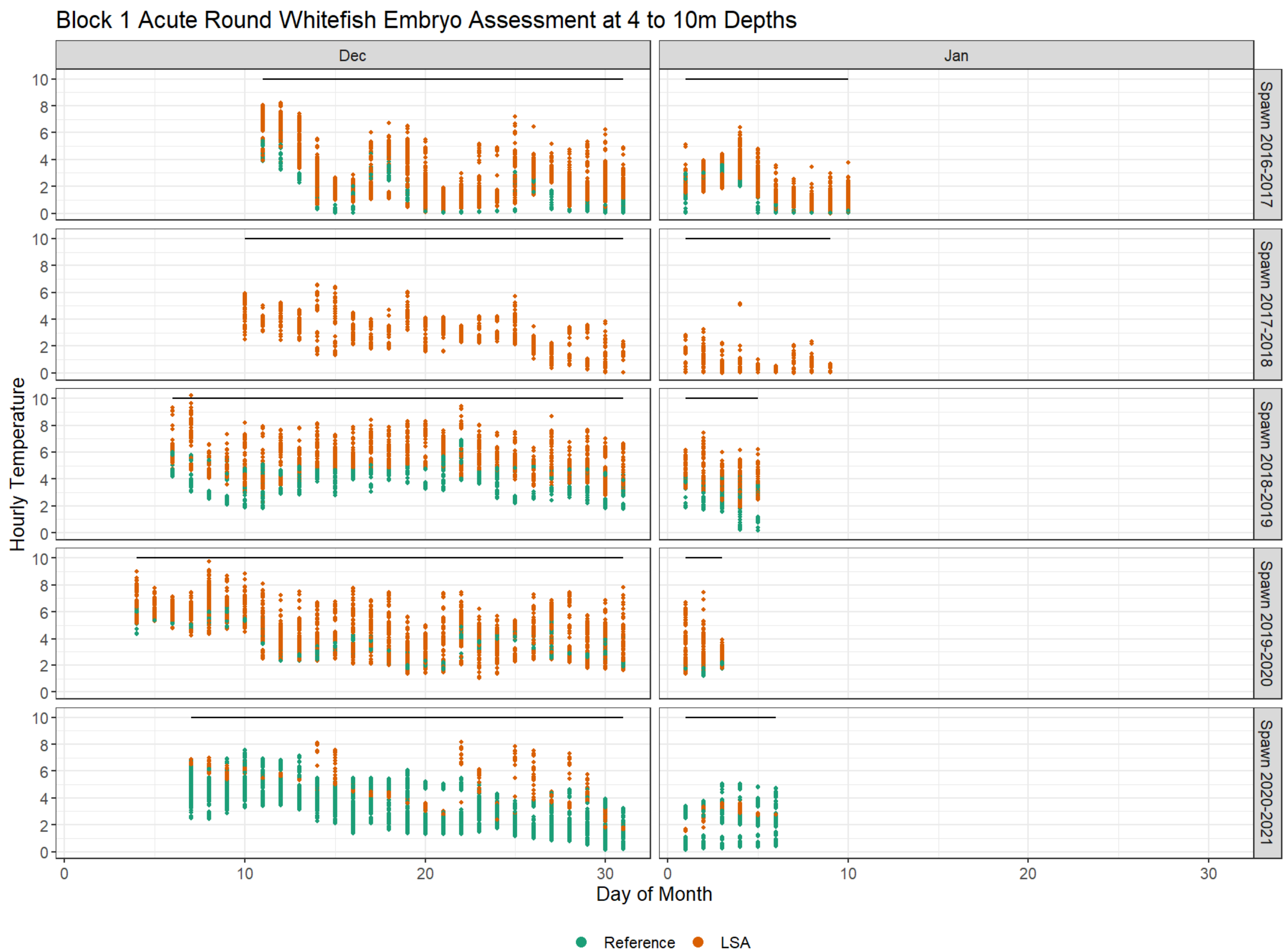

Figure 95 Round Whitefish Block 1 Acute Assessment showing Hourly Temperatures for Sites at 4m to 10m Depth, excluding Sites in Baie du Doré. Black lines indicate acute threshold of 10°C.

Round Whitefish Embryos Block 1 – Spatial Extent (>10% of LSA at ≥3° Difference between Operations and Non-Operations at the 25th, 50th and 75th percentile)

The spatial extent of the LSA affected by a modelled 3°C difference between operational and non-operational conditions is shown in Table 186. Compared to the 10% criteria, no exceedances occurred at the 25th or 50th percentile during Round Whitefish Block 1. At the 75th percentile, small exceedances of the 10% criteria occurred during Round Whitefish Block 1 in 2018-19 and 2019-2020.

Table 186 Spatial extent of 3°C difference between operational and non-operational conditions during Round Whitefish Block 1 for the 2022 ERA

Year	25th Percentile		50th Percentile		75th Percentile	
	Area (km^2)	%LSA	Area (km^2)	% LSA	Area (km^2)	%LSA

2016-17	1.74	1.9	3.77	4.2	6.68	7.5
2017-18	0.09	0.1	1.68	1.9	6.00	6.7
2018-19	1.53	1.7	5.90	6.6	**10.53**	**11.8**
2019-20	2.55	2.9	6.91	7.7	**10.83**	**12.1**
2020-21	0.19	0.2	3.50	2.9	9.36	10.5

Shading indicated an exceedance of the 10% spatial criteria.

Round Whitefish Embryos - Chronic Risk Assessment (≤3°C Difference from Reference Site)

The Primary and Secondary reference site for each LSA site was determined using the RMSE of the difference between sites within the LSA and reference sites under modelled non-operational conditions (see Sections 9.3.4.1 and 9.4.3.3 for details). Temperatures were typically below the Delta T threshold of 3°C, although there were short periods of time when the threshold was exceeded in all years except 2017-2018 (Figure 96).

Figure 96 Delta T Assessment for Round Whitefish Embryos. Black dotted lines indicate delta T threshold, with criteria of the reference site temperature plus 3°C for reference sites identified according to lowest RMSE. Each LSA site and depth has an assigned primary and secondary reference site and depth, resulting in multiple black dotted lines for most years assessed. Reference site depth may be <4m or >10m and green reference site temperature plots are only shown if depths are between 4m and 10m (resulting in more black lines than green lines in some years). In 2017-2018, there was no available reference site between 4m and 10m depth and a deeper reference site was used to create the black dotted reference line.

Acute and Chronic Benchmark Assessment – Entire Incubation Period

HQs for egg stage Round Whitefish were calculated as described in the methodology and are presented using violin plots by site group in Figure 97 and over time in Figure 98. The chronic thermal benchmark exceedances are clustered at the beginning and end of the Round Whitefish egg incubation period. Acute thermal exceedances occur at the end of the incubation period in 2017.

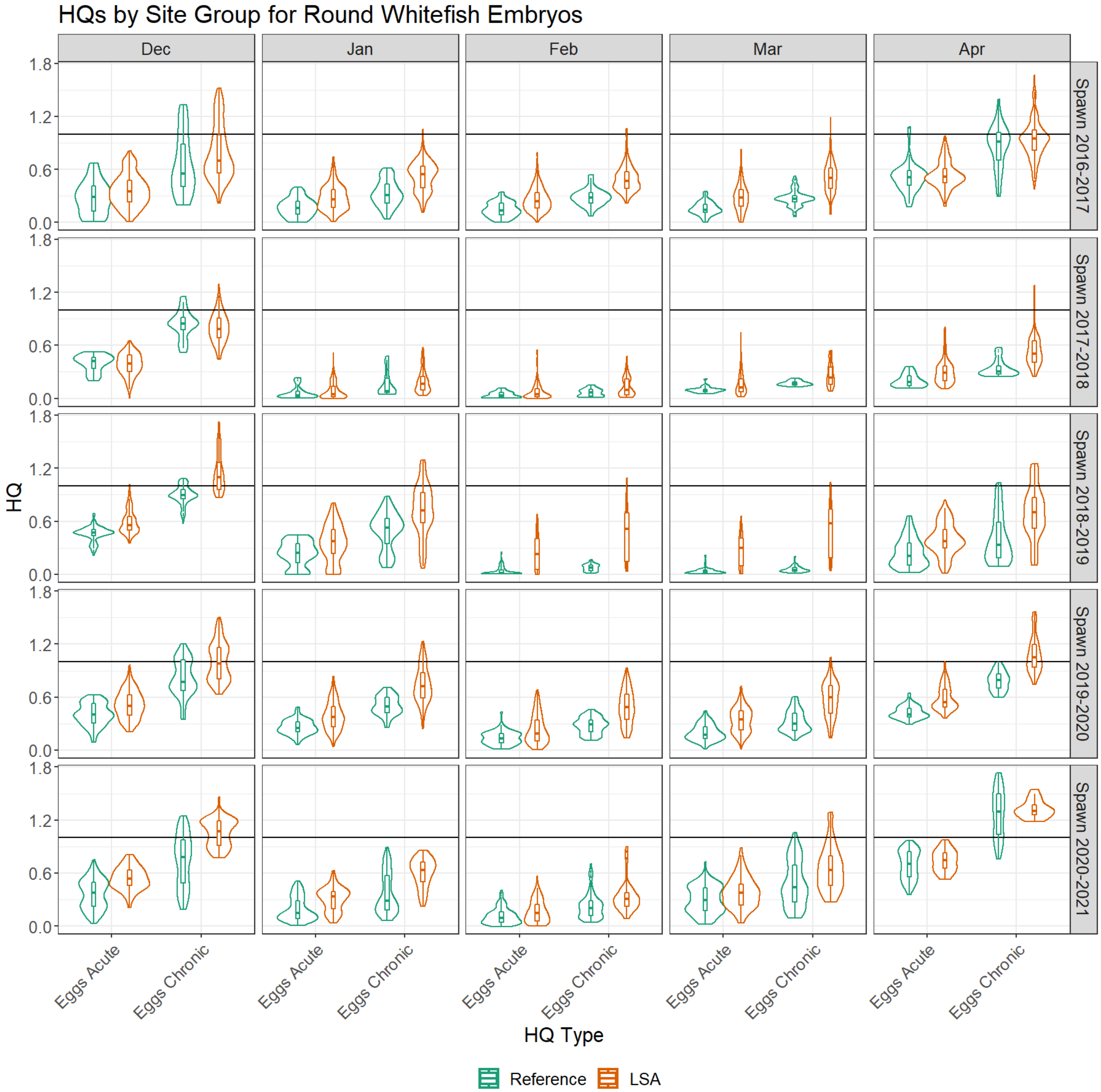

Figure 97 HQs for Round Whitefish Eggs by Site at Depths of between 4m and 10m. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

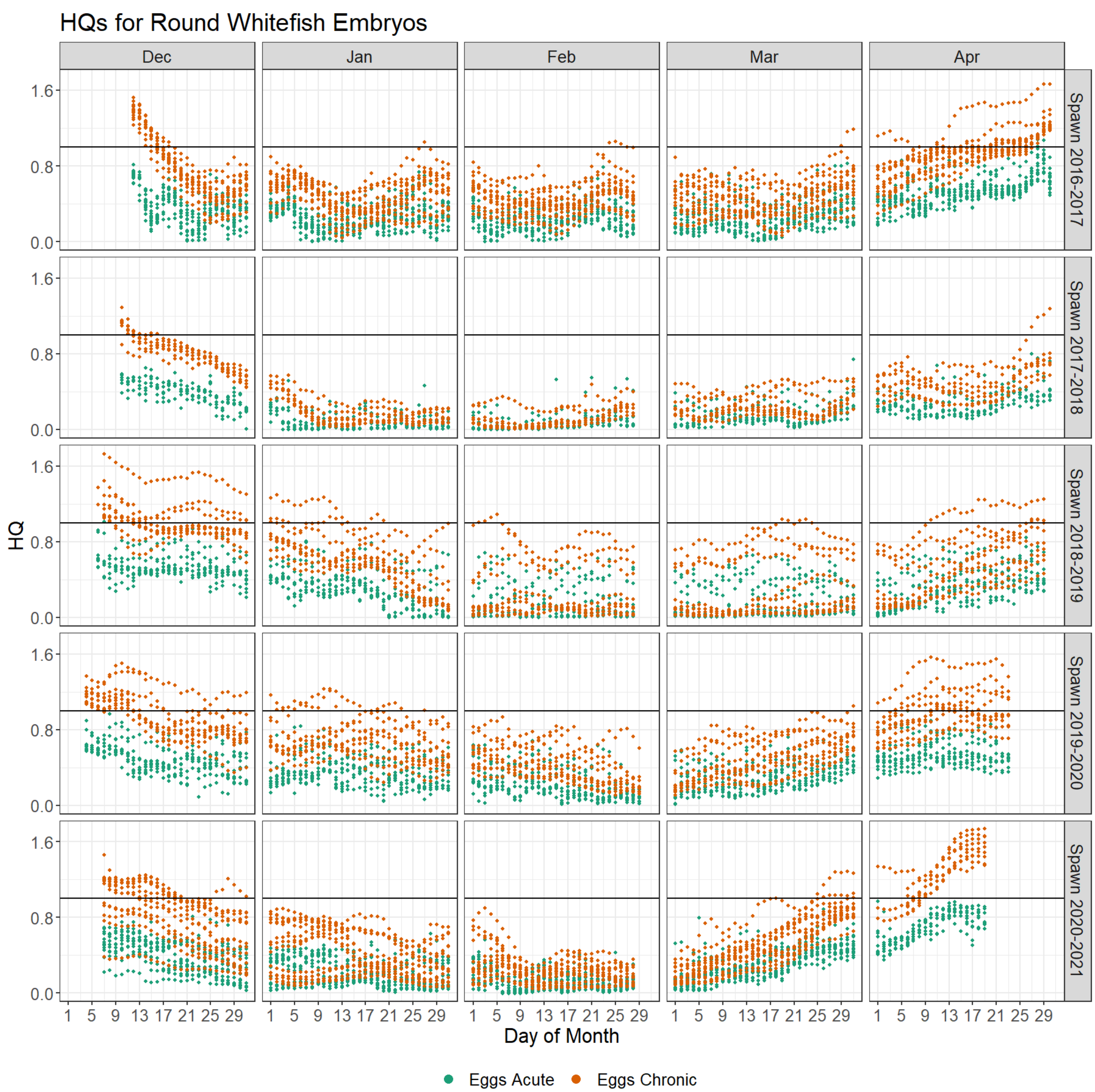

Figure 98 HQs for Round Whitefish Eggs at Depths of Between 4m and 10m by Benchmark. Black line indicates HQ of 1.0.

For Block 1 benchmarks, the chronic, sub-chronic or acute benchmarks for Round Whitefish were excluded from further assessment following the preliminary screening due to a lack of thermal exceedances. The Block 1 spatial extent of the 3°C difference between operational and non-operational conditions was retained for assessment in the secondary screening. For benchmarks covering the entire incubation period, the acute, chronic and delta T benchmark were retained for assessment in the secondary screening.

Larvae

Acute and chronic HQs for larval Round Whitefish were calculated as described in the methodology and are presented using violin plots by site group in Figure 99 and over time in Figure 100. There were no acute threshold exceedances. Widespread chronic larval HQ exceedances occurred for all months assessed in Baie du Doré. Intermittent chronic larval exceedances occurred in the remainder of the LSA and at Reference sites.

Figure 99 HQs for Round Whitefish Larvae by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

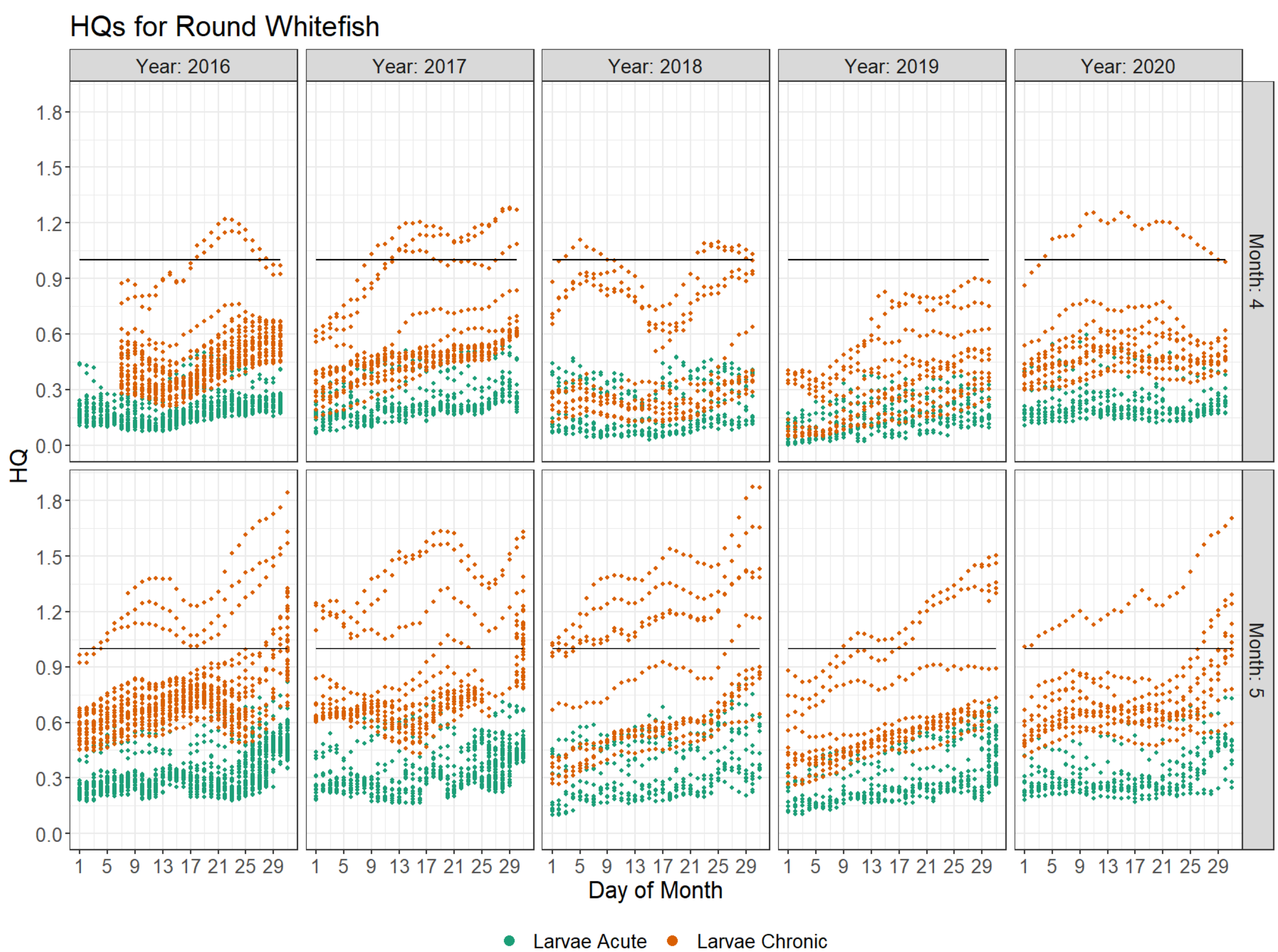

Figure 100 HQs for Round Whitefish Larval Stage by Benchmark. Black line indicates HQ of 1.0.

The chronic larval benchmark was retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment of the acute larval threshold was required.

Secondary Screening

Embryos

During Block 1, there were no exceedances of the chronic, sub-chronic or acute benchmarks for Round Whitefish. The spatial extent of the 3°C difference between modelled operational and non-operational temperatures did slightly exceed 10% at the 75th percentile at 11.8% in 2018-19 and 12.1% in 2019-20. During Block 1, there were also limited exceedances of the delta T threshold of 3°C in December of 2018-2019 (1 day at Site 40), in December of 2019-2020 (4 days at Site 9) and in December of 2020-21 (23 days at Site IHL01). Spatial extent exceedances were retained for assessment in the TRA.

Over the entire egg incubation period, there were no exceedances of the delta T threshold in 2017-2018 (Table 187). The delta T assessment shows limited infrequent exceedances of the 3°C threshold in 2016-2017 and 2019-2020. In 2018-2019, there were 22 exceedances in March of 2019, with 3 occurring at Site 26, 6 occurring at Site 12 and 13 occurring at Site 40. In 2020-21, there were a significant number of exceedances in December 2020, all of which occurred at IHL01. The exceedances in December of 2020 occurred during the Block 1 Round Whitefish assessment period and there were no exceedances of the chronic, sub-chronic or acute absolute temperature thresholds during this same time period. Delta T exceedances in the LSA were retained for assessment in the TRA.

Table 187 Number of exceedances of Primary and Secondary Delta T threshold of 3°C by season and site group for Round Whitefish Embryos at depths of 4m to 10m

Round Whitefish (Bottom)		2016-17		2017-18		2018-19		2019-20		2020-21	
		T>Δ 3°C	Total	T>Δ 3°C	Total	T>Δ 3°C	Total	T>Δ 3°C	Total	T>Δ 3°C	Total
Eggs (Chronic)											
LSA	Dec	-	100	-	22	1	79	4	124	23	94
	Jan	3	164	-	31	1	96	1	127	-	31
	Feb	-	140	-	28	6	90	-	116	4	40
	Mar	2	161	-	31	22	111	-	124	-	31
	Apr	3	159	-	27	-	27	7	113	-	16

A count of significant chronic HQ exceedances for the egg stage is presented in Table 189, according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. These limited number of significant chronic exceedances occurred in the early part of incubation period, when the chronic threshold of 5.4°C is equal to the rolling weekly average temperature of 5.5°C that initiates the Round Whitefish incubation period. HQ exceedances also occurred at reference sites during this period, indicating that these conditions are lake wide and not an isolated event near Site. During this same early incubation period, absolute chronic monthly average, sub-chronic rolling weekly average and acute criteria of 6°C, 8.5°C and 10°C respectively were not exceeded. Exceedances occurring in April likely occurred after hatch was triggered by warming spring temperatures. Chronic egg exceedances in the LSA were retained for assessment in the TRA.

Table 188 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Round Whitefish eggs at depths of 4m and 10m

Round Whitefish (Bottom)		2016-17		2017-18		2018-19		2019-20		2020-21	
		HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Chronic)$^{\beta}$											
LSA*	Dec	21	100	-	22	67	76	41	112	13	25
	Jan	-	155	-	31	-	93	32	124	-	31
	Feb	-	140	-	28	-	84	-	116	-	28
	Mar	-	155	-	31	-	93	-	124	-	31

	Apr	28	150	4	30	20	87	80	92	19[β]	19
Ref.	Dec	-	20	-	-	5	50	8	28	35	200
	Jan	-	31	-	-	-	62	-	31	-	248
	Feb	-	28	-	-	-	56	-	29	-	224
	Mar	-	31	-	-	-	62	-	31	6	248
	Apr	15	30	-	-	-	58	-	23	97	122

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.
[β] Only duration considered for thermal exceedances in April 2021. No consideration of reference site exceedances or spatial extent, resulting in additional thermal benchmark exceedances included.

Larvae

The extent of the significant thermal exceedances for the chronic threshold of larval Round Whitefish is presented in Table 189 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Intermittent larval chronic thermal benchmark exceedances occurred in all years assessed. Chronic larval exceedances in the LSA and Baie du Doré were retained for assessment in the TRA.

Table 189 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Round Whitefish

Round Whitefish (Bottom)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Larvae (Chronic)										
Baie du Doré*	27	55	31	61	86	183	15	61	-	-
LSA*	8	1,084	6	618	5	305	-	301	9	427
Reference	-	356	-	166	-	61	-	239	-	183

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

<u>Thermal Risk Assessment</u>

Embryos – Block 1

During Block 1 of Round Whitefish incubation, the thermal risk assessment shows no exceedances of chronic, sub-chronic or acute thresholds. There are limited exceedances of the Block 1 delta T 3°C threshold and of the spatial extent of the 3°C difference between modelled operational and non-operational temperatures at the 75th percentile in two of the five years assessed. The risk to Round Whitefish embryos in December has been fully assessed using absolute temperature thresholds through the chronic, sub-chronic and acute thresholds. No exceedances of these absolute thresholds were found. As a result, the biological significance of relative threshold exceedances (i.e., delta 3°C and spatial extent of the 3°C difference between operations and non-operations) where absolute thresholds (i.e., chronic, sub-chronic and acute) are not exceeded indicates a low risk to Block 1 Round Whitefish embryos.

Embryos – Entire Incubation Period

During the entire Round Whitefish incubation period, there were also limited exceedances of the delta T threshold. Outside of Block 1, the majority of these exceedances occurred at the end of the incubation period where hatch was likely already triggered within the LSA. Most of these delta T exceedances occurred in March of 2018-2019 at Sites 12 (n=6), 26 (n=3) and 40 (n=13). This is the same year where the majority of the hatch advances >30 days occurred for Lake Whitefish.

Additional modelled thermal benchmarks of a chronic MWAT of 5.4°C and an acute UILT of 10.1°C were also assessed, with exceedances of the chronic MWAT benchmark focused on the early incubation period where the MWAT value was close to the rolling weekly average value triggering the beginning of incubation. No exceedances of the UILT of 10.1°C were reported. The spatial extent of the exceedances of the chronic MWAT of 5.4°C is described in Table 190, with consistent spatial extent of over 10% in December of all years evaluated. This is expected given the proximity of the MWAT benchmark of 5.4°C to the spawning starting temperature of 5.5°C. These December exceedances have also been evaluated using the Block 1 Round Whitefish chronic, sub-chronic and acute criteria and there were no exceedances in the Block 1 Round Whitefish absolute temperature benchmarks. There are also thermal benchmark exceedances in April of each year assessed. These exceedances are related to warming lake conditions and likely trigger hatch of the Round Whitefish embryos.

Table 190 Median (25th - 75th percentile) extent of LSA (%) at 4m to 10m depth with significant thermal exceedances for Round Whitefish eggs

Round Whitefish (Bottom)	Spawn 2016-2017	Spawn 2017-2018	Spawn 2018-2019	Spawn 2019-2020	Spawn 2020-2021
Eggs (Chronic)					
December	**87 (75-96)**	--	**31 (20-36)**	**15 (10-67)**	**40 (24-85)**
January	--	--	--	5 (3-9)	--
February	--	--	--	--	--
March	--	--	--	--	--
April	**80 (25-93)**	**31 (28-34)**	9 (6-11)	**50 (46-61)**	NA

Shading indicates median extent of LSA is greater than 10%.
NA: Extent of LSA risk characterization not completed for April 2021.
Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as "--"in the table.

Information from industry and academic research is available to provide ecological context to these risk assessment results. Several years of gill netting during spawning season as well as a larger mark and recapture study demonstrated that spawning whitefish were not abundant in the vicinity of the site.[R-285] Spawning Lake and Round Whitefish likely use a much broader local area during spawning season. Work by Graham et al. (2016) from the University of

Regina supports this with both ecological and genetic analyses failing to find small local Round Whitefish populations near Bruce Power.[R-295]

Given the overall findings of the thermal risk assessment for Round Whitefish embryos, including limited delta T and Block 1 spatial extent exceedances in small areas of the LSA and the ecological context for Round Whitefish spawning behaviour, thermal effluent from Bruce Power poses a low risk to the development, survival and reproductive success for the low abundance of embryos likely to be incubating near Bruce Power. There is no unreasonable risk to the overall development, survival and reproductive success of the Round Whitefish embryos in Lake Huron.

Larvae

The extent of the significant thermal exceedances for the chronic threshold of larval Round Whitefish is presented in Table 191. Significant thermal HQ exceedances do not encompass more than 10% of the LSA for Round Whitefish, except in May of 2020.Therefore thermal effluent generally poses no unreasonable risk to larval stage Round Whitefish.

Table 191 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for Round Whitefish

Round Whitefish (Bottom)	2016	2017	2018	2019	2020
Larvae (Chronic)					
April	--	--	--	--	--
May	1 (1-24)	5 (2-19)	4 (1-13)	1 (1-2)	**35 (24-48)**
Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.					

The risk characterization of the extent of the LSA impact by larval Round Whitefish HQ exceedances shows a single year above the 10% threshold criteria at the end of the larval presence near Bruce Power in May. Given the single year above 10% of the LSA and the potential for larvae to be moving offshore as the end of May, thermal effluent from Bruce Power poses a low risk to the limited number of Round Whitefish embryos and larvae in the LSA and no unreasonable risk to Round Whitefish populations in Lake Huron.

9.5.1.6 Deepwater Sculpin

Little is known about the life history of Deepwater Sculpin. The preferred habitat for adults is the cold bottom waters of the hypoliminion at depths of 60-150m in the Great Lakes. Adult Deepwater Sculpin serve as a prey source for larger sport fish, such as Lake Trout. All life stages are presumed to occur offshore, in deep water, however the larval stage may move with the current and come inshore.[R-289] The latest COSEWIC assessment for Deepwater Sculpin was made in 2017. This assessment continued the designation of Deepwater Sculpin as a species of special concern (“a species which may become threatened or endangered because of a combination of biological characteristics and identified threats”

[R-348]), primarily because of trawl data from Lake Ontario indicating very low adult abundance [R-82].

Larvae are expected to remain in a pelagic phase for between 40 and 60 days as they grow from 8mm to 20-25mm in length.[R-81][R-82] The 8mm larvae have little to no yolk sac remaining when captured during larval tows.[R-81] This suggests that the movement to pelagic habitat might be driven by the need for a higher density of plankton in the early larval stages that is only available during the early spring on the nearshore side of the thermal bar (i.e., surface temperatures >4°C, generally near 6°C). This is supported by the finding that larvae on the nearshore side of the thermal bar in Lake Michigan were found in greater densities and were larger with faster growth based on daily growth rings (Wang 2013 in [R-82]). Survival of Deepwater Sculpin larvae from the pelagic to benthic stages is estimated to be 0.1-0.4% (Geffen and Nash 1992 in [R-82]).

Deepwater Sculpin larvae were found at De Tour and Hammond Bay on Lake Huron from mid-April to June 2007, with larval density ranging from 0.4 to 2.4 larvae per 1,000m^3. [R-349] This location of Deepwater Sculpin larvae far away from presumed deep water spawning grounds provide evidence of advection (i.e. movement with water flow) of the pelagic larval stage [R-81][R-82]. No quantitative assessment of the dispersal of adult Deepwater Sculpin has been completed to date [R-82].

In the local area, Deepwater Sculpin larvae have been entrained in the spring months of April through June. There has been no evidence of any other life stage in the nearshore. There are no thermal criteria available for Deepwater Sculpin larvae. Modelling of Deepwater Sculpin thermal benchmarks is not possible due to the lack of information on thermal benchmarks for related species. Acute thresholds are not assessed for Deepwater Sculpin. The determination of a chronic larval threshold is described below based on overall seasonal lake temperatures and maximum temperatures where Deepwater Sculpin larvae have been located.

Source water tows retrieved three larval Deepwater Sculpin near Bruce Power on May 28, 2014, when water temperatures were recorded to be 10.7°C [R-350].

Roseman et al. (2014) collected pelagic larval Deepwater Sculpin from inshore sites at depths of 1-15m at DeTour and Hammond Bay in northern Lake Huron during mid-April to May in water temperatures ranging from 2.5°C to 9.0°C and in the main channel of the Detroit River during late-March to May in water temperatures ranging from 3.7°C to 11.8°C. Following monthly sampling from May to September, age-0 benthic Deepwater Sculpin were collected in early September during lake-bottom trawls at depths of 37m and 91m off DeTour and Hammond Bay in water temperatures ranging from 4.2°C to 4.7°C. Hatch dates for Deepwater Sculpin were estimated to be in late-March in this study. These results demonstrate that in northern Lake Huron, Deepwater Sculpin appear to be hatching in late-March, becoming pelagic sometime after hatch until May, then moving to a benthic habitat that would be outside the influence of the Bruce Power site sometime in the summer [R-83].

Deepwater Sculpin larvae were found in Lake Michigan at five sites between 1973 and 1980. At three sites on the East Shore of Lake Michigan, Deepwater Sculpin larvae were found at depths of 1.5-17m in temperatures ranging from 0°C to 11°C between February 2nd and

August 18th. Summer collections were associated with sites at least 15m in depth or with cold water upwelling events. At two sites on the West Shore of Lake Michigan, Deepwater Sculpin were found at depths of 0-12m in temperatures ranging from 2°C to 7°C between April 4th and July 11th. The length of larval Deepwater Sculpin in this study ranged from 8mm to 22mm and larval densities ranged from <10 to 78 larvae per 1,000m^3. The 8mm larvae in this study had little yolk present and may not have been newly hatched. Larvae occurred regularly in surface and midwater samples. Deepwater Sculpin larvae smaller than 8mm are hypothesized to remain near guarded nests in deep water. Greater abundance of Deepwater Sculpin was noted at sites with more frequent upwellings [R-81].

Deepwater Sculpin are only present in the near shore during the larval life stage and then return to deeper off shore waters as juveniles and adults, where the cold temperatures remain well outside any influence of the Bruce Power site. Sheldon (2006) examined the habitat for adult Deepwater Sculpin found at depths of 18.6-285m. Temperatures were measured at lake-bottom for lakes with depths of <55m or directly above lake-bottom where lakes had depths >55m. Temperatures at the lake bottom or at a depth of 55m in lakes where adult Deepwater Sculpin were found ranged between 3.15-6.93°C. Adult Deepwater Sculpin were most commonly found from 50m to the maximum depth of the lake examined where the lake depth exceeded 50m as it does in Lake Huron. This is not reflective of the near shore habitat for larval Deepwater Sculpin. The temperature at the lake bottom or at a depth of 55m in lakes surveyed in Sheldon (2006) would have been considerably warmer at the near shore habitat present in those same lakes. This warmer near shore habitat was presumably used by larval Deepwater Sculpin and would have had much higher temperatures than those measured at the lake bottom or at a depth of 55m [R-351]. Given the above information, a conservative chronic larval threshold of 9°C in April and 11.8°C in May and June is assessed based on the warmest waters where larval Deepwater Sculpin have been located and on knowledge of seasonal lake warming trends.

<u>Preliminary Screening</u>

Temperatures during the potential presence of larval Deepwater Sculpin are presented in Figure 101, showing the similarity between median temperatures within the LSA and for reference sites, with significantly warmer temperatures within Baie du Doré.

HQs for larval Deepwater Sculpin were calculated as described in the methodology and are presented using violin plots by site group in Figure 102 and over time in Figure 103. Widespread chronic larval HQ exceedances occurred for all months assessed in Baie du Doré. For the remainder of the LSA and at Reference sites, the magnitude of the exceedance and the number of HQ exceedances increase through May and June. Reference sites in June 2019 and June 2020 included shallow sites from the CWMP program and these sites showed a similar temperature and HQ profile to the sites located in Baie du Doré (Figure 104), which suggests that the thermal conditions in the bay in June are not an isolated event near Bruce Power.

Figure 101 Temperatures during potential Larval Deepwater Sculpin Presence near Bruce Power

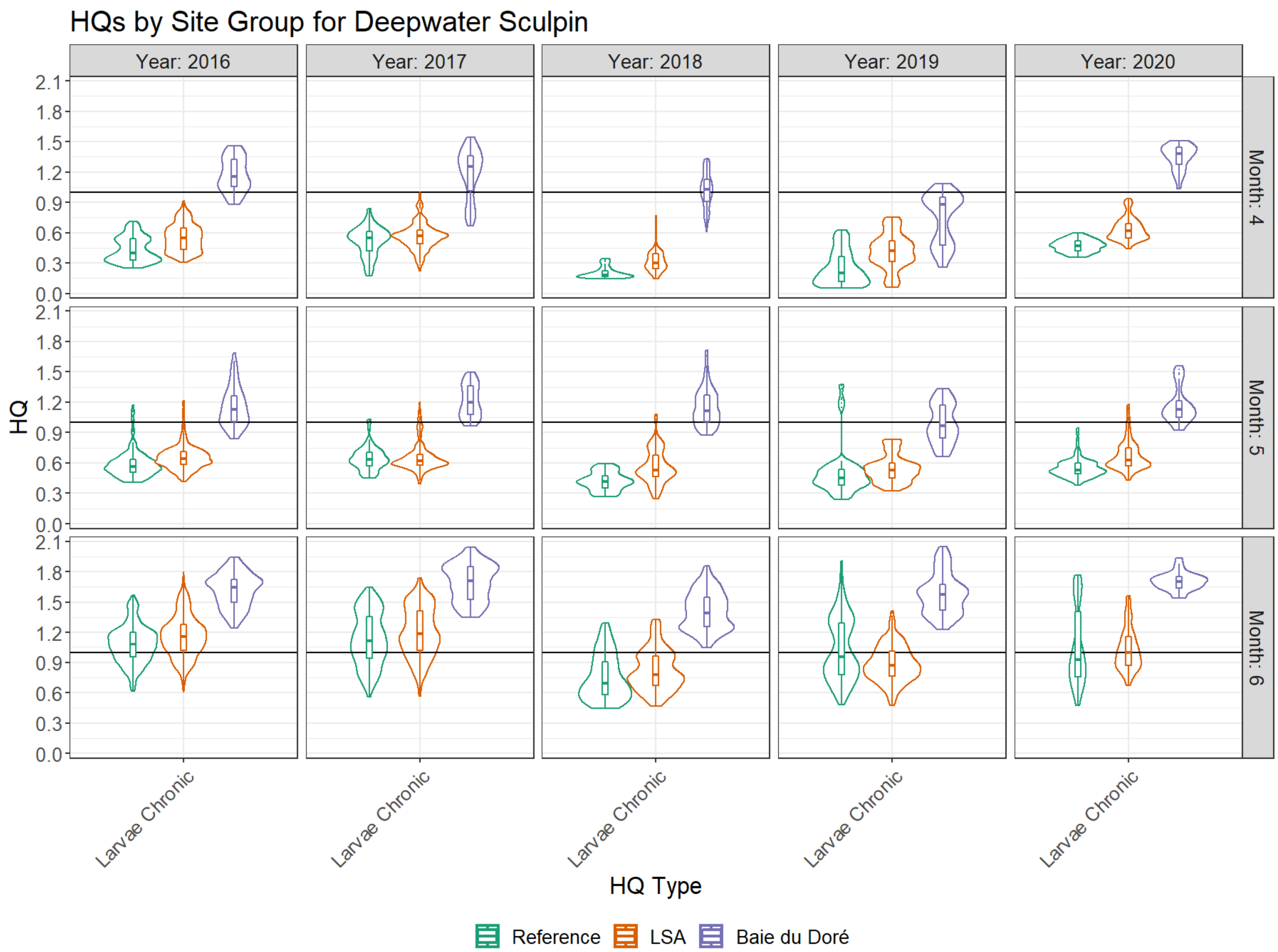

Figure 102 Chronic HQs for Deepwater Sculpin Larvae by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

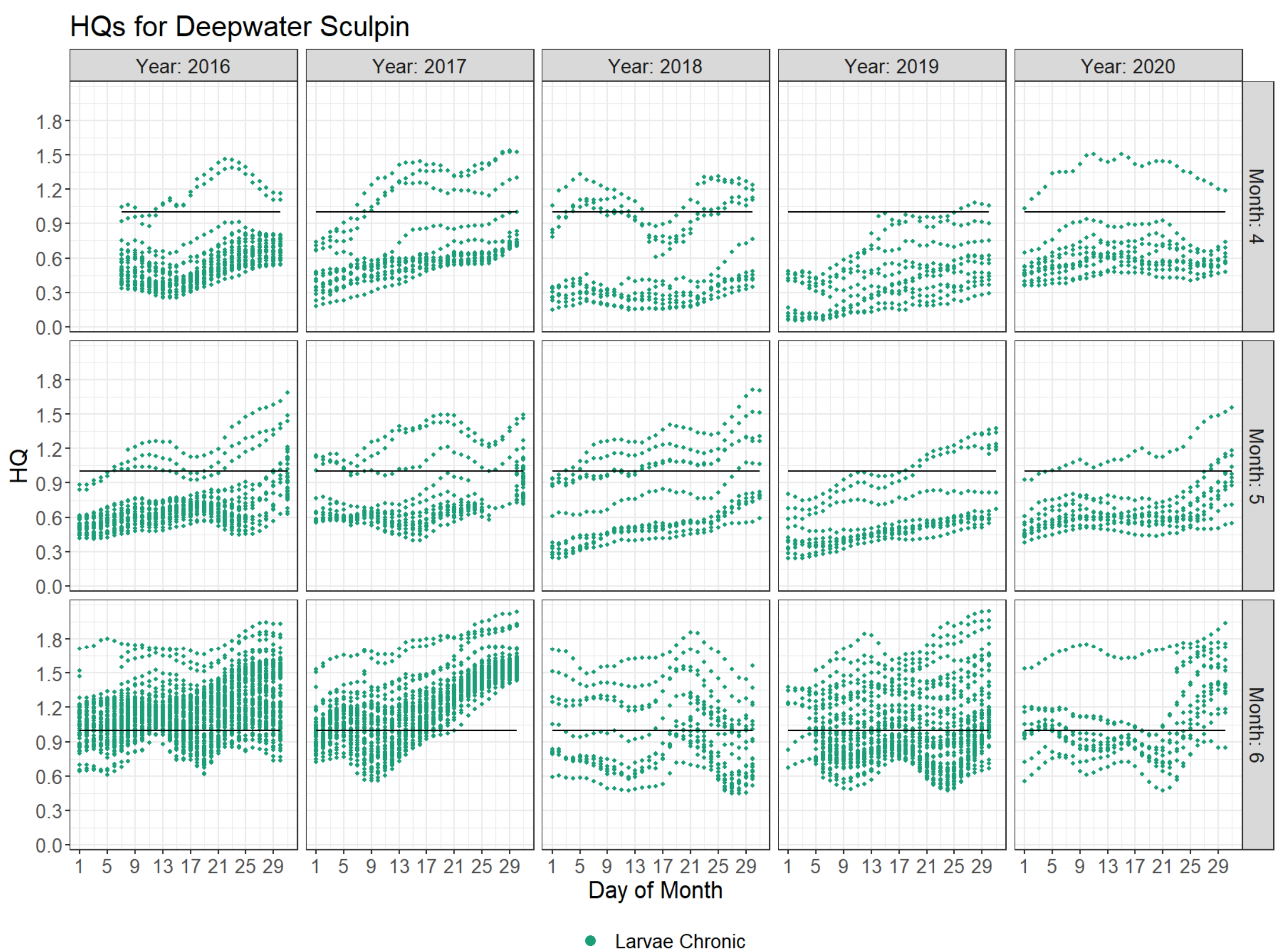

Figure 103 HQs for Deepwater Sculpin Larvae by Benchmark. Black line indicates HQ of 1.0.

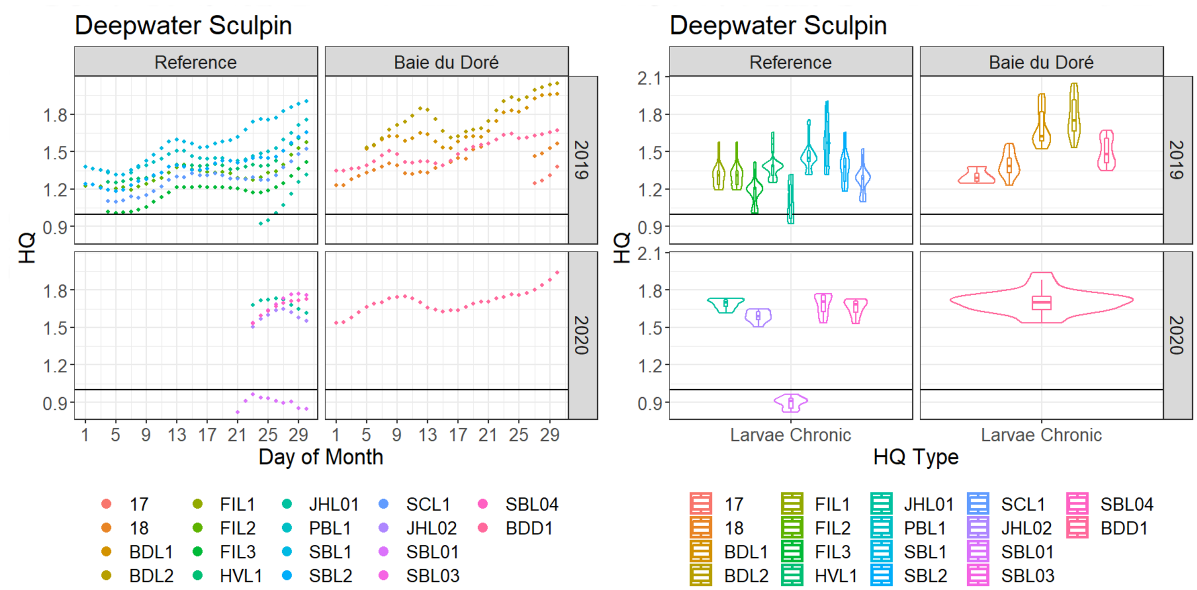

Figure 104 Chronic HQs for Larval Deepwater Sculpin for shallow Reference sites from the CWMP program (FIL1, FIL2, FIL3, HVL1, JHL01, PBL1, SBL1, SBL2, SCL1, JHL02, SBL01, SBL03, SBL04) and for sites located within Baie du Doré (17, 18, BDD1, BDL1, BDL2) in June of 2019 and 2020. June 2020 start date delayed for CWMP sites due to Covid. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

Chronic larval Deepwater Sculpin benchmarks were retained for the secondary screening.

Secondary Screening

A count of significant HQ exceedances is presented in Table 192 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Chronic larval benchmark exceedances across the LSA and Baie du Doré were retained for further assessment in the TRA.

Table 192 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Deepwater Sculpin

Deepwater Sculpin (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Larvae (Bottom)										
Baie du Doré*	19	128	48	108	142	273	35	89	-	-
LSA*	4	1,496	45	978	18	465	28	529	98	637
Reference	121	501	82	316	-	111	17	340	41	297
Larvae (Surface)										

Baie du Doré*	48	134	104	177	50	91	13	143	57	91
LSA*	-	333	-	435	9	101	81	220	-	-
Reference	144	146	145	153	9	20	233	345	8	18

*Include only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of larval Deepwater Sculpin is presented in Table 193.

Table 193 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for larval Deepwater Sculpin

Deepwater Sculpin (Chronic)	2016	2017	2018	2019	2020
Larvae (Bottom)					
April	--	3 (3-4)	--	--	--
May	0 (0-2)	2 (1-6)	2 (1-12)	1 (1-1)	**28 (21-36)**
June	**55 (54-55)**	**53 (48-77)**	**14 (8-25)**	**42 (36-46)**	**58 (40-77)**
Larvae (Surface)					
April	--	**99 (97-100)**	--	--	--
May	--	**99 (94-99)**	**99 (87-100)**	**87 (71-99)**	**99 (57-100)**
June	--	--	**99 (84-99)**	**36 (32-40)**	**100 (100-100)**

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

Thresholds for Deepwater Sculpin larvae are based only on water temperatures during field work and do not represent controlled trials or extensive thermal tolerance field work. As shown in Figure 105, water temperatures at all locations increase through the months on May and June. Outside of sites in Baie du Doré, temperature increases at LSA and Reference Sites occur with the same timing and are generally similar in magnitude.

Figure 105 Temperatures during the Presence of Deepwater Sculpin Larvae. Black lines represent thresholds of 9°C in April and 11.8°C in May and June.

Significant thermal HQ exceedances encompass more than 10% of the LSA for Deepwater Sculpin in all five years evaluated. From a biological and ecological perspective, these exceedances occur during a 40 to 60 day pelagic window where the presence of Deepwater Sculpin larvae near Bruce Power is driven by the prevailing currents and upwelling events [R-81][R-82]. There is no special habitat or preferential use of the LSA for Lake Huron larval Deepwater Sculpin. Given the limited duration of the exceedances, poor survival during the pelagic life stage (Geffen and Nash 1992 in [R-82]) and the complete lack of knowledge regarding thermal tolerances for larval Deepwater Sculpin, it is extremely difficult to assign a thermal risk characterization to this species. When compared to other nearshore areas assessed by the CWMP program, the temperature profile at shallow sites near Bruce Power is similar to the shallow reference sites (Figure 104), suggesting that the warmer temperatures are likely primarily driven by ambient lake conditions. In order to be conservative, and given that this species is of special concern, the above thermal exceedances are anticipated to pose a low risk to larval Deepwater Sculpin in the LSA and no unreasonable risk to the reproductive success of the greater Lake Huron population of Deepwater Sculpin.

9.5.2 Cool Water Fish Species

Acute and chronic thermal benchmarks were assessed for six cool water fish species present in the LSA, generally between April and September of each year. Table 194 and Table 195 list the thermal benchmarks used in the calculation of HQs by month. Sources for the thermal benchmarks are described in Section 9.3.6.1.

Table 194 Acute thermal benchmarks (˚C) by month for cool water fish species considered in thermal risk assessment

Acute ONLY (Hierarchy of CTM > UILT > STmax and Adult acute used where spawning acute N/A)								
Species	**Month**							
	Jan-Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct-Dec**
Emerald Shiner				Eggs 35.2[α], Larvae 35.2		Larvae 35.2, Growth 35.2	Growth: 35.2	
Gizzard Shad				Eggs 33.3	Eggs 33.3, Larvae 35.6	Larvae 35.6, Growth 31.0	Growth 31.0	
Smallmouth Bass			Parent 36.3, Eggs 29	Parent 36.3, Eggs 29, Larvae 38	Parent 36.3, Larvae 38, Growth 36.9	Growth 36.9		
Walleye		Eggs 20	Eggs 20, Larvae 19.2		Larvae 19.2	Growth 35.0		
White Sucker			Parent & Egg: Stream C	Parent & Egg: Stream C, Larvae 37, Growth 40.6	Growth 40.6			
Yellow Perch		Eggs 19.9	Eggs 19.9, Larvae 28	Larvae 28	Growth 34.0			

[α]Larval benchmarks used to assess egg stage for Emerald Shiner.
Note: Overall most sensitive thermal benchmark from all guilds in each month in red. Species listed as not available (N/A) in yellow. Grey cells indicate species are expected to be offshore.

Table 195 Chronic MWAT thermal benchmarks (˚C) by month for cool water fish species

Chronic ONLY (MWAT) - Adult MWAT used when spawning MWAT not available								
Species	**Month**							
	Jan-Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct-Dec**
Emerald Shiner				Eggs 27.1[α], Larvae 27.1		Larvae 27.1, Growth 30	Growth 30.0	
Gizzard Shad				Eggs 25.9	Eggs 25.9, Larvae 25.9	Larvae 25.9, Growth 23.2	Growth 23.2	
Smallmouth Bass			Parent 17.0, Eggs 23.7	Parent 17.0, Eggs 23.7, Larvae 26.3	Parent 17.0, Larvae 26.3, Growth 33.0	Growth 33.0		
Walleye		Eggs 14.8	Eggs 14.8, Larvae 16.7		Larvae 16.7	Growth 25		
White Sucker			Parent & Eggs: Stream C	Parent & Eggs: Steam C, Larvae: 28.9, Growth: 26.0	Growth: 26.0			
Yellow Perch		Eggs: 16.6	Eggs: 16.6, Larvae:19.7	Larvae: 19.7	Growth: 22		Growth: 22	

[α]Larval benchmarks used to assess egg stage for Emerald Shiner.
Note: Overall most sensitive thermal benchmark from all guilds in each month in red. Species and life stages where thermal benchmarks are not available (N/A) indicated in yellow. Grey cells indicate species are expected to be offshore.

9.5.2.1 Emerald Shiner

Emerald Shiners spawn in late spring to early summer when water temperatures reach 24°C. Eggs incubate for less than 1 week in June through July. The larval stage is present in the nearshore in June through July. The young of the year form large schools in inshore waters and move into deeper water for overwintering. They move nearshore at night to feed and then to deeper water during the day.[R-289] This species is a prey species for piscivores and is harvested as a commercial baitfish. Emerald Shiner is known to be present near the site based on Smallmouth Bass surveys and impingement monitoring results.

In the local area, Emerald Shiner eggs and larvae may be present in the nearshore and Baie du Doré in June through possibly August. The growth stage may be present in August and September and would also be able to move with diurnal changes in temperature.

The egg stage for Emerald Shiner does not have an available chronic or acute benchmark. Given the similar preferred temperature, overlapping life stages and short incubation period for Emerald Shiner larvae, chronic and acute larval Emerald Shiner benchmarks are also used to assess the eggs stage.

Preliminary Screening

HQs for Emerald Shiner were calculated as described in the methodology and are presented using violin plots by site group in Figure 106 and Figure 107 and over time in Figure 108.

Figure 106 Chronic HQs for Emerald Shiner by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

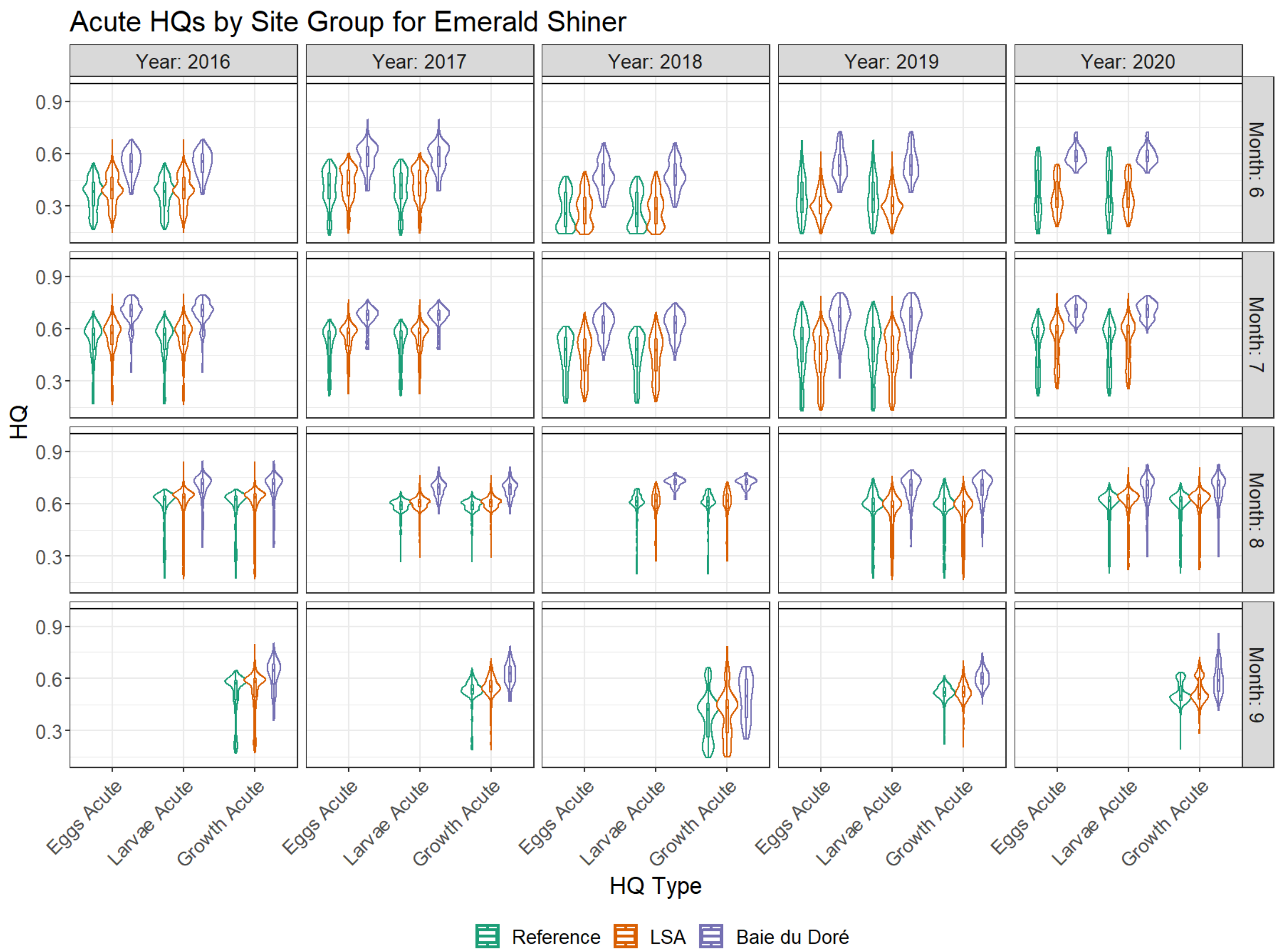

Figure 107 Acute HQs for Emerald Shiner by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

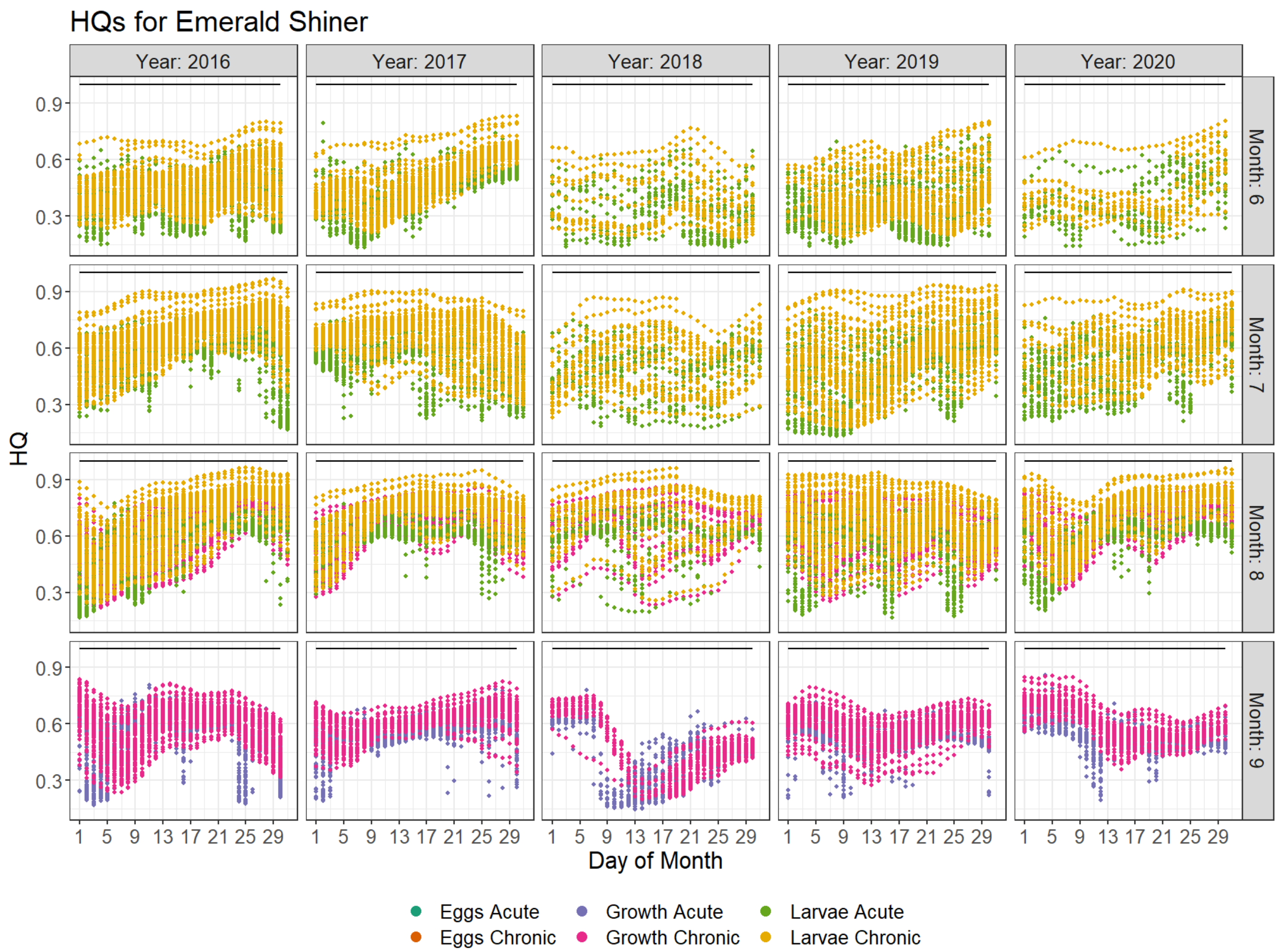

Figure 108 HQs for Emerald Shiner by Benchmark. Black line indicates HQ of 1.0.

There are no thermal benchmark exceedances for Emerald Shiner egg, larvae or growth stages. Based on the HQ results and available thermal benchmarks, thermal effluent poses no unreasonable risk to Emerald Shiner in the LSA.

9.5.2.2 Gizzard Shad

Gizzard Shad move inshore to spawn when lake temperature reaches 17-23°C in June to July and then return to deeper water. The spawn occurs midwater over sand-gravel-boulder substrates at shallow depths of 1-2m. Eggs are adhesive and incubate for 2-7 days before hatching. Larvae begin feedings after 5 days and grow rapidly.[R-289]

In the local area, the young life stages of Gizzard Shad may be present in the shallow nearshore and in Baie du Doré, with eggs in June and July, larvae in July and August and growth stages in August and September. Adult Gizzard shad are known to be present in the vicinity of the site based on Smallmouth Bass survey results and impingement monitoring.

Gizzard Shad are sensitive to sudden drops in ambient lake temperature, known as cold shock. The impact of cold shock on Gizzard Shad is discussed in Section 9.3.7.4.

Preliminary Screening

HQs for Gizzard Shad were calculated as described in the methodology and are presented using violin plots by site group in Figure 109 and Figure 110 and over time in Figure 111. There were no acute HQ exceedances. Chronic exceedances occurred throughout the five years assessed for the larval and growth life stages.

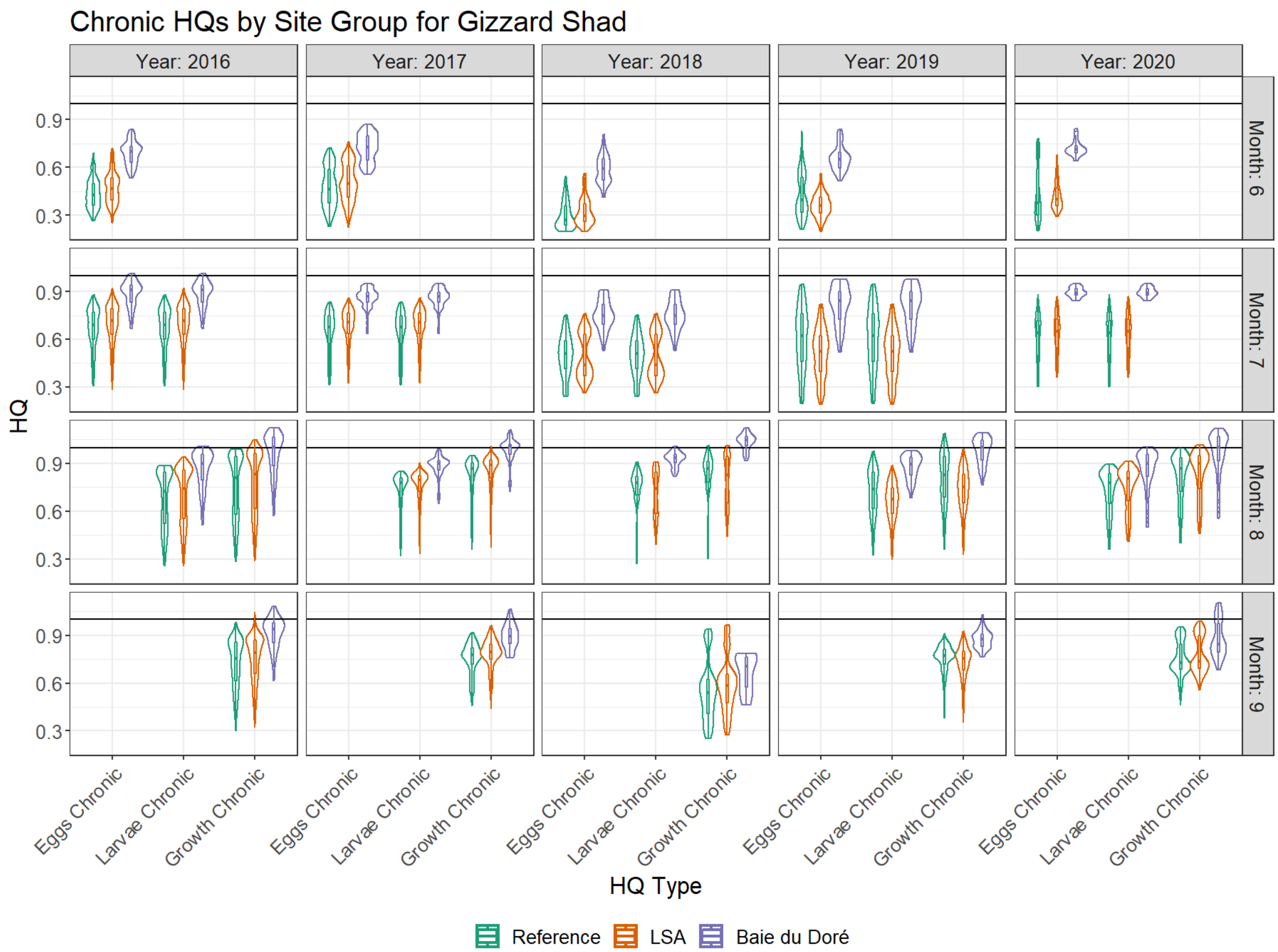

Figure 109 Chronic HQs for Gizzard Shad by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

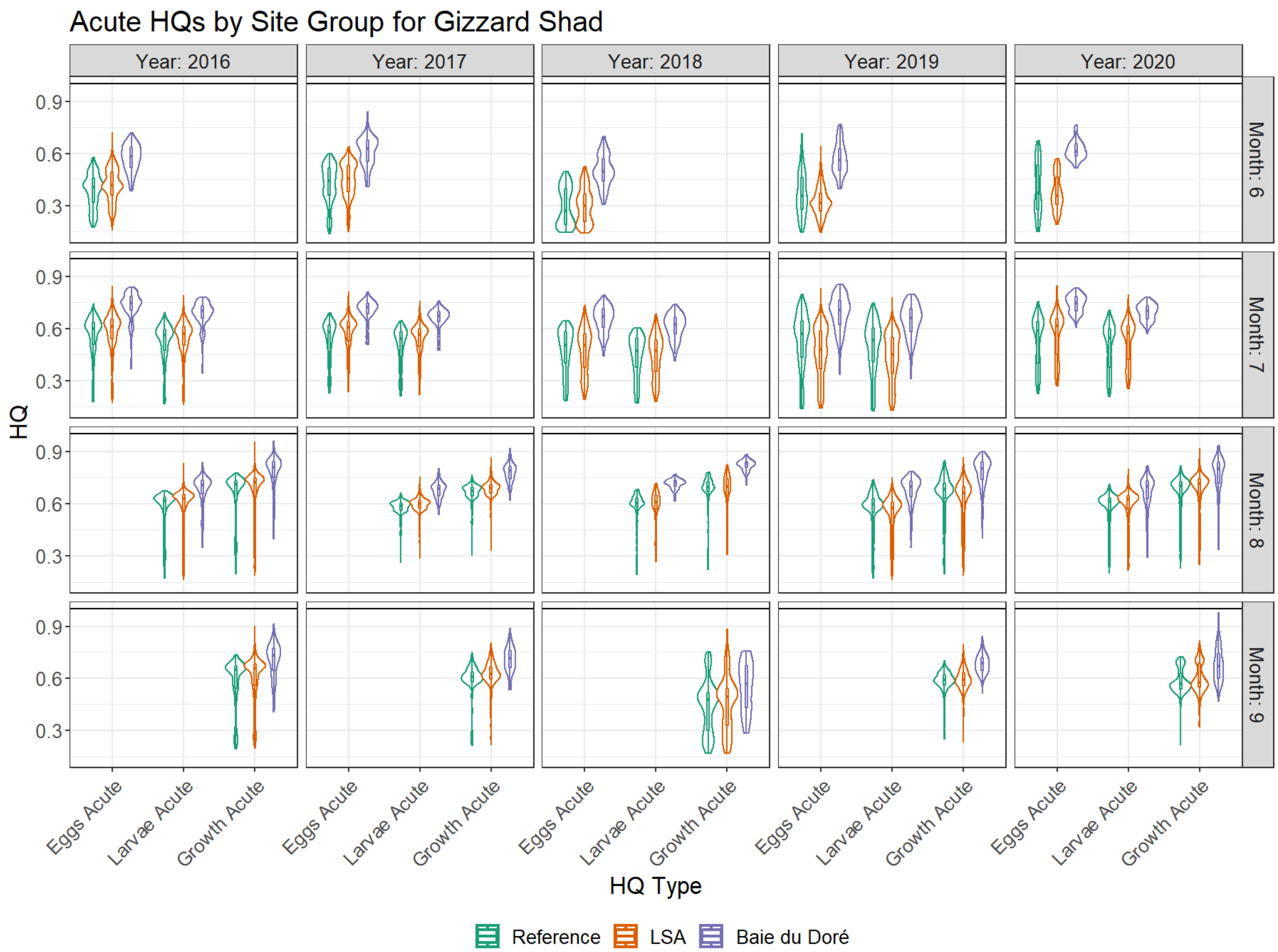

Figure 110 Acute HQs for Gizzard Shad by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

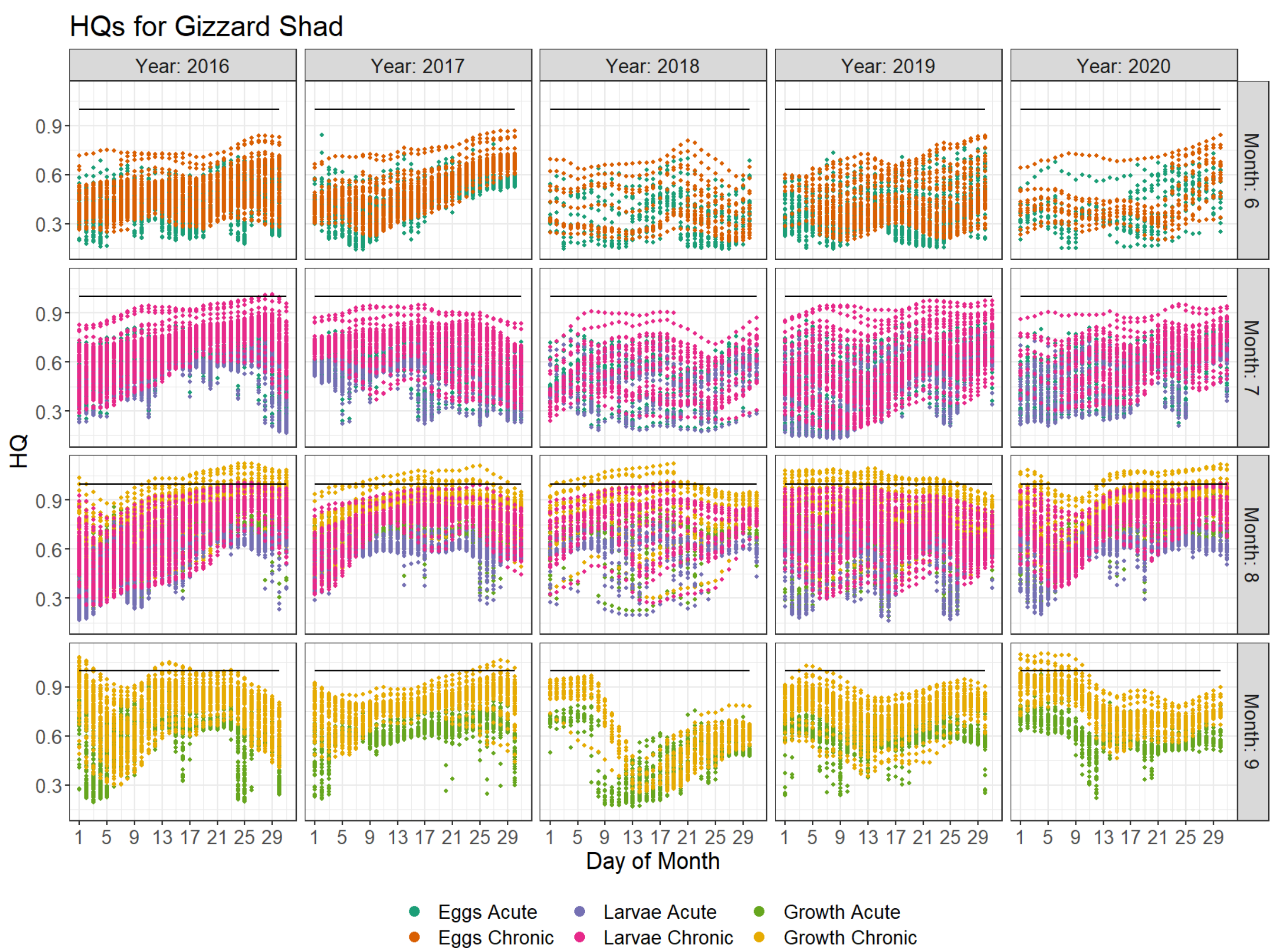

Figure 111 HQs for Gizzard Shad by Benchmark. Black line indicates HQ of 1.0.

Chronic growth and larval benchmarks were retained for the secondary screening. Due to a lack of thermal benchmark exceedances, acute larval and growth and acute and chronic egg benchmarks did not required further assessment.

<u>Secondary Screening</u>

Secondary screening results are presented in the form of a table for each species assessed. These tables indicate the number of significant HQ exceedances for LSA and Baie du Doré sites. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. For each HQ exceedance value presented, the total number of HQs calculated in the LSA, Baie du Doré and Reference areas are presented for context as to the proportion of all the calculated HQs presented that exceed one. All significant HQs within the LSA and Baie du Doré are advanced to the TRA.

A count of significant chronic HQ exceedances is presented in Table 196 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Significant thermal exceedances occurred mainly in Baie du Doré during the growth stage. The chronic growth benchmark was retained in the LSA and Baie du Doré for further assessment in the TRA. There were no significant acute or chronic larval thermal HQ exceedances for Gizzard Shad.

Table 196 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Gizzard Shad

Gizzard Shad (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Growth (Bottom)										
Baie du Doré*	49	183	-	122	42	57	10	122	13	118
LSA*	-	854	-	732	4	351	-	610	-	486
Reference	-	305	-	305	-	189	-	244	-	543

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of egg, larval and growth stage Gizzard Shad are presented in Table 197.

Table 197 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for Gizzard Shad

Gizzard Shad (Chronic)	2016	2017	2018	2019	2020
Growth (Bottom)					
August	**11 (1-29)**	--	3 (2-4)	**26 (18-32)**	2 (1-6)
September	--	--	--	--	--

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

For the growth stage, the majority of significant HQ exceedances occurred in August of each year, with exceedances in 2016 and 2019 encompassing more than 10% of the LSA, although only 2019 remained above 10% at the 25th percentile. This indicates that thermal conditions above optimal conditions are not consistently present throughout the month of August. By 5 days of age, Gizzard Shad are mobilizing in a diurnal pattern and consuming plankton. By the time they reach 22mm in length, they are existing mainly on water fleas, a relatively fast moving prey [R-289]. Although there is no available literature to characterize the thermoregulatory behaviour of growth stage gizzard shad, there is sufficient mobility at this life stage to mobilize to area of cooler water if required. Additionally, the nearshore area in the vicinity of Bruce Power does not provide specialized habitat for growth Gizzard Shad.

There are no significant thermal exceedances for Gizzard Shad eggs and larvae. As a result of the lack of exceedances for early life stages, the mobility of the growth stage and the lack of specialized habitat, thermal effluent generally poses no unreasonable risk to Gizzard Shad eggs and larvae, a low risk to growth Gizzard Shad and no unreasonable risk to the population success of Gizzard Shad near Bruce Power.

9.5.2.3 Smallmouth Bass

Smallmouth Bass spawn over 6-10 days in late spring and early summer (May and early June) when lake temperature is 16.1-18.3°C. The male comes prior to build a nest in sand/gravel/rocky substrates at depths<6m. After egg deposition, the male remains by the nest to guard the young until hatch and dispersal of fry. Egg incubation takes 4-10 days, and after hatch the larvae absorb their yolk sacs for the next 2 weeks before rising from the lake bed and dispersing.[R-289]

Near Bruce Power, Smallmouth Bass are known to spawn in Baie du Doré and also in the Bruce A and Bruce B discharge channels. The temperatures in the Bruce A and B discharge channels were not quantitatively assessed due to the continued successful reproduction in the discharge channels monitored since 2009 [R-352]. Spawning occurs in May to July and the guarding male remains present during egg incubation and larval periods. Larvae are observed in June and July for approximately 3 weeks before dispersing into the open water. The growth stage is expected to be in the nearshore in July and August. This species is a sought after game species for local anglers based on creel surveys and is a traditional forage species for some local Indigenous groups (i.e., HSM and MNO) (see Appendix A Section 1.8.6 and 1.8.7).

Preliminary Screening

HQs for Smallmouth Bass were calculated as described in the methodology and are presented using violin plots by site group in Figure 112 and Figure 113 and over time in Figure 114. HQ exceedances occurred primarily for chronic benchmarks in the parent life stage.

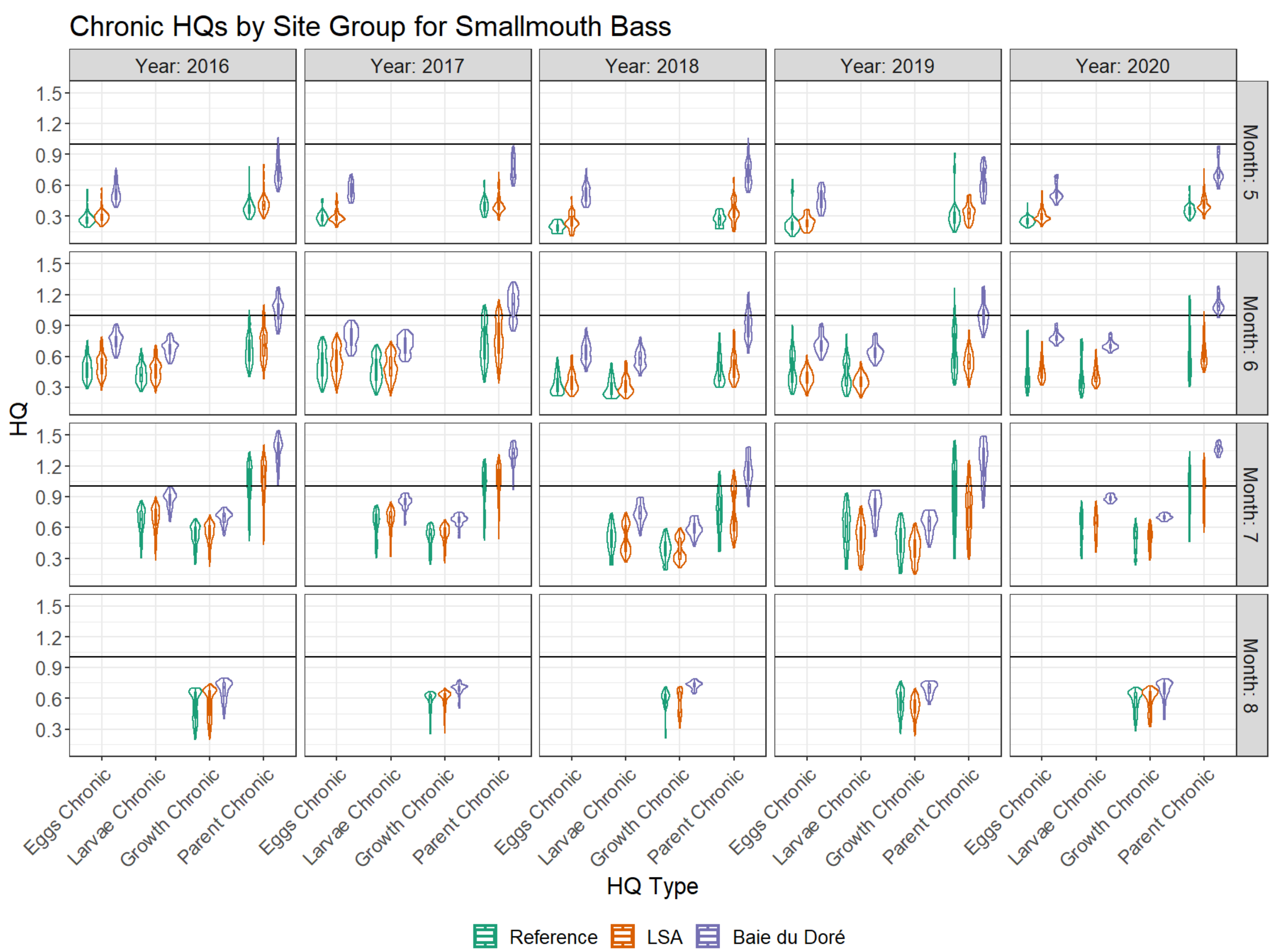

Figure 112 Chronic HQs for Smallmouth Bass by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

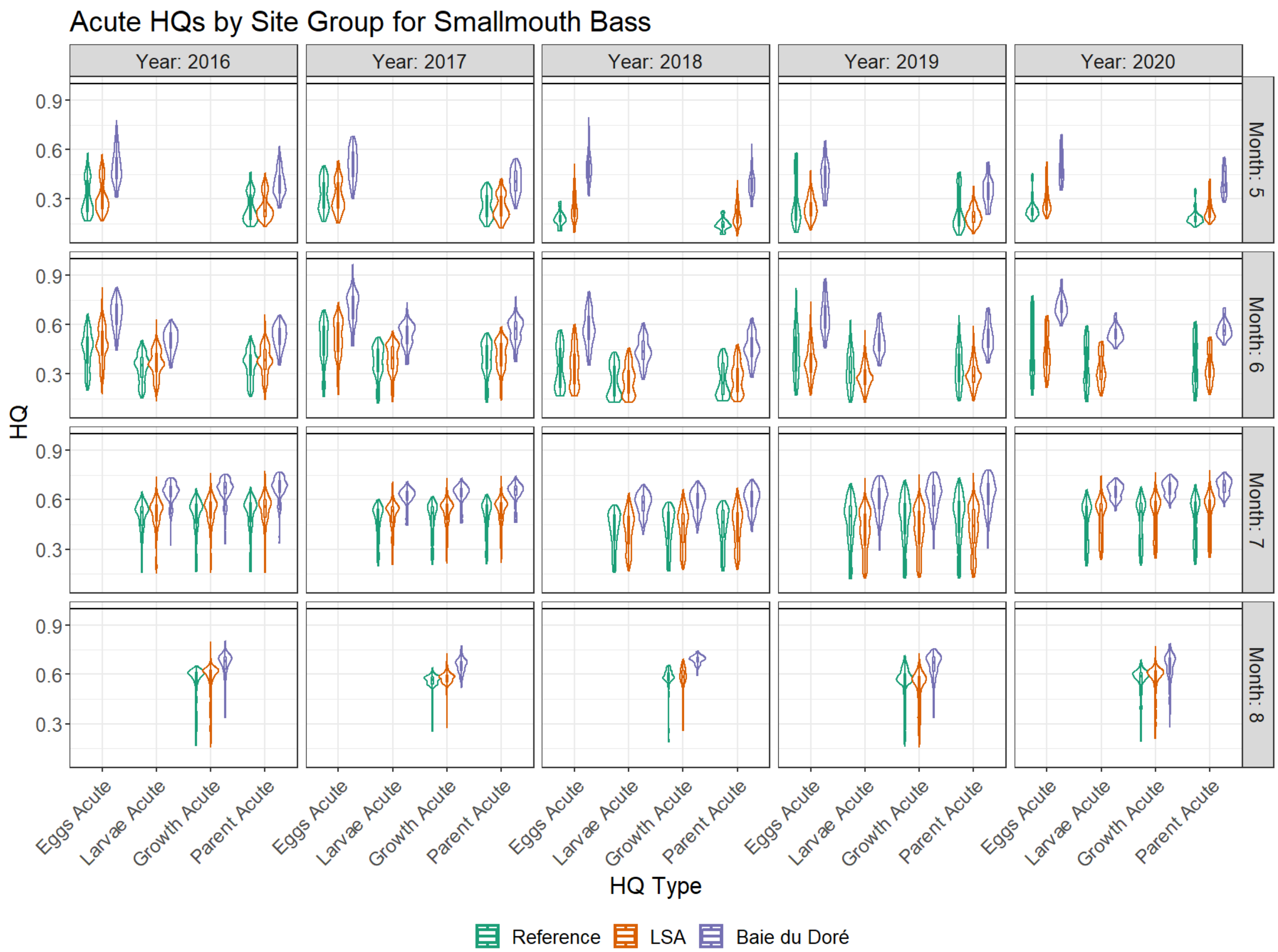

Figure 113 Acute HQs for Smallmouth Bass by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

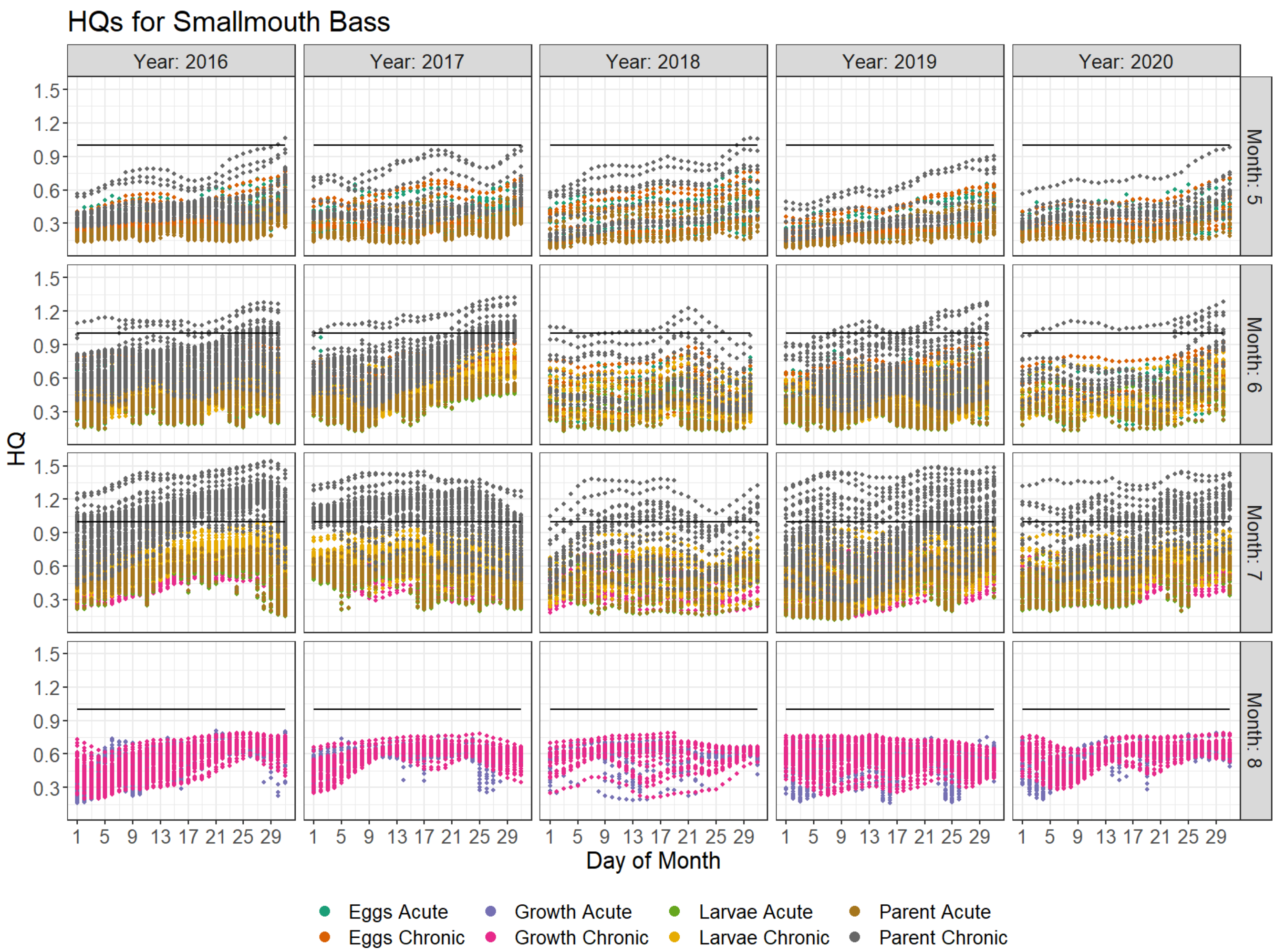

Figure 114 HQs for Smallmouth Bass by Benchmark. Black line indicates HQ of 1.0.

The chronic parent benchmark was retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment was required for the acute parent benchmark or the acute and chronic egg, larval or growth benchmarks.

Secondary Screening

A count of significant HQ exceedances is presented in Table 198 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. There were no significant HQ exceedances for the acute benchmarks for any life stages assessed. The chronic parent benchmark in the LSA and Baie du Doré was retained for further assessment in the TRA.

Table 198 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Smallmouth Bass

Smallmouth Bass (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Parent (Bottom)										
Baie du Doré*	49	197	5	140	56	276	18	121	-	-
LSA*	19	1,426	76	1,020	18	501	13	689	79	602
Reference	89	488	87	381	-	174	22	344	120	399
Parent (Surface)										
Baie du Doré*	65	172	44	179	30	80	43	206	76	109
LSA*	81	736	12	869	16	133	15	530	95	138
Reference	145	301	172	308	18	82	308	748	138	198

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of parent stage Smallmouth Bass are presented in Table 199.

Table 199 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for Smallmouth Bass

Smallmouth Bass (Chronic)	2016	2017	2018	2019	2020
Parent (Bottom)					
June	1 (0-1)	**36 (24-42)**	--	--	**11 (10-12)**
July	8 (2-38)	**61 (53-68)**	9 (5-13)	**37 (24-48)**	**49 (29-63)**
Parent (Surface)					
June	**69 (2-73)**	4 (2-55)	1 (0-1)	2 (2-4)	**60 (30-92)**
July	**78 (77-82)**	--	**73 (25-82)**	**83 (28-84)**	**92 (43-97)**

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as "--"in the table.

Bruce Power has completed annual Smallmouth Bass nesting surveys since 2009 and has documented the success of Smallmouth Bass nesting in the Bruce A and B discharge channels and in Baie du Doré (Appendix A Section 1.8.6) [R-40]. The Bruce A and Bruce B discharge channels were not quantitatively evaluated in the TRA, but rather field evidence of successful nesting for over 12 years indicates that parent Smallmouth Bass are acclimating to conditions within the discharge channels in order to seek out this habitat as a nesting location. This continued nesting success suggests that the thermal benchmark exceedances for parent Smallmouth Bass are not posing an unreasonable risk to the survival, reproductive success and development of Smallmouth Bass in the Bruce A and Bruce B discharge channels and in Baie du Doré. Statistical analysis of the nesting survey results indicated that increased surface water elevation and water temperature are not significant predictors of either the total count of nests or the number of successful nests [R-352].

There are no significant thermal exceedances for the egg, larval or growth stages of Smallmouth Bass, providing additional evidence to support the results of 10 years of Smallmouth Bass nesting survey indicating that successful reproduction is occurring in the LSA and specifically in Baie du Doré.

Significant thermal HQ exceedances for parent Smallmouth Bass encompass more than 10% of the LSA for Smallmouth Bass in all years assessed. The additional monitoring from the Smallmouth Bass nesting surveys from 2009 to 2020 and the continued use of the Bruce A, Bruce B and Baie du Doré nesting sites [R-352] indicates the continued use of the LSA for successful nesting by parent Smallmouth Bass despite the numerical HQ evaluation. Smallmouth Bass males exhibit site fidelity from year to year and the continued use of the Bruce A, Bruce B and Baie du Doré nesting sites indicates that current thermal conditions are adequate for successful nesting [R-289]. The current benchmark for parent Smallmouth Bass is likely too low to accurately represent the thermal tolerance of Smallmouth Bass using the LSA. This additional field evidence supports the finding of a low risk to parent Smallmouth Bass and no unreasonable risk for Smallmouth Bass populations utilizing the LSA.

As a result, thermal effluent generally poses a low risk to parent Smallmouth Bass in the LSA, and no unreasonable risk to the egg, larval and growth stage and to the population success of Smallmouth Bass near Bruce Power.

9.5.2.4 Walleye

Walleye spawn in spring or early summer, from April to June, usually after ice break up when temperatures reach 6.7-8.9°C. Eggs are broadcast in a single night over rocky areas generally in the white water of rivers and occasionally over boulder to coarse gravel shoals. Eggs incubate in rocky crevices for 12-18 days. After hatch, the larvae remain for another 10-15 days absorbing the yolk sac and dispersing into the upper levels of open water. In late summer, the young of the year move toward the bottom and can be found in 3-9m depth water.[R-289]

In the local area, Walleye eggs may be in the nearshore shoals or in rivers, creeks and intermittent streams for a period of 3 weeks in April to June [R-289][R-353]. In May through July, larvae may be present for 1 week before dispersing into the open water body. The growth stage may be found in August at depths of 5-10m. Adult Walleye are known to be near the Bruce Power site based on entrainment and impingement monitoring and Smallmouth Bass surveys. This species is of importance to MNO and HSM as a traditional and commercial species (see Appendix A Section 1.8.7).

<u>Preliminary Screening</u>

HQs for Walleye were calculated as described in the methodology and are presented using violin plots by site group in Figure 115 and Figure 116 and over time in Figure 117. Consistent HQ exceedances occurred over the five years assessed for egg (chronic), larval (acute and chronic) and growth (chronic) life stages. Egg and larval benchmark exceedances occurred across Baie du Doré, LSA and Reference sites. Chronic growth benchmark exceedances occurred only in Baie du Doré.

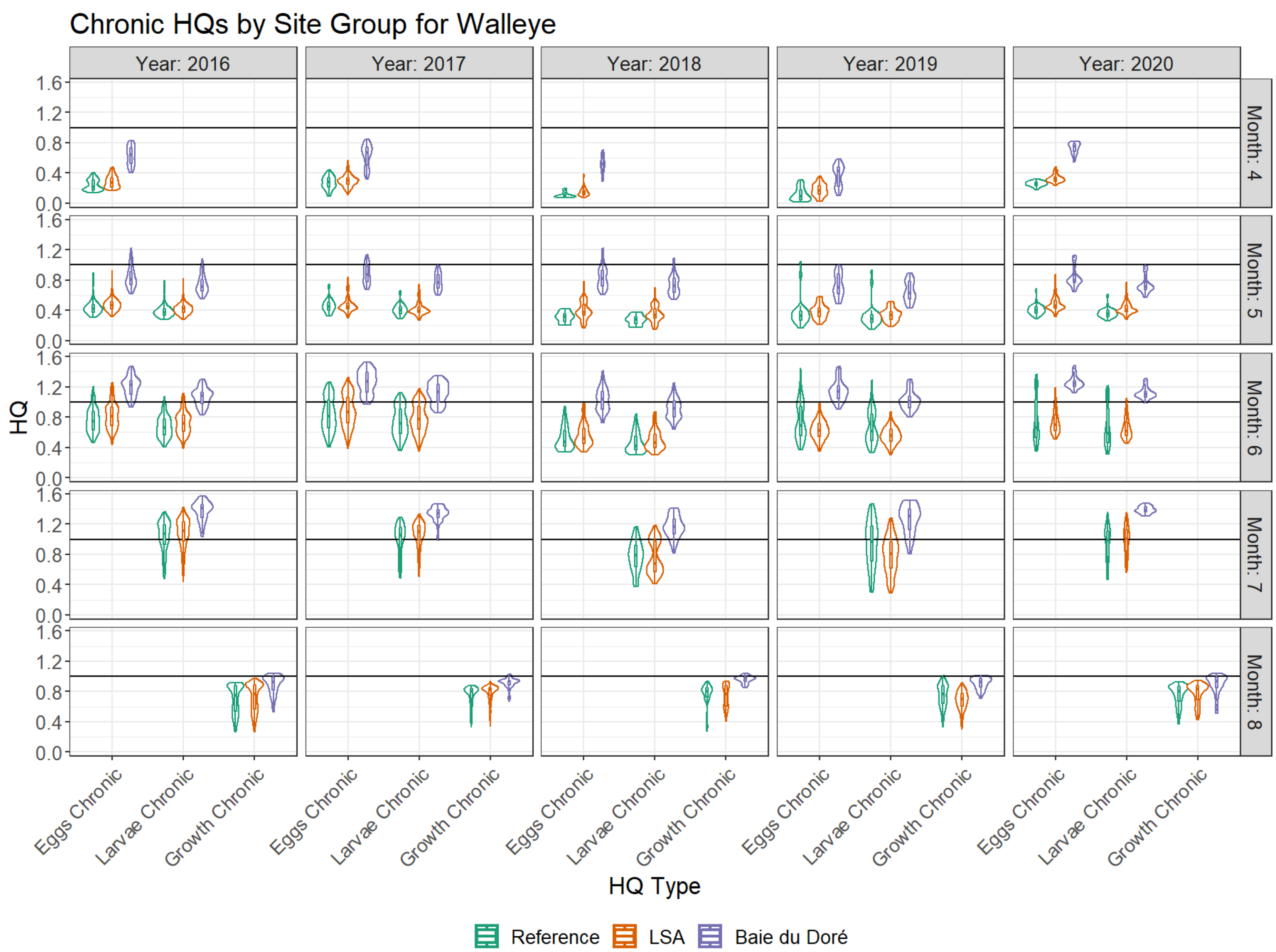

Figure 115 Chronic HQs for Walleye by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

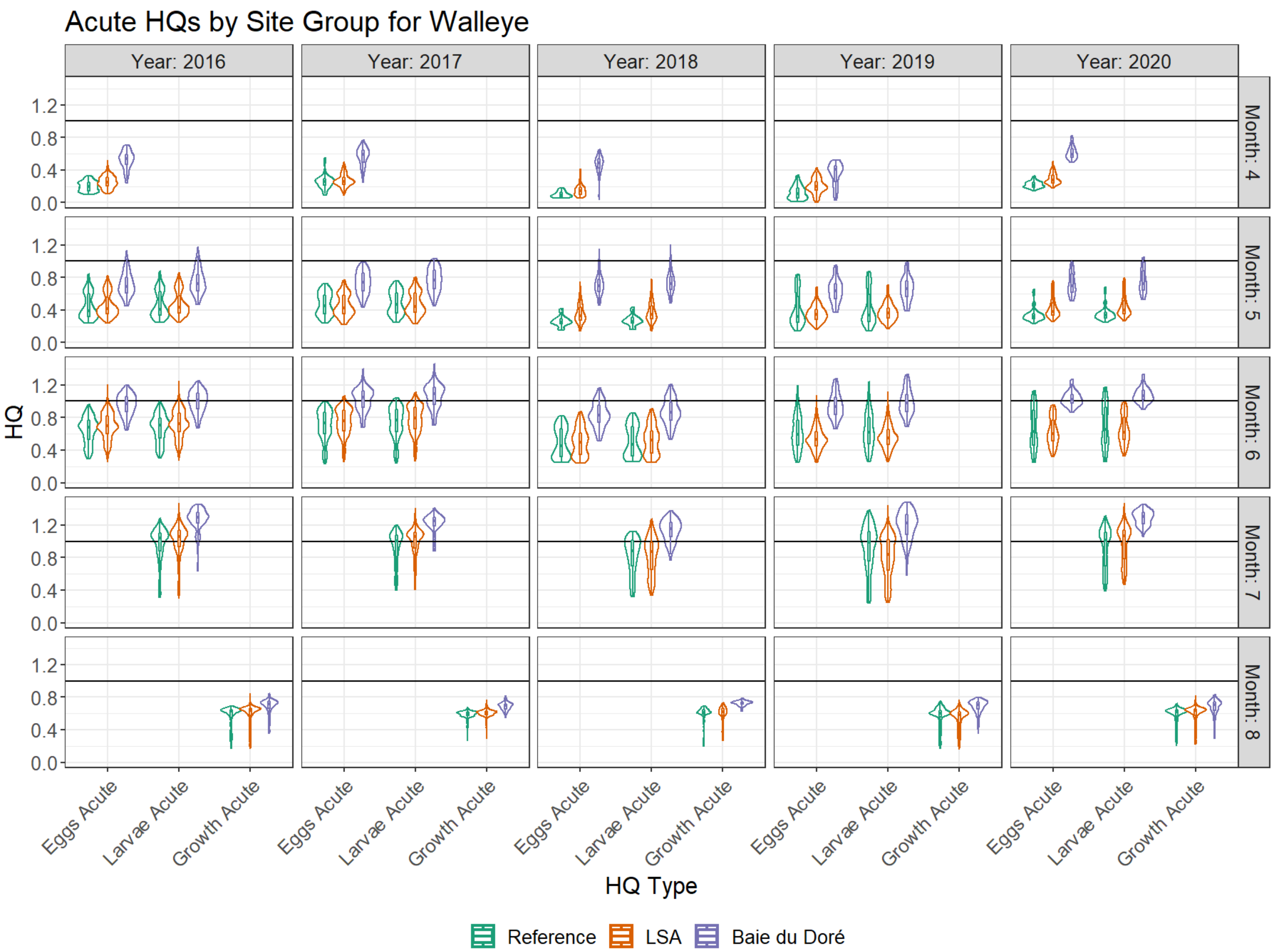

Figure 116 Acute HQs for Walleye by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

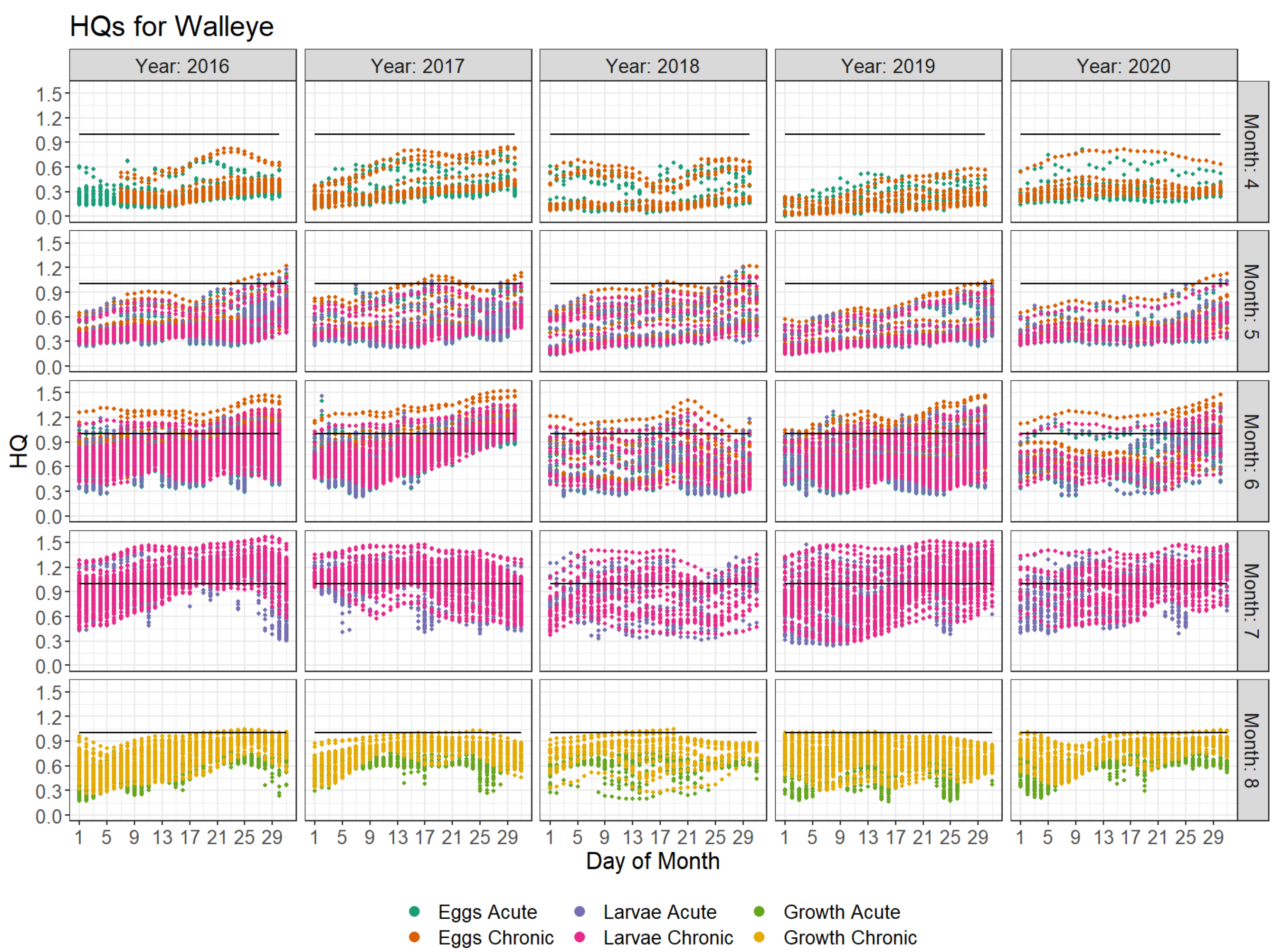

Figure 117 HQs for Walleye by Benchmark. Black line indicates HQ of 1.0.

The acute and chronic benchmarks for the egg and larval stage and the chronic growth benchmark were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment was required for the acute growth benchmark.

<u>Secondary Screening</u>

A count of significant HQ exceedances is presented in Table 200 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. The acute and chronic benchmarks for the egg and larval stage and the chronic growth benchmark were retained in the LSA and Baie du Doré for further assessment in the TRA.

Table 200 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Walleye

Walleye	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Acute Bottom)[β]										
Baie du Doré*	19	151	28	120	5	273	4	101	-	-
LSA*	-	1,705	-	1,038	-	471	-	576	-	637
Reference	-	572	-	346	-	123	-	364	19	315
Eggs (Chronic Bottom)[β]										
Baie du Doré*	45	128	22	108	42	273	15	89	-	-
LSA*	13	1,496	8	978	-	465	-	529	6	637
Reference	-	501	38	316	-	111	-	340	24	297
Larvae (Acute Surface)										
Baie du Doré*	68	183	54	184	27	80	38	218	72	119
LSA*	49	814	29	953	17	139	31	590	135	178
Reference	119	331	131	338	32	94	294	826	160	249
Larvae (Chronic Surface)										
Baie du Doré*	64	172	42	179	32	80	49	206	77	109
LSA*	92	736	-	869	20	133	21	530	104	138
Reference	153	301	181	308	25	82	316	748	144	198
Growth (Chronic Bottom)										
Baie du Doré*	16	93	-	62	10	57	-	62	-	58
LSA*	-	434	-	372	-	186	-	310	-	246
Reference	-	155	-	155	-	93	-	124	-	273

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.
[β]Differences in total number of HQs calculated for acute and chronic results are related to the use of 7-day moving averages for chronic temperature data aggregation (i.e., no HQs calculated for the first 6 days of a deployment).

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of larval and growth stage Walleye are presented in Table 201.

Table 201 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for Walleye

Walleye	2016	2017	2018	2019	2020
Eggs (Acute Bottom)					
June	1 (0-1)	**12 (6-14)**	0 (0-1)	1 (0-5)	--
Eggs (Chronic Bottom)					
May	--	--	--	--	--
June	2 (1-14)	2 (1-50)	0 (0-2)	0 (0-1)	**44 (25-58)**
Larvae (Acute Surface)					
May	5 (4-6)	--	**11 (4-22)**	--	--
June	**17 (4-27)**	**26 (16-33)**	**13 (1-18)**	3 (2-4)	**77(57-94)**
July	**32 (11-46)**	**22 (5-46)**	**78 (63-85)**	**27 (24-31)**	**67 (44-94)**
Larvae (Chronic Surface)					
June	**75 (2-78)**	3 (2-5)	1 (1-2)	3 (2-4)	**65 (40-95)**
July	**84 (84-87)**	--	**79 (51-85)**	**34 (25-85)**	**97 (47-99)**
Growth (Chronic Bottom)					
August	1 (0-1)	--	--	--	--
Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.					

For the egg stage, there were significant thermal exceedances that encompassed more than 10% of the LSA for acute benchmarks in June of 2017 and for chronic benchmarks in June of 2020. For the larval stage, significant thermal HQ exceedances encompass more than 10% of the LSA in all years assessed. Despite this, the violin plots of acute and chronic larval HQs in the LSA and at reference areas (Figure 115 and Figure 116) were similar in all years assessed. In 2019 and 2020, where shallow CWMP sites were included in the assessment, the range of acute and chronic larval HQs in reference areas generally encompassed that of the HQs calculated for Baie du Doré. This supports some uncertainty in the larval thermal benchmark for Lake Huron. There were no exceedances encompassing more than 10% of the LSA for the growth stage.

Walleye rarely lay their eggs on rocky shoal in the lake and the vast majority of egg and early larval stages occur in rivers. The majority of larvae hatch in rivers and in June and July [R-353] when the egg and larval thermal exceedances encompassed more than 10% of the LSA, the majority of the LSA larvae would still be in the rivers feeding. As a result of this biological and ecological context, thermal effluent poses a low risk to the reproductive success of Walleye in the LSA and no unreasonable risk to the population success of Walleye near Bruce Power.

9.5.2.5 White Sucker

The spawning season for White Sucker occurs in early May to early June in gravelly streams when water temperatures are 10°C. Eggs are scattered and adhere to gravel or other substrate downstream. The adults remain for another 10-14 days before returning to the lake. Eggs incubate for 2 weeks and larvae remain in the gravel for 1-2 weeks before migrating to the lake [R-289]. White Suckers are common prey for large piscivores and represent a species of interest to MNO and HSM (see Appendix A Section 1.8.7).

Near Bruce Power, White Sucker may spawn in Stream C in May or June and eggs would be present for 2 weeks in May or June. The egg stage for White Sucker is excluded from the thermal risk assessment because it is only present in Stream C. Larvae would also be in the stream for 1-2 weeks in June and are then expected to travel to Baie du Doré and the open water body. The growth stage may be present in Baie du Doré and the nearshore in June through July.

<u>Preliminary Screening</u>

HQs for White Sucker were calculated as described in the methodology and are presented using violin plots by site group in Figure 118 and Figure 119 and over time in Figure 120.

Figure 118 Chronic HQs for White Sucker by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

Figure 119 Acute HQs for White Sucker by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

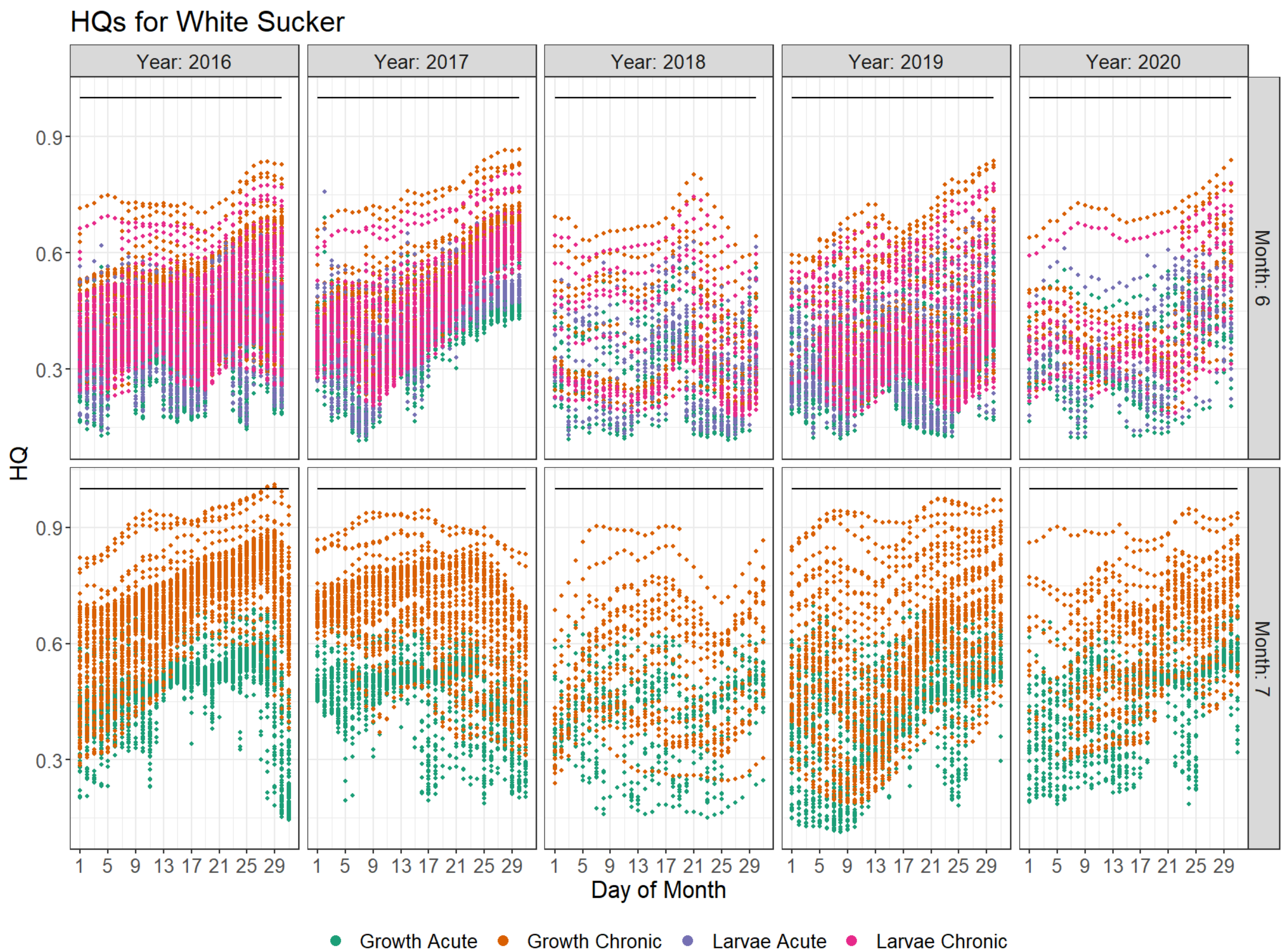

Figure 120 HQs for White Sucker by Benchmark. Black line indicates HQ of 1.0.

No HQ exceedances occurred for White Sucker except for a brief exceedance of the chronic benchmark for the growth stage in July 2016. The growth benchmark for White Sucker was retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment was required for the acute and chronic larval benchmark or the acute benchmark.

<u>Secondary Screening</u>

There are no significant HQ exceedances for White Suckers according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. The duration of the brief exceedance of the chronic growth benchmark was sufficiently short that it did not screen in as a significant thermal benchmark exceedance. No benchmarks were retained for further assessment in the TRA.

Based on the lack of significant HQ results and available thermal benchmarks, thermal effluent poses no unreasonable risk to White Sucker in the LSA.

9.5.2.6 Yellow Perch

Typically Yellow Perch spawn in mid-April to early May, at temperatures ranging from 6.7-12.2°C in shallows of lakes and tributary streams near rooted vegetation, submerged brush, fallen trees, sand or gravel. Eggs are released as a mass in a long sack/tube that is semi-buoyant and adheres to submerged vegetation or substrate. The eggs hatch in 8-10 days. Larvae are inactive for the first 5 days as the yolk is absorbed and grow rapidly. The growth stage forms compact schools in summer and are found nearer shore than adults.[R-289]

In the local region, Yellow Perch eggs may be in the very shallows of the nearshore and in Baie du Doré for a period of <2 weeks in late April-early May. Larvae may be present in the shallows for up to 1 week in May or June and the growth stage may be found in Baie du Doré and the nearshore in July through September. Yellow Perch are known to be near the Bruce Power site based on entrainment and impingement monitoring. This species is of importance to MNO and HSM as a traditional and commercial species (see Appendix A Section 1.8.7).

<u>Preliminary Screening</u>

HQs for Yellow Perch were calculated as described in the methodology and are presented using violin plots by site group in Figure 121 and Figure 122 and over time in Figure 123.

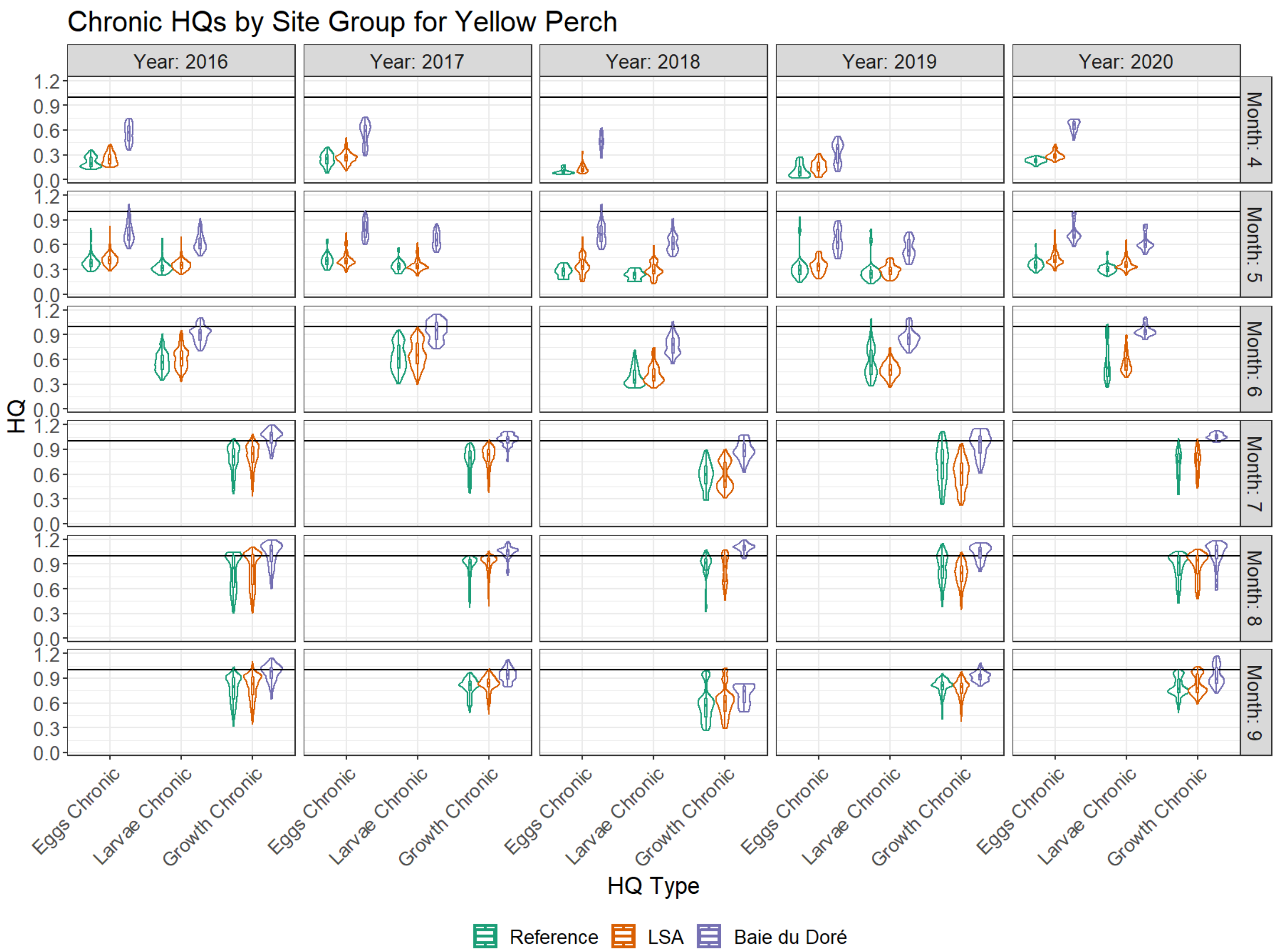

Figure 121 Chronic HQs for Yellow Perch by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

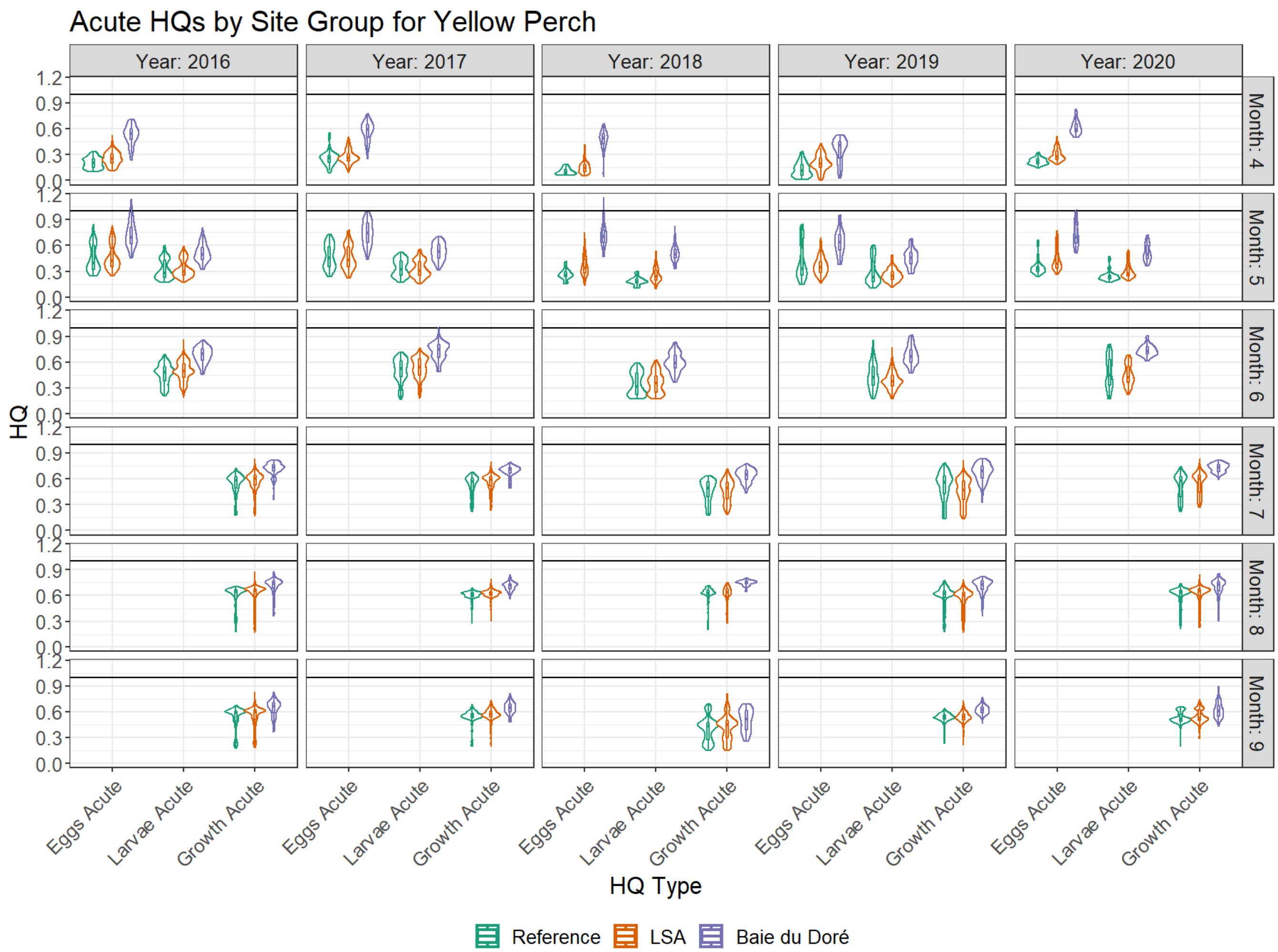

Figure 122 Acute HQs for Yellow Perch by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

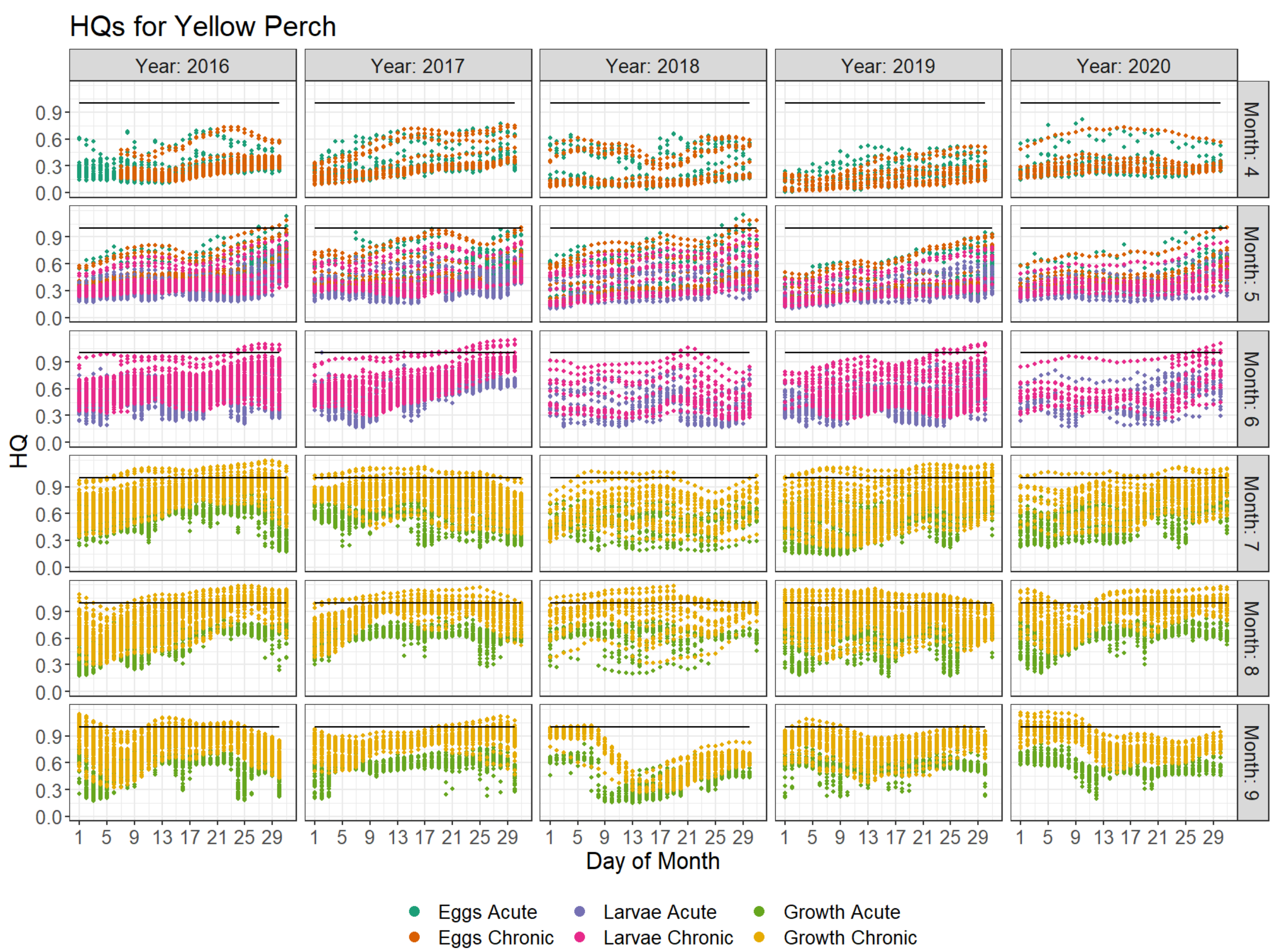

Figure 123 HQs for Yellow Perch by Benchmark. Black line indicates HQ of 1.0.

There were chronic HQ exceedances for larval and growth stage over all five years assessed. There were no acute HQ exceedances except for eggs in May 2016 and 2018. Chronic larval and growth benchmarks and acute egg benchmarks were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment of acute larval and growth and chronic egg benchmarks was required.

Secondary Screening

A count of significant HQ exceedances is presented in Table 202 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. There are no significant acute egg exceedances and no further assessment was required. Chronic larval and growth exceedances in the LSA and Baie du Doré were retained for further assessment in the TRA.

Table 202 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Yellow Perch

Yellow Perch (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Larvae (Bottom)										
Baie du Doré*	6	104	15	78	-	183	-	59	-	-
LSA*	-	992	-	648	-	315	-	379	-	427
Reference	-	333	-	226	-	81	-	220	-	207
Larvae (Surface)										
Baie du Doré*	14	110	25	117	-	61	-	113	5	61
LSA*	-	333	-	435	-	71	-	220	-	-
Reference	-	146	-	153	-	20	-	345	-	18
Growth (Bottom)										
Baie du Doré*	88	276	-	184	38	150	40	184	20	118
LSA*	-	1,288	-	1,104	29	537	-	920	67	661
Reference	43	460	-	460	-	282	-	368	31	735
Growth (Surface)										
Baie du Doré*	100	184	54	184	15	35	49	276	113	229
LSA*	73	1,196	5	1,288	23	230	11	920	97	563
Reference	87	460	-	460	24	221	224	1,196	90	818

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of larval and growth stage Yellow Perch are presented in Table 203.

Table 203 Median (25^{th} - 75^{th} percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for larval and growth Yellow Perch

Yellow Perch (Chronic)	2016	2017	2018	2019	2020
Larvae (Bottom)					
June	--	4 (3-6)	--	--	--
Larvae (Surface)					
June	2 (1-3)	10 (1-21)	--	--	**46 (46-56)**
Growth (Bottom)					
July	3 (1-5)	--	--	--	--
August	--	--	**11 (4-15)**	**32 (29-35)**	**19 (12-37)**

September	1 (1-1)	--	8 (8-12)	2 (1-3)	**13 (12-15)**
Growth (Surface)					
July	**21 (3-77)**	5 (3-8)	0 (0-0)	5 (3-7)	3 (1-8)
August	**77 (55-83)**	--	**79 (60-94)**	**15 (11-24)**	**69 (48-76)**
September	**16 (8-40)**	--	**30 (26-37)**	--	**60 (55-63)**
Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.					

With the exception of the surface temperatures for June 2020, significant thermal HQ exceedances do not encompass more than 10% of the LSA for larval Yellow Perch. For the growth stage at the surface, there were significant HQ exceedances encompassing more than 10% of the LSA in July 2016, August 2019 and August and September of 2016, 2018 and 2020. At the bottom, there were exceedances of more than 10% of the LSA in August of 2018, 2019 and 2020 and September of 2020.

Larval Yellow Perch tended to cluster around areas of higher water temperature when the range of water temperature varied from 13.0°C and 22.3°C and in areas with substrate covered by vegetation debris in Lake Saint-Pierre, Québec [R-354]. This suggests that the larval chronic benchmark of 19.7°C may be too low for the LSA. Temperatures within the LSA and Baie du Doré remained at or below this temperature range during all five years assessed (see Figure 105 under Deepwater Sculpin), indicating that the risk to larval Yellow Perch in the LSA is low.

During the first summer after hatching, schools of Yellow Perch are often observed [R-289] in the local study area. Juvenile Yellow Perch have been observed to shoal in a spatial pattern that is independent of habitat characteristics, including temperatures ranging from 19.0°C to 29.0°C in Lake Saint-Pierre, Québec [R-354]. Yearling Yellow Perch (mean weight of 60g) have exhibited behavioural thermoregulation in a diel pattern, with the pre-dawn preferred temperature of 16.7°C increasing to 23.8°C by dusk [R-355]. These studies suggest that the larval chronic benchmark of 22°C may be too low for the LSA. Figure 124 demonstrates that temperatures within the LSA remain within the range of preferred temperatures during the growth stage and at or below the temperatures measured in Lake Saint-Pierre, Québec during the month of July [R-354]. Additionally, a study examining growth of Yellow Perch in Lake Huron modelled increased growth with warming water temperature under a climate change scenario with high prey consumption but decreased growth if prey availability was reduced [R-347].

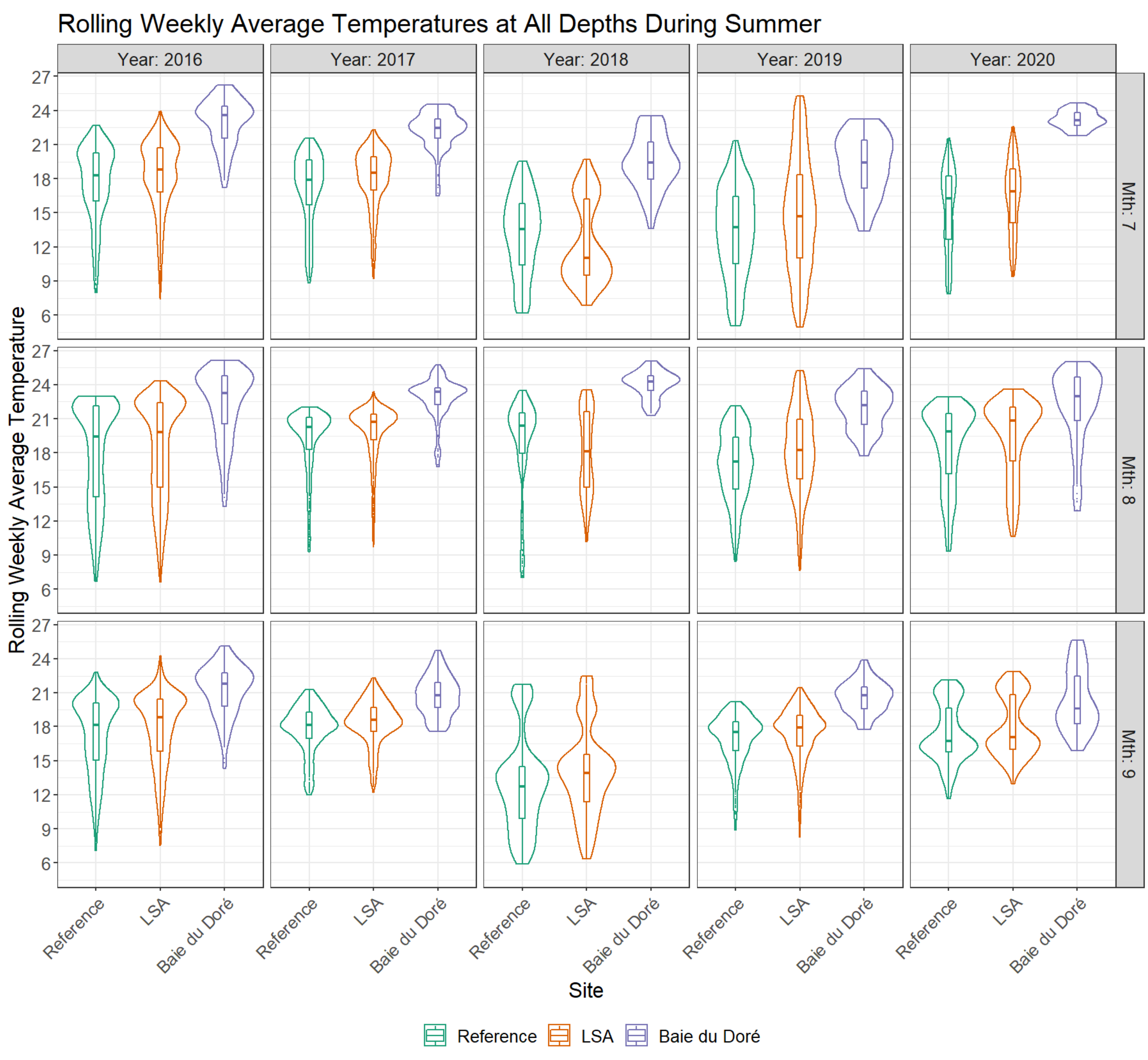

Figure 124 Rolling Weekly Average Temperatures during Yellow Perch Growth Stage presence in the LSA.

Given the evidence for high abundance of larval Yellow Perch at the temperatures occurring in the LSA in June and the single year of exceedances encompassing more than 10% of the LSA, the overall risk characterization for larval Yellow Perch is low. Given the evidence of shoaling behaviour independent of temperature characteristics and evidence for diel behavioural thermoregulation and the evidence for successful populations of Yellow Perch at temperatures occurring within the LSA, the overall risk characterization for growth Yellow Perch is low despite thermal exceedances encompassing more than 10% of the LSA in four of the five years assessed. Both the chronic larval and growth benchmarks may be too low for the LSA. As a result, thermal effluent generally poses no unreasonable risk to the egg stage and a low risk to larval and growth Yellow Perch in the LSA, and no unreasonable risk to the population success of Yellow Perch near Bruce Power.

9.5.3 Warm Water Fish Species

Acute and chronic thermal benchmarks were assessed for five warm water fish species present in the LSA, generally between May and September of each year. Table 204 and Table 205 list the thermal benchmarks used in the calculation of HQs by month. Sources for the thermal benchmarks are described in Section 9.3.6.1.

Table 204 Acute thermal benchmarks by month for warm water fish species considered in thermal risk assessment

Acute ONLY (Hierarchy of CTM > UILT > STmax and Adult acute used where spawning acute N/A)							
Species	**Month**						
	Jan-Apr	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct-Dec**
Brown Bullhead		Parent: 33.4, Eggs: 25	Parent: 33.4, Eggs: 25, Larvae: 38.2	Parent: 33.4, Larvae: 38.2, Growth: 36	Growth: 36	Growth: 36	
Channel Catfish		Parent: 36.7, Eggs: 29	Parent: 36.7, Eggs: 29, Larvae: N/A	Parent: 36.7, Eggs: 29, Larvae: N/A	Parent: 36.7, Larvae: N/A, Growth: 39.0	Growth: 39.0	
Common Carp		Eggs: 40.6	Eggs: 40.6, Larvae: 38.8	Eggs: 40.6, Larvae: 38.8	Eggs: 40.6, Larvae: 38.8, Growth: 40.6	Larvae: 38.8, Growth: 40.6	
Freshwater Drum				Eggs: 26, Larvae: N/A	Eggs: 26, Larvae: N/A, Growth: 32.8	Larvae: N/A, Growth: 32.8	
White Bass		Eggs: 26	Eggs: 26, Larvae: 31.7	Larvae: 31.7, Growth: 35.3	Growth: 35.3	Growth: 35.3	

Note: Overall most sensitive thermal benchmark from all guilds in each month in red. Species listed as not available (N/A) in yellow. Grey cells indicate species are expected to be offshore.

Table 205 Chronic MWAT thermal benchmarks by month for cool water fish species

Chronic ONLY (MWAT) - Adult MWAT used when spawning MWAT not available							
Species	**Month**						
	Jan-Apr	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct-Dec**
Brown Bullhead		Parent: 21.1, Eggs: 21.1$^{\alpha}$	Parent: 21.1, Eggs: 21.1$^{\alpha}$, Larvae: 29.1	Parent: 21.1, Larvae: 29.1, Growth: 32	Growth: 32	Growth: 32	

Channel Catfish		Parent: 32.4, Eggs: 27	Parent: 32.4, Eggs: 27, Larvae: N/A	Parent: 32.4, Eggs: 27, Larvae: N/A	Parent: 32.4, Larvae: N/A, Growth: 32	Growth: 32	
Common Carp		Eggs: 25	Eggs: 25, Larvae: 27.9	Eggs: 25, Larvae: 27.9	Eggs: 25, Larvae: 27.9, Growth: 34	Larvae:27.9, Growth: 34	
Freshwater Drum				Eggs: 23.9[Ω], Larvae: N/A	Eggs: 23.9[Ω], Larvae: N/A, Growth: 25.6	Larvae: N/A, Growth: 25.6	
White Bass		Eggs: 19[µ]	Eggs: 19[µ], Larvae: 24.1	Larvae: 24.1, Growth: 26.7	Growth: 26.7	Growth: 26.7	

[α]Parent benchmark used as egg incubation benchmarks for Brown Bullhead.
[Ω]Preferred egg incubation temperature used as MWAT not applicable due to short incubation period of 2 days.
[µ]Spawning benchmark used as MWAT not applicable due to short incubation period of 2 days.
Note: Overall most sensitive thermal benchmark from all guilds in each month in red. Species and life stages where thermal benchmarks are not available (N/A) indicated in yellow. Grey cells indicate species are expected to be offshore.

9.5.3.1 Brown Bullhead

Brown Bullhead spawn in late spring or early summer when lake temperature reaches 21.1°C, typically May or June in a shallow nest in mud or sand or rotten vegetation near the protection of a rock stump or tree in the shores of lakes, coves and bays. Eggs are adhesive and parents remain to regularly move and fan the eggs. After 6-9 days the eggs hatch and the larvae remain in the nest inactive for the first 7 days. Afterwards they swim under the protection of the parents for the next several weeks.[R-289]

Adult Brown Bullhead may spawn locally in the shallow regions of Baie du Doré and remain for the months of May, June and July. Eggs may be present in May or June for a period of less than 2 weeks. Larvae would remain in the shallows for June and July under the protection of their parents. The growth stage may occur from July through September.

Given the presence of adults during spawning, parental care of eggs and the initial larval phase, the MWAT for spawning of 21.1°C was used for May and June, followed by the adult stage MWAT of 32°C for July. The egg stage for Brown Bullhead does not have an available chronic benchmark. Given the very short incubation of Brown Bullhead eggs, parental care provided and the lengthy spawning season, the parent benchmarks were used for the chronic egg stage benchmarks.

<u>Preliminary Screening</u>

HQs for Brown Bullhead were calculated as described in the methodology and are presented using violin plots by site group in Figure 125 and Figure 126 and over time in Figure 127. Thermal HQs >1 occurred during the parent stage primarily in Baie du Doré in all five years assessed. There was a brief acute egg benchmark exceedance in June of 2017.

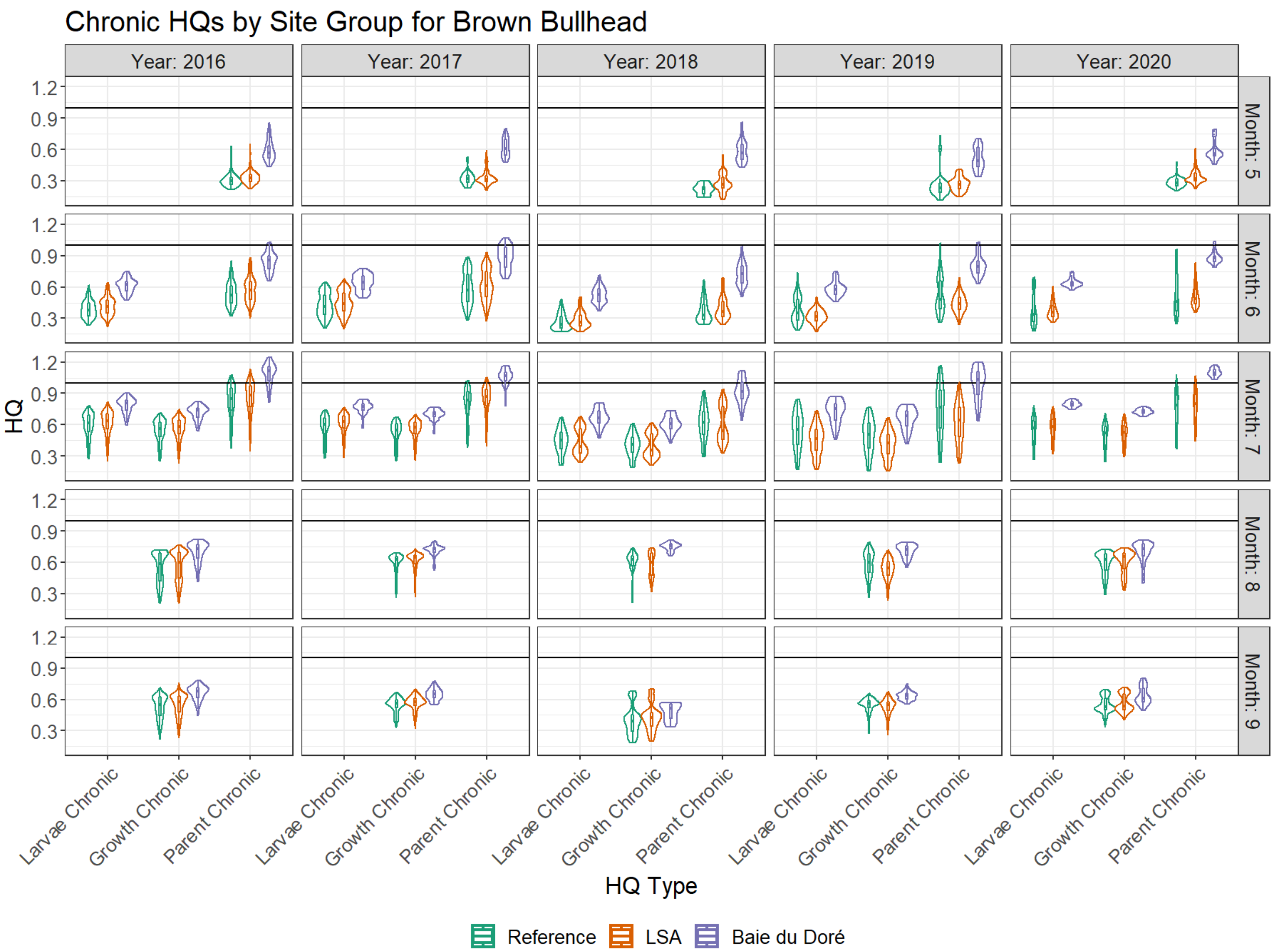

Figure 125 Chronic HQs for Brown Bullhead by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

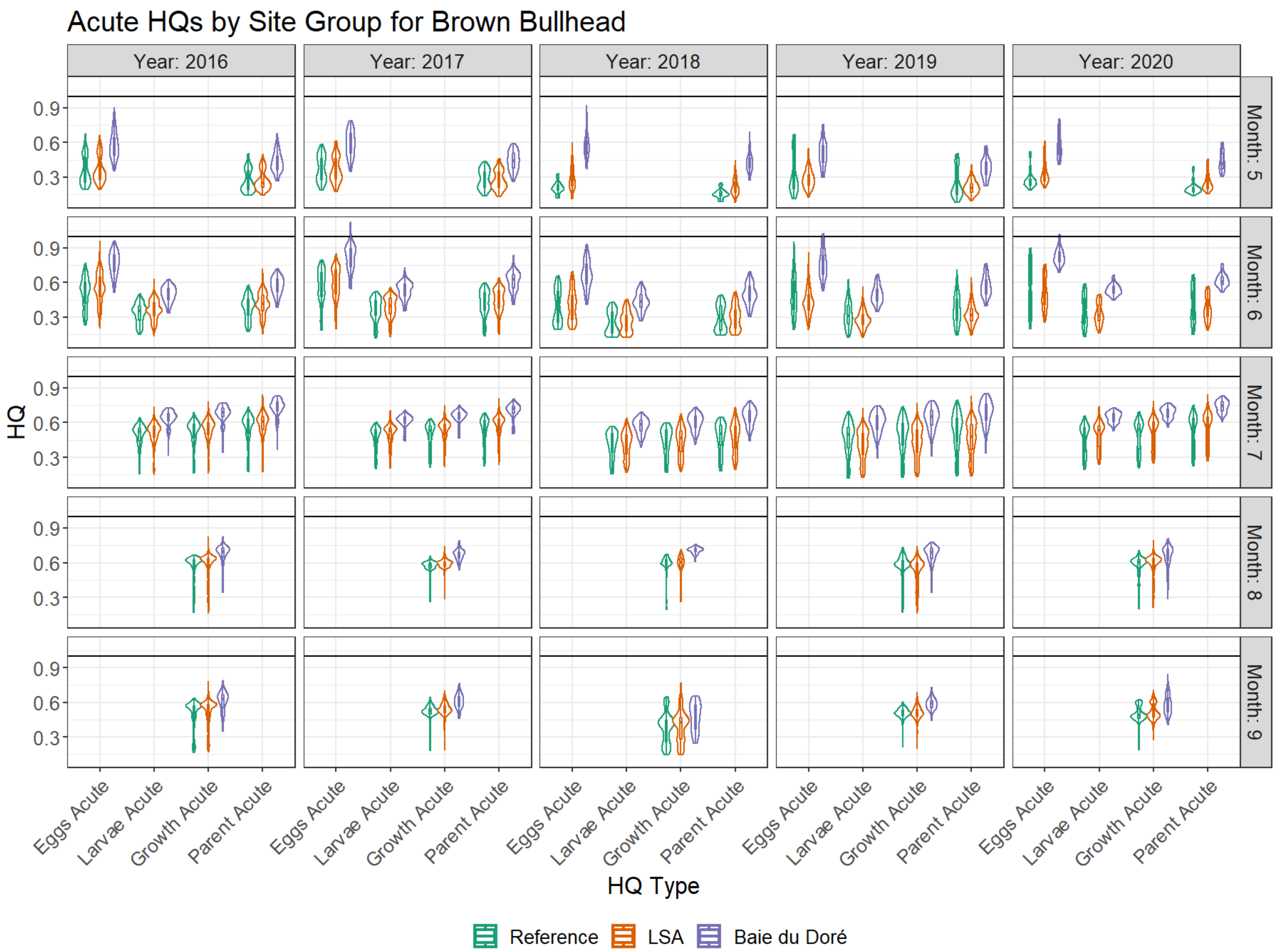

Figure 126 Acute HQs for Brown Bullhead by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

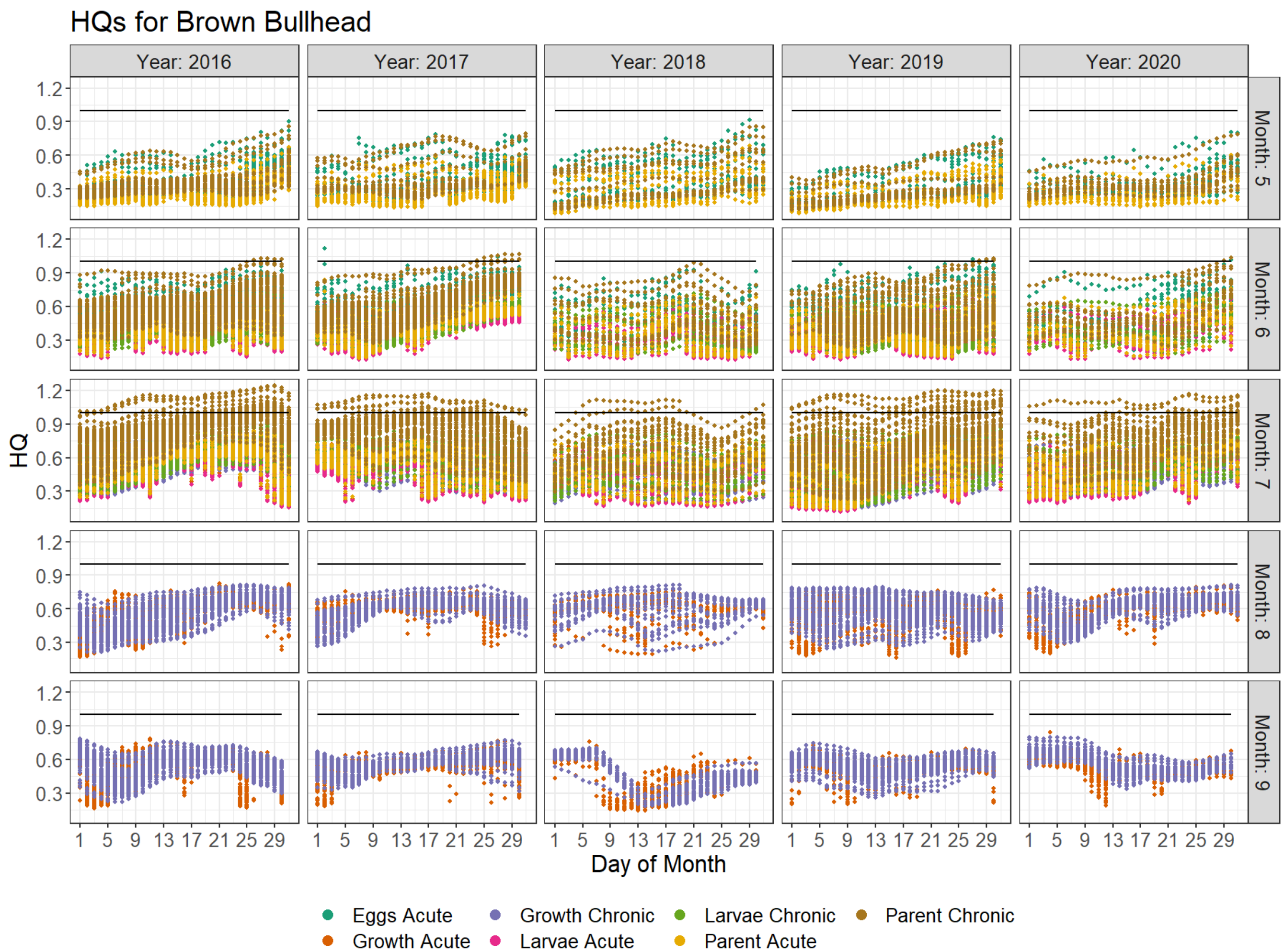

Figure 127 HQs for Brown Bullhead by Benchmark. Black line indicates HQ of 1.0.

Parent benchmarks were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment was required for acute and chronic larval and growth benchmarks and acute egg and parent benchmarks.

<u>Secondary Screening</u>

Secondary screening results are presented in the form of a table for each species assessed. These tables indicate the number of significant HQ exceedances for LSA and Baie du Doré sites. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. For each HQ exceedance value presented, the total number of HQs calculated in the LSA, Baie du Doré and Reference areas are presented for context as to the proportion of all the calculated HQs presented that exceed one. All significant HQs within the LSA and Baie du Doré are advanced to the TRA.

A count of significant HQ exceedances is presented in Table 206 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. There were no significant acute exceedances in any of the years assessed. Chronic parent benchmark exceedances in the LSA and Baie du Doré were retained for further assessment in the TRA.

Table 206 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Brown Bullhead

Brown Bullhead (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Parent (Bottom)										
Baie du Doré*	46	197	36	140	14	276	10	121	-	-
LSA*	6	1,426	-	1,020	-	501	-	689	-	602
Reference	-	488	-	381	-	174	-	344	11	399

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for Brown Bullhead is presented in Table 207.

Table 207 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for larval Brown Bullhead

Brown Bullhead (Bottom)	2016	2017	2018	2019	2020
Parent (Chronic)					
July	6 (1-30)	2 (2-3)	0 (0-0)	**30 (27-31)**	--

Shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

Given the parental care required by Brown Bullhead eggs, the thermal risk assessment findings for the parent Brown Bullhead also apply to the egg stage for Brown Bullhead. The parent MWAT used in this assessment is 21.1°C from Wismer and Christie [R-276], however, a more recent aggregation of thermal benchmark research completed by Hasnain et al. (2013) [R-300] suggests that the preferred temperature for spawning Brown Bullhead is 21.1 ± 1.3°C. No UILT was available to calculate a new MWAT temperature for the purposes of the thermal risk assessment, however, the aggregation of data for the new preferred temperature suggests that the parent MWAT of 21.1°C is too low. Additionally, the month of July represents the end of the parent life stage for Brown Bullhead and many of the adult fish may have moved out of the LSA by this time after the hatching of the eggs.

Significant thermal HQ exceedances encompass more than 10% of the LSA for parent Brown Bullhead in July of 2019 but not for the remaining four years assessed and, when combined with the uncertainty over the actual parent MWAT value and the end of the life stage timing, the overall thermal risk characterization is low risk for the egg and parent stage of Brown Bullhead and no unreasonable risk to the larval or growth stages. There is no unreasonable risk to the overall population of Brown Bullhead within the LSA.

9.5.3.2 Channel Catfish

The spawning season for Channel Catfish occurs in late spring or early summer when water temperature reaches 23.9-29.5°C. Eggs are deposited in secluded, semi-dark nests in holes, log jams or rocks and the male stays with the nest to move and fan the eggs and protect the young. Eggs hatch in 5-10 days and the larvae stay at bottom for another 2-5 days before swimming to the surface to feed. The growth stage grows rapidly.[R-289]

In the local area, Channel Catfish may spawn in Baie du Doré and the parents and young life stages are expected to remain for the months of May through July. Larvae may also be present in August and the growth stage may be found in August and September. Channel Catfish are known to be present near the site based on impingement monitoring and Smallmouth Bass survey information and are a species of cultural importance to HSM (see Appendix A Section 1.8.7).

Given the presence of adults during spawning and parental care of eggs, the adult MWAT and CTM were used as thermal assessment benchmarks during the months of May through July. No larval benchmarks were available for Channel Catfish. The larval stage for Channel Catfish was not assessed given that the preferred larval temperature of 25.5°C lies between the preferred egg incubation temperature of 22.9°C and the preferred adult temperature of 27.3°C and that both the egg and parent stages are assessed for acute and chronic benchmarks.

Preliminary Screening

HQs for Channel Catfish were calculated as described in the methodology and are presented using violin plots by site group in Figure 128 and Figure 129 and over time in Figure 130.

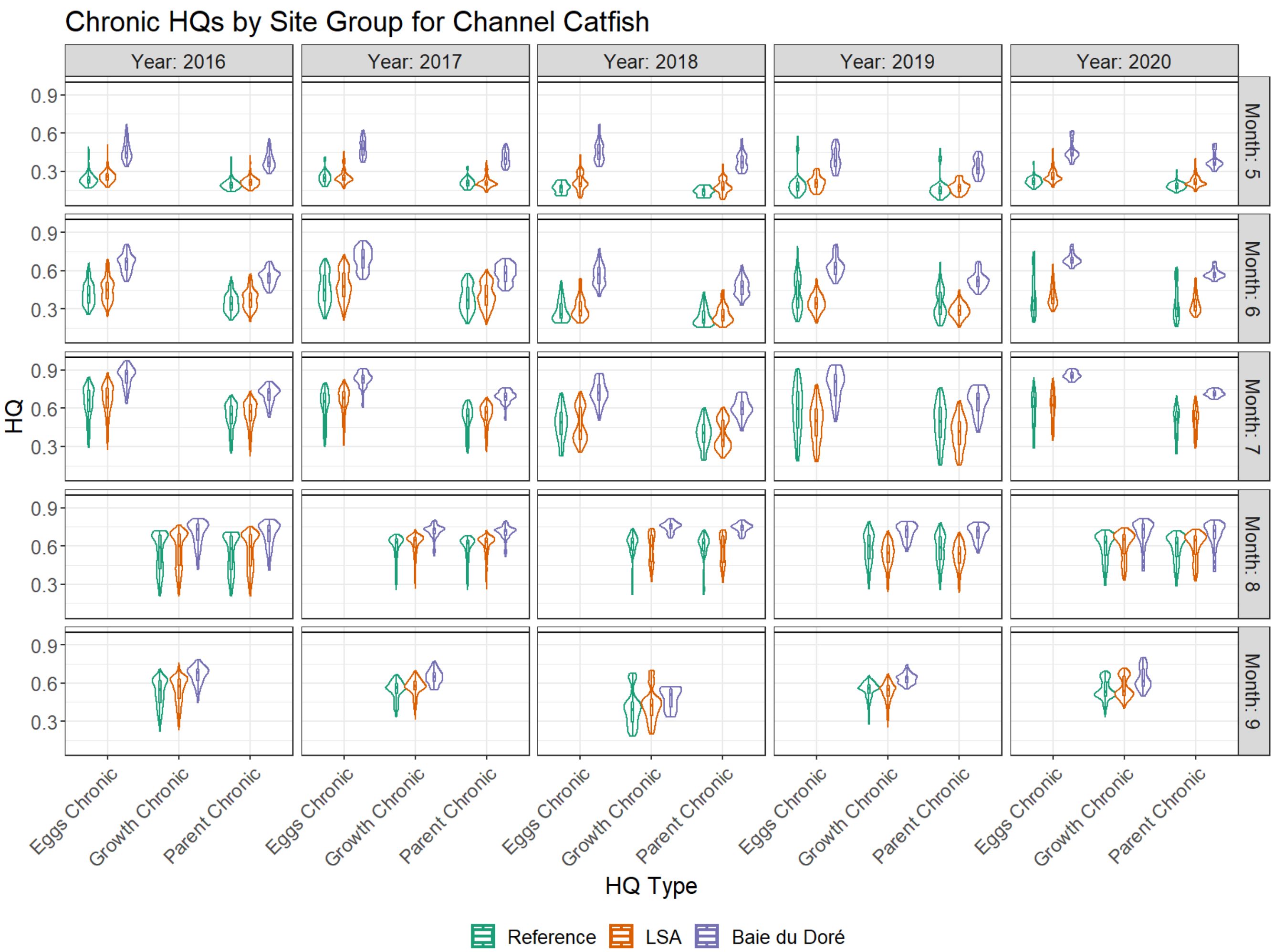

Figure 128 Chronic HQs for Channel Catfish by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

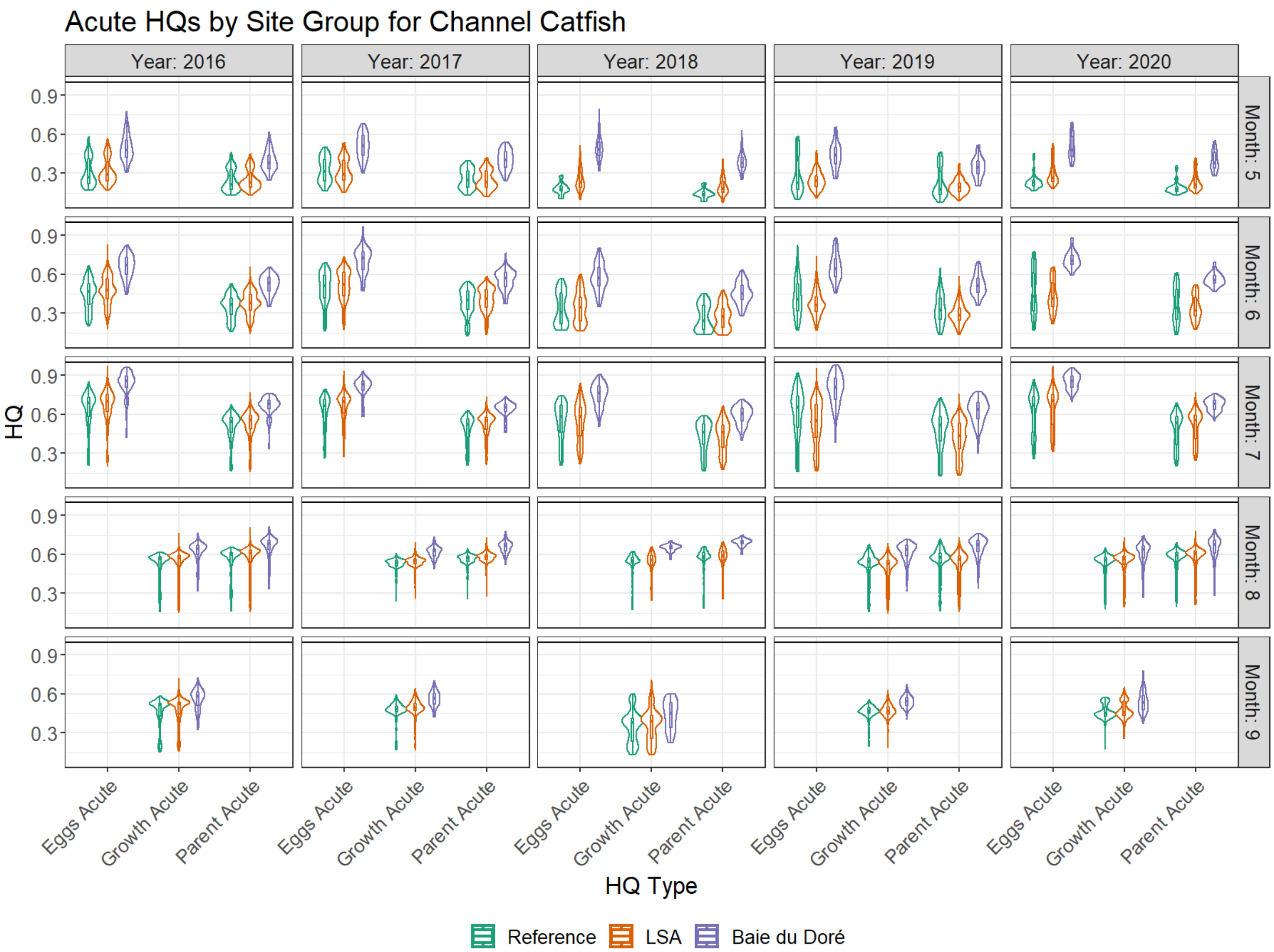

Figure 129 Acute HQs for Channel Catfish by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

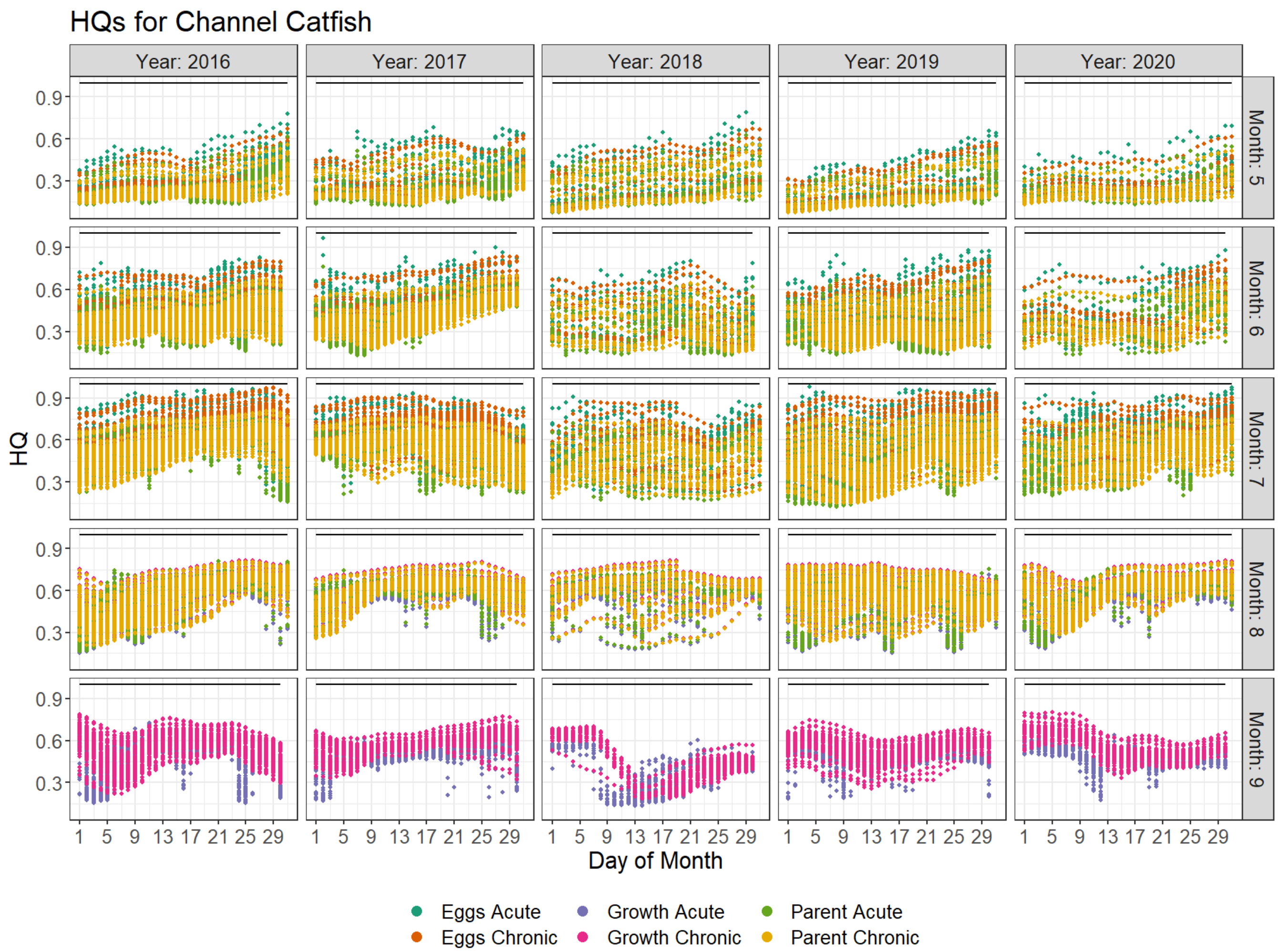

Figure 130 HQs for Channel Catfish by Benchmark. Black line indicates HQ of 1.0.

There are no thermal benchmark exceedances to report for Channel Catfish. Due to a lack of thermal benchmark exceedances, no further assessment was required. Based on the HQ results and available thermal benchmarks, thermal effluent poses no unreasonable risk to Channel Catfish in the LSA.

9.5.3.3 Common Carp

Common Carp spawn in spring and early summer (May to August in the Great Lakes) at a temperature ≥17°C. The spawn continues for several weeks and halts when temperatures rise to about 26°C. Eggs are deposited randomly in weedy or grassy shallows and adhere to submerged vegetation. Eggs hatch in less than one week and the young grow rapidly [R-289].

Near Bruce Power, Common Carp may spawn in Baie du Doré in May through August depending on the lake temperature. Eggs would be present for less than one week in that time. It is assumed that the larval stage would be present in the bay from May through September. Common Carp are known to be present near the site based on impingement monitoring and Smallmouth Bass survey information and are a species of cultural importance to HSM (see Appendix A Section 1.8.7).

Preliminary Screening

HQs for Common Carp were calculated as described in the methodology and are presented using violin plots by site group in Figure 131 and Figure 132 and over time in Figure 133.

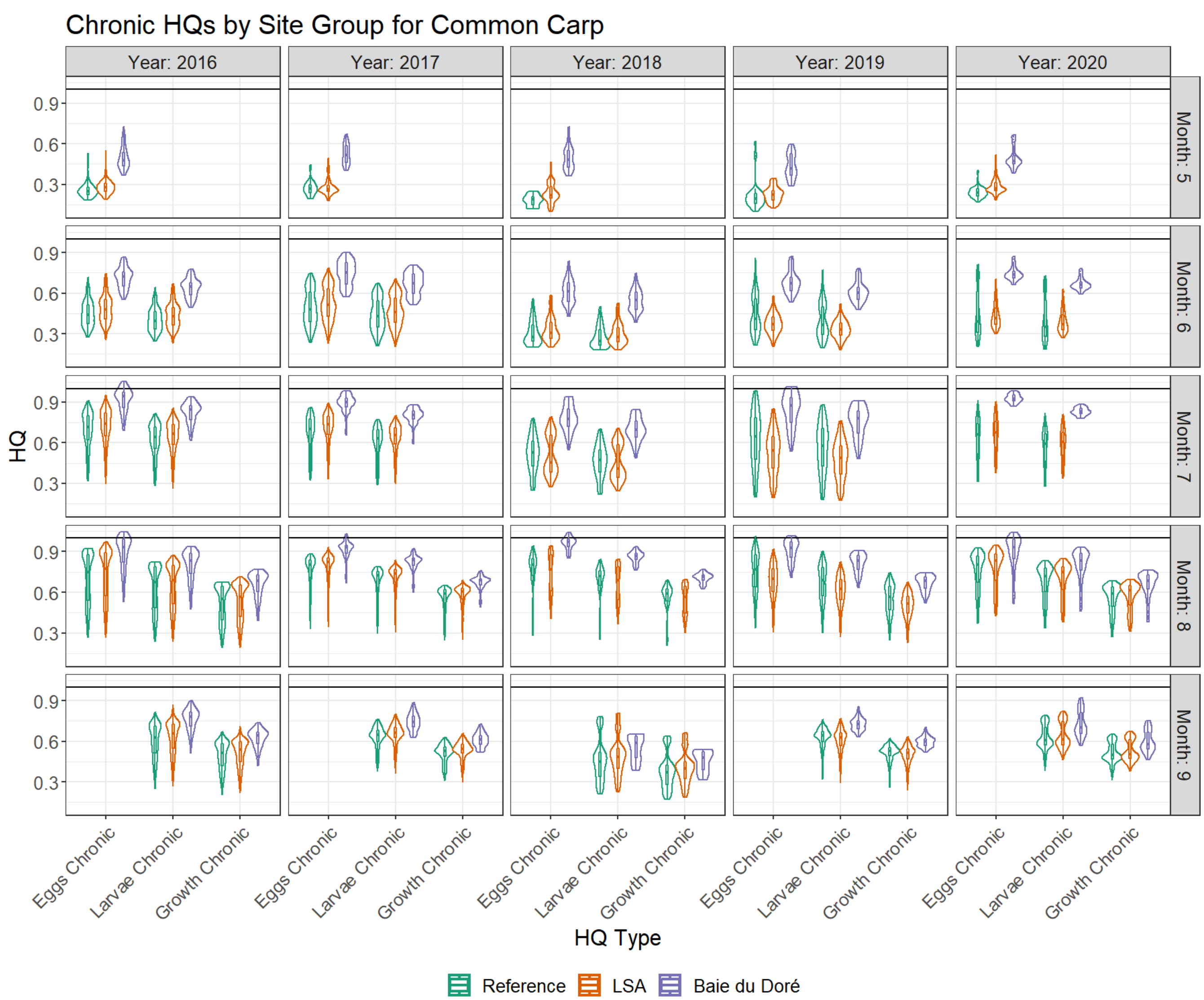

Figure 131 Chronic HQs for Common Carp by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

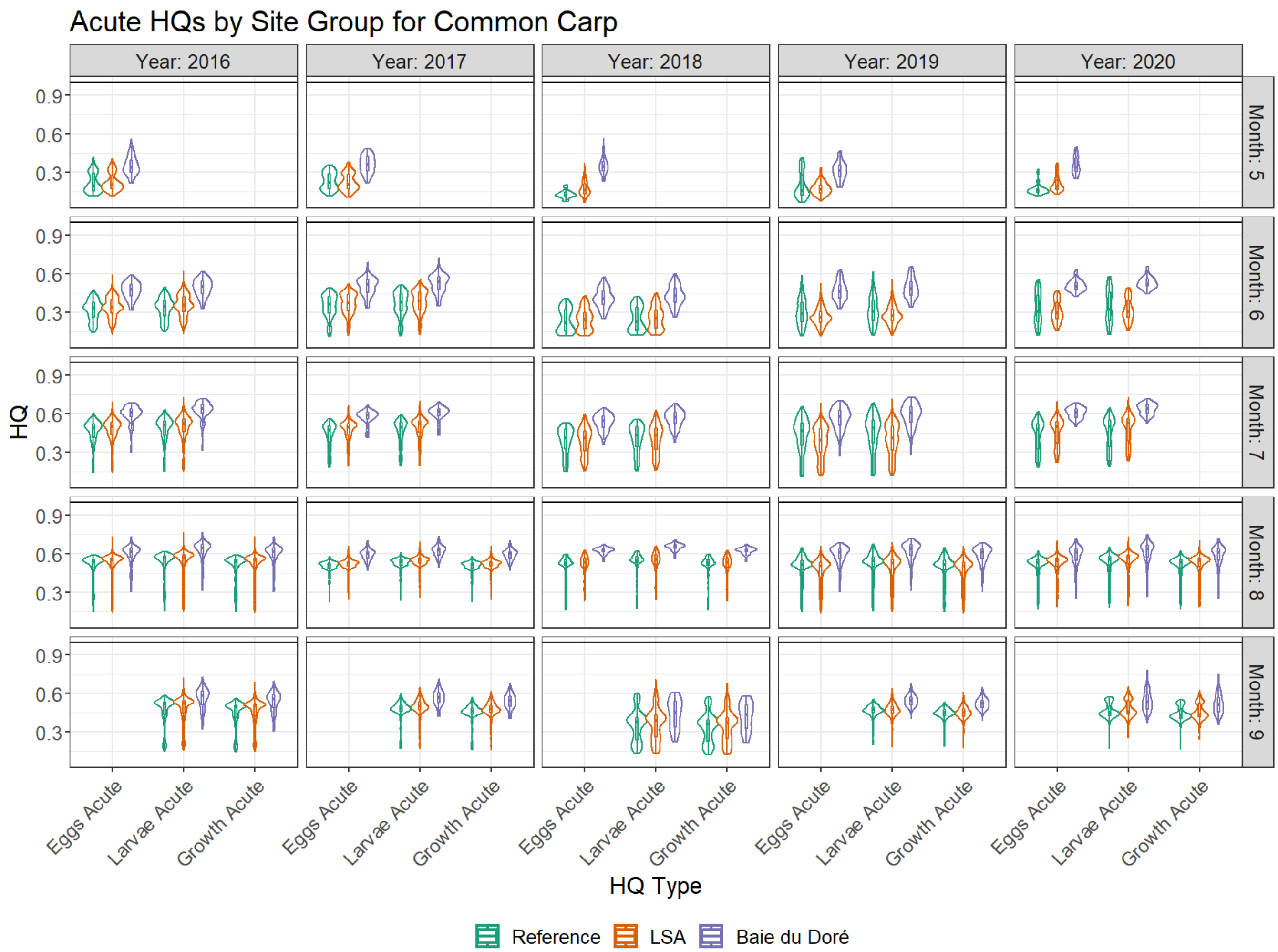

Figure 132 Acute HQs for Common Carp by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

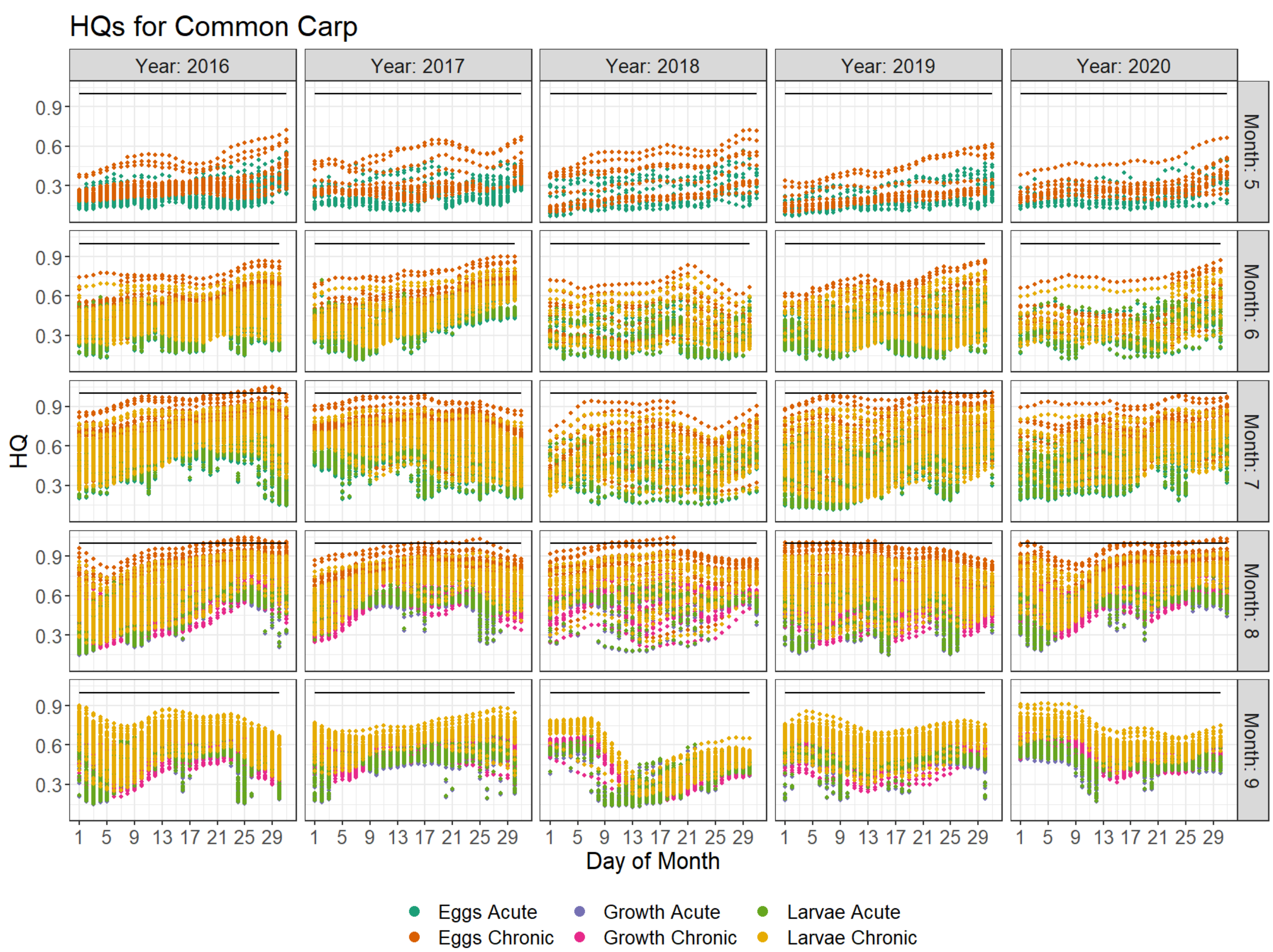

Figure 133 HQs for Common Carp by Benchmark. Black line indicates HQ of 1.0.

Chronic thermal exceedances occur during the egg stage in primarily Baie du Doré in July and August for all five years. There were no thermal exceedances for any acute benchmarks assessed. Chronic egg benchmarks were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment was required for acute egg and acute and chronic larval and growth benchmarks.

<u>Secondary Screening</u>

A count of significant HQ exceedances is presented in Table 208 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. A small number of significant chronic HQ exceedances occur in Baie du Doré in 2016 and 2018. Chronic egg benchmark exceedances in Baie du Doré were retained for further assessment in the TRA.

Table 208 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Common Carp

Common Carp (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Bottom)										
Baie du Doré*	22	290	-	202	10	333	-	183	-	58
LSA*	-	1,860	-	1,392	-	687	-	999	-	848
Reference	-	643	-	536	-	267	-	468	-	672

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for Common Carp is presented in Table 209.

Table 209 Extent of LSA including Baie du Doré (%) with significant thermal exceedances for Common Carp

Common Carp (Bottom)	2016	2017	2018	2019	2020
Eggs (Chronic)					
July	0 (0-1)	--	--	--	--
August	1 (0-1)	--	--	--	--

Red shading indicates median extent of LSA is greater than 10%. Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as "--"in the table.

Significant thermal HQ exceedances do not encompass more than 10% of the LSA for Common Carp and therefore pose no unreasonable risk to Common Carp. As a result, thermal effluent generally poses no unreasonable risk to Common Carp in the LSA, and no unreasonable risk to the population success of Common Carp near Bruce Power.

9.5.3.4 Freshwater Drum

Freshwater Drum typically spawn in July or August in bays, lower parts of rivers and lakes in depths of less than one meter over sand and mud. The eggs are buoyant and float at the surface. When temperatures are 22°C, eggs hatch in two days. There is rapid growth in the first year.[R-289]

In the local region, Freshwater Drum eggs may be present in the shallow waters in the very nearshore and Baie du Doré in July or August for up to two days. The larval growth stages may be present in August or September. The egg and larval stages for Freshwater Drum do not have available chronic benchmarks and the larval stage lacks an acute benchmark. The preferred egg incubation temperature is used instead of an MWAT in a conservative assessment of the egg stage chronic benchmark. No larval information is available but the assessment of both egg or growth stage acute and chronic benchmarks will likely be protective of the larval stage. Freshwater Drum is known to be present near the site based on impingement monitoring and Smallmouth Bass and creel survey information.

<u>Preliminary Screening</u>

HQs for Freshwater Drum were calculated as described in the methodology and are presented using violin plots by site group in Figure 134 and Figure 135 and over time in Figure 136.

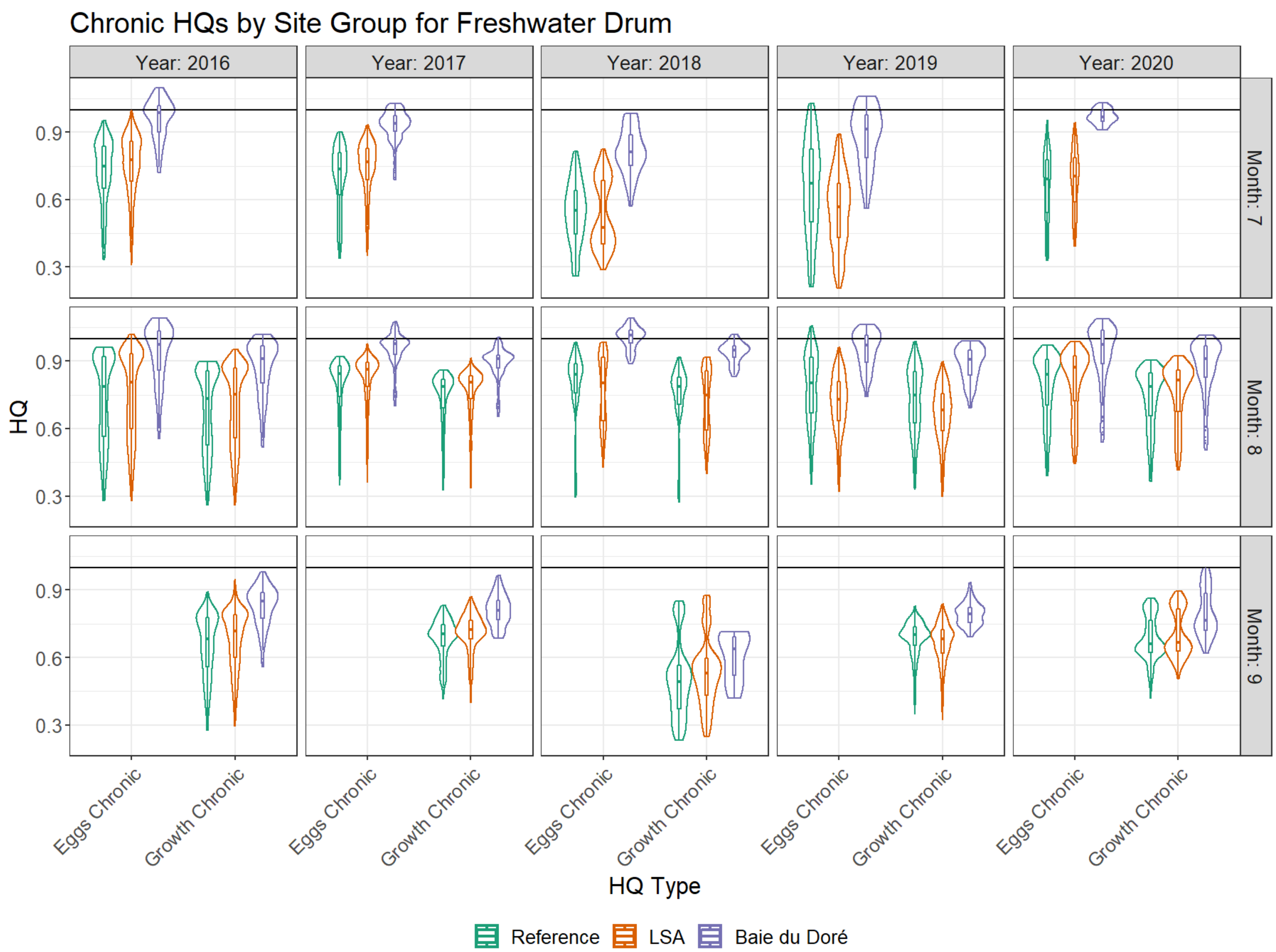

Figure 134 Chronic HQs for Freshwater Drum by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

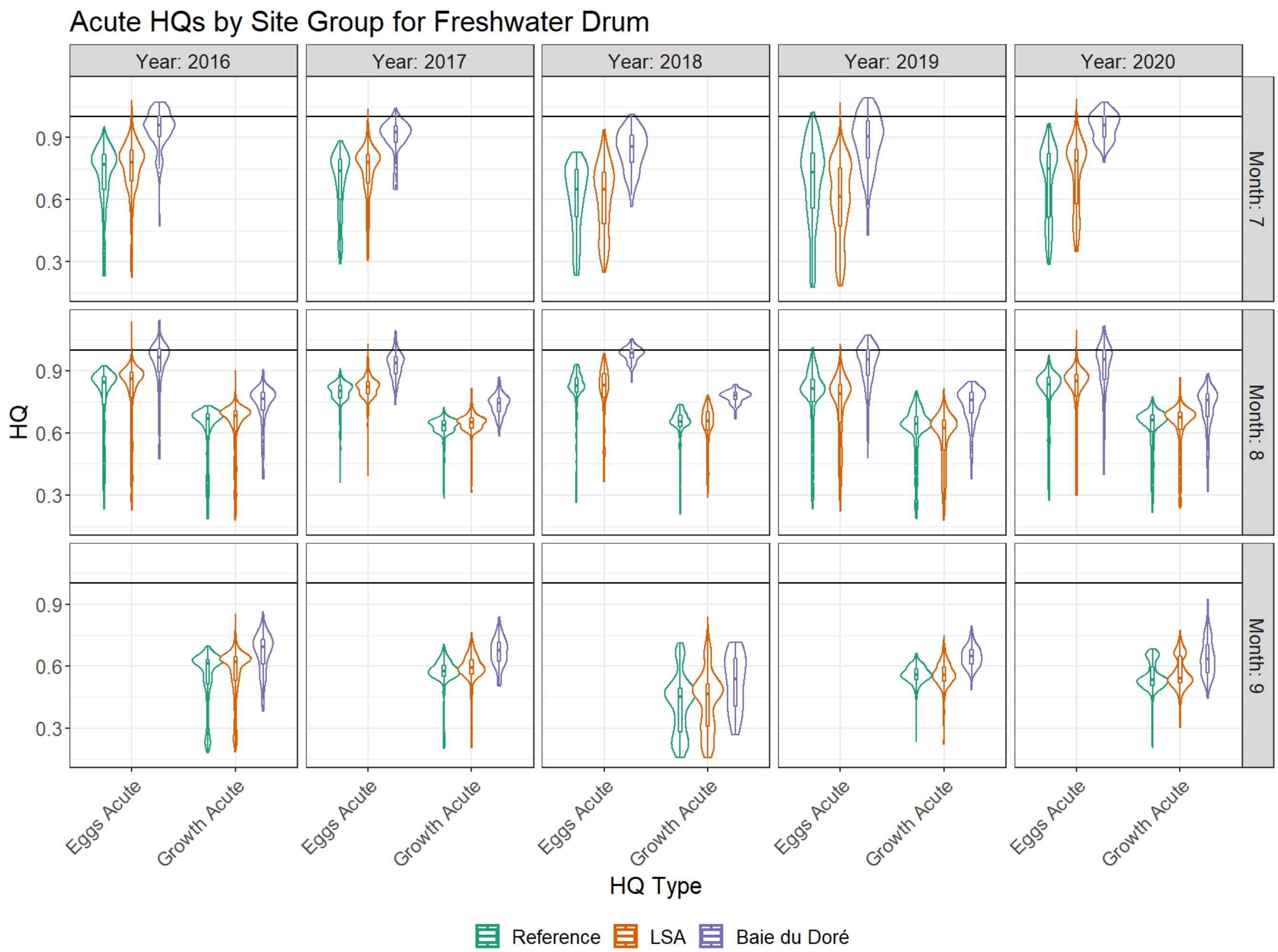

Figure 135 Acute HQs for Freshwater Drum by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

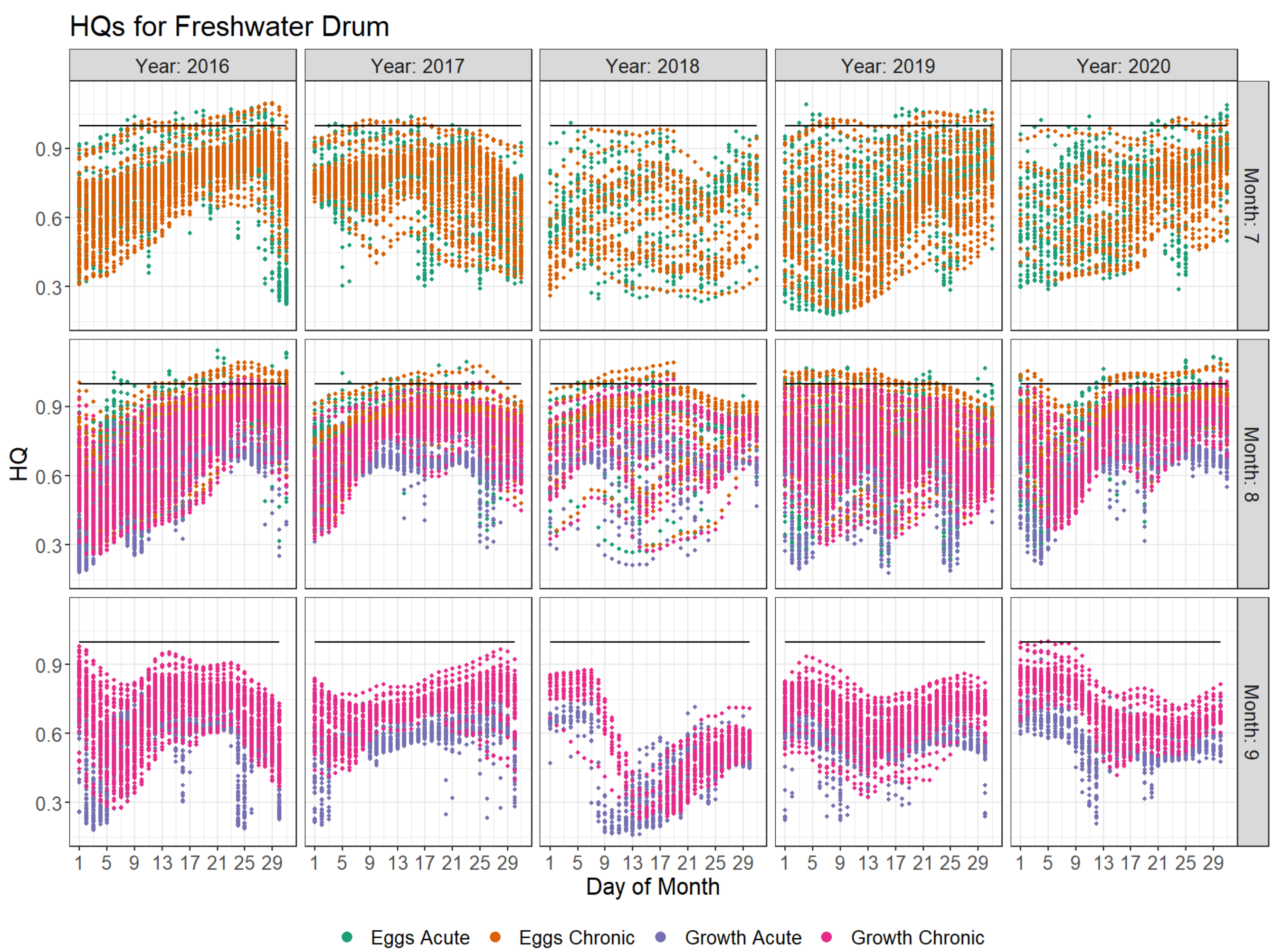

Figure 136 HQs for Freshwater Drum by Benchmark. Black line indicates HQ of 1.0.

HQ exceedances of acute growth benchmarks and chronic egg and growth benchmarks occurred during all five years assessed, concentrated in Baie du Doré. Acute and chronic egg and chronic growth benchmarks were retained for secondary screening. Due to a lack of thermal benchmark exceedances, no further assessment was required for acute growth benchmarks.

<u>Secondary Screening</u>

A count of significant HQ exceedances is presented inTable 210 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. Acute and chronic egg and chronic growth benchmark exceedances in Baie du Doré were retained for further assessment in the TRA.

Table 210 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for Freshwater Drum

Freshwater Drum (Bottom)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Acute)[β]										
Baie du Doré*	39	186	-	124	15	150	9	124	-	70
LSA*	-	868	-	744	-	372	-	620	-	469
Reference	-	310	-	310	-	186	-	248	-	495
Eggs (Chronic)[β]										
Baie du Doré*	59	186	-	124	36	150	-	124	-	58
LSA*	-	868	-	744	-	372	-	620	-	421
Reference	-	310	-	310	-	186	-	248	-	465
Growth (Chronic)										
Baie du Doré*	5	183	-	122	4	57	-	122	-	118
LSA*	-	854	-	732	-	351	-	610	-	486
Reference	-	305	-	305	-	189	-	244	-	543

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.
[β]Differences in total number of HQs calculated for acute and chronic results are related to the use of 7-day moving averages for chronic temperature data aggregation (i.e., no HQs calculated for the first 6 days of a deployment).

Thermal Risk Assessment

The extent of the significant thermal exceedances for the chronic threshold of Freshwater Drum is presented in Table 211.

Table 211 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for Freshwater Drum

Freshwater Drum (Bottom)	2016	2017	2018	2019	2020
Eggs (Acute)					
July	1 (1-1)	--	--	--	--
August	1 (1-3)	--	1 (0-1)	1 (1-3)	--
Eggs (Chronic)					
July	1 (1-1)	--	--	--	--
August	1 (1-3)	--	2 (1-2)	--	--
Growth (Chronic)					
August	0 (0-1)	--	--	--	--

Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

Despite the use of a preferred temperature instead of an MWAT as a chronic benchmark, significant thermal HQ exceedances do not encompass more than 10% of the LSA for Freshwater Drum at egg or growth life stages and therefore pose no unreasonable risk to larval Freshwater Drum.

As a result, thermal effluent generally poses no unreasonable risk to Freshwater Drum in the LSA, and no unreasonable risk to the population success of Freshwater Drum near Bruce Power.

9.5.3.5 White Bass

Scott and Crossman note that White Bass spawn over 5-10 days in May or June when water temperatures range between 12.8-21.1°C. The spawn occurs over shoals or estuaries in daylight at the surface. There is no parental care and the adults return to areas over deeper water once the spawn is complete. The eggs are heavy and adhesive and sink to the bottom to adhere on gravel, boulders or vegetation. The eggs hatch in 2 days when the water temperature is 15.6°C. There is rapid growth in the first year [R-289].

Near Bruce Power White Bass may spawn over shoals in May or June. Eggs would be present at the substrate in May to June for less than one week and larvae may be expected in June to July. Egg and larval White Bass are not expected to be in Baie du Doré. The growth stage may be present in the nearshore in July through September. The egg stage for White Bass does not have an available chronic benchmark. The spawning chronic benchmark is conservatively used given the short incubation period. White Bass are known to be present near the site based on impingement monitoring and are a species of cultural importance to MNO (see Appendix A Section 1.8.7).

<u>Preliminary Screening</u>

HQs for White Bass were calculated as described in the methodology and are presented using violin plots by site group in Figure 137 and Figure 138 and over time in Figure 139.

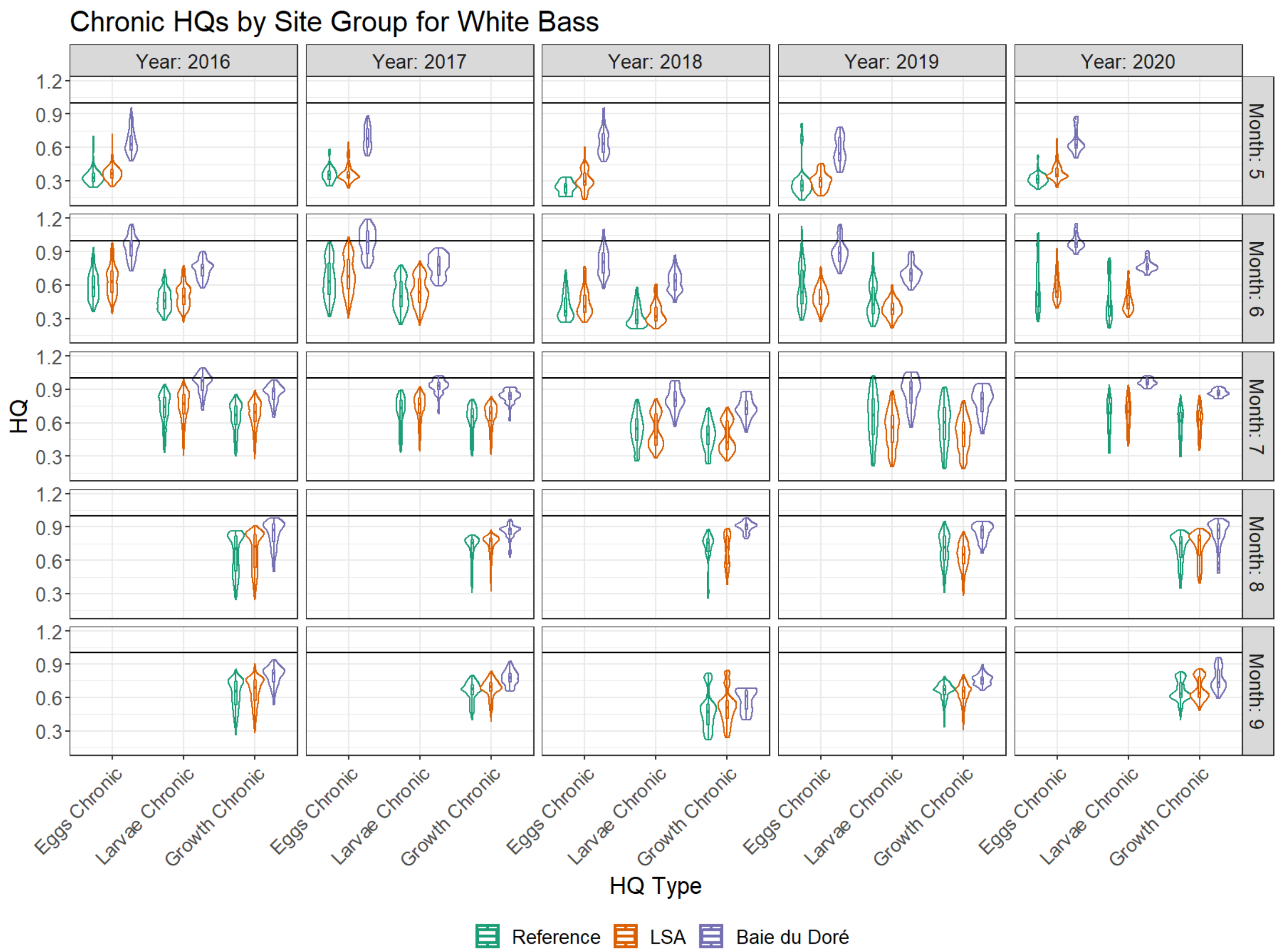

Figure 137 Chronic HQs for White Bass by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

Figure 138 Acute HQs for White Bass by Site Group. Outer lines around each site indicate density of HQ data and boxplot inside each site indicate median and interquartile range. Black line indicates HQ of 1.0.

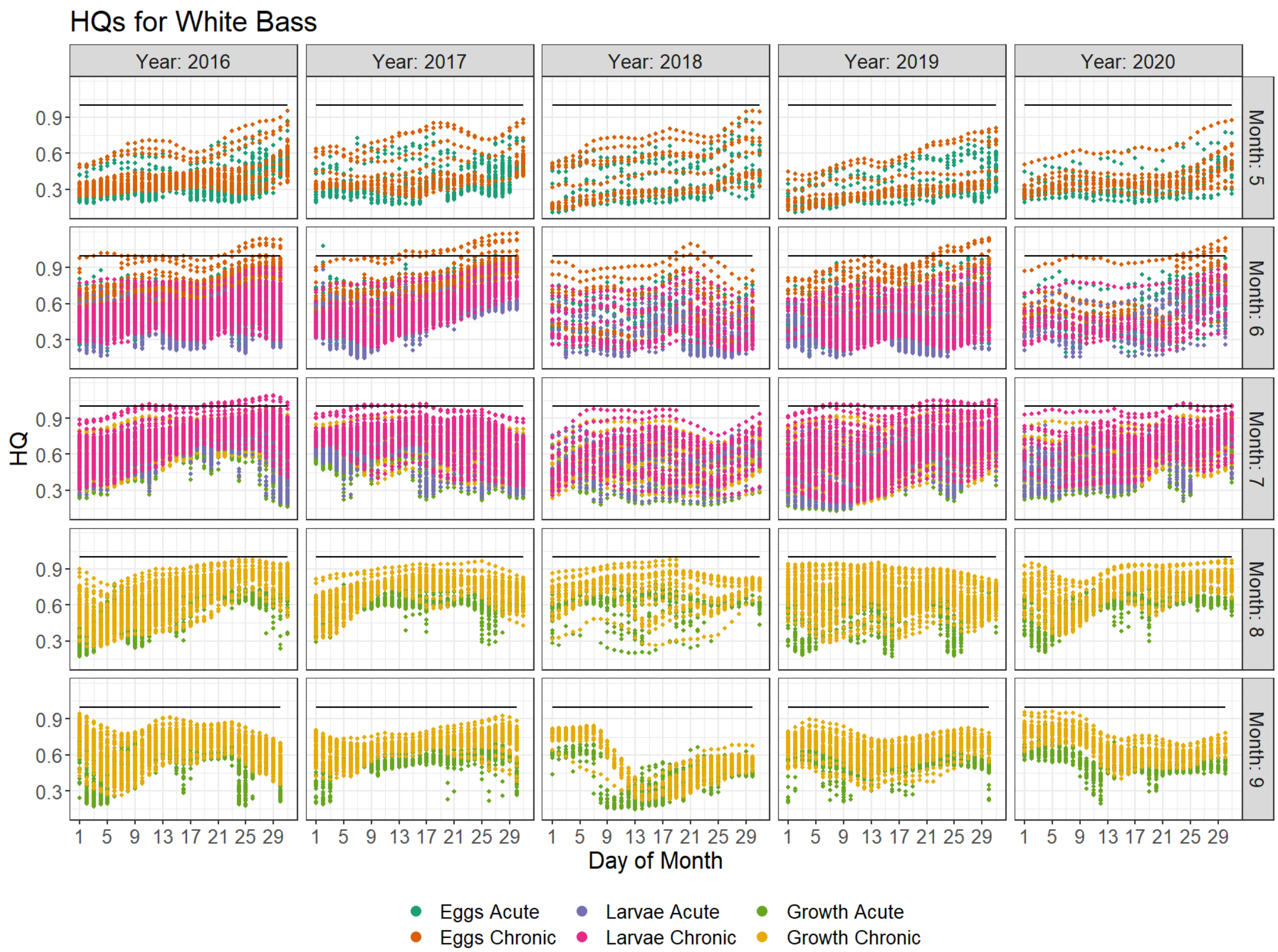

Figure 139 HQs for White Bass by Benchmark. Black line indicates HQ of 1.0.

Thermal exceedances of chronic and acute egg and larval thresholds were retained for secondary screening, mainly in Baie du Doré. Due to a lack of thermal benchmark exceedances, no further assessment was required for acute and chronic growth thresholds.

<u>Secondary Screening</u>

A count of significant HQ exceedances is presented in Table 212 according to the criteria described in Section 9.3.8.1. The total number of HQ exceedances for Reference sites is presented to provide a context for ambient lake conditions. There were no significant exceedances of acute thermal benchmarks in the secondary screening and no further assessment of these was required. Significant exceedances of chronic egg and larval benchmarks in Baie du Doré were retained for further assessment in the TRA.

Table 212 Number of significant HQs above 1.0 and total number of HQs calculated by year and site group for White Bass

White Bass (Chronic)	2016		2017		2018		2019		2020	
	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total	HQ>1	Total
Eggs (Bottom)										
Baie du Doré*	7	104	16	78	-	183	-	59	-	-
LSA*	-	992	-	648	-	315	-	379	-	427
Reference	-	333	-	226	-	81	-	220	8	207
Larvae (Bottom)										
Baie du Doré*	19	166	-	109	-	183	-	90	-	-
LSA*	-	846	-	732	-	346	-	538	-	385
Reference	-	300	-	305	-	143	-	225	-	306
Larvae (Surface)										
Baie du Doré*	29	117	-	117	-	49	30	175	6	78
LSA*	-	733	-	854	-	102	-	530	-	138
Reference	-	299	-	305	-	82	17	739	-	198

*Includes only thermal exceedances (HQ>1.0) with 1) No exceedances at the primary or secondary reference site on the same date 2) Lasting for >10% of calendar days in a month and 3) For chronic benchmarks only, having a modelled temperature contour of >10% of the LSA.

Thermal Risk Assessment

The extent of the significant thermal exceedances for White Bass is presented in Table 213.

Table 213 Median (25th - 75th percentile) extent of LSA including Baie du Doré (%) with significant thermal exceedances for White Bass

White Bass (Chronic)	2016	2017	2018	2019	2020
Eggs (Bottom)					
June	--	10 (6-12)	--	--	--
Larvae (Bottom)					
July	1 (1-1)	--	--	--	--
Larvae (Surface)					
July	2 (2-5)	--	--	6 (5-7)	2 (1-4)

Where the results is 0% and the interquartile range rounds to less than 1, the extent of the LSA is represented as “--“in the table.

Significant thermal HQ exceedances do not encompass more than 10% of the LSA for White Bass and occur exclusively in Baie du Doré where White Bass are not expected to be. As a result, thermal effluent generally poses no unreasonable risk to White Bass in the LSA, and no unreasonable risk to the population success of White Bass near Bruce Power.

9.5.4 Climate Change

The current thermal risk assessment covers temperature data from April 1, 2016 to March 31, 2021 and this assessment has encompassed any temperature changes that have occurred in the temperatures measured near the Bruce Power site (see Figure 69 to Figure 74 in Section 9.4.2). As a result, the short term effects of climate change are incorporated into the current thermal risk assessment. The gradual changes in water temperature expected over a longer period has been modelled by Golder Associates Ltd. Full details of these expected changes are available in [R-90] and are summarized below.

The potential effects of climate change on the nearshore environment around the Bruce Power site were investigated for a potential end-of-operational-life corresponding to the year 2064. This allows Bruce Power to estimate the effects of climate change on the aquatic environment in the absence and presence of continued plant operations. To evaluate the implications of climate change, global level climate projections from a GCM were used to drive a regional meteorological model (MM5) of the Lake Huron basin. The meteorological model was used to generate the future weather data required for the MIKE3 hydrothermal model of Lake Huron.

Three one-year climate change scenarios - corresponding to the warmest, coolest and median air temperature conditions - were selected from multiple GCM runs considering three emissions scenarios (RCP4.5, RCP6.0 and RCP8.5) covering the climatic period between 2054 and 2074. A full range of meteorological parameters was used to initialize and generate boundary conditions for the RCM of the Lake Huron basin. The RCM was used to simulate local meteorological conditions over the lake for the 365-days corresponding to each selected climate scenario (e.g., warmest, coolest and median year). These simulated local meteorological conditions were integrated into the boundary conditions to drive the MIKE3FM model of Lake Huron (excluding Georgian Bay). Annual historical low, average and high lake water level records and representative river inflows were used to inform the MIKE3FM model of Lake Huron. The MIKE3FM model was used to simulate the thermal and hydrodynamic responses to each climate scenario independently for maximum-recorded operational output from the Bruce A and Bruce B Condenser Cooling Water (CCW) discharges and for non-operational conditions (i.e. in the absence of CCW operations).

The results of these simulations were used to evaluate climate change implications on average monthly air and water temperatures in the nearshore environment and at both the Bruce A and Bruce B CCW intakes. The timing of lake turnover and the intensity of upwelling events under future climate scenarios was also examined. The findings are listed below.

- Relative to the selected baseline year of 2011, mean annual air temperatures could increase by up to 2.2˚C under median climate change conditions or by up to 3.5˚C during an extreme warm year by 2064. These projections fall within the range of temperature forecast provided by ClimateData.ca (1.9˚C to 3.9 ˚C) and the Ontario Climate Change Data Portal (2.7˚C to 3.3˚C for RCP8.5).

- The largest increases in monthly average air temperature are expected to occur during the winter months, with increases relative to 2011 peaking at 3.2˚C and 3.8˚C in January for the median and extreme warm climate condition, respectively. In general, the winter period is projected to coincide with a greater degree of air temperature variability than expected for the summer months.

- In the absence of operations, the changes in climate meteorology projected for the area at the nominal end of Bruce Power's operational life in 2064 are expected to increase average annual nearshore water temperatures by approximately 1.5˚C and 2.2˚C for the median and extreme warm climate year, respectively.

- Regardless of the location within the water column (bottom or surface), changes to water temperature resulting from climate change are expected to be similar, however, water temperature increases are expected to be slightly greater in shallower than deeper waters, owing to the reduced heat assimilation capacity of shallower waters relative to deeper waters.

- In general, water temperatures within the lake are expected to increase most dramatically during the shoulder seasons (spring and fall) leading to establishment of stronger summer thermocline that maintains warmer surface and mid-depth temperatures. While the lake will remain dimictic (turnover twice a year), changing climate conditions are expected to result in a shortening of the winter thermocline and an expansion of the summer thermocline relative to baseline conditions.

- Comparisons of all four climatic scenarios (including the 2011 baseline, future extreme cool year, future median year and future extreme warm year conditions) reveal that operational heating of nearshore locations in the vicinity of the Bruce Power site will remain relatively consistent. It is noted that annual average differences between all scenarios are within a quarter of one degree Celsius and that this variation is well within the range of variation attributed to differences in hydrodynamic responses to different wind conditions under each climate scenario. In other words, climate change does not appear to exacerbate or reduce the nearshore effects of operational heating.

- Under future climate conditions, the effects of operational heating remain highest in the winter months and lowest during summer, given that the relative significance of operational versus atmospheric heating increases during periods of reduced solar radiation.

  - The largest temperature increases of approximately 1.0°C resulting from operational heating across all locations tend to occur the months of November and December, although peak increases of 1.6°C-2.0°C at Bruce A and of 0.6°C-0.9°C at Bruce B occur as late as December/January and March/April, respectively.

  - The lowest temperature increases attributed to operational heating tend to occur in the months of June and July.

- Average monthly water temperatures at the Bruce A and B intakes for the month of August could increase to nearly 25˚C and exceed 23˚C, respectively, under future extreme warm climate conditions by 2054-2074.

The effect on fish species in Lake Huron is difficult to predict. The gradual increase in water temperature is unlikely to result in fish mortality. Instead, gradual increases in temperature may initially increase growth and productivity for cold water fish species. If absolute temperature increases cross important thermal thresholds for cold water fish species, these cold water species will leave the area and the species composition will shift towards warmer water species.[R-356][R-357] The effect of climate change on fish species will be related to changes in the suitability of local habitat conditions, behavioural thermoregulatory ability and changes to prey availability [R-347]. For example, simulated growth of Yellow Perch and Lake Whitefish in Lake Huron increased with warming water temperature under a climate change scenario with high prey consumption but decreased if prey availability was reduced [R-347]. The overall effect of climate change on fish species in Lake Huron may not be directly related to thermal guild and encompasses complex interactions between environmental and ecosystem changes.

Changes to fish community composition related to cold water species changes near site, despite potentially occurring slightly earlier than in the rest of Lake Huron, are expected to generally reflect the projected changes in the Lake Huron temperature and habitat. Thermoregulatory behaviour among fish may be more plastic than previously thought [R-358] and there is considerable uncertainty about the effect of climate change on community composition.

This temperature change is expected to be a gradual increase in long term average temperatures over time, and while there will continue to be warmer and cooler years, a sudden step increase in temperature is not expected. The effects of climate change on current Bruce Power thermal conditions are continually evaluated and modified as required using adaptive management. Regular existing processes, such as this Environmental Risk Assessment (ERA), Environmental Compliance Approvals (ECAs) and licensing renewals, require monitoring and evaluation of lake temperatures. Existing processes will enable Bruce Power to adapt to gradually increasing average monthly water temperatures.

The effect of these projected changes in water temperature on future overall thermal risk assessments remains uncertain at this time. However, the updated thermal risk assessment methodology is adaptive to changes in water temperature related to climate change for the LSA determination and reference site selection. Current thermal benchmark research is dated for many species and the adaptation of species to changing environmental conditions through acclimation is unknown, with current research suggesting that species at the latitude of the Bruce Power site have a warming tolerance in the 5 to 15°C range.[R-359]

9.6 Overall Thermal Risk Assessment

The final thermal risk assessment characterization is presented in Table 214. The final risk characterization included consideration of the quantitative criteria of the spatial extent of the thermal exceedance within the LSA and qualitative consideration of the mobility of the life stage, the ecological context for the species and the biological significance of the exceedance (See Section 9.3.8.5 for details).

Table 214 Final Thermal Risk Assessment Characterization

Guild	No Unreasonable Risk		Low Risk	
	Species	**Life Stage**	**Species**	**Life Stage**
Cold	Chinook Salmon Lake Trout Round Whitefish	Larvae Larvae, Growth Larvae	Chinook Salmon Rainbow Trout Lake Trout Lake Whitefish Round Whitefish Deepwater Sculpin	Growth Growth Egg Egg, Larvae, Growth Egg Larvae
Cool	Emerald Shiner Gizzard Shad Smallmouth Bass White Sucker Yellow Perch	Egg, Larvae, Growth Egg, Larvae Egg, Larvae, Growth Larvae, Growth Eggs, Larvae	Gizzard Shad Smallmouth Bass Walleye Yellow Perch	Growth Parent Egg, Larvae, Growth Growth
Warm	Brown Bullhead Channel Catfish Freshwater Drum White Bass	Egg, Larvae, Growth Egg, Growth, Parent Egg, Growth Egg, Larvae, Growth	Brown Bullhead	Egg, Parent

In response to the low risk posed by thermal effluent to several fish species, Bruce Power will continue to execute thermal monitoring through logger deployments, as described in N288.4-10 [R-235], and thermal modelling work to monitor the risk posed by thermal effluent in the LSA.

Thermal logger deployments at depths over 10m will be discontinued during the winter period starting in the fall of 2022. Deployments at 3m, 5m and 10m depths will continue. Bluetooth technology for data loggers is being trialed to help improve retrieval of temperature loggers at shallow depths (≤10m). Deep locations (>10m) are difficult to retrieve in the spring, resulting in more field days and additional exposure of field personnel to health and safety concerns as a result of searching for and pulling these deep locations from the lake bottom.

Over the winter period, the TRA considers only Lake Whitefish and Round Whitefish eggs at depths of 4-10m and Lake Trout Eggs at depths of over 12m. For Lake Trout eggs, the only species and life stage assessed over the winter period at depths greater than 10m, thermal exceedances occur equitably at both reference and LSA sites early in the incubation period (see Appendix I, Section 9.5.1.3). As a result, deployment and retrieval of temperature loggers over this time period at depths greater than 10m is not contributing substantially to the assessment of thermal effects. Lake Trout eggs will continue to be included in the TRA but temperatures used for HQ calculations will be generated using the LSA Remapping Tool rather than relying exclusively on measured data. Lake and Round Whitefish eggs will also continue to be included in the TRA but the HQ calculations will be completed using the LSA Remapping Tool and measured data as available. The LSA Remapping Tool generates daily average and daily maximum temperatures that can be used in the same manner as measured temperature values in the TRA process for Lake Whitefish eggs, Round Whitefish eggs and Lake Trout eggs.

9.7 Uncertainty in the Thermal Risk Assessment

The following section documents a number of individual uncertainties that could affect the thermal risk assessment. It is noted that despite these individual uncertainties, the combination of methods employed to evaluate thermal risk to fish considerably limits the compounding effect of these individual uncertainties on the conclusions drawn from the overall thermal risk assessment.

9.7.1 Thermal Monitoring

Field conditions on Lake Huron generate inhospitable conditions for the thermal monitoring program that affects the retrieval rate of thermal loggers. Under extreme lake conditions, poor logger retrieval reduces data availability and contributes to uncertainty in the thermal risk assessment results. To help offset this unavoidable variability in data availability, the assessment includes five years of data and all available thermal monitoring sites, including loggers from the thermal monitoring program and the Coastal Waters Monitoring Program.

Additional sources of uncertainty are related to measurements errors. These errors may include positional errors (i.e. GPS location and depth) and measurement errors (i.e. accuracy of temperature measurements).

9.7.2 Thermal Modelling

The HHT model currently provides the best available model for predicting water temperatures at the Bruce Power site [R-92]. The statistical comparison of model benchmarks to literature benchmarks indicates that the HHT model provides performance that is equal to, or better than, the results typically presented in literature and that this model can adequately represent current and temperature conditions in the area of Bruce Power. The HHT model is a sophisticated prediction tool which provides temperature and current predictions in the range of published values and is therefore, well suited for evaluating meteorological and operational thermal effects in the vicinity of the Bruce Power facility.

There are factors that will still result in differences between predicted and measured temperatures. These differences can be the result of data input limitations such as simplifying assumptions and missing data, computational errors, limitations to model resolution and errors that result from the simplification of natural physical processes within the model.

Assumptions and limitations of the HHT Model include:

- The HHT model does not account for sediment-water and ice-water heat exchange. This may slightly overestimate water temperatures in the spring and summer as the model does not account for the energy transferred to the sediment layer when the lake is warming up and may slightly underestimate water temperatures in the fall and winter as the model does not account for the heat stored in the sediment and transferred to the water column.

- Density is calculated as a function of temperature only and excludes circulation and density effects driven by differences caused by dissolved and suspended solids. The exclusion of dissolved solids in the temperature-density function in the model may slightly affect the timing and magnitude of upwelling events and, to a lower degree, lake circulation and temperature structure. However, since the dissolved solids concentrations in Lake Huron are low and the effects on density derived from changes in salinity (within expected salinity variations in Lake Huron) are orders of magnitude lower than from those caused by changes in temperature, the overall effect of not including dissolved solids is not significant. The exclusion of suspended solids is also not expected to have any significant effects on model predictions.

- The validation of model predictions for some parameters in other parts of the lake is not possible given the lack of available measured data. Therefore, model results must be interpreted with caution outside of the area of interest (i.e. the area of the Bruce Power thermal monitoring sites). Additional logger deployments (Sites A-F) in the coming years will assist in further validating model performance beyond the area of interest (e.g., the LSA).

- The availability of measured current data (Gunn Point) is limited to a single location, therefore the validation of current predictions at locations other than the monitoring point is limited. However, visual observation of the hydrodynamics in the nearfield and adequate prediction of temperatures are indicative of overall adequate model performance at capturing lake circulation processes elsewhere throughout Lake Huron and the model domain.

- MIKE3 models, including the HHT, do not include a comprehensive ice module and are not able to generate ice cover based on meteorology and water temperature alone. This is a limitation of many models used for the Great Lakes [R-360]. Limited satellite surface ice data is available but there is no available method to integrate it into the MIKE3 HHT models at the spatial scale required and it cannot be validated using surface buoy data [R-360][R-361]. While ice thickness and timing could be manually applied to the model based on the limited available data, this implementation would be expected to have minimal effects on absolute water temperature predictions in some months of the year at specific locations and would increase uncertainty in other ways (e.g. unknown ice thicknesses and insufficiently detailed extents of ice cover during periods of occasional ice cover). The RMSE values in the winter remain comparable to the summer and annual values, indicating that the absence of ice cover does not have a significant effect on model performance. Based on the comparison of predicted water temperatures to measured values, the performance of the model during the winter is similar to the performance during the ice-free period. This suggests that the exclusion of ice in the model has a minimal effect on the overall ability of the model to predict winter water bottom temperatures and accuracy of any potential thermal effects associated with Bruce Power. The species and life stages located in the LSA during the winter months (Lake Whitefish eggs, Round Whitefish Eggs and Lake Trout eggs and larvae) are located on the lake bottom at depths likely greater than 4m. As a result, the focus on the validation of the MIKE3 HHT model during the winter months is on bottom temperature accuracy rather than on temperature accuracy throughout the water column.

9.7.3 LSA and Reference Site Selection and LSA Remapping Tool

Although use of HHT model outputs provide a significant enhancement to the thermal risk assessment, particularly in the area of risk characterization, each of these outputs has some sources of uncertainty.

LSA Selection

The LSA selection is based on the 95th percentile of a 1°C difference between operational and non-operational conditions over five years (April 1, 2016 to March 31, 2021) at the surface and bottom. Although this quantitative LSA determination methodology represents a significant improvement from past methods, there remains potential for uncertainty as to the exact size of the LSA. Additionally, by defining the LSA boundary over five years at the surface and bottom, some minor fluctuations in the size and shape of the LSA that would be expected to occur between years may not be fully captured in the thermal risk assessment. This uncertainty is not expected to bias the results of the thermal risk assessment as these fluctuations occur at the periphery of the LSA where operational temperature effects are limited to a maximum of approximately 1°C.

Reference Site Selection

Reference site selection is based on the RMSE between effect and reference sites under modelled non-operational conditions (i.e., when Bruce Power is not producing thermal effluent). The site and depth with the lowest and second lowest RMSE are selected as the primary and secondary reference sites. Some uncertainty may be introduced to the thermal ERA under two circumstances: 1) where available effect and reference site pairings do not meet the RMSE criteria of <3°C and 2) when the time period covered by the matched reference site and LSA site is not identical. To ensure a conservative approach to the assessment, all HQ exceedances at sites without a designated reference site below an RMSE of 3.0°C or occurring during non-overlapping time periods are carried forward in the assessment. This conservative approach is expected to slightly over-estimate the risk posed by thermal effluent within the LSA.

LSA Remapping Tool

The LSA Remapping Tool was developed to automatically complete several data adjustment tasks according to a pre-determined process. The tool was developed in steps to ensure that each task was completed properly. During development, interim results were compared to results from a parallel process (i.e., identical data manipulation in a spreadsheet) to verify the tool. The errors and limitations of the remapping tool are generally associated with the assumption and simplifications of the remapping process and logger data itself. The primary limitations are:

1. The individual loggers are assumed to be located at the same location as the nearest node in the HHT model. As the exact location of the loggers varies with each deployment, the nearest HHT model node may vary slightly over time.

2. The remapping tool uses a 2-D linear interpolation process that may not represent the non-linear fluctuations that naturally occur or are predicted by the HHT model between locations.
3. The remapping tool uses as all the available logger data on any given date. On days where there are limited loggers available (occasionally, as few as one), the tool will apply temperature corrections to the entire LSA based on the limited data available on any given day. This may result in the application of an unrepresentative temperature correction to portions of the LSA at times (e.g., a temperature correction from Baie du Dore may be applied to a location near McRae Point).

While the remapping tool is not expected to completely compensate for model error, the corrected HHT model predictions provided by the tool are expected to provide a more accurate representation of actual water temperatures throughout the LSA than provided by the HHT model alone. The use of the remapping tool is likely to mitigate some of the small uncertainties associated with the HHT model itself.

9.7.4 Thermal Benchmarks

There is uncertainty associated with the thermal benchmarks used in the assessment. The effect of this uncertainty may result in an over- or under-estimate of the potential thermal impacts to fish. Acclimation temperature strongly influences thermal benchmark test results and has been presented with the benchmark when available. If multiple benchmarks with different acclimation temperatures were available, the benchmark with the acclimation temperature closest to seasonal reference site temperatures was selected. Research has found that acclimation temperature differences can cause the CTM to vary up to 10°C within a species, particularly for warmwater species. Seasonal and diel variation in temperature toxicity results can be as much as approximately 2°C [R-280].

There is also uncertainty in the selection of optimal thermal benchmarks, although this uncertainty is reduced with the hierarchical approach used in this assessment (see Section 9.3.6.1). Under the hierarchical approach, thermal benchmarks complied from multiple sources are used as the first choice, followed by benchmarks derived by a single study, chosen based on the most similar acclimation temperature if multiple studies are available, and finally, by modelled or calculated benchmarks. The use of this approach ensures that each thermal benchmark selected utilizes the available scientific evidence to the fullest extent practicable.

9.7.5 Climate Change

Although water temperatures increases under operational and non-operational climate scenarios are expected to be similar in magnitude, these increases will present challenges to the ERA assessment in the area of thermal risk assessment. Species composition utilizing the local study area may change with increasing water temperatures and the VEC list may need to be adjusted accordingly. Additionally, thermal benchmarks used to complete the risk assessment will need to be adjusted to higher acclimation temperatures. This will require a concentrated effort to identify key species and understand the impact of increasing ambient water temperatures on assessed thermal benchmarks. Development of a more nuanced assessment of the risk posed by thermal effluent may be required if scenarios develop where all reference sites and local study sites are above the thermal benchmarks available.

The current thermal risk assessment includes temperature data from April 1, 2016 to March 31, 2021 and covers any temperature changes measured near the Bruce Power site over the 5 years of this risk assessment (see Figure 69 to Figure 74 in Section 9.4.2). As a result, the short-term effects of climate change are covered in the current thermal risk assessment. There is significant uncertainty related to the long term acclimation of fish species to gradual increases in lake temperatures. As lake temperatures increase, further thermal benchmark research will become more important to evaluate changes in thermal benchmarks that will occur as fish species and life stage acclimate to higher lake temperatures. This will ensure that thermal benchmarks used in the thermal risk assessment will be more reflective of the actual thermal tolerances of fish species near Bruce Power. Fish living in Lake Huron at the present time may in fact, have very different acclimation temperatures and thermal tolerances compared to the fish used to conduct thermal benchmark research, particularly research conducted several decades ago. Additionally, further exploration of the utility of modelled thermal benchmarks would be a useful addition to laboratory and field thermal benchmark research as thermal benchmarks evolve with climate change [R-359]. The use of Bayesian modelling techniques may allow thermal benchmark research to be updated using a selection of fish species in an experimental setting and further adjustment of the thermal benchmarks for the remaining species to occur through modelling work.

9.7.6 Overall Thermal Risk Assessment

The layered approach used for the thermal risk assessment uses both measured and modelled thermal data to complete a holistic assessment of the risk posed by thermal effluent from the Bruce Power site. This approach ensures that the risks to all selected VEC species and life stages present in the LSA are fully assessed to the extent possible and uses defined spatial and temporal criteria along with biological and ecological contextual information to determine the overall thermal risk characterization. This comprehensive approach reduces the uncertainties associated with reliance solely on measured or modelled data.

9.8 Conclusion

In general, thermal effluent poses no unreasonable risk to fish species located in the LSA near Bruce Power. Fish species assessed included Lake Whitefish, Round Whitefish, Deepwater Sculpin, Chinook Salmon, Rainbow Trout, Lake Trout, Emerald Shiner, Gizzard Shad, Smallmouth Bass, Walleye, White Sucker, Yellow Perch, Brown Bullhead, Channel Catfish, Common Carp, Freshwater Drum and White Bass at the applicable life stage occurring in the nearshore environment potentially affected by thermal effluent from Bruce Power. Most species were found to be at no unreasonable risk from temperatures measured at thermal monitoring sites in the LSA from April 1, 2016 to March 31, 2021 (as defined in Section 9.3.8.5).

Several species in particular life stages were found to be at low risk from thermal effluent near Bruce Power following a detailed quantitative assessment and consideration of the biological and ecological context of the species and life stage. Thermal effluent poses a low risk to the following species and life stages within the LSA:

1) Lake Trout, Lake Whitefish, Round Whitefish, Walleye and Brown Bullhead eggs

2) Larval Deepwater Sculpin, Lake Whitefish and Walleye

3) Growth Rainbow Trout, Chinook Salmon, Lake Whitefish, Walleye, Gizzard Shad and Yellow Perch

4) Parent Smallmouth Bass and Brown Bullhead.

Thermal effluent does not pose a moderate or higher risk to any fish species considered within the LSA.

All of the fish species noted to be at low risk from thermal effluent within the LSA utilize habitat along the length of the Lake Huron coastline and the area within the LSA does not represent specialized habitat in any way. Additionally, for some of the fish species assessed, specifically Lake and Round Whitefish embryos, the habitat within the LSA is sub-optimal based on the high exposure to prevailing currents and the high-energy environment compared to well-known protected spawning and incubation areas further north, such as the Fishing Islands and Stokes Bay [R-362].

9.8.1 Recommendations

In response to the low risk posed by thermal effluent to several fish species, Bruce Power will continue to execute thermal monitoring through logger deployments, as described in N288.4-10 [R-235], and thermal modelling work to monitor the risk posed by thermal effluent in the LSA.

Assessment of egg stage Lake and Round Whitefish will be simplified for the 2027 ERA to eliminate duplicate assessment of benchmarks due to the availability of modelled benchmarks. The assessment criteria for the 2027 ERA for Lake and Round Whitefish are summarized in Table 215. Given the temperature criteria used to start the incubation period and the MWAT value evaluated, HQ exceedances are expected to continue in the early part of the egg incubation period for both species. Due to the availability of modelled thermal benchmarks, the delta 3°C criteria will no longer be applied. For Round Whitefish, the Block 1 chronic (6°C average over 30 days), sub-chronic (8.5°C rolling weekly average) thresholds will continue to be used to assess the Block 1 portion of the incubation period due to the expected thermal exceedances related to the proximity of the MWAT of 5.4°C and the incubation start temperature of 5.5°C.

Table 215 Lake and Round Whitefish Egg Stage Thermal Criteria for 2027 ERA

Period	Criteria		Inclusion in 2027 ERA	Rationale
Lake Whitefish				
Dates Assessed	Start	First date the retrospective rolling weekly average drops below 8°C and remains below 8°C for 7 days	Yes	Temperature defined start and end dates reflect inter-annual variations in lake temperatures.
	End	Last date of median hatch calculated for Lake Whitefish at a reference site.	Yes	
Whole Incubation	Delta T	Threshold of a 3°C difference between LSA logger and reference logger	No	Not required with availability of modelled MWAT and UILT values. Assessment of delta T values does not reflect biological impacts to organism.
	Chronic	6.7°C MWAT value	Yes	Modelled MWAT value aligns with process used for other species.
	Acute	10.1°C UILT value	Yes	Modelled UILT value aligns with process used for other species.
	Hatch Advance	≥30 days	Yes	Hatch advance is a secondary effect of thermal effluent and will continue to be assessed.
Round Whitefish				
Dates assessed	Start	First date the retrospective rolling weekly average drops below 5.5°C and remains below 5.5°C for 7 days	Yes	Temperature defined start and end dates reflect inter-annual variations in lake temperatures.
	Block 1	Start date + 30 days	Yes	
	End	Last date of median hatch calculated for Lake Whitefish at a reference site.	Yes	

Period	Criteria		Inclusion in 2027 ERA	Rationale
Block 1	Chronic	6°C average over 30 days	Yes	Provide additional assessment for Block 1 time period where MWAT exceedances are expected due to proximity of MWAT value to start temperatures.
	Sub-chronic	8.5°C rolling weekly average	Yes	
	Acute	10°C for 6 hours	No	Modelled acute UILT of 10.1°C assessed for entire incubation period.
	Spatial Extent	Percent of LSA encompassed by a 3°C difference between Operational and Non-Operational Conditions at the 25th, 50th and 75th percentiles	No	Modelled UILT and MWAT values now available. Spatial extent of 3°C difference not reflective of biological impact on organisms. Spatial extent of exceedances will be captured using the LSA Risk Characterization process as per all other fish species and life stage.
Whole Incubation	Delta T	Threshold of a 3°C difference between LSA logger and reference logger	No	Not required with availability of modelled MWAT and UILT values. Assessment of delta T values does not reflect biological impacts to organism.
	Chronic	5.4°C MWAT value	Yes	Modelled MWAT value aligns with process used for other species.
	Acute	10.1°C UILT value	Yes	Modelled UILT value aligns with process used for other species.

10.0 APPENDIX J: RELEASE RATES FROM THE BRUCE POWER SITE

Table 216 to Table 220 in this appendix were populated using data from the 2016-2020 annual Environmental Monitoring reports published by Bruce Power [R-37]–[R-40][R-255]. Table 221 and Table 222 represent the five year average release rates and the five year maximum release rates. For the purposes of the assessment, the majority of emission and effluent release samples reported as less than a minimum detection limit were considered to be indistinguishable from background and were excluded from release calculations. In some years, all analyses were less than detection limits, therefore the annual release is reported as < Ld (less than the limit of detection). For the purpose of this assessment, these values were not used in calculating average or upper range release rates. Additionally, some release rates are reported as N/A; this indicates that this radionuclide is not monitored in this emission or effluent stream, or that the emission or effluent stream does not exist. For example, CMF waterborne effluent releases are not reported, since these are directed to and monitored as part of Bruce A waterborne effluent release.

An investigation of alpha emission data was conducted to provide additional information regarding detection limits and measured values [R-202]. For airborne emissions, annual alpha release rates are calculated based on weekly measurements of stack particulate filter gross alpha. Based on data from Bruce A and Bruce B for 2012 to 2016, approximately 99% of these measurements were below the detection limit. Using uncensored data, the average weekly stack gross alpha measurement at Bruce A is 3.98E-09 Ci, while the average detection limit is 7.93E-07 Ci. At Bruce B, the uncensored average weekly stack gross alpha measurement is 1.06E-07 Ci, while the average detection limit is 1.74E-06 Ci. This provides an indication of the magnitude of conservatism associated with the previous release rate calculation approach, which had assumed that measured values less than the Ld are equal to the Ld.

For waterborne effluent, annual alpha releases for Bruce A and Bruce B are calculated based on analysis of monthly composite samples obtained from each active liquid waste (ALW) tank pumpout. Analysis is performed by an external laboratory. Data from 2017 indicated that the majority of monthly composite samples (23 out of 24) were below the detection limit for gross alpha. Using uncensored data, the average monthly ALW composite gross alpha measurement at Bruce A is -2.31E-15 Ci/Kg, while the average detection limit is 4.39E-13 Ci/Kg. At Bruce B, the uncensored average monthly ALW composite gross alpha measurement is 6.23E-14 Ci/Kg, while the average detection limit is 4.81E-13 Ci/Kg. This analysis of airborne and waterborne alpha releases confirms that the previous approach was overconservative, and the current approach of excluding results less than detection limits from emission and effluent release calculations is justified.

Table 216 2016 release rates (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	5.66E+14	5.70E+14	6.99E+09	2.06E+13	1.59E+11	N/A	N/A	**1.16E+15**
Noble Gas	5.63E+13	5.25E+13	N/A	N/A	N/A	N/A	N/A	**1.09E+14**
Iodine (mfp)	4.40E+06	<Ld	<Ld	1.71E+05	N/A	N/A	N/A	**4.57E+06**
Particulate (Beta/Gamma)	3.14E+05	1.13E+06	<Ld	5.42E+03	N/A	N/A	N/A	**1.45E+06**
Particulate (Alpha)	2.46E+03	1.85E+03	<Ld	N/A	N/A	N/A	N/A	**4.31E+03**
C-14	1.69E+12	1.13E+12	N/A	3.94E+09	6.10E+09	N/A	N/A	**2.83E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	2.36E+14	5.07E+14	N/A	6.12E+11	2.23E+10	N/A	**7.44E+14**
Gross Beta/Gamma	9.96E+08	1.42E+09	N/A	4.62E+08	1.05E+07	N/A	**2.89E+09**
Gross Alpha	6.96E+04	<Ld	N/A	N/A	8.98E+06	N/A	**9.05E+06**
C-14	1.66E+09	1.76E+09	N/A	N/A	N/A	N/A	**3.42E+09**

Table 217 2017 release rates (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	7.32E+14	7.14E+14	1.52E+10	1.72E+13	1.12E+11	N/A	N/A	**1.46E+15**
Noble Gas	9.48E+13	4.82E+13	N/A	N/A	N/A	N/A	N/A	**1.43E+14**
Iodine (mfp)	2.06E+07	1.41E+06	<Ld	1.38E+05	N/A	N/A	N/A	**2.21E+07**
Particulate (Beta/Gamma)	4.39E+05	2.34E+06	<Ld	4.52E+03	2.29E+04	N/A	N/A	**2.81E+06**
Particulate (Alpha)	4.08E+03	3.70E+03	7.84E+01	N/A	1.64E+03	N/A	N/A	**9.50E+03**
C-14	1.89E+12	1.23E+12	N/A	4.09E+09	N/A	N/A	N/A	**3.12E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	2.26E+14	7.15E+14	N/A	2.59E+11	3.57E+10	N/A	**9.41E+14**
Gross Beta/Gamma	1.08E+09	2.04E+09	N/A	2.84E+08	2.56E+07	N/A	**3.43E+09**
Gross Alpha	<Ld	<Ld	N/A	N/A	1.12E+07	N/A	**1.12E+07**
C-14	9.13E+08	2.39E+09	N/A	N/A	N/A	N/A	**3.30E+09**

Table 218 2018 release rates (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	6.08E+14	3.86E+14	2.26E+10	3.25E+12	7.96E+11	4.20E+07	N/A	**9.98E+14**
Noble Gas	8.46E+13	4.24E+13	N/A	N/A	N/A	N/A	N/A	**1.27E+14**
Iodine (mfp)	6.57E+06	3.43E+06	8.94E+03	7.23E+04	N/A	N/A	N/A	**1.01E+07**
Particulate (Beta/Gamma)	1.28E+06	2.21E+06	<Ld	2.41E+04	4.55E+04	N/A	N/A	**3.56E+06**
Particulate (Alpha)	1.10E+04	2.37E+04	<Ld	N/A	3.07E+03	N/A	N/A	**3.78E+04**
C-14	1.14E+12	1.13E+12	N/A	1.57E+09	1.51E+09	N/A	N/A	**2.27E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	1.96E+14	5.60E+14	N/A	3.64E+11	2.73E+10	N/A	**7.56E+14**
Gross Beta/Gamma	1.20E+09	2.55E+09	N/A	1.69E+08	1.97E+07	N/A	**3.94E+09**
Gross Alpha	<Ld	<Ld	N/A	N/A	1.18E+07	N/A	**1.18E+07**
C-14	9.73E+08	1.38E+09	N/A	N/A	N/A	N/A	**2.35E+09**

Table 219 2019 release rates (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	4.63E+14	3.30E+14	2.23E+10	1.03E+13	2.41E+11	1.88E+11	N/A	**8.03E+14**
Noble Gas	7.07E+13	3.39E+13	N/A	N/A	N/A	N/A	N/A	**1.05E+14**
Iodine (mfp)	4.17E+07	4.40E+05	2.52E+04	<Ld	N/A	N/A	N/A	**4.21E+07**
Particulate (Beta/Gamma)	1.97E+06	4.76E+06	<Ld	6.52E+02	3.90E+04	N/A	N/A	**6.77E+06**
Particulate (Alpha)	2.43E+04	2.63E+04	<Ld	N/A	4.94E+03	N/A	N/A	**5.54E+04**
C-14	1.34E+12	1.08E+12	N/A	2.62E+09	N/A	N/A	N/A	**2.43E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	2.12E+14	8.82E+14	N/A	1.60E+11	3.73E+10	N/A	**1.09E+15**
Gross Beta/Gamma	2.13E+09	2.26E+09	N/A	7.08E+07	4.52E+07	0.00E+00	**4.51E+09**
Gross Alpha	<Ld	<Ld	N/A	N/A	6.75E+06	N/A	**6.75E+06**
C-14	8.17E+08	4.68E+09	N/A	N/A	N/A	N/A	**5.49E+09**

Table 220 2020 release rates (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	3.35E+14	3.06E+14	2.43E+10	1.73E+13	4.10E+11	1.18E+11	1.26E+09	**6.59E+14**
Noble Gas	7.81E+13	2.63E+13	N/A	N/A	N/A	N/A	N/A	**1.04E+14**
Iodine (mfp)	2.22E+07	2.85E+06	<Ld	<Ld	N/A	N/A	N/A	**2.51E+07**
Particulate (Beta/Gamma)	2.94E+06	6.35E+06	<Ld	1.37E+04	1.38E+05	N/A	N/A	**9.44E+06**
Particulate (Alpha)	2.96E+04	4.29E+04	<Ld	N/A	8.44E+03	N/A	N/A	**8.09E+04**
C-14	1.58E+12	9.89E+11	N/A	2.63E+10	N/A	N/A	N/A	**2.60E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	2.50E+14	5.73E+14	N/A	2.36E+11	1.74E+10	N/A	**8.23E+14**
Gross Beta/Gamma	7.66E+08	2.26E+09	N/A	9.54E+07	3.31E+07	N/A	**3.15E+09**
Gross Alpha	<Ld	<Ld	N/A	N/A	8.34E+06	N/A	**8.34E+06**
C-14	1.14E+09	1.79E+09	N/A	N/A	N/A	N/A	**2.93E+09**

Table 221 Average annual release rates (2016-2020) (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	5.41E+14	4.61E+14	1.83E+10	1.37E+13	3.44E+11	1.02E+11	1.26E+09	**1.02E+15**
Noble Gas	7.69E+13	4.07E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**1.18E+14**
Iodine (mfp)	1.91E+07	2.03E+06	1.71E+04	1.27E+05	0.00E+00	0.00E+00	0.00E+00	**2.08E+07**
Particulate (Beta/Gamma)	1.39E+06	3.36E+06	0.00E+00	9.68E+03	6.14E+04	0.00E+00	0.00E+00	**4.82E+06**
Particulate (Alpha)	1.43E+04	1.97E+04	7.84E+01	0.00E+00	4.52E+03	0.00E+00	0.00E+00	**3.76E+04**
C-14	1.53E+12	1.11E+12	0.00E+00	7.70E+09	3.81E+09	0.00E+00	0.00E+00	**2.65E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	2.24E+14	6.47E+14	0.00E+00	3.26E+11	2.80E+10	0.00E+00	**8.72E+14**
Gross Beta/Gamma	1.23E+09	2.11E+09	0.00E+00	2.16E+08	2.68E+07	0.00E+00	**3.58E+09**
Gross Alpha	6.96E+04	0.00E+00	0.00E+00	0.00E+00	9.41E+06	0.00E+00	**9.44E+06**
C-14	1.10E+09	2.40E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**3.50E+09**

Table 222 Maximum annual release rates (2016-2020) (Bq/y)

Air	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	CSF	Total
H-3	7.32E+14	7.14E+14	2.43E+10	2.06E+13	7.96E+11	1.88E+11	1.26E+09	**1.47E+15**
Noble Gas	9.48E+13	5.25E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**1.47E+14**
Iodine (mfp)	4.17E+07	3.43E+06	2.52E+04	1.71E+05	0.00E+00	0.00E+00	0.00E+00	**4.21E+07**
Particulate (Beta/Gamma)	2.94E+06	6.35E+06	0.00E+00	2.41E+04	1.38E+05	0.00E+00	0.00E+00	**9.45E+06**
Particulate (Alpha)	2.96E+04	4.29E+04	7.84E+01	0.00E+00	8.44E+03	0.00E+00	0.00E+00	**8.10E+04**
C-14	1.89E+12	1.23E+12	0.00E+00	2.63E+10	6.10E+09	0.00E+00	0.00E+00	**3.12E+12**

Water	Bruce A	Bruce B	CMLF	WWMF	CNL	Kinectrics	Total
Tritium	2.50E+14	8.82E+14	0.00E+00	6.12E+11	3.73E+10	0.00E+00	**1.09E+15**
Gross Beta/Gamma	2.13E+09	2.55E+09	0.00E+00	4.62E+08	4.52E+07	0.00E+00	**4.51E+09**
Gross Alpha	6.96E+04	0.00E+00	0.00E+00	0.00E+00	1.18E+07	0.00E+00	**1.18E+07**
C-14	1.66E+09	4.68E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**5.49E+09**

11.0 APPENDIX K: TRIPLE JOINT FREQUENCY FILES

Table 223 shows the triple-joint frequency (TJF) files used for the 2016-2020 models, as well as the average TJF used in both the average and upper-range cases. Since 2017, there have been several recurring technical issues regarding on-site meteorological monitoring. Due to this, the data had significant gaps and as such did not meet the requirements set out by CSA N288.2-19 [R-363]. Therefore, the five-year datasets from 2011-2016 were used to derive meteorological datasets to represent the TJF for the Bruce Power site in 2020, as recommended by CSA N288.2-19 Clauses 4.3.1.3.3 and 4.3.1.3.4.1 [R-363].

Table 223 Annual Average TJF for Bruce Power site for 2020 – 50 m Meteorological Tower

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
A	N	0.53	0.30	0.25	0.05	0.03	0.03	**1.19**
	NNE	0.52	0.36	0.34	0.11	0.03	0.01	**1.37**
	NE	0.29	0.17	0.09	0.02	0.01	0.01	**0.58**
	ENE	0.33	0.15	0.10	0.01	0.00	0.00	**0.59**
	E	0.46	0.20	0.07	0.01	0.01	0.00	**0.76**
	ESE	0.43	0.12	0.05	0.02	0.01	0.00	**0.63**
	SE	0.36	0.18	0.05	0.02	0.00	0.00	**0.60**
	SSE	0.35	0.13	0.11	0.03	0.00	0.00	**0.62**
	S	0.34	0.16	0.13	0.03	0.01	0.00	**0.68**
	SSW	0.37	0.14	0.13	0.07	0.03	0.00	**0.74**
	SW	0.37	0.27	0.19	0.08	0.01	0.01	**0.93**
	WSW	0.36	0.28	0.20	0.03	0.01	0.02	**0.89**
	W	0.29	0.37	0.16	0.02	0.02	0.02	**0.88**
	WNW	0.35	0.39	0.16	0.02	0.01	0.00	**0.94**
	NW	0.49	0.43	0.14	0.05	0.03	0.00	**1.14**
	NNW	0.90	0.54	0.19	0.07	0.03	0.00	**1.72**
	Total	**6.72**	**4.19**	**2.37**	**0.64**	**0.23**	**0.11**	**14.26**
B	N	0.21	0.10	0.32	0.32	0.12	0.05	**1.12**
	NNE	0.35	0.37	0.55	0.42	0.15	0.05	**1.89**
	NE	0.13	0.09	0.14	0.12	0.03	0.02	**0.54**
	ENE	0.26	0.10	0.14	0.11	0.03	0.00	**0.65**
	E	0.11	0.11	0.08	0.03	0.00	0.00	**0.32**

Table 223 Annual Average TJF for Bruce Power site for 2020 – 50 m Meteorological Tower

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
	ESE	0.07	0.05	0.07	0.05	0.03	0.02	**0.29**
	SE	0.24	0.16	0.12	0.05	0.03	0.02	**0.63**
	SSE	0.37	0.28	0.26	0.15	0.08	0.06	**1.20**
	S	0.40	0.21	0.27	0.26	0.12	0.10	**1.36**
	SSW	0.38	0.27	0.37	0.41	0.36	0.40	**2.19**
	SW	0.77	0.38	0.94	0.90	0.42	0.15	**3.56**
	WSW	0.26	0.18	0.28	0.12	0.08	0.06	**0.98**
	W	0.15	0.14	0.25	0.11	0.08	0.09	**0.81**
	WNW	0.22	0.15	0.22	0.21	0.13	0.10	**1.03**
	NW	0.23	0.14	0.22	0.27	0.12	0.10	**1.09**
	NNW	0.34	0.35	0.47	0.39	0.20	0.14	**1.89**
	Total	**4.49**	**3.09**	**4.71**	**3.90**	**1.98**	**1.36**	**19.54**
C	N	0.00	0.01	0.03	0.03	0.02	0.01	**0.10**
	NNE	0.03	0.03	0.02	0.01	0.00	0.00	**0.08**
	NE	0.01	0.01	0.01	0.01	0.00	0.00	**0.05**
	ENE	0.09	0.05	0.03	0.02	0.00	0.00	**0.20**
	E	0.02	0.02	0.00	0.00	0.00	0.00	**0.03**
	ESE	0.01	0.00	0.00	0.00	0.00	0.00	**0.03**
	SE	0.08	0.01	0.00	0.00	0.00	0.00	**0.10**
	SSE	0.14	0.12	0.10	0.04	0.01	0.01	**0.42**
	S	0.19	0.16	0.14	0.08	0.05	0.01	**0.64**
	SSW	0.17	0.11	0.13	0.06	0.08	0.07	**0.62**
	SW	0.18	0.14	0.39	0.47	0.19	0.24	**1.60**
	WSW	0.21	0.13	0.19	0.18	0.19	0.54	**1.43**
	W	0.07	0.11	0.09	0.11	0.11	0.23	**0.73**
	WNW	0.06	0.04	0.06	0.09	0.07	0.13	**0.45**
	NW	0.01	0.01	0.04	0.06	0.07	0.11	**0.30**
	NNW	0.04	0.05	0.12	0.16	0.08	0.16	**0.61**
	Total	**1.33**	**1.00**	**1.34**	**1.33**	**0.88**	**1.51**	**7.39**

Table 223 Annual Average TJF for Bruce Power site for 2020 – 50 m Meteorological Tower

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
D	N	0.00	0.03	0.43	0.33	0.22	0.24	**1.26**
	NNE	0.00	0.00	0.24	0.27	0.14	0.11	**0.76**
	NE	0.07	0.03	0.26	0.21	0.10	0.05	**0.73**
	ENE	0.22	0.17	0.29	0.11	0.04	0.04	**0.87**
	E	0.11	0.02	0.11	0.04	0.01	0.00	**0.29**
	ESE	0.05	0.02	0.12	0.07	0.04	0.03	**0.33**
	SE	0.15	0.09	0.27	0.17	0.08	0.04	**0.80**
	SSE	0.57	0.69	0.76	0.25	0.12	0.04	**2.43**
	S	0.52	0.38	0.92	0.63	0.25	0.11	**2.81**
	SSW	0.25	0.45	0.86	0.72	0.64	0.68	**3.60**
	SW	0.02	0.19	0.50	0.51	0.42	0.51	**2.15**
	WSW	0.01	0.12	0.31	0.51	0.42	0.91	**2.28**
	W	0.00	0.07	0.30	0.35	0.34	0.72	**1.80**
	WNW	0.00	0.08	0.37	0.44	0.51	0.66	**2.06**
	NW	0.00	0.06	0.37	0.48	0.45	0.43	**1.79**
	NNW	0.00	0.07	0.54	0.54	0.44	0.45	**2.05**
	Total	**1.99**	**2.48**	**6.63**	**5.63**	**4.24**	**5.03**	**26.00**
E	N	0.03	0.23	0.06	0.00	0.00	0.00	**0.32**
	NNE	0.06	0.15	0.10	0.00	0.00	0.00	**0.32**
	NE	0.22	0.18	0.05	0.00	0.00	0.00	**0.45**
	ENE	0.68	0.22	0.02	0.00	0.00	0.00	**0.91**
	E	0.38	0.10	0.02	0.00	0.00	0.00	**0.51**
	ESE	0.20	0.08	0.00	0.00	0.00	0.00	**0.29**
	SE	0.60	0.30	0.01	0.00	0.00	0.00	**0.92**
	SSE	1.17	0.60	0.02	0.00	0.00	0.00	**1.78**
	S	1.20	0.55	0.03	0.00	0.00	0.00	**1.78**
	SSW	0.93	0.48	0.04	0.00	0.00	0.00	**1.44**
	SW	0.40	0.24	0.05	0.00	0.00	0.00	**0.69**
	WSW	0.34	0.17	0.03	0.00	0.00	0.00	**0.54**
	W	0.17	0.11	0.03	0.00	0.00	0.00	**0.30**

Table 223 Annual Average TJF for Bruce Power site for 2020 – 50 m Meteorological Tower

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
	WNW	0.21	0.13	0.05	0.00	0.00	0.00	**0.39**
	NW	0.06	0.18	0.05	0.00	0.00	0.00	**0.29**
	NNW	0.06	0.27	0.07	0.00	0.00	0.00	**0.41**
	Total	**6.72**	**4.00**	**0.63**	**0.00**	**0.00**	**0.00**	**11.35**
F	N	0.94	0.27	0.00	0.00	0.00	0.00	**1.21**
	NNE	0.97	0.30	0.00	0.00	0.00	0.00	**1.27**
	NE	1.05	0.25	0.00	0.00	0.00	0.00	**1.31**
	ENE	1.37	0.22	0.00	0.00	0.00	0.00	**1.59**
	E	1.42	0.17	0.00	0.00	0.00	0.00	**1.59**
	ESE	1.08	0.12	0.00	0.00	0.00	0.00	**1.20**
	SE	1.43	0.17	0.00	0.00	0.00	0.00	**1.60**
	SSE	1.95	0.22	0.00	0.00	0.00	0.00	**2.17**
	S	2.14	0.34	0.00	0.00	0.00	0.00	**2.49**
	SSW	1.47	0.25	0.00	0.00	0.00	0.00	**1.72**
	SW	1.01	0.18	0.00	0.00	0.00	0.00	**1.20**
	WSW	0.37	0.12	0.00	0.00	0.00	0.00	**0.49**
	W	0.42	0.14	0.00	0.00	0.00	0.00	**0.55**
	WNW	0.57	0.15	0.00	0.00	0.00	0.00	**0.73**
	NW	0.86	0.19	0.00	0.00	0.00	0.00	**1.05**
	NNW	1.03	0.27	0.00	0.00	0.00	0.00	**1.31**
	Total	**18.09**	**3.38**	**0.00**	**0.00**	**0.00**	**0.00**	**21.46**
Grand Total		**39.33**	**18.15**	**15.69**	**11.49**	**7.33**	**8.01**	**100.00**

12.0 APPENDIX L: EXPOSURE POINT CONCENTRATIONS FOR THE HHRA

Table 224 and Table 225 in this Appendix contain all of the data used to determine the exposure point concentrations for each human receptor.

The background values for each radionuclide are taken from provincial radiological environmental monitoring, as well as far-field samples from Bruce Power REM. A map of the provincial background locations is provided in Figure 140 [R-364].

Background levels of radioactive material may be classified as either naturally occurring radioactive material (NORM) or anthropogenic (i.e., generated from human activities). Tritium and carbon-14 are naturally cosmogenic, i.e., they are produced by the interaction of cosmic radiation and elements in the atmosphere. All of the radionuclides (i.e., tritium, carbon-14, cobalt-60 and radiocesiums) are anthropogenic, primarily originating from global fallout from severe nuclear accidents (e.g., Chernobyl and Fukushima) and open-air nuclear weapons testing.

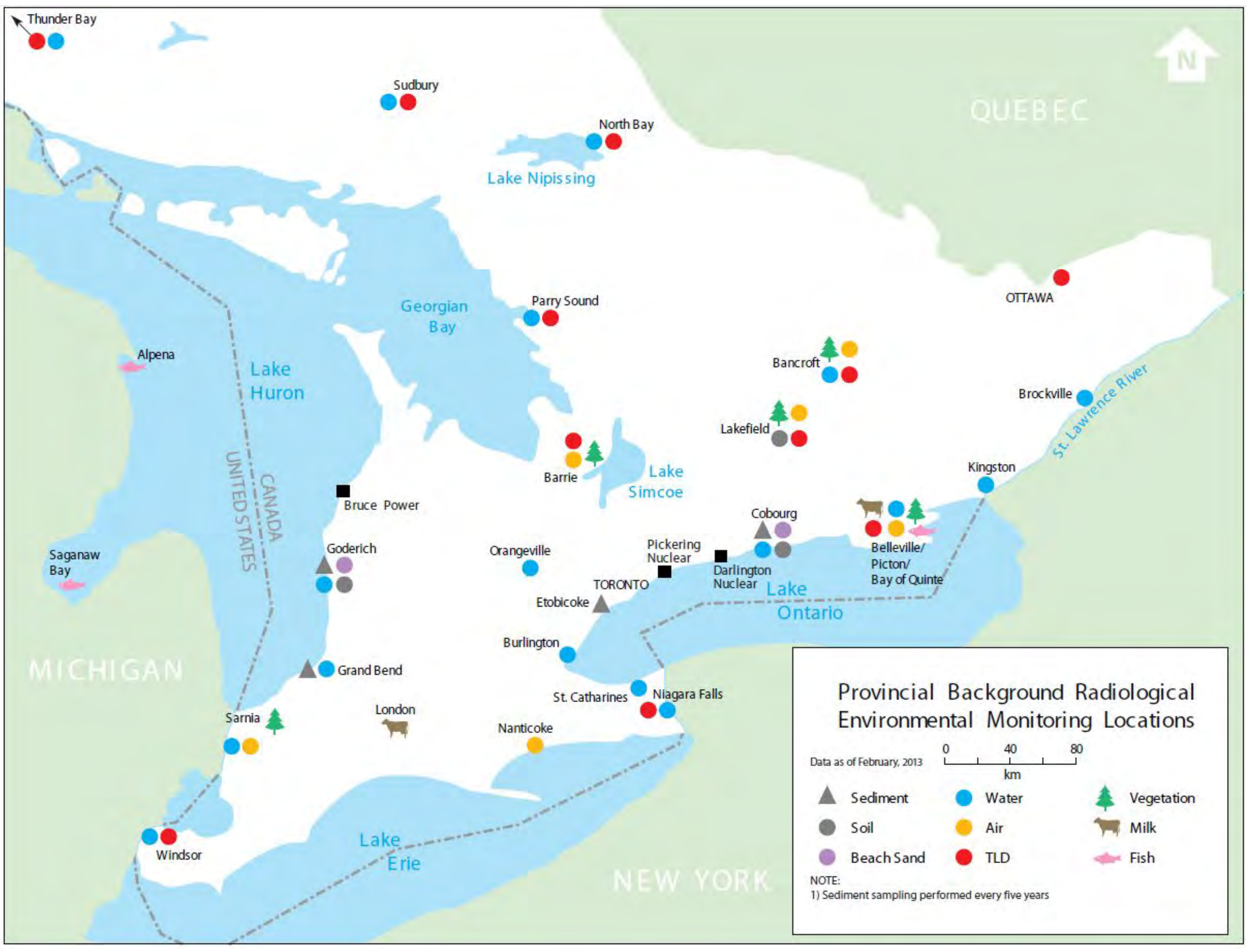

Figure 140 Provincial background radiological environmental monitoring locations

Table 224 Background values and measurement units for each media and radionuclide

Medium	Radionuclide	Background Values					Reported Units	Required Units in IMPACT	Conversion Factor
		2016	2017	2018	2019	2020			
Air	Tritium	1.55E-01	3.23E-02	9.50E-02	3.35E-02	3.63E-02	Bq/m3	same	1
Air	Iodine	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Bq/m3	Bq/m^3	1
Air	Particulate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Bq/m3	same	1
Air	Noble Gas	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Gamma Bq-MeV/m3	same	1
Air	C-14	2.27E+02	2.36E+02	2.33E+02	2.11E+02	2.11E+02	Bq/kg-C	same	0.00021 kg-C/m^3
Fruit	Tritium	1.39E+00	1.94E+00	3.91E-01	2.21E+00	1.13E+00	Bq/L (free water)	Bq/kg	0.9 kg (free water)/kg-fw
Fruit	C-14	2.40E+02	2.35E+02	2.32E+02	2.21E+02	2.35E+02	Bq/kg-C	Bq/kg	0.5 kg-C/kg-dw x 0.1 kg-dw/kg-fw
Vegetables	Tritium	1.48E+00	2.20E+00	1.23E+00	9.25E-01	3.06E+00	Bq/L (free water)	Bq/kg	0.9 kg (free water)/kg-fw
Vegetables	C-14	2.22E+02	2.20E+02	2.47E+02	2.17E+02	2.38E+02	Bq/kg-C	Bq/kg	0.5 kg-C/kg-dw x 0.1 kg-dw/kg-fw
Well Water - Deep	Tritium	1.69E+00	1.66E+00	1.63E+00	1.60E+00	1.58E+00	Bq/L	same	1
Well Water - Shallow	Tritium	2.28E+00	2.11E+00	1.91E+00	2.10E+00	1.91E+00	Bq/L	same	1
Lake	Tritium	1.69E+00	1.66E+00	1.63E+00	1.60E+00	1.58E+00	Bq/L	same	1
Lake	Gross Beta	8.25E-02	8.25E-02	8.10E-02	8.02E-02	8.50E-02	Bq/L	same	1
Soil	Cs-137	2.77E+00	5.39E+00	5.39E+00	5.39E+00	5.39E+00	Bq/kg - dry weight	same	1
Beach sand/sediment	Cs-137	3.84E-01	3.40E-01	2.86E-01	3.37E-01	4.00E-01	Bq/kg - dry weight	same	1
Beach sand/sediment	Cs-134	7.52E-02	8.13E-02	8.13E-02	6.50E-02	6.93E-02	Bq/kg - dry weight	same	1
Beach sand/sediment	Co-60	6.40E-02	6.50E-02	6.50E-02	8.13E-02	5.11E-02	Bq/kg - dry weight	same	1

Table 224 Background values and measurement units for each media and radionuclide

Medium	Radionuclide	Background Values					Reported Units	Required Units in IMPACT	Conversion Factor
		2016	2017	2018	2019	2020			
Fish	Tritium	2.39E+00	3.39E+00	2.08E+00	1.60E+00	3.48E+00	Bq/L (free water)	Bq/kg-fw	0.75 kg (water)/kg-fw
Fish	C-14	2.32E+02	2.40E+02	2.38E+02	2.31E+02	2.22E+02	Bq/kg-C	Bq/kg-fw	0.122 kg-C/kg-fw
Fish	Cs-137	4.63E-01	4.53E-01	5.52E-01	3.88E-01	2.14E-01	Bq/kg-fw	same	1
Fish	Cs-134	5.34E-02	0.00E+00	4.79E-02	4.79E-02	4.89E-02	Bq/kg-fw	same	1
Fish	Co-60	4.57E-02	0.00E+00	4.09E-02	4.09E-02	4.04E-02	Bq/kg-fw	same	1
Milk	Tritium	1.28E+00	1.77E+00	1.00E+00	2.34E+00	1.69E+00	Bq/L	Bq/kg	0.9 kg water/kg-fw
Milk	C-14	2.27E+02	2.40E+02	2.34E+02	2.22E+02	2.29E+02	Bq/kg-C	Bq/kg	0.065 kg-C/kg-fw
Eggs	Tritium	2.67E-02	NA	NA	NA	NA	Bq/L	Bq/kg	0.7 kg (water)/kg-fw
Eggs	C-14	1.84E+00	2.87E+00	3.41E-01	1.80E+00	2.18E+00	Bq/kg-C	Bq/kg	0.157 kg-C/kg-fw
Deer	Tritium	2.47E+02	2.36E+02	2.31E+02	2.23E+02	2.23E+02	Bq/L	Bq/kg	0.7 kg water/kg-fw
Deer	C-14	1.77E+00	2.59E+00	1.38E+00	2.98E+00	2.10E+00	Bq/kg-C	Bq/kg	0.201 kg-C/kg-fw
Deer	Cs-137	2.33E+02	2.33E+02	2.36E+02	2.19E+02	2.23E+02	Bq/kg	same	1
Deer	Cs-134	NA	NA	NA	1.80E+00	4.14E+00	Bq/kg	same	1
Deer	Co-60	NA	NA	NA	2.23E+02	2.24E+02	Bq/kg	same	1
Grain	Tritium	1.84E+00	2.87E+00	3.41E-01	1.80E+00	2.10E+00	Bq/L	Bq/kg	0.13 kg (free water)/kg-fw
Grain	C-14	2.47E+02	2.36E+02	2.31E+02	2.23E+02	2.23E+02	Bq/kg-C	Bq/kg	0.5 kg-C/kg-dw x 0.87 kg-dw/kg-fw
Honey	Tritium	NA	NA	NA	NA	NA	Bq/L	Bq/kg	0.172 kg-fw/kg-fw
Honey	C-14	NA	NA	NA	NA	NA	Bq/kg-C	Bq/kg	0.5 kg-C/kg-dw x 0.828 kg-dw/kg-fw

Note: Conversion factors are taken from CSA Standard N288.1 [R-97].
Available meat C-14 concentrations were based on samples of chicken and lamb. Therefore, the conversion factor for carbon concentration in meat is the average of values for chicken and lamb.
Honey dw/fw factor 0.828 taken from [R-365].
NA = Not available; fw = fresh weight; dw = dry weight.

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
All Groups	Lake	Tritium	Maximum of BM4, BM10 or BM20	5.07E+01	8.41E+01	9.44E+01	6.36E+0	7.26E+01	4.90E+01	8.25E+01	9.27E+01	6.20E+01	7.10E+01	7.14E+01	9.27E+01
All Groups	Lake	Gross Beta	Average of all lake samples	8.17E-02	8.71E-02	9.38E-02	1.30E-01	8.53E-02	NA	4.60E-03	1.27E-02	4.97E-02	2.89E-04	1.68E-02	4.97E-02
All Groups	Sediment	Cs-137	Average of all Bruce Power local samples	2.25E+00	2.25E+00	2.25E+00	1.16E+0	1.16E+00	1.87E+00	1.91E+00	1.97E+00	8.27E-01	7.64E-01	1.47E+00	1.97E+00
All Groups	Sediment	Cs-134	almost all samples <LD, use LD	2.67E-01	2.67E-01	2.67E-01	1.35E-01	1.35E-01	1.91E-01	1.85E-01	1.85E-01	6.99E-02	6.56E-02	1.39E-01	1.91E-01
All Groups	Sediment	Co-60	almost all samples <LD, use LD	2.36E-01	2.36E-01	2.36E-01	1.19E-01	1.19E-01	1.72E-01	1.71E-01	1.71E-01	3.77E-02	6.80E-02	1.24E-01	1.72E-01
All Groups	Fish	Tritium	Average of all near field samples	5.64E+00	1.35E+01	8.77E+00	5.21E+0	8.40E+00	2.43E+00	7.56E+00	5.02E+00	2.71E+00	3.70E+00	4.28E+00	7.56E+00
All Groups	Fish	C-14	Average of all near field samples	2.37E+02	2.32E+02	2.33E+02	2.45E+0	2.35E+02	5.43E-01	NA	NA	1.79E+00	1.65E+00	1.33E+00	1.79E+00
All Groups	Fish	Cs-137	Average of all near field samples	4.03E-01	1.85E-01	3.77E-01	4.03E-01	3.56E-01	NA	NA	NA	1.43E-02	1.41E-01	7.77E-02	1.41E-01
All Groups	Fish	Cs-134	Average of all near field samples	1.64E-01	1.79E-01	2.04E-01	1.09E-01	1.16E-01	1.11E-01	1.79E-01	1.56E-01	6.10E-02	6.70E-02	1.15E-01	1.79E-01
All Groups	Fish	Co-60	Average of all near field samples	1.59E-01	1.79E-01	1.93E-01	1.09E-01	1.08E-01	1.13E-01	1.79E-01	1.52E-01	6.80E-02	6.74E-02	1.16E-01	1.79E-01
All Groups	Milk	Tritium	Average of all milk samples	9.12E+00	1.06E+01	1.01E+01	8.51E+0	6.37E+00	7.06E+00	7.90E+00	8.16E+00	5.56E+00	4.21E+00	6.58E+00	8.16E+00
All Groups	Milk	C-14	Average of all milk samples	2.42E+02	2.28E+02	2.27E+02	2.33E+0	2.41E+02	1.00E+00	NA	NA	7.06E-01	8.14E-01	8.41E-01	1.00E+00
All Groups	Eggs	Tritium	Site Average	NA	1.52E+01	3.59E+01	2.25E+0	2.80E+01	NA	8.83E+00	2.42E+01	1.36E+01	1.67E+01	1.58E+01	2.42E+01
All Groups	Eggs	C-14	Site Average	NA	2.12E+02	2.20E+02	2.42E+0	2.28E+02	NA	NA	NA	3.49E+00	6.28E-01	2.06E+00	3.49E+00
All Groups	Deer	Tritium	Site Average	NA	6.84E+01	NA	2.01E+0	1.86E+01	NA	4.59E+01	NA	1.39E+02	1.16E+01	6.56E+01	1.39E+02

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
All Groups	Deer	C-14	Site Average	NA	2.11E+02	NA	2.11E+0	2.61E+02	NA	NA	NA	NA	7.69E+00	7.69E+00	7.69E+00
All Groups	Deer	Cs-137	Site Average	NA	1.10E-01	NA	7.47E-01	6.47E-01	NA	1.10E-01	NA	7.47E-01	6.47E-01	5.01E-01	7.47E-01
All Groups	Deer	Cs-134	Site Average	NA	2.00E-01	NA	-1.61E-01	1.06E-01	NA	2.00E-01	NA	NA	1.06E-01	1.53E-01	2.00E-01
All Groups	Deer	Co-60	Site Average	NA	1.70E-01	NA	6.46E-02	9.77E-02	NA	1.70E-01	NA	6.46E-02	9.77E-02	1.11E-01	1.70E-01
All Groups	Grain	Tritium	Average of all grain samples collected at Bruce	4.50E+01	7.55E+01	4.42E+01	2.14E+0	2.73E+01	4.96E+00	9.02E+00	5.14E+00	2.25E+00	3.18E+00	4.91E+00	9.02E+00
All Groups	Grain	C-14	Average of all grain samples collected at Bruce	2.44E+02	2.32E+02	2.27E+02	2.26E+0	2.38E+02	7.42E+00	NA	NA	NA	1.15E+01	9.46E+00	1.15E+01
All Groups	Honey	Tritium	Site Average	5.77E+01	NA	2.08E+01	3.34E+0	2.10E+01	9.69E+00	NA	3.50E+00	5.37E+00	3.42E+00	5.50E+00	9.69E+00
All Groups	Honey	C-14	Site Average	2.36E+02	NA	2.30E+02	2.53E+0	2.42E+02	NA	NA	NA	1.31E+01	2.85E+00	7.97E+00	1.31E+01
BR1	Air	Tritium	Used HTO at B5	2.03E+00	2.58E+00	1.91E+00	1.48E+0	1.12E+00	1.88E+00	2.55E+00	1.82E+00	1.45E+00	1.08E+00	1.75E+00	2.55E+00
BR1	Air	Iodine	Used HTO at B5	8.04E-09	3.90E-08	1.93E-08	7.77E-08	4.26E-08	8.04E-09	3.90E-08	1.93E-08	7.77E-08	4.26E-08	3.73E-08	7.77E-08
BR1	Air	Particulate(Co-60)	Used HTO at B5	2.55E-09	4.91E-09	6.73E-09	1.24E-08	1.58E-08	2.55E-09	4.91E-09	6.73E-09	1.24E-08	1.58E-08	8.48E-09	1.58E-08
BR1	Air	Noble Gas	Used HTO at B5	1.91E-01	2.52E-01	2.43E-01	1.93E-01	1.78E-01	1.91E-01	2.52E-01	2.43E-01	1.93E-01	1.78E-01	2.11E-01	2.52E-01
BR1	Air	C-14	BR1	2.58E+02	2.53E+02	2.43E+02	2.48E+0	2.49E+02	6.41E-03	3.62E-03	1.93E-03	7.62E-03	8.07E-03	5.53E-03	8.07E-03
BR1	Fruit	Tritium	ENE Sector (BG11; BG13)	1.26E+02	1.39E+02	8.69E+01	7.36E+0	5.52E+01	1.12E+02	1.23E+02	7.79E+01	6.42E+01	4.87E+01	8.52E+01	1.23E+02
BR1	Fruit	C-14	ENE Sector (BG11; BG13)	2.56E+02	2.28E+02	2.24E+02	2.49E+0	2.48E+02	7.82E-01	NA	NA	1.41E+00	6.44E-01	9.44E-01	1.41E+00
BR1	Vegetables	Tritium	ENE wind sector (NF01; BF50)	4.77E+01	0.00E+00	9.32E+01	4.52E+0	3.72E+01	4.16E+01	NA	8.28E+01	3.98E+01	3.07E+01	4.87E+01	8.28E+01

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BR1	Vegetables	C-14	ENE wind sector (NF01; BF50)	2.40E+02	0.00E+00	2.49E+02	2.58 E+0	2.56E+02	8.83E-01	NA	9.94E-02	2.05E+00	9.19E-01	9.88E-01	2.05E+00
BR1	Well Water - De	Tritium	Lc value	5.70E+00	4.69E+01	2.80E+00	3.02 E+0	2.98E+00	4.01E+00	4.52E+01	1.17E+00	1.42E+00	1.39E+00	1.06E+01	4.52E+01
BR1	Well Water - Sh	Tritium	Maximum of R2, R3 and R4	9.80E+01	1.03E+02	1.00E+02	9.16 E+0	9.77E+01	9.57E+01	1.01E+02	9.82E+01	8.95E+01	9.58E+01	9.60E+01	1.01E+02
BR17	Air	Tritium	Used HTO at B10	1.41E+00	1.67E+00	1.56E+00	1.02 E+0	9.33E-01	1.26E+00	1.64E+00	1.46E+00	9.85E-01	8.97E-01	1.25E+00	1.64E+00
BR17	Air	Iodine	Used HTO at B10	5.58E-09	2.53E-08	1.57E-08	5.35 E-08	3.55E-08	5.58E-09	2.53E-08	1.57E-08	5.35E-08	3.55E-08	2.71E-08	5.35E-08
BR17	Air	Particulate(Co-60)	Used HTO at B10	1.77E-09	3.18E-09	5.48E-09	8.54 E-09	1.32E-08	1.77E-09	3.18E-09	5.48E-09	8.54E-09	1.32E-08	6.43E-09	1.32E-08
BR17	Air	Noble Gas	Used HTO at B10	1.33E-01	1.64E-01	1.98E-01	1.33 E-01	1.48E-01	1.33E-01	1.64E-01	1.98E-01	1.33E-01	1.48E-01	1.55E-01	1.98E-01
BR17	Air	C-14	Used HTO at B10	2.43E+02	2.53E+02	2.50E+02	2.26 E+0	2.28E+02	3.45E-03	3.57E-03	3.54E-03	3.08E-03	3.68E-03	3.46E-03	3.68E-03
BR17	Fruit	Tritium	ESE Sector (BG7; BG8)	5.00E+01	7.32E+01	7.30E+01	7.21 E+0	3.76E+01	4.37E+01	6.41E+01	6.53E+01	6.29E+01	3.28E+01	5.38E+01	6.53E+01
BR17	Fruit	C-14	ESE Sector (BG7; BG8)	2.65E+02	2.26E+02	2.29E+02	2.57 E+0	2.70E+02	1.23E+00	NA	NA	1.81E+00	1.74E+00	1.59E+00	1.81E+00
BR17	Vegetables	Tritium	ESE wind sector	7.31E+01	5.52E+01	2.64E+01	7.21 E+0	3.76E+01	6.45E+01	4.77E+01	2.27E+01	6.41E+01	3.11E+01	4.60E+01	6.45E+01
BR17	Vegetables	C-14	ESE wind sector	2.32E+02	2.45E+02	2.25E+02	2.57 E+0	2.70E+02	4.83E-01	1.25E+00	NA	2.00E+00	1.62E+00	1.34E+00	2.00E+00
BR17	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02 E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BR17	Well Water - Sh	Tritium	BF6	2.40E+01	2.09E+01	2.12E+01	1.39 E+0	2.93E+00	2.18E+01	1.87E+01	1.93E+01	1.18E+01	1.02E+00	1.45E+01	2.18E+01
BR25	Air	Tritium	Used HTO at B3	2.18E+00	1.99E+00	2.29E+00	1.63 E+0	1.55E+00	2.03E+00	1.96E+00	2.20E+00	1.60E+00	1.51E+00	1.86E+00	2.20E+00
BR25	Air	Iodine	Used HTO at B3	8.63E-09	3.01E-08	2.32E-08	8.56 E-08	5.89E-08	8.63E-09	3.01E-08	2.32E-08	8.56E-08	5.89E-08	4.13E-08	8.56E-08

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BR25	Air	Particulate(Co-60)	Used HTO at B3	2.74E-09	3.79E-09	8.08E-09	1.37E-08	2.19E-08	2.74E-09	3.79E-09	8.08E-09	1.37E-08	2.19E-08	1.00E-08	2.19E-08
BR25	Air	Noble Gas	Used HTO at B3	2.05E-01	1.95E-01	2.92E-01	2.12E-01	2.46E-01	2.05E-01	1.95E-01	2.92E-01	2.12E-01	2.46E-01	2.30E-01	2.92E-01
BR25	Air	C-14	B3	2.48E+02	2.84E+02	2.52E+02	2.48E+0	2.58E+02	4.31E-03	9.97E-03	3.88E-03	7.67E-03	9.96E-03	7.16E-03	9.97E-03
BR25	Fruit	Tritium	Maximum values for SE or SSE wind sector (BG16;	6.15E+01	7.14E+01	7.34E+01	1.02E+0	7.38E+01	5.41E+01	6.25E+01	6.57E+01	8.98E+01	6.54E+01	6.75E+01	8.98E+01
BR25	Fruit	C-14	Maximum values for SE or SSE wind sector (BG16;	2.58E+02	2.26E+02	2.31E+02	2.52E+0	2.50E+02	8.82E-01	NA	NA	1.56E+00	7.44E-01	1.06E+00	1.56E+00
BR25	Vegetables	Tritium	Maximum value for SE or SSE wind sector (BF08;	5.79E+01	6.49E+01	3.77E+01	5.88E+0	5.29E+01	5.08E+01	5.64E+01	3.28E+01	5.21E+01	4.49E+01	4.74E+01	5.64E+01
BR25	Vegetables	C-14	Maximum value for SE or SSE wind sector (BF08;	2.52E+02	2.58E+02	2.54E+02	2.56E+0	3.15E+02	1.48E+00	1.90E+00	3.49E-01	1.95E+00	3.87E+00	1.91E+00	3.87E+00
BR25	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BR25	Well Water - Sh	Tritium	BR32	1.63E+01	1.78E+01	2.19E+01	1.69E+0	1.69E+01	1.41E+01	1.57E+01	2.00E+01	1.48E+01	1.50E+01	1.59E+01	2.00E+01
BR27	Air	Tritium	Used HTO at B3	2.18E+00	2.20E+00	2.45E+00	1.63E+0	1.55E+00	2.03E+00	2.17E+00	2.36E+00	1.60E+00	1.51E+00	1.93E+00	2.36E+00
BR27	Air	Iodine	Used HTO at B3	8.63E-09	3.33E-08	2.48E-08	8.56E-08	5.89E-08	8.63E-09	3.33E-08	2.48E-08	8.56E-08	5.89E-08	4.22E-08	8.56E-08
BR27	Air	Particulate	Used HTO at B3	2.74E-09	4.18E-09	8.63E-09	1.37E-08	2.19E-08	2.74E-09	4.18E-09	8.63E-09	1.37E-08	2.19E-08	1.02E-08	2.19E-08
BR27	Air	Noble Gas	Used HTO at B3	2.05E-01	2.15E-01	3.12E-01	2.12E-01	2.46E-01	2.05E-01	2.15E-01	3.12E-01	2.12E-01	2.46E-01	2.38E-01	3.12E-01
BR27	Air	C-14	B3	2.48E+02	2.84E+02	2.52E+02	2.48E+0	2.58E+02	4.31E-03	9.97E-03	3.88E-03	7.67E-03	9.96E-03	7.16E-03	9.97E-03
BR27	Fruit	Tritium	SSE wind sector (BG1/BG3/BG17/BG18/BG	6.40E+01	7.14E+01	7.34E+01	1.02E+0	6.13E+01	5.63E+01	6.25E+01	6.57E+01	8.98E+01	5.42E+01	6.57E+01	8.98E+01
BR27	Fruit	C-14	SSE wind sector (BG1/BG3/BG17/BG18/BG	2.74E+02	2.22E+02	2.31E+02	2.52E+0	2.50E+02	1.68E+00	NA	NA	1.56E+00	7.44E-01	1.33E+00	1.68E+00

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BR27	Vegetables	Tritium	SSE wind sector (BF14, BF15)	5.79E +01	6.49E +01	5.57E +01	5.88 E+0	5.29E +01	5.08E +01	5.64E +01	4.90E +01	5.21E +01	4.49E +01	5.06E+01	5.64E+01
BR27	Vegetables	C-14	SSE wind sector (BF14, BF15)	2.52E +02	2.58E +02	2.38E +02	2.56 E+0	3.15E +02	1.48E +00	1.90E +00	NA	1.95E +00	3.87E +00	2.30E+00	3.87E+00
BR27	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BR27	Water WSP	Tritium	Kincardine WSP	5.90E +00	4.94E +00	5.00E +00	4.33 E+0	4.95E +00	4.21E +00	3.28E +00	3.37E +00	2.73E +00	3.37E +00	3.39E+00	4.21E+00
BR27	Well Water - Sh	Tritium	BR32	1.63E +01	1.78E +01	2.19E +01	1.69 E+0	1.69E +01	1.41E +01	1.57E +01	2.00E +01	1.48E +01	1.50E +01	1.59E+01	2.00E+01
BR32	Air	Tritium	Used HTO at B7	2.14E +00	2.20E +00	2.45E +00	1.61 E+0	1.39E +00	1.99E +00	2.17E +00	2.36E +00	1.58E +00	1.35E +00	1.89E+00	2.36E+00
BR32	Air	Iodine	Used HTO at B7	8.47E -09	3.33E -08	2.48E -08	8.45 E-08	5.28E -08	8.47E -09	3.33E -08	2.48E -08	8.45E -08	5.28E -08	4.08E-08	8.45E-08
BR32	Air	Particulate	Used HTO at B7	2.69E -09	4.18E -09	8.63E -09	1.35 E-08	1.96E -08	2.69E -09	4.18E -09	8.63E -09	1.35E -08	1.96E -08	9.72E-09	1.96E-08
BR32	Air	Noble Gas	Used HTO at B7	2.02E -01	2.15E -01	3.12E -01	2.10 E-01	2.20E -01	2.02E -01	2.15E -01	3.12E -01	2.10E -01	2.20E -01	2.32E-01	3.12E-01
BR32	Air	C-14	B3	2.48E +02	2.84E +02	2.52E +02	2.48 E+0	2.58E +02	4.31E -03	9.97E -03	3.88E -03	7.67E -03	9.96E -03	7.16E-03	9.97E-03
BR32	Fruit	Tritium	SSE wind sector (BG1/BG3/BG17/BG18/BG	6.40E +01	7.14E +01	7.34E +01	1.02 E+0	6.13E +01	5.63E +01	6.25E +01	6.57E +01	8.98E +01	5.42E +01	6.57E+01	8.98E+01
BR32	Fruit	C-14	SSE wind sector (BG1/BG3/BG17/BG18/BG	2.74E +02	2.22E +02	2.31E +02	2.52 E+0	2.50E +02	1.68E +00	NA	NA	1.56E +00	7.44E -01	1.33E+00	1.68E+00
BR32	Vegetables	Tritium	SSE wind sector (BF14, BF15)	4.29E +01	6.49E +01	5.57E +01	5.88 E+0	5.29E +01	3.73E +01	5.64E +01	4.90E +01	5.21E +01	4.49E +01	4.79E+01	5.64E+01
BR32	Vegetables	C-14	SSE wind sector (BF14, BF15)	2.38E +02	2.58E +02	2.38E +02	2.56 E+0	3.15E +02	7.83E -01	1.90E +00	NA	1.95E +00	3.87E +00	2.13E+00	3.87E+00
BR32	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BR32	Water WSP	Tritium	Kincardine WSP	5.90E +00	4.94E +00	5.00E +00	4.33 E+0	4.95E +00	4.21E +00	3.28E +00	3.37E +00	2.73E +00	3.37E +00	3.39E+00	4.21E+00

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BR32	Well Water - Sh	Tritium	BR32	1.63E+01	1.78E+01	2.19E+01	1.69 E+0	1.69E+01	1.41E+01	1.57E+01	2.00E+01	1.48E+01	1.50E+01	1.59E+01	2.00E+01
BR48	Air	Tritium	Used HTO at B4	2.05E+00	3.20E+00	2.65E+00	2.13 E+0	1.95E+00	1.89E+00	3.17E+00	2.55E+00	2.10E+00	1.92E+00	2.33E+00	3.17E+00
BR48	Air	Iodine	Used HTO at B4	8.08E-09	4.85E-08	2.68E-08	1.12 E-07	7.43E-08	8.08E-09	4.85E-08	2.68E-08	1.12E-07	7.43E-08	5.39E-08	1.12E-07
BR48	Air	Particulate	Used HTO at B4	2.56E-09	6.09E-09	9.32E-09	1.79 E-08	2.76E-08	2.56E-09	6.09E-09	9.32E-09	1.79E-08	2.76E-08	1.27E-08	2.76E-08
BR48	Air	Noble Gas	Used HTO at B4	1.92E-01	3.13E-01	3.37E-01	2.78 E-01	3.10E-01	1.92E-01	3.13E-01	3.37E-01	2.78E-01	3.10E-01	2.86E-01	3.37E-01
BR48	Air	C-14	Used HTO at B4	2.51E+02	2.69E+02	2.62E+02	2.42 E+0	2.47E+02	5.00E-03	6.84E-03	6.03E-03	6.44E-03	7.70E-03	6.40E-03	7.70E-03
BR48	Fruit	Tritium	Maximum value from E and ESE wind sectors (BG10;	1.25E+02	1.98E+02	1.12E+02	9.22 E+0	7.95E+01	1.11E+02	1.76E+02	1.00E+02	8.10E+01	7.05E+01	1.08E+02	1.76E+02
BR48	Fruit	C-14	Maximum value from E and ESE wind sectors (BG10;	2.61E+02	2.62E+02	2.43E+02	2.57 E+0	2.70E+02	1.03E+00	1.37E+00	5.37E-01	1.81E+00	1.74E+00	1.30E+00	1.81E+00
BR48	Vegetables	Tritium	Maximum value from E and ESE wind sectors (BR15)	7.31E+01	5.52E+01	2.64E+01	2.70 E+0	3.10E+01	6.45E+01	4.77E+01	2.27E+01	2.35E+01	2.51E+01	3.67E+01	6.45E+01
BR48	Vegetables	C-14	Maximum value from E and ESE wind sectors (BR15)	2.32E+02	2.45E+02	2.54E+02	2.48 E+0	2.53E+02	4.83E-01	1.25E+00	3.49E-01	1.55E+00	7.69E-01	8.81E-01	1.55E+00
BR48	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02 E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BR48	Well Water - Sh	Tritium	Maximum (R2, R3, R4)	9.80E+01	1.03E+02	1.00E+02	9.16 E+0	9.77E+01	9.57E+01	1.01E+02	9.82E+01	8.95E+01	9.58E+01	9.60E+01	1.01E+02
BF8	Air	Tritium	Used HTO at B11	8.53E-01	8.98E-01	9.37E-01	6.11 E-01	6.43E-01	6.98E-01	8.66E-01	8.42E-01	5.78E-01	6.06E-01	7.18E-01	8.66E-01
BF8	Air	Iodine	Used HTO at B11	3.37E-09	1.36E-08	9.46E-09	3.21 E-08	2.44E-08	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	1.66E-08	3.21E-08
BF8	Air	Particulate	Used HTO at B11	1.07E-09	1.71E-09	3.30E-09	5.12 E-09	9.07E-09	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	4.05E-09	9.07E-09
BF8	Air	Noble Gas	Used HTO at B11	8.03E-02	8.78E-02	1.19E-01	7.95 E-02	1.02E-01	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	9.37E-02	1.19E-01

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BF8	Air	C-14	B11	2.40E +02	2.62E +02	2.54E +02	2.25 E+0	2.40E +02	2.68E -03	5.51E -03	4.24E -03	2.73E -03	6.13E -03	4.26E-03	6.13E-03
BF8	Fruit	Tritium	SE wind sector (BG16; BG20; BG21)	5.00E +01	6.52E +01	7.30E +01	7.21 E+0	7.38E +01	4.37E +01	5.69E +01	6.53E +01	6.29E +01	6.54E +01	5.89E+01	6.54E+01
BF8	Fruit	C-14	SE wind sector (BG16; BG20; BG21)	2.37E +02	2.26E +02	2.29E +02	2.51 E+0	2.50E +02	NA	NA	NA	1.51E +00	7.44E -01	1.13E+00	1.51E+00
BF8	Vegetables	Tritium	SE wind sector (BF08)	2.04E +01	3.84E +01	3.77E +01	2.08 E+0	1.49E +01	1.70E +01	3.26E +01	3.28E +01	1.79E +01	1.07E +01	2.22E+01	3.28E+01
BF8	Vegetables	C-14	SE wind sector (BF08)	2.48E +02	2.37E +02	2.54E +02	2.44 E+0	2.35E +02	1.28E +00	8.54E -01	3.49E -01	1.35E +00	NA	9.59E-01	1.35E+00
BF8	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BF8	Well Water - Sh	Tritium	BF6	2.40E +01	2.09E +01	2.12E +01	1.39 E+0	2.93E +00	2.18E +01	1.87E +01	1.93E +01	1.18E +01	1.02E +00	1.45E+01	2.18E+01
BF14	Air	Tritium	Used HTO at B7	2.14E +00	2.20E +00	2.45E +00	1.61 E+0	1.39E +00	1.99E +00	2.17E +00	2.36E +00	1.58E +00	1.35E +00	1.89E+00	2.36E+00
BF14	Air	Iodine	Used HTO at B7	8.47E -09	3.33E -08	2.48E -08	8.45 E-08	5.28E -08	8.47E -09	3.33E -08	2.48E -08	8.45E -08	5.28E -08	4.08E-08	8.45E-08
BF14	Air	Particulate	Used HTO at B7	2.69E -09	4.18E -09	8.63E -09	1.35 E-08	1.96E -08	2.69E -09	4.18E -09	8.63E -09	1.35E -08	1.96E -08	9.72E-09	1.96E-08
BF14	Air	Noble Gas	Used HTO at B7	2.02E -01	2.15E -01	3.12E -01	2.10 E-01	2.20E -01	2.02E -01	2.15E -01	3.12E -01	2.10E -01	2.20E -01	2.32E-01	3.12E-01
BF14	Air	C-14	BF14	2.48E +02	2.50E +02	2.34E +02	2.53 E+0	2.43E +02	4.36E -03	2.93E -03	4.34E -05	8.77E -03	6.81E -03	4.58E-03	8.77E-03
BF14	Fruit	Tritium	SSE wind sector (BG1; BG3; BG17; BG18; BG19)	7.20E +01	7.34E +01	7.34E +01	1.02 E+0	6.13E +01	6.35E +01	6.43E +01	6.57E +01	8.98E +01	5.42E +01	6.75E+01	8.98E+01
BF14	Fruit	C-14	SSE wind sector (BG1; BG3; BG17; BG18; BG19)	2.49E +02	2.38E +02	2.31E +02	2.52 E+0	2.50E +02	4.32E -01	1.69E -01	NA	1.56E +00	7.44E -01	7.25E-01	1.56E+00
BF14	Vegetables	Tritium	SSE wind sector (BF14, BF15)	5.79E +01	6.49E +01	5.57E +01	5.88 E+0	5.29E +01	5.08E +01	5.64E +01	4.90E +01	5.21E +01	4.49E +01	5.06E+01	5.64E+01
BF14	Vegetables	C-14	SSE wind sector (BF14, BF15)	2.52E +02	2.58E +02	2.38E +02	2.56 E+0	3.15E +02	1.48E +00	1.90E +00	NA	1.95E +00	3.87E +00	2.30E+00	3.87E+00

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BF14	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BF14	Well Water - Sh	Tritium	BR32	1.63E+01	1.78E+01	2.19E+01	1.69E+0	1.69E+01	1.41E+01	1.57E+01	2.00E+01	1.48E+01	1.50E+01	1.59E+01	2.00E+01
BF16	Air	Tritium	Used HTO at B10	1.41E+00	1.67E+00	1.56E+00	1.02E+0	9.33E-01	1.26E+00	1.64E+00	1.46E+00	9.85E-01	8.97E-01	1.25E+00	1.64E+00
BF16	Air	Iodine	Used HTO at B10	5.58E-09	2.53E-08	1.57E-08	5.35E-08	3.55E-08	5.58E-09	2.53E-08	1.57E-08	5.35E-08	3.55E-08	2.71E-08	5.35E-08
BF16	Air	Particulate	Used HTO at B10	1.77E-09	3.18E-09	5.48E-09	8.54E-09	1.32E-08	1.77E-09	3.18E-09	5.48E-09	8.54E-09	1.32E-08	6.43E-09	1.32E-08
BF16	Air	Noble Gas	Used HTO at B10	1.33E-01	1.64E-01	1.98E-01	1.33E-01	1.48E-01	1.33E-01	1.64E-01	1.98E-01	1.33E-01	1.48E-01	1.55E-01	1.98E-01
BF16	Air	C-14	Used HTO at B10	2.43E+02	2.53E+02	2.50E+02	2.26E+0	2.28E+02	3.45E-03	3.57E-03	3.54E-03	3.08E-03	3.68E-03	3.46E-03	3.68E-03
BF16	Fruit	Tritium	ESE wind sector (BG7; BG8)	4.11E+01	7.32E+01	6.15E+01	5.10E+0	3.76E+01	3.57E+01	6.41E+01	5.50E+01	4.39E+01	3.28E+01	4.63E+01	6.41E+01
BF16	Fruit	C-14	ESE wind sector (BG7; BG8)	2.65E+02	2.09E+02	2.22E+02	2.57E+0	2.70E+02	1.23E+00	NA	NA	1.81E+00	1.74E+00	1.59E+00	1.81E+00
BF16	Vegetables	Tritium	ESE wind sector	4.11E+01	7.32E+01	2.64E+01	5.10E+0	3.76E+01	3.57E+01	6.39E+01	2.27E+01	4.51E+01	3.11E+01	3.97E+01	6.39E+01
BF16	Vegetables	C-14	ESE wind sector	2.65E+02	2.09E+02	2.25E+02	2.57E+0	2.70E+02	2.13E+00	NA	NA	2.00E+00	1.62E+00	1.92E+00	2.13E+00
BF16	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BF16	Well Water - Sh	Tritium	BF6	2.40E+01	2.09E+01	2.12E+01	1.39E+0	2.93E+00	2.18E+01	1.87E+01	1.93E+01	1.18E+01	1.02E+00	1.45E+01	2.18E+01
BSF2	Air	Tritium	Used HTO at B11	8.53E-01	8.98E-01	9.37E-01	6.11E-01	6.43E-01	6.98E-01	8.66E-01	8.42E-01	5.78E-01	6.06E-01	7.18E-01	8.66E-01
BSF2	Air	Iodine	Used HTO at B11	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	1.66E-08	3.21E-08
BSF2	Air	Particulate	Used HTO at B11	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	4.05E-09	9.07E-09

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BSF2	Air	Noble Gas	Used HTO at B11	8.03E-02	8.78E-02	1.19E-01	7.95 E-02	1.02E-01	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	9.37E-02	1.19E-01
BSF2	Air	C-14	B11	2.40E+02	2.62E+02	2.54E+02	2.25 E+0	2.40E+02	2.68E-03	5.51E-03	4.24E-03	2.73E-03	6.13E-03	4.26E-03	6.13E-03
BSF2	Fruit	Tritium	SE wind sector (BG16; BG20; BG21)	2.04E+01	3.84E+01	7.30E+01	7.21 E+0	7.38E+01	1.71E+01	3.28E+01	6.53E+01	6.29E+01	6.54E+01	4.87E+01	6.54E+01
BSF2	Fruit	C-14	SE wind sector (BG16; BG20; BG21)	2.48E+02	2.37E+02	2.29E+02	2.51 E+0	2.50E+02	3.82E-01	1.19E-01	NA	1.51E+00	7.44E-01	6.88E-01	1.51E+00
BSF2	Vegetables	Tritium	SE wind sector (BF08)	2.04E+01	3.84E+01	3.77E+01	2.08 E+0	1.49E+01	1.70E+01	3.26E+01	3.28E+01	1.79E+01	1.07E+01	2.22E+01	3.28E+01
BSF2	Vegetables	C-14	SE wind sector (BF08)	2.48E+02	2.37E+02	2.54E+02	2.44 E+0	2.35E+02	1.28E+00	8.54E-01	3.49E-01	1.35E+00	NA	9.59E-01	1.35E+00
BSF2	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02 E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BSF2	Well Water - Sh	Tritium	BF6	2.40E+01	2.09E+01	2.12E+01	1.39 E+0	2.93E+00	2.18E+01	1.87E+01	1.93E+01	1.18E+01	1.02E+00	1.45E+01	2.18E+01
BSF2	Milk	Tritium	Average of all local samples	9.12E+00	1.02E+01	1.01E+01	8.51 E+0	6.37E+00	7.06E+00	7.56E+00	8.16E+00	5.56E+00	4.21E+00	6.51E+00	8.16E+00
BSF2	Milk	C-14	Average of all local samples	2.42E+02	2.28E+02	2.27E+02	2.33 E+0	2.41E+02	1.00E+00	NA	NA	7.06E-01	8.14E-01	8.41E-01	1.00E+00
BSF3	Air	Tritium	Used HTO at B11	8.53E-01	8.98E-01	9.37E-01	6.11 E-01	6.43E-01	6.98E-01	8.66E-01	8.42E-01	5.78E-01	6.06E-01	7.18E-01	8.66E-01
BSF3	Air	Iodine	Used HTO at B11	3.37E-09	1.36E-08	9.46E-09	3.21 E-08	2.44E-08	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	1.66E-08	3.21E-08
BSF3	Air	Particulate	Used HTO at B11	1.07E-09	1.71E-09	3.30E-09	5.12 E-09	9.07E-09	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	4.05E-09	9.07E-09
BSF3	Air	Noble Gas	Used HTO at B11	8.03E-02	8.78E-02	1.19E-01	7.95 E-02	1.02E-01	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	9.37E-02	1.19E-01
BSF3	Air	C-14	B11	2.40E+02	2.62E+02	2.54E+02	2.25 E+0	2.40E+02	2.68E-03	5.51E-03	4.24E-03	2.73E-03	6.13E-03	4.26E-03	6.13E-03
BSF3	Fruit	Tritium	ESE wind sector (BG7; BG8)	4.02E+01	6.74E+01	6.15E+01	5.10 E+0	3.76E+01	3.49E+01	5.89E+01	5.50E+01	4.39E+01	3.28E+01	4.51E+01	5.89E+01

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BSF3	Fruit	C-14	ESE wind sector (BG7; BG8)	2.65E +02	1.98E +02	2.22E +02	2.57 E+0	2.70E +02	1.23E +00	NA	NA	1.81E +00	1.74E +00	1.59E+00	1.81E+00
BSF3	Vegetables	Tritium	ESE wind sector	4.02E +01	6.74E +01	2.64E +01	5.10 E+0	3.76E +01	3.48E +01	5.87E +01	2.27E +01	4.51E +01	3.11E +01	3.85E+01	5.87E+01
BSF3	Vegetables	C-14	ESE wind sector	2.65E +02	1.98E +02	2.25E +02	2.57 E+0	2.70E +02	2.13E +00	NA	NA	2.00E +00	1.62E +00	1.92E+00	2.13E+00
BSF3	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BSF3	Well Water - Sh	Tritium	BF6	2.40E +01	2.09E +01	2.12E +01	1.39 E+0	2.93E +00	2.18E +01	1.87E +01	1.93E +01	1.18E +01	1.02E +00	1.45E+01	2.18E+01
BSF3	Milk	Tritium	Average of all local samples	9.12E +00	1.02E +01	1.01E +01	8.51 E+0	6.37E +00	7.06E +00	7.56E +00	8.16E +00	5.56E +00	4.21E +00	6.51E+00	8.16E+00
BSF3	Milk	C-14	Average of all local samples	2.42E +02	2.28E +02	2.27E +02	2.33 E+0	2.41E +02	1.00E +00	NA	NA	7.06E -01	8.14E -01	8.41E-01	1.00E+00
BDF1	Air	Tritium	Used HTO at B10	1.41E +00	1.67E +00	1.56E +00	1.02 E+0	9.33E -01	1.26E +00	1.64E +00	1.46E +00	9.85E -01	8.97E -01	1.25E+00	1.64E+00
BDF1	Air	Iodine	Used HTO at B10	5.58E -09	2.53E -08	1.57E -08	5.35 E-08	3.55E -08	5.58E -09	2.53E -08	1.57E -08	5.35E -08	3.55E -08	2.71E-08	5.35E-08
BDF1	Air	Particulate	Used HTO at B10	1.77E -09	3.18E -09	5.48E -09	8.54 E-09	1.32E -08	1.77E -09	3.18E -09	5.48E -09	8.54E -09	1.32E -08	6.43E-09	1.32E-08
BDF1	Air	Noble Gas	Used HTO at B10	1.33E -01	1.64E -01	1.98E -01	1.33 E-01	1.48E -01	1.33E -01	1.64E -01	1.98E -01	1.33E -01	1.48E -01	1.55E-01	1.98E-01
BDF1	Air	C-14	Used HTO at B10	2.43E +02	2.53E +02	2.50E +02	2.26 E+0	2.28E +02	3.45E -03	3.57E -03	3.54E -03	3.08E -03	3.68E -03	3.46E-03	3.68E-03
BDF1	Fruit	Tritium	SE or ESE wind sector (2020)	4.11E +01	3.84E +01	7.30E +01	7.21 E+0	3.76E +01	3.57E +01	3.28E +01	6.53E +01	6.29E +01	3.28E +01	4.59E+01	6.53E+01
BDF1	Fruit	C-14	SE or ESE wind sector (2020)	2.65E +02	2.37E +02	2.29E +02	2.51 E+0	2.70E +02	1.23E +00	1.19E -01	NA	1.51E +00	1.74E +00	1.15E+00	1.74E+00
BDF1	Vegetables	Tritium	SE or ESE wind sector (2020)	2.04E +01	3.84E +01	3.77E +01	2.08 E+0	3.76E +01	1.70E +01	3.26E +01	3.28E +01	1.79E +01	3.11E +01	2.63E+01	3.28E+01
BDF1	Vegetables	C-14	SE or ESE wind sector (2020)	2.48E +02	2.37E +02	2.54E +02	2.44 E+0	2.70E +02	1.28E +00	8.54E -01	3.49E -01	1.35E +00	1.62E +00	1.09E+00	1.62E+00

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BDF1	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BDF1	Well Water - Sh	Tritium	BF6	2.40E +01	2.09E +01	2.12E +01	1.39 E+0	2.93E +00	2.18E +01	1.87E +01	1.93E +01	1.18E +01	1.02E +00	1.45E+01	2.18E+01
BDF1	Milk	Tritium	Average of all samples from DF1	1.04E +01	1.05E +01	1.28E +01	5.07 E+0	4.86E +00	8.24E +00	7.86E +00	1.07E +01	2.46E +00	2.85E +00	6.41E+00	1.07E+01
BDF1	Milk	C-14	Average of all samples from DF1	2.48E +02	2.30E +02	2.31E +02	2.32 E+0	2.39E +02	1.36E +00	NA	NA	6.55E -01	6.93E -01	9.04E-01	1.36E+00
BDF9	Air	Tritium	Used HTO at B11	8.53E -01	8.98E -01	9.37E -01	6.11 E-01	6.43E -01	6.98E -01	8.66E -01	8.42E -01	5.78E -01	6.06E -01	7.18E-01	8.66E-01
BDF9	Air	Iodine	Used HTO at B11	3.37E -09	1.36E -08	9.46E -09	3.21 E-08	2.44E -08	3.37E -09	1.36E -08	9.46E -09	3.21E -08	2.44E -08	1.66E-08	3.21E-08
BDF9	Air	Particulate	Used HTO at B11	1.07E -09	1.71E -09	3.30E -09	5.12 E-09	9.07E -09	1.07E -09	1.71E -09	3.30E -09	5.12E -09	9.07E -09	4.05E-09	9.07E-09
BDF9	Air	Noble Gas	Used HTO at B11	8.03E -02	8.78E -02	1.19E -01	7.95 E-02	1.02E -01	8.03E -02	8.78E -02	1.19E -01	7.95E -02	1.02E -01	9.37E-02	1.19E-01
BDF9	Air	C-14	B11	2.40E +02	2.62E +02	2.54E +02	2.25 E+0	2.40E +02	2.68E -03	5.51E -03	4.24E -03	2.73E -03	6.13E -03	4.26E-03	6.13E-03
BDF9	Fruit	Tritium	SE wind sector (BG16; BG20; BG21)	1.19E +02	3.84E +01	7.30E +01	7.21 E+0	7.38E +01	1.06E +02	3.28E +01	6.53E +01	6.29E +01	6.54E +01	6.65E+01	1.06E+02
BDF9	Fruit	C-14	SE wind sector (BG16; BG20; BG21)	2.88E +02	2.37E +02	2.29E +02	2.51 E+0	2.50E +02	2.38E +00	1.19E -01	NA	1.51E +00	7.44E -01	1.19E+00	2.38E+00
BDF9	Vegetables	Tritium	SE wind sector (BG08)	2.04E +01	3.84E +01	3.77E +01	2.08 E+0	1.49E +01	1.70E +01	3.26E +01	3.28E +01	1.79E +01	1.07E +01	2.22E+01	3.28E+01
BDF9	Vegetables	C-14	SE wind sector (BG08)	2.48E +02	2.37E +02	2.54E +02	2.44 E+0	2.35E +02	1.28E +00	8.54E -01	3.49E -01	1.35E +00	NA	9.59E-01	1.35E+00
BDF9	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BDF9	Well Water - Sh	Tritium	BF6	2.40E +01	2.09E +01	2.12E +01	1.39 E+0	2.93E +00	2.18E +01	1.87E +01	1.93E +01	1.18E +01	1.02E +00	1.45E+01	2.18E+01
BDF9	Milk	Tritium	Average of all samples from DF9	6.43E +00	9.51E +00	9.55E +00	1.56 E+0	8.62E +00	4.64E +00	6.96E +00	7.69E +00	1.19E +01	6.24E +00	7.49E+00	1.19E+01

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BDF9	Milk	C-14	Average of all samples from DF9	2.42E +02	2.32E +02	2.28E +02	2.36 E+0	2.42E +02	9.74E -01	NA	NA	9.26E -01	8.72E -01	9.24E-01	9.74E-01
BDF12	Air	Tritium	Used HTO at B10	1.41E +00	1.67E +00	1.56E +00	1.02 E+0	9.33E -01	1.26E +00	1.64E +00	1.46E +00	9.85E -01	8.97E -01	1.25E+00	1.64E+00
BDF12	Air	Iodine	Used HTO at B10	5.58E -09	2.53E -08	1.57E -08	5.35 E-08	3.55E -08	5.58E -09	2.53E -08	1.57E -08	5.35E -08	3.55E -08	2.71E-08	5.35E-08
BDF12	Air	Particulate	Used HTO at B10	1.77E -09	3.18E -09	5.48E -09	8.54 E-09	1.32E -08	1.77E -09	3.18E -09	5.48E -09	8.54E -09	1.32E -08	6.43E-09	1.32E-08
BDF12	Air	Noble Gas	Used HTO at B10	1.33E -01	1.64E -01	1.98E -01	1.33 E-01	1.48E -01	1.33E -01	1.64E -01	1.98E -01	1.33E -01	1.48E -01	1.55E-01	1.98E-01
BDF12	Air	C-14	Used HTO at B10	2.43E +02	2.53E +02	2.50E +02	2.26 E+0	2.28E +02	3.45E -03	3.57E -03	3.54E -03	3.08E -03	3.68E -03	3.46E-03	3.68E-03
BDF12	Fruit	Tritium	ESE wind sector (BG7; BG8)	4.11E +01	7.32E +01	6.15E +01	5.10 E+0	3.76E +01	3.57E +01	6.41E +01	5.50E +01	4.39E +01	3.28E +01	4.63E+01	6.41E+01
BDF12	Fruit	C-14	ESE wind sector (BG7; BG8)	2.65E +02	2.09E +02	2.22E +02	2.57 E+0	2.70E +02	1.23E +00	NA	NA	1.81E +00	1.74E +00	1.59E+00	1.81E+00
BDF12	Vegetables	Tritium	ESE wind sector	4.11E +01	7.32E +01	2.64E +01	5.10 E+0	3.76E +01	3.57E +01	6.39E +01	2.27E +01	4.51E +01	3.11E +01	3.97E+01	6.39E+01
BDF12	Vegetables	C-14	ESE wind sector	2.65E +02	2.09E +02	2.25E +02	2.57 E+0	2.70E +02	2.13E +00	NA	NA	2.00E +00	1.62E +00	1.92E+00	2.13E+00
BDF12	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BDF12	Well Water - Sh	Tritium	BF6	2.40E +01	2.09E +01	2.12E +01	1.39 E+0	2.93E +00	2.18E +01	1.87E +01	1.93E +01	1.18E +01	1.02E +00	1.45E+01	2.18E+01
BDF12	Milk	Tritium	Average of all samples from DF12	1.05E +01	1.45E +01	1.40E +01	9.15 E+0	6.99E +00	8.31E +00	1.15E +01	1.17E +01	6.13E +00	4.77E +00	8.47E+00	1.17E+01
BDF12	Milk	C-14	Average of all samples from DF12	0.00E +00	2.28E +02	2.27E +02	2.35 E+0	2.48E +02	NA	NA	NA	8.45E -01	1.25E +00	1.05E+00	1.25E+00
BDF13	Air	Tritium	Used HTO at B11	8.53E -01	8.98E -01	9.37E -01	6.11 E-01	6.43E -01	6.98E -01	8.66E -01	8.42E -01	5.78E -01	6.06E -01	7.18E-01	8.66E-01
BDF13	Air	Iodine	Used HTO at B11	3.37E -09	1.36E -08	9.46E -09	3.21 E-08	2.44E -08	3.37E -09	1.36E -08	9.46E -09	3.21E -08	2.44E -08	1.66E-08	3.21E-08

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BDF13	Air	Particulate	Used HTO at B11	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	4.05E-09	9.07E-09
BDF13	Air	Noble Gas	Used HTO at B11	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	9.37E-02	1.19E-01
BDF13	Air	C-14	B11	2.40E+02	2.62E+02	2.54E+02	2.25E+0	2.40E+02	2.68E-03	5.51E-03	4.24E-03	2.73E-03	6.13E-03	4.26E-03	6.13E-03
BDF13	Fruit	Tritium	ESE wind sector (BG7; BG8)	4.11E+01	7.32E+01	6.15E+01	5.10E+0	3.76E+01	3.57E+01	6.41E+01	5.50E+01	4.39E+01	3.28E+01	4.63E+01	6.41E+01
BDF13	Fruit	C-14	ESE wind sector (BG7; BG8)	2.65E+02	2.09E+02	2.22E+02	2.57E+0	2.70E+02	1.23E+00	NA	NA	1.81E+00	1.74E+00	1.59E+00	1.81E+00
BDF13	Vegetables	Tritium	ESE wind sector	4.11E+01	2.04E+01	2.64E+01	5.10E+0	3.76E+01	3.57E+01	1.64E+01	2.27E+01	4.51E+01	3.11E+01	3.02E+01	4.51E+01
BDF13	Vegetables	C-14	ESE wind sector	2.65E+02	2.48E+02	2.25E+02	2.57E+0	2.70E+02	2.13E+00	1.40E+00	NA	2.00E+00	1.62E+00	1.79E+00	2.13E+00
BDF13	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BDF13	Well Water - Sh	Tritium	BF6	2.40E+01	2.09E+01	2.12E+01	1.39E+0	2.93E+00	2.18E+01	1.87E+01	1.93E+01	1.18E+01	1.02E+00	1.45E+01	2.18E+01
BDF13	Milk	Tritium	Average of all samples from DF13	0.00E+00	1.45E+01	1.01E+01	7.35E+0	6.87E+00	NA	1.15E+01	8.16E+00	4.51E+00	4.66E+00	7.20E+00	1.15E+01
BDF13	Milk	C-14	Average of all samples from DF13	0.00E+00	2.28E+02	2.27E+02	2.39E+0	2.26E+02	NA	NA	NA	1.11E+00	NA	1.11E+00	1.11E+00
BDF14	Air	Tritium	Used HTO at B11	8.53E-01	8.98E-01	9.37E-01	6.11E-01	6.43E-01	6.98E-01	8.66E-01	8.42E-01	5.78E-01	6.06E-01	7.18E-01	8.66E-01
BDF14	Air	Iodine	Used HTO at B11	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	1.66E-08	3.21E-08
BDF14	Air	Particulate	Used HTO at B11	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	4.05E-09	9.07E-09
BDF14	Air	Noble Gas	Used HTO at B11	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	9.37E-02	1.19E-01
BDF14	Air	C-14	B11	2.40E+02	2.62E+02	2.54E+02	2.25E+0	2.40E+02	2.68E-03	5.51E-03	4.24E-03	2.73E-03	6.13E-03	4.26E-03	6.13E-03

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BDF14	Fruit	Tritium	SE wind sector (BG16; BG20; BG21)	1.19E+02	3.84E+01	7.30E+01	7.21E+0	7.38E+01	1.06E+02	3.28E+01	6.53E+01	6.29E+01	6.54E+01	6.65E+01	1.06E+02
BDF14	Fruit	C-14	SE wind sector (BG16; BG20; BG21)	2.88E+02	2.37E+02	2.29E+02	2.51E+0	2.50E+02	2.38E+00	1.19E-01	NA	1.51E+00	7.44E-01	1.19E+00	2.38E+00
BDF14	Vegetables	Tritium	SE wind sector (BG08)	2.04E+01	3.84E+01	3.77E+01	2.08E+0	1.49E+01	1.70E+01	3.26E+01	3.28E+01	1.79E+01	1.07E+01	2.22E+01	3.28E+01
BDF14	Vegetables	C-14	SE Sector (BG08)	2.48E+02	2.37E+02	2.54E+02	2.44E+0	2.35E+02	1.28E+00	8.54E-01	3.49E-01	1.35E+00	NA	9.59E-01	1.35E+00
BDF14	Well Water - De	Tritium	Lc value	5.70E+00	5.75E+00	2.80E+00	3.02E+0	2.98E+00	4.01E+00	4.09E+00	1.17E+00	1.42E+00	1.39E+00	2.42E+00	4.09E+00
BDF14	Well Water - Sh	Tritium	BF6	2.40E+01	2.09E+01	2.12E+01	1.39E+0	2.93E+00	2.18E+01	1.87E+01	1.93E+01	1.18E+01	1.02E+00	1.45E+01	2.18E+01
BDF14	Milk	Tritium	Average of all samples from DF14	0.00E+00	1.04E+01	7.67E+00	7.35E+0	6.87E+00	NA	7.73E+00	6.00E+00	4.51E+00	4.66E+00	5.72E+00	7.73E+00
BDF14	Milk	C-14	Average of all samples from DF14	0.00E+00	2.26E+02	2.28E+02	2.39E+0	2.26E+02	NA	NA	NA	1.11E+00	NA	1.11E+00	1.11E+00
BDF15	Air	Tritium	Used HTO at B11	8.53E-01	8.98E-01	9.37E-01	6.11E-01	6.43E-01	6.98E-01	8.66E-01	8.42E-01	5.78E-01	6.06E-01	7.18E-01	8.66E-01
BDF15	Air	Iodine	Used HTO at B11	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	3.37E-09	1.36E-08	9.46E-09	3.21E-08	2.44E-08	1.66E-08	3.21E-08
BDF15	Air	Particulate	Used HTO at B11	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	1.07E-09	1.71E-09	3.30E-09	5.12E-09	9.07E-09	4.05E-09	9.07E-09
BDF15	Air	Noble Gas	Used HTO at B11	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	8.03E-02	8.78E-02	1.19E-01	7.95E-02	1.02E-01	9.37E-02	1.19E-01
BDF15	Air	C-14	B11	2.40E+02	2.62E+02	2.54E+02	2.25E+0	2.40E+02	2.68E-03	5.51E-03	4.24E-03	2.73E-03	6.13E-03	4.26E-03	6.13E-03
BDF15	Fruit	Tritium	SE Sector (BG16; BG20; BG21)	1.19E+02	3.84E+01	7.30E+01	7.21E+0	7.38E+01	1.06E+02	3.28E+01	6.53E+01	6.29E+01	6.54E+01	6.65E+01	1.06E+02
BDF15	Fruit	C-14	SE Sector (BG16; BG20; BG21)	2.88E+02	2.37E+02	2.29E+02	2.51E+0	2.50E+02	2.38E+00	1.19E-01	NA	1.51E+00	7.44E-01	1.19E+00	2.38E+00
BDF15	Vegetables	Tritium	SE Sector (BG08)	2.04E+01	3.84E+01	3.77E+01	2.08E+0	1.49E+01	1.70E+01	3.26E+01	3.28E+01	1.79E+01	1.07E+01	2.22E+01	3.28E+01

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BDF15	Vegetables	C-14	SE wind sector (BG08)	2.48E +02	2.37E +02	2.54E +02	2.44 E+0	2.35E +02	1.28E +00	8.54E -01	3.49E -01	1.35E +00	NA	9.59E-01	1.35E+00
BDF15	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00
BDF15	Well Water - Sh	Tritium	BF6	2.40E +01	2.09E +01	2.12E +01	1.39 E+0	2.93E +00	2.18E +01	1.87E +01	1.93E +01	1.18E +01	1.02E +00	1.45E+01	2.18E+01
BDF15	Milk	Tritium	Average of all samples from DF15	0.00E +00	6.17E +00	6.29E +00	4.22 E+0	4.92E +00	NA	3.96E +00	4.76E +00	1.69E +00	2.90E +00	3.33E+00	4.76E+00
BDF15	Milk	C-14	Average of all samples from DF15	0.00E +00	2.24E +02	2.26E +02	2.28 E+0	2.40E +02	NA	NA	NA	4.00E -01	7.58E -01	5.79E-01	7.58E-01
BHF1	Air	Tritium	Used HTO at B8	2.70E -01	4.76E -01	3.38E -01	1.94 E-01	2.14E -01	1.15E -01	4.44E -01	2.43E -01	1.60E -01	1.78E -01	2.28E-01	4.44E-01
BHF1	Air	Iodine	Used HTO at B8	1.07E -09	7.20E -09	3.42E -09	1.02 E-08	8.14E -09	1.07E -09	7.20E -09	3.42E -09	1.02E -08	8.14E -09	6.00E-09	1.02E-08
BHF1	Air	Particulate	Used HTO at B8	3.38E -10	9.05E -10	1.19E -09	1.62 E-09	3.02E -09	3.38E -10	9.05E -10	1.19E -09	1.62E -09	3.02E -09	1.42E-09	3.02E-09
BHF1	Air	Noble Gas	Used HTO at B8	2.54E -02	4.65E -02	4.30E -02	2.52 E-02	3.39E -02	2.54E -02	4.65E -02	4.30E -02	2.52E -02	3.39E -02	3.48E-02	4.65E-02
BHF1	Air	C-14	Used HTO at B8	2.30E +02	2.41E +02	2.37E +02	2.14 E+0	2.15E +02	6.61E -04	1.02E -03	7.70E -04	5.85E -04	8.43E -04	7.75E-04	1.02E-03
BHF1	Water WSP	Tritium	Average of Southampton WSP	9.90E +00	9.97E +00	9.87E +00	1.16 E+0	1.04E +01	8.21E +00	8.31E +00	8.24E +00	1.00E +01	8.79E +00	8.72E+00	1.00E+01
BEC	Air	Tritium	Used HTO at B10	1.41E +00	1.67E +00	1.56E +00	1.02 E+0	9.33E -01	1.26E +00	1.64E +00	1.46E +00	9.85E -01	8.97E -01	1.25E+00	1.64E+00
BEC	Air	Iodine	Used HTO at B10	5.58E -09	2.53E -08	1.57E -08	5.35 E-08	3.55E -08	5.58E -09	2.53E -08	1.57E -08	5.35E -08	3.55E -08	2.71E-08	5.35E-08
BEC	Air	Particulate	Used HTO at B10	1.77E -09	3.18E -09	5.48E -09	8.54 E-09	1.32E -08	1.77E -09	3.18E -09	5.48E -09	8.54E -09	1.32E -08	6.43E-09	1.32E-08
BEC	Air	Noble Gas	Used HTO at B10	1.33E -01	1.64E -01	1.98E -01	1.33 E-01	1.48E -01	1.33E -01	1.64E -01	1.98E -01	1.33E -01	1.48E -01	1.55E-01	1.98E-01
BEC	Air	C-14	Used HTO at B10	2.43E +02	2.53E +02	2.50E +02	2.26 E+0	2.28E +02	3.45E -03	3.57E -03	3.54E -03	3.08E -03	3.68E -03	3.46E-03	3.68E-03

Table 225 Average and maximum exposure concentrations for each receptor location

Receptor Group	Medium	Radionuclide	Measurement Location	Measured values					Background subtracted and unit conversion for IMPACT					Average	Max
				2016	2017	2018	2019	2020	2016	2017	2018	2019	2020		
BEC	Well Water - De	Tritium	Lc value	5.70E +00	5.75E +00	2.80E +00	3.02 E+0	2.98E +00	4.01E +00	4.09E +00	1.17E +00	1.42E +00	1.39E +00	2.42E+00	4.09E+00

Note: NA (Not Available) is indicated where measurements were not available or were below background and excluded from the determination of the average.
When vegetable values were not available, fruit values were used instead.

13.0 APPENDIX M: RADIATION DOSE TO HUMANS

For information to be considered in the development of the Environmental Monitoring Program, a more detailed examination of the contribution from each exposure pathway to the total effective dose is provided in the following paragraphs.

Figure 141 shows the top radionuclide contributors by pathway for the receptor with the highest radiation dose based on average radionuclide concentrations: a subsistence farmer adult at BSF3. The contributions from all other pathways are summed and are shown on the chart as “Other”.

The largest dose contributors for this receptor are ingestion of carbon-14 in terrestrial plants (41%), ingestion carbon-14 in terrestrial animal products (23%), ingestion of HTO in terrestrial plants (12%), and inhalation of HTO in air (7%).

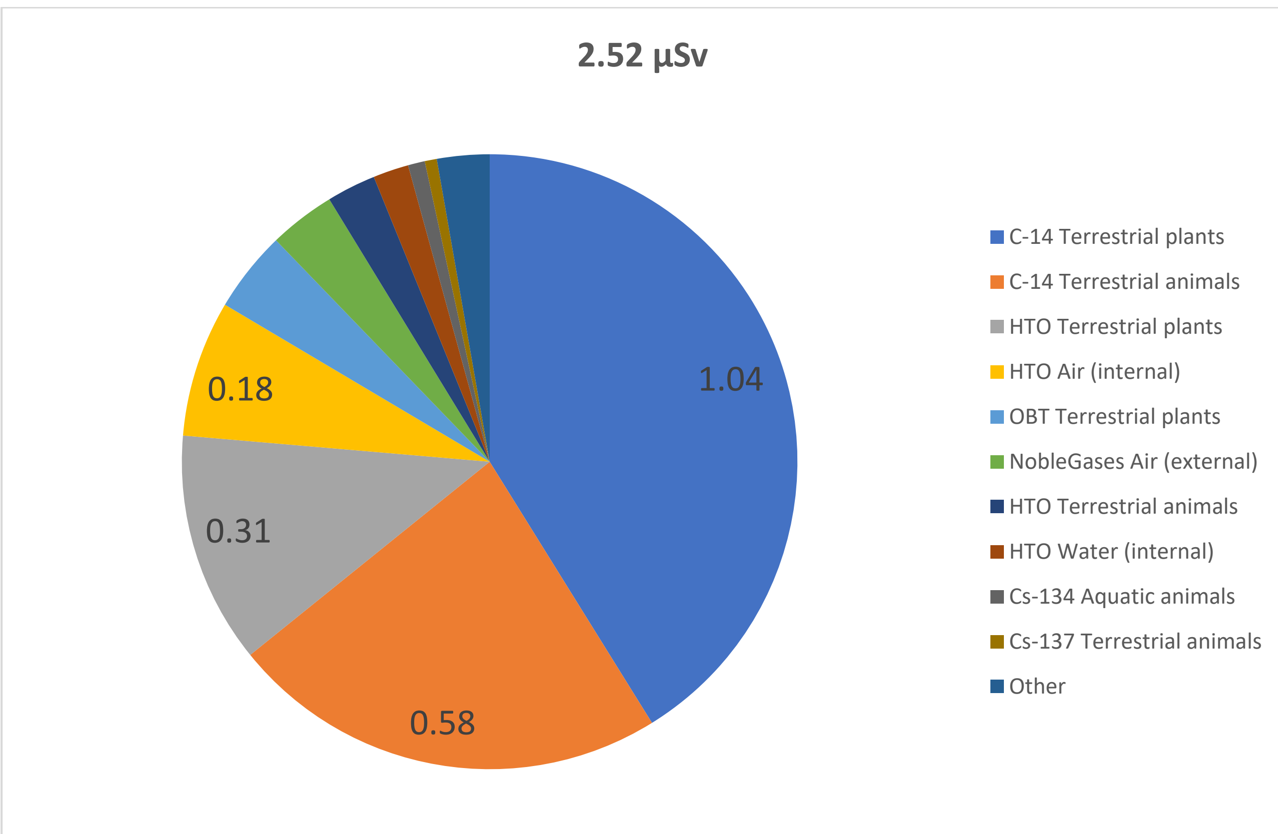

Figure 141 Dose from Individual Exposure Pathways – BSF3 Adult

Since the intake fractions of local foodstuffs (i.e., terrestrial animals and plants) for the subsistence farmer are higher than all other receptors, the corresponding relative contributions to the total effective dose are also higher.

Figure 142 shows the top radionuclide contributors by pathway for the farm receptor with the highest radiation dose based on average radionuclide concentrations: an adult at BF14. The largest dose contributors are inhalation of HTO in air (25%), ingestion of carbon-14 in terrestrial plants (21%), ingestion of carbon-14 in terrestrial animal products (15%), and ingestion of HTO in terrestrial plants (14%).

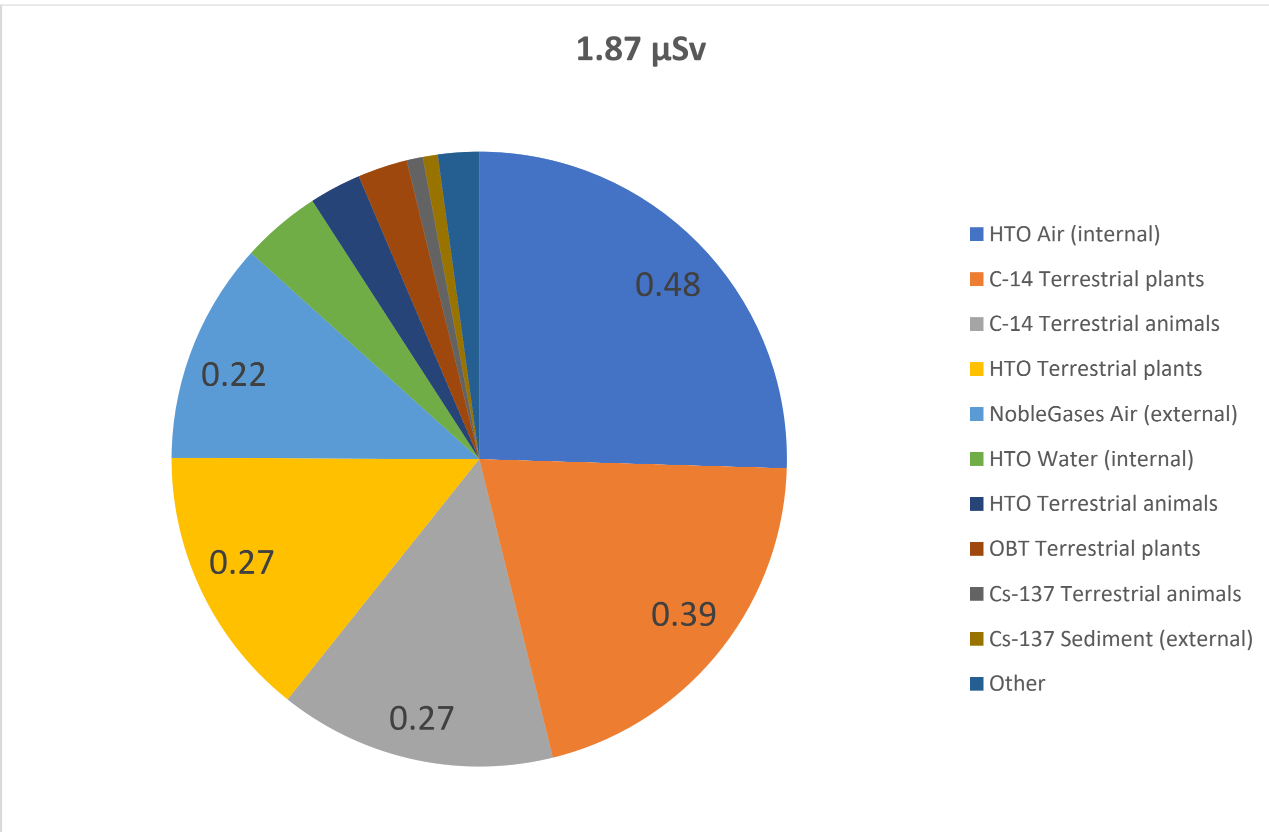

Figure 142 Dose from Individual Exposure Pathways – BF14 Adult

Figure 143 shows the top radionuclide contributors by pathway for the residential receptor with the highest radiation dose based on average radionuclide concentrations: an adult at BR48. The largest dose contributors are inhalation of HTO in air (38%), external exposure to noble gasses (17%), ingestion of carbon-14 in terrestrial animal products (14%), and ingestion of carbon-14 in terrestrial plants (12%).

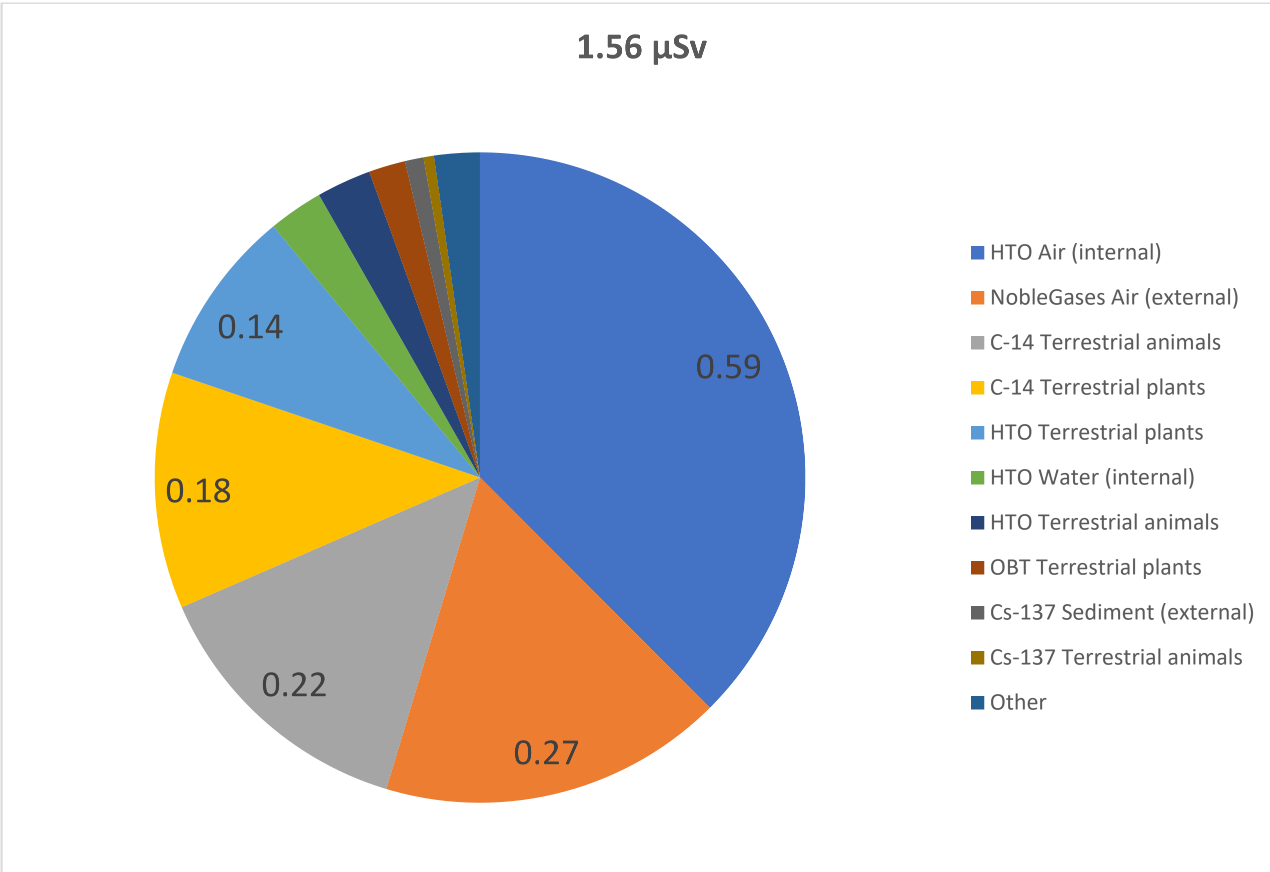

Figure 143 Dose from Individual Exposure Pathways – BR48 Adult

Figure 144 shows the top radionuclide contributors by pathway for the dairy farm receptors with the highest radiation dose based on average radionuclide concentrations: an adult at BDF12. The largest dose contributors are ingestion of carbon-14 from terrestrial plants (29%), ingestion of carbon-14 from terrestrial animal products (21%), inhalation of HTO in air (18%), and ingestion of HTO from terrestrial plants (10%).

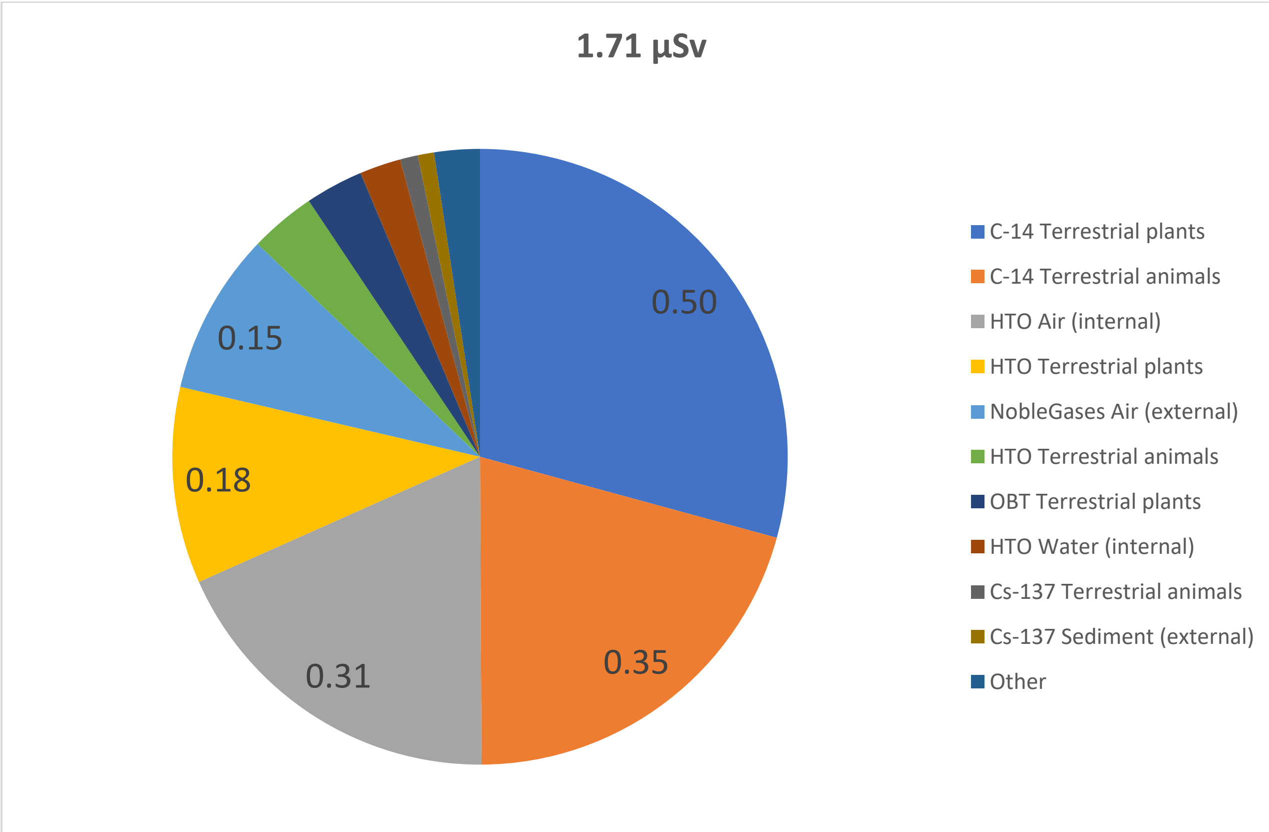

Figure 144 Dose from Individual Exposure Pathways – BDF12 Adult

Figure 145 shows the top radionuclide contributors by pathway for the hunter/fisher receptor with the highest radiation dose based on average radionuclide concentrations: an adult at BHF1. The largest dose contributors are external exposure to cobalt-60 in soil (39%), ingestion of carbon-14 from terrestrial plants (17%), ingestion of HTO from drinking water (11%), and ingestion of carbon-14 from terrestrial animal products (8%).

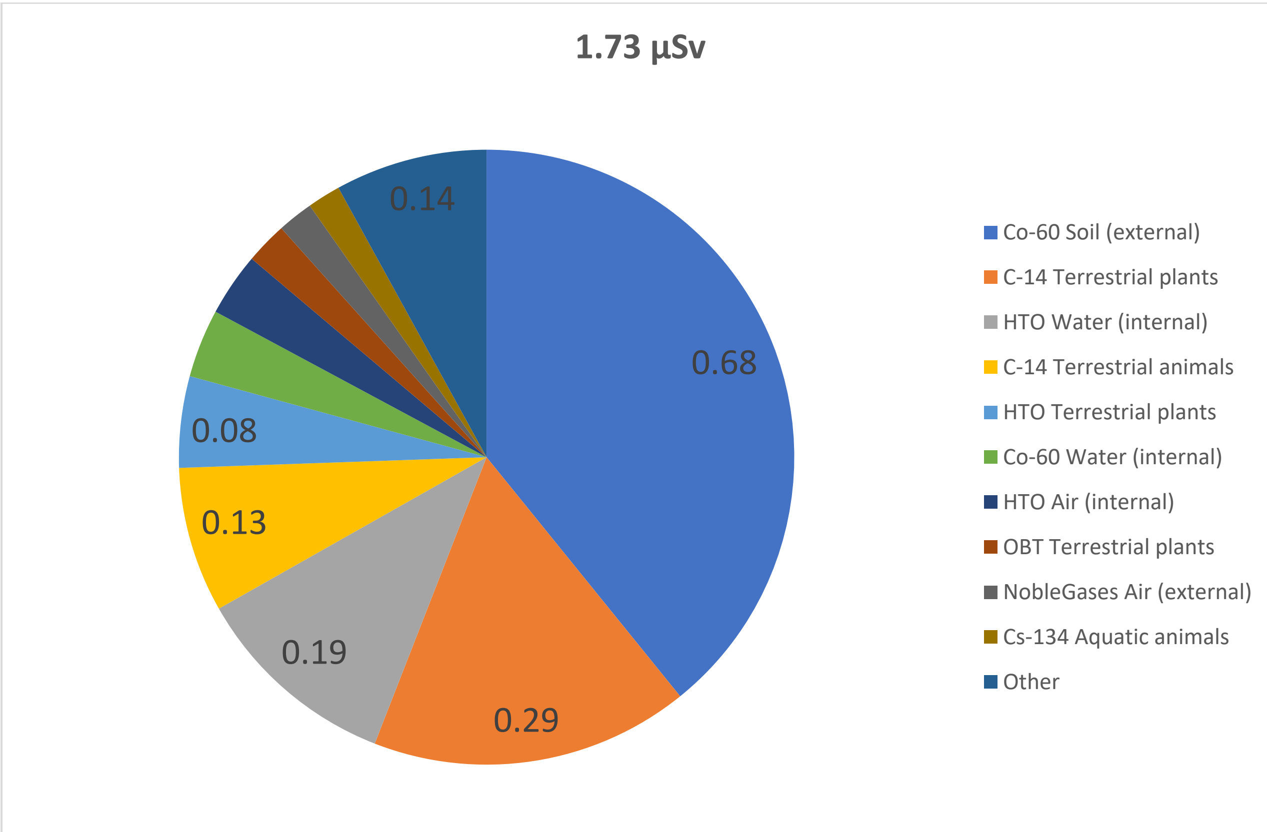

Figure 145 Dose from Individual Exposure Pathways – BHF1 Adult

Table 226 to Table 229 contains the specific contributions of each radionuclide and exposure pathway to the total dose to each human receptor, both for average and upper-range releases from the Site and exposure point concentrations.

Table 226 Average case - dose by radionuclide (Sv/y)

Receptor Group	Age	C-14	Np-237	Co-60	Cs-134	Cs-137	HTO	I(mfp)	NobleGases	OBT	Pu-239	Total
BDF1	Adult	7.58E-07	2.39E-11	7.22E-09	1.39E-08	3.31E-08	5.46E-07	7.95E-12	1.45E-07	5.52E-08	2.92E-10	1.56E-06
	Child	7.49E-07	1.41E-11	8.26E-09	5.25E-09	1.92E-08	5.53E-07	1.64E-11	1.45E-07	5.48E-08	1.61E-09	1.54E-06
	Infant	7.98E-07	6.15E-12	6.80E-09	3.02E-09	2.07E-08	4.73E-07	2.12E-11	1.88E-07	5.03E-08	2.65E-09	1.54E-06
BDF12	Adult	8.55E-07	2.20E-11	7.23E-09	1.39E-08	3.31E-08	5.92E-07	7.95E-12	1.45E-07	6.14E-08	2.92E-10	1.71E-06
	Child	8.43E-07	1.28E-11	8.27E-09	5.25E-09	1.92E-08	5.92E-07	1.64E-11	1.45E-07	6.02E-08	1.61E-09	1.67E-06
	Infant	9.06E-07	5.54E-12	6.81E-09	3.02E-09	2.07E-08	5.18E-07	2.12E-11	1.88E-07	5.58E-08	2.65E-09	1.70E-06
BDF13	Adult	8.65E-07	1.38E-11	6.17E-09	1.39E-08	3.31E-08	4.17E-07	4.84E-12	8.80E-08	5.59E-08	2.92E-10	1.48E-06
	Child	8.51E-07	9.38E-12	7.19E-09	5.25E-09	1.92E-08	4.06E-07	1.00E-11	8.80E-08	5.60E-08	1.61E-09	1.43E-06
	Infant	9.27E-07	4.91E-12	5.41E-09	3.02E-09	2.07E-08	3.70E-07	1.29E-11	1.14E-07	5.18E-08	2.65E-09	1.49E-06
BDF14	Adult	7.78E-07	1.19E-11	6.05E-09	1.39E-08	3.31E-08	4.11E-07	4.83E-12	8.80E-08	5.44E-08	2.92E-10	1.39E-06
	Child	7.82E-07	8.15E-12	7.07E-09	5.25E-09	1.92E-08	4.05E-07	1.00E-11	8.80E-08	5.51E-08	1.61E-09	1.36E-06
	Infant	8.72E-07	4.33E-12	5.26E-09	3.02E-09	2.07E-08	3.70E-07	1.29E-11	1.14E-07	5.15E-08	2.65E-09	1.44E-06
BDF15	Adult	7.40E-07	1.27E-11	6.16E-09	1.39E-08	3.31E-08	4.05E-07	4.84E-12	8.80E-08	5.38E-08	2.92E-10	1.34E-06
	Child	6.92E-07	8.73E-12	7.18E-09	5.25E-09	1.92E-08	3.92E-07	1.00E-11	8.80E-08	5.38E-08	1.61E-09	1.26E-06
	Infant	6.79E-07	4.64E-12	5.40E-09	3.02E-09	2.07E-08	3.42E-07	1.29E-11	1.14E-07	4.85E-08	2.65E-09	1.21E-06
BDF9	Adult	7.65E-07	1.41E-11	6.37E-09	1.39E-08	3.31E-08	4.16E-07	4.85E-12	8.80E-08	5.48E-08	2.92E-10	1.38E-06
	Child	7.51E-07	9.28E-12	7.39E-09	5.25E-09	1.92E-08	4.14E-07	1.00E-11	8.80E-08	5.61E-08	1.61E-09	1.34E-06
	Infant	8.05E-07	4.73E-12	5.68E-09	3.02E-09	2.07E-08	3.92E-07	1.30E-11	1.14E-07	5.37E-08	2.65E-09	1.40E-06
BEC	Adult	8.03E-11	4.76E-12	4.41E-10	0.00E+00	0.00E+00	7.23E-08	1.83E-12	3.34E-08	0.00E+00	0.00E+00	1.06E-07
BF14	Adult	6.60E-07	6.21E-11	8.83E-09	1.32E-08	3.28E-08	8.78E-07	1.19E-11	2.17E-07	5.71E-08	2.95E-10	1.87E-06
	Child	5.34E-07	3.94E-11	1.05E-08	4.95E-09	1.90E-08	8.52E-07	2.46E-11	2.17E-07	5.16E-08	1.61E-09	1.69E-06
	Infant	4.53E-07	1.89E-11	6.99E-09	2.90E-09	2.06E-08	6.73E-07	3.18E-11	2.81E-07	4.58E-08	2.65E-09	1.49E-06
BF16	Adult	6.46E-07	3.76E-11	8.80E-09	1.32E-08	3.28E-08	6.37E-07	7.96E-12	1.45E-07	4.76E-08	2.95E-10	1.53E-06

Table 226 Average case - dose by radionuclide (Sv/y)

Receptor Group	Age	C-14	Np-237	Co-60	Cs-134	Cs-137	HTO	I(mfp)	NobleGases	OBT	Pu-239	Total
	Child	5.49E-07	2.21E-11	1.05E-08	4.95E-09	1.90E-08	6.00E-07	1.64E-11	1.45E-07	4.35E-08	1.61E-09	1.37E-06
	Infant	4.90E-07	9.62E-12	6.96E-09	2.90E-09	2.06E-08	4.66E-07	2.12E-11	1.88E-07	3.79E-08	2.65E-09	1.21E-06
BF8	Adult	5.55E-07	3.97E-11	8.01E-09	1.32E-08	3.28E-08	4.62E-07	4.86E-12	8.80E-08	4.11E-08	2.95E-10	1.20E-06
	Child	4.66E-07	2.42E-11	9.67E-09	4.95E-09	1.90E-08	4.27E-07	1.00E-11	8.80E-08	3.97E-08	1.61E-09	1.06E-06
	Infant	4.19E-07	1.11E-11	5.91E-09	2.90E-09	2.06E-08	3.50E-07	1.30E-11	1.14E-07	3.69E-08	2.65E-09	9.52E-07
BSF2	Adult	1.43E-06	3.60E-11	9.31E-09	3.07E-08	4.09E-08	5.32E-07	4.84E-12	8.80E-08	1.09E-07	7.13E-10	2.24E-06
	Child	1.36E-06	2.19E-11	1.38E-08	1.34E-08	2.31E-08	5.04E-07	1.00E-11	8.80E-08	1.12E-07	1.91E-09	2.11E-06
	Infant	1.29E-06	1.02E-11	1.10E-08	6.24E-09	2.23E-08	4.78E-07	1.30E-11	1.14E-07	1.00E-07	2.81E-09	2.03E-06
BSF3	Adult	1.63E-06	4.11E-11	9.57E-09	3.07E-08	4.09E-08	6.07E-07	4.86E-12	8.80E-08	1.19E-07	7.13E-10	2.52E-06
	Child	1.53E-06	2.46E-11	1.40E-08	1.34E-08	2.31E-08	5.50E-07	1.00E-11	8.80E-08	1.20E-07	1.91E-09	2.34E-06
	Infant	1.44E-06	1.12E-11	1.14E-08	6.24E-09	2.23E-08	5.07E-07	1.30E-11	1.14E-07	1.05E-07	2.81E-09	2.21E-06
BR1	Adult	3.85E-07	1.09E-10	6.76E-09	9.90E-09	2.50E-08	7.93E-07	1.09E-11	1.97E-07	3.51E-08	2.82E-10	1.45E-06
	Child	3.44E-07	6.77E-11	7.81E-09	4.33E-09	1.74E-08	7.60E-07	2.26E-11	1.97E-07	3.33E-08	1.61E-09	1.37E-06
	Infant	3.43E-07	3.06E-11	6.35E-09	2.75E-09	2.02E-08	5.52E-07	2.92E-11	2.56E-07	3.13E-08	2.65E-09	1.21E-06
BR17	Adult	3.85E-07	5.06E-11	7.07E-09	9.90E-09	2.50E-08	4.97E-07	7.96E-12	1.45E-07	3.04E-08	2.82E-10	1.10E-06
	Child	3.61E-07	3.08E-11	8.12E-09	4.33E-09	1.74E-08	5.05E-07	1.64E-11	1.45E-07	2.92E-08	1.61E-09	1.07E-06
	Infant	3.64E-07	1.36E-11	6.76E-09	2.75E-09	2.02E-08	4.01E-07	2.12E-11	1.88E-07	2.67E-08	2.65E-09	1.01E-06
BR25	Adult	4.45E-07	5.38E-11	7.35E-09	9.90E-09	2.50E-08	6.71E-07	1.21E-11	2.15E-07	3.26E-08	2.82E-10	1.41E-06
	Child	3.82E-07	3.39E-11	8.40E-09	4.33E-09	1.74E-08	7.01E-07	2.50E-11	2.15E-07	3.10E-08	1.61E-09	1.36E-06
	Infant	3.70E-07	1.57E-11	7.12E-09	2.75E-09	2.02E-08	5.53E-07	3.23E-11	2.79E-07	2.88E-08	2.65E-09	1.26E-06
BR27	Adult	4.66E-07	3.79E-11	6.92E-09	9.90E-09	2.50E-08	7.02E-07	1.23E-11	2.23E-07	3.32E-08	3.27E-10	1.47E-06
	Child	4.00E-07	2.79E-11	8.04E-09	4.33E-09	1.74E-08	7.29E-07	2.55E-11	2.23E-07	3.13E-08	1.63E-09	1.41E-06
	Infant	3.86E-07	1.68E-11	6.38E-09	2.75E-09	2.02E-08	5.69E-07	3.30E-11	2.88E-07	2.89E-08	2.65E-09	1.30E-06
BR32	Adult	4.60E-07	2.28E-11	1.08E-08	9.90E-09	2.50E-08	7.09E-07	1.19E-11	2.17E-07	3.27E-08	3.91E-10	1.46E-06

Table 226 Average case - dose by radionuclide (Sv/y)

Receptor Group	Age	C-14	Np-237	Co-60	Cs-134	Cs-137	HTO	I(mfp)	NobleGases	OBT	Pu-239	Total
	Child	3.95E-07	2.04E-11	1.19E-08	4.33E-09	1.74E-08	7.26E-07	2.46E-11	2.17E-07	3.10E-08	1.66E-09	1.40E-06
	Infant	3.83E-07	1.48E-11	1.12E-08	2.75E-09	2.02E-08	5.57E-07	3.18E-11	2.81E-07	2.86E-08	2.65E-09	1.29E-06
BR48	Adult	4.02E-07	1.14E-10	8.82E-09	9.90E-09	2.50E-08	8.14E-07	1.58E-11	2.68E-07	3.47E-08	2.82E-10	1.56E-06
	Child	3.56E-07	6.81E-11	9.88E-09	4.33E-09	1.74E-08	8.65E-07	3.27E-11	2.68E-07	3.36E-08	1.61E-09	1.56E-06
	Infant	3.56E-07	2.91E-11	9.04E-09	2.75E-09	2.02E-08	6.95E-07	4.22E-11	3.47E-07	3.28E-08	2.65E-09	1.46E-06
BHF1	Adult	4.33E-07	5.73E-12	7.72E-07	4.12E-08	5.05E-08	3.59E-07	1.82E-12	3.26E-08	4.29E-08	2.85E-10	1.73E-06
	Child	4.26E-07	3.26E-12	8.03E-07	1.77E-08	2.62E-08	2.71E-07	3.62E-12	3.26E-08	4.30E-08	3.03E-10	1.62E-06
	Infant	3.51E-07	2.39E-12	9.11E-07	7.93E-09	2.35E-08	1.70E-07	4.68E-12	4.22E-08	3.59E-08	3.62E-10	1.54E-06

Table 227 Upper-range case – dose by radionuclide (Sv/y)

Receptor Group	Age	C-14	Np-237	Co-60	Cs-134	Cs-137	HTO	I(mfp)	NobleGases	OBT	Pu-239	Total
BDF1	Adult	9.79E-07	5.00E-11	1.45E-08	1.96E-08	4.80E-08	7.47E-07	1.57E-11	1.85E-07	9.08E-08	3.68E-10	2.08E-06
	Child	9.93E-07	2.94E-11	1.61E-08	7.62E-09	2.68E-08	7.55E-07	3.24E-11	1.85E-07	9.18E-08	2.03E-09	2.08E-06
	Infant	1.10E-06	1.29E-11	1.13E-08	4.32E-09	2.81E-08	6.58E-07	4.18E-11	2.40E-07	8.41E-08	3.34E-09	2.13E-06
BDF12	Adult	1.02E-06	4.60E-11	1.45E-08	1.96E-08	4.80E-08	8.43E-07	1.57E-11	1.85E-07	1.04E-07	3.68E-10	2.23E-06
	Child	1.01E-06	2.68E-11	1.61E-08	7.62E-09	2.68E-08	8.22E-07	3.24E-11	1.85E-07	1.02E-07	2.03E-09	2.17E-06
	Infant	1.08E-06	1.16E-11	1.14E-08	4.32E-09	2.81E-08	7.15E-07	4.18E-11	2.40E-07	9.19E-08	3.34E-09	2.18E-06
BDF13	Adult	1.06E-06	2.89E-11	1.24E-08	1.96E-08	4.8E-08	5.76E-07	9.35E-12	1.11E-07	9.43E-08	3.68E-10	1.92E-06
	Child	1.00E-06	1.96E-11	1.40E-08	7.62E-09	2.68E-08	5.49E-07	1.94E-11	1.11E-07	9.53E-08	2.03E-09	1.81E-06
	Infant	1.04E-06	1.03E-11	8.64E-09	4.32E-09	2.81E-08	5.11E-07	2.50E-11	1.44E-07	8.70E-08	3.34E-09	1.83E-06
BDF14	Adult	1.01E-06	2.48E-11	1.22E-08	1.96E-08	4.80E-08	5.75E-07	9.34E-12	1.11E-07	9.28E-08	3.68E-10	1.87E-06
	Child	9.73E-07	1.71E-11	1.38E-08	7.62E-09	2.68E-08	5.52E-07	1.94E-11	1.11E-07	9.45E-08	2.03E-09	1.78E-06
	Infant	1.04E-06	9.07E-12	8.31E-09	4.32E-09	2.81E-08	5.09E-07	2.50E-11	1.44E-07	8.64E-08	3.34E-09	1.82E-06
BDF15	Adult	9.81E-07	2.65E-11	1.24E-08	1.96E-08	4.80E-08	5.67E-07	9.35E-12	1.11E-07	9.21E-08	3.68E-10	1.83E-06
	Child	9.13E-07	1.83E-11	1.40E-08	7.62E-09	2.68E-08	5.36E-07	1.94E-11	1.11E-07	9.28E-08	2.03E-09	1.70E-06
	Infant	9.08E-07	9.73E-12	8.63E-09	4.32E-09	2.81E-08	4.73E-07	2.50E-11	1.44E-07	8.27E-08	3.34E-09	1.65E-06
BDF9	Adult	9.95E-07	2.95E-11	1.29E-08	1.96E-08	4.80E-08	5.85E-07	9.38E-12	1.11E-07	9.38E-08	3.68E-10	1.87E-06
	Child	9.45E-07	1.94E-11	1.45E-08	7.62E-09	2.68E-08	5.74E-07	1.94E-11	1.11E-07	9.68E-08	2.03E-09	1.78E-06
	Infant	9.77E-07	9.89E-12	9.24E-09	4.32E-09	2.81E-08	5.60E-07	2.51E-11	1.44E-07	9.16E-08	3.34E-09	1.82E-06
BEC	Adult	8.54E-11	9.90E-12	9.03E-10	0.00E+00	0.00E+00	9.51E-08	3.61E-12	4.26E-08	0.00E+00	0.00E+00	1.39E-07
BF14	Adult	1.00E-06	1.30E-10	1.92E-08	1.86E-08	4.74E-08	1.11E-06	2.47E-11	2.92E-07	8.09E-08	3.72E-10	2.58E-06
	Child	7.87E-07	8.20E-11	2.29E-08	7.15E-09	2.65E-08	1.08E-06	5.11E-11	2.92E-07	7.48E-08	2.03E-09	2.29E-06
	Infant	6.67E-07	3.94E-11	1.20E-08	4.13E-09	2.80E-08	8.46E-07	6.60E-11	3.78E-07	6.62E-08	3.33E-09	2.00E-06

Table 227 Upper-range case – dose by radionuclide (Sv/y)

Receptor Group	Age	C-14	Np-237	Co-60	Cs-134	Cs-137	HTO	I(mfp)	NobleGases	OBT	Pu-239	Total
BF16	Adult	7.61E-07	7.83E-11	1.92E-08	1.86E-08	4.74E-08	9.01E-07	1.57E-11	1.85E-07	7.83E-08	3.72E-10	2.01E-06
	Child	6.50E-07	4.61E-11	2.29E-08	7.15E-09	2.65E-08	8.31E-07	3.24E-11	1.85E-07	7.17E-08	2.03E-09	1.80E-06
	Infant	5.80E-07	2.00E-11	1.20E-08	4.13E-09	2.80E-08	6.39E-07	4.19E-11	2.40E-07	6.12E-08	3.33E-09	1.57E-06
BF8	Adult	7.27E-07	8.29E-11	1.78E-08	1.86E-08	4.74E-08	5.99E-07	9.40E-12	1.11E-07	6.37E-08	3.72E-10	1.59E-06
	Child	6.00E-07	5.06E-11	2.14E-08	7.15E-09	2.65E-08	5.37E-07	1.94E-11	1.11E-07	6.13E-08	2.03E-09	1.37E-06
	Infant	5.37E-07	2.32E-11	1.01E-08	4.13E-09	2.80E-08	4.22E-07	2.51E-11	1.44E-07	5.43E-08	3.33E-09	1.20E-06
BSF2	Adult	1.86E-06	7.54E-11	1.74E-08	4.57E-08	6.21E-08	7.31E-07	9.36E-12	1.11E-07	1.86E-07	8.98E-10	3.01E-06
	Child	1.74E-06	4.59E-11	2.42E-08	2.03E-08	3.39E-08	6.72E-07	1.94E-11	1.11E-07	1.91E-07	2.41E-09	2.80E-06
	Infant	1.65E-06	2.12E-11	1.74E-08	9.33E-09	3.11E-08	6.27E-07	2.50E-11	1.44E-07	1.67E-07	3.54E-09	2.65E-06
BSF3	Adult	1.99E-06	8.59E-11	1.79E-08	4.57E-08	6.21E-08	8.48E-07	9.40E-12	1.11E-07	2.02E-07	8.98E-10	3.28E-06
	Child	1.85E-06	5.14E-11	2.49E-08	2.03E-08	3.39E-08	7.44E-07	1.94E-11	1.11E-07	2.03E-07	2.41E-09	2.99E-06
	Infant	1.74E-06	2.34E-11	1.82E-08	9.33E-09	3.11E-08	6.70E-07	2.51E-11	1.44E-07	1.74E-07	3.54E-09	2.79E-06
BR1	Adult	5.31E-07	2.26E-10	1.36E-08	1.43E-08	3.59E-08	1.65E-06	2.27E-11	2.36E-07	6.21E-08	3.56E-10	2.54E-06
	Child	4.60E-07	1.41E-10	1.53E-08	6.36E-09	2.42E-08	1.38E-06	4.70E-11	2.36E-07	5.75E-08	2.02E-09	2.18E-06
	Infant	4.47E-07	6.36E-11	1.02E-08	3.94E-09	2.74E-08	8.11E-07	6.07E-11	3.05E-07	5.20E-08	3.33E-09	1.66E-06
BR17	Adult	4.76E-07	1.05E-10	1.46E-08	1.43E-08	3.59E-08	6.72E-07	1.57E-11	1.85E-07	4.80E-08	3.56E-10	1.45E-06
	Child	4.46E-07	6.41E-11	1.63E-08	6.36E-09	2.42E-08	6.73E-07	3.24E-11	1.85E-07	4.64E-08	2.02E-09	1.40E-06
	Infant	4.44E-07	2.83E-11	1.15E-08	3.94E-09	2.74E-08	5.23E-07	4.19E-11	2.40E-07	4.11E-08	3.33E-09	1.29E-06
BR25	Adult	6.29E-07	1.12E-10	1.54E-08	1.43E-08	3.59E-08	8.30E-07	2.50E-11	2.73E-07	4.94E-08	3.56E-10	1.85E-06
	Child	5.24E-07	7.07E-11	1.72E-08	6.36E-09	2.42E-08	8.54E-07	5.18E-11	2.73E-07	4.79E-08	2.02E-09	1.75E-06
	Infant	4.93E-07	3.27E-11	1.26E-08	3.94E-09	2.74E-08	6.70E-07	6.69E-11	3.54E-07	4.35E-08	3.33E-09	1.61E-06
BR27	Adult	6.32E-07	7.90E-11	1.43E-08	1.43E-08	3.59E-08	8.73E-07	2.50E-11	2.92E-07	4.96E-08	4.12E-10	1.91E-06
	Child	5.28E-07	5.82E-11	1.61E-08	6.36E-09	2.42E-08	9.02E-07	5.17E-11	2.92E-07	4.80E-08	2.05E-09	1.82E-06
	Infant	4.97E-07	3.50E-11	1.09E-08	3.94E-09	2.74E-08	7.05E-07	6.68E-11	3.78E-07	4.36E-08	3.33E-09	1.67E-06

Table 227 Upper-range case – dose by radionuclide (Sv/y)

Receptor Group	Age	C-14	Np-237	Co-60	Cs-134	Cs-137	HTO	I(mfp)	NobleGases	OBT	Pu-239	Total
BR32	Adult	6.32E-07	4.75E-11	1.95E-08	1.43E-08	3.59E-08	8.92E-07	2.46E-11	2.92E-07	4.95E-08	4.93E-10	1.94E-06
	Child	5.28E-07	4.25E-11	2.13E-08	6.36E-09	2.42E-08	9.12E-07	5.10E-11	2.92E-07	4.80E-08	2.09E-09	1.83E-06
	Infant	4.97E-07	3.09E-11	1.77E-08	3.94E-09	2.74E-08	7.05E-07	6.59E-11	3.78E-07	4.36E-08	3.33E-09	1.68E-06
BR48	Adult	5.17E-07	2.37E-10	1.86E-08	1.43E-08	3.59E-08	1.17E-06	3.29E-11	3.15E-07	5.94E-08	3.56E-10	2.13E-06
	Child	4.55E-07	1.42E-10	2.03E-08	6.36E-09	2.42E-08	1.22E-06	6.78E-11	3.15E-07	5.76E-08	2.02E-09	2.11E-06
	Infant	4.49E-07	6.06E-11	1.67E-08	3.94E-09	2.74E-08	9.87E-07	8.76E-11	4.08E-07	5.50E-08	3.33E-09	1.95E-06
BHF1	Adult	5.37E-07	1.20E-11	2.26E-06	6.14E-08	7.76E-08	5.14E-07	3.08E-12	4.40E-08	7.64E-08	3.59E-10	3.57E-06
	Child	5.28E-07	6.84E-12	2.34E-06	2.69E-08	3.91E-08	4.13E-07	6.14E-12	4.40E-08	7.69E-08	3.82E-10	3.47E-06
	Infant	4.38E-07	5.01E-12	2.66E-06	1.19E-08	3.31E-08	2.96E-07	7.93E-12	5.70E-08	6.39E-08	4.55E-10	3.56E-06

Table 228 Average case –dose by pathway (Sv/y)

Receptor Group	Age	Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Animal Ingestion	Terrestrial plants	Terrestrial animals	Total
BDF1	Adult	3.15E-07	1.45E-07	3.71E-08	6.84E-09	4.88E-15	1.73E-09	1.72E-10	1.72E-08	1.17E-08	5.94E-07	4.30E-07	1.56E-06
	Child	3.68E-07	1.45E-07	2.07E-08	6.02E-09	1.17E-13	1.73E-09	1.66E-09	1.72E-08	8.37E-09	5.80E-07	3.87E-07	1.54E-06
	Infant	2.74E-07	1.88E-07	0.00E+00	1.36E-10	3.09E-13	2.25E-09	2.81E-09	2.24E-08	4.95E-09	4.93E-07	5.55E-07	1.54E-06
BDF12	Adult	3.15E-07	1.45E-07	3.71E-08	6.84E-09	4.81E-15	1.74E-09	1.72E-10	1.72E-08	1.17E-08	7.28E-07	4.46E-07	1.71E-06
	Child	3.68E-07	1.45E-07	2.07E-08	6.02E-09	1.17E-13	1.74E-09	1.66E-09	1.72E-08	8.37E-09	6.82E-07	4.23E-07	1.67E-06
	Infant	2.74E-07	1.88E-07	0.00E+00	1.36E-10	3.09E-13	2.27E-09	2.81E-09	2.24E-08	4.95E-09	5.72E-07	6.34E-07	1.70E-06
BDF13	Adult	1.81E-07	8.80E-08	3.70E-08	6.84E-09	1.94E-15	6.88E-10	1.72E-10	1.72E-08	1.17E-08	6.83E-07	4.53E-07	1.48E-06
	Child	2.12E-07	8.80E-08	2.06E-08	6.02E-09	4.65E-14	6.88E-10	1.66E-09	1.72E-08	8.37E-09	6.51E-07	4.29E-07	1.43E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	1.23E-13	8.95E-10	2.81E-09	2.24E-08	4.95E-09	5.51E-07	6.41E-07	1.50E-06
BDF14	Adult	1.81E-07	8.80E-08	3.70E-08	6.84E-09	1.61E-15	5.70E-10	1.72E-10	1.72E-08	1.17E-08	5.94E-07	4.48E-07	1.38E-06
	Child	2.12E-07	8.80E-08	2.06E-08	6.02E-09	3.86E-14	5.70E-10	1.66E-09	1.72E-08	8.37E-09	5.89E-07	4.20E-07	1.36E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	1.02E-13	7.41E-10	2.81E-09	2.24E-08	4.95E-09	5.15E-07	6.22E-07	1.44E-06
BDF15	Adult	1.81E-07	8.80E-08	3.70E-08	6.84E-09	1.85E-15	6.79E-10	1.72E-10	1.72E-08	1.17E-08	5.94E-07	4.03E-07	1.34E-06
	Child	2.12E-07	8.80E-08	2.06E-08	6.02E-09	4.53E-14	6.79E-10	1.66E-09	1.72E-08	8.37E-09	5.89E-07	3.15E-07	1.26E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	1.21E-13	8.83E-10	2.81E-09	2.24E-08	4.95E-09	5.15E-07	3.97E-07	1.22E-06
BDF9	Adult	1.81E-07	8.80E-08	3.70E-08	6.84E-09	2.40E-15	8.84E-10	1.72E-10	1.72E-08	1.17E-08	5.94E-07	4.40E-07	1.38E-06
	Child	2.12E-07	8.80E-08	2.06E-08	6.02E-09	5.88E-14	8.84E-10	1.66E-09	1.72E-08	8.37E-09	5.89E-07	3.99E-07	1.34E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	1.56E-13	1.15E-09	2.81E-09	2.24E-08	4.95E-09	5.15E-07	5.78E-07	1.40E-06
BEC	Adult	7.24E-08	3.34E-08	0.00E+00	0.00E+00	1.47E-15	4.41E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-07
BF14	Adult	4.76E-07	2.17E-07	7.96E-08	6.84E-09	6.58E-15	1.87E-09	1.72E-10	1.72E-08	1.04E-08	7.03E-07	3.55E-07	1.87E-06
	Child	5.56E-07	2.17E-07	4.57E-08	6.02E-09	1.38E-13	1.87E-09	1.66E-09	1.72E-08	7.44E-09	6.26E-07	2.12E-07	1.69E-06
	Infant	4.14E-07	2.81E-07	0.00E+00	1.36E-10	3.60E-13	2.43E-09	2.81E-09	2.24E-08	4.41E-09	5.52E-07	2.06E-07	1.49E-06

Table 228 Average case –dose by pathway (Sv/y)

Receptor Group	Age	Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Animal Ingestion	Terrestrial plants	Terrestrial animals	Total
BF16	Adult	3.15E-07	1.45E-07	7.95E-08	6.84E-09	5.69E-15	1.84E-09	1.72E-10	1.72E-08	1.04E-08	6.35E-07	3.20E-07	1.53E-06
	Child	3.68E-07	1.45E-07	4.57E-08	6.02E-09	1.29E-13	1.84E-09	1.66E-09	1.72E-08	7.44E-09	5.82E-07	1.99E-07	1.37E-06
	Infant	2.74E-07	1.88E-07	0.00E+00	1.36E-10	3.38E-13	2.39E-09	2.81E-09	2.24E-08	4.41E-09	5.23E-07	1.97E-07	1.21E-06
BF8	Adult	1.81E-07	8.80E-08	7.95E-08	6.84E-09	4.05E-15	1.04E-09	1.72E-10	1.72E-08	1.04E-08	4.90E-07	3.25E-07	1.20E-06
	Child	2.12E-07	8.80E-08	4.57E-08	6.02E-09	8.06E-14	1.04E-09	1.66E-09	1.72E-08	7.44E-09	4.77E-07	2.01E-07	1.06E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	2.08E-13	1.36E-09	2.81E-09	2.24E-08	4.41E-09	4.50E-07	1.99E-07	9.52E-07
BSF2	Adult	1.81E-07	8.80E-08	4.75E-08	6.84E-09	3.04E-15	7.88E-10	1.72E-10	1.72E-08	4.66E-08	1.17E-06	6.82E-07	2.24E-06
	Child	2.12E-07	8.80E-08	2.65E-08	6.02E-09	6.07E-14	7.88E-10	1.66E-09	1.72E-08	3.34E-08	1.18E-06	5.46E-07	2.11E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	1.57E-13	1.02E-09	2.81E-09	2.24E-08	1.97E-08	1.01E-06	7.02E-07	2.03E-06
BSF3	Adult	1.81E-07	8.80E-08	4.75E-08	6.84E-09	3.82E-15	1.05E-09	1.72E-10	1.72E-08	4.66E-08	1.45E-06	6.82E-07	2.52E-06
	Child	2.12E-07	8.80E-08	2.65E-08	6.02E-09	7.86E-14	1.05E-09	1.66E-09	1.72E-08	3.34E-08	1.41E-06	5.46E-07	2.34E-06
	Infant	1.58E-07	1.14E-07	0.00E+00	1.36E-10	2.04E-13	1.36E-09	2.81E-09	2.24E-08	1.97E-08	1.19E-06	7.02E-07	2.21E-06
BR1	Adult	4.43E-07	1.97E-07	1.70E-07	7.95E-09	9.00E-15	1.68E-09	1.72E-10	1.72E-08	1.07E-08	3.43E-07	2.62E-07	1.45E-06
	Child	5.17E-07	1.97E-07	9.50E-08	6.95E-09	1.52E-13	1.68E-09	1.66E-09	1.72E-08	7.66E-09	3.32E-07	1.89E-07	1.37E-06
	Infant	3.85E-07	2.56E-07	0.00E+00	6.44E-10	3.83E-13	2.18E-09	2.81E-09	2.24E-08	4.54E-09	3.09E-07	2.31E-07	1.21E-06
BR17	Adult	3.15E-07	1.45E-07	4.25E-08	6.91E-09	6.71E-15	1.98E-09	1.72E-10	1.72E-08	1.07E-08	3.39E-07	2.21E-07	1.10E-06
	Child	3.68E-07	1.45E-07	2.38E-08	6.09E-09	1.44E-13	1.98E-09	1.66E-09	1.72E-08	7.66E-09	3.27E-07	1.73E-07	1.07E-06
	Infant	2.74E-07	1.88E-07	0.00E+00	2.07E-10	3.75E-13	2.57E-09	2.81E-09	2.24E-08	4.54E-09	2.96E-07	2.21E-07	1.01E-06
BR25	Adult	4.69E-07	2.15E-07	4.25E-08	6.91E-09	7.24E-15	2.26E-09	1.72E-10	1.72E-08	1.07E-08	3.62E-07	2.81E-07	1.41E-06
	Child	5.49E-07	2.15E-07	2.38E-08	6.09E-09	1.61E-13	2.26E-09	1.66E-09	1.72E-08	7.66E-09	3.43E-07	1.95E-07	1.36E-06
	Infant	4.08E-07	2.79E-07	0.00E+00	2.07E-10	4.21E-13	2.94E-09	2.81E-09	2.24E-08	4.54E-09	3.07E-07	2.35E-07	1.26E-06
BR27	Adult	4.88E-07	2.23E-07	5.12E-08	6.95E-09	5.92E-15	1.68E-09	1.72E-10	1.72E-08	1.07E-08	3.86E-07	2.82E-07	1.47E-06
	Child	5.70E-07	2.23E-07	2.88E-08	6.11E-09	1.24E-13	1.68E-09	1.66E-09	1.72E-08	7.66E-09	3.62E-07	1.96E-07	1.41E-06

Table 228 Average case –dose by pathway (Sv/y)

Receptor Group	Age	Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Animal Ingestion	Terrestrial plants	Terrestrial animals	Total
	Infant	4.25E-07	2.88E-07	0.00E+00	2.38E-10	3.24E-13	2.18E-09	2.81E-09	2.24E-08	4.54E-09	3.24E-07	2.36E-07	1.31E-06
BR32	Adult	4.77E-07	2.17E-07	7.38E-08	7.21E-09	2.41E-14	5.42E-09	1.72E-10	1.72E-08	1.07E-08	3.76E-07	2.81E-07	1.47E-06
	Child	5.57E-07	2.17E-07	4.15E-08	6.34E-09	4.55E-13	5.42E-09	1.66E-09	1.72E-08	7.66E-09	3.55E-07	1.96E-07	1.40E-06
	Infant	4.15E-07	2.81E-07	0.00E+00	2.00E-10	1.11E-12	7.05E-09	2.81E-09	2.24E-08	4.54E-09	3.18E-07	2.35E-07	1.29E-06
BR48	Adult	5.87E-07	2.68E-07	4.25E-08	6.91E-09	1.39E-14	3.73E-09	1.72E-10	1.72E-08	1.07E-08	3.50E-07	2.76E-07	1.56E-06
	Child	6.86E-07	2.68E-07	2.38E-08	6.09E-09	2.83E-13	3.73E-09	1.66E-09	1.72E-08	7.66E-09	3.48E-07	1.94E-07	1.56E-06
	Infant	5.11E-07	3.47E-07	0.00E+00	2.07E-10	7.32E-13	4.85E-09	2.81E-09	2.24E-08	4.54E-09	3.38E-07	2.34E-07	1.46E-06
BHF1	Adult	5.75E-08	3.26E-08	2.51E-07	9.39E-09	1.03E-08	6.78E-07	3.89E-11	1.72E-08	6.22E-08	4.16E-07	1.97E-07	1.73E-06
	Child	6.72E-08	3.26E-08	1.95E-07	9.01E-09	4.04E-11	6.78E-07	3.39E-10	1.72E-08	4.46E-08	4.35E-07	1.39E-07	1.62E-06
	Infant	5.01E-08	4.22E-08	0.00E+00	2.24E-09	1.09E-10	8.82E-07	5.38E-10	2.24E-08	2.64E-08	3.61E-07	1.55E-07	1.54E-06

Table 229 Upper-range case – dose by pathway (Sv/y)

Receptor Group	Age	Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic animal ingestion	Terrestrial plants	Terrestrial animals	Total
BDF1	Adult	4.14E-07	1.85E-07	6.28E-08	1.22E-08	1.00E-14	3.55E-09	2.18E-10	2.32E-08	1.84E-08	7.95E-07	5.70E-07	2.08E-06
	Child	4.84E-07	1.85E-07	3.50E-08	1.11E-08	2.40E-13	3.55E-09	2.11E-09	2.32E-08	1.30E-08	7.74E-07	5.46E-07	2.08E-06
	Infant	3.60E-07	2.40E-07	0.00E+00	2.30E-10	6.34E-13	4.61E-09	3.56E-09	3.02E-08	7.58E-09	6.64E-07	8.19E-07	2.13E-06
BDF12	Adult	4.14E-07	1.85E-07	6.28E-08	1.22E-08	9.91E-15	3.58E-09	2.18E-10	2.32E-08	1.84E-08	9.48E-07	5.65E-07	2.23E-06
	Child	4.84E-07	1.85E-07	3.50E-08	1.11E-08	2.39E-13	3.58E-09	2.11E-09	2.32E-08	1.30E-08	8.82E-07	5.32E-07	2.17E-06
	Infant	3.60E-07	2.40E-07	0.00E+00	2.30E-10	6.35E-13	4.65E-09	3.56E-09	3.02E-08	7.58E-09	7.40E-07	7.90E-07	2.18E-06
BDF13	Adult	2.19E-07	1.11E-07	6.27E-08	1.22E-08	4.25E-15	1.54E-09	2.18E-10	2.32E-08	1.84E-08	8.83E-07	5.88E-07	1.92E-06
	Child	2.56E-07	1.11E-07	3.50E-08	1.11E-08	1.03E-13	1.54E-09	2.11E-09	2.32E-08	1.30E-08	8.37E-07	5.19E-07	1.81E-06
	Infant	1.90E-07	1.44E-07	0.00E+00	2.30E-10	2.74E-13	2.00E-09	3.56E-09	3.02E-08	7.58E-09	7.08E-07	7.45E-07	1.83E-06
BDF14	Adult	2.19E-07	1.11E-07	6.27E-08	1.22E-08	3.53E-15	1.28E-09	2.18E-10	2.32E-08	1.84E-08	8.40E-07	5.78E-07	1.87E-06
	Child	2.56E-07	1.11E-07	3.50E-08	1.11E-08	8.56E-14	1.28E-09	2.11E-09	2.32E-08	1.30E-08	8.31E-07	4.97E-07	1.78E-06
	Infant	1.90E-07	1.44E-07	0.00E+00	2.30E-10	2.27E-13	1.66E-09	3.56E-09	3.02E-08	7.58E-09	7.46E-07	6.95E-07	1.82E-06
BDF15	Adult	2.19E-07	1.11E-07	6.27E-08	1.22E-08	4.07E-15	1.52E-09	2.18E-10	2.32E-08	1.84E-08	8.40E-07	5.44E-07	1.83E-06
	Child	2.56E-07	1.11E-07	3.50E-08	1.11E-08	1.01E-13	1.52E-09	2.11E-09	2.32E-08	1.30E-08	8.31E-07	4.19E-07	1.70E-06
	Infant	1.90E-07	1.44E-07	0.00E+00	2.30E-10	2.68E-13	1.98E-09	3.56E-09	3.02E-08	7.58E-09	7.46E-07	5.28E-07	1.65E-06
BDF9	Adult	2.19E-07	1.11E-07	6.27E-08	1.22E-08	5.27E-15	1.98E-09	2.18E-10	2.32E-08	1.84E-08	8.40E-07	5.77E-07	1.87E-06
	Child	2.56E-07	1.11E-07	3.50E-08	1.11E-08	1.31E-13	1.98E-09	2.11E-09	2.32E-08	1.30E-08	8.31E-07	4.94E-07	1.78E-06
	Infant	1.90E-07	1.44E-07	0.00E+00	2.30E-10	3.47E-13	2.57E-09	3.56E-09	3.02E-08	7.58E-09	7.46E-07	6.93E-07	1.82E-06
BEC	Adult	9.52E-08	4.26E-08	0.00E+00	0.00E+00	3.03E-15	9.05E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-07
BF14	Adult	5.95E-07	2.92E-07	1.22E-07	1.22E-08	1.35E-14	3.77E-09	2.18E-10	2.32E-08	1.64E-08	9.90E-07	5.22E-07	2.58E-06
	Child	6.95E-07	2.92E-07	7.19E-08	1.11E-08	2.81E-13	3.77E-09	2.11E-09	2.32E-08	1.15E-08	8.84E-07	2.94E-07	2.29E-06
	Infant	5.18E-07	3.78E-07	0.00E+00	2.30E-10	7.30E-13	4.90E-09	3.56E-09	3.02E-08	6.75E-09	7.86E-07	2.77E-07	2.00E-06

Table 229 Upper-range case – dose by pathway (Sv/y)

Receptor Group	Age	Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic animal ingestion	Terrestrial plants	Terrestrial animals	Total
BF16	Adult	4.14E-07	1.85E-07	1.22E-07	1.22E-08	1.17E-14	3.77E-09	2.18E-10	2.32E-08	1.64E-08	8.28E-07	4.06E-07	2.01E-06
	Child	4.84E-07	1.85E-07	7.19E-08	1.11E-08	2.64E-13	3.77E-09	2.11E-09	2.32E-08	1.15E-08	7.53E-07	2.51E-07	1.80E-06
	Infant	3.60E-07	2.40E-07	0.00E+00	2.30E-10	6.94E-13	4.90E-09	3.56E-09	3.02E-08	6.75E-09	6.74E-07	2.48E-07	1.57E-06
BF8	Adult	2.19E-07	1.11E-07	1.22E-07	1.22E-08	8.78E-15	2.34E-09	2.18E-10	2.32E-08	1.64E-08	6.40E-07	4.40E-07	1.59E-06
	Child	2.56E-07	1.11E-07	7.19E-08	1.11E-08	1.78E-13	2.34E-09	2.11E-09	2.32E-08	1.15E-08	6.14E-07	2.64E-07	1.37E-06
	Infant	1.91E-07	1.44E-07	0.00E+00	2.30E-10	4.59E-13	3.04E-09	3.56E-09	3.02E-08	6.75E-09	5.70E-07	2.56E-07	1.20E-06
BSF2	Adult	2.19E-07	1.11E-07	8.04E-08	1.22E-08	6.59E-15	1.76E-09	2.18E-10	2.32E-08	7.34E-08	1.59E-06	9.01E-07	3.01E-06
	Child	2.56E-07	1.11E-07	4.48E-08	1.11E-08	1.34E-13	1.76E-09	2.11E-09	2.32E-08	5.18E-08	1.60E-06	6.96E-07	2.80E-06
	Infant	1.90E-07	1.44E-07	0.00E+00	2.30E-10	3.46E-13	2.29E-09	3.56E-09	3.02E-08	3.02E-08	1.38E-06	8.73E-07	2.65E-06
BSF3	Adult	2.19E-07	1.11E-07	8.04E-08	1.22E-08	8.29E-15	2.35E-09	2.18E-10	2.32E-08	7.34E-08	1.86E-06	9.01E-07	3.28E-06
	Child	2.56E-07	1.11E-07	4.48E-08	1.11E-08	1.73E-13	2.35E-09	2.11E-09	2.32E-08	5.18E-08	1.79E-06	6.96E-07	2.99E-06
	Infant	1.90E-07	1.44E-07	0.00E+00	2.30E-10	4.51E-13	3.05E-09	3.56E-09	3.02E-08	3.02E-08	1.52E-06	8.73E-07	2.79E-06
BR1	Adult	6.43E-07	2.36E-07	7.09E-07	1.75E-08	1.80E-14	3.13E-09	2.18E-10	2.32E-08	1.69E-08	5.16E-07	3.76E-07	2.54E-06
	Child	7.51E-07	2.36E-07	3.96E-07	1.55E-08	2.95E-13	3.13E-09	2.11E-09	2.32E-08	1.19E-08	4.87E-07	2.55E-07	2.18E-06
	Infant	5.59E-07	3.05E-07	0.00E+00	2.54E-09	7.38E-13	4.07E-09	3.56E-09	3.02E-08	6.95E-09	4.50E-07	2.98E-07	1.66E-06
BR17	Adult	4.14E-07	1.85E-07	7.09E-08	1.23E-08	1.38E-14	4.06E-09	2.18E-10	2.32E-08	1.69E-08	4.45E-07	2.76E-07	1.45E-06
	Child	4.84E-07	1.85E-07	3.98E-08	1.12E-08	2.95E-13	4.06E-09	2.11E-09	2.32E-08	1.19E-08	4.23E-07	2.15E-07	1.40E-06
	Infant	3.60E-07	2.40E-07	0.00E+00	3.59E-10	7.70E-13	5.28E-09	3.56E-09	3.02E-08	6.95E-09	3.77E-07	2.71E-07	1.29E-06
BR25	Adult	5.55E-07	2.73E-07	7.09E-08	1.23E-08	1.55E-14	4.93E-09	2.18E-10	2.32E-08	1.69E-08	5.19E-07	3.72E-07	1.85E-06
	Child	6.49E-07	2.73E-07	3.98E-08	1.12E-08	3.48E-13	4.93E-09	2.11E-09	2.32E-08	1.19E-08	4.83E-07	2.51E-07	1.75E-06
	Infant	4.83E-07	3.54E-07	0.00E+00	3.59E-10	9.13E-13	6.41E-09	3.56E-09	3.02E-08	6.95E-09	4.29E-07	2.94E-07	1.61E-06

Table 229 Upper-range case – dose by pathway (Sv/y)

Receptor Group	Age	Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic animal ingestion	Terrestrial plants	Terrestrial animals	Total
BR27	Adult	5.95E-07	2.92E-07	7.22E-08	1.23E-08	1.25E-14	3.59E-09	2.18E-10	2.32E-08	1.69E-08	5.22E-07	3.74E-07	1.91E-06
	Child	6.96E-07	2.92E-07	4.07E-08	1.12E-08	2.65E-13	3.59E-09	2.11E-09	2.32E-08	1.19E-08	4.86E-07	2.52E-07	1.82E-06
	Infant	5.18E-07	3.78E-07	0.00E+00	3.69E-10	6.90E-13	4.67E-09	3.56E-09	3.02E-08	6.95E-09	4.33E-07	2.94E-07	1.67E-06
BR32	Adult	5.95E-07	2.92E-07	9.17E-08	1.25E-08	3.59E-14	8.86E-09	2.18E-10	2.32E-08	1.69E-08	5.22E-07	3.73E-07	1.94E-06
	Child	6.96E-07	2.92E-07	5.16E-08	1.14E-08	7.08E-13	8.86E-09	2.11E-09	2.32E-08	1.19E-08	4.86E-07	2.51E-07	1.83E-06
	Infant	5.18E-07	3.78E-07	0.00E+00	2.51E-10	1.76E-12	1.15E-08	3.56E-09	3.02E-08	6.95E-09	4.33E-07	2.94E-07	1.68E-06
BR48	Adult	8.00E-07	3.15E-07	7.10E-08	1.23E-08	2.96E-14	8.11E-09	2.18E-10	2.32E-08	1.69E-08	5.28E-07	3.53E-07	2.13E-06
	Child	9.34E-07	3.15E-07	3.99E-08	1.12E-08	6.09E-13	8.11E-09	2.11E-09	2.32E-08	1.19E-08	5.15E-07	2.44E-07	2.10E-06
	Infant	6.96E-07	4.08E-07	0.00E+00	3.59E-10	1.58E-12	1.05E-08	3.56E-09	3.02E-08	6.95E-09	5.06E-07	2.90E-07	1.95E-06
BHF1	Adult	1.12E-07	4.40E-08	4.01E-07	2.36E-08	3.02E-08	1.99E-06	5.07E-11	2.32E-08	9.83E-08	5.74E-07	2.69E-07	3.57E-06
	Child	1.31E-07	4.40E-08	3.86E-07	2.32E-08	1.19E-10	1.99E-06	4.40E-10	2.32E-08	6.93E-08	6.03E-07	1.95E-07	3.47E-06
	Infant	9.74E-08	5.70E-08	0.00E+00	5.73E-09	3.21E-10	2.59E-06	6.96E-10	3.02E-08	4.05E-08	5.09E-07	2.28E-07	3.56E-06

14.0 APPENDIX N: RADIATION DOSE TO NON-HUMAN BIOTA

This Appendix contains the quantitative data used to calculate the internal and external dose to each representative non-human biota considered in this assessment. The concentrations of radionuclides in environmental media are based on REM data presented in the annual Environmental Protection Reports, as well as additional information collected specifically to support the ERA, which is presented below. The detailed non-human biota dose calculations, including all parameters used in the assessment and their source, are provided (Table 230 to Table 233).

The ERICA Tool, an industry-accepted tool for radiological EcoRA, was used to calculate dose to non-human biota [R-366]. The ERICA Tool specifies concentration ratios for terrestrial biota in units of Bq/kg(fw) per Bq/kg soil for most radionuclides, or Bq/kg(fw) per Bq/m^3 air for Hydrogen (H), Carbon (C), Sulphur (S) and Phosphorous (P). Specifically for H and C, a specific activity model (recommended in CSA Standard N288.1) is used to derive the concentration ratios [R-367].

The use of concentration ratios implicitly incorporates all internal exposure pathways. These are empirically-derived values which correlate whole body tissue concentrations and the concentration in soil or air for terrestrial biota, or water for aquatic biota. Equilibrium concentrations are assumed for all environmental media.

For H and C, any ingestion of soil is accounted for in the measured whole body tissue concentration; for particulates, inhalation is also accounted for in the measured whole body tissue concentration.

A sampling campaign to investigate gamma emitter activity in on-site soil was undertaken in 2019. Sample locations were distributed throughout the site, at varying distances and directionsas shown in Figure 146. These locations were selected to align with the predominant wind diretions from both Bruce A and Bruce B, and are therefore expected to represent the locations with the highest potential for radionuclide concentration from airborne deposition.

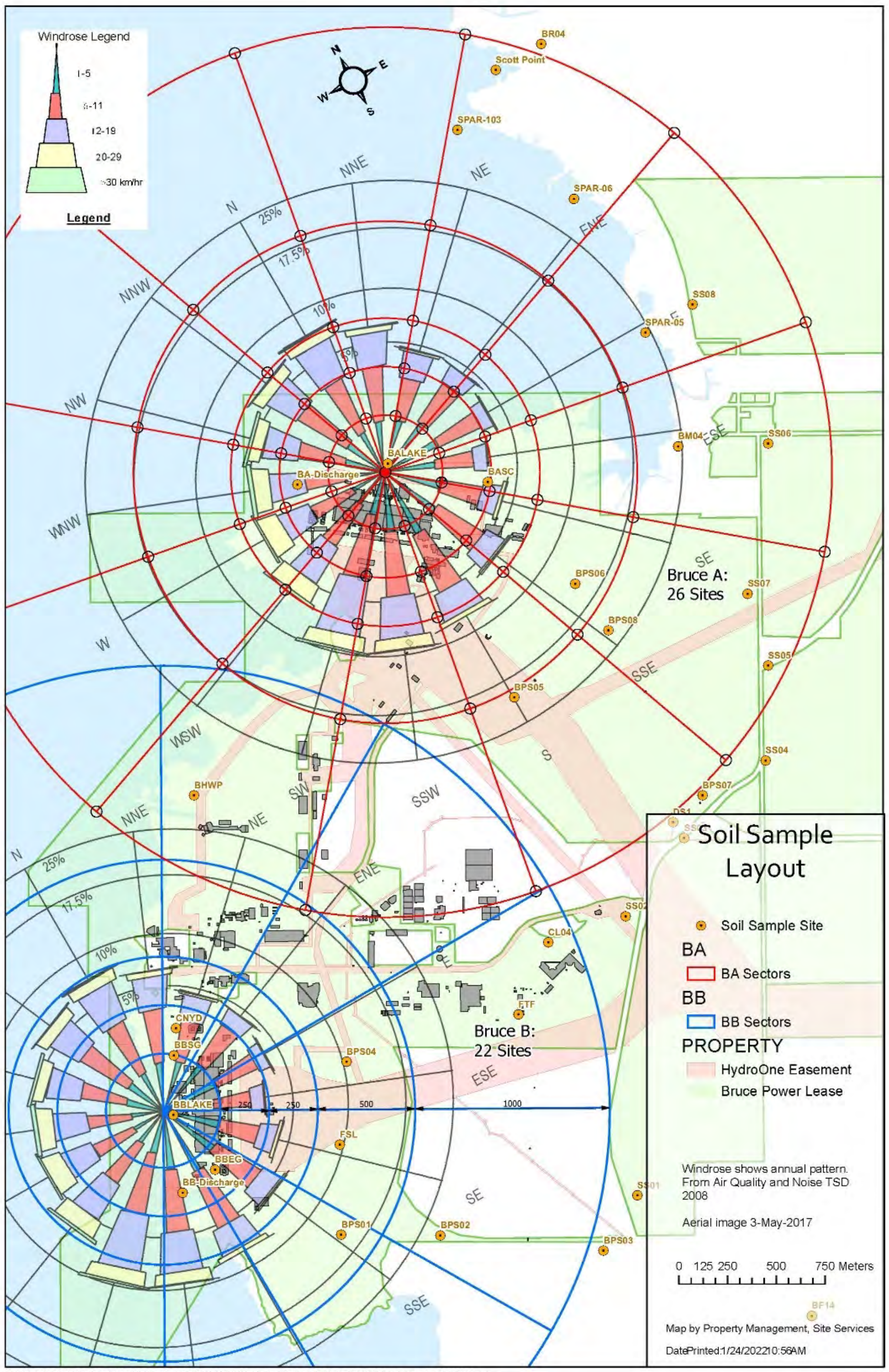

Figure 146 2019 Soil Sampling Locations with Wind Rose Overlay

Excluding cesium-137 and naturally occurring radionuclides (potassium-40, beryllium-7, and the progenies of radon, uranium and thorium), all radionuclides were below critical levels. The radionuclides cobalt-60, cesium-134 and iodine-131 were not detected. Therefore, cesium-137 was the only gamma emitter identified above critical levels. The cesium-137 results are shown in Table 230.

The concentration of cesium-137 ranged from 0.517 Bq/kg dw to 30.92 Bq/kg-dw, with an average concentration of 6.013 Bq/kg-dw. For comparison, the provincial average for cesium-137, which is based on samples taken from Cobourg, Goderich and Lakefield, was most recently measured to be 5.39 Bq/kg-dw in 2017. The maximum concentration was measured at SS5, which is south of Bruce A and northeast of Bruce B. For the purpose of a bounding ecological risk assessment, it is assumed that all terrestrial biota are exposed to soil with the maximum background subtracted on site concentration (25.53 Bq/kg-dw).

Given that this is significantly higher than the average on-site cesium-137 concentration, and samples at varied distances and directions from Bruce Power emissions sources were considered, this represents conservative management of the spatial heterogeneity of soil concentrations on-site.

The selection of the bounding on-site waterbody for the aquatic biota assessment considered data collected annually as part of Radiological Environmental Monitoring from Stream C, Former Sewage Lagoon, and the B31 Pond. Tritium concentrations measured in these waterbodies from 2016 – 2020 are shown in Table 231.

Additionally, a sampling campaign to investigate the activity of radionuclides in surface water from Stream C and South Railway Ditch was undertaken in 2020 and 2021, and additional sampling of Stream C, the B31 Pond, and B16 Stormwater Pond was conducted in 2021. The tritium in water and gamma emitters in sediment results (for FSL, B31 Pond, and B16 Stormwater Pond) from this additional sampling are shown in Table 232 and Table 233. The locations of on-site waterbody sampling are provided in Figure 147. The Stream C samples BC02-WC and SW2 were collected at the same location.

Annual sampling of on-site waterbodies has demonstrated that the Former Sewage Lagoon has the bounding tritium concentrations (Table 231). Sampling of additional on-site waterbodies in 2020 and 2021 confirmed that the FSL is bounding (Table 232). Therefore, FSL is used as the on-site aquatic biota location for the ecological risk assessment. The highest tritium concentration of 655 Bq/L observed in the FSL from 2016-2021 is used as the exposure concentration for the assessment of dose to on-site aquatic biota. Given that tritium concentrations in all other on-site waterbodies are significantly lower, this represents conservative management of the spatial heterogeneity of water concentrations on-site.

Regarding the sediment samples, excluding cesium-137 and naturally occurring radionuclides, the majority of radionuclides were below critical levels. All cesium-134 samples were below detection. One cobalt-60 sample in the Former Sewage Lagoon was greater than the critical level, however the activity concentration (~1 Bq/kg) is far lower than cesium-137 concentrations, and therefore the contribution to dose is negligible. Therefore, cesium-137 is used as the representative radionuclide for the on-site aquatic biota exposure assessment.

The highest concentration of cesium-137 measured in the FSL was 134.00 Bq/kg, background subtracted to 133.65 Bq/kg (based on average provincial sediment background value of 0.35 Bq/kg for 2016-2020). Therefore, this concentration is used in the on-site aquatic biota exposure assessment.

Table 230 Cs-137 results for 2019 shallow soil samples

Location	Identification Confidence %	Activity (Bq/kg)	Uncertainty (Bq/kg)	LC (Bq/kg)	LD (Bq/kg)
Shallow Soil 1 (SS1)	99.55	1.170E+00	3.373E-01	8.326E-02	1.709E-02
Shallow Soil 2 (SS2)	99.80	2.417E+00	3.406E-01	7.627E-02	1.562E-01
Shallow Soil 3 (SS3)	99.88	4.888E+00	4.253E-01	9.364E-02	1.915E-01
Shallow Soil 4 (SS4)	99.81	1.528E+00	3.019E-01	8.373E-02	1.715E-01
Shallow Soil 5 (SS5)	99.76	3.092E+01	2.566E+00	1.242E-01	2.541E-01
Shallow Soil 6 (SS6)	99.50	5.682E+00	5.488E-01	6.350E-02	1.302E-01
Shallow Soil 7 (SS7)	99.94	6.215E+00	5.410E-01	1.392E-01	2.834E-01
Shallow Soil 8 (SS8)	99.78	1.580E+00	4.067E-01	1.122E-01	2.292E-01
Shallow Soil 9 (SS9)	99.84	5.170E-01	1.890E+00	7.061E-02	1.447E-01
Shallow Soil 10 (SS10)	99.72	4.385E+00	3.996E-01	1.319E-01	2.690E-01
Shallow Soil 11 (SS11)	99.86	1.210E+01	1.018E+00	1.694E-01	3.440E-01
Shallow Soil 12 (SS12)	99.77	1.265E+01	1.162E+00	9.900E-02	2.039E-01
Shallow Soil 13 (SS13)	99.86	1.636E+00	1.646E-01	7.965E-02	1.628E-01
Shallow Soil 14 (SS14)	99.92	8.060E-01	2.847E-01	8.728E-02	1.788E-01
Shallow Soil 15 (SS15)	99.76	3.698E+00	5.811E-01	1.494E-01	3.038E-01
Average	99.78	6.013E+00	7.312E-01	1.042E-01	2.027E-01
STDEV	0.12	7.854E+00	6.756E-01	3.185E-02	8.148E-02
Max	99.94	3.092E+01	2.566E+00	1.694E-01	3.440E-01

Table 231 Average surface water tritium concentrations 2016-2020 (Bq/L)

	Baie du Doré	FSL (BM21-WL)	B31 Pond	Stream C (BC02-WC)
2016	5.07E+01	No sample	No sample	1.01E+02
2017	8.41E+01	6.14E+02	1.86E+02	7.78E+01
2018	9.44E+01	6.22E+02	1.48E+02	1.01E+02
2019	6.40E+01	5.46E+02	1.96E+02	8.31E+01
2020	7.26E+01	5.26E+02	1.15E+02	8.53E+01
Average	7.31E+01	5.77E+02	1.61E+02	8.95E+01
Max	9.44E+01	6.22E+02	1.96E+02	1.01E+02

Table 232 Surface water tritium concentrations, 2020 and 2021

Location	Activity (Bq/L)
B16 Pond 2021	1.71E+02
B31 Pond 2021	2.02E+02
BM21-WL Pond (Former Sewage Lagoon, FSL) 2021	6.55E+02
BC02-WC Stream C 2021	8.21E+01
SW2 - Stream C 2020[1]	4.60E+01
South Railway Ditch (SRD) 2020[1]	3.72E+02
SW2 - Stream C 2021[1]	8.01E+01
Average	**2.60E+02**
Maximum	**6.55E+02**

[1]2020 Stream C and South Railway Ditch concentrations are the average of 2 and 3 samples, respectively. The 2021 Stream C concentration is the average of 2 samples. SW2 is collected at the same location as BC02-WC.

Table 233 Sediment gamma emitter concentration in on-site ponds 2021

Location	Cs-137					Co-60					Cs-134				
	Confidence (%)	Activity (Bq/kg)	Uncertainty	Lc	Ld	Confidence (%)	Activity (Bq/kg)	Uncertainty	Lc	Ld	Confidence (%)	Activity (Bq/kg)	Uncertainty	Lc	Ld
B16 Pond	99.84	2.830E-01	7.153E-02	7.853E-02	1.607E-01	00.00	1.328E-01	2.063E-01	1.473E-01	3.000E-01	00.00	3.011E-02	1.479E-01	1.782E-01	3.610E-01
B31 Pond (BM16)	99.95	7.652E+00	8.172E-01	1.410E-01	2.870E-01	00.00	4.521E-02	3.465E-01	2.398E-01	4.869E-01	00.00	-4.916E-01	1.817E-01	2.963E-01	5.990E-01
FSL 1	99.97	1.340E+02	1.060E+01	2.411E-01	4.890E-01	99.94	1.337E+00	1.821E-01	1.381E-01	2.861E-01	00.00	-4.284E-01	1.860E-01	2.899E-01	5.886E-01
FSL 2	99.95	1.103E+00	1.289E-01	8.353E-02	1.707E-01	00.00	-6.766E-02	2.080E-01	1.462E-01	2.977E-01	00.00	2.524E-02	1.460E-01	1.725E-01	3.496E-01
Stream C[1]	-	<Lc	-	-	-	-	<Lc	-	-	-	-	<Lc	-	-	-
SRD[1]	-	1.905	-	-	-	-	<Lc	-	-	-	-	<Lc	-	-	-
Average	**99.93**	**2.899E+01**	**2.904E+00**	**1.360E-01**	**2.769E-01**	**24.99**	**3.618E-01**	**2.357E-01**	**1.679E-01**	**3.427E-01**	**0.00**	**-2.162E-01**	**1.654E-01**	**2.342E-01**	**4.746E-01**
Maximum	**99.97**	**1.340E+02**	**1.060E+01**	**2.411E-01**	**4.890E-01**	**99.94**	**1.337E+00**	**3.465E-01**	**2.398E-01**	**4.869E-01**	**0.00**	**3.011E-02**	**1.860E-01**	**2.963E-01**	**5.990E-01**

Note: Samples above the critical level are highlighted orange.

[1]Analysis of Stream C and SRD sediment samples was performed separately, and confidence %, uncertainty, Lc and Ld are not provided. The average Cs-137 concentration of 5 SRD samples is shown. For Co-60 and Cs-137, all samples were below detection limits

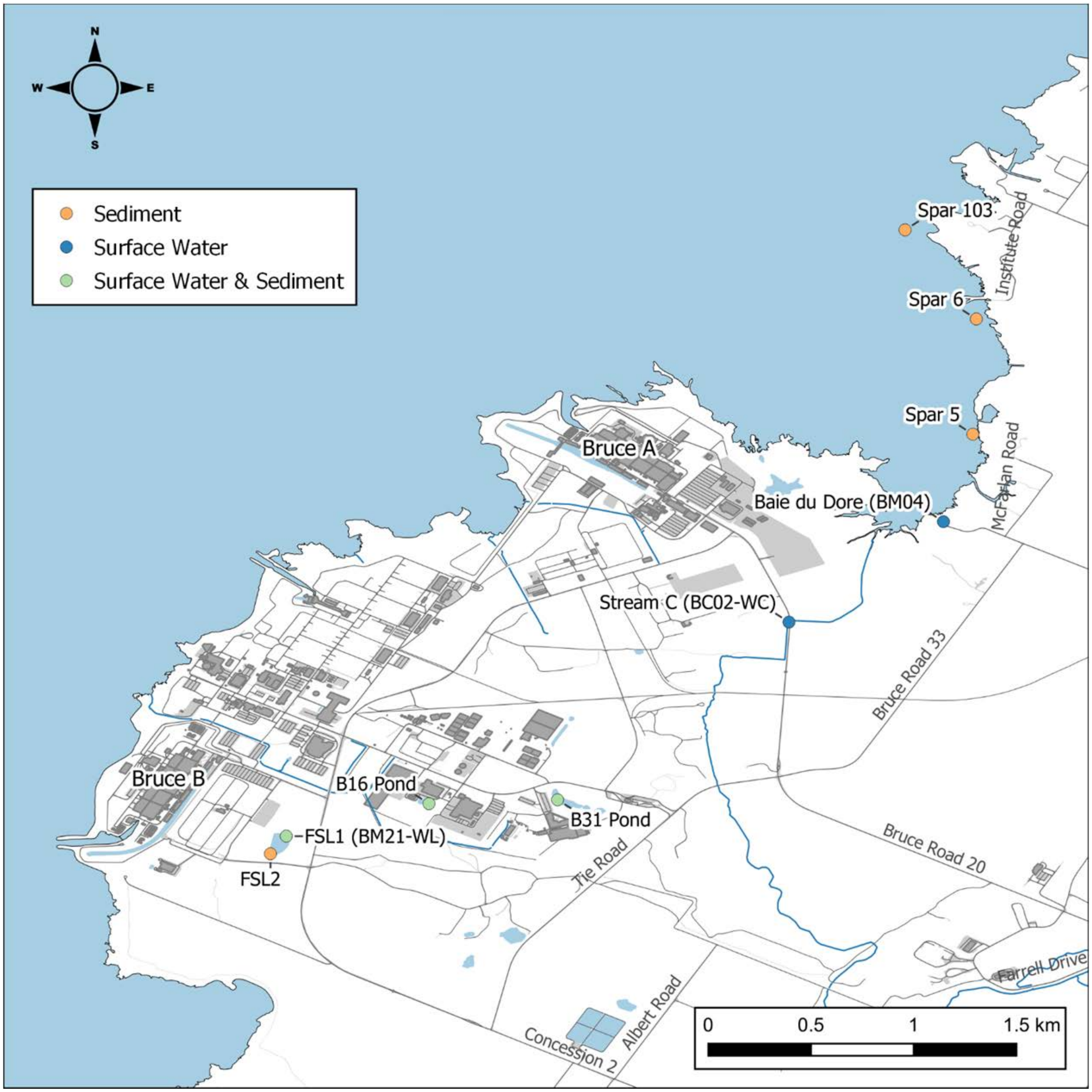

Figure 147: Baie du Doré and On-site waterbody sampling locations

14.1 Terrestrial Radiation Pathway Contributions

Figure 148 shows the radionuclide contributors by pathway for the terrestrial receptors. The relative contributions for the bird are very similar to the amphibian and are therefore not shown below. Likewise, the relative contributions for grasses and herbs are similar to the soil invertebrate and are not shown below. For all terrestrial biota, excluding the large mammal receptor, the total dose is predominantly attributable to internal exposure from tritium. For the large mammal, for which tritium and carbon-14 in tissue samples was measured, the dominant contributors are internal exposure from tritium and external exposure from airborne noble gases and cesium-137.

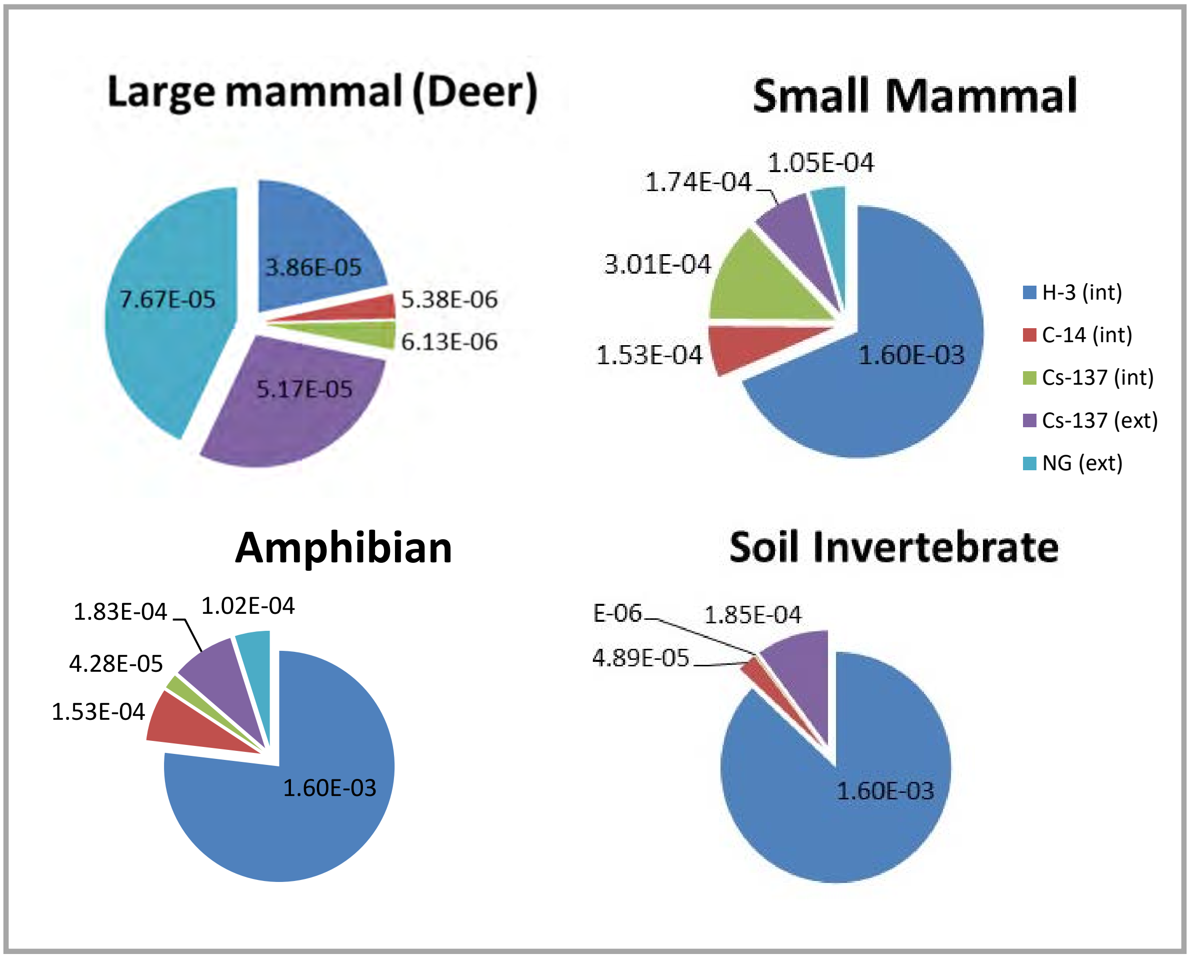

Figure 148
Dose Rate (mGy/d) from Individual Exposure Pathways – Terrestrial Biota

14.2 Aquatic Radiation Pathway Contributions – Baie du Doré

Figure 149 show the radionuclide contributors by pathway for Baie du Doré pelagic fish, benthic fish, freshwater invertebrates and freshwater plants, respectively. The relative contributions for the aquatic bird, aquatic mammal and insect larvae receptors are all very similar to the freshwater invertebrate and are thus not shown.

The dose rate to pelagic fish is solely due to internal exposure pathways, with the highest contribution from cesium-137, HTO, and carbon-14 with smaller contribution from OBT and Cm-244. For benthic fish, approximately 60% of the dose rate is due to external exposure to gamma-emitting radionuclides (cesium-137) in sediment.

The majority of the dose rate to the aquatic bird, aquatic mammal and freshwater invertebrate receptors comes from internal exposure to tritium and carbon-14. The dose to the freshwater plant predominantly comes from internal exposure to tritium, and the dose to the insect larvae is split between the internal dose from carbon-14 and tritium and the external dose from cesium-137.

Since the dose rate for the benthic invertebrate is 0.002% of the corresponding benchmark value, any uncertainties in the benchmark value due to the greater radiosensitivity of species in their early life stages are expected to have a negligible effect on the risk characterization for those species.

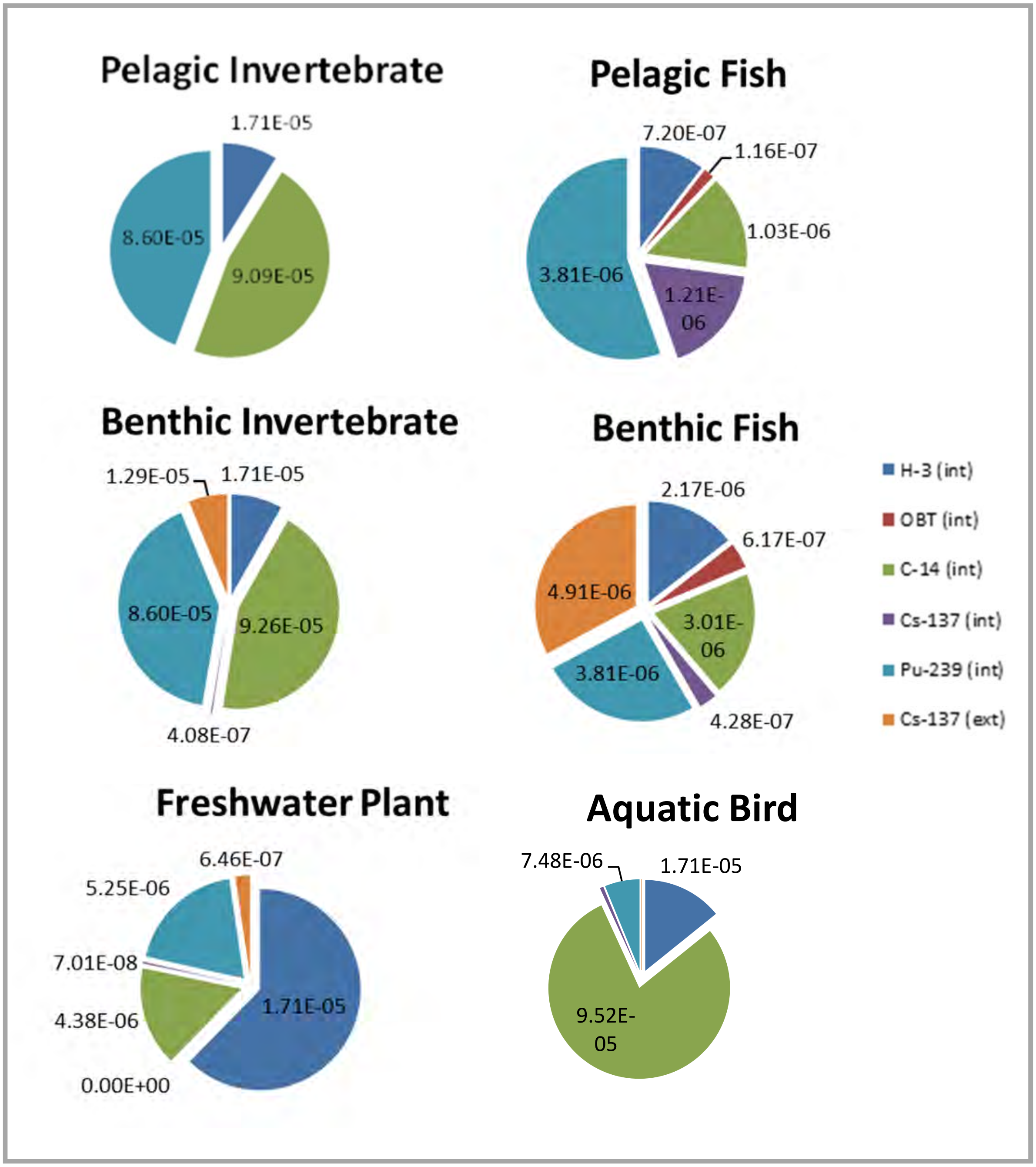

Figure 149
Dose Rate (mGy/d) from Individual Exposure Pathways – Baie du Doré

14.3 Aquatic Radiation Pathway Contributions – Former Sewage Lagoon

Figure 150 shows the radionuclide contributors by pathway for The Former Sewage Lagoon pelagic fish, benthic fish, pelagic invertebrates, benthic invertebrates and freshwater plants respectively. The relative contributions for the aquatic bird and aquatic mammal receptors are very similar to the pelagic fish and are not shown.

The dose rate to pelagic fish is solely due to internal exposure pathways, with the highest contribution from carbon-14, cesium-137 and tritium. For benthic fish, approximately 40% of the dose rate is due to external exposure to gamma-emitting radionuclides (cesium-137) in sediment, with the rest of the total dose coming from the same internal sources as pelagic fish.

The majority of the dose rate to the aquatic bird, aquatic mammal and freshwater invertebrate receptors comes from internal exposure to carbon-14, tritium, and cesium-137. The dose rate to the insect larvae receptor mostly comes from external exposure to cesium-137 and internal exposure to carbon-14, while the dose rate to freshwater plant is mostly due to internal exposure to tritium and external exposure to cesium-137.

Since the dose rate for the insect larvae is 0.02% of the corresponding benchmark value, any uncertainties in the benchmark value due to the greater radiosensitivity of species in their early life stages are expected to have a negligible effect on the risk characterization for those species.

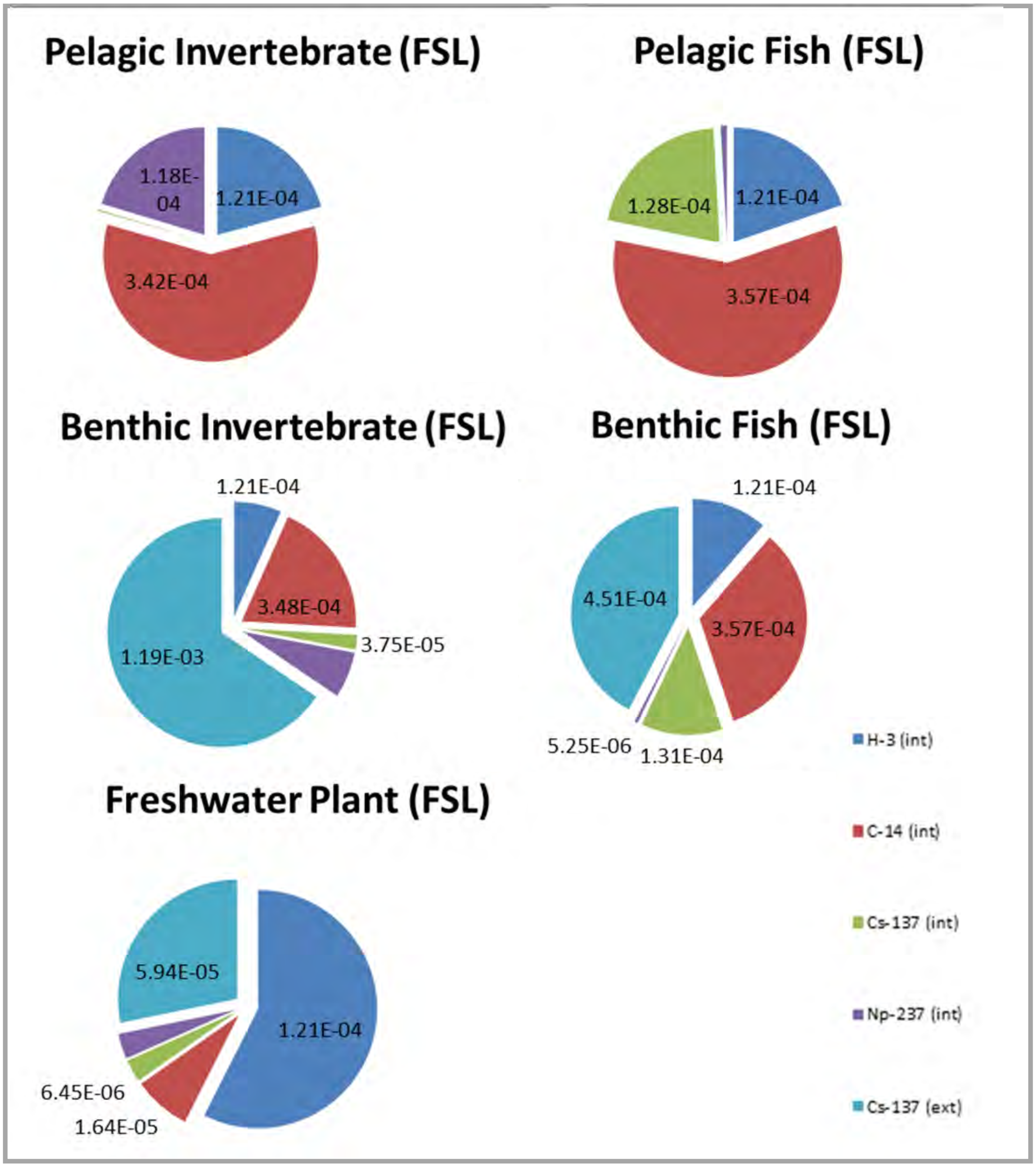

Figure 150
Dose Rate (mGy/d) from Individual Exposure Pathways – Former Sewage Lagoon

The detailed calculation of dose to all non-human biota considered in the assessment is presented in Table 234 to Table 253. The calculations follow the methodology described in Section 2.4. The “Source of Info” column indicates the reference used, and any environmental monitoring data directly considered in the assessment. Where no specific source is noted, radionuclide concentrations in media are calculated using distribution coefficients and concentration ratios as described in Section 2.4.

Parameters for the terrestrial assessment are:

D_{total}	=	total radiation dose (µGy•h^{-1})
D_{int}	=	internal radiation dose (µGy•h^{-1})
D_{ext}	=	external radiation dose (µGy•h^{-1})
$DC_{int\_lowbeta}$	=	dose coefficient for radionuclide in tissue from low-energy beta (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{int\_normalbeta}$	=	dose coefficient for radionuclide in tissue from beta/gamma (µGy•h^{-1}•Bq^{-1}•kg)
DC_{int_alpha}	=	dose coefficient for radionuclide in tissue from alpha (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{ext,s}$	=	dose coefficient for radionuclide in soil (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{ext,ss}$	=	dose coefficient for radionuclide on soil surface (µGy•h^{-1}•Bq^{-1}•m^{2})
$DC_{ext,a}$	=	dose coefficient for radionuclide in air (µGy•h^{-1}•Bq^{-1}•m^{3})
OF_s	=	fraction of time spent immersed in soil (unitless)
OF_{ss}	=	fraction of time spent on the soil surface (unitless) [R-51]
OF_a	=	fraction of time spent air (unitless)
C_t	=	whole body tissue concentration (Bq•kg^{-1} *fw*)
C_s	=	soil concentration (Bq•kg^{-1} *dw*)
C_{ss}	=	surface soil concentration (Bq•m^{-2})
C_a	=	air concentration (Bq•m^{-3})

Parameters for the aquatic assessment are:

D_{total}	=	total radiation dose (µGy)
D_{int}	=	internal radiation dose (µGy•h^{-1})
D_{ext}	=	external radiation dose (µGy•h^{-1})
$DC_{int\_lowbeta}$	=	dose coefficient for radionuclide in tissue from low-energy beta (µGy•h^{-1}•Bq^{-1}•kg)
$DC_{int\_normalbeta}$	=	dose coefficient for radionuclide in tissue from beta/gamma (µGy•h^{-1}•Bq^{-1}•kg)
DC_{int_alpha}	=	dose coefficient for radionuclide in tissue from alpha (µGy•h^{-1}•Bq^{-1}•kg)
OF_s	=	fraction time spent immersed in sediment (unitless)
OF_{ss}	=	fraction of time spent on the sediment surface (unitless)
OF_w	=	fraction of time spent in the water column (unitless)
OF_{ws}	=	fraction of time spent on the water surface (unitless)
C_t	=	whole body tissue concentration (Bq•kg^{-1} *fw*)
C_w	=	water concentration (Bq•L^{-1})
C_s	=	sediment concentration (Bq•kg^{-1} *fw*)

Table 234 Calculations used to determine the dose rate to large mammal

Reference organism	Large Mammal (Deer)
Category	Terrestrial
Location	Bruce A

Radionuclide	H-3	C-14	Cs-137	Np-237	I-131	Noble Gas	Total	Units	Source of info
D_{total}	1.61E-03	2.24E-04	2.41E-03	1.77E-08	4.26E-09	3.20E-03	**7.44E-03**	uGy/h	
D_{int}	1.61E-03	2.24E-04	2.55E-04	1.73E-08	1.25E-10	0.00E+00	2.09E-03	uGy/h	
D_{ext}	0.00E+00	0.00E+00	2.15E-03	4.53E-10	4.13E-09	3.20E-03	5.35E-03	uGy/h	
C_t	1.39E+02	7.69E+00	7.47E-01	6.11E-07	4.94E-07			Bq/kg fw tissue	H-3, C-14 and Cs-137 tissue concentrations use background corrected max annual average
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	1.34E+03	2.85E+00	2.74E-02	5.65E-03	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per Bq/m3 air (H-3 and C-14)	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	3.41E-04	2.32E-04	2.52E-04	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03	0.00E+00	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$								uGy/h per Bq/kg in soil	ERICA Tool

Table 234 Calculations used to determine the dose rate to large mammal

Reference organism	Large Mammal (Deer)
Category	Terrestrial
Location	Bruce A

Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
$DC_{ext,ss}$			8.44E-05	2.03E-05	4.73E-05			uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						4.51E-04		uGy/h per Bq/m3	ERICA Tool - Bounding noble gas DC among Ar-41, Kr-85, Kr-88, Xe-131m, Xe-133 used
OF_s	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Noble Gas manually input
OF_{ss}	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Noble Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Noble Gas manually input

Table 235 Calculations used to determine the dose rate to small mammal

Reference organism	Small Mammal								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
D_{total}	6.66E-02	6.38E-03	1.98E-02	1.92E-08	1.58E-08	4.37E-03	**9.71E-02**	uGy/h	
D_{int}	6.66E-02	6.38E-03	1.25E-02	1.72E-08	6.53E-11	0.00E+00	8.55E-02	uGy/h	
D_{ext}	0.00E+00	0.00E+00	7.24E-03	1.96E-09	1.58E-08	4.37E-03	1.16E-02	uGy/h	
C_t	8.65E+03	2.19E+02	7.27E+01	6.11E-07	4.94E-07	0.00E+00		Bq/kg fw tissue	
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	1.34E+03	2.85E+00	2.74E-02	5.65E-03	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per Bq/m3 air (H-3 and C-14)	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07	0.00E+00		uGy/h per Bq/kg fw	ERICA Tool

Table 235 Calculations used to determine the dose rate to small mammal

Reference organism	Small Mammal								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
								tissue	
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.71E-04	1.60E-04	1.31E-04	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03	0.00E+00	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$			2.84E-04	8.77E-05	1.80E-04			uGy/h per Bq/kg in soil	ERICA Tool
$DC_{ext,ss}$			1.35E-04	3.56E-05	7.93E-05			uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						6.16E-04		uGy/h per Bq/m3	ERICA Tool
OF_s	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_{ss}	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Nobel Gas manually input

Table 236 Calculations used to determine the dose rate to amphibian

Reference organism	Amphibian								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
D_{total}	6.66E-02	6.37E-03	9.40E-03	6.38E-08	1.66E-08	4.24E-03	**8.66E-02**	uGy/h	
D_{int}	6.66E-02	6.37E-03	1.78E-03	6.18E-08	5.22E-11	0.00E+00	7.47E-02	uGy/h	
D_{ext}	0.00E+00	0.00E+00	7.62E-03	2.06E-09	1.66E-08	4.24E-03	1.19E-02	uGy/h	
C_t	8.65E+03	2.19E+02	1.15E+01	2.19E-06	4.34E-07	0.00E+00		Bq/kg fw tissue	
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	1.34E+03	4.51E-01	9.82E-02	4.97E-03	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per Bq/m3 air (H-3 and C-14)	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used

Table 236 Calculations used to determine the dose rate to amphibian

Reference organism	Amphibian								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.54E-04	1.51E-04	1.19E-04	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03	0.00E+00	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$			2.98E-04	9.22E-05	1.90E-04			uGy/h per Bq/kg in soil	ERICA Tool
$DC_{ext,ss}$			1.37E-04	3.66E-05	8.10E-05			uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						5.98E-04		uGy/h per Bq/m3	ERICA Tool
OF_s	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_{ss}	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Nobel Gas manually input

Table 237 Calculations used to determine the dose rate to bird

Reference organism	Bird								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
D_{total}	6.66E-02	6.38E-03	6.03E-03	1.86E-08	6.84E-09	4.59E-03	**8.36E-02**	uGy/h	
D_{int}	6.66E-02	6.38E-03	2.66E-03	1.78E-08	7.17E-11	0.00E+00	7.56E-02	uGy/h	
D_{ext}	0.00E+00	0.00E+00	3.37E-03	7.75E-10	6.77E-09	4.59E-03	7.96E-03	uGy/h	
C_t	8.65E+03	2.19E+02	1.40E+01	6.32E-07	4.94E-07	0.00E+00		Bq/kg fw tissue	
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	1.34E+03	5.47E-01	2.83E-02	5.65E-03	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu,

Table 237 Calculations used to determine the dose rate to bird

Reference organism	Bird								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
								Bq/m3 air (H-3 and C-14)	U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.90E-04	1.68E-04	1.44E-04	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}				2.80E-03				uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$								uGy/h per Bq/kg in soil	ERICA Tool
$DC_{ext,ss}$			1.32E-04	3.47E-05	7.74E-05			uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						6.48E-04		uGy/h per Bq/m3	ERICA Tool
OF_s	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_{ss}	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Nobel Gas manually input

Table 238 Calculations used to determine the dose rate to grasses and herbs

Reference organism	Grasses and Herbs								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
D_{total}	6.66E-02	4.22E-03	6.96E-03	9.54E-08	7.37E-09	0.00E+00	**7.77E-02**	uGy/h	
D_{int}	6.66E-02	4.22E-03	4.08E-03	9.45E-08	6.44E-10	0.00E+00	7.49E-02	uGy/h	
D_{ext}	0.00E+00	0.00E+00	2.88E-03	9.20E-10	6.72E-09	0.00E+00	2.88E-03	uGy/h	
C_t	8.65E+03	1.46E+02	2.89E+01	3.36E-06	5.76E-06	0.00E+00		Bq/kg fw tissue	
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	8.90E+02	1.13E+00	1.50E-01	6.59E-02	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per Bq/m3 air (H-3 and	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used

Table 238 Calculations used to determine the dose rate to grasses and herbs

Reference organism	Grasses and Herbs								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
								C-14)	
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07			uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.81E-05	1.40E-04	1.44E-04	1.11E-04			uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}				2.80E-03	0.00E+00			uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$								uGy/h per Bq/kg in soil	ERICA Tool
$DC_{ext,ss}$			1.13E-04	4.12E-05	7.70E-05			uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						0.00E+00		uGy/h per Bq/m3	ERICA Tool
OF_s	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_{ss}	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Nobel Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Nobel Gas manually input

Table 239 Calculations used to determine the dose rate to tree

Reference organism	Tree								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
D_{total}	6.66E-02	6.19E-03	3.62E-03	6.61E-09	5.96E-09	0.00E+00	**7.64E-02**	uGy/h	
D_{int}	6.66E-02	6.19E-03	1.32E-03	5.90E-09	5.86E-10	0.00E+00	7.41E-02	uGy/h	
D_{ext}	0.00E+00	0.00E+00	2.30E-03	7.14E-10	5.37E-09	0.00E+00	2.30E-03	uGy/h	
C_t	8.65E+03	2.13E+02	4.05E+00	2.09E-07	2.37E-06	0.00E+00		Bq/kg fw tissue	
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	1.30E+03	1.59E-01	9.35E-03	2.71E-02	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per Bq/m3 air (H-3 and	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used

Table 239 Calculations used to determine the dose rate to tree

Reference organism	Tree								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
								C-14)	
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	3.24E-04	2.32E-04	2.47E-04	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03	0.00E+00	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$								uGy/h per Bq/kg in soil	ERICA Tool
$DC_{ext,ss}$			9.01E-05	3.20E-05	6.15E-05			uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						0.00E+00		uGy/h per Bq/m3	ERICA Tool
OF_s	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Noble Gas manually input
OF_{ss}	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Noble Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Noble Gas manually input

Table 240 Calculations used to determine the dose rate to soil invertebrate

Reference organism	Soil Invertebrate								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
D_{total}	6.66E-02	2.04E-03	7.87E-03	7.94E-08	1.87E-08	0.00E+00	**7.65E-02**	uGy/h	
D_{int}	6.66E-02	2.04E-03	1.51E-04	7.73E-08	1.89E-09	0.00E+00	6.87E-02	uGy/h	
D_{ext}	0.00E+00	0.00E+00	7.72E-03	2.09E-09	1.68E-08	0.00E+00	7.72E-03	uGy/h	
C_t	8.65E+03	7.02E+01	1.06E+00	2.75E-06	1.68E-05	0.00E+00		Bq/kg fw tissue	
C_s			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_{ss}			2.55E+01	2.23E-05	8.74E-05			Bq/kg dw soil	Soil concentration uses background corrected 2019 maximum sample data and IMPACT results
C_a	5.77E+01	1.64E-01				7.08E+00		Bq/m3 air	H-3, C-14 air concentrations use background corrected max annual average, others use IMPACT results
$CR_{t,s}$	1.50E+02	4.29E+02	4.15E-02	1.23E-01	1.92E-01	0.00E+00		Bq/kg fw tissue per Bq/kg soil OR per Bq/m3 air (H-3 and C-14)	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used

Table 240 Calculations used to determine the dose rate to soil invertebrate

Reference organism	Soil Invertebrate								
Category	Terrestrial								
Location	Bruce A								
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**I-131**	**Noble Gas**	**Total**	**Units**	**Source of info**
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05	2.76E-07	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.81E-05	1.41E-04	1.45E-04	1.12E-04	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03	0.00E+00	0.00E+00		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{ext,s}$			3.02E-04	9.34E-05	1.92E-04			uGy/h per Bq/kg in soil	ERICA Tool
$DC_{ext,ss}$								uGy/h per Bq/kg on soil	ERICA Tool
$DC_{ext,a}$						0.00E+00		uGy/h per Bq/m3	ERICA Tool
OF_s	1.00	1.00	1.00	1.00	1.00	0.00		unitless	ERICA Tool - Noble Gas manually input
OF_{ss}	0.00	0.00	0.00	0.00	0.00	0.00		unitless	ERICA Tool - Noble Gas manually input
OF_a	0.00	0.00	0.00	0.00	0.00	1.00		unitless	ERICA Tool - Noble Gas manually input

Table 241 Calculations used to determine the dose rate to aquatic bird Baie du Doré

Reference organism	Aquatic Bird BdD						
Category	Aquatic						
Location	Baie du Doré						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	7.14E-04	3.97E-03	3.09E-05	3.12E-04	5.02E-03	uGy/h	
D_{int}	7.14E-04	3.97E-03	3.09E-05	3.12E-04	5.02E-03	uGy/h	
D_{ext}	3.55E-11	1.37E-11	2.40E-08	2.98E-13	2.41E-08	uGy/h	
C_t	9.27E+01	1.36E+02	1.62E-01	1.03E-02		Bq/kg fw tissue	
C_w	9.27E+01	7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baie du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01	1.51E+00	1.45E+00	8.49E-01		Bq/Kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00	2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,w}$	1.00E+00	1.80E+05	1.88E+03	2.91E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.38E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.90E-04	3.51E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.83E-13	1.81E-08	2.79E-04	8.42E-08		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 242 Calculations used to determine the dose rate to aquatic mammal Baie du Doré

Reference organism	Aquatic Mammal BdD						
Category	Aquatic						
Location	Baie du Doré						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	7.14E-04	3.97E-03	7.39E-05	5.12E-04	5.27E-03	uGy/h	
D_{int}	7.14E-04	3.97E-03	7.39E-05	5.12E-04	5.27E-03	uGy/h	
D_{ext}	2.71E-11	9.40E-12	2.20E-08	2.26E-13	2.20E-08	uGy/h	
C_t	9.27E+01	1.36E+02	3.45E-01	1.69E-02		Bq/kg fw tissue	
C_w	9.27E+01	7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baire du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01	1.51E+00	1.45E+00	8.49E-01		Bq/kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00	2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,w}$	1.00E+00	1.80E+05	4.00E+03	4.79E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.38E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	2.13E-04	3.53E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	2.93E-13	1.24E-08	2.55E-04	6.38E-08		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 243 Calculations used to determine the dose rate to freshwater invertebrate Baie du Doré

Reference organism	Pelagic Invertebrate BdD						
Category	Aquatic						
Location	Baie du Doré						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	7.14E-04	3.79E-03	6.00E-07	3.58E-03	8.09E-03	uGy/h	
D_{int}	7.13E-04	3.79E-03	5.66E-07	3.58E-03	8.09E-03	uGy/h	
D_{ext}	1.22E-08	9.95E-10	3.38E-08	1.67E-12	4.70E-08	uGy/h	
C_t	9.27E+01	1.36E+02	7.34E-03	1.19E-01		Bq/kg fw tissue	
C_w	9.27E+01	7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baire du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01	1.51E+00	1.45E+00	8.49E-01		Bq/kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00	2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	8.52E+01	3.35E+04		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.38E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.69E-05	7.61E-05	3.11E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	1.32E-10	1.32E-06	3.93E-04	4.73E-07		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 244 Calculations used to determine the dose rate to insect larvae Baie du Doré

Reference organism	Benthic Invertebrate BdD						
Category	Aquatic						
Location	Baie du Doré						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	7.14E-04	3.86E-03	5.55E-04	3.59E-03	8.71E-03	uGy/h	
D_{int}	7.14E-04	3.86E-03	1.70E-05	3.58E-03	8.17E-03	uGy/h	
D_{ext}	2.96E-11	1.25E-06	5.38E-04	3.75E-07	5.39E-04	uGy/h	
C_t	9.27E+01	1.36E+02	1.71E-01	1.19E-01		Bq/kg fw tissue	
C_w	9.27E+01	7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baire du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01	1.51E+00	1.45E+00	8.49E-01		Bq/kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00	2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	1.99E+03	3.35E+04		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.38E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.74E-05	9.82E-05	3.14E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.19E-13	8.24E-07	3.70E-04	4.42E-07		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	0.00	0.00	0.00	0.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	1.00	1.00	1.00	1.00		Unitless	IMPACT

Table 245 Calculations used to determine the dose rate to freshwater plant Baie du Doré

Reference organism	Freshwater Plant BdD						
Category	Aquatic						
Location	Baie du Doré						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	7.13E-04	1.83E-04	2.98E-05	2.19E-04	1.14E-03	uGy/h	
D_{int}	7.13E-04	1.83E-04	2.92E-06	2.19E-04	1.12E-03	uGy/h	
D_{ext}	1.63E-07	8.41E-08	2.69E-05	1.87E-08	2.72E-05	uGy/h	
C_t	9.27E+01	6.51E+00	2.94E-02	7.25E-03		Bq/kg fw tissue	
C_w	9.27E+01	7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baire du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01	1.51E+00	1.45E+00	8.49E-01		Bq/kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00	2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	8.62E+03	3.42E+02	2.05E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.37E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.71E-05	9.83E-05	3.14E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	1.76E-09	1.10E-06	3.70E-04	4.41E-07		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	0.90	0.90	0.90	0.90		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 246 Calculations used to determine the dose rate to benthic fish Baie du Doré

Reference organism	Benthic Fish BdD							
Category	Aquatic							
Location	Baie du Doré							
Radionuclide	**H-3**	**OBT**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	9.04E-05	2.57E-05	1.25E-04	2.22E-04	1.59E-04	6.23E-04	uGy/h	
D_{int}	9.04E-05	2.57E-05	1.25E-04	1.78E-05	1.59E-04	4.18E-04	uGy/h	
D_{ext}	3.64E-11	0.00E+00	1.30E-08	2.05E-04	3.59E-08	2.05E-04	uGy/h	
C_t	1.17E+01	3.34E+00	4.31E+00	9.48E-02	5.26E-03		Bq/kg fw tissue	H-3, C-14 and Cs-137 tissue concentrations taken from background correct maximum value in Baire du dore
C_w	9.27E+01		7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baire du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01		1.51E+00	1.45E+00	8.49E-01		Bq/kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00		2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00		1.80E+05	3.65E+03	1.49E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	2.21E-06	3.06E-07	3.37E-07	1.38E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	1.06E-06	2.82E-05	1.87E-04	3.51E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.93E-13	0.00E+00	1.72E-08	2.81E-04	8.47E-08		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool

Table 246 Calculations used to determine the dose rate to benthic fish Baie du Doré

Reference organism	Benthic Fish BdD							
Category	Aquatic							
Location	Baie du Doré							
Radionuclide	**H-3**	**OBT**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
OF_{ws}	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool
OF_{ss}	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool
OF_{s}	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool

Table 247 Calculations used to determine the dose rate to pelagic fish Baie du Doré

Reference organism	Pelagic Fish BdD							
Category	Aquatic							
Location	Baie du Doré							
Radionuclide	**H-3**	**OBT**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
D_{total}	3.00E-05	4.85E-06	4.30E-05	5.03E-05	1.59E-04	2.87E-04	uGy/h	
D_{int}	3.00E-05	4.85E-06	4.30E-05	5.03E-05	1.59E-04	2.87E-04	uGy/h	
D_{ext}	3.55E-11	0.00E+00	1.37E-11	2.45E-08	3.16E-13	2.46E-08	uGy/h	
C_t	3.90E+00	6.30E-01	1.48E+00	2.72E-01	5.26E-03		Bq/kg fw tissue	H-3, C-14 and Cs-137 tissue concentrations taken from background correct maximum value in Baire du dore
C_w	9.27E+01		7.56E-04	8.61E-05	3.54E-06		Bq/kg	H-3 Water concentration taken from background corrected maximum annual average in Baire du dore, C-14 water concentrations taken from concentrations in fish and CR with surface water
C_s	9.27E+01		1.51E+00	1.45E+00	8.49E-01		Bq/kg	Cs-137 sediment concentration taken from the max of sediment values at Baie du Dore (see Excel tab)
K_d	1.00E+00		2.00E+03	1.69E+04	1.09E+05		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00		1.80E+05	3.65E+03	1.49E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	2.21E-06	3.06E-07	3.37E-07	1.38E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	1.06E-06	2.82E-05	1.84E-04	3.50E-06		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.83E-13	0.00E+00	1.81E-08	2.85E-04	8.92E-08		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	0.00	1.00	1.00	1		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool

Table 247 Calculations used to determine the dose rate to pelagic fish Baie du Doré

Reference organism	Pelagic Fish BdD							
Category	Aquatic							
Location	Baie du Doré							
Radionuclide	**H-3**	**OBT**	**C-14**	**Cs-137**	**Pu-239**	**Total**	**Units**	**Source of info**
OF_{ss}	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool
OF_s	0.00	0.00	0.00	0.00	0		Unitless	ERICA Tool

Table 248 Calculations used to determine the dose rate to aquatic bird Former Sewage Lagoon

Reference organism	Aquatic Bird FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	1.49E-02	2.85E-03	4.29E-04	2.32E-02	uGy/h	
D_{int}	5.04E-03	1.49E-02	2.84E-03	4.29E-04	2.32E-02	uGy/h	
D_{ext}	2.51E-10	5.13E-11	2.21E-06	5.50E-10	2.21E-06	uGy/h	
C_t	6.55E+02	5.12E+02	1.49E+01	1.52E-02		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
C_s	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	1.88E+03	2.91E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.90E-04	1.68E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.83E-13	1.81E-08	2.79E-04	1.05E-04		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 249 Calculations used to determine the dose rate to aquatic mammal Former Sewage Lagoon

Reference organism	Aquatic Mammal FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	1.49E-02	6.79E-03	7.05E-04	2.74E-02	uGy/h	
D_{int}	5.04E-03	1.49E-02	6.79E-03	7.05E-04	2.74E-02	uGy/h	
D_{ext}	1.92E-10	3.53E-11	2.02E-06	4.93E-10	2.02E-06	uGy/h	
C_t	6.55E+02	5.12E+02	3.17E+01	2.50E-02		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
C_s	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	4.00E+03	4.79E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	2.13E-04	1.79E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	2.93E-13	1.24E-08	2.55E-04	9.44E-05		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 250 Calculations used to determine the dose rate to pelagic invertebrate Former Sewage Lagoon

Reference organism	Pelagic Invertebrate FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	1.42E-02	5.51E-05	4.93E-03	2.43E-02	uGy/h	
D_{int}	5.04E-03	1.42E-02	5.20E-05	4.93E-03	2.42E-02	uGy/h	
D_{ext}	8.62E-08	3.74E-09	3.11E-06	7.97E-10	3.20E-06	uGy/h	
C_t	6.55E+02	5.12E+02	6.75E-01	1.75E-01		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
C_s	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	8.52E+01	3.35E+04		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.69E-05	7.61E-05	1.21E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	1.32E-10	1.32E-06	3.93E-04	1.53E-04		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table N-18: Calculations used to determine the dose rate to benthic invertebrate Former Sewage Lagoon

Reference organism	Benthic Invertebrate FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	1.45E-02	5.10E-02	4.93E-03	7.55E-02	uGy/h	
D_{int}	5.04E-03	1.45E-02	1.56E-03	4.93E-03	2.60E-02	uGy/h	
D_{ext}	2.09E-10	4.68E-06	4.94E-02	7.53E-09	4.94E-02	uGy/h	
C_t	6.55E+02	5.12E+02	1.57E+01	1.75E-01		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
Cs	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	1.99E+03	3.35E+04		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.74E-05	9.82E-05	1.29E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.19E-13	8.24E-07	3.70E-04	1.44E-04		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	0.00	0.00	0.00	0.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
Of_s	1.00	1.00	1.00	1.00		Unitless	IMPACT

Table 251 Calculations used to determine the dose rate to freshwater plant Former Sewage Lagoon

Reference organism	Freshwater Plant FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	6.86E-04	2.74E-03	3.01E-04	8.77E-03	uGy/h	
D_{int}	5.04E-03	6.85E-04	2.69E-04	3.01E-04	6.29E-03	uGy/h	
D_{ext}	1.15E-06	3.16E-07	2.48E-03	1.13E-09	2.48E-03	uGy/h	
C_t	6.55E+02	2.45E+01	2.71E+00	1.07E-02		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
C_s	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	8.62E+03	3.42E+02	2.05E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.71E-05	9.83E-05	1.24E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	1.76E-09	1.10E-06	3.70E-04	1.49E-04		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	0.90	0.90	0.90	0.90		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
Of_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 252 Calculations used to determine the dose rate to benthic fish Former Sewage Lagoon

Reference organism	Benthic Fish FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	1.49E-02	2.43E-02	2.19E-04	4.44E-02	uGy/h	
D_{int}	5.04E-03	1.49E-02	5.44E-03	2.19E-04	2.56E-02	uGy/h	
D_{ext}	2.57E-10	4.88E-08	1.88E-02	3.05E-09	1.88E-02	uGy/h	
C_t	6.55E+02	5.12E+02	2.89E+01	7.76E-03		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
C_s	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	3.65E+03	1.49E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.87E-04	1.67E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.93E-13	1.72E-08	2.81E-04	1.06E-04		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	0.00	0.00	0.00	0.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

Table 253 Calculations used to determine the dose rate to pelagic fish Former Sewage Lagoon

Reference organism	Pelagic Fish FSL						
Category	Aquatic						
Location	FSL						
Radionuclide	**H-3**	**C-14**	**Cs-137**	**Np-237**	**Total**	**Units**	**Source of info**
D_{total}	5.04E-03	1.49E-02	5.35E-03	2.19E-04	2.55E-02	uGy/h	
D_{int}	5.04E-03	1.49E-02	5.35E-03	2.19E-04	2.55E-02	uGy/h	
D_{ext}	2.51E-10	5.13E-11	2.25E-06	5.63E-10	2.25E-06	uGy/h	
C_t	6.55E+02	5.12E+02	2.89E+01	7.76E-03		Bq/kg fw tissue	
C_w	6.55E+02	2.84E-03	7.92E-03	5.22E-06		Bq/kg	H-3 water concentration taken from background corrected maximum annual average in FSL
C_s	6.55E+02	5.67E+00	1.34E+02	5.22E-05		Bq/kg	IMPACT
K_d	1.00E+00	2.00E+03	1.69E+04	1.00E+02		L/kg	ERICA Tool
$CR_{t,a}$	1.00E+00	1.80E+05	3.65E+03	1.49E+03		uGy/h	ERICA Tool - Bounding alpha CR among Am, Cm, Np, Pu, U used
$DC_{int\_lowbeta}$	2.21E-06	3.06E-07	3.37E-07	1.15E-05		uGy/h per Bq/kg fw tissue	ERICA Tool
$DC_{int\_normalbeta}$	1.06E-06	2.82E-05	1.84E-04	1.66E-04		uGy/h per Bq/kg fw tissue	ERICA Tool
DC_{int_alpha}	0.00E+00	0.00E+00	0.00E+00	2.80E-03		uGy/h per Bq/kg fw tissue	ERICA Tool
Dc_{ext}	3.83E-13	1.81E-08	2.85E-04	1.08E-04		uGy/h per Bq/kg water or sediment	ERICA Tool
OF_w	1.00	1.00	1.00	1.00		Unitless	ERICA Tool
OF_{ws}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_{ss}	0.00	0.00	0.00	0.00		Unitless	IMPACT
OF_s	0.00	0.00	0.00	0.00		Unitless	IMPACT

15.0 APPENDIX O: TRITIUM IN WATER

This appendix is provided in response to a CNSC request from the 2017 ERA for additional assessment of the spatial distribution of tritium in the terrestrial environment, including assessment of well BATR-1-14B [R-293]. It includes an updated comparison of measured groundwater tritium concentrations to those modelled in IMPACT from airborne deposition, and a discussion of the results of waterborne tritium in the radiological HHRA and EcoRA as they relate to Ontario drinking water standards for tritium [R-243].

The ERA does not directly apply screening criteria for tritium because radionuclides are not subject to screening under N288.6, but are instead incorporated directly into dose assessments. The radiological EcoRA utilizes bounding concentrations of tritium in on-site surface waterbodies (Appendix N). The radiological HHRA utilizes data from the monitoring of tritium in Water Supply Plants and residential wells (Appendix L).

In responding to regulatory comments on the 2017 ERA, Bruce Power committed to using screening criterion for tritium in porewater/groundwater that is protective of non-human biota if the corresponding location is considered habitat for aquatic biota and a screening criterion protective of humans if the groundwater was considered potable [R-243]. Groundwater discharge to surface water is assessed through surface water sampling results in the 2022 ERA.

The current established standard in the Ontario Drinking Water Quality Standards for tritium in drinking water in Ontario is an annual average of 7,000 Bq/L, however, groundwater is not used as drinking water on site [R-9]. There is no regulatory criterion for tritium in non-potable water. The groundwater results presented here do not represent aquatic habitat. Because these groundwater results do not represent aquatic habitat or potable drinking water, no screening criteria is required.

15.1 Groundwater

15.1.1 Methods

As a follow-up to the 2017 ERA and comments from the CNSC, a supplementary study of tritium in groundwater was conducted at the Bruce Power Site to compare measured tritium concentrations to values modelled in IMPACT based on airborne tritium emissions [R-202]. It was concluded that for most wells, tritium levels measured in 2016/2017 were consistent with dispersion and deposition modelled by IMPACT. Of the >100 wells that were measured, only three had measured tritium concentrations that were higher than modelled porewater concentrations, two of which were very similar to the modelled threshold. The well at BATR-1-14B near Bruce A had measured tritium concentrations that were ~30% greater than modelled, and further monitoring was completed at this location for the 2022 ERA [R-293].

The supplementary study of tritium in groundwater completed following the 2017 ERA [R-293] is updated in this appendix with data from 2018 to 2020. This update describes the concentrations of tritium in groundwater at the Bruce Power Site, and evaluates whether measured concentrations are within the range expected based on current atmospheric emissions as modelled by IMPACT. The update includes a total of 163 groundwater wells at locations near Bruce A, Bruce B and within Centre of Site. Measured concentrations were compared to concentrations modelled in IMPACT based on the 5-year average airborne tritium emissions. Measurements of average annual tritium in precipitation samples at Bruce A, Bruce B, and WWMF in 2019 and 2020 are also presented. These provide an indication of the contribution of wet deposition of atmospheric emissions to tritium levels in groundwater.

It is important to note that the IMPACT model is not designed for use immediately adjacent to nuclear power plants because the dispersion model does not simulate the cavity that forms within the lee of a building (within approximately three building heights downwind), and therefore may not be accurate for estimating groundwater concentrations at certain wells, particularly in close proximity to Bruce A and Bruce B. Therefore, the concentrations at these locations are estimated values for the purposes of comparison only. Tritium groundwater concentrations, as modelled by IMPACT, provide an estimate of the concentrations that are present because of airborne emissions. Therefore, this comparison facilitates the identification of any unexpected areas of tritium contamination requiring investigation.

IMPACT determines average tritium concentrations in air based on release rates and meteorological data. Average release rates used in the calculation are based on 2016-2020 data. Soil water (surface groundwater) HTO concentration is calculated as follows:

$$Soil_{HTO} = Air_{HTO} \times \frac{RF_{SW}}{H_a}$$

Where:

- $Soil_{HTO}$ is the concentration of tritium in soil water (surface groundwater) (Bq/L);
- Air_{HTO} is the concentration of tritium in air (Bq/m^3);
- RF_{SW} is the ratio of HTO concentration in soil water to that in air moisture, default value 0.3 (Bq/L soil water per Bq/L air moisture) [R-97];
- H_a is the annual average absolute humidity, default value for Western Ontario 0.0066 (L/m^3) [R-97];

Since groundwater transit time at each well is not known, the modelling comparison is based on shallow porewater concentrations. These provide an upper range estimate of borehole tritium concentration based on airborne emissions, assuming no radioactive decay during transport from the surface to the well. Given that the majority of boreholes are located in areas where the overburden material is relatively fast-draining backfill, this is expected to be a reasonable assumption.

15.1.2 Bruce A Groundwater Results

Locations of the Bruce A groundwater wells measured for tritium are shown in Figure 151.

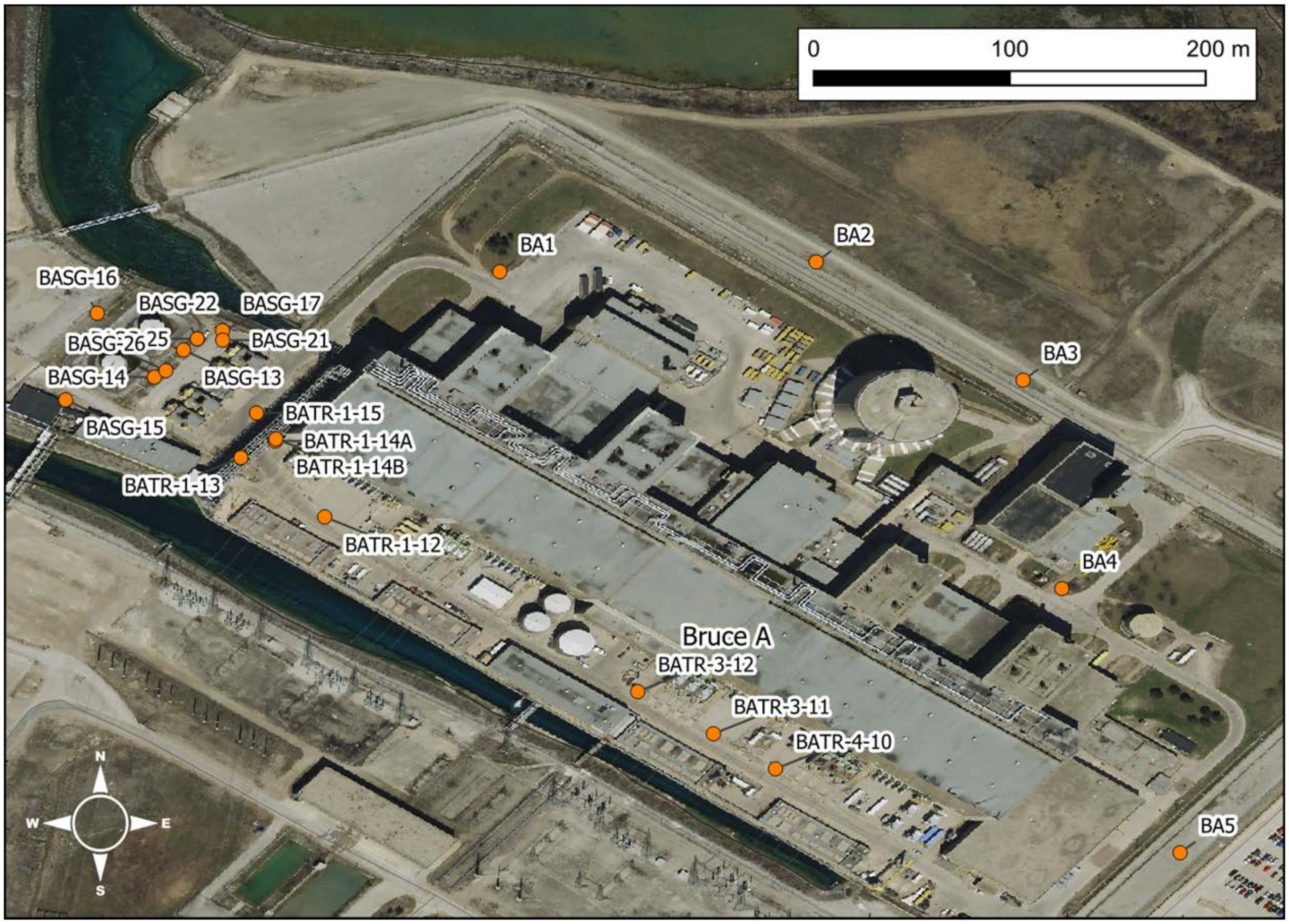

Figure 151 Bruce A Groundwater Wells

A comparison between the measured groundwater wells and the IMPACT calculated tritium concentrations is shown in Figure 152. Average tritium values in precipitation at Bruce A were 784 Bq/Lin 2019 and 464 Bq/L in 2020. In 2020, measured concentrations in all Bruce A wells were below modelled values, although there were several instances where tritium levels from previous years exceeded modelled concentrations. The BATR-3-12, BA 4-2, and BATR-1-14B wells exceeded the predicted levels between 2016 and 2018. Continued monitoring of these wells has demonstrated concentrations decreasing below modelled values. A historic moderator spill at BA 4-2 in 2012 is the likely cause of the elevated tritium levels at that well. This event is described in the 2013 EPR and tritium peaked in June of 2013 at 6,090 Bq/L [R-242].

Modelled concentrations are based on 2016-2020 average emissions data, therefore exceedances may be attributable to variability in tritium emissions in specific years. Additionally, the IMPACT model is not explicitly designed to model airborne emissions in the immediate vicinity of buildings due to changes in airborne dispersion that occurs near buildings.

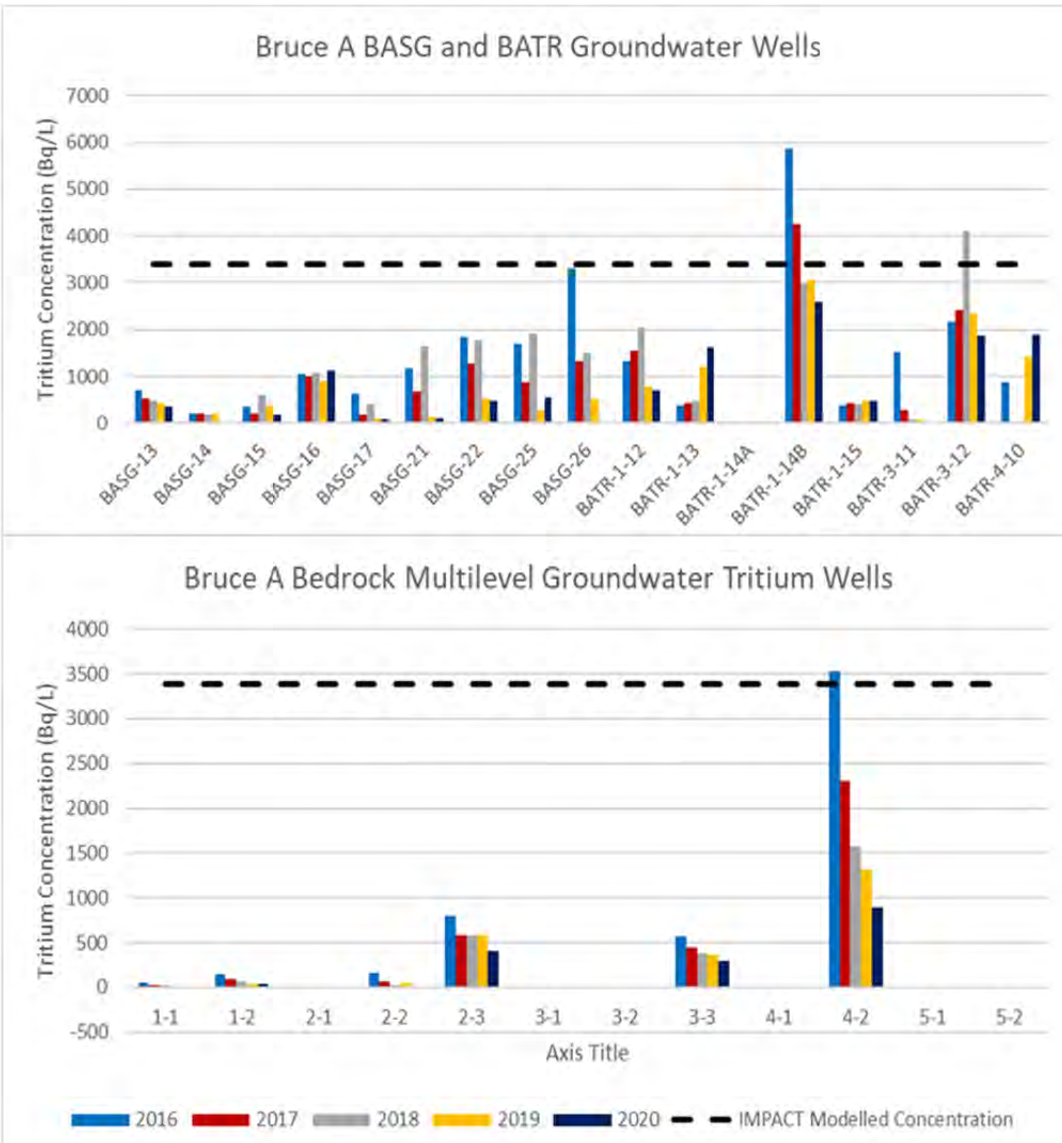

Figure 152 Bruce A groundwater wells tritium concentration compared to IMPACT calculated porewater concentrations. (Note: For the multilevel wells, the first digit indicates well #, and second digit indicates well depth with higher being closer to the surface)

15.1.3 Bruce B Groundwater Results

Locations of Bruce B groundwater wells measured for tritium are shown in Figure 153.

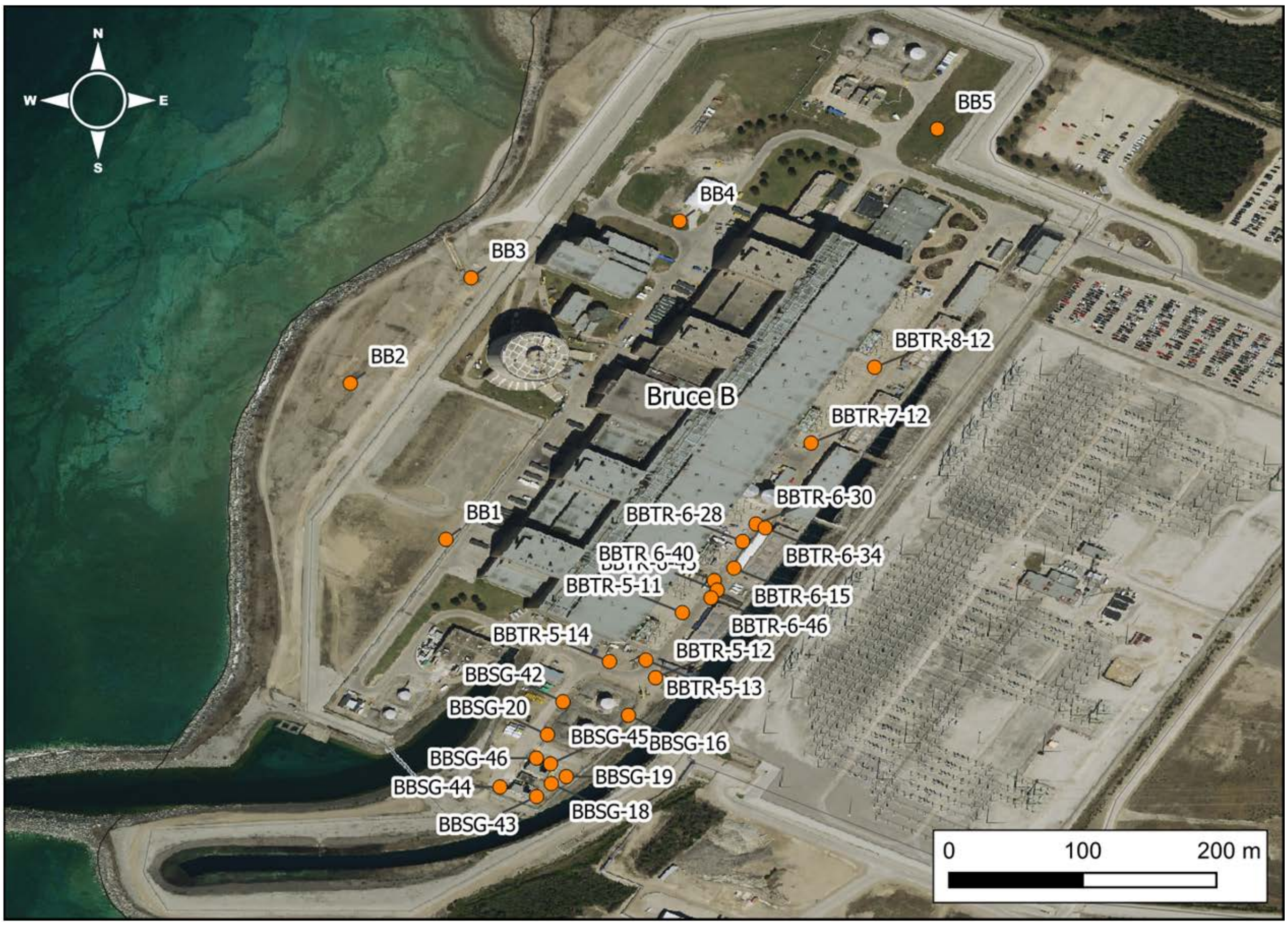

Figure 153 Bruce B Groundwater Wells

A comparison between the measured groundwater wells and the IMPACT calculated tritium concentrations is shown in Figure 154. Average tritium values in precipitation at Bruce B were 513 Bq/Lin 2019 and 425 Bq/L in 2020. In 2020, measured concentrations in all Bruce B wells were below modelled values, although there were instances where tritium levels from previous years exceeded modelled concentrations. The BBTR-7-12 well tritium concentration exceeded predicted levels in 2017 and 2018. Continued monitoring of this well has demonstrated concentrations decreasing below modelled values. It is noted that modelled concentrations are based on 2016-2020 average emissions data, therefore exceedances may be attributable to variability in tritium emissions in specific years. Additionally, the IMPACT model is not explicitly designed to model airborne emissions in the immediate vicinity of buildings due to changes in airborne dispersion that occurs near buildings.

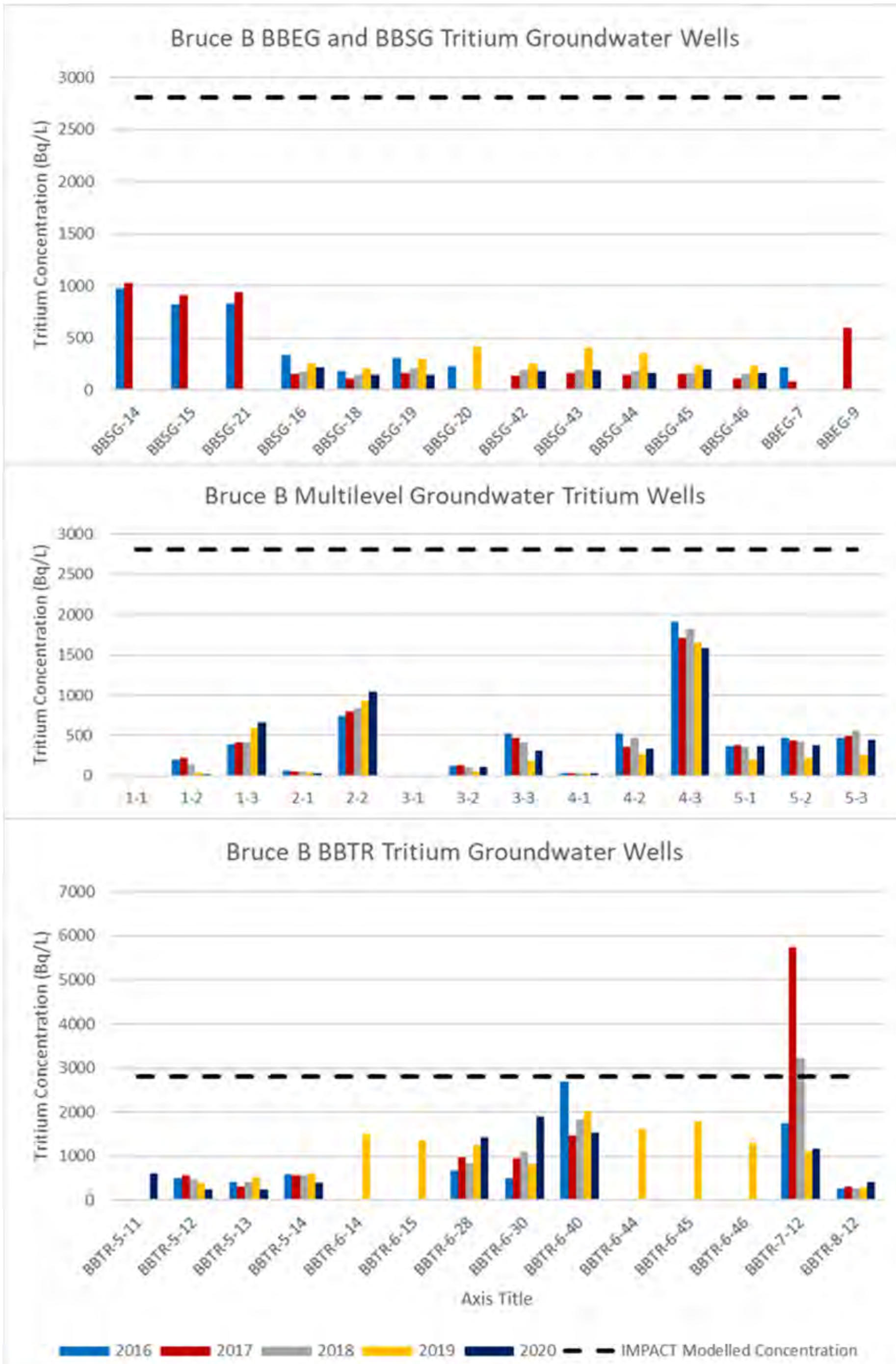

Figure 154 Bruce B groundwater wells tritium concentration compared to IMPACT calculated porewater concentrations. (Note: For the multilevel wells, the first digit indicates well #, and second digit indicates well depth with higher being closer to the surface)

15.1.4 Center of Site Groundwater Results

Locations of the center of site groundwater wells measured for tritium are shown in Figure 74.

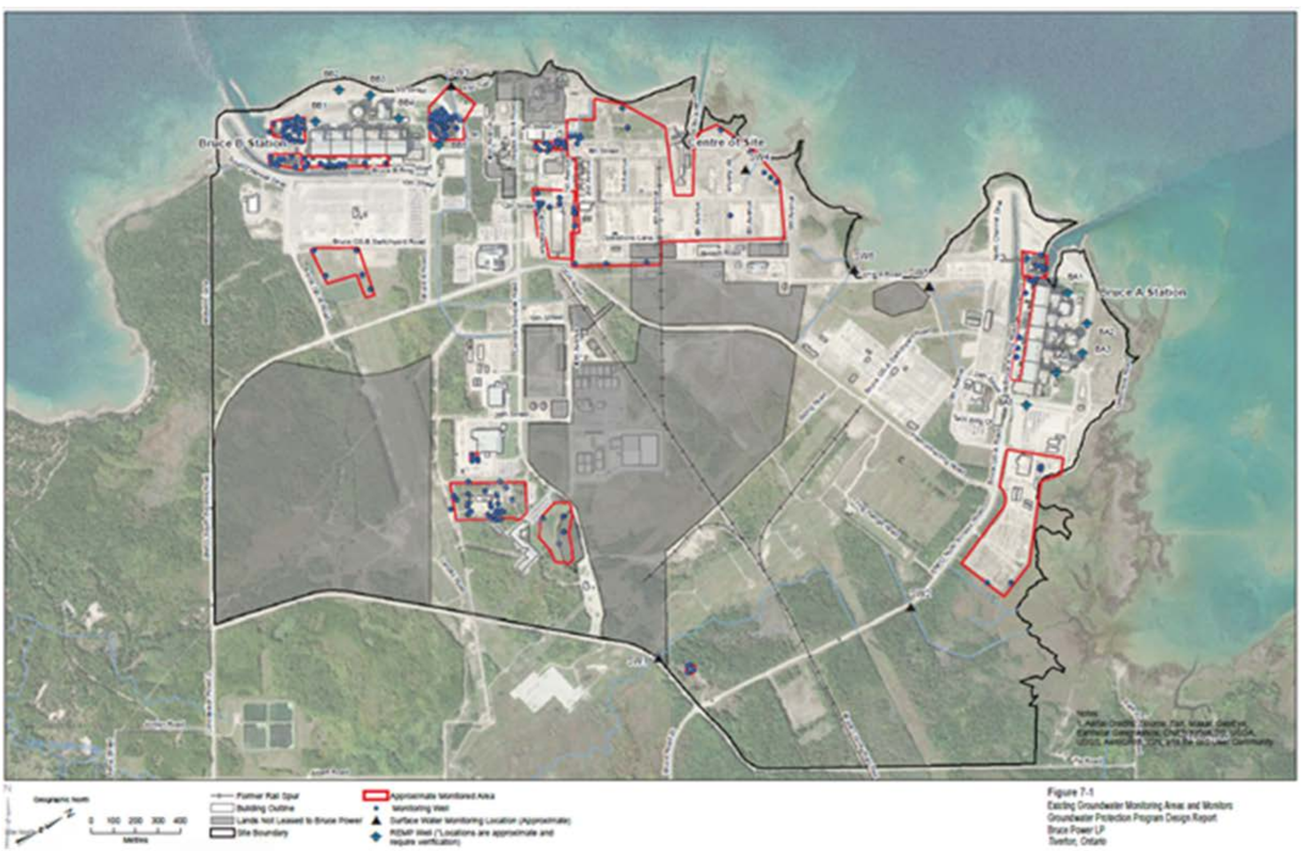

Figure 155 Bruce Site Groundwater Well Locations

A comparison between the measured groundwater wells and the IMPACT calculated tritium concentrations is shown in Figure 156, Figure 157, Figure 158 and Figure 159. Average tritium values in precipitation at WWMF were 580 Bq/L in 2019 and 527 Bq/L in 2020. In 2020, all wells were below modelled values. There were two instances in 2017 where the measured groundwater tritium value marginally (by less than 50 Bq/L) exceeds the calculated 5-year average IMPACT concentration based on airborne emissions, with one instance at the Former Sewage Lagoon and at one instance at the Bruce A Storage Compound. Given that the IMPACT concentration represents a 5-year average, these marginal sampling event exceedances would be expected in the context of a reliable and accurate model. Continued monitoring at the FSL location has demonstrated concentrations decreasing below modelled values. While the value at BASC-16 slightly exceeded predicted trtium concentrations in 2017, levels are within the expected range given historical tritium emissions. Based on previous modelling considering 2012-2016 emissions data, the tritium concentrations at BASC-16 in 2017 are attributable to airborne deposition. BASC-16 is installed at a shallower interval than the remaining BASC wells and may be subject to additional airborne deposition due to its shallower depth.

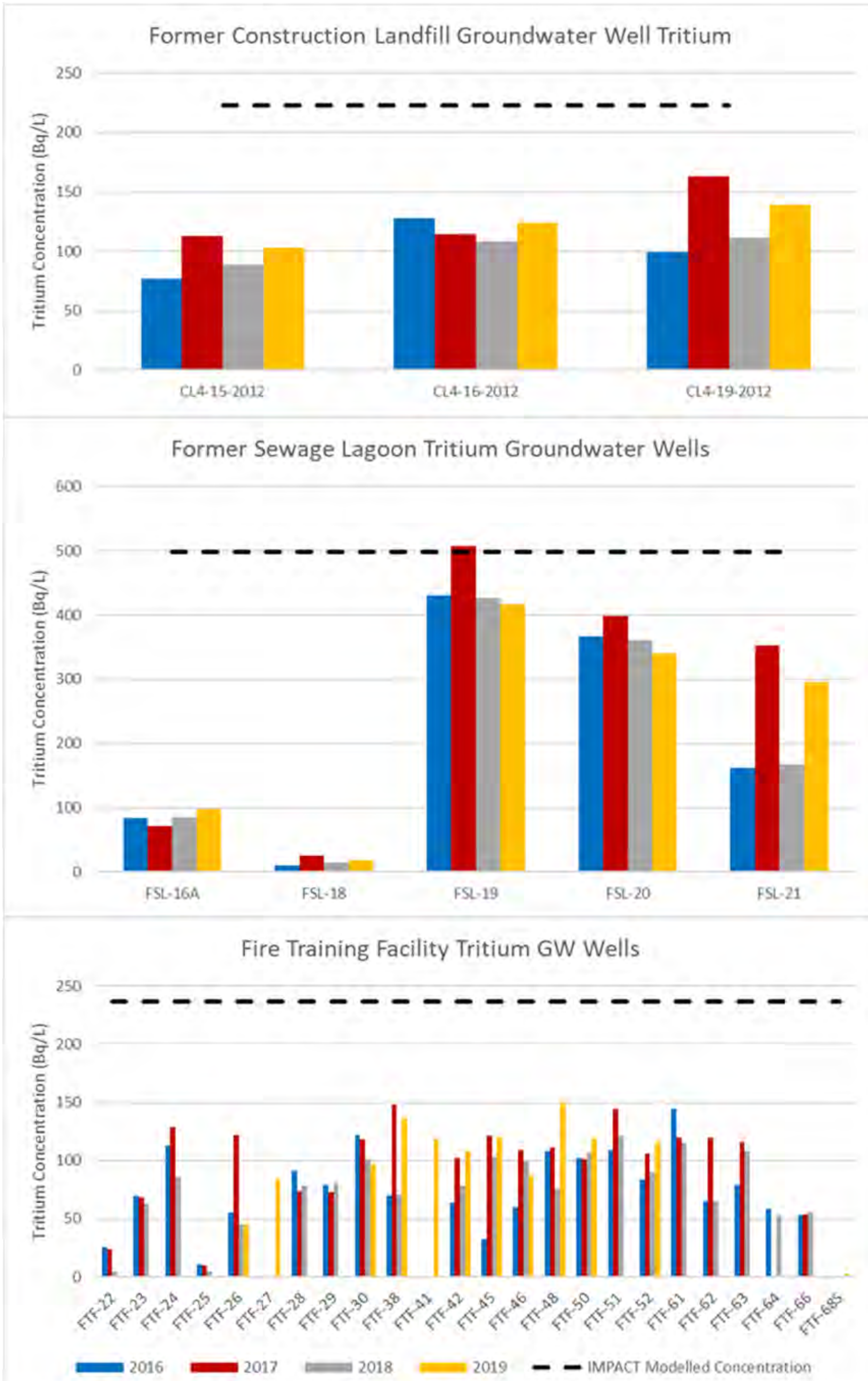

Figure 156 Construction Landfill #4, Former Sewage Lagoon and Fire Trainign Facility groundwater wells tritium concentration compared to IMPACT calculated porewater concentrations.

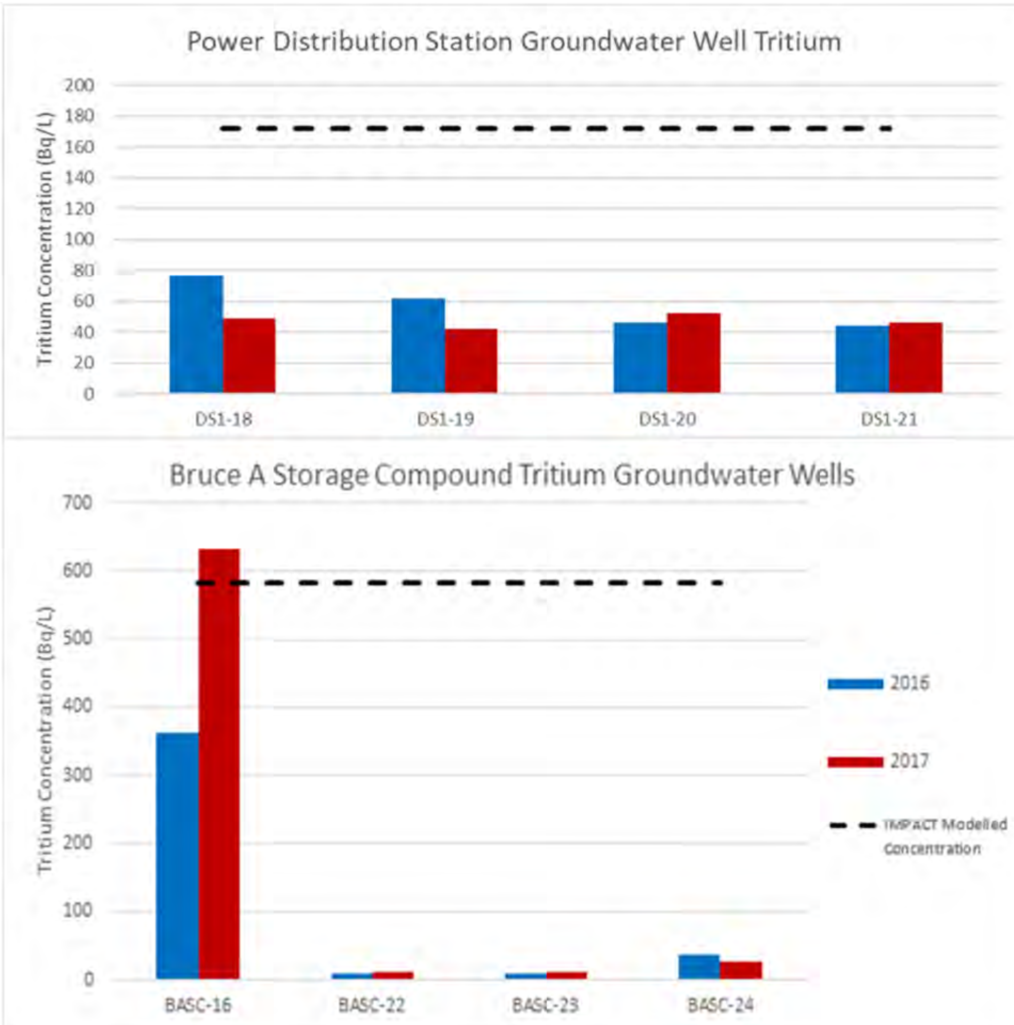

Figure 157 Distribution Station #1 and Bruce A Storage Compund groundwater wells tritium concentration compared to IMPACT calculated porewater concentrations. BASC-16 is installed at a shallower interval than the remaining BASC wells and may be subject to additional airborne deposition due to its shallower depth.

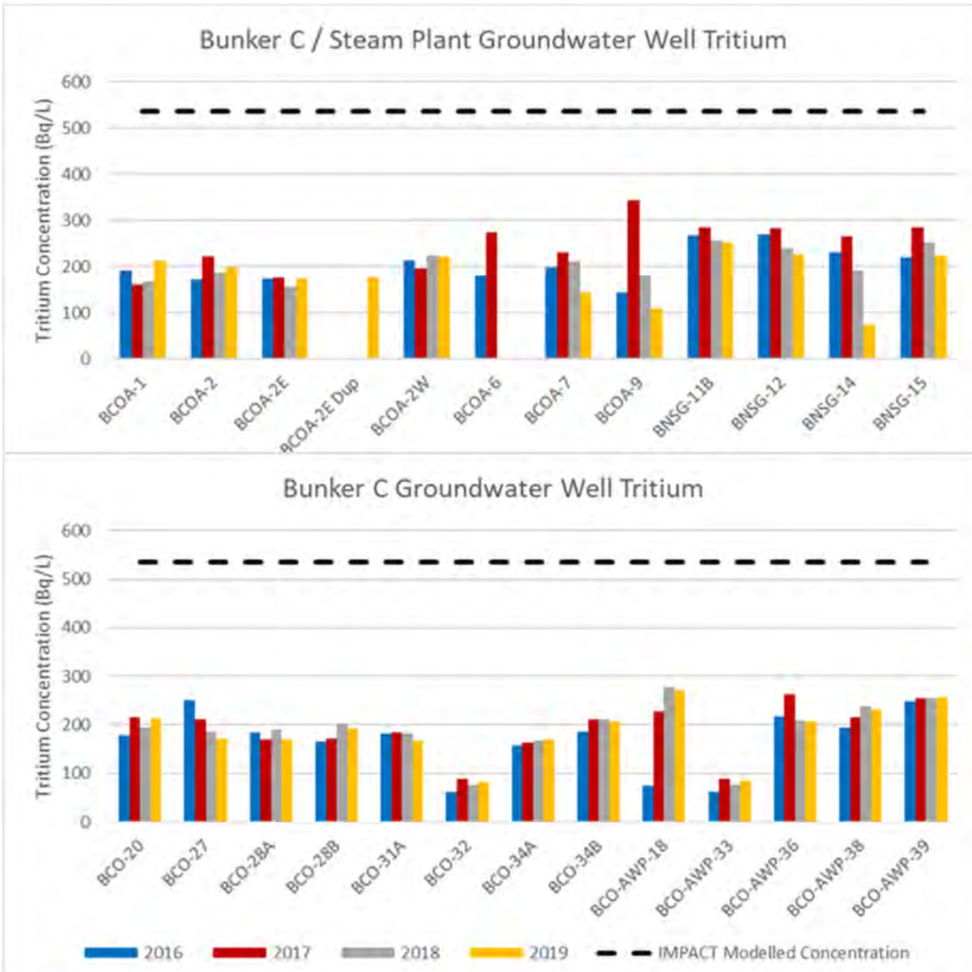

Figure 158 Buncker C/Steam Plant groundwater wells tritium concentration compared to IMPACT calculated porewater concentrations.

Figure 159 Central Maintenance and Laundry Facility and Former Heavy water Lands groundwater wells tritium concentration compared to IMPACT calculated porewater concentrations.

15.1.5 Conclusion

Measured concentrations in groundwater are generally below modelled concentrations and precipitation results, indicating that the measured tritium concentrations correspond to levels expected, and conservatively estimated by the IMPACT model, based on airborne emissions.

Some caveats must be noted with respect to utilizing IMPACT to calculate tritium concentration in groundwater. As discussed, modelling calculations have utilized 5-year average emission rates and meteorological data, as well as a specific activity model which assumes a constant ratio between HTO in air moisture and soil water. In reality, tritium concentrations may be affected by variations in factors including emission rates, meteorological data, humidity, and wind directions during precipitation events. The dispersion model does not simulate the cavity that forms within the lee of a building (within approximately three building heights downwind), and therefore may not be accurate for estimating groundwater concentrations at certain wells, particularly in close proximity to Bruce A and Bruce B. The concentrations at these locations are estimated values for the purposes of comparison only.

In 2020, measured concentrations in all Bruce Power wells were below modelled values. There were five instances where concentrations in previous years exceeded modelled concentrations, however these exceedances are expected based on model uncertainties and variability in tritium emissions in specific years. A sixth exceedance of modelled concentrations is attributable to a historic spill at BA 4-2. The 2016-2020 groundwater results for tritium concentrations at all measured wells remain well below the Ontario Drinking water Standard (ODWS) of 7,000 Bq/L.

The Bruce Power groundwater wells presented are from boreholes surrounding site facilities (e.g., surrounding standby generators, transformer area, etc.), and do not represent areas of known contamination. Results are generally within the range expected based on emissions modelling. Based on the spatial distribution of these wells and the absence of known tritium plumes, contour diagrams would not provide any additional useful information to improve the protection of groundwater as a resource on the Bruce Power site.

Bruce Power's Groundwater Protection and Monitoring Program follows CSA Standard N288.7 and is designed to ensure the protection of groundwater as a resource. Future analysis of tritium in groundwater will be based on comparison to the ODWS, and a statistical approach to compare against historical results and understand any deviations from normal. When deviations from normal are observed, further investigations are undertaken as needed. Therefore, re-analysis of expected tritium concentrations in groundwater based on IMPACT modelling will not be included in future ERAs.

15.2 HHRA for Radiological Contaminants

Bruce Power monitors tritium concentrations from municipal water supply plants (WSPs), residential wells, lakes, and streams.

Bruce Power has a longstanding commitment to maintain annual and monthly average tritium concentrations at WSPs below 100 Bq/L [R-368]. Both the Kincardine and Southampton WSPs had average annual tritium concentrations that were well below Bruce Power's administrative level of 100 Bq/L from 2016-2020. The highest annual average tritium concentrations for the plants were 11.6 Bq/L for the Southampton plant (2019) and 5.9 Bq/L for the Kincardine plant (2016). The corresponding background-subtracted values used in the HHRA were 10.0 Bq/L and 4.2 Bq/L, respectively.

The average annual tritium concentration for all wells, both shallow and deep, were far below the Ontario Drinking Water Standard of 7,000 Bq/L from 2016-2020. The majority of deep well tritium values from 2016-2020 were below the limit of detection, and were conservatively assumed to be equal to the detection limit in the Radiological HHRA. The highest annual average tritium concentration in the deep wells was 46.9 Bq/L (BR1, 2017) and 103.1 Bq/L (BR04, 2017) for the shallow wells. The corresponding background-subtracted values used in the HHRA were 45.2 Bq/L and 101.0 Bq/L, respectively.

All concentrations of tritium in drinking water are far below the ODWS guideline of 7,000 Bq/L [R-9]. Measurements of tritium in drinking water are incorporated in the Radiological HHRA. The radiation doses to members of the public residing in the area surrounding the Site are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). Even considering bounding values from 2016-2020, the maximum calculated doses to all human receptors continue to be below the 10 uSv *de minimis* value. Furthermore, tritium in drinking water is a small contributor to calculated doses to members of the public.

15.3 EcoRA for Radiological Contaminants

There are no explicit screening criteria for tritium in water that are protective of biota, however dose from tritium in water is represented in the dose to biota assessment. The location with the highest waterborne tritium concentration was used in the dose to aquatic biota calculations, the Former Sewage Lagoon. The maximum measurement of waterborne tritium at the FSL from 2021 was used to conservatively represent the FSL in all calculations. This concentration (655 Bq/L) is far below the ODWS of 7,000 Bq/L [R-9].

The other aquatic site used in the dose to biota calculations was the Baie du Doré location, located near Bruce A. The value used to represent the waterborne tritium concentrations (93 Bq/L) was the maximum sample concentration from 2016-2020, which was also far below the ODWS [R-9].

The resulting dose to aquatic biota was found to be far below the UNSCEAR limits, as well as the more restrictive benchmark values proposed by Environment Canada/Health Canada of 0.5 mGy/d for fish. All receptors had dose rates less than 1% of the limits.

16.0 APPENDIX P: 2017 ERA CONCORDANCE TABLE

Table 254 Concordance Table for CNSC/ECCC Comment from the Closure of the 2017 ERA requiring Additional Actions in the 2022 ERA

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
1/Comparisons for I&E Losses	Bruce Power must add summary statements to bullet #10 in Section 5.4.11 to include additional comparisons included in Section 5.4.5 regarding Ontario Commercial Fisheries Association statistics for Round Whitefish, White Bass, Channel Catfish and Northern Pike harvests for all of Lake Huron, Bruce Power's Creel survey data and Smallmouth Bass surveys conducted from 2010-2017.	[R-243][R-286]	Risk characterization of the impacts of population level effects from I & E losses is supported by comparisons of I&E values to the following: • Commercial fisheries data from the Ontario Commercial Fisheries Association (OCFA); • Commercial fishery data from management zone-1 based on Ontario Ministry of Natural Resources and Forests (MNRF) data; • Sport fishing data from creel survey data; • Smallmouth Bass nesting data, and; • HPI values of other Great Lakes.	Section 6.4 Fish Entrainment Impingement: Risk Characterization in [R-22]
2/Hazardous Contaminants in South Railway Ditch	Bruce Power must revise Section 9.2.4 to include the following recommendation: "From the EcoRA, the concentration of hazardous contaminants in the sediments and water of the South Railway Ditch must be measured to determine if the concentrations for the aquatic biota exposure assessment are higher than in Stream C."	[R-243][R-286]	Sampling was coordinated with OPG in 2020 and results are presented in [R-369]. Full environmental risk assessment of the South Railway Ditch is presented in the 2021 Update to the WWMF ERA [R-2].	Appendix E of [R-369] in Table 129 and Table 133.

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
3/Radiological Contaminants in South Railway Ditch	Bruce Power must revise Section 9.2.5 to include a modification to the recommendation as follows: "From the EcoRA, the radioactivity in the sediments and water of the South Railway Ditch must be measured to determine if the concentrations for the aquatic biota exposure assessment are higher than in Stream C."	[R-243][R-286]	Sampling was coordinated with OPG in 2020 and results are presented in [R-369]. Full ERA assessment of the South Railway Ditch is presented in the 2021 Update to the WWMF ERA [R-2].	Appendix N of [R-369] in Table 232 and Table 233.
4/ Discharge channel interactions	Bruce Power must include a more complete description of the interaction of the jet plume from the discharge channels with the prevailing current and the potential impact on the local ecosystem and consider additional monitoring for Gas Bubble Trauma (GBT) when the life-extension program is complete and all reactors are operable to confirm the conclusions of the ERA. Further, the conclusions included in Subsection 9.1.1.4 must be complete and include conclusions regarding young smallmouth bass and zooplankton displacement and GBT.	[R-243][R-293]	All currently available information to describe to the interaction of the jet plume from the discharge channel with the prevailing currents is included in Section 6.2. Information on potential impacts to aquatic plants, plankton, benthic invertebrates and fish is provided. This includes potential impacts to young Smallmouth Bass and zooplankton as requested by CNSC/ECCC. Current available information regarding GBT is presented. The need to evaluate for monitoring related to Gas Bubble Trauma at the completion of the Life Extension Program will be carried to the 2027 ERA. Thermal plume modeling, including modeling of the currents created by the water flow, will continue as part of the routine conventional environmental monitoring program.	Section 6.2 of the conventional EcoRA in [R-22].

Comment Number/Title	**Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA**	**Source of CNSC or ECCC Comment**	**Bruce Power's Response in 2022 ERA**	**Location of Information in 2022 ERA**
5/ Deepwater Sculpin Populations	Bruce Power must continue to engage with Fisheries and Oceans Canada to determine reasonable methods for future monitoring of Deepwater Sculpin to gain a better understanding of the local population and the potential impacts of entrainment.	[R-243][R-293]	DFO has indicated that they are planning multi-depth trawls in the vicinity of Bruce Power, pending available funding [R-370]. Bruce Power has completed a literature review on current Deepwater Sculpin research and has included a summary of the findings in the Site Description.	Section 1.8.9 of Appendix A: Site Description in [R-369]

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
6/Reptile and Amphibian Assessment	Bruce Power must provide a more complete and quantitative risk assessment of contaminant impacts on relevant reptile and amphibian species, including those inhabiting the Former Sewage Lagoon site as well as other potential habitat such as wetlands and meadows.	[R-243][R-293]	Surface water and sediment samples were obtained from Stream C, and the permanent drainage features on site, including Former Sewage Lagoon, B16 Pond, B31 Pond and the Eastern Drainage Ditch. A quantitative assessment of relevant reptile and amphibian species was completed using available assessment criteria.	Contaminant results are provided in Appendix E. Screening of results is provided in Appendix C Chemical Screening. Full EcoRA results are available in Appendix F: Ecological Risk Assessment for Chemicals – Exposure and Risk Tables. A summary of the EcoRA of reptile and amphibian species is included in Section 4.0 of [R-22].

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
7/Tritium in well BATR-1-14B	Bruce Power must conduct the recommended investigation of elevated tritium in well BATR-1-14B and provide the conclusions. "The BATR-1-14B well, located in the Bruce A West Transformer Area, had an average measured tritium concentration of 5.07E+03 Bq/L, which is ~30% greater than modelled porewater concentrations near Bruce A. It is recommended that the cause of the increased tritium concentration at this well be investigated."	[R-243][R-293]	The supplementary study completed after the 2017 ERA [R-202] has been updated with recent data in Appendix O: Tritium in Water [R-369]. Measured concentrations in groundwater are generally below modelled concentrations and precipitation results, indicating that the tritium concentrations present correspond to levels expected based on airborne emissions. Specifically, the BATR-1-14B well has been trending downward since 2016 and is now below the modelled tritium concentration.	Appendix O: Tritium in Water [R-369], Section 15.2 Groundwater.
8/Radiological contaminants below MDL	Bruce Power must address the issue of radiological contaminants where the results are below laboratory detection limits. An acceptable method can be found in Annex D of CSA N288.4.	[R-243][R-293]	Results of radiological contaminants in airborne emissions (weekly) and waterborne effluents (monthly) that are below the detection limits are considered to be indistinguishable from background and are not included in the summed annual totals. This is consistent with CSA N288.0-22 Annex D, which has effectively replaced CSA N288.4 Annex D. The justification of this approach is provided in Appendix J of the 2022 ERA.	Section 3.2.4 of the Radiological HHRA, Section 5.28 of the Radiological EcoRA in [R-22] Appendix J, Section 10.0.
9/ Soil Monitoring program	A recommendation was added to Section 9.2.4: It is recommended that soil monitoring continue specifically in locations where risks were not reduced to HQs less than 1 (i.e., the Fire Training Facility and the Bruce A Storage Compound).	[R-243]	Soil monitoring was completed in 2021 at locations where risks were not reduced to an HQ of less than 1, including the Fire Training Facility and the Bruce A Storage Compound.	Results are presented in Appendix E of [R-369] in Table 85 to Table 124.

Comment Number/Title	**Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA**	**Source of CNSC or ECCC Comment**	**Bruce Power's Response in 2022 ERA**	**Location of Information in 2022 ERA**
10/Groundwater COPC Screening	Consider the Federal Interim Groundwater Quality Guidelines in future iterations of the ERA.	[R-243]	The Federal Interim Groundwater Quality Guidelines (Table 3 – Tier 1 Criteria for Industrial Use) were considered as part of the preliminary screening for groundwater in the 2022 ERA.	Appendix C of [R-369] in Section 3.4.4.

11/COPCs for consideration in the next ERA	Consider additional COPCs in the next ERA:
	COPCs in soil samples:
	• Construction Landfill #1
	• Construction Landfill #2
	• Construction Landfill #3
	• Construction Landfill #4
	• FTF
	• Former Sewage Lagoon
	• Bruce A Storage Compound
	• Distribution Station #1
	• Bruce Snow Dump
	• Bruce B Empty Drum Laydown
	COPCs in groundwater samples:
	• CL4
	COPCs in surface water samples:
	• Off-site:
	  ○ Bruce A Discharge
	  ○ Off Douglas Pt.
	  ○ Bruce B Discharge
	  ○ Off Bruce B
	  ○ MacPherson Bay
		[R-243]	The 2022 ERA report considers only Bruce Power leased lands at the Bruce Power site. As a result, the following locations are excluded from further sampling in the 2022 ERA:
			• Construction Landfill #1
			• Construction Landfill #2
			• Construction Landfill #3
			• Construction Landfill #4 (except on boundary between CL#4 and Ornamental Pond)
			• Former Clariflocculator Sludge Lagoon
			• Drain under Interconnecting Road
			For the remaining locations, soil sample data from 2000 to the present was incorporated into the 2022 ERA. Surface water and sediment samples from 2017 to 2021 are also considered at the remaining locations. These locations included Construction Landfill #4 (boundary between CL#4 and Ornamental Pond only), Fire Training Facility, Former Sewage Lagoon, Bruce A Storage Compound, Distribution Stations #1 and the Bruce B Empty Drum Laydown Area.
				Individual COPCs to be considered for the 2022 ERA are dispositioned in Table 255 below.
				Locations and potential COPCs that are now excluded from the Bruce Power ERA due to being located on OPG retained lands are listed in Table 256 below

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
	○ McRae Pt • On-site: ○ South Railway Ditch – East ○ Railway Ditch ○ Drain Under Interconnecting Road ○ CL-4 stations ○ CSL-5-AW ○ FSL ○ Stream C locations: ○ Stream C – upstream ○ Stream C – downstream ○ Stream C (general) COPCs in sediment samples: • Lake Huron (background) • Railway Ditch • South Railway Ditch West • Former Clariflocculator Sludge Lagoon • Former Sewage Lagoons • SW 2-SED • Scott Pt			

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
12/ Sediment COPC monitoring at Scott Point	Continue monitoring sediment for COPCs at Scott Point, including N-methylnaphthalene.	[R-243]	Sediment at Scott Point was monitored for N-methylnaphthalene in 2021.	Section 3.4.6 of Appendix C: Tier 1 Chemical Screening and Appendix E Table 136.
13/ Thermal thresholds for larval Round Whitefish and Deepwater Sculpin	Re-assess temperature thresholds for larval Deepwater Sculpin and larval Round Whitefish for the 2022 ERA	[R-286]	Modelled thermal benchmarks for larval Round Whitefish have been established using the methodology by Hasnain et al. (2018) [R-303] of a CTM of 27.5°C and an MWAT of 10.8°C. Insufficient information was available to model a thermal benchmark for larval Deepwater Sculpin. Instead, the most recently available literature for Deepwater Sculpin was examined and temperature values consistent with areas of capture of larval Deepwater Sculpin were used as surrogate thermal benchmarks. Thermal benchmarks of 9°C in April and 11.8°C in May and June were assessed.	Appendix I: Thermal Risk Assessment, Sections 9.3.6.1, 9.5.1.5 and 9.5.1.6
14/ Thermal Assessment for Round Whitefish eggs	Complete thermal assessment for Block 1 Round Whitefish embryos: • Start the day the rolling weekly average drops below 5.5°C for 30 days at thermal monitoring sites with depths of 5m and 10m • Chronic threshold: 6°C for 30 days • Sub-acute threshold: 8.5°C rolling weekly average (including days 1-6 with information from prior to the assessment period)	[R-243][R-287][R-293]	Round Whitefish Black 1 Assessment completed as requested by ECCC/CNSC according to the methodology used in the 2017 ERA [R-231]. Thermal benchmarks for Round Whitefish embryos have been established using Bayesian modelling, following the methods used by Hasnain et al. (2018) [R-303]. These new benchmarks will be used to in future ERAs and the assessment of Block 1 Round Whitefish	Appendix I: Thermal Risk Assessment, Sections 9.3.2.1, 9.3.6.4, 9.3.6.5 and 9.5.1.5.

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
	• Acute threshold: 10°C for 6 hours • Delta threshold: within 3°C of the reference site temperature selected using modelled non-operational condition temperature to be continued until the modelled date of last hatch • Spatial Extent: 75th percentile of 3°C difference between modelled Operations and Non-Operational conditions during Block 1 as an extent of the Local Study Area • Local Study Area is defined as the 95th percentile of the 1°C of the difference between Operations and Non-Operations for thermal modelling years of April 1, 2016 to March 31, 2021.		embryos will be limited to the current chronic (6°C average for the 30 days of Block 1) and sub-acute (8.5°C rolling weekly average) thresholds. The Block 1 chronic and sub-acute thresholds will be retained due to the proximity of the incubation starting temperature of 5.5°C to the modelled chronic threshold of 5.4°C. Keeping these Block 1 specific thresholds will enable Bruce Power to contextualize the exceedances of the chronic threshold value that are expected to occur during Block 1 each year. New modelled Round Whitefish thermal benchmarks: • Acute: 10.1°C (Modelled UILT) • Chronic: 5.4°C (MWAT – calculated based on a modelled UILT and Tpref of 3.0°C) Temperature based metrics for incubation start time and Lake Whitefish hatch timing models will continue to be used to ensure the correct time period is assessed for Round Whitefish embryos.	
15/ FCSAP Guidance	Consider ECCCs Federal Contaminated Sites Action Plan Ecological Risk Assessment (FCSAP) guidance for the evaluation of hazard quotients for receptors in the terrestrial environment.	[R-243]	FCSAP 2021 [R-141] was used as the primary source to select toxicity reference values for mammals and birds in the conventional EcoRA.	Appendix B of [R-369], Section 2.3.5.4 and 2.3.6.4.

Comment Number/Title	**Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA**	**Source of CNSC or ECCC Comment**	**Bruce Power's Response in 2022 ERA**	**Location of Information in 2022 ERA**
16/ Thermal Risk Assessment	Provide a map detailing current and historical thermal monitoring locations.	[R-287]	Historic thermal modelling locations considered in previous ERAs are also considered in the 2016-2018 data used for the 2022 ERA and, as a result, all locations used for thermal risk assessment are shown in the current thermal risk assessment.	Appendix I: Thermal Risk Assessment, Section 9.4.1.
17/Uranium at the Former Sewage Lagoon	In recent years, there has been some stakeholder focus on the COPC uranium; therefore, an overview regarding this potential contaminant is provided here. In the 2017 ERA Tier 1 Chemical Screening for Soil, there was 10 exceedances of the reference value of 2.5 µg/g in data in soil collected prior to 2016 at CL4, FSL and BPS 04. This is the typical background value for uranium in soil across Ontario in pristine locations. All soil data from the 2017 ERA were considered in the 2022 ERA if they were at depths ≤1.5mbgs. There were no sediment or surface water exceedances and a single groundwater exceedance in the 2017 ERA. Results of the 2017 ERA demonstrated that the HQ for uranium was below the target of one, indicating that there are negligible risks from exposure to uranium to ecological receptors that may use limited habitat within the Site. In addition, Bruce Power does not have measurable levels of uranium in effluent.	[R-243]	In recent years, there has been some stakeholder focus on the COPC uranium; therefore, an overview regarding this potential contaminant is provided here. Uranium was retained for soil at CL4, FSL and BPS/SS against the preliminary screening criteria of 2.5µg/g and at FSL for shallow groundwater against the preliminary screening criteria of 0.0089mg/L. Uranium was not retained for surface water or sediment in the preliminary screening. The maximum soil values at CL4 of 2.6µg/g, at FSL of 3.6µg/g and at the BPS/SS sites of 13µg/g were excluded from further assessment in the secondary screening based on the criteria for terrestrial plants, soil organisms for CCME and MECP of 500µg/g and the criteria for terrestrial wildlife from MECP of 33µg/g. The maximum shallow groundwater value at FSL of 0.0115mg/L was excluded from further assessment based on the MECP Aquatic Protection Value of 0.033mg/L. No further assessment of uranium was required for the	Appendix C: Identification of Chemicals of Potential Concern, Sections 3.4.3 and 3.5.1.

Comment Number/Title	Summary of CNSC or ECCC Staff Comment from Review of 2017 ERA to be addressed in the 2022 ERA	Source of CNSC or ECCC Comment	Bruce Power's Response in 2022 ERA	Location of Information in 2022 ERA
			2022 ERA.	

Table 255 Disposition of CNSC/ECCC Additional COPC Requests from the 2017 ERA

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
Construction Landfill #4	Soil	Cadmium	Not a COPC. The Tier 1 screening standard of 1.2 mg/kg was exceeded in 2 samples obtained in 2000: - CL4-3 at 15ft – 5.0 mg/kg - CL4-7 at 3ft – 6.5 mg/kg Shallow soil results (<1.5mbgs) with potential for receptor exposure from the 2017 ERA were fully assessed in the 2022 ERA.	Identified as a COPC in the preliminary screening. The maximum concentration was 6.5 mg/kg and the average concentration was 0.55 mg/kg. Excluded for terrestrial plants and soil organisms during the secondary screening but included as a COPC for terrestrial wildlife. Maximum HQs ranged from 2 to 4.2 and average HQs from 0.3 to 1.7 for terrestrial wildlife. The depth of the single elevated cadmium result was 90cm, far below the depth where terrestrial wildlife would be exposed. The risk from cadmium at CL4 is negligible.
		4-bromophenyl phenyl ether	Identified as a COPC in the Tier 1 screening. The maximum soil concentration was 0.01 mg/kg and the average soil concentration was 0.0003 mg/kg. No toxicological benchmarks are available and HQs could not be calculated.	Identified as a COPC in the preliminary screening. The maximum concentration was 0.01 mg/kg. Included as COPC during secondary screening for terrestrial plants and soil organisms and for terrestrial wildlife. No toxicological benchmarks are available and HQs could not be calculated.
		Copper	Identified as a COPC in the Tier 1 screening. The maximum soil concentration was 287 mg/kg and the average soil concentration was 30 mg/kg. Not carried into the HQ calculations. Shallow soil results (<1.5mbgs) with potential for receptor exposure from the 2017 ERA were fully assessed in the 2022 ERA.	Identified as a COPC in the preliminary screening. The maximum concentration was 120 mg/kg and the average concentration was 49 mg/kg. Included as COPC during secondary screening for terrestrial plants and soil organisms. Excluded during the secondary screening for terrestrial wildlife. The maximum HQ was 1.7 and the average HQs was 0.7 for terrestrial plants and soil invertebrates. No

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
				further assessment required due to the average concentration having an HQ below 1.
		Uranium	Not a COPC. The Tier 1 screening standard of 2.5 mg/kg was exceeded in 2 samples obtained in 2000: - CL4-8 at 0.2ft – 2.6 mg/kg - CL4-3 at 10ft – 2.5 mg/kg Shallow soil results (<1.5mbgs) with potential for receptor exposure from the 2017 ERA were fully assessed in the 2022 ERA.	Identified as a COPC in the preliminary screening. The maximum concentration was 2.6 mg/kg. Excluded as COPC during secondary screening for terrestrial plants and soil organisms and for terrestrial wildlife. No further assessment required.
		Benzene	Not a COPC. The Tier 1 screening standard of 0.0095 mg/kg was not exceeded.	Identified as a COPC in the preliminary screening. The preliminary benchmark was 0.02 mg/kg and the maximum concentration was <0.04 mg/kg. Excluded as COPC during secondary screening for terrestrial plants and soil organisms and for terrestrial wildlife. No further assessment required.
		Vanadium	Not a COPC. The Tier 1 screening standard of 86 mg/kg was exceeded in 1 sample obtained in 2000: - CL4-3 at 10ft – 438.9 mg/kg No shallow soil results (<1.5mbgs) with potential for receptor exposure. Soil results not assessed in the 2022 ERA.	Not a COPC. The preliminary benchmark was 86mg/kg and the maximum value in the 2022 ERA was 37.8mg/kg.
		Arsenic	Not a COPC. The Tier 1 screening standard of 12 mg/kg was exceeded in 1 sample obtained in 2000: - CL4-6 at 20ft – 19.4 mg/kg No shallow soil results (<1.5mbgs) with potential for receptor exposure. Soil results not assessed in the 2022 ERA.	Not a COPC. The preliminary benchmark was 12mg/kg and the maximum value in the 2022 ERA was 3.9mg/kg.
		TPH Light (C10-24)	Not a COPC. The Tier 1 screening standard of 10 mg/kg was exceeded in 3 location and 5 samples obtained in 2000: - CL4-1 at 10ft – 109 mg/kg - CL4-1 at 15ft – 47 mg/kg - CL4-4 at 3.5ft – 97 mg/kg	Not a COPC. The preliminary benchmark was 10mg/kg and the maximum value in the 2022 ERA was <10mg/kg.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- CL4-4 at 13ft – 43 mg/kg - CL4-7 at 20ft – 410 mg/kg CL4-1 and CL4-4 not evaluated in 2022 ERA as they are located on OPG retained lands. The remaining site, CL4-7, was not a shallow soil result (<1.5mbgs) with potential for receptor exposure. Soil results with exceedances in 2017 ERA were not within scope for the 2022 ERA.	
		TPH Heavy (C24-50)	Not a COPC. The Tier 1 screening standard of 120 mg/kg was exceeded in 3 location and 5 samples obtained in 2000: - CL4-1 at 10ft – 587 mg/kg - CL4-1 at 15ft – 200 mg/kg - CL4-4 at 3.5ft – 396 mg/kg - CL4-7 at 20ft – 2,808 mg/kg CL4-1 and CL4-4 not evaluated in 2022 ERA as they are located on OPG retained lands. The remaining site, CL4-7 is not a shallow soil result (<1.5mbgs) with potential for receptor exposure. Soil results with exceedances in 2017 ERA are not within scope for the 2022 ERA.	Not a COPC. The preliminary benchmark was 120mg/kg and the maximum value in the 2022 ERA was <100mg/kg.
		Nickel	Not a COPC. The Tier 1 screening standard of 50 mg/kg was exceeded in 1 sample obtained in 2000: - CL4-3 at 10ft – 103.5 mg/kg CL4-3 is not evaluated in 2022 ERA as it was located on OPG retained lands.	Not a COPC. The preliminary benchmark was 82mg/kg and the maximum value in the 2022 ERA was 25.3mg/kg.
		Boron	Not a COPC. Boron did not have a Tier 1 screening value in the 2017 ERA.	Not a COPC. The preliminary benchmark was 36mg/kg and the maximum value in the 2022 ERA was 13mg/kg.
		Mercury	Not a COPC. The Tier 1 screening standard of 0.27 mg/kg was exceeded in 3 samples obtained in 2000: - CL4-1 at 1.5ft –0.375 mg/kg - CL4-3 at 20ft – 0.337 mg/kg	Not a COPC. The preliminary benchmark was 0.27mg/kg and the maximum value in the 2022 ERA was <0.25mg/kg.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- CL4-4 at 20ft – 0.393 mg/kg CL4-1, CL4-3 and CL4-4 not evaluated in 2022 ERA as they are located on OPG retained lands.	
		Tetrachloroethylene	Not a COPC. The Tier 1 screening standard of 0.05 mg/kg was exceeded in 1 sample obtained in 2000: - CL4-4 at 10ft – 0.14 mg/kg CL4-4 is not evaluated in 2022 ERA as they are located on OPG retained lands.	Not a COPC. The preliminary benchmark was 0.05mg/kg and the maximum value in the 2022 ERA was <0.05mg/kg.
		Toluene	Not a COPC. The Tier 1 screening standard of 0.2 mg/kg was not exceeded in 2000.	Not a COPC. The preliminary benchmark was 0.2mg/kg and the maximum value in the 2022 ERA was <0.04mg/kg.
		1,1,1-trichloroethane	Not a COPC. The Tier 1 screening standard of 0.05 mg/kg was not exceeded in 2000.	The preliminary benchmark was 0.05mg/kg and the maximum value in the 2022 ERA was <0.05mg/kg. Not retained as a COPC.
		Trichloroethylene	Not a COPC. The Tier 1 screening standard of 0.01 mg/kg was not exceeded in 2000.	Not a COPC. The preliminary benchmark was 0.01mg/kg and the maximum value in the 2022 ERA was <0.05mg/kg. Not retained as a COPC as trichloroethylene was not detected across the assessed sites. This approach is explained in Section 3.4.3.2 of Appendix C.
		Chloroform	Not a COPC. The Tier 1 screening standard of 0.05 mg/kg was not exceeded in 2000.	Not a COPC. The preliminary benchmark was 0.05mg/kg and the maximum value in the 2022 ERA was <0.05mg/kg.
	Groundwater	Boron Molybdenum Copper Benzene Tetrachloroethylene Toluene 1,1,1-trichloroethane	Groundwater at CL4 was not included in 2017 ERA.	Not included in the 2022 ERA as groundwater wells on CL#4 are located on OPG retained land.
	Surface Water (B31 Pond)	Copper	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 125	Identified as a COPC in the preliminary screening. Included as COPC during secondary screening for

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			µg/L and the average surface water concentration was 120.25 µg/L. Calculated HQs were all below 1 and no further assessment was required.	Aquatic Communities. The maximum concentration was 4.8 µg/L. The maximum calculated HQ was 2.4. Further routine surface water monitoring is planned, including measurement of DOC to validate potential risks.
		Iron	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 5707 µg/L and the average surface water concentration was 5216.5 µg/L. No toxicological benchmarks are available and HQs could not be calculated.	Identified as a COPC in the preliminary screening. Included as a COPC during secondary screening for Aquatic Communities. The maximum concentration was 310 µg/L. Calculated HQs were all below 1 and no further assessment was required.
		Molybdenum	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 53 µg/L and the average surface water concentration was 48.75 µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. The preliminary benchmark was 40 µg/L and the maximum value in the 2022 ERA was 0.62 µg/L.
		Vanadium	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 28 µg/L and the average surface water concentration was 26.25 µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. The preliminary benchmark was 6 µg/L and the maximum value in the 2022 ERA was 1.3 µg/L.
Fire Training Facility	Soil	Ethylbenzene	Not a COPC. The Tier 1 screening standard of 0.05 mg/kg was exceeded at 4 sites obtained in 2009: - FTF-69 at 3.8-4.4mbgs– 0.16 mg/kg - FTF-71 at 1.5-2.1mbgs– 0.052 mg/kg - FTF-74 at 3.0-3.6mbgs – 0.356mg/kg - FTF-75 at 3.0-3.6mbgs – 0.209mg/kg The affected sites are not shallow soil results (<1.5mbgs) with potential for receptor exposure. Soil results with exceedances in 2017 ERA are not within scope for the 2022 ERA.	Identified as a COPC in the preliminary screening. The preliminary benchmark was 0.05 mg/kg and the maximum value in the 2022 ERA was 1.5 mg/kg. Excluded as a COPC during secondary screening for Terrestrial Plants and Soil Organisms and for Terrestrial Wildlife. No further assessment required.
		Silver	Not a COPC. The Tier 1 screening standard of 0.5 mg/kg was exceeded at 1 site obtained in 2000:	Not a COPC. The preliminary benchmark was 0.5 mg/kg and the maximum value in the 2022 ERA

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- FTF-2 at 1.5ft – 1.284 mg/kg Shallow soil result (<1.5mbgs) with potential for receptor exposure from the 2017 ERA was assessed in the preliminary screening of the 2022 ERA.	was 1.3 mg/kg. The average concentration (0.14 mg/kg) and the 95th percentile concentration (<0.25 mg/kg) were below the preliminary benchmark. The silver exceedance is also not co-located with any other metal exceedances.
		Selenium	Not a COPC. The Tier 1 screening standard of 1 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-5 at 4.5ft – 1.2 mg/kg - FTF-21 at 5ft – 1.3 mg/kg The affected sites are not shallow soil results (<1.5mbgs) with potential for receptor exposure or are not sites included in the 2022 ERA due to being paved over. Soil results with exceedances in 2017 ERA are not within scope for the 2022 ERA.	Not a COPC. The preliminary benchmark was 1.5mg/kg and the maximum value in the 2022 ERA was 1mg/kg.
		F2 (C10-C16 hydrocarbons)	Not a COPC. The Tier 1 screening standard of 10 mg/kg was exceeded at 3 sites obtained in 2009: - FTF-69 at 3.8-4.4mbgs– 6,490 mg/kg - FTF-69 at 4.6-4.8mbgs– 20 mg/kg - FTF-74 at 1.5-2.1mbgs– 548 mg/kg - FTF-74 at 3.0-3.6mbgs– 5050 mg/kg - FTF-75 at 3.0-3.6mbgs– 6,080 mg/kg The affected sites are not shallow soil results (<1.5mbgs) with potential for receptor exposure. Soil results with exceedances in 2017 ERA are not within scope for the 2022 ERA.	Not a COPC. The preliminary benchmark was 10mg/kg and the maximum value in the 2022 ERA was <10mg/kg.
		F3 (C16-C34 hydrocarbons)	Not a COPC. The Tier 1 screening standard of 10 mg/kg was exceeded at 3 sites obtained in 2009: - FTF-69 at 3.8-4.4mbgs– 4,690 mg/kg - FTF-74 at 1.5-2.1mbgs– 690 mg/kg - FTF-74 at 3.0-3.6mbgs– 4,290 mg/kg - FTF-75 at 3.0-3.6mbgs– 4,760 mg/kg The affected sites are not shallow soil results (<1.5mbgs) with potential for receptor exposure. Soil results with exceedances in 2017 ERA are not	Not a COPC. The preliminary benchmark was 240mg/kg and the maximum value in the 2022 ERA was 90mg/kg.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			within scope for the 2022 ERA.	
		Acid-base neutral extractables (i.e. 2,5-dinitrotoluene)	Only acid-base extractables with Tier 1 exceedances are listed here. **Acid-base extractable results at depths and sites included in the scope of the 2022 ERA are listed in bold. Sites with depths of >1.5m or located in areas that have been paved over and are no longer accessible to ecological receptors are excluded from the 2022 ERA.** The following acid base extractables were included as COPCs following the Tier 1 screening, but were not assessed further due to a complete lack of toxicological benchmarks. **<u>2,3,4,5-Tetrachlorophenol</u>** The Tier 1 screening standard of 0.5 mg/kg was exceeded at 4 sites obtained in 2000: - FTF-9 at 0.2ft – 0.77mg/kg - FTF-9 at 1.0ft – 30mg/kg - FTF-9 at 2.0ft – 68mg/kg - FTF-9 at 4.0ft – 21mg/kg - FTF-11 at 3.0ft – 3.6mg/kg - FTF-11 at 6.0ft – 4.3mg/kg - **FTF-12 at 1.5ft – 23mg/kg** - **FTF-12 at 3.0ft – 32mg/kg** - FTF-12 at 5.0ft- 13mg/kg - **FTF-18 at 3.0ft – 8.9 mg/kg** **<u>2,3,5-Trichlorophenol</u>** The Tier 1 screening standard of 0.5 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 2.0ft – 0.77mg/kg **<u>2,4-Dimethyphenol</u>** The Tier 1 screening standard of 0.2 mg/kg was exceeded at 1 site obtained in 2000:	All COPCs with exceedances in the 2017 ERA are included as COPCs in the 2022 ERA if they are <1.5m depth and are located on an areas accessible to ecological receptors (i.e., not paved over). The following chemicals were included as COPCs during the primary screening but excluded during the secondary screening: **<u>Anthracene</u>** The preliminary screening standard of 0.161 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-12 at 0.2ft – 0.47mg/kg - FTF-12 at 3.0ft – 0.18mg/kg - FTF-18 at 3.0ft – 0.35mg/kg **<u>Phenol</u>** The preliminary screening standard of 0.5 mg/kg was exceeded at 3 sites obtained in 2000: - FTF-12 at 0.2ft – 1.1mg/kg - FTF-12 at 1.5ft – 2.1mg/kg - FTF-12 at 3.0ft – 2.6mg/kg **<u>Phenanthrene</u>** The preliminary screening standard of 0.046 mg/kg was exceeded at 7 sites obtained in 2000 & 2009: - FTF-8 at 3.7ft – 0.08mg/kg - FTF-18 at 3.0ft – 0.95 mg/kg **<u>Fluorene</u>** The preliminary screening standard of 0.12 mg/kg was exceeded at 3 sites obtained in 2000 & 2009: - FTF-6 at 0.2ft – 0.2mg/kg - FTF-10 at 0.2ft - 0.14 mg/kg - FTF-12 at 0.2ft – 0.95mg/kg

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- FTF-9 at 1.0ft – 0.29mg/kg - FTF-9 at 2.0ft –0.498mg/kg **3,3'-Dichlorobenzidine** The Tier 1 screening standard of 1 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 2.0ft – 1.3mg/kg No toxicological benchmarks are available for birds, terrestrial plants and soil invertebrates or mammals and HQs could not be calculated for birds, terrestrial plants and soil invertebrates or mammals. The following acid base extractables were included as COPCs following the Tier 1 screening, but were not assessed further due to a lack of some toxicological benchmarks. Where toxicological benchmarks existed, these were assessed as described below: **2,4,5-Trichlorophenol** The Tier 1 screening standard of 0.1 mg/kg was exceeded at 3 sites obtained in 2000: - FTF-3 at 0.2ft – 0.35mg/kg - FTF-5 at 1.5ft – 0.51mg/kg - FTF-9 at 0.2ft – 0.36mg/kg - FTF-9 at 1.0ft – 0.42mg/kg - FTF-9 at 2.0ft – 0.61mg/kg - FTF-9 at 4.0ft – 0.32mg/kg **2,4-Dicholorophenol** The Tier 1 screening standard of 0.1 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-3 at 0.2ft – 0.25mg/kg - FTF-3 at 1.5ft – 0.12mg/kg - FTF-5 at 1.5ft – 0.61mg/kg **2,4,6-Trichlorophenol**	- FTF-12 at 3.0ft – 0.13mg/kg The following chemicals were retained as COPCs following the preliminary and secondary screening: **2,3,4,5-Tetrachlorophenol** The preliminary screening standard of 0.5 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-12 at 1.5ft – 23mg/kg - FTF-12 at 3.0ft – 32mg/kg - FTF-18 at 3.0ft – 8.9 mg/kg **2-Methyphenol** The preliminary screening standard of 0.1 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-12 at 1.5ft – 12mg/kg - FTF-12 at 3.0ft – 16mg/kg - FTF-18 at 3.0ft – 8mg/kg No toxicological benchmarks could be identified for 2,3,4,5-Tetrachlorophenol and 2-Methyphenol and these chemicals could not be assessed further. **Acenaphthylene** The preliminary screening standard of 0.093 mg/kg was exceeded at 3 sites obtained in 2000: - FTF-6 at 0.2ft – 0.4 mg/kg - FTF-12 at 1.5ft – 0.4mg/kg - FTF-12 at 3.0ft – 0.71mg/kg - FTF-18 at 3.0ft – 0.4mg/kg All HQs were below 1 and no further assessment was required. **Dibenzo(a,h)anthracene** The preliminary screening standard of 0.1 mg/kg was exceeded at 1 site obtained in 2000: - FTF-12 at 0.2ft – 0.22mg/kg - FTF-12 at 1.5ft – 0.13mg/kg

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			The Tier 1 screening standard of 0.1 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 0.2ft – 0.55mg/kg - FTF-9 at 1.0ft – 0.12mg/kg - FTF-9 at 2.0ft – 0.11mg/kg **2,4-Dichlorophenol** The Tier 1 screening standard of 0.1 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 1.0ft – 0.54mg/kg **2,4-Dinitrophenol** The Tier 1 screening standard of 1 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 1.0ft – 2mg/kg - FTF-9 at 2.0ft – 3.1mg/kg - FTF-9 at 4.0ft – 1.2mg/kg HQs 2,4,5-Trichlorophenol, 2,4-Dicholorophenol, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2,4-Dinitrophenol for terrestrial plants and soil invertebrates were all below 1 and no further assessment was required. **2,6-Dinitrotoluene** The Tier 1 screening standard of 0.5 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 2.0ft – 1.1mg/kg No toxicological benchmarks are available for birds or mammals and HQs could not be calculated for birds or mammals. TRVs were not available for terrestrial plants and soil invertebrates, although this was not listed in the 2017 ERA. TRVs for mammals were only available for the Red Fox. HQs for the Red Fox were all below 1 and no further assessment was required. **2-Methyphenol** The Tier 1 screening standard of 0.1 mg/kg was	- FTF-12 at 3.0ft – 0.2mg/kg All HQs for Dibenzo(a,h)anthracene were below 1 and no further assessment was required. **Hexachlorobenzene** Included as a COPC in the 2017 ERA. The preliminary screening standard of 0.01 mg/kg was exceeded at 3 sites obtained in 2000: - FTF-6 at 0.2ft – 0.1mg/kg - FTF-12 at 0.2ft – 0.18mg/kg - FTF-12 at 1.5ft – 1.9mg/kg - FTF-12 at 3.0ft – 2.4mg/kg - FTF-18 at 3.0ft – 1.5mg/kg - FTF-18 at 4.0ft – 0.08mg/kg All HQs were below 1 and no further assessment was required. **Benzo(a)anthracene** The preliminary screening standard of 0.36 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-12 at 1.5ft – 1.8mg/kg - FTF-12 at 3.0ft – 2.1mg/kg - FTF-18 at 3.0ft – 0.79mg/kg All terrestrial plant and soil invertebrate HQs were below 1 and no further assessment was required. Assessment of terrestrial wildlife was excluded during the secondary screening. **Acenaphthene** The preliminary screening standard of 0.072 mg/kg was exceeded at 1 sites obtained in 2000: - FTF-8 at 3.7ft -0.41 mg/kg All terrestrial plant and soil invertebrate HQs were below 1 and no further assessment was required. Assessment of terrestrial wildlife was excluded during the secondary screening.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			exceeded at 4 sites obtained in 2000: - FTF-9 at 1.0ft – 16mg/kg - FTF-9 at 2.0ft – 17mg/kg - FTF-9 at 4.0ft – 12mg/kg - FTF-11 at 1.5ft – 2.6mg/kg - FTF-11 at 3.0ft – 2.3mg/kg - FTF-11 at 6.0ft – 2.7mg/kg - **FTF-12 at 1.5ft – 12mg/kg** - **FTF-12 at 3.0ft – 16mg/kg** - FTF-12 at 5.0ft – 6.8mg/kg - **FTF-18 at 3.0ft – 8mg/kg** No toxicological benchmarks are available for birds, terrestrial plants and soil invertebrates and HQs could not be calculated for birds, terrestrial plants and soil invertebrates. TRVs for mammals were only available for the Red Fox. HQs for the Red Fox were all below 1 and no further assessment was required. **2-Chlorophenol** The Tier 1 screening standard of 0.1 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 1.0ft – 0.34mg/kg - FTF-9 at 2.0ft – 0.22mg/kg - FTF-9 at 4.0ft – 0.18mg/kg No toxicological benchmarks are available for mammals and HQs could not be calculated for mammals. TRVs for mammals were only available for the Red Fox. HQs for the Red Fox were all below 1 and no further assessment was required. HQs for birds, terrestrial plants and soil invertebrates were all below 1 and no further assessment was required. The following chemicals were not included as	**Naphthalene** All sites with naphthalene exceedances in the 2017 ERA were too deep to be included in the 2022 ERA. **Nitrobenzene, Isophorone and Dipenylamines (total)** Nitrobenzene, isophorone and diphenylamines (total) were retained during the preliminary and secondary screening in the 2022 ERA due to a lack of benchmarks. For nitrobenzene, there were TRVs available for mammals and terrestrial plants and soil invertebrates for not birds or hepafauna. All mammal HQs were below 1. The maximum HQ at FTF for terrestrial plants and soil invertebrates for nitrobenzene was 2.0, while the 95th percentile HQ was 0.3. For diphenylamines (total), there were TRVs available for birds/hepafauna but not for mammals or and terrestrial plants and soil invertebrates. All bird/herpafauna HQs were below 1 and no further assessment was required. There were not TRVs available for isophorone.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			COPCs in the 2017 ERA. **Acenaphthylene** The Tier 1 screening standard of 0.093 mg/kg was exceeded at 7 sites obtained in 2000: - **FTF-6 at 0.2ft – 0.4 mg/kg** - FTF-7 at 0.2ft – 2.7 mg/kg - FTF-7 at 1.5ft & 3ft– 0.3 mg/kg - FTF-9 at 1.0ft – 0.44mg/kg - FTF-9 at 2.0ft – 0.19mg/kg - FTF-9 at 4.0ft – 0.26mg/kg - FTF-11 at 1.5ft – 0.16 mg/kg - FTF-11 at 6.0ft – 0.13mg/kg - **FTF-12 at 1.5ft – 0.4mg/kg** - **FTF-12 at 3.0ft – 0.71mg/kg** - FTF-12 at 5.0ft – 0.33mg/kg - FTF-12 at 6.5ft – 0.27mg/kg - FTF-13 at 3.0ft – 0.17mg/kg - **FTF-18 at 3.0ft – 0.4mg/kg** **Benzo(a,h)anthracene** The Tier 1 screening standard of 0.1 mg/kg was exceeded at 1 site obtained in 2000: - **FTF-12 at 0.2ft – 0.22mg/kg** - **FTF-12 at 1.5ft – 0.13mg/kg** - **FTF-12 at 3.0ft – 0.2mg/kg** **1-Methynaphthalene** The Tier 1 screening standard of 0.59 mg/kg was exceeded at 3 sites obtained in 2000 & 2009: - FTF-8 at 5.0ft – 1.1mg/kg - FTF-12 at 6.5ft – 4.8mg/kg - FTF-74 at 1.5-2.1 mbgs – 1.48mg/kg **2-Methynaphthalene** The Tier 1 screening standard of 0.59 mg/kg was exceeded at 3 sites obtained in 2000: - FTF-8 at 5.0ft – 0.91mg/kg	

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- FTF-12 at 6.5ft – 3.6mg/kg - FTF-74 at 1.5-2.1 mbgs – 2.3mg/kg **Fluorene** The Tier 1 screening standard of 0.12 mg/kg was exceeded at 7 sites obtained in 2000 & 2009: - **FTF-6 at 0.2ft – 0.2mg/kg** - FTF-7 at 11.5ft – 0.32 mg/kg - FTF-8 at 5.0ft – 0.3mg/kg - FTF-8 at 7.0ft – 0.14mg/kg - FTF-9 at2.0ft – 0.13 mg/kg - **FTF-10 at 0.2ft - 0.14 mg/kg** - **FTF-12 at 0.2ft – 0.95mg/kg** - **FTF-12 at 3.0ft – 0.13mg/kg** - FTF-12 at 6.5ft – 0.17mg/kg - FTF-74 at 1.5-2.1 mbgs – 0.738mg/kg **Acenaphthylene** The Tier 1 screening standard of 0.093 mg/kg was exceeded at 1 site obtained in 2000: - FTF-3 at 0.2ft – 0.2mg/kg **2,6-Dichlorophenol** The Tier 1 screening standard of 0.5 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 0.2ft – 0.65mg/kg - FTF-9 at 1.0ft – 0.88mg/kg - FTF-9 at 4.0ft – 0.5mg/kg Hexachlorobenzene and phenol were fully assessed as a COPC in the 2017 ERA. **Hexachlorobenzene** Included as a COPC in the 2017 ERA. The Tier 1 screening standard of 0.01 mg/kg was exceeded at 7 sites obtained in 2000: - **FTF-6 at 0.2ft – 0.1mg/kg** - FTF-7 at 0.2ft & 1.5ft & 3.0ft – 0.3 mg/kg - FTF-9 at 0.2ft – 0.09 mg/kg	

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- FTF-9 at 1.0ft – 1.4 mg/kg - FTF-9 at 2.0ft – 2.8 mg/kg - FTF-9 at 4.0ft – 0.07 mg/kg - FTF-11 at 0.2ft - 0.16 mg/kg - FTF-11 at 1.5ft - 0.68 mg/kg - **FTF-12 at 0.2ft – 0.18mg/kg** - **FTF-12 at 1.5ft – 1.9mg/kg** - **FTF-12 at 3.0ft – 2.4mg/kg** - FTF-12 at 5.0ft – 0.95mg/kg - FTF-13 at 3.0ft – 0.02 mg/kg - **FTF-18 at 3.0ft – 1.5mg/kg** - **FTF-18 at 4.0ft – 0.08mg/kg** The maximum HQs were 210, 23 and 57 and the average HQs were 13, 1.5 and 3.6 for the American Woodcock, the Red Fox and the Short-Eared Owl. HQs for the Mourning Dove were all below 1. **<u>Phenol</u>** The Tier 1 screening standard of 0.5 mg/kg was exceeded at 3 sites obtained in 2000: - FTF-9 at 1.0ft – 1.1 mg/kg - FTF-9 at 2.0ft – 2.0 mg/kg - FTF-9 at 4.0ft – 0.59 mg/kg - FTF-11 at 1.5ft - 0.73 mg/kg - **FTF-12 at 0.2ft – 1.1mg/kg** - **FTF-12 at 1.5ft – 2.1mg/kg** - **FTF-12 at 3.0ft – 2.6mg/kg** - FTF-12 at 5.0ft – 1.4mg/kg HQs calculated for mammals and birds were all below 1 and no further assessment was required. HQ for terrestrial plants and soil invertebrates a max of 3.3, with an average HQ of 0.22. The following acid-base extractables were included	

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			as COPCs in the 2017 ERA and were fully assessed as part of the total HMV PAH HQ calculations: **Acenaphthene** The Tier 1 screening standard of 0.072 mg/kg was exceeded at 5 sites obtained in 2000: - FTF-7 at 11.5ft – 0.1 mg/kg - FTF-7 at 15.2ft – 0.42 mg/kg - **FTF-8 at 3.7ft -0.41 mg/kg** - FTF-8 at 5.0ft – 0.6 mg/kg - FTF-8 at 6.0ft & 7.0ft – 1.1 mg/kg - FTF-12 at 6.5ft – 0.81mg/kg - FTF-14 at 15.7ft – 0.18mg/kg - FTF-18 at 6.0ft – 0.08mg/kg **Anthracene** The Tier 1 screening standard of 0.161 mg/kg was exceeded at 5 sites obtained in 2000: - FTF-7 at 1.5ft – 0.2 mg/kg - FTF-8 at 5.0ft – 0.68 mg/kg - FTF-9 at 1.0ft – 0.25mg/kg - FTF-9 at 2.0ft – 1.1mg/kg - **FTF-12 at 0.2ft – 0.47mg/kg** - **FTF-12 at 3.0ft – 0.18mg/kg** - FTF-12 at 6.5ft – 0.59 mg/kg - **FTF-18 at 3.0ft – 0.35mg/kg** **Benzo(a)anthracene** The Tier 1 screening standard of 0.36 mg/kg was exceeded at 4 sites obtained in 2000: - FTF-9 at 1.0ft – 0.97mg/kg - FTF-9 at 2.0ft – 1.7mg/kg - FTF-9 at 4.0ft – 0.49mg/kg - FTF-11 at 1.5ft – 0.64 mg/kg - FTF-11 at 6.0ft – 0.41mg/kg	

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- **FTF-12 at 1.5ft – 1.8mg/kg** - **FTF-12 at 3.0ft – 2.1mg/kg** - FTF-12 at 5.0ft – 1.2mg/kg - **FTF-18 at 3.0ft – 0.79mg/kg** **<u>Napthalene</u>** The Tier 1 screening standard of 0.013 mg/kg was exceeded at 4 sites obtained in 2000: - FTF-7 at 11.5ft – 0.57mg/kg - FTF-7 at 11.5ft – 0.09mg/kg - FTF-8 at 5.0ft – 0.33 mg/kg - FTF-8 at 5.0ft – 0.25 mg/kg - FTF-12 at 6.5ft – 1.1mg/kg - FTF-14 at 15.7ft – 1.4mg/kg **<u>Phenanthrene</u>** The Tier 1 screening standard of 0.046 mg/kg was exceeded at 7 sites obtained in 2000 & 2009: - FTF-7 at 11.5ft – 0.82mg/kg - FTF-7 at 11.5ft – 0.12mg/kg - **FTF-8 at 3.7ft – 0.08mg/kg** - FTF-8 at 5.0ft – 0.96mg/kg - FTF-8 at 5.2ft – 0.72mg/kg - FTF-8 at 7.0ft – 0.2mg/kg - FTF-9 at 1.0ft – 0.12 mg/kg - FTF-12 at 6.5ft – 6.1mg/kg - FTF-14 at 15.7ft – 0.15 mg/kg - **FTF-18 at 3.0ft – 0.95 mg/kg** - FTF-74 at 1.5-2.1 mbgs – 1.55mg/kg The maximum HQs were 3.4 and the average HQs were 0.19 for the American Woodcock. All other HQs calculated were below 1. **<u>Nitrobenzene, isophorone and diphenylamines (total)</u>** Nitrobenzene, isophorone and diphenylamines	

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			(total) had detectable concentrations in the 2017 ERA but there is no establish Tier 1 screening benchmark for these chemicals. These were screened into the EcoRA. Nirtobenzene was assessed for mammals and soil invertebrates. No bird TRVs were available. No further assessment of isophorone and diphenylamines (total) was possible.	
		VOCs (i.e., 1,1,2,2-tetrachloroethane)	Only VOCs with Tier 1 exceedances are listed here. **VOC results at depths and sites included in the scope of the 2022 ERA are listed in bold. Sites with depths of >1.5m or located in areas that have been paved over and are no longer accessible to ecological receptors are excluded from the 2022 ERA.** 1,1,2,2-Tetrachloroethane The Tier 1 screening standard of 0.05 mg/kg was exceeded at 1 site obtained in 2000: - FTF-3 at 0.2ft – 0.15mg/kg Acetone The Tier 1 screening standard of 0.5 mg/kg was exceeded at 7 sites obtained in 2000: - **FTF-1 at 1.5ft – 0.56mg/kg** - **FTF-1 at 3.0ft – 1.1mg/kg** - **FTF-1 at 4.5ft – 0.81mg/kg** - **FTF-2 at 3.0ft – 1.1mg/kg** - **FTF-12 at 3.0ft – 0.78mg/kg** - FTF-13 0.2ft &1.5ft – 0.68mg/kg - FTF-13 at 3.0ft – 1.27mg/kg - **FTF-16 at 0.2ft – 1.6mg/kg** - **FTF-16 at 2.0ft – 1.1mg/kg** - **FTF-16 at 3.0ft – 1.8mg/kg** - **FTF-18 at 3.0ft – 0.75mg/kg** - **FTF-18 at 4.0ft – 1mg/kg**	The following COPCs were retained following the preliminary screening but excluded on the secondary screening: **Benzene** The preliminary screening standard of 0.0095 mg/kg was exceeded at 7 sites obtained in 2000: - **FTF-1 at 1.5ft – 0.03mg/kg** - **FTF-1 at 3.0ft – 0.02mg/kg** - **FTF-1 at 4.5ft – 0.02mg/kg** - **FTF-12 at 0.2ft – 0.19mg/kg** - **FTF-12 at 1.5ft – 0.22mg/kg** - **FTF-12 at 3.0ft – 0.42 mg/kg** - **FTF-18 at 3.0ft & 4ft – 0.06mg/kg** - **FTF-20 at 0.2ft – 0.04mg/kg** **Chloroform** The preliminary screening standard of 0.05 mg/kg was exceeded at 8 sites obtained in 2000 & 2009: - **FTF-1 at 1.5ft – 0.23mg/kg** - **FTF-1 at 4.5ft – 0.12mg/kg** - **FTF-2 at 3.0ft – 0.42mg/kg** - **FTF-12 at 0.2ft – 0.23mg/kg** - **FTF-12 at 1.5ft – 0.18mg/kg** - **FTF-12 at 3.0ft – 0.19 mg/kg** - **FTF-18 at 3.0ft – 0.17mg/kg** - **FTF-18 at 4.0ft – 0.26mg/kg** - **FTF-20 at 0.2ft – 0.75mg/kg**

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- **FTF-20 at 0.2ft & 1.5ft – 1mg/kg** Benzene The Tier 1 screening standard of 0.0095 mg/kg was exceeded at 7 sites obtained in 2000: - **FTF-1 at 1.5ft – 0.03mg/kg** - **FTF-1 at 3.0ft – 0.02mg/kg** - **FTF-1 at 4.5ft – 0.02mg/kg** - FTF-9 at 2.0ft – 0.93mg/kg - FTF-11 at 1.5ft & 3.0ft – 0.08mg/kg - **FTF-12 at 0.2ft – 0.19mg/kg** - **FTF-12 at 1.5ft – 0.22mg/kg** - **FTF-12 at 3.0ft – 0.42 mg/kg** - FTF-12 at 5.0ft – 0.1mg/kg - FTF-13 at 0.2ft – 0.02mg/kg - FTF-13 at 3.0ft – 0.04mg/kg - **FTF-18 at 3.0ft & 4ft – 0.06mg/kg** - **FTF-20 at 0.2ft – 0.04mg/kg** Chloroform The Tier 1 screening standard of 0.05 mg/kg was exceeded at 8 sites obtained in 2000 & 2009: - **FTF-1 at 1.5ft – 0.23mg/kg** - **FTF-1 at 4.5ft – 0.12mg/kg** - **FTF-2 at 3.0ft – 0.42mg/kg** - FTF-11 at 1.5ft – 0.22mg/kg - FTF-11 at 3.0ft – 0.18mg/kg - **FTF-12 at 0.2ft – 0.23mg/kg** - **FTF-12 at 1.5ft – 0.18mg/kg** - **FTF-12 at 3.0ft – 0.19 mg/kg** - FTF-12 at 5.0ft – 0.2mg/kg - FTF-12 at 6.0ft – 0.26mg/kg - FTF-13 at 0.2ft – 0.29mg/kg - FTF-13 at1.5ft – 0.27mg/kg - FTF-13 at 3.0ft – 0.37mg/kg - **FTF-18 at 3.0ft – 0.17mg/kg**	- **FTF-20 at 1.5ft – 0.77mg/kg** **Methyl Ethyl Ketone** The preliminary screening standard of 0.5 mg/kg was exceeded at 6 sites obtained in 2000: - **FTF-1 at 1.5ft – 0.62mg/kg** - **FTF-2 at 3.0ft – 1.3mg/kg** - **FTF-12 at 0.2ft – 1.2mg/kg** - **FTF-12 at 1.5ft – 1.1mg/kg** - **FTF-12 at 3.0ft – 1.3 mg/kg** - **FTF-18 at 3.0ft – 1.2mg/kg** - **FTF-18 at 4.0ft – 1.7mg/kg** **Ethylbenzene** The preliminary screening standard of 0.05 mg/kg was exceeded at 2 sites obtained in 2000: - **FTF-12 at 0.2ft – 0.08mg/kg** - **FTF-12 at 1.5ft – 0.87mg/kg** - **FTF-12 at 3.0ft – 1.5 mg/kg** **Toluene** The preliminary screening standard of 0.2 mg/kg was exceeded at 2 sites obtained in 2000: - **FTF-12 at 1.5ft – 1.3mg/kg** - **FTF-12 at 3.0ft – 2.5 mg/kg** The following COPCs were retained following the preliminary and secondary screening: **Acetone** The preliminary screening standard of 0.5 mg/kg was exceeded at 7 sites obtained in 2000: - **FTF-1 at 1.5ft – 0.56mg/kg** - **FTF-1 at 3.0ft – 1.1mg/kg** - **FTF-1 at 4.5ft – 0.81mg/kg** - **FTF-2 at 3.0ft – 1.1mg/kg** - **FTF-12 at 3.0ft – 0.78mg/kg**

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			- **FTF-18 at 4.0ft – 0.26mg/kg** - **FTF-20 at 0.2ft – 0.75mg/kg** - **FTF-20 at 1.5ft – 0.77mg/kg** - FTF-69 at 3.8-44mbgs – 0.16mg/kg Methyl Ethyl Ketone The Tier 1 screening standard of 0.5 mg/kg was exceeded at 6 sites obtained in 2000: - **FTF-1 at 1.5ft – 0.62mg/kg** - **FTF-2 at 3.0ft – 1.3mg/kg** - FTF-11 at 0.2ft – 0.6mg/kg - FTF-11 at 1.5ft – 1.6mg/kg - FTF-11 at 3.0ft – 1.4mg/kg - **FTF-12 at 0.2ft – 1.2mg/kg** - **FTF-12 at 1.5ft – 1.1mg/kg** - **FTF-12 at 3.0ft – 1.3 mg/kg** - FTF-12 at 5.0ft – 1.2mg/kg - FTF-12 at 6.0ft – 0.7mg/kg - FTF-13 at 0.2ft – 0.76mg/kg - FTF-13 at1.5ft – 0.72mg/kg - FTF-13 at 3.0ft – 1mg/kg - **FTF-18 at 3.0ft – 1.2mg/kg** - **FTF-18 at 4.0ft – 1.7mg/kg** Ethylbenzene The Tier 1 screening standard of 0.05 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-9 at 1.0ft – 0.09mg/kg - FTF-9 at 2.0ft – 4.6mg/kg - FTF-9 at 4.0ft – 1.02mg/kg - **FTF-12 at 0.2ft – 0.08mg/kg** - **FTF-12 at 1.5ft – 0.87mg/kg** - **FTF-12 at 3.0ft – 1.5 mg/kg** - FTF-12 at 5.0ft – 0.57mg/kg Styrene The Tier 1 screening standard of 0.05 mg/kg was	- **FTF-16 at 0.2ft – 1.6mg/kg** - **FTF-16 at 2.0ft – 1.1mg/kg** - **FTF-16 at 3.0ft – 1.8mg/kg** - **FTF-18 at 3.0ft – 0.75mg/kg** - **FTF-18 at 4.0ft – 1mg/kg** - **FTF-20 at 0.2ft & 1.5ft – 1mg/kg** TRVs were not available for terrestrial plants and soil invertebrates and HQs could not be calculated. No further assessment was possible.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			exceeded at 1 site obtained in 2000: - FTF-9 at 2.0ft – 0.4mg/kg - FTF-9 at 4.0ft – 0.11mg/kg Toluene The Tier 1 screening standard of 0.2 mg/kg was exceeded at 2 sites obtained in 2000: - FTF-9 at 2.0ft – 7.45mg/kg - FTF-9 at 4.0ft – 0.28mg/kg - **FTF-12 at 1.5ft – 1.3mg/kg** - **FTF-12 at 3.0ft – 2.5 mg/kg** - FTF-12 at 5.0ft – 0.35mg/kg Xylenes (total) The Tier 1 screening standard of 0.05 mg/kg was exceeded at 1 site obtained in 2009: - FTF-69 at 3.8-4.4mbgs – 0.7mg/kg	
		Chlorodibromomethane	Not a COPC. The Tier 1 screening standard of 0.05 mg/kg was exceeded at 1 site obtained in 2000: - FTF-9 at 1.0ft – 0.07mg/kg	Not a COPC. There were no exceedances of the preliminary benchmark, although there was a single instance at FTF-1-16 where the MDL was 0.10 mg/kg in comparison to the preliminary benchmark of 0.05 mg/kg. This location was excluded from further assessment as it was not detected in any sample collected from FTF, further based on the rationale is provided in Section 3.4.3 of Appendix C.
Former Sewage Lagoon	Soil	Silver	Not a COPC. The Tier 1 screening standard of 0.5 mg/kg was exceeded at 2 sites obtained in 2000 & 2016: - FSL-6-A at 3ft – 1.36mg/kg - FSL-1 at 0-0.1m -0.52mg/kg	Identified as a COPC in the preliminary screening. The preliminary benchmark was 0.5 mg/kg and the maximum value in the 2022 ERA was 1.35 mg/kg. Excluded for terrestrial plants and soil organisms but included for terrestrial wildlife during the secondary screening. Calculated HQs were all below 1 and no further assessment was required.
		Iron	Not a COPC. The Tier 1 screening standard of 34,000 mg/kg was not exceeded in 2000.	Not a COPC. The preliminary benchmark of 34,000 mg/kg was not exceeded in any of the samples and the maximum value included in the 2022 ERA was

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
				10,300 mg/kg.
		Titanium	Not a COPC. The Tier 1 screening standard of 4,700 mg/kg was not exceeded in 2000.	Not a COPC. The preliminary benchmark of 4,700 mg/kg was not exceeded in any of the samples and the maximum value included in the 2022 ERA was 303.5 mg/kg.
	Surface Water	Antimony	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 38µg/L and the average surface water concentration was 21.5µg/L. No toxicological benchmarks are available and HQs could not be calculated.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 6 µg/L and the maximum value included in the 2022 ERA was <0.50 µg/L.
		Arsenic	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 14µg/L and the average surface water concentration was 9.5µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 5µg/L and the maximum value included in the 2022 ERA was <1.0 µg/L.
		Mercury	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 0.8µg/L and the average surface water concentration was <0.1µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 0.026 µg/L, however, the MDL was higher than the preliminary benchmark at 0.10 µg/L. Mercury has not been detected at the FSL since 2017 and was not retained as a COPC according to the rationale described in Section 3.4.5 of Appendix C.
		Molybdenum	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 49µg/L and the average surface water concentration was 30µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 40 µg/L and the maximum value included in the 2022 ERA was 0.55 µg/L.
		Selenium	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 5µg/L and the average surface water concentration was 5µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 1 µg/L however, the MDL was higher than the preliminary benchmark at 2.0 µg/L. The detection limits exceeding the preliminary benchmarks are a function of the method detection

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
				limits that were achievable at the time of the analysis or the method detection limit may have been elevated due to matrix interference (e.g., sediment in the sample). Selenium has not been detected since 2017 and was not retained as a COPC, according to the rationale explained in Section 3.4.5 of Appendix C.
		Vanadium	Identified as a COPC in the Tier 1 screening. The maximum surface water concentration was 22µg/L and the average surface water concentration was 21µg/L. Calculated HQs were all below 1 and no further assessment was required.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 6µg/L and the maximum value included in the 2022 ERA was 0.53 µg/L.
	Sediment	Copper	Not a COPC. Sediment sampling of FSL not completed for the 2017 ERA.	Identified as a COPC in the preliminary screening. The preliminary benchmark of 12mg/kg was exceeded with a maximum value of 210 mg/kg. Included as COPC during secondary screening for Aquatic Communities. Max HQ for benthic invertebrates is 1.1 and the risk is considered negligible. No further assessment required.
		Mercury		Identified as a COPC in the preliminary screening. The preliminary benchmark of 0.17 mg/kg was exceeded with a maximum value of 0.61 mg/kg. Included as COPC during secondary screening for Aquatic Communities. Max HQ for benthic invertebrates is 1.2 and the risk is considered negligible. No further assessment required.
		Lead		Identified as a COPC in the preliminary screening. The preliminary benchmark of 27.7 mg/kg was exceeded with a maximum value of 50 mg/kg. Excluded as COPC during secondary screening for Aquatic Communities but included for Semi-Aquatic Life. The max HQs ranged from 1.3 to 1.6 based on the NOAEL but calculations using the LOAEL indicate that the max HQs range from

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
				0.6 to 1.2. The risk is considered negligible and no further assessment is required.
		Cadmium		Identified as a COPC in the preliminary screening. The preliminary benchmark of 0.6mg/kg was exceeded with a maximum value of 2mg/kg. Excluded as COPC during secondary screening for aquatic communities but included for semi-aquatic wildlife. Calculated HQs were all below 1 and no further assessment was required.
		Chromium		Identified as a COPC in the preliminary screening. The preliminary benchmark of 26mg/kg was exceeded with a maximum value of 37 mg/kg. Excluded as COPC during secondary screening for aquatic communities and semi-aquatic wildlife. No further assessment required.
		Nickel		Identified as a COPC in the preliminary screening. The preliminary benchmark of 16 mg/kg was exceeded with a maximum value of 17 mg/kg. Excluded as COPC during secondary screening for aquatic communities and semi-aquatic wildlife. No further assessment required.
		Zinc		Identified as a COPC in the preliminary screening. The preliminary benchmark of 120 mg/kg was exceeded with a maximum value of 310 mg/kg. Excluded as COPC during secondary screening for aquatic communities and semi-aquatic wildlife. No further assessment required.
		Silver		Not a COPC. The preliminary benchmark of 0.5mg/kg was exceeded with a maximum value of 54 mg/kg. The elevated silver concentrations are unlikely associated with site activities as analytical results for other media at FSL show the parameter was not historically detected in surface water and was below the Table 1 SCS for soil.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
		Arsenic		Not a COPC. The preliminary benchmark of 5.9mg/kg was not exceeded with a maximum value of 3.3 mg/kg in FSL sediment.
Bruce A Storage Compound	Soil	Hexavalent Chromium	Not a COPC. Not sampled in 2000. The Tier 1 screening standard of 0.4mg/kg was exceeded at 1 site obtained in 2016: - BASC-1 at 0-0.1m – 1mg/kg	Identified as a COPC in the preliminary screening. The preliminary benchmark of 0.66mg/kg was exceeded with a maximum value of 1 mg/kg. Included for terrestrial plants and soil organisms but excluded for terrestrial wildlife during the secondary screening. Calculated HQs were all below 1 and no further assessment was required.
		Molybdenum	Not a COPC. The Tier 1 screening standard of 2mg/kg was exceeded at 1 site obtained in 2000: - BASC-1 at 0.2ft – 5.59mg/kg	Not a COPC. The preliminary benchmark of 2 mg/kg was exceeded with a maximum value of 5.59 mg/kg. The average concentration (0.71 mg/kg) and the 95th percentile (1.5 mg/kg) were below the preliminary benchmark. The molybdenum exceedance was also not co-located with any other metal impacts.
		Selenium	Not a COPC. The Tier 1 screening standard of 1mg/kg was exceeded at 2 sites obtained in 2000: - BASC-4 at 3ft – 1.4mg/kg - BASC-5 at 3.5ft – 1.1mg/kg	Not a COPC. The preliminary benchmark of 1.5mg/kg was not exceeded in any of the samples and the maximum value obtained was 1.4 mg/kg.
		Mercury	Not a COPC. The Tier 1 screening standard of 0.27mg/kg was exceeded at 1 site obtained in 2000: - BASC-14 at 0.2ft – 1.21mg/kg	Not a COPC. The preliminary benchmark of 0.27 mg/kg was exceeded with a maximum value of 1.21 mg/kg. The isolated mercury exceedance occurred in 2000, where follow-up sampling in 2016 and 2021 had concentrations below detection limits. The mercury exceedance was also not co-located with any other metal impacts.
		TPH heavy (C24-50)	Not a COPC. The Tier 1 screening standard of 120mg/kg was exceeded at 1 site obtained in 2000: - BASC-15 at 3.0ft – 180mg/kg	Not a COPC. PHC concentrations were measured across BASC in 2016 and 2021, including adjacent to the historical TPH impacts. TPH data will not be retained for further assessment and the petroleum impacts at BASC will be assessed using recent PHC F1 to F4 sampling data.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
		Ethylbenzene	Not a COPC. The Tier 1 screening standard of 0.05mg/kg was exceeded at 1 site obtained in 2000: - BASC-14 at 5.0ft – 27mg/kg	Not a COPC. The preliminary benchmark of 0.05 mg/kg was not exceeded in any of the included samples and the maximum value detected was 0.031 mg/kg. The exceedance in the 2017 ERA is located at a depth that is out of scope for the 2022 ERA.
Distribution Station #1	Soil	Arsenic	Not a COPC. The Tier 1 screening standard of 12mg/kg was exceeded at 1 site obtained in 2000: - DS1-13 at 7.5ft – 16mg/kg	Not a COPC. The preliminary benchmark of 12 mg/kg was not exceeded in any of the included samples and the maximum value obtained was 10 mg/kg. The exceedance in the 2017 ERA is located at a depth that is out of scope for the 2022 ERA.
		TPH heavy (C24-50)	Not a COPC. The Tier 1 screening standard of 120mg/kg was exceeded at 2 sites obtained in 2000: - DS1-10 at 8.0ft – 129mg/kg - DS1-13 at 7.5ft – 196mg/kg	Not a COPC. The preliminary benchmark of 120 mg/kg was not exceeded in any of the included samples and the maximum value obtained was <100 mg/kg. The exceedance in the 2017 ERA is located at a depth that is out of scope for the 2022 ERA.
Bruce Snow Dump	Soil	Cadmium Mercury Selenium Strontium Uranium	Not sampled in 2017 ERA. Snow dump sampling was targeted for sodium and chloride only and no driver exists for additional or expanded sampling based on past and present site activities.	Not assessed in the 2022 ERA.
Bruce B Empty Drum Laydown	Soil	TPH heavy (C24-50)	Not a COPC. The Tier 1 screening standard of 120mg/kg was exceeded at 1 site obtained in 2000: - BBED-12 at 2ft – 159mg/kg	Not a COPC. The preliminary benchmark of 120mg/kg was exceeded with a maximum value of 159mg/kg. Samples collected in the top 0.2 m were not detected across the BBED site. There is negligible exposure potential from TPHs at BBED; therefore, these parameters were not retained as COPCs for further assessment.
Bruce A Discharge (LWQ1 in 2022 ERA)	Surface Water	Morpholine	Not a COPC in the EcoRA. The Tier 1 screening benchmark of 4 µg/L was not exceeded at the Bruce A Discharge. Morpholine in Lake Huron was assessed in the HHRA of the 2017 ERA.	Not a COPC. The ECA limit of 15µg/L was not exceeded from 2017 to 2021. Surface water samples from the Bruce A Discharge Channel did not exceed the preliminary benchmark of 0.004 mg/L.

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
Bruce B Discharge (LWQ2 in 2022 ERA)	Surface Water	Toluene	Identified as a COPC in the Tier 1 screening at McRae Point. At the Bruce B Discharge, the Tier 1 benchmark of 0.8 µg/L was not exceeded with a maximum value of 0.2 µg/L at the Bruce B Discharge. Toluene was excluded from the HHRA for being below the drinking water standards of 60 µg/L and 24 µg/L. Toluene was included in Lake Huron surface water in the EcoRA with a maximum concentration at McRae Point of 12 µg/L. A maximum hazard quotient of 1.2 was calculated for toluene in lake Huron surface water at McRae Point.	Not a COPC. Surface water samples from the Bruce B Discharge Channel did not exceed the preliminary benchmark of 0.8 µg/L.
		Morpholine	Not a COPC in the EcoRA. Assessed in the HHRA. The Tier 1 screening benchmark of 4 µg/L was exceeded at the Bruce B Discharge at 5 µg/L. Morpholine in Lake Huron was assessed in the HHRA of the 2017 ERA.	Not a COPC. The ECA limit of 15µg/L was not exceeded from 2017 to 2021. Surface water samples from the Bruce B Discharge Channel did not exceed the preliminary benchmark of 0.004 mg/L.
Lake Huron – Off Douglas Point (LWQ3/LWQ11 in 2022 ERA)	Surface Water	Lead	Not a COPC. Surface water samples Off Douglas Point considered in the 2017 ERA exceeded the Tier 1 benchmark of 5 µg/L and the maximum value obtained was 220 µg/L. This was excluded on the basis that the exceedance occurred in a single surface water sampling event in May 2007 and subsequent sampling events in June and October 2007 and in 2009 and 2016 did not show further exceedances.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 1-5 µg/L and the maximum value obtained was 0.71 µg/L.
		Mercury	Identified as a COPC in the Tier 1 screening. The Tier 1 benchmark of 0.026 µg/L was exceeded at a maximum of 0.3 µg/L and an average of 0.2 µg/L. HQ for Belted Kingfisher a max of 0.07 and an average of 0.05. HQs for Aquatic Life were calculated at a maximum of 1.3.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 0.026 µg/L and the maximum value obtained was <0.1 µg/L. Excluded as a COPC because there were no detections since 2017 despite the detection limit being higher than the preliminary benchmark.
Lake Huron –	Surface Water	Mercury	Identified as a COPC in the Tier 1 screening. HQ	Not a COPC. Surface water samples considered in

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
Off Bruce B (LWQ11 in 2022 ERA)			for Belted Kingfisher a max of 0.1 and an average of 0.5. HQs for Aquatic Life were calculated at a maximum of 1.3.	the 2022 ERA did not exceed the preliminary benchmark of 0.026 µg/L and the maximum value obtained was <0.1 µg/L. Excluded as a COPC because there were no detections since 2017 despite the detection limit being higher than the preliminary benchmark.
Lake Huron – MacPherson Bay (LWQ3/LWQ6 in 2022 ERA)	Surface Water	Aluminum	Not a COPC. There were no exceedances of the Tier 1 benchmark.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 75-100 µg/L and the maximum value obtained was 62 µg/L.
		Iron	Not a COPC. There were no exceedances of the Tier 1 benchmark.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 300 µg/L. and the maximum value obtained was <100 µg/L.
Lake Huron – McRae Point (LWQ8 in 2022 ERA)	Surface Water	Toluene	Identified as a COPC in the Tier 1 screening. The Tier 1 benchmark of 0.8µg/L was exceeded at a maximum of 12 µg/L and an average of 4.13 µg/L. HQ for Belted Kingfisher a max of 0.01 and an average of <0.01.	Not a COPC. Surface water samples at McRae Point considered in the 2022 ERA did not exceed the preliminary benchmark of 0.8 µg/L.
		Xylene	Not a COPC. No Tier 1 benchmark is available.	Not a COPC. No preliminary benchmark is available, evaluated under Xylene (total).
		Total xylene	Identified as a COPC in the Tier 1 screening. The Tier 1 benchmark of 2 µg/L was exceeded at a maximum of 14 µg/L and an average of 4.93 µg/L. HQ for Belted Kingfisher a max of 0.01 and an average of <0.01.	Not a COPC. Surface water samples considered in the 2022 ERA did not exceed the preliminary benchmark of 2 µg/L and the maximum value obtained was <0.4 µg/L.
Lake Huron – Background (Scott's Point, Spar 103, Spar 6, Spar 5)	Sediment	Copper	Not a COPC. There were no exceedances of the Tier 1 benchmark near Bruce Power. Deep Basin lake samples were not assessed in the EcoRA as there is no connection to Bruce Power site operations.	Not a COPC. Sediment samples considered in the 2022 ERA did not exceed the preliminary benchmark of 12 mg/kg and the maximum value obtained was 4.3 mg/kg.
		Lead	Not a COPC. There were no exceedances of the Tier 1 benchmark. Deep Basin lake samples were not assessed in the EcoRA as there is no	Not a COPC. Sediment samples considered in the 2022 ERA did not exceed the preliminary benchmark of 27.7 mg/kg and the maximum value

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			connection to Bruce Power site operations.	obtained was 2.4 mg/kg.
		Zinc	Not a COPC. There were no exceedances of the Tier 1 benchmark. Deep Basin lake samples were not assessed in the EcoRA as there is no connection to Bruce Power site operations.	Not a COPC. Sediment samples considered in the 2022 ERA did not exceed the preliminary benchmark of 120 mg/kg and the maximum value obtained was 27 mg/kg.
Lake Huron – Scott's Point	Sediment	2-methylnaphthalene	Not a COPC. Excluded following Tier 1 screening due to the single exceedance occurring at 2km from the facility. The screening value was 0.0202 µg/g and the measured concentration was 0.067 µg/g.	Not a COPC. Value obtained in 2021 was below detection limit and below the CSQG PEL level of 0.2017µg/g. The detection limit was higher than the Tier 1 benchmark of 0.0202 µg/g. Excluded as a COPC following the preliminary screening due to the measured value being below the PEL value of 0.2017µg/g.
Stream C – Upstream	Surface Water (SW1 in 2022 ERA)	Aluminum	COPCs not evaluated for upstream samples as these results are not related to site activities.	COPCs not evaluated for upstream samples as these results are not related to site activities.
		Iron	COPCs not evaluated for upstream samples as these results are not related to site activities.	COPCs not evaluated for upstream samples as these results are not related to site activities.
		Mercury	COPCs not evaluated for upstream samples as these results are not related to site activities.	COPCs not evaluated for upstream samples as these results are not related to site activities.
Stream C – Downstream	Surface Water (SW2/Stream C Confluence in 2022 ERA)	Aluminum	Identified as a COPC in the Tier 1 screening. Max HQs ranging from 0.3 to 3.2 for aquatic birds and average HQs ranging from 0.007 to 1.8.	Not a COPC. The preliminary benchmark of 75-100 µg/L was exceeded with a maximum value of 1,540 µg/L. Excluded during the preliminary screening due to concurrent exceedance at higher values at upstream (non-impacted) locations, with a maximum upstream value of 1,630 µg/L.
	Sediment (SW2 in 2022 ERA)	Acetone	Not a COPC. Acetone exceeded the Tier 1 screening guideline in a single sediment sample and was not detected in surface water samples. As it is most likely to have an effect in surface water, acetone was excluded as a COPC.	Not a COPC. Acetone was detected (1.2 µg/g) in a single downstream sample of Stream C in January 2017 and exceeded the Stream C US concentration (<0.5 µg/g). Acetone was not detected at any other location or in surface water sampling. As acetone was not prevalent in the media where it is most likely to have an effect, it was not retained as a COPC for sediment.
		F2	Not a COPC.	Not COPCs. The maximum measured concentrations of PHC F2 and F3 (35 mg/kg and
		F3	Not a COPC. The maximum measured	

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
			concentrations of PHC F3 slightly the Tier 1 screening benchmark (240 mg/kg) in a single sample in Stream C. The values did not exceed the CCME SQG of 300 mg/kg.	290 mg/kg, respectively) slightly exceeded their respective preliminary benchmarks (10 mg/kg for PHC F2 and 200 mg/kg for PHC F3) in Stream C in January 2017. PHC F2 was measured below detection limits and PHC F3 was below the preliminary benchmark in subsequent sediment sampling completed in June 2021 as well as across all surface water sampling events. Historical data from September 2009 also did not detect PHC concentrations in sediment within Stream C. Heavy hydrocarbons such as PHC F3 found in sediment can be the result of organic matter breakdown in the aquatic environment. The isolated elevated levels are not expected to have an impact on aquatic receptors.
Stream C - General	Surface Water (SW1/SW2/Stream C Confluence in 2022 ERA)	Fluoride	Identified as a COPC in the Tier 1 screening.	Not a COPC. Not emitted or used by Bruce Power operations and high levels of fluoride occur naturally in local groundwater and surface water (see Section 3.4.5.3).
		Iron	Identified as a COPC in the Tier 1 screening.	Not a COPC. Excluded during the preliminary screening due to concurrent exceedance of the preliminary benchmark (300 µg/L) at upstream (non-impacted) of up to 1,300 µg/L and downstream locations at up to 1,360 µg/L. Additionally iron in Stream C is likely related to sub-oxic groundwater discharges (see Section 3.4.5.3).
Drain Under Interconnecting Road (SW5)	Surface Water	- Aluminum - Copper - Iron	Stormwater results are not assessed in the 2017 ERA for non-permanent drainage features.	Stormwater results are not assessed in the 2022 ERA for non-permanent drainage features.

Table 256 Disposition of CNSC/ECCC Additional COPC Requests from the 2017 ERA for locations not included on Bruce Power leased lands

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
Construction Landfill #1	Soil	- Molybdenum, - Uranium - Lead - Copper - Selenium - Silver - TPH heavy (C24-50)	N/A	Location not included in 2022 ERA – located on OPG retained land.
Construction Landfill #2	Soil	- Lead - Silver - Zinc - pH - Selenium - TPH heavy (C24-50)	N/A	Location not included in 2022 ERA – located on OPG retained land.
Construction Landfill #3	Soil	- PHCs: TPH Light (C10-24); TPH Heavy (C24-50)) - Dimethylphthalate; - Benzo(a)anthracene - Di-n-butyl phthalate - Acetone	N/A	Location not included in 2022 ERA – located on OPG retained land.
Former Clariflocculator Sludge Lagoon CSL-5-AW	Surface Water	- Uranium	N/A	Location not included in 2022 ERA – located on OPG retained land.
	Sediment	- Copper		
Railway Ditch	Surface Water	- Copper - Iron	N/A	Location not included in 2022 ERA – located on OPG retained land.
	Sediment	- Copper - Zinc - Cadmium - Nickel		
South Railway Ditch	Surface Water	- Aluminum - Iron	N/A	Location not assessed in 2022 ERA – located on OPG retained land. Data is presented in Appendix E to fulfill 2017 ERA closure requirements. Location is
	Sediment	- Arsenic - Cadmium		

Location	Media	Chemical	Characterization of Results in 2017 ERA	Disposition for 2022 ERA
		- Copper - Nickel - Zinc		assessed in the 2021 update of the WWMF ERA [R-2].

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