



Report

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**2024 Environmental Risk Assessment Addendum
for the Darlington Nuclear Site**

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2024 ENVIRONMENTAL RISK ASSESSMENT ADDENDUM FOR THE DARLINGTON NUCLEAR SITE

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2024 ENVIRONMENTAL RISK ASSESSMENT ADDENDUM FOR THE DARLINGTON NUCLEAR SITE


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LAND ACKNOWLEDGEMENT

The lands and waters on which the Darlington (DN) Site is situated are the traditional and treaty territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

The DN Site is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualities are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.



List of Acronyms and Symbols

ACRONYMS

AAQC	ambient air quality criteria
ACB	Air Contaminants Benchmarks
ALARA	as low as reasonably achievable
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
BAP	benzo(a)pyrene
BB	Boiler Blowdown
BCF	bioconcentration factor
BC MOE	British Columbia Ministry of the Environment
BM	Birds and Mammals
BTEX	benzene, toluene, ethylbenzene, and xylenes
C-14	Carbon-14
CAAQS	Canadian Ambient Air Quality Standards
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CCW	condenser cooling water
CDWG	Canadian Drinking Water Quality Guideline
CEAA	Canadian Environmental Assessment Act
CFU/100mL	colony forming units per 100 millilitres
CN	Canadian National Railway Company
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
COPC	contaminant of potential concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSA	Canadian Standards Association
CSM	Conceptual Site Model
CSQG	Canadian Sediment Quality Guidelines
CWQG	Canadian water quality guideline
dB	decibels
dBA	A-weighted decibels
DC	dose coefficient
DFO	Department of Fisheries and Oceans Canada
DN	Darlington Nuclear
DNGS	Darlington Nuclear Generating Station
DNNP	Darlington New Nuclear Project
DRHD	Durham Region Health Department
DRL	derived release limit
DSC	dry storage container
DWMF	Darlington Waste Management Facility

DWP	Demineralized Water Plant
DYEC	Durham York Energy Centre
EA	environmental assessment
EC	Environment Canada
ECA	environmental compliance approval
ECCC	Environment and Climate Change Canada
EcoRA	ecological risk assessment
Eco-SSLs	Ecological Soil Screening Levels
EIS	Environmental impact statement
EMP	environmental monitoring program
ERA	environmental risk assessment
ESA	Endangered Species Act
ESDM	Emissions Summary and Dispersion Modelling
ESL	Effects Screening Levels
ESSB	Engineering Support and Services Building
FCSAP	Federal Contaminated Sites Action Plan
FEQG	Federal Environmental Quality Guideline
FFAA	fuelling facilities auxiliary areas
FUMP	Follow-Up Monitoring Program
GWMP	groundwater monitoring program
GWPP	groundwater protection program
HC	Health Canada
HHRA	human health risk assessment
HQ	hazard quotient
HT	elemental tritium
HTO	tritium oxide
IAD	inactive drainage
IARC	International Agency for Research on Cancer
ICSQC	Interim Canadian Soil Quality Criteria
ILCR	incremental lifetime cancer risk
IRIS	US EPA Integrated Risk Information System
Imfp	radioiodine mixed fission products
iPWQO	interim provincial water quality objective
ISO	International Organization for Standardization
LAS	linear alkylbenzene sulphonates
logK _{ow}	hydrophobicity
mbgs	metres below ground surface
MECP	Ministry of Environment, Conservation, and Parks
mGy/d	milligray per day
Mo-99	Molybdenum-99
MOE	Ontario Ministry of the Environment
MOECC	Ontario Ministry of the Environment and Climate Change
MOEE	Ontario Ministry of Environment and Energy
mSv/a	millisievert per annum

NND	New Nuclear-Darlington
NO ₂	Nitrogen dioxide
NOAEL	no observed adverse effect level
NO _x	Nitrogen oxides
NSCA	Nuclear Safety and Control Act
NSS-DWMF	Nuclear Sustainability Services – Darlington Waste Management Facility
OBT	organically bound tritium
ODWS	Ontario Drinking Water Standards
OPG	Ontario Power Generation
O.Reg.	Ontario Regulation
OTR ₉₈	Ontario Typical Range
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHC	petroleum hydrocarbons
PM _{2.5}	particulate matter with diameter of 2.5 micrometres or less
PM ₁₀	particulate matter with diameter of 10 micrometres or less
POI	point of impingement
POR	point of reception
PQRA	preliminary quantitative risk assessment
PSO	Plants and Soil Organisms
PSQG	Provincial Sediment Quality Guidelines
PWQO	provincial water quality objective
QA	quality assurance
QSAR	Quantitative Structure-Activity Relationship
RCO	Refurbishment and Continued Operation
RfD	Reference Dose
RLW	Radioactive liquid waste
RSL	Regional Screening Level
RWSB	Retube Waste Storage Building
SAR	sodium adsorption ratio
SARA	Species at Risk Act
SARO	Species at Risk in Ontario
SG	Standby Generator
SMC	St. Mary's Cement
SMR	small modular reactor
SO ₂	Sulphur dioxide
SPI	safety performance indicator
SQG _E	Soil Quality Guidelines for Environmental Health
SSA	site study area
SSC	structures, systems, and components
SQG	Soil Quality Guideline
TCEQ	Texas Commission on Environmental Quality
TDI	tolerable daily intakes
TDS	Target Delivery System

TF	transfer factor
THQ	target hazard quotient
TRC	total residual chlorine
TRF	Tritium Removal Facility
TRV	toxicity reference value
TSP	total suspended particulates
UCLM	upper confidence limit on the arithmetic mean
UFDS	used fuel dry storage
$\mu\text{Gy/h}$	microgray per hour
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
US EPA	United States Environmental Protection Agency
VEC	valued ecosystem component
VOC	volatile organic compounds
WHO	World Health Organization
WSP	water supply plant
WTFNs	Williams Treaties First Nations
WTP	Water Treatment Plant

SYMBOLS

Human Non-radiological Parameters

C	=	concentration of contaminant in drinking water (mg/L)
IR	=	receptor intake rate (L/d)
RAF_{GIT}	=	absorption factor from the gastrointestinal tract (unitless)
D_2	=	days per week exposed $\cdot (7 \text{ days})^{-1}$ (d/d)
D_3	=	weeks per year exposed $\cdot (52 \text{ weeks})^{-1}$ (wk/wk)
D_4	=	total years exposed to site (years) (for carcinogens only)
BW	=	body weight (kg)
$C_{\text{food } i}$	=	concentration of contaminant in food I (mg/kg)
$\text{IR}_{\text{food } i}$	=	receptor ingestion rate for food I (kg/d)
$\text{RAF}_{\text{GIT } i}$	=	relative absorption factor from the gastrointestinal tract for contaminant i (unitless)
D_i	=	days per year during which consumption of food I will occur (d/a)
365	=	total days per year (constant) (d/a)
LE	=	life expectancy (years) (for carcinogens only)

Ecological Radiological Dose Parameters

D_{int}	=	internal radiation dose ($\mu\text{Gy/d}$)
D_{ext}	=	external radiation dose ($\mu\text{Gy/d}$)
DC_{int}	=	internal dose coefficient ($(\mu\text{Gy/d})/(\text{Bq/kg})$)
DC_{ext}	=	external dose coefficient ($(\mu\text{Gy/d})/(\text{Bq/kg})$)
$\text{DC}_{\text{ext},s}$	=	external dose coefficient (in soil) ($(\mu\text{Gy/d})/(\text{Bq/kg})$)

$DC_{ext,ss}$	=	external dose coefficient (on soil surface) ($\mu\text{Gy/d}/(\text{Bq/kg})$)
C_m	=	media concentration (Bq/L or Bq/kg)
C_f	=	average concentration in food (Bq/kg fw)
C_w	=	water concentration (Bq/L)
C_s	=	soil/sediment concentration (Bq/kg fw)
C_t	=	whole body tissue concentration (Bq/kg fw)
C_x	=	concentration in the ingested item x (Bq/kg fw)
OF_w	=	occupancy factor in water (unitless)
OF_{ws}	=	occupancy factor at water surface (unitless)
OF_s	=	occupancy factor in soil/sediment (unitless)
OF_{ss}	=	occupancy factor at soil/sediment surface (unitless)
BAF	=	bioaccumulation factor (L/kg or kg/kg)
BMF	=	biomagnification factor (unitless)
I_x	=	ingestion rate of item x (kg fw/d)
TF	=	ingestion transfer factor (d/kg)
DW_a	=	dry/fresh weight ratio for animal products (kg-dw/kg fw)
$1-DW_a$	=	water content of the animal (L water /kg fw)
$1-DW_p$	=	water content of the plant/food (L water /kg fw plant)
$BAF_{a,HTO}$	=	aquatic animal BAFs for tritium (L/kg fw)
$BAF_{p,HTO}$	=	plant BAF for tritium (L/kg fw)
k_{af}	=	fraction of food from contaminated sources
k_{aw}	=	fraction of water from contaminated sources (assumed to be 1)
f_{OBT}	=	fraction of total tritium in the animal product in the form of OBT as a result of HTO ingestion
f_{w-w}	=	fraction of the animal water intake derived from direct ingestion of water
f_{w-pw}	=	fraction of the animal water intake derived from water in the plant feed
f_{w-dw}	=	fraction of the animal water intake that results from the metabolic decomposition of the organic matter in the feed
$P_{HTOwater_animal}$	=	transfer of HTO to animals through water ingestion (L/kg fw)
$P_{HTOfood_animal}$	=	transfer of HTO to animals through food ingestion
S_a	=	stable carbon content in the aquatic animal/invertebrate/plant (gC/kg fw)
S_w	=	mass of stable carbon in the dissolved inorganic phase in water (gC/L)
S_p	=	stable carbon content in the food (gC/kg fw)
$BAFa_{C14}$	=	C-14 BAF for aquatic animals, invertebrates, and plants (L/kg fw)
$P_{C14food_animal}$	=	transfer of C-14 from food to animals

Ecological Non-Radiological Parameters

C_x	=	concentration in the ingested item (x) (mg/kg)
D_{ing}	=	dose from ingestion pathway (mg/kg body weight/d)
I_x	=	ingestion rate of item x (kg/d)
W	=	body weight of consumer (kg fw)
ΔT	=	change in temperature ($^{\circ}\text{C}$)

Executive Summary

This Addendum to the 2020 Environmental Risk Assessment (ERA) for Darlington Nuclear (DN) (hereinafter referred to as the "ERA Addendum" or "this Addendum") has been prepared to be compliant with CSA N288.6:22 "Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills" (CSA, 2022) and also meets the requirements for an ERA outlined in Section 4.1 of REGDOC-2.9.1 "Environmental Protection: Environmental Principles, Assessments and Protection Measures" (CNSC, 2020e). This ERA Addendum should be read in conjunction with the 2020 ERA for Darlington.

The DN site is located in the Municipality of Clarington, in the former township of Darlington, on the north shore of Lake Ontario at Raby Head. The DN site is about 5 km southwest of the community of Bowmanville and about 10 km east-southeast of the City of Oshawa. The DN site is comprised of the DN Generating Station, with four CANada Deuterium Uranium (CANDU) pressurized heavy water generating reactors, the Tritium Removal Facility (TRF), the Nuclear Sustainability Services - Darlington Waste Management Facility (NSS-DWMMF), the Darlington New Nuclear Project (DNNP) Lands, and all other land under Ontario Power Generation (OPG) ownership within the property boundary at DN.

OPG has safely operated the DN Generating Station since 1990, meeting all regulatory, federal and provincial guidelines, including regulatory dose limits. OPG operates the DN Generating Station in a manner that ensures the health and safety of employees, the public and the environment.

This ERA Addendum focuses on activities that occurred on the DN site during the 2020 to 2022 period that encompass normal operations at DN during the operations and refurbishment phases of the facility. In some cases, data from 2023 were available at the time of writing the report and were included for completeness. The overall goals of this ERA Addendum are:

- To update existing conditions for the DN Site (2020 to 2022).
- To provide an interim update to the ERA in general accordance with the CSA N288.6:22 Standard (i.e., in the form of an ERA Addendum) prior to the next routine ERA update currently scheduled for submission in 2026.
- To provide focus for the environmental monitoring program on relevant chemicals and radionuclides (also known as contaminants of potential concern or COPCs), media, and ecological and human receptors.

The specific objectives of this ERA Addendum, consistent with CSA N288.6:22, are:

- To evaluate the risk to relevant human and ecological receptors resulting from exposure to contaminants and stressors related to the DN site and its activities with a focus on the years 2020 to 2022.
- To recommend potential further monitoring or assessment as needed based on the results of the ERA Addendum.

Environmental data for the ERA Addendum were generally obtained from the 2020 DN ERA, existing DN environmental assessments (EAs), Emission Summary and Dispersion Modelling (ESDM) reports from 2020 to 2022, Environmental Compliance Approvals (ECAs) from 2020 to 2022, and environmental monitoring data from 2020 to 2022, including environmental monitoring data collected to support DNNP licence renewal.

OPG integrates adaptive management into its environmental management system. Specifically, adaptive management is fundamental to the environmental monitoring program (EMP) to ensure that the monitoring activities remain valid, and to enable OPG to appropriately identify and address any adverse findings or areas of risk. EMP program design reviews, self-assessments and audits are regularly conducted to confirm effectiveness of environmental monitoring activities and to practice continual improvement. The ERA process is also a means for adaptive management as it is undertaken every 5 years and considers changes to site activities and environmental conditions to identify any areas where changes in mitigation or monitoring may be needed. Through the existing processes, if a risk to the environment is identified or predicted through the ERA, it can trigger changes to the EMP, supplementary studies, and/or mitigation measures, as required.

Human Health Risk Assessment (HHRA)

Predicted exposures to sources from DN were evaluated on the basis of toxicological effects from non-carcinogenic COPCs, potential cancer risk from carcinogens, and potential radiation exposure from radionuclides.

Human Receptors

The same human receptors identified in the 2020 DN ERA were adopted for this ERA Addendum. Human receptors evaluated in both the radiological and non-radiological assessment are off-site members of the public, specifically those potential critical groups used for dose calculations in the OPG Annual EMP Reports, including:

- Urban Residents (Oshawa/Courtice, Bowmanville, West/East Beach)
- Farm
- Dairy Farm
- Rural Resident
- Industrial/Commercial Worker
- Sport Fisher
- Camper

These potential critical groups are off-site members of the public who are most exposed to the radiological and non-radiological COPCs from DN. They are intended to be protective of the rest of the general population who are less exposed to radiological and non-radiological COPCs from DN. On-site receptors were not addressed in the HHRA, since human exposures on the site are kept within safe levels through OPG's Health and Safety Management System Program and Radiation Protection Program.

Screening of COPCs for Human Health

For this Addendum, human health risks are only calculated if, compared to the 2020 ERA, there is a new COPC, or there is a COPC with a higher maximum concentration based on the 2020 – 2022 data. The only chemical COPC retained for evaluation of human health risks is hydrazine in surface water. Selected radiological stressors are considered of public interest and therefore are carried forward quantitatively in the HHRA. The radionuclides identified as the limiting radionuclides based on their Derived Release Limits (DRLs) were considered appropriate for assessment in the HHRA. Radionuclides were evaluated based on the total public dose to the critical receptor. **Table ES-1** summarizes the COPCs that were carried forward to the exposure assessment in this Addendum.

Table ES-1: Summary of COPCs Selected for the HHRA

Category	Radiological COPC	Chemical COPC
Air	C-14, Co-60, elemental tritium (HT), tritium oxide (HTO), noble gases, radioiodine mixed fission products (Imfp)	None
Surface water	C-14, Cs-134, HTO	Hydrazine
Soil	C-14, Co-60, Cs-134, HTO, I-131	None
Groundwater	HTO, I-131	None
Sediment (beach sand)	C-14, Cs-134, HTO	None
Physical Stressors	None	

Results of HHRARadiological HHRA

For exposure of human receptors to radiological COPCs, the relevant exposure pathways and human receptors (potential critical groups) were those presented in the annual OPG EMP reports. The 2020-2022 public dose estimates for the critical groups are at most approximately 0.06% of the regulatory public dose limit of 1 mSv/a, and at most approximately 0.04% of the dose from background radiation (1.4 mSv/a) in the vicinity of DN. Demonstration that these critical groups are protected implies that other receptor groups near DN are also protected.

Non-radiological HHRA

Based on the COPC and media retained for quantitative evaluation in the HHRA (hydrazine in surface water), the only exposure pathways evaluated (i.e., the only exposure pathways that are complete for the relevant receptors) are ingestion of water and ingestion of fish. The relevant receptors are those that may utilize water from the Bowmanville or Oshawa Water Supply Plants (WSPs), specifically the Oshawa/Courtice Urban Resident, Bowmanville Urban Resident, West/East Beach Urban Resident, Rural Resident, Industrial/Commercial Worker, and the

Camper. Also relevant are those that may consume fish from Lake Ontario, including the West/East Beach Urban Resident, Sport Fisher, and Camper receptors.

Potential risks to human receptors were characterized quantitatively in terms of incremental lifetime cancer risk for hydrazine, a potential carcinogen. Consistent with CSA N288.6:22, the acceptable risk level is less than a cancer risk of 10^{-6} , which represents an essentially negligible risk compared to background cancer risks.

No risk to human receptors via drinking water is expected. The estimated cancer risk level for hydrazine for surface water ingestion based on mean and maximum hydrazine concentrations in the condenser cooling water (CCW) were below the one in one million cancer risk level for all human receptors. Although the concentrations of hydrazine at the CCW discharge point were greater compared to the 2020 ERA, cancer risks to human receptors from the concentrations of hydrazine in surface water have been assessed to be lower, as a 90% decay factor for hydrazine at the WSPs was applied in this assessment to account for hydrazine degradation at the WSPs.

No risk to the Sport Fisher, Camper, and West/East Beach Urban Resident via fish consumption is expected. The cancer risk level for hydrazine did not exceed the acceptable cancer risk level based on mean hydrazine concentration in fish near the CCW.

A recommendation from the 2020 ERA was to analyze Lake Ontario surface water samples for hydrazine using a lower detection limit. Since there are currently no commercial laboratories available to achieve a lower detection limit for hydrazine in surface water, OPG will look for opportunities to achieve a lower detection limit if hydrazine is measured in lake water in the future, to reduce the uncertainty in the hydrazine dataset.

Ecological Risk Assessment (EcoRA)

Ecological Receptors

The assessment for the EcoRA focused on the nearshore Lake Ontario (generally in the area surrounding the outfall from the DN diffuser) and the DN site and surrounding area. The assessment has been divided into polygons (AB – Coot's Pond, C, D – Treefrog Pond, and E), generally consistent with past EcoRAs.

Ecological receptors were selected for dose and risk analysis because they are known to exist on-site, and/or are representative of major taxonomic/ecological groups, major pathways of exposure, or have a special importance or value. The ecological receptors selected were based on previous ecological assessments for the DN site (the 2020 DN ERA, the New Nuclear-Darlington (NND) EA, and the Refurbishment and Continued Operation (RCO) EA), updated based on consideration of new species observed during the 2020 to 2023 period.

The model used for assessment of dose and risk is either specific to the selected ecological species or is a more generic biota assessment model that is appropriate to a number of ecological receptors with similar exposure characteristics. **Table ES-2** shows the selected

ecological receptors, and the assessment models used in estimating their COPC exposure, dose, and risk. Protection of the ecological receptors implies that other species in the same ecological receptor category are also protected.

Table ES-2: Summary of Ecological Receptors and their Assessment Models used in the EcoRA

Receptor Category	Assessment Model	Representative Ecological Receptor
Fish	Bottom Feeding Fish	Northern Redbelly Dace
		Round Whitefish
		White Sucker
		American Eel
	Pelagic Fish	Alewife
		Lake Trout
Reptiles and Amphibians	Bottom Feeding Fish	Turtles
		Frogs
Aquatic Plants	Aquatic Plant	Aquatic Plants
Aquatic Invertebrates	Benthic Invertebrate	Benthic Invertebrates
Riparian Birds	Bufflehead	Bufflehead
	Mallard	Mallard
	Green Heron	Green Heron
Riparian Mammals	Muskrat	Muskrat
Terrestrial Invertebrates	Soil Invertebrate	Earthworm
Terrestrial Birds	American Robin	American Robin
	Bank Swallow	Bank Swallow
	Song Sparrow	Song Sparrow
	Yellow Warbler	Yellow Warbler
Terrestrial Plants	Terrestrial Plant	Grass
	Terrestrial Plant	Sugar Maple
Terrestrial Mammals	Eastern Cottontail	Eastern Cottontail
	Meadow Vole	Meadow Vole
	White-tailed Deer	White-tailed Deer
	Common Shrew	Common Shrew
	Raccoon	Raccoon
	Red Fox	Red Fox
	Short-tailed Weasel	Short-tailed Weasel

Each identified Species at Risk was assigned a representative species for the EcoRA.

Assessment endpoints are attributes of the receptors that we wish to protect in environmental programs (Suter et al., 1993). The purpose of an ERA is to evaluate whether these environmental protection goals are being achieved. Consistent with CSA N288.6, the assessment endpoint for all receptors (other than species at risk) in this ecological risk assessment is population

abundance. The assessment endpoint for identified species at risk is the individual, since effects on even a few individuals of species at risk would not be acceptable.

Screening of COPCs for EcoRA

Contaminants were retained for evaluation of ecological health risks in this Addendum if they;

- Were a new COPC not previously identified in the 2020 ERA; or,
- Were a COPC evaluated in the 2020 ERA and the maximum concentration in 2020 – 2022 was greater than that evaluated in the 2020 ERA.

The framework for the chemical COPC screening process used in the EcoRA is consistent with the 2020 ERA, with updated guidelines applied where available. Selected radiological stressors are considered of public interest and, therefore, are carried forward quantitatively in the EcoRA. The radiological COPCs that were selected to evaluate radiological dose are consistent with those in the HHRA.

There were new non-radiological COPCs identified in soil (sodium adsorption ratio (SAR), petroleum hydrocarbons (PHC) F1, PHC F2, PHC F3) for polygon E. There were no COPCs retained for evaluation in other media, as there were no new COPCs and COPC concentrations were not greater than those in the 2020 ERA.

The relevant exposure pathway for the identified soil COPCs is direct contact with soil by plants and soil invertebrates. The SAR parameter is relevant to osmotic effects in soil organisms, which refers to an altered ability for soil organisms to take up nutrients from the soil. Thus, the SAR parameter only affects soil organisms and is not evaluated for terrestrial vertebrates. As described by the CCME, PHCs are “readily metabolized by vertebrates, modified into a more readily excretable form, and thus do not tend to accumulate in tissues” (CCME, 2008). As such, risks to mammals and birds based on PHC exposure are considered negligible and not evaluated herein.

All radionuclides retained in the 2020 ERA were also retained for the Addendum. As such, the same exposure pathways that were evaluated in the 2020 ERA for exposure to radiological COPCs are relevant for this ERA Addendum.

Results of EcoRA

For radiological COPCs, there were no exceedances of the 9.6 mGy/d radiation benchmark for aquatic biota at any location, nor any exceedances of the 2.4 mGy/d radiation benchmark for terrestrial or riparian biota at any location.

For non-radiological COPCs, the assessment focused on plants and soil invertebrates in Polygon E. The following is a summary of results:

- Based on upper confidence limit of the arithmetic mean (UCLM) exposure concentrations, the hazard quotients (HQs) were below 1; therefore, risks to plant and soil invertebrate populations are acceptable.
- Maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 exceeded benchmarks for ecological health. However, maximum concentrations assume that the entire ecological population of each receptor is only exposed to the maximum and not to a range of concentrations. Comparison to the UCLM is more representative of expected risks. Additionally, the terrestrial habitat in Polygon E is minimal with limited vegetation; therefore, any toxic effects at these discrete locations would have little population or community level impact.

Recommendation

Risks were deemed negligible for human and ecological receptors due to the exposure levels to both radiological and non-radiological COPCs. While no specific recommendations are required, OPG will look for opportunities to reduce the analytical detection limit of hydrazine in water, if hydrazine is measured in lake water in the future, to reduce the uncertainties in the hydrazine dataset for future assessments. A hydrazine detection limit of 0.05 µg/L in surface water is recommended for any future sampling programs.

There are no risk management recommendations based on the outcome of this ERA Addendum.

Conclusion

Overall, Darlington Nuclear is operating in a manner that is protective of human and ecological receptors residing in the surrounding area.

Table of Contents

LAND ACKNOWLEDGEMENT..... I

LIST OF ACRONYMS AND SYMBOLS..... I

EXECUTIVE SUMMARYVI

TABLE OF CONTENTS XIII

LIST OF TABLES XVI

LIST OF FIGURES XVII

1.0 INTRODUCTION..... 1.1

1.1 Background and Methodology 1.1

 1.1.1 Indigenous Engagement..... 1.1

 1.1.2 Summary of Previous Environmental Assessments, Environmental Risk Assessments, and
 Follow-up Monitoring Programs 1.3

1.2 Goals, Objectives, and Scope..... 1.3

 1.2.1 Spatial Boundaries..... 1.4

1.3 Periodic Review of the ERA 1.5

1.4 Recommendations from the 2020 ERA 1.8

1.5 Organization of Report 1.11

2.0 SITE HISTORY AND DESCRIPTION..... 2.1

2.1 Site History 2.1

2.2 Site Description 2.2

2.3 Engineered Site Facilities 2.4

 2.3.1 Changes to Site Layout..... 2.4

 2.3.2 Molybdenum-99 / Target Delivery System 2.7

2.4 Description of the Natural and Physical Environment 2.7

 2.4.1 Meteorology and Climate..... 2.7

 2.4.2 Geology..... 2.9

 2.4.3 Hydrogeology 2.10

 2.4.4 Hydrology..... 2.10

 2.4.5 Vegetation Communities 2.10

 2.4.6 Wildlife Habitat..... 2.10

 2.4.7 Aquatic Communities..... 2.17

2.4.8	Human Land Use	2.19
2.4.9	Population Distribution	2.19
2.5	Uncertainties in Site Characterization	2.19
3.0	HUMAN HEALTH RISK ASSESSMENT (HHRA)	3.1
3.1	Problem Formulation	3.1
3.1.1	Receptor Selection and Characterization	3.1
3.1.2	Selection of Chemical, Radiological, and Other Stressors	3.3
3.1.3	Selection of Exposure Pathways	3.19
3.1.4	Human Health Conceptual Model	3.19
3.1.5	Uncertainties in the Problem Formulation	3.20
3.2	Exposure Assessment	3.20
3.2.1	Exposure Locations	3.20
3.2.2	Exposure Duration and Frequency	3.20
3.2.3	Exposure and Dose Calculations	3.20
3.2.4	Exposure Factors	3.21
3.2.5	Dispersion Models	3.21
3.2.6	Exposure Point Concentrations and Doses	3.23
3.2.7	Uncertainties in the Exposure Assessment	3.31
3.3	Toxicity Assessment	3.31
3.3.1	Toxicological Reference Values (TRVs)	3.31
3.3.2	Radiation Dose Limits and Targets	3.31
3.3.3	Uncertainties in the Toxicity Assessment	3.31
3.4	Risk Characterization	3.32
3.4.1	Risk Estimation	3.32
3.4.2	Discussion of Chemical and Radiation Effects	3.35
3.4.3	Uncertainties in the Risk Characterization	3.38
4.0	ECOLOGICAL RISK ASSESSMENT (ECORA)	4.1
4.1	Problem Formulation	4.1
4.1.1	Receptor Selection and Characterization	4.3
4.1.2	Assessment and Measurement Endpoints	4.10
4.1.3	Selection of Chemical, Radiological, and Other Stressors	4.10
4.1.4	Selection of Exposure Pathways	4.23
4.1.5	Ecological Health Conceptual Model	4.27
4.1.6	Uncertainties in the Problem Formulation	4.27
4.2	Exposure Assessment	4.27
4.2.1	Exposure Points	4.27
4.2.2	Exposure Averaging	4.28
4.2.3	Exposure and Dose Calculations	4.28
4.2.4	Exposure Factors	4.28
4.2.5	Dispersion Models	4.29
4.2.6	Exposure Point Concentrations and Doses	4.29
4.2.7	Uncertainties in Exposure Assessment	4.39

4.3 Toxicity Assessment 4.39

4.3.1 Toxicological Benchmarks 4.39

4.3.2 Radiation Benchmarks 4.39

4.3.3 Uncertainties in the Toxicity Assessment 4.39

4.4 Risk Characterization 4.40

4.4.1 Risk Estimation 4.40

4.4.2 Discussion of Chemical and Radiation Effects 4.42

4.4.3 Uncertainties in the Risk Characterization 4.43

5.0 CONCLUSIONS AND RECOMMENDATIONS 5.1

5.1 Conclusions 5.1

5.1.1 Conclusions of the Human Health Risk Assessment (HHRA) 5.1

5.1.2 Conclusions of the Ecological Risk Assessment (EcoRA) 5.2

5.2 Cumulative Effects from On-Site Sources 5.3

5.3 Climate Change Considerations 5.3

5.4 Recommendations for the Monitoring Program 5.4

5.5 Risk Management Recommendations 5.4

6.0 QUALITY ASSURANCE/QUALITY CONTROL 6.1

7.0 REFERENCES 7.1

APPENDIX A SCREENING TABLES FOR CHEMICAL COPCS A.1

APPENDIX B SOIL CHARACTERIZATION DATA SUMMARY TABLE B.1

APPENDIX C MODELLED CONCENTRATIONS FOR ECOLOGICAL RECEPTORS C.1

APPENDIX D SAMPLE CALCULATIONS D.1

List of Tables

Table 1-1: Indigenous Engagement Summary – Key Issues for ERA 2020-2023	1.2
Table 1-2: Periodic Review for DN ERA Addendum.....	1.5
Table 1-3: Recommendations from the 2020 Darlington Nuclear ERA.....	1.8
Table 2-1: Breeding Bird Species Observed during 2011 to 2022 Biodiversity Surveys	2.11
Table 2-2: Mammals Species List (1997-2022).....	2.14
Table 2-3: Amphibian and Reptile Species List.....	2.15
Table 2-4: Wildlife Species at Risk Observed within the Vicinity of DN (2006-2022)	2.16
Table 3-1: Sound Level Limits for Class 1 Areas (MECP, 2013).....	3.15
Table 3-2: Fall and Spring 2022 and 2018/2019 Acoustic Monitoring Results.....	3.17
Table 3-3: Summary of COPCs Selected for the HHRA	3.19
Table 3-4: Human Exposure Factors for Non-Radiological Dose Calculations.....	3.22
Table 3-5: Assumed Fractions of Drinking Water from WSPs and Fish from DN Outfall (OPG, 2021i)	3.22
Table 3-6: Summary of Doses to Most Exposed Critical Groups from 2020 to 2022.....	3.23
Table 3-7: Summary of Exposure Point Concentrations of Hydrazine in Surface Water	3.26
Table 3-8: Maximum and Mean Exposure Point Concentrations for Hydrazine in Surface Water	3.26
Table 3-9: Summary of Estimated Doses Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Surface Water.....	3.27
Table 3-10: Summary of Exposure Point Concentrations of Hydrazine in Fish	3.29
Table 3-11: Maximum and UCLM Concentration of Hydrazine in Fish	3.29
Table 3-12: Summary of Estimated Doses Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Fish	3.30
Table 3-13: Summary of Estimated Risk Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Surface Water.....	3.33
Table 3-14: Summary of Estimated Risk Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Fish	3.34
Table 4-1: Summary of Ecological Receptors and their Assessment Models used in the EcoRA.....	4.3
Table 4-2: Representative Species for Identified Species at Risk (2020 – 2022)	4.6
Table 4-3: Summary of Reported Wildlife Injuries/Fatalities at DN (2020 to 2022)	4.22
Table 4-4: Summary of COPCs Selected for the EcoRA.....	4.23
Table 4-5: Complete Exposure Pathways for All Selected Ecological Receptors	4.24
Table 4-6: Exposure Point Concentrations for Soil COPCs in Polygon E.....	4.29
Table 4-7: Exposure Point Concentrations for Radionuclides in Lake Ontario	4.30
Table 4-8: Exposure Point Concentrations for Radionuclides in Polygon AB	4.30
Table 4-9: Exposure Point Concentrations for Polygon C.....	4.31
Table 4-10: Exposure Point Concentrations for Polygon D.....	4.31
Table 4-11: Exposure Point Concentrations for Polygon E.....	4.32
Table 4-12: Emissions to Air used to Model Exposure Point Concentrations.....	4.32

Table 4-13: Estimated Radiation Doses for Aquatic and Riparian Receptors for Lake Ontario (mGy/d)	4.34
Table 4-14: Estimated Radiation Doses for Aquatic and Terrestrial Receptors for Polygon AB (mGy/d)	4.35
Table 4-15: Estimated Radiation Doses for Terrestrial Receptors for Polygon C (mGy/d)	4.36
Table 4-16: Estimated Radiation Doses for Aquatic and Terrestrial Receptors for Polygon D (mGy/d)	4.37
Table 4-17: Estimated Radiation Doses for Terrestrial Receptors for Polygon E (mGy/d)	4.38
Table 4-18: Toxicological Benchmarks for Soil for Terrestrial Invertebrates and Plants	4.39
Table 4-19: Summary of Total Radiation Dose Estimates for Ecological Receptors for Lake Ontario, Polygon AB, C, D, and E (mGy/d)	4.41
Table 4-20: Hazard Quotients for Polygon E	4.42

List of Figures

Figure 2-1: DN Site Location and Vicinity (OPG, 2022a)	2.3
Figure 2-2: Changes to DN Site Layout	2.6
Figure 2-3: 2017-2021 Annual Average Windrose at 10-m Tower (2017, 2020-2021 DN, and 2018-2019 Pickering Nuclear)	2.8
Figure 2-4: 2013 – 2019 Annual Average Windrose at 10-m Tower from Pearson International Airport	2.9
Figure 2-5: Fish Habitat Assessment of the Drainage Features	2.18
Figure 3-1: Location of OPG East and OPG West Air Quality Monitoring Stations (IEC, 2023)	3.5
Figure 3-2: Hierarchy of Screening Criteria for HHRA Chemical COPCs in Air	3.6
Figure 3-3: Hierarchy of Screening Criteria for HHRA Chemical COPCs in Surface Water	3.9
Figure 3-4: Location of Points of Reception (POR1-4)	3.18
Figure 3-5: Health Neighbourhoods in Durham Region (DRHD, 2023)	3.36
Figure 4-1: Area of Assessment for Ecological Risk Assessment	4.2
Figure 4-2: Hierarchy of Screening Criteria for Chemical COPCs in Air	4.11
Figure 4-3: Selection of Screening Criteria for Chemical COPCs in Surface Water	4.13
Figure 4-4: Selection of Screening Criteria for COPCs in Sediment	4.16
Figure 4-5: Selection of Screening Criteria for Chemical COPCs in Soil	4.18

1.0 Introduction

1.1 Background and Methodology

The Nuclear Safety and Control Act (NSCA) mandates the Canadian Nuclear Safety Commission (CNSC) to regulate the nuclear industry in a manner that prevents unreasonable risk to the environment and makes adequate provision for environmental protection, in conformity with international obligations. This mandate is reflected in the General Nuclear Safety and Control Regulations under the NSCA, and in the CNSC Regulatory Document REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2.

Consistent with the CNSC REGDOC-2.9.1 (CNSC, 2020e) and REGDOC-3.1.1 (CNSC, 2016), Ontario Power Generation (OPG) is required to update their ERAs at least once every 5 years. The initial issuance of the most recent 2020 Darlington Nuclear (DN) environmental risk assessment (ERA) was in 2021 and it was last revised in 2022 (Ecometrix, 2022a).

The next routine ERA update is not due for submission to the CNSC until 2026 and the existing operating licence, PROL 13.03/2025, for the Darlington Nuclear Generating Station (DNGS) will expire in 2025 (CNSC, 2021e). Therefore, prior to the routine ERA update in 2026, OPG has voluntarily undertaken this ERA Addendum, which constitutes a one-time interim ERA update, to augment the 2020 ERA and better support the licence renewal. This ERA assesses any differences in environmental quality data collected between 2020 and 2022; in some cases, data from 2023 were available at the time of writing the report and were included for completeness.

This Addendum to the 2020 DN ERA (hereinafter referred to as the “ERA Addendum”) has been prepared to be compliant with CSA N288.6:22 “Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills” (CSA, 2022) and also meets the requirements for an ERA outlined in Section 4.1 of REGDOC-2.9.1 “Environmental Protection: Environmental Principles, Assessments and Protection Measures” (CNSC, 2020e). The ERA Addendum, as in the 2020 DN ERA, has used IMPACT™, a proprietary exposure and risk modeling software, to perform the required calculations which comply with the above-noted regulatory requirements. The ERA Addendum has been developed with current science and current regulatory attitudes in mind.

1.1.1 Indigenous Engagement

OPG recognizes that while the assessment of effects from the DN Site has been satisfied from the Western scientific perspective, it may not fully address the impact on Indigenous inherent and treaty rights as they are understood today.

OPG has communicated their interest in engaging with the Williams Treaties First Nations (WTFNs) on the selection of receptors for the ERA. Between 2020 and 2023, OPG has coordinated several meetings during which the WTFNs and other Indigenous communities have participated and provided feedback, some of which has been directly relevant for this ERA Addendum and the future 2026 full ERA update (see **Table 1-1**):

Table 1-1: Indigenous Engagement Summary – Key Issues for ERA 2020-2023

Issue Raised by Indigenous Nation/Community	Response/Approach to Address the Issue by OPG
WTFNs recommended to incorporate Indigenous Knowledge into environmental monitoring programs.	OPG will explore the opportunity to incorporate Indigenous Knowledge into environmental monitoring, where this information is made available to OPG.
WTFNs requested consideration of the cumulative effects of a small modular reactor (SMR) positioned near DNGS, and the waste produced by SMR technology.	Cumulative effects from site preparation activities at the Darlington New Nuclear Project (DNNP), have been considered in this ERA Addendum (Section 5.2).
WTFNs have expressed the need to identify a project or facility's impacts on the environment as well as on inherent and treaty rights. The Nations have also expressed interest in collaborating and participating in monitoring activities.	OPG is working directly with the Nations to explore these areas.
Information from available or future Indigenous Knowledge studies could be reflected in the ERAs, if appropriate and with permission from the Nations/communities. One area this can be reflected is in the selection of representative ecological receptors. OPG has heard through engagement that the Nations view the different species and elements within an ecosystem as "all our relations", that they are all inter-related and protection of one should not be prioritized over another. OPG has also heard mention at times of certain species that are culturally significant.	OPG will continue to collaborate with the Nations on the selection of ecological receptors. Any feedback received will be incorporated into future ERAs.
OPG has received some initial feedback from the WTFNs regarding appropriate representation of Indigenous characteristics in a receptor group. There has been a recommendation for a distinct critical group to encompass First Nations individuals and also a recommendation to ensure the characteristics of the existing receptors are protective of all people around the station rather than have a separate receptor group.	OPG will continue to engage the WTFNs on this subject to further discussion on the approach and receptor characteristics.
OPG received in 2023 comments from the Mississaugas of Scugog Island First Nation on the 2022 Pickering Nuclear ERA and 2022 Addendum of the Predictive Effects Assessment Pickering Nuclear Safe Storage. A number of issues were raised related to terminology, questions on	OPG has addressed some of the concepts and suggestions identified through these comments in this ERA Addendum, if they are relevant to the DN site. Some examples include: <ul style="list-style-type: none"> Moving away from using the term "baseline" to describe the current environmental conditions.

Issue Raised by Indigenous Nation/Community	Response/Approach to Address the Issue by OPG
environmental monitoring data, and explanation of ERA results.	<ul style="list-style-type: none"> • Inclusion of text to describe how adaptive management is considered. • Discussion added on how sensitive and vulnerable populations are considered in the human health risk assessment (HHRA). • Discussion added on large-bodied fish being protective of small-bodied fish based on 100% occupancy assumptions.
Métis Nation of Ontario Region 8 inquired whether harvesting of plant species, including the use of wood or Butternut tree nuts from OPG property, would be acceptable given the potential for plants to take up radionuclides or other contaminants from the environment.	OPG was supportive of the harvesting of plants or seeds/nuts from OPG lands provided they are not directly eaten. However, no seeds could be collected before removing the trees for re-introduction purpose as neither tree produced any seeds.

OPG's Indigenous Relations group will continue to coordinate engagement, which may impact the understanding of surrounding land use and receptor selection.

OPG endeavors to continue to work with Indigenous Nations and communities to develop more fulsome and ongoing engagement. OPG plans to share this ERA Addendum report with Indigenous nations and communities. It is acknowledged that as of the date of this report, this ERA Addendum does not benefit from being informed by an Indigenous Knowledge Study. As of June 2024, an Indigenous Knowledge Study is in the process of being scoped by representatives of the Williams Treaties First Nations (WTFN) with support provided by OPG. Information from this Indigenous Knowledge Study, if shared with OPG, could help apply an Indigenous lens to future risk assessments. It is also noted that the ERA is an iterative process and thus could be updated to incorporate Indigenous Knowledge if available in a future revision.

1.1.2 Summary of Previous Environmental Assessments, Environmental Risk Assessments, and Follow-up Monitoring Programs

Please refer to the 2020 ERA (Ecometrix, 2022a) for the summary of previous assessments and programs up to 2019.

1.2 Goals, Objectives, and Scope

The overall goals of this ERA Addendum are:

- To update existing conditions for the DN Site (2020 to 2022).
- To provide an interim update to the ERA in general accordance with the CSA N288.6:22 Standard (i.e., in the form of an ERA Addendum) prior to the next routine ERA update currently scheduled for submission in 2026.

- To provide focus for the environmental monitoring program on relevant chemicals and radionuclides (also known as contaminants of potential concern or COPCs), media, and ecological and human receptors.

The specific objectives of this ERA Addendum, consistent with CSA N288.6:22, are:

- To evaluate the risk to relevant human and ecological receptors resulting from exposure to contaminants and stressors related to the DN site and its activities with a focus on the years 2020 to 2022.
- To recommend potential further monitoring or assessment as needed based on the results of the ERA Addendum.

The scope of the ERA Addendum encompasses normal operations at DN (including the DNGS, the Darlington New Nuclear Project (DNNP) lands, the Nuclear Sustainability Services – Darlington Waste Management Facility (NSS-DWFM), the Tritium Removal Facility (TRF), and any other OPG activities within the DN property boundary) during the operations and refurbishment phases of the facility. It does not include decommissioning activities and does not address acute or high-level exposures resulting from accidents. The scope looks at the potential effects of releases from the DN facilities on the human and ecological environment, as well as physical stressors. The ERA Addendum focuses on the three-year period from 2020 to 2022 but incorporates other years of data when necessary.

OPG integrates adaptive management into its environmental management system. Specifically, adaptive management is fundamental to the environmental monitoring program (EMP) to ensure that the monitoring activities remain valid, and to enable OPG to appropriately identify and address any adverse findings or areas of risk. EMP program design reviews, self-assessments, and audits are regularly conducted to confirm effectiveness of environmental monitoring activities and to practice continual improvement. The ERA process is also a means for adaptive management as it is undertaken every 5 years and considers changes to site activities and environmental conditions to identify any areas where changes in mitigation or monitoring may be needed. Through the existing processes, if a risk to the environment is identified or predicted through the ERA, it can trigger changes to the EMP, supplementary studies, and/or mitigation measures, as required.

1.2.1 Spatial Boundaries

Spatial boundaries define the geographical extent(s) over which likely or potential environmental effects will be considered. The spatial boundaries have not changed since the 2020 ERA (Ecometrix, 2022a), and are as follows:

- The spatial scale for humans includes identified human receptors (potential critical groups) within about 10 km of the DN site, as shown in Figure 3-12 of the 2020 ERA (Ecometrix, 2022a). This study area also includes a portion of Lake Ontario abutting the property and used by those communities for activities such as recreation and community water supply and waste water discharge.

- The spatial scale for ecological receptors includes receptors on-site and within the immediate site boundary and the near-field receiving waters, known as the site study area (SSA) in past EAs. The SSA for the ecological risk assessment (EcoRA) is presented in Figure 4-1 of the 2020 ERA (Ecometrix, 2022a).

1.3 Periodic Review of the ERA

The 2020 DN ERA (Ecometrix, 2022a) was reviewed according to the recommendations in Clause 11 of CSA N288.6:22 for periodic review of the ERA. The purpose of the periodic review is to identify any new risks, changes to existing risks, or changes in risk assessment variables that need to be updated to reflect the new risk profile for the facility, considering various review elements. The periodic review findings and where the associated information can be found in this ERA Addendum are provided in **Table 1-2**.

Table 1-2: Periodic Review for DN ERA Addendum

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
Changes to site ecology or surrounding land use	<p>The 2021 bat acoustic monitoring (Beacon, 2021) identified four (4) endangered bat species at the DN site. This included the Eastern small-footed myotis, which was the first time this species was observed on the DN site. Some changes to species at risk federal or provincial statuses were noted, although these did not have an impact on the selected ecological receptors for the EcoRA.</p> <p>OPG's Indigenous Relations group continues to coordinate engagement with the WTFNs, which may inform the understanding of surrounding land use and receptor selection.</p>	<p>Section 2.4 (Biodiversity data)</p> <p>Section 1.1.1 (Indigenous engagement)</p> <p>Section 4.1.1.1 (Considerations of Species at Risk)</p>
Changes to the physical facility or facility processes	<p>Changes identified to facility or facility processes include:</p> <ul style="list-style-type: none"> Changes to the physical features of the DN site resulting from the site preparation activities associated with the DNNP (largely site clearing and grading activities). Molybdenum-99 (Mo-99) Isotope Irradiation System was 	<p>Section 2.1 (Site History) and Section 2.3 (Engineered Site Facilities)</p>

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
	<p>commissioned in reactor unit 2 in the 2022 and 2023 period. Harvesting commenced in 2023.</p> <ul style="list-style-type: none"> The Yard Drainage area was expanded due to the extension/realignment of Holt Road. A Demineralized Water Plant (DWP) is intended to replace the existing Water Treatment Plant (WTP) after commissioning (currently expected in 2024), which included expansion of the existing Yard Drainage to accommodate stormwater management at the DWP. 	
New environmental monitoring data	<p>Ongoing EMP monitoring occurred during the 2020 to 2023 monitoring period.</p> <p>Groundwater flow and quality is monitored under the groundwater monitoring program (GWMP). No changes have occurred that would affect the ERA Addendum.</p> <p>Some supplementary studies were conducted during this period:</p> <ul style="list-style-type: none"> In 2021, in support of DNNP, soil quality characterization was reported. In 2021, in support of DNNP, an acoustic bat monitoring study was completed to more fully characterize bat species present on the site as well as specific areas where they may be roosting. 	<p>Section 3.1.2 (Human health)</p> <p>Section 4.1.3 (Ecological health)</p>
Scientific advances	<p>The Canadian Council of Ministers of the Environment (CCME) long-term water quality guidelines for the protection of aquatic life for manganese and zinc were updated in 2019 and 2018, respectively, as the result of new toxicology studies and new CCME assessments for these COPCs. The updated guidelines are lower (more stringent) than previously used guidelines and therefore, have potential</p>	<p>Section 3.1.2 and Section 3.3 (Human health)</p> <p>Section 4.1.3 and Section 4.3 (Ecological health)</p>

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
	<p>to change existing risk implications. Updated Federal Environmental Quality Guidelines (FEQG) have also been posted in 2018 for hexavalent chromium, in 2019 for iron, in 2020 for lead and strontium, in 2021 for copper, and in 2022 for aluminum and selenium. The updated guidelines were used in the selection of COPCs for the EcoRA.</p> <p>In 2021, Health Canada (HC) and Environment and Climate Change Canada (ECCC) released updated Toxicity Reference Values (TRVs) for human health and wildlife receptors, respectively (HC, 2021a; ECCC, 2021a). These documents were considered during toxicity reference value (TRV) selection during the ERA update with a focus on new studies supporting the use of TRVs relevant to the COPCs for the HHRA and EcoRA.</p>	
Changes in regulatory requirements	<p>REGDOC 2.9.1, <i>Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2</i> was published in September 2020. While REGDOC 2.9.1 is a CNSC regulatory document that outlines the CNSC’s approach to conducting environmental assessments, it also provides requirements and guidance for conducting ERAs. The requirement is for a facility to conduct the ERA in accordance with CSA N288.6-12 (now N288.6:22).</p> <p>In 2020, Canadian Council of Ministers of the Environment (CCME) published an updated Ecological Risk Assessment Guidance Document (CCME, 2020). While not considered to be a regulatory requirement, this document is used as</p>	<p>Section 3.0 (HHRA) and Section 4.0 (EcoRA)</p>

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
	additional guidance to this ERA update, in addition to the CSA N288.6 standard.	

1.4 Recommendations from the 2020 ERA

Table 1-3 provides a summary of recommendations for the monitoring program from the 2020 DN ERA that were associated with uncertainties regarding interpretation of risk to human health or the environment (refer to Section 5.2.2 in the 2020 DN ERA (Ecometrix, 2022a)). The means by which the recommendations were addressed are described below.

Table 1-3: Recommendations from the 2020 Darlington Nuclear ERA

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
Human Health Risk Assessment		
Hydrazine in fish	Risks for hydrazine could not be ruled out for the Sport Fisher consuming fish from Lake Ontario near the DN site. A recommendation was made to complete a supplementary study sampling lake water for hydrazine but with a detection limit of 0.05 µg/L (compared to the detection limit relied on in the 2020 DN ERA of 0.1 µg/L). (Note that potential risks were only identified based on exposure to the maximum hydrazine concentration in the effluent; however, based on the UCLM, no risks were identified.)	The 2020 DN ERA identified a recommendation to collect hydrazine along and at the outlet of the DN diffuser at a lower detection limit of 0.05 µg/L. Since 2020, the understanding of what may be feasible with hydrazine has evolved. The ultra-low level detection limit is not achievable at commercial laboratories at this time. For the DN ERA Addendum, a refined water-to-fish bioconcentration factor (BCF) has been incorporated; see Section 3.2.6.2.2 . Lake water sampling with a lower detection limit is not identified as a recommendation of this DN ERA Addendum.
Hydrazine in drinking water	Risks could not be ruled out for Oshawa/Courtice and Bowmanville Urban Residents as well as Campers due to hydrazine in drinking water.	Risks were re-assessed in the ERA Addendum to verify whether potential risks may still be present for these receptors

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
	<p>Oshawa/Courtice Urban Residents and Campers obtained their drinking water from the Oshawa WSP, and Bowmanville Urban Residents from the Bowmanville WSP. (Note that potential risks were only identified based on exposure to the maximum hydrazine concentration in the effluent; however, based on the UCLM, no risks were identified.)</p> <p>No specific recommendation was included in the 2020 DN ERA; however, the uncertainties were raised in the 2020 DN ERA, and the uncertainties were addressed in the current DN ERA Addendum as described in the column to the right.</p>	<p>(Oshawa/Courtice and Bowmanville Urban Residents, Campers). Additionally, given that pre-treatment concentrations were assessed (i.e., water concentrations at the intake prior to water treatment), further information on the expected degradation of hydrazine due to water treatment was incorporated into the DN ERA Addendum (Section 3.2.6.2.1).</p>
NO ₂ in air	<p>Nitrogen dioxide (NO₂) data from the air quality monitoring planned to be initiated at the DN site in 2021 should be used in the next ERA to refine the risk estimates for human and ecological receptors and provide a more realistic interpretation of risk.</p>	<p>One-hour and 24-hour NO₂ data were collected in 2022 and compared to relevant criteria (IEC, 2023). These data were assessed in Section 3.1.2.1.3.2 in the ERA Addendum.</p>
Ecological Risk Assessment		
Fish Impingement/ Entrainment	<p>Impingement and entrainment studies have been carried out as required at DNGS prior to refurbishment and are considered appropriate for consideration in the DN ERA Addendum and future routine update to the DN ERA. Future impingement and entrainment studies will be conducted as per conditions of the Fisheries Act Authorization (FAA).</p> <p>Impingement studies were conducted between May 2010 and April 2011, which indicated that fish losses due to impingement were negligible.</p>	<p>Routine impingement monitoring is not required at DNGS. As a condition of the DFO Fisheries Act Authorization for the DNGS, OPG will be required to conduct a two-year fish impingement and entrainment monitoring study after Refurbishment is completed. The field portion of the impingement and entrainment study is to be conducted in 2027 and 2028 based on the current DN Authorization. This monitoring</p>

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
	<p>Studies of fish egg and larval entrainment at DN were conducted in 2004 (June – August), 2006 (March – September), and 2010 (April and July). A more recent entrainment study conducted between 2015 and 2016 determined the estimated annual entrainment to be higher than the 2004 and 2006 studies, but that overall fish losses were considered too low to significantly affect Lake Ontario fish populations. Overall, entrainment was considered to have a negligible effect on aquatic communities.</p> <p>The expectation is that impingement and entrainment studies would continue when feasible and as required by the FAA, and that new results should be considered in future risk assessments. Routine impingement monitoring is not currently required at DNGS. As a condition of the Department of Fisheries and Oceans Canada (DFO) Fisheries Act Authorization for the DNGS, OPG will be required to conduct fish impingement and entrainment monitoring studies after Refurbishment is completed. Refurbishment at DNGS is currently ongoing. The requirement to resume fish impingement and entrainment monitoring after Refurbishment is also documented in the DNGS Refurbishment Environmental Assessment (EA) Follow-Up Monitoring Program (FUMP) (OPG, 2013).</p>	<p>is also intended to address commitments made in the DNGS Refurbishment EA FUMP, noting that schedule implementation years have shifted to the years above.</p>
Soil quality	Soil quality analysis of the yard waste and building materials storage area was undertaken and the data are summarized in Appendix B . It is recommended to use the results of the soil quality analysis to determine the next steps for	The soil quality analysis data have been incorporated into the soil quality dataset for Polygon E as shown in Table A-20 in Appendix A .

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
	management of soil from the yard waste and building material storage area (identified as location DN6 and DN6A in Figure B-4, Appendix B, and zone F15 in <i>Review of the Darlington Nuclear Site Specific Survey</i> (OPG, 2018), so as to mitigate potential risks to ecological receptors.	

1.5 Organization of Report

The main sections of the ERA Addendum report, generally consistent with the suggested table of contents in CSA N288.6:22 (CSA, 2022), are as follows:

- **Section 0:** Site Description
- **Section 3.0:** Human Health Risk Assessment
- **Section 4.0:** Ecological Risk Assessment
- **Section 5.0:** Conclusions and Recommendations
- **Section 6.0:** Quality Assurance/Quality Control
- **Section 7.0:** References

This report has been prepared with similar headings to the 2020 DN ERA (Ecometrix, 2022a) to facilitate ease of review. Where no changes have been introduced since the 2020 ERA, this report refers to the relevant sections of the 2020 ERA where information can be found. Where viewing that information in this report would be helpful for a reviewer, it has been included, although in an abbreviated form.

2.0 Site History and Description

2.1 Site History

The DN site is located in the Province of Ontario, in the Regional Municipality of Durham, in the Municipality of Clarington, in the former township of Darlington, on the north shore of Lake Ontario at Raby Head. The DN site is about 5 km southwest of the community of Bowmanville and about 10 km east-southeast of the City of Oshawa. The site location and vicinity are shown in **Figure 2-1**. Furthermore, the site is located within the Gunshot Treaty lands of the Mississauga First Nations of Scugog Island, Curve Lake, Hiawatha and Alderville.

As described in the *Aboriginal Interests Technical Supporting Document* of the 2009 DNNP Environmental Impact Statement (EIS) (OPG, 2009), the discovery of archaeological resources and artifacts (e.g., “flakes”, the waste products of making stone tools) pertaining to Indigenous Peoples within the EIS Site Study Area (i.e., the DN site) suggest that hunting and gathering activities have historically occurred in the DN area, dating back thousands of years.

In the mid 1700s, the Indigenous Peoples in southeastern Ontario were compelled to cede their lands along the northern shore of Lake Ontario to the Crown. Three agreements and treaties with First Nations have historically related to the lands comprising the DN site: The Toronto Purchase Treaty (1787 and 1805) and The Gunshot Treaty (1787), which were ultimately replaced by the Williams Treaties (1923). To the present day, the DN site remains covered by the Williams Treaties (OPG, 2009).

OPG and its vendors recognize the importance of the 2018 Settlement between the seven members of the Williams Treaties First Nations (WTFN), the Province of Ontario and Canada. The Settlement (Government of Canada, 2018) pertains to the lands of the DN site and reaffirms the rights of WTFN citizens, which has fundamentally shifted how WTFN is engaged and consulted on site development.

The DN site was initially identified as a suitable location for electricity production by Ontario Hydro (the predecessor to OPG) in the late 1960s. In 1971, the Ontario government approved the land acquisition for the site and the local council approved the site for development as an energy production centre. Most of the land now occupied by the DN site was acquired by Ontario Hydro in the early 1970s for energy production purposes (SENES & MMM, 2009).

Ontario Hydro submitted a proposal for the Darlington Nuclear Generating Station to the Ontario government in 1976, and the construction licence for the project was approved by the Atomic Energy Control Board (the predecessor to the CNSC) in 1981 (SENES & MMM, 2009). The first operational unit of the DNGS (Unit 2) entered service in 1990; all four units were operational and in service by mid-1993.

2.2 Site Description

Today, the DN Site contains the following facilities (details of each can be found in Sections 2.1 and 2.2 in the 2020 ERA (Ecometrix, 2022a)):

- The DNGS is comprised of four CANada Deuterium Uranium (CANDU) reactor units. Units 2 and 3 have undergone recent refurbishment (completed in June 2020 and July 2023, respectively). Unit 1 and 4 refurbishments are underway and are expected to be completed in Q2 2025 and Q4 2026, respectively.
- TRF.
- NSS-DWMF, used for used fuel dry storage (UFDS) and dry storage container (DSC) processing.

The eastern portion of the DN Site has been allocated for the DNNP. The DNNP involves the construction and operation of up to four small modular reactors and the associated infrastructure. An Environmental Assessment (EA) was completed in accordance with the Canadian Environmental Assessment Act (CEAA). The DNNP lands will be developed as associated licensing and permitting achieved regulatory approval. In December 2021, OPG selected the small modular reactor (SMR) BWRX-300 for deployment at the DNNP site and started working with the vendor, GE Hitachi Nuclear Energy, to progress the design of the BWRX-300. A comprehensive review of the EIS for the deployment of up to four BWRX-300 SMR for the DNNP was undertaken by OPG to ensure that the results of the EIS remain valid (OPG, 2023a).

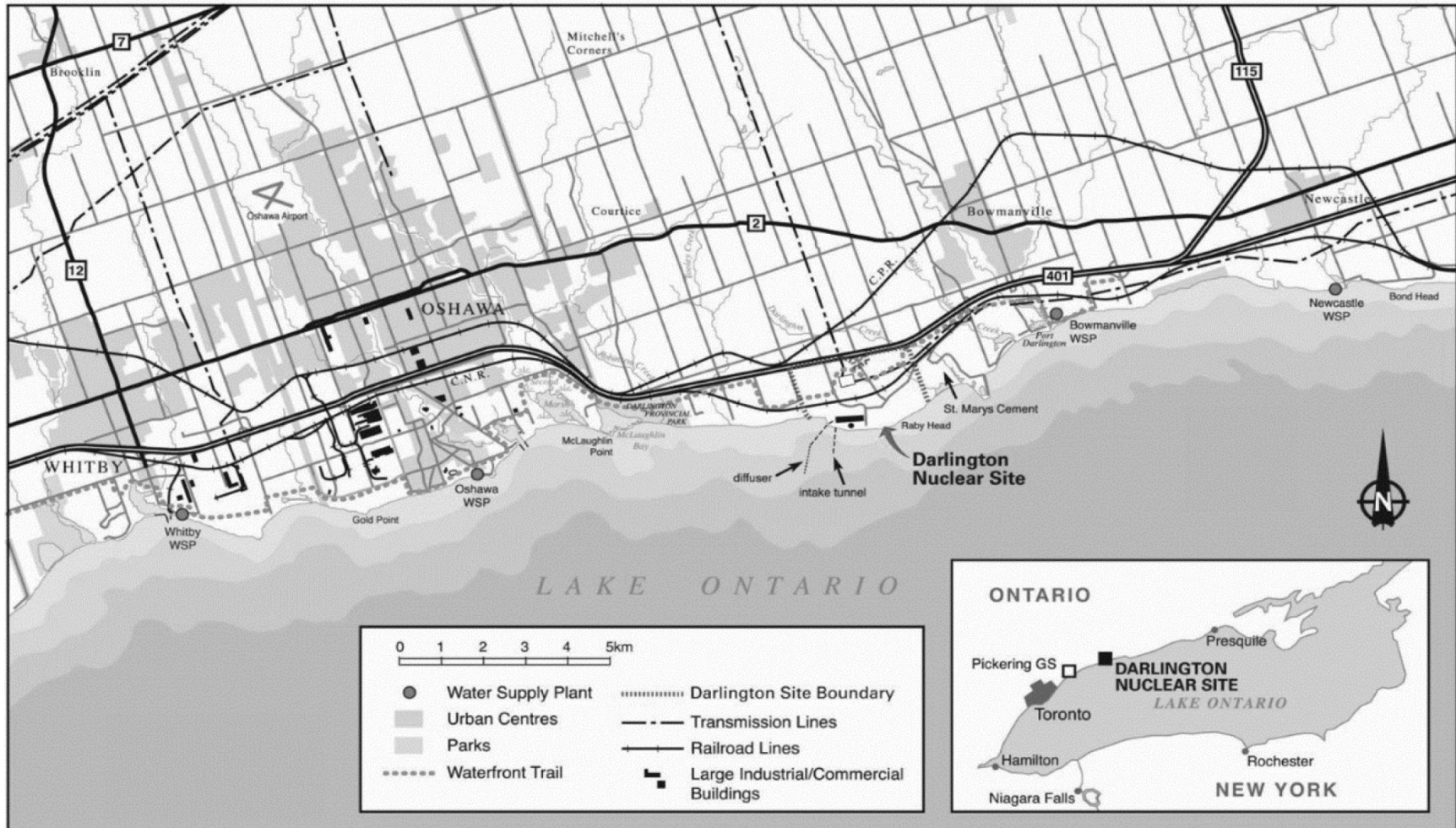


Figure 2-1: DN Site Location and Vicinity (OPG, 2022a)

2.3 Engineered Site Facilities

Detailed information regarding engineered site facilities can be found in Section 2.2 of the 2020 ERA (Ecometrix, 2022a). Some changes to the site layout and facilities (e.g., demolition and construction of various buildings, addition of a Molybdenum-99 / Target Delivery System into Unit 2 at DNGS) have occurred between 2020 and 2023 and brief descriptions of those changes are presented in the following subsections.

2.3.1 Changes to Site Layout

Changes to the DN site layout are presented in **Figure 2-2** below. Pertinent changes to site layout since the 2020 ERA up to and including to the end of 2023, include the following:

- Construction of the DWP.
- New parking lots and laydown areas, including a new upper Engineering Support and Services Building (ESSB) parking lot west of the lagoon, and new gravel areas west of Park Road to support laydown of construction materials.
- Site preparation activities associated with DNNP, which included the following changes to the site layout:
 - clearing and grubbing of land for the first SMR and the lands immediately north and south of 2nd Line;
 - grading at the first SMR area and nearby lands;
 - clearing of several storage areas within the DNNP site;
 - some parking lots were taken out of service to allow for DNNP site preparation activities;
 - construction of Phase 1 stormwater management facilities for the first SMR area, including outfall into Lake Ontario (excluded from **Figure 2-2**);
 - installation of new overhead and underground hydro lines (excluded from **Figure 2-2**); and,
 - construction of a Spoils Pile for the storage of excavated soils.
- The Western Storage Area has been constructed which includes an adjacent new gravel parking lot.
- Various road closures and re-alignments:
 - Holt Road is in the process of realignment and extension, which will include widening in certain sections;

- An east-west lane/haul road has been constructed to connect the Spoils Pile with access to Holt Road;
- A portion of 2nd Line (interface of 2nd Line and Hold Road) is closed to traffic and used for transport or staging heavy equipment for rail transfer; and,
- A portion of 3rd Line (immediately south of Building 363) was demolished and closed to accommodate the construction of a new UFDS building (UFDS #3).

Note that emissions associated with the site layout changes listed above, including fugitive dusts produced during land clearing and site preparation activities, are captured within the air monitoring programs undertaken at the Site on a routine basis (**Section 3.1.2.1**).

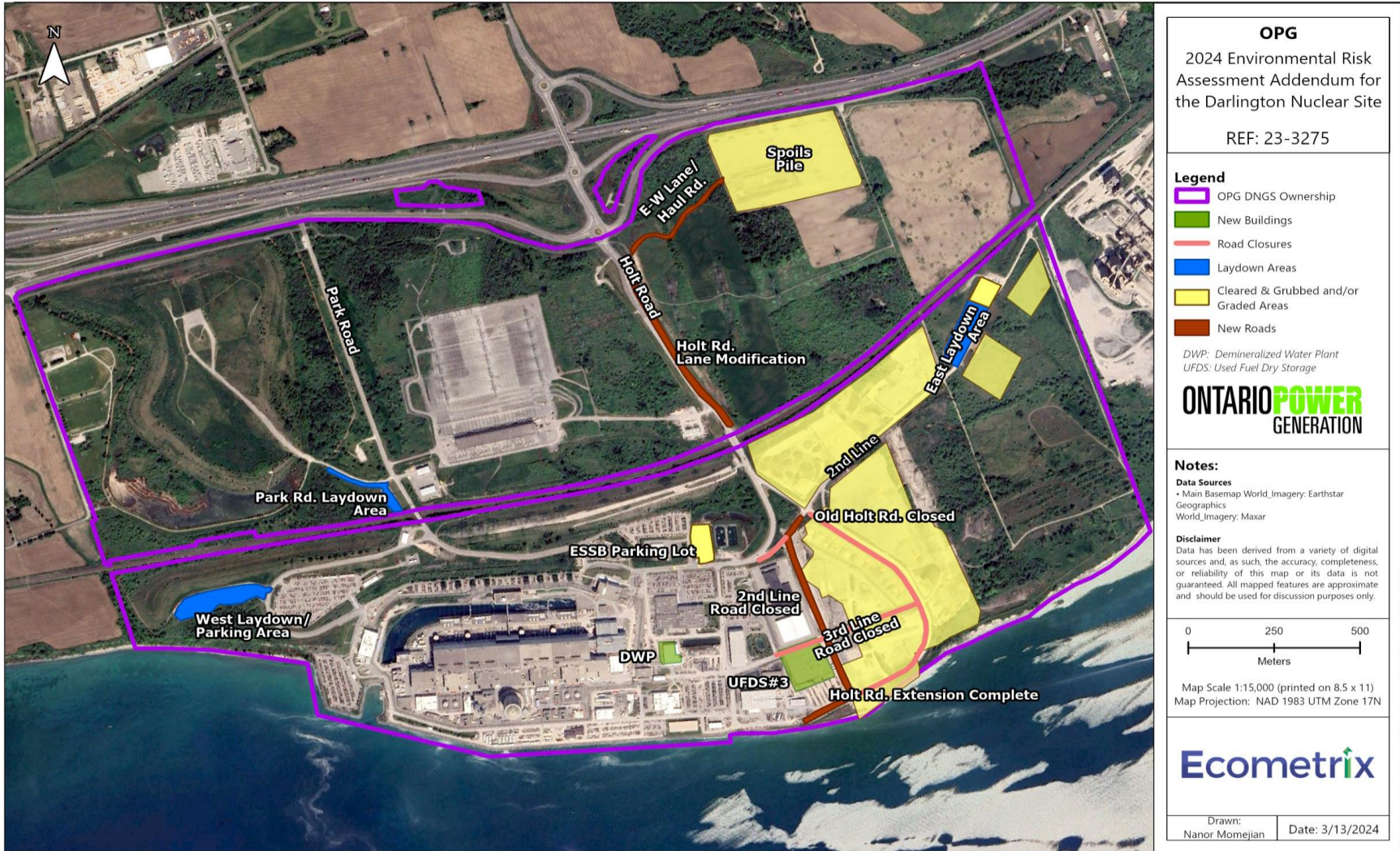


Figure 2-2: Changes to DN Site Layout

2.3.2 Molybdenum-99 / Target Delivery System

During 2022-2023, the Unit 2 Molybdenum-99/Target Delivery System (TDS) was commissioned. Monitoring of the releases from the TDS have been accomplished through the existing station effluent monitoring system and program that aligns with the requirements of CSA N288.5 standard, "Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills" (as outlined in N-STD-OP-0031, "Monitoring of Nuclear and Hazardous Substances in Effluents"). Releases from the TDS are largely expected to be represented by tritium during the process of seeding and harvesting targets, although there will be a small amount of particulates released from the zirconium sheath around the target capsule, with zirconium-95 as the dominant particulate. A HEPA filter will retain 99.97% of airborne particles (including with zirconium-95) before exhausting to the contaminated exhaust system. As such, particulate emissions are not evaluated further herein.

The contribution of releases from the TDS have been considered through the comparison of public dose estimates for the DN site as provided in the EMP reports for the years 2020, 2021, and 2022 (OPG, 2021c; OPG, 2023d). The 2022 DN site public dose was 0.6 μSv as represented by the Farm adult, which was unchanged from the 2021 and 2020 doses. The public dose of 0.6 μSv is less than 0.1% of the 1,000 μSv per year legal limit for a member of the public, and less than 0.1% of the estimated average background dose around the DN site from naturally occurring and man-made radiation of about 1,400 μSv per year. Therefore, the contribution of releases from the TDS to overall DN site emissions are negligible.

2.4 Description of the Natural and Physical Environment

2.4.1 Meteorology and Climate

Detailed information regarding meteorology and climate can be found in Section 2.3.1 of the 2020 ERA (Ecometrix, 2022a). No new climate data (temperature and precipitation) were available as of the writing of this report (December 2023) from the Canadian Climate Normals database (Government of Canada, 2023). It is noted that the website is currently in the process of reporting the Climate Normals for the period 1991-2020 for groups of stations and the data from the Oshawa and Bowmanville weather monitoring stations were not available at this time.

2.4.1.1 Wind

Wind data for the DN site meteorological station for the period 2017 to 2021 are presented as a wind rose in **Figure 2-3**. Data could not be collected from the DN meteorological tower for much of 2018 and 2019; therefore, data from the meteorological station at OPG's Pickering Nuclear Generating Station were used for those years consistent with the EMP reports. The prevailing winds blew from the north-west sector. The dominant wind direction was the northwest, followed by the west direction. The distribution of winds at the DN site is generally similar to that reported for the region based on wind patterns reported at Pearson International

Airport (2013 to 2019), where the wind direction is primarily from the north and west (see **Figure 2-4**).

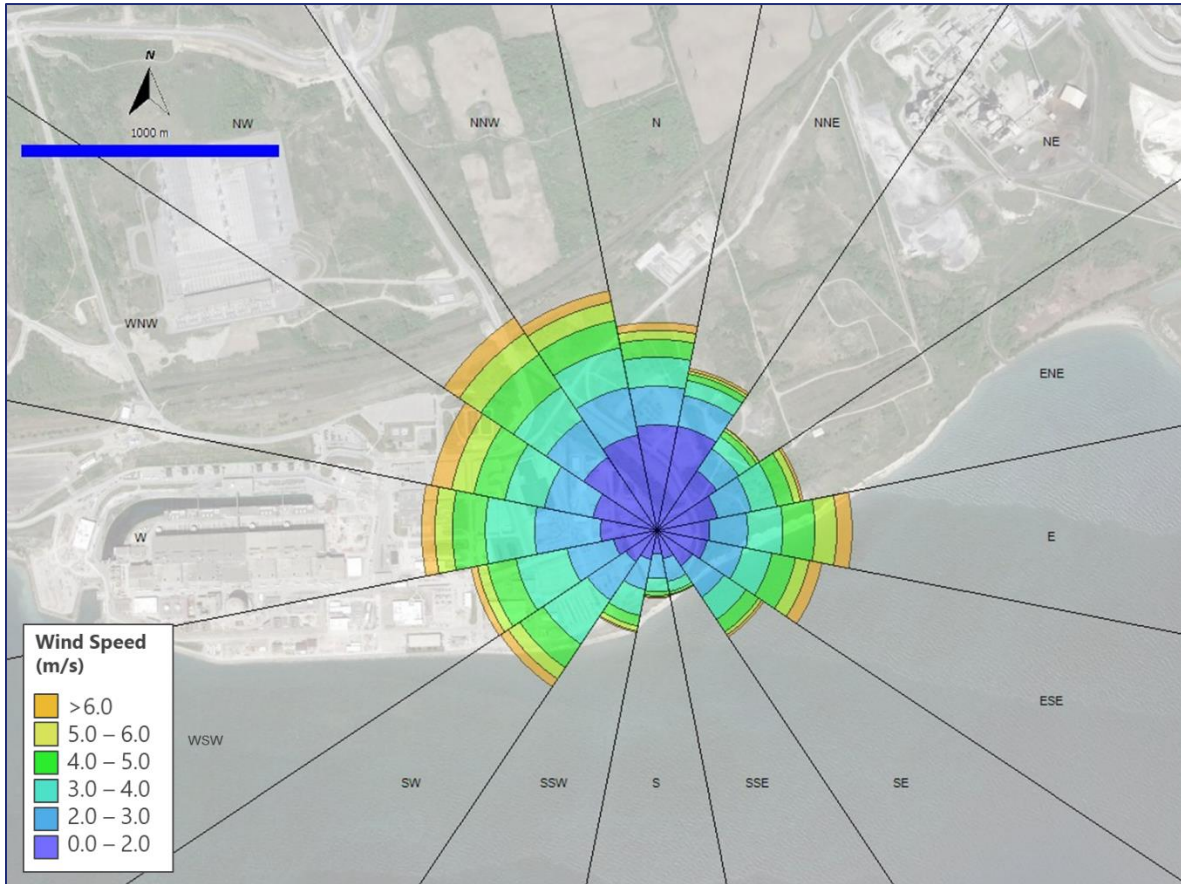


Figure 2-3: 2017-2021 Annual Average Windrose at 10-m Tower (2017, 2020-2021 DN, and 2018-2019 Pickering Nuclear)

Note: Direction is where wind blows from.

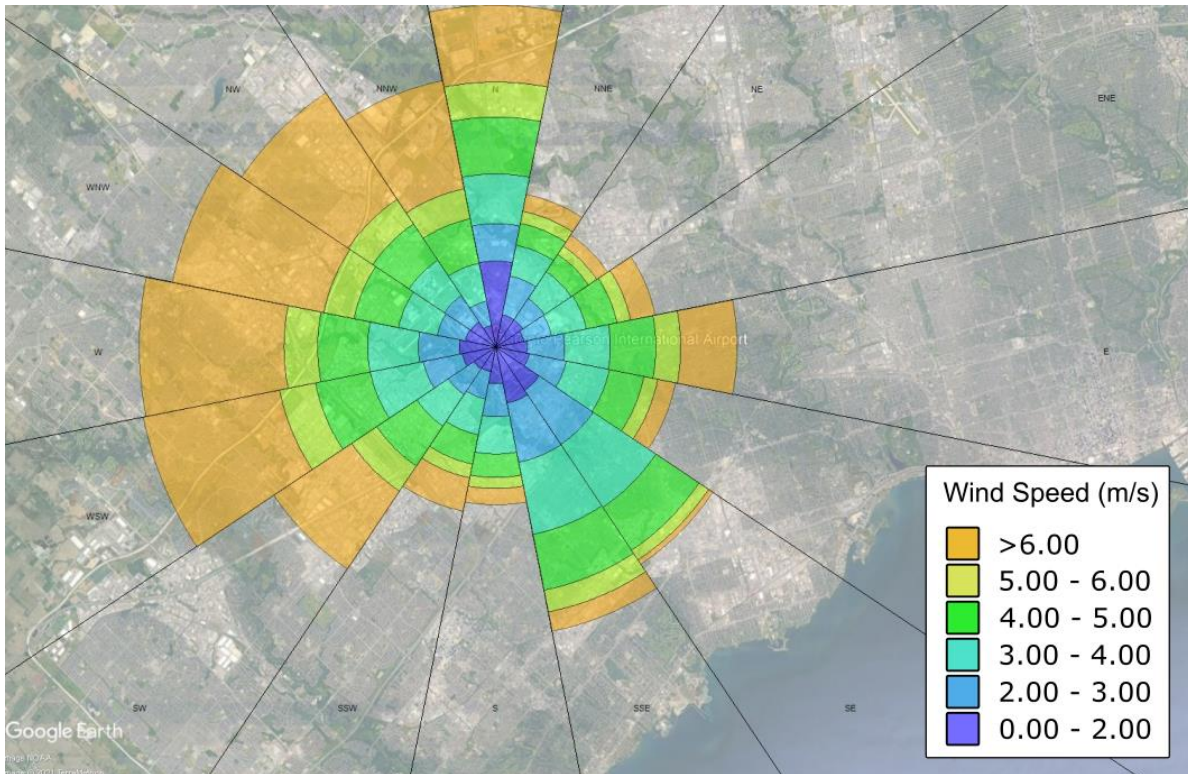


Figure 2-4: 2013 – 2019 Annual Average Windrose at 10-m Tower from Pearson International Airport

Note: Direction is where wind blows from.

2.4.2 Geology

Detailed information regarding geology, including bedrock, surficial geology and soil can be found in Section 2.3.2 of the 2020 ERA (Ecometrix, 2022a). No changes to bedrock or surficial geology have been reported from 2020 to 2022.

2.4.2.1 Soil

Detailed information regarding soil can be found in Section 2.3.2.3 of the 2020 ERA (Ecometrix, 2022a).

A soil characterization study was carried out in 2021 at the DNNP lands prior to the movement of soils for the purposes of regrading the DNNP lands; the soils have been moved to the DNNP northeast landfill area which is the current location of the Spoils Pile (as described in **Section 2.3.1**). The overburden materials within the DNNP lands were comprised of surficial fill that was underlain by native soils ranging from sandy silt, silty sand, clayey silt, silty clay, and gravel. These findings are in agreement with the soil types characterized for the remainder of the DN Site.

The soil type used in the IMPACT model is loam. This is consistent with the recommendation in CSA N288.1-20 to use a clay or loam soil type for Southern Ontario.

2.4.3 Hydrogeology

Detailed information regarding hydrogeology can be found in Section 2.3.3 of the 2020 ERA (Ecometrix, 2022a). No changes to hydrogeology have been reported in the 2020, 2021 and 2022 groundwater monitoring reports (OPG, 2021a, 2022b, 2023b). In brief, the predominant shallow groundwater flow patterns at the site remained unchanged between 2020 to 2022 from historical groundwater flow interpretations. Outside the protected area, groundwater generally flows from the north to the south, towards Lake Ontario. Inside the protected area and in the vicinity of the powerhouse, groundwater flows west and north towards the Forebay. Farther south of the powerhouse, groundwater flows towards Lake Ontario.

2.4.4 Hydrology

Detailed information regarding hydrology can be found in Section 2.3.4 of the 2020 ERA (Ecometrix, 2022a). The existing data on lake-wide circulation, lake water temperature, thermal information, and surface drainage are still relevant for the Site.

Therefore, no changes to the assessed water bodies nor hydrological connections in the IMPACT model were required for the ERA Addendum.

2.4.5 Vegetation Communities

Detailed information regarding vegetation communities can be found in Section 2.3.5 of the 2020 ERA (Ecometrix, 2022a). No incidental findings related to changes in vegetation communities were reported in the three-year biodiversity report (2019-2021) (Beacon, 2022) and the 2022 annual biodiversity report (Beacon, 2023). Some vegetation removal has occurred as part of site preparation activities (e.g., land clearing and grubbing) on the DNNP lands, though this is not expected to change the biodiversity of the overall vegetation community at the DN site as these areas of the DNNP lands were sparsely vegetated.

Therefore, no changes to the vegetation species assessed in the 2020 ERA were required.

2.4.6 Wildlife Habitat

Detailed information regarding wildlife habitat can be found in Section 2.3.6 of the 2020 ERA (Ecometrix, 2022a). Biodiversity monitoring at the DN site is carried out on an annual basis and is available for the period 2020 to 2022 (reporting for 2023 is not yet available). Updated biodiversity information is summarized below from the three-year biodiversity report (2019-2021) (Beacon, 2022) and the 2022 annual biodiversity report (Beacon, 2023).

2.4.6.1 Wildlife Habitat and Terrestrial Species

Overall, wildlife habitat and terrestrial species observations for the period 2020 to 2022 have not changed significantly since reported in the 2020 ERA (Ecometrix, 2022a). Updates to some statistics and individual species are noted below.

Birds

The DN site provides breeding habitat for many bird species as well as habitat for migrant songbirds. A total of 236 different species of birds have been observed at the DN site and almost all have occurred as migrants, even if they breed on the property (Beacon, 2023). The total annual number of confirmed and probable breeding bird species at the DN site since 1997 has varied between 53 and 73, and was 73 in 2022 (Beacon, 2023). The list of confirmed breeding birds for the DN site compiled for 2011 to 2022 is presented in **Table 2-1** for areas southwest and southeast of DN as well as within the DN Generating Station area itself.

Table 2-1: Breeding Bird Species Observed during 2011 to 2022 Biodiversity Surveys

Common Name	Scientific Name	Southwest	Station	Southeast
Green Heron	<i>Butorides virescens</i>			√
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	√		
Mute Swan	<i>Cygnus olor</i>	√	√	√
Double-breasted Cormorant	<i>Phalacrocorax auritus</i>		√	
Canada Goose	<i>Branta Canadensis</i>		√	√
Mallard	<i>Anas platyrhynchos</i>	√	√	√
Gadwall	<i>Anas strepera</i>	√	√	√
American Kestrel	<i>Falco sparverius</i>	√	√	√
Red-tailed Hawk	<i>Buteo jamaicensis</i>	√		√
Killdeer	<i>Charadrius vociferous</i>	√	√	√
American Woodcock	<i>Scolopax minor</i>	√		√
Rock Pigeon	<i>Columbia livia</i>	√	√	√
Mourning Dove	<i>Zenaida macroura</i>	√	√	√
Chimney Swift	<i>Chaetura pelagica</i>	√		
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>			√
Downy Woodpecker	<i>Picoides pubescens</i>	√		√
Hairy Woodpecker	<i>Dryobates villosus</i>			√
Northern Flicker	<i>Colaptes auratus</i>	√	√	√
Willow Flycatcher	<i>Empidonax traillii</i>	√	√	√
Alder Flycatcher	<i>Empidonaxalnorum</i>	√	√	√
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	√	√	√
Least Flycatcher	<i>Empidonax minimus</i>	√		√
Eastern Kingbird	<i>Tyrannus tyrannus</i>	√	√	√
N. Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	√	√	√
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>		√	
Tree Swallow	<i>Tachycineta bicolor</i>	√		√
Barn Swallow	<i>Hirundo rustica</i>	√	√	√

Common Name	Scientific Name	Southwest	Station	Southeast
Bank Swallow	<i>Riparia riparia</i>			√
Blue Jay	<i>Cyanocitta cristata</i>	√	√	√
American Crow	<i>Corvus brachyrhynchos</i>	√	√	√
Common Raven	<i>Corvus corax</i>	√		√
Black-capped Chickadee	<i>Poecile atricapillus</i>	√	√	√
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	√	√	√
House Wren	<i>Troglodytes aedon</i>	√	√	√
American Robin	<i>Turdus migratorius</i>	√	√	√
Wood Thrush	<i>Hylocichla mustelina</i>			√
Northern Mockingbird	<i>Mimus polyglottus</i>	√	√	√
Gray Catbird	<i>Dumetella carolinensis</i>	√	√	√
Brown Thrasher	<i>Toxostoma rufum</i>	√	√	√
Cedar Waxwing	<i>Bombycilla cedrorum</i>	√	√	√
European Starling	<i>Sturnus vulgaris</i>	√	√	√
Northern Cardinal	<i>Cardinalis cardinalis</i>	√	√	√
Warbling Vireo	<i>Vireo gilvus</i>	√	√	√
Red-eyed Vireo	<i>Vireo olivaceus</i>	√	√	√
Yellow Warbler	<i>Dendroica petechia</i>	√	√	√
Mourning Warbler	<i>Geothlypis philadelphia</i>			√
American Redstart	<i>Setophaga ruticilla</i>	√		√
Chestnut-sided Warbler	<i>Setophaga pensylvanica</i>			√
Common Yellowthroat	<i>Geothlyphis trichas</i>	√	√	√
Chipping Sparrow	<i>Spizella passerina</i>		√	
Field Sparrow	<i>Spizella pusilla</i>	√	√	√
Savannah Sparrow	<i>Passerculus sandwichensis</i>	√	√	√
Song Sparrow	<i>Melospiza melodia</i>	√	√	√
Clay-colored Sparrow	<i>Spizella pallida</i>			√
Swamp Sparrow	<i>Melospiza georgiana</i>		√	√
House Sparrow	<i>Passer domesticus</i>	√	√	√
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	√	√	√
Eastern Meadowlark	<i>Sturnella magna</i>	√		√
Common Grackle	<i>Quiscalus quiscula</i>	√	√	√
Brown-headed Cowbird	<i>Molothrus ater</i>	√	√	√
Orchard Oriole	<i>Icterus spurius</i>	√	√	√
Baltimore Oriole	<i>Icterus galbula</i>	√	√	√
House Finch	<i>Haemorhous mexicanus</i>	√	√	√
American Goldfinch	<i>Spinus tristis</i>	√	√	√
Merlin	<i>Falco columbarius</i>			√
Turkey Vulture	<i>Cathartes aura</i>		√	√
Spotted Sandpiper	<i>Actitis macularius</i>	√	√	√
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	√		√
Belted Kingfisher	<i>Megaceryle alcyon</i>	√	√	√
Osprey	<i>Pandion haliaetus</i>			√
Wild Turkey	<i>Meleagris gallopavo</i>	√		√

Common Name	Scientific Name	Southwest	Station	Southeast
Ruby-throated Hummingbird	<i>Archilochus colubris</i>			√
Eastern Wood Peewee	<i>Contopus virens</i>	√		√
Red-breasted Nuthatch	<i>Sitta canadensis</i>	√		√
Indigo Bunting	<i>Passerina cyanea</i>			√
Bobolink	<i>Dolichonyx oryzivorus</i>	√		√
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>			√

Source: (Beacon, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019a, 2019b, 2022, 2023)

Check marks (√) indicate that at least one sighting of that species occurred in the general area noted.

The bluffs along the Lake Ontario shoreline provide nesting habitat for threatened Bank Swallows. The species also forages in various parts of the DN site. The lakeshore colonies have been surveyed for over ten years. In 2022 at the DN site, a total of 1,795 burrows were documented, which is similar to the average of 1,811 burrows over the past 16 years of monitoring (Beacon, 2023). All the burrows in 2022 were located in the eastern-most third of the shoreline of the DN site, as is typical. The number of burrows on the DN site has varied during the 2007 to 2022 period from 1,118 burrows to 2,617 burrows (Beacon, 2023). Based on the broader evaluation area extending from the site, since 2012 Bank Swallow burrows have decreased, 2020 being the lowest number of burrows recorded (Beacon, 2023).

Mammals

Thirty-seven mammal species have been inventoried at the DN site as a result of incidental observations during field investigations conducted for non-biological inventory purposes since 1997 (**Table 2-2**) (Beacon, 2023).

Table 2-2: Mammals Species List (1997-2022)

Common Name	Scientific Name
MAMMALS	
Virginia Opossum	<i>Didelphis virginiana</i>
Masked Shrew	<i>Sorex cinereus</i>
Smoky Shrew	<i>Sorex fumeus</i>
Pygmy Shrew	<i>Sorex hoyi</i>
Northern Short-tailed Shrew	<i>Blarina brevicauda</i>
Star-nosed Mole	<i>Condylura cristata</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Northern Myotis	<i>Myotis septentrionalis</i>
Small-footed Myotis	<i>Myotis leibii</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Tri-coloured Bat	<i>Pipistrellus subflavus</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Eastern Red Bat	<i>Lasiurus borealis</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Eastern Cottontail	<i>Sylvilagus floridanus</i>
European Hare	<i>Lepus europaeus</i>
Eastern Chipmunk	<i>Tamias striatus</i>
Woodchuck	<i>Marmota monax</i>
Grey Squirrel	<i>Sciurus carolinensis</i>
Red Squirrel	<i>Tamiasciurus hudsonicus</i>
Beaver	<i>Castor canadensis</i>
White-footed Mouse	<i>Peromyscus leucopus</i>
Deer Mouse	<i>Peromyscus maniculatus</i>
Meadow Vole	<i>Microtus pennsylvanicus</i>
Muskrat	<i>Ondatra zibethicus</i>
Norway Rat	<i>Rattus norvegicus</i>
Meadow Jumping Mouse	<i>Zapus hudsonius</i>
Woodland Jumping Mouse	<i>Napaeozapus insignis</i>
Eastern Coyote	<i>Canis latrans</i>
Red Fox	<i>Vulpes vulpes</i>
Black Bear	<i>Ursus americanus</i>
Raccoon	<i>Procyon lotor</i>
Short-tailed Weasel	<i>Mustela erminea</i>
Long-tailed Weasel	<i>Mustela frenata</i>
Mink	<i>Mustela vison</i>
Striped Skunk	<i>Mephitis mephitis</i>
White-tailed Deer	<i>Odocoileus virginianus</i>

Source: (Beacon, 2019b, 2022, 2023)

Amphibians and Reptiles

Eight species of amphibians and five species of reptiles have been inventoried for the DN site during the breeding season from 2008 to 2022 (**Table 2-3**) (Beacon, 2019b, 2023).

Table 2-3: Amphibian and Reptile Species List

Common Name	Scientific Name
REPTILES AND AMPHIBIANS	
American Toad	<i>Bufo americanus</i>
Eastern Gray Treefrog	<i>Hyla versicolor</i>
Western Chorus Frog	<i>Pseudacris triseriata</i>
Northern Leopard Frog	<i>Rana pipiens</i>
Green Frog	<i>Rana clamitans</i>
Wood Frog	<i>Rana sylvatica</i>
Midland Painted Turtle	<i>Chrysemys picta</i>
Common Snapping Turtle	<i>Chelydra serpentine</i>
Red-eared Slider	<i>Trachemys scripta</i>
Eastern Garter Snake	<i>Thamnophis sirtalis</i>
Spring Peeper	<i>Pseudacris crucifer</i>
DeKay's Brownsnake	<i>Storeria dekayi</i>
Red-back Salamander	<i>Plethodon cinereus</i>

Source: (Beacon, 2019b, 2023)

Insects and other invertebrates

To date, 304 insect species (butterflies, dragonflies/damselflies, moths, and other insects) have been inventoried for the DN site (Beacon, 2019b, 2023). Moths represent the most diverse group (211 species), followed by dragonflies and damselflies (42 species), and butterflies (33 species). Other invertebrate groups that have been identified include tiger beetles (2 species), spiders (2 species), and other insects (14 species).

2.4.6.2 Terrestrial Animal Species at Risk

Two reptile species, eighteen breeding bird species, four mammals (bats), three insects, and one tree species at risk with a provincial ranking of endangered, threatened, or special concern were recorded at the DN site over the period from 2006 to 2022. One insect species (American Bumble Bee) is listed as special concern provincially and federally as of 2023. Eastern Small-Footed Myotis was identified for the first time on the DN site during bat acoustic monitoring in 2021 (Beacon, 2021). A list of the animal species that have a species at risk ranking of endangered, threatened, or special concern in Ontario and have been recorded at the DN site is provided in **Table 2-4**, along with their regional federal status ranking under Schedule 1 of the *Species at Risk Act* (SARA) and/or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Table 2-4: Wildlife Species at Risk Observed within the Vicinity of DN (2006-2022)

Scientific Name	Common Name	Federal Species at Risk Status ⁽¹⁾	Provincial Ranking ⁽²⁾	Most Recent Year Observed
Amphibians and Reptiles				
<i>Chelydra serpentina</i>	Snapping Turtle	Special Concern	Special Concern	2020
<i>Chrysemys picta marginata</i>	Midland Painted Turtle	Special Concern ³	No status	2022
Birds				
<i>Ixobrychus exilis</i>	Least Bittern	Threatened	Threatened	2022
<i>Falco peregrinus</i>	Peregrine Falcon	Special Concern	Special Concern	2022
<i>Chlidonias niger</i>	Black Tern	No status	Special Concern	2008
<i>Asio flammeus</i>	Short-eared Owl	Special Concern	Threatened	2018
<i>Chordeiles minor</i>	Common Nighthawk	Special Concern	Special Concern	2019
<i>Chaetura pelagica</i>	Chimney Swift	Threatened	Threatened	2021
<i>Anrostomus vociferus</i>	Eastern Whip-poor-will	Threatened	Threatened	2018
<i>Contopus cooperi</i>	Olive-sided Flycatcher	Special Concern	Special Concern	2019
<i>Contopus virens</i>	Eastern Wood Peewee	Special Concern	Special Concern	2022
<i>Riparia riparia</i>	Bank Swallow	Threatened	Threatened	2022
<i>Hirundo rustica</i>	Barn Swallow	Threatened	Special Concern	2022
<i>Hylocichla mustelina</i>	Wood Thrush	Threatened	Special Concern	2022
<i>Cardellina canadensis</i>	Canada Warbler	Threatened	Special Concern	2011
<i>Icteria virens auricollis</i>	Yellow-breasted Chat	Endangered	Endangered	2009
<i>Dolichonyx oryzivorus</i>	Bobolink	Threatened	Threatened	2022
<i>Sturnella magna</i>	Eastern Meadowlark	Threatened	Threatened	2022
<i>Euphagus carolinus</i>	Rusty Blackbird	Special Concern	Special Concern	2010
Mammals				
<i>Myotis lucifugus</i>	Little Brown Myotis (bat)	Endangered	Endangered	2022
<i>Myotis septentrionalis</i>	Northern Myotis (bat)	Endangered	Endangered	2021
<i>Myotis leibii</i>	Eastern Small-footed Myotis (bat)	No status	Endangered	2021
<i>Pipistrellus subflavus</i>	Tri-colored Bat	Endangered	Endangered	2022
Insects				
<i>Danaus plexippus</i>	Monarch (butterfly)	Endangered	Special Concern	2022
<i>Bombus pensylvanicus</i>	American Bumble Bee	Special Concern	Special Concern	2022
<i>Bombus terricola</i>	Yellow-banded Bumble Bee	Special Concern	Special Concern	2022

Scientific Name	Common Name	Federal Species at Risk Status ⁽¹⁾	Provincial Ranking ⁽²⁾	Most Recent Year Observed
Plants				
<i>Juglans cinerea</i>	Butternut (tree)	Endangered	Endangered	2022

Notes:

The Provincial Species at Risk in Ontario List and Federal List of Wildlife Species at Risk (Schedule 1 of the SARA) are frequently revised.

(1) SARA Schedule 1 ranks species at risk as Extirpated, Endangered, Threatened Species, and Special Concern. Prohibitions of the Act do not apply to species of Special Concern.

(2) The provincial Endangered Species Act (ESA) (2007) came into effect on June 30, 2008, and it applies to species once they appear on the official list.

(3) Midland Painted Turtle was assessed as Special Concern by COSEWIC in 2018 but currently no Federal status or schedule

Sources: (Beacon, 2019a, 2019b, 2022, 2023)

Although there have been some observations of new Species at Risk, the selected receptors from the 2020 ERA are still relevant and representative. None of the newly observed Species at Risk introduce any new exposure pathways or exposure characteristics not already represented by the list of selected receptors from the 2020 ERA. As noted in the 2020 ERA, no bats were selected as valued ecosystem components (VECs) for the ecological risk assessment as the assessment of other terrestrial mammals is expected to be protective of this receptor group; this same assumption applies to the Eastern Small-footed Myotis, which would experience similar exposure characteristics and pathways as the other previously identified bat species. The American Bumble Bee and the Yellow-banded Bumble Bee are expected to be adequately represented by the Earthworm, as they are all terrestrial invertebrates. Both species of bumble bees and the Earthworm are assumed to be exposed to airborne contaminants via soil. As the Earthworm dwells underground and is more highly exposed to soil, using the Earthworm to represent the American Bumble Bee and the Yellow-banded Bumble Bee is considered conservative. No associated changes to the receptors assessed in the ERA Addendum were required.

2.4.7 Aquatic Communities

Detailed information regarding aquatic communities can be found in Section 2.3.7 of the 2020 ERA (Ecometrix, 2022a). The existing information on aquatic communities is still relevant for the Site.

Since the 2020 ERA, as part of the work to support the DNNP project, a channelized drainage feature which provides site drainage for Hydro One and OPG properties was assessed for fish habitat (Ecometrix, 2022b). The location of the ditch and drainage feature are shown on **Figure 2-5** below.

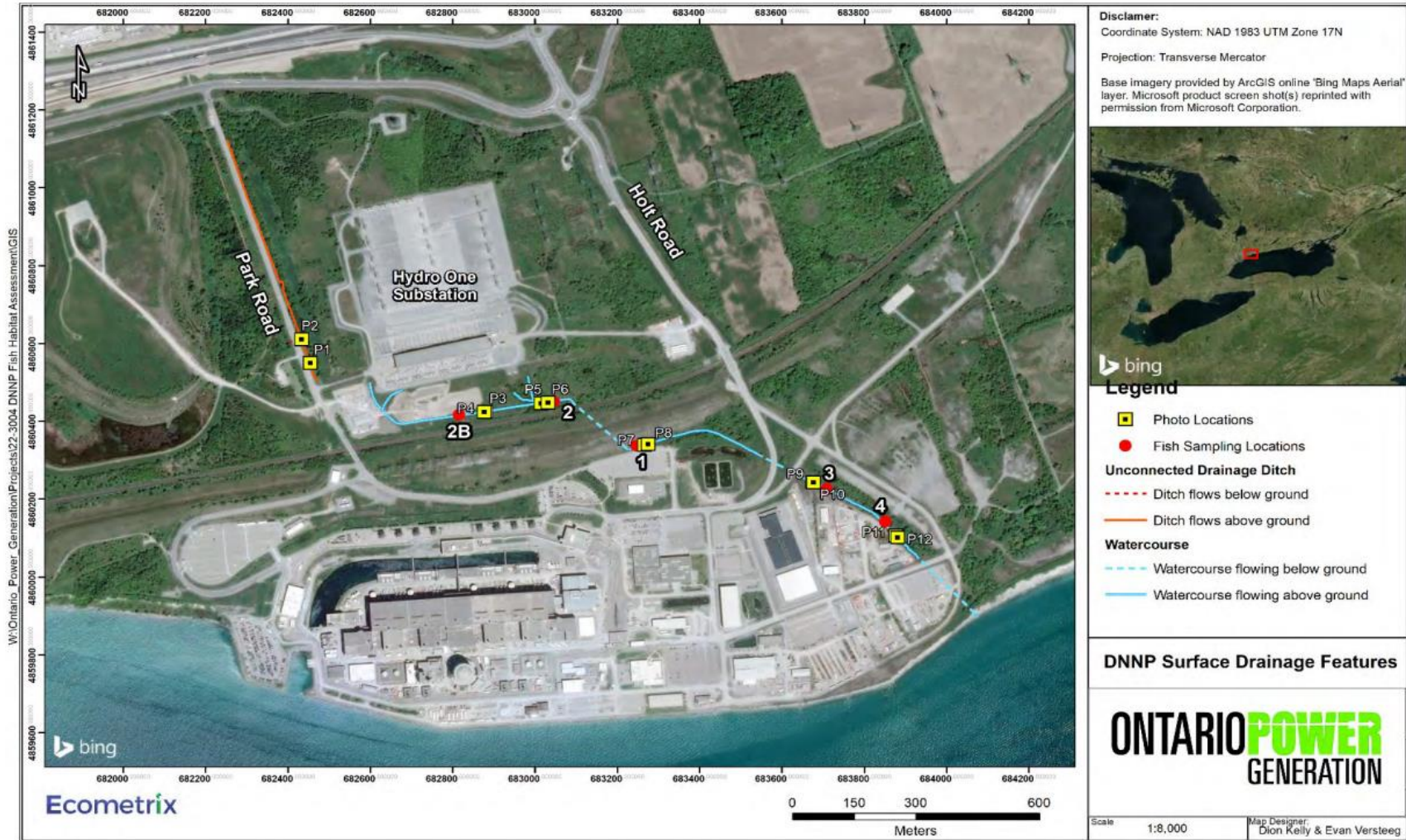


Figure 2-5: Fish Habitat Assessment of the Drainage Features

The fish habitat assessment was conducted using the principles of the Ontario Stream Assessment Protocol and included electrofishing. From the survey results, it was concluded that the channelized drainage feature does not support fish and there is no connectivity to fish bearing waters (i.e., Lake Ontario); thus, the drainage feature does not meet the definition of fish habitat under the *Fisheries Act*.

In May 2023, eDNA sampling was conducted in the drainage feature. Fish DNA was not present based on DNA barcoding.

Therefore, no new aquatic communities or aquatic community information has been incorporated into the ERA Addendum.

2.4.8 Human Land Use

Detailed information regarding human land use can be found in Section 2.3.8 of the 2020 ERA (Ecometrix, 2022a). The existing information on human land use is still relevant for the Site.

2.4.9 Population Distribution

The population distribution information remains unchanged from the 2020 ERA, as new census data is not available. Detailed information regarding population distribution use can be found in Section 2.3.9 of the 2020 ERA (Ecometrix, 2022a).

2.5 Uncertainties in Site Characterization

The DN Site is considered to be well-characterized. No residual uncertainties in the Site Characterization have been identified.

3.0 Human Health Risk Assessment (HHRA)

The human health risk assessment (HHRA) is a process that evaluates the potential for health risks to humans who may be exposed to chemical and radiological contaminants.

The HHRA consists of the following steps:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

3.1 Problem Formulation

The problem formulation provides the objectives, goals, framework, and methodology for the risk assessment and consists of identifying the relevant components for the HHRA. These components include the identification of human receptors that may be potentially present in or around the DN Site; the identification of exposure pathways operating on or around the DN Site, based on the fate and transport of chemical and radiological contaminants in the environment; the identification of chemical, radiological, and other stressors; and a conceptual site model that illustrates all of these relationships.

During the problem formulation stage, decisions are made on which COPCs and receptors that should be focused on for further assessment in the HHRA. For this Addendum, the receptors and exposure pathways remain consistent with the 2020 ERA; however, the COPC screening is new, based on data collected since 2020.

3.1.1 Receptor Selection and Characterization

Consistent with the 2020 ERA, on-site workers, contractors, and visitors are protected through the Health and Safety Management System Program and the Radiation Protection Program and are not considered in the HHRA.

The receptors selected for the assessment and their characteristics remain unchanged from the 2020 ERA (Ecometrix, 2022a), as presented below.

- The **Oshawa/Courtice** potential critical group consists of urban residents in Oshawa and in the community of Courtice within the Municipality of Clarington located to the W and WNW of the site starting at about 6 km from the site. These residents obtain drinking water from the Oshawa WSP and grow a small percentage of their annual fruit and vegetable consumption in gardens.
- The **Bowmanville** potential critical group consists of urban residents located to the NE and NNE of the site at distances from 4 to 7 km from DN. These residents obtain drinking water from the Bowmanville WSP and grow a small percentage of their annual fruit and

vegetable consumption in gardens. They also purchase a small percentage of their annual meat, poultry, and egg consumption from local farms.

- The **West/East Beach** potential critical group consists of urban residents located to the ENE of the site at distances from 3.5 km to 7 km. These residents obtain their drinking water from both wells and the Bowmanville WSP and grow a small percentage of their annual fruit and vegetable consumption in gardens. They also purchase a small percentage of their annual poultry and egg consumption from local farms.
- The **Farm** potential critical group consists of agricultural farms (but not dairy farms) located in all landward wind sectors around the DN site at distances from 1.5 km to 10 km. The closest is in the WNW wind sector. Members of this group obtain their water supply mostly from wells and use it for drinking, bathing, irrigation, and watering livestock. They also obtain a large fraction of their annual fruit, vegetable, and animal product consumption from locally grown products.
- The **Dairy Farm** potential critical group consists of dairy farms located in all landward wind sectors around the DN site at distances from 3 km to over 10 km. The closest is in the N wind sector. Members of this group obtain their water supply from wells and use it for drinking, bathing, irrigation, and livestock watering. They also obtain a large fraction of their annual fruit, vegetable and animal product consumption, including fresh cow's milk, from locally grown products.
- The **Rural Resident** potential critical group consist of residents in rural areas in all landward wind sectors around the site at distances of about 2 km to 5 km. Members of this group obtain about half of their water supply from wells and half from the Bowmanville WSP, and use it for drinking, bathing, and irrigation. They obtain a moderate fraction of their annual fruits, vegetables, poultry, and eggs from locally grown products.
- The **Industrial/Commercial** potential critical group consist of adult workers whose work location is close to the nuclear site. The closest location for this group is the St. Mary's cement (SMC) plant about 1.8 km NE of the site; however, the most affected location due to updated meteorological data is the Courtice Water Pollution Control Plant about 2 km W of DN. Members of this group are typically at this location about 23% of the time. They consume water from the Bowmanville WSP.
- The **Sport Fisher** potential critical group is comprised of non-commercial individuals fishing near the DN site discharge, about 0.5 km S of the DN site. Members of this group were conservatively assumed to obtain their entire amount of fish for consumption from the vicinity of the DN site and spend 1% of their time at the discharge location where atmospheric exposure occurs.
- The **Camper** potential critical group consists of campers at the Darlington Provincial Park, located from 4 to 6 km W of the site at the lakeshore, and includes McLaughlin Bay, a shallow water body where some fishing takes place. The campers are assumed to be in the park no more than six months of the year. They consume drinking water from the Oshawa WSP, and purchase a small fraction of their annual fruits, vegetables, meat, poultry, and eggs from locally grown sources.

The HHRA and receptor selection does not directly address sensitive or vulnerable populations; however, sensitive or vulnerable human health groups are considered through the use of toxicity reference values (TRVs) in **Section 3.3.1** that incorporate uncertainty factors to account for sensitive individuals.

3.1.2 Selection of Chemical, Radiological, and Other Stressors

The DN facility emits certain chemicals and radionuclides to air and water in the normal course of operations. Measurements and modelled concentrations of chemical COPCs in air and water, from 2020 to the end of 2022, were screened against available screening benchmarks that are protective of human health to determine if any COPCs required further study in the context of human health risk assessment. The selection of COPCs in other environmental media is also discussed in the sections below. Contaminants were retained for evaluation of human health risks in this Addendum if they:

- Were a new COPC not previously identified in the 2020 ERA, or
- Were a COPC evaluated in the 2020 ERA and the maximum concentration in 2020 – 2022 was greater than that evaluated in the 2020 ERA.

The framework for the chemical COPC screening process used in the HHRA is consistent with the 2020 ERA, with updated guidelines applied where available. Generally, maximum observed or modelled concentrations were screened against the more conservative of federal or Ontario provincial guidelines. If there was no such guideline, guidelines from other jurisdictions, or the literature were considered and/or derived using federally and/or provincially accepted methods. For COPCs where these criteria were not available, conservative toxicity benchmarks (e.g., no effects levels) or upper limit of background concentrations were used as screening criteria. Maximum measured or modelled concentrations of parameters in air and surface water were compared to the selected screening criteria. Subsequent sections for each environmental medium provide hierarchical depictions outlining the specific guidelines considered in the screening process for that medium.

Since radionuclides are considered of public interest, relevant radionuclides are carried forward quantitatively in the HHRA, bypassing the screening assessment.

3.1.2.1 Selection of Chemical COPCs in Air

3.1.2.1.1 Emission Summary and Dispersion Modelling (ESDM) Reports

The ESDM Reports from 2020 to 2022 were consulted to aid in chemical COPC selection for air. The ESDM report presents the estimated atmospheric emissions of COPCs from the DN site (ORTECH, 2021, 2022a, 2022b). The impact of contaminant emissions was assessed within the ESDM reports by comparing point-of-impingement (POI) concentrations modeled from emission rates to POI exposure benchmarks listed in the Ministry of Environment, Conservation, and Parks (MECP) publication: *Air Contaminants Benchmarks (ACB) List: Standards, guidelines, and screening levels for assessing point of impingement concentrations of air contaminants* (the 'ACB list')

(MECP, 2023a). The ACB list encompasses the air standards set out in Ontario Regulation (O. Reg.) 419/05, as well as a broader list of additional benchmarks further intended to aid facilities in preparing ESDM reports. Modelled POI concentrations were compared to respective MECP POI benchmarks with corresponding averaging periods, typically 24-hour or annual averages.

3.1.2.1.2 DNNP Air Quality Monitoring Data

In November 2021, OPG initiated an air quality study in support of the DNNP, with the goal of re-establishing existing air quality conditions at the DN site prior to the start of DNNP site preparation and construction activities (IEC, 2023). The study monitors priority air contaminants including particulate matter (PM₁₀, PM_{2.5}, total suspended particulates [TSP]), pollutant gases (Nitrogen dioxide, NO₂; Sulphur dioxide, SO₂), volatile organic compounds (VOCs), and benzo(a)pyrene (BAP; a surrogate for total polycyclic aromatic hydrocarbons [PAHs]). Air quality data are presented for two monitoring locations situated on the western and eastern boundaries of the DNNP site (OPG West and OPG East) as shown in **Figure 3-1**.

3.1.2.1.3 HHRA Air Screening

3.1.2.1.3.1 ESDM Report Screening

The maximum predicted POI concentrations for each of the modelled parameters in Table 1 of the ESDM reports were compared to selected health-based screening benchmarks. Selection of health-based screening criteria followed the hierarchy depicted in **Figure 3-2**. Preferred primary guidelines consisted of the most conservative of the MECP ACBs (MECP, 2023a), and the Canadian Council of Ministers of the Environment (CCME) Canadian Ambient Air Quality Standards (CAAQS) (CCME, 2019). CAAQS are only available for four parameters. Secondary guidelines consisted of the MECP ambient air quality criteria (MECP, 2023b), while tertiary guidelines were the Texas Commission on Environmental Quality Effects Screening Levels (TCEQ, 2023).



Figure 3-1: Location of OPG East and OPG West Air Quality Monitoring Stations (IEC, 2023)

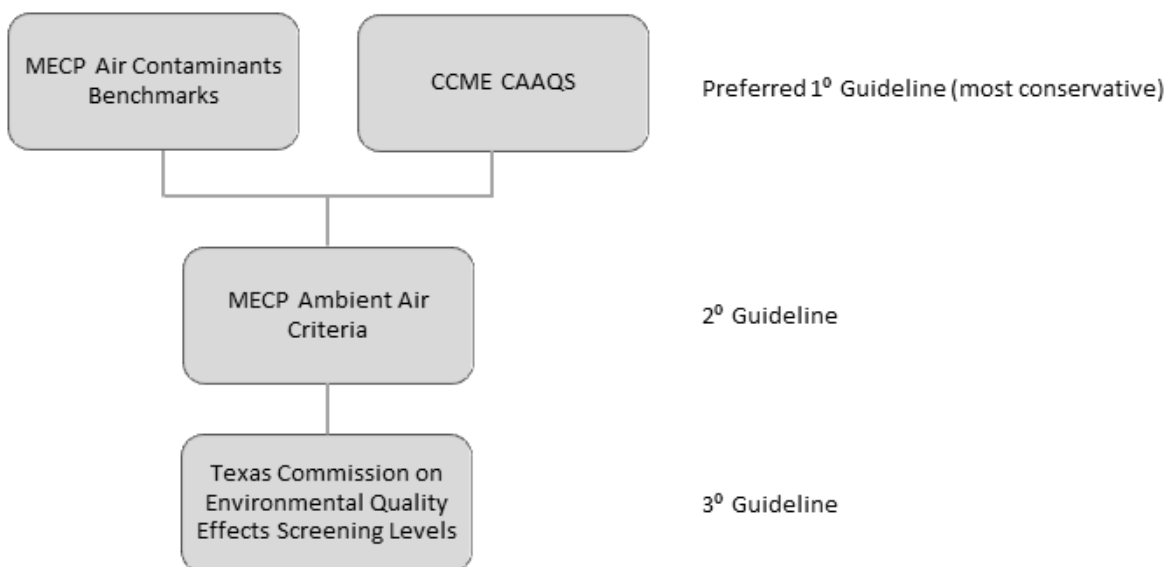


Figure 3-2: Hierarchy of Screening Criteria for HHRA Chemical COPCs in Air

The HHRA screening of chemical COPCs based on maximum predicted POI concentrations is shown in **Table A-1** in **Appendix A**. Modelled POI concentrations were directly compared to guidelines with the same averaging periods (e.g., 24-hour or annual) or were adjusted to meet the timeframes of the relevant screening criteria. With the exception of nitrogen oxides (NO_x), no other modelled concentrations exceeded selected screening criteria from 2020 to 2022. Maximum POI concentrations of NO_x in 2020, 2021, and 2022 exceeded the 1-hour CCME CAAQS (205 µg/m³ > 113 µg/m³). The maximum POI 1-hour concentration from 2020 – 2022 (205 µg/m³) was the same as the maximum POI concentration from 2016 – 2020 (205 µg/m³). Thus, this concentration of NO_x was evaluated in the 2020 ERA and does not need to be repeated.

The POI concentrations calculated for the DN site tend to be conservative as they consider the worst-case operating conditions resulting in the highest POI concentrations for each air pollutant (and relevant averaging period) that the DN site is capable of producing. For example, the maximum POI concentration for NO_x was calculated to be 205 µg/m³, whereas the monitoring data from the DNNP air quality monitoring (see next section) measured the concentration of NO₂ (comparable to NO_x) to be 127 µg/m³. Its important to note, as described in the next section, that the concentration of NO₂ measured in the DNNP air study likely captured other sources of NO₂ external to the DN site, further suggesting that the POI concentrations are likely to be a conservative overestimate of DN air emissions.

3.1.2.1.3.2 DNNP Air Quality Monitoring Screening

Monitored air quality data were also compared against selected HHRA screening criteria (**Figure 3-2**) in **Table A-2** in **Appendix A**. Monitored air quality data are mostly presented as 24-hour averages. In addition to 24-hour averages, PM₁₀, PM_{2.5}, NO₂, and SO₂ are presented as 1-hour averages, and four parameters (methylene chloride, 1,2-dichloroethane, tetrachloroethylene, and benzene) are presented as annual averages. The exceedances are discussed below.

Out of 90 samples (East and West stations), there were 9 exceedances of the 24-hour ambient air quality criteria (AAQC) value for TSP. The exceedances were all at the East station, which is located close to St. Mary's Cement (SMC). Exceedances were likely due to factors such as the degree of truck traffic at SMC, the predominant wind direction, and whether there was precipitation or frozen ground that would suppress dust generation from SMC roads. Each TSP exceedance coincided with a PM₁₀ exceedance at one or both stations.

For PM_{2.5}, there were 3 exceedances at the East station and 1 exceedance at the West station of the 24-hour AAQC from November 2021 to November 2022. The PM_{2.5} concentrations were similar at the East and West stations, with short term peaks occurring more often at the East station during the late spring and early summer months.

For PM₁₀, there were 57 exceedances at the East station and 16 exceedances at the West station of the 24-hour AAQC from November 2021 to November 2022. The PM₁₀ concentrations at the West station were largely stable with some short-term peaks, while the concentrations at the East station tended to peak more frequently and over a much larger concentration range compared to the West station. This pattern is similar to TSP and is expected to be due to the SMC facility operations and associated truck traffic on unpaved roads. All of the PM₁₀ exceedances at the West station coincided (in time) with the exceedances at the East station. Seasonally, the number of exceedances were lower in the winter months where frozen ground and/or snow-covered / wet ground would suppress the re-suspension of dust.

SO₂ concentrations did not vary greatly between the two monitoring stations, though there were more short-term spikes in concentration at the West station. There were no exceedances of the 24-hour SO₂ criteria at either station; however, there was one exceedance of the 1-hr AAQC at the East station, and 21 at the West station. Most of the exceedances at the West station (15 out of 21) occurred when winds were from the east. As there were no corresponding exceedances at the East station, this indicates that the SO₂ emissions may have originated from OPG property (i.e., Holt Road) or possibly from plume dispersion from the Durham-York Energy Centre (DYEC) tall stack. Other exceedances occurred when winds were from the west, north, and north-west suggesting that other local sources may at times be contributing to higher short-term concentrations of SO₂ (i.e., Highway 401, Highway 418, SMC, DYEC, etc.).

For BAP, there were 25 samples at the East station and 22 samples at the West station that exceeded the 24-hour AAQC from November 2021 to November 2022. The BAP concentrations at the OPG stations were generally within the same range as the concentrations measured at the DYEC stations. This suggests sources of BAP that are external to the Site as mentioned above for particulate.

For NO₂, there were 3 samples at the East station that exceeded the 1-hour NO₂ CCME CAAQS from May 2022 to August 2022. The hourly NO₂ concentrations did not vary greatly between the two monitoring stations, with the exception of a 3-week period where concentrations at the East station were consistently above those at the West station. These elevated NO₂ concentrations at the East station may have been attributed to overlapping activities associated with the nearby Ministry of Transportation Trailer and Staging and Black and McDonald Bulk Storage projects,

which are close to the East Station. At the East station, the 98th percentile of the daily maximum 1-hour average concentrations was 45 ppb, while the CCME CAAQS is 60 ppb. There were no samples with exceedances of the 1-hour NO₂ CCME CAAQS at the West station. There were no samples with exceedances of the 24-hour NO₂ CCME CAAQS at either station.

Though these parameters exceed their respective air quality screening criteria, they are not retained as air COPCs with respect to human health. Under the influence of changing wind directions and meteorological conditions, the DNNP air quality monitoring program is likely to capture sources of pollution external to the DN site from local and regional industry and traffic, including from the nearby SMC, DYEC, Canadian National and Canadian Pacific railways, and Highway 401.

Based on these results, there were no COPCs that were retained in air.

3.1.2.2 Selection of Chemical COPCs in Surface Water

The surface water screening is based on measurements of chemical COPCs in lake water, condensing cooling water (CCW) discharges, and stormwater discharges. In 2020 – 2022, there were no new measurements for lake water or stormwater discharges. Therefore, the 2016 – 2020 data for lake water and stormwater discharge was re-screened against updated guidelines. New data were available for CCW Effluent for 2020 – 2022.

3.1.2.2.1 Lake Water Sampling

Surface water sampling was conducted quarterly (spring, summer, early fall, and early winter) in 2019 (Ecometrix, 2022c). The results of this sampling program were used as the basis for the screening of COPCs in Lake Ontario.

Selection of surface water screening criteria followed the hierarchy depicted in **Figure 3-3**. Maximum measured concentrations were compared to the following criteria, in order of preference:

- The more conservative of:
 - Health Canada (HC) Canadian Drinking Water Quality Guidelines (CDWG) (HC, 2022); or,
 - Ontario Drinking Water Standards (ODWS) for Potable Ground Water (MECP, 2011) and the related GW1 Component Values in Ontario Regulation 153/04;
- Guidelines available from other jurisdictions (e.g., British Columbia Ministry of Environment (BC MOE) Source Drinking Water Quality Guidelines (BC MOE, 2020); United States Environmental Protection Agency (US EPA) Regional Screening Levels (RSLs) for resident tap water - target hazard quotients (THQ) of 0.2) (US EPA, 2023a);
- Modified toxicity values available from other sources (e.g., World Health Organization (WHO) (WHO, 2011); US EPA Integrated Risk Information System (IRIS) (US EPA, 2023b));

HC (HC, 2022)), or background typically found in drinking water (Agency for Toxic Substances and Disease Registry (ATSDR) (ATSDR, 2023);

- 95th percentile background concentrations (based on 2019 data from sampling station SW2 at Cobourg).

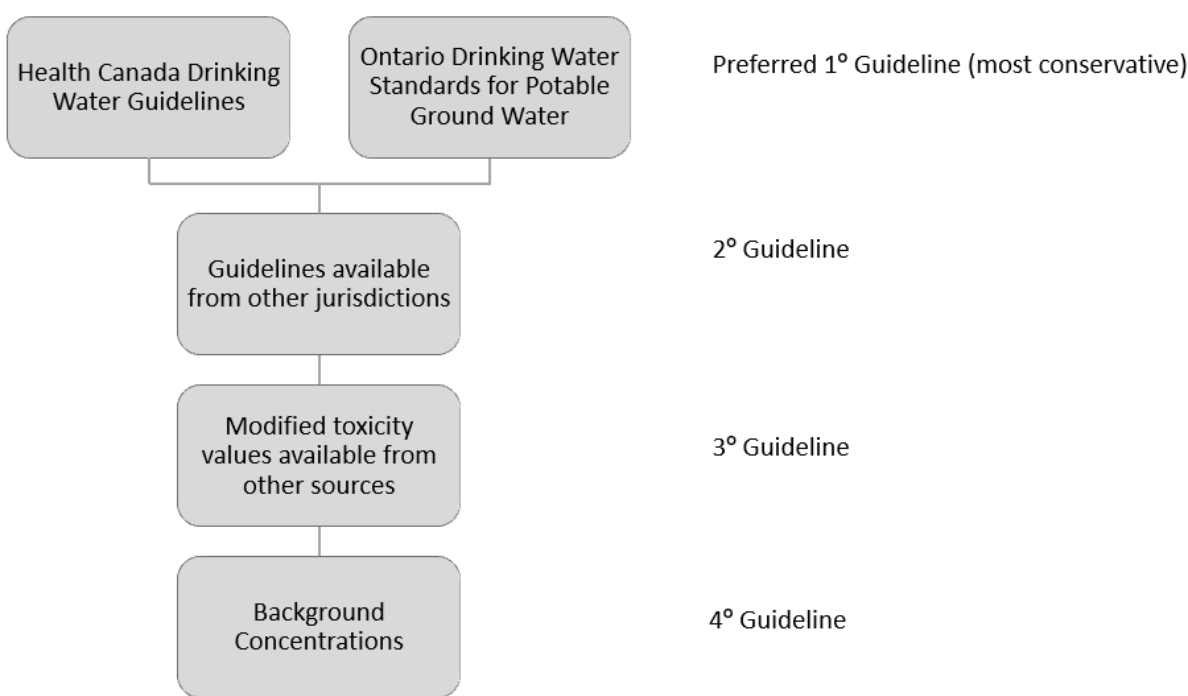


Figure 3-3: Hierarchy of Screening Criteria for HHRA Chemical COPCs in Surface Water

Selections of human health screening criteria are shown in **Table A-3** in Error! Reference source not found.. The results of this screening can be found in **Table A-4** in Error! Reference source not found..

As shown in **Table A-4**, the estimated *Escherichia coli*, fecal coliform, and total coliform bacteria concentrations in Lake Ontario were detectable at 2000, 2000, and 2100 CFU/100mL, respectively, which does not meet the HHRA screening criteria that stipulates these microbial parameters must not be detectable. However, *E. coli*, fecal coliform, and total coliform bacteria are naturally-occurring in the environment and not considered to be hazardous. Furthermore, these microbes are not specifically associated with nuclear facilities and are not released as part of normal DN operations. As such, *E. coli*, fecal coliform, and total coliform bacteria have not been considered as COPCs for human health.

The list of COPCs with concentrations that exceed screening criteria is unchanged from the 2020 ERA. As there was no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained in lake water for assessment of human health risks in this Addendum.

3.1.2.2.2 Liquid Effluent Sampling

Clause 0.2.2 and 7.2.5.2 of Canadian Standards Association (CSA) N288.6 discuss screening of liquid effluents, highlighting the relationship of effluent monitoring programs to environmental risk assessment and the screening process. Information from 2020 to 2022 on the concentration of COPCs discharged in liquid effluents into the environment was available from DN Environmental Compliance Approval (ECA) reports. This information was assessed to aid in COPC selection to ensure that the lake water chemical COPC selection was complete.

Waterborne effluent from DN discharged to the CCW duct is diluted through the diffuser as it is released to the lake. Concentrations of COPCs measured in the CCW represent concentrations prior to release to Lake Ontario via the diffuser. Effluent quality results were therefore converted to estimated concentrations in the mixing zone using a dilution factor of 7 at the diffuser (OPG, 2022c).

3.1.2.2.2.1 Monitoring for ECA Requirements

As part of the ECA requirements, the effluent from the CCW is sampled and analyzed for compliance with effluent limits for unionized ammonia, hydrazine, morpholine, pH, and TRC (OPG, 2021b, 2022d, 2023c). For each of these chemicals, the maximum concentration in the mixing zone was estimated based on the maximum measured concentration in the CCW and a dilution factor of 7 at the diffuser (OPG, 2022c). Estimated mixing zone concentrations from 2020 to 2022 were screened against the same screening criteria as the lake water samples.

Hydrazine does not have a HC drinking water guideline nor an ODWS. However, the US EPA estimated that a hydrazine concentration of 0.00001 mg/L corresponds to a cancer risk level of one in one million (1×10^{-6}) (EC and HC, 2011; US EPA, 1988), based on a drinking water intake rate of 2 L/day and no exposure amortization. As shown in **Table A-5** in **Appendix A**, the estimated maximum effluent concentration of hydrazine exceeds the drinking water value of 0.00001 mg/L. Additionally, the maximum concentration of hydrazine estimated in the mixing zone is 0.0011 mg/L, compared to the human health screening level of 0.00001 mg/L. The maximum hydrazine concentration from 2020-2022 of 0.0011 mg/L was greater than the maximum concentration of 0.0009 mg/L from the 2020 ERA. As such, hydrazine from CCW effluent was retained for further assessment of human health risks in this Addendum.

3.1.2.2.2.2 Effluent Characterization

Liquid effluent sampling and analysis were performed in 2016 to provide data for the characterization of non-radiological parameters. OPG is aware that CANDU Owners Group (COG) has carried out a one-time monitoring event of the DNGS effluent streams in 2018; however, given this was a one-time event and the 2016 effluent characterization program was much more comprehensive, the DN ERA Addendum continues to rely on the 2016 effluent characterization.

The 2016 program was part of a follow-up monitoring program from the 2011 Refurbishment and Continued Operation (RCO) EA (OPG, 2013) which included broad spectrum characterization of DN liquid effluents to confirm EA predictions of no residual adverse effects on surface water.

Under the program, five effluent streams were characterized through weekly sampling and chemical analysis for metals, glycols, morpholine, TRC, petroleum hydrocarbons (PHCs), phosphorus and nitrate, alkyl ethoxylates, alkylphenol ethoxylates, and linear alkylbenzene sulphonates (LAS). These streams included radioactive liquid waste (RLW), inactive drainage (IAD; building effluent treatment facility lagoon), boiler blowdown (BB), water treatment plant (WTP), and the condenser cooling water (CCW).

As identified in the 2020 ERA, and still the case based on updated guidelines, no exceedances of screening criteria in the initial mixing zone are expected for the 2016 CCW effluent parameters, as shown in **Table A-6a** and **Table A-6b** in **Appendix A**. As such, no COPCs were carried forward for human health risk assessment in this Addendum.

3.1.2.2.3 Stormwater Sampling

The Stormwater Management System, or Yard Drainage System, collects storm runoff from the entire DN site and discharges to Lake Ontario either directly through the storm sewer drainage system or through drainage swales/creeks via culverts which eventually discharge to the lake. There has been no new stormwater sampling subsequent to the 2020 ERA. The stormwater screening from the 2020 ERA was repeated based on the same data, but with updated human health screening criteria, where available.

Consistent with the 2020 DN ERA, nearshore Lake Ontario concentrations were modelled based on the release and subsequent dilution of stormwater effluent into the lake. The estimated Lake Ontario concentrations were screened against the same human health screening criteria used in the lake water screening. As shown in **Table A-7** in **Appendix A**, the estimated *E. coli*, fecal coliform, and total coliform bacteria concentrations in Lake Ontario exceeded the HHRA screening criteria that stipulates these microbial parameters must be non-detectable. However, *E. coli*, fecal coliform, and total coliform bacteria are naturally occurring in the environment. Furthermore, they are not specifically associated with and are not released by normal operations at the DN site. As such, *E. coli*, fecal coliform, and total coliform bacteria have not been considered as COPCs for human health.

None of the remaining stormwater constituents had estimated Lake Ontario concentrations exceeding the selected human health screening criteria. There was no new stormwater data, and there were no new COPCs identified based on updated guidelines. As such, no further assessment of human health risks related to stormwater were carried out in this Addendum.

3.1.2.3 Selection of Chemical COPCs in Soil

As identified in the 2020 ERA for the human health risk assessment, potential risks from soil were determined to be of little concern. On-site workers, contractors, and visitors are potentially exposed to on-site soil; however, these exposures are considered and controlled through OPG's Environment Health and Safety Managed System Program. Human exposure to contaminants in off-site soil is unlikely, since the results of the air screening show acceptable concentrations for contaminants that could deposit on soil.

Overall, exposure from soil was not carried forward for further analysis in this Addendum.

3.1.2.4 Selection of Chemical COPCs in Groundwater

The DN site has a groundwater protection program (GWPP) and groundwater monitoring program (GWMP) compliant with CSA (2017) N288.7-15 Standard "Groundwater protection programs at Class I nuclear facilities and uranium mines and mills". The GWPP is a comprehensive document that defines groundwater protection goals for the DN site based on site-specific hydrogeological conditions and groundwater end uses that are presented in a conceptual site model (CSM). A systematic planning process is used to design a GWMP that collects the information required to meet each of the GWPP objectives. Groundwater monitoring and reporting follows the design provided in the GWMP.

In the CSM, structures, systems, and components (SSCs) were identified in order to identify high priority SSCs: those which act as potential sources of chemicals to groundwater. Chemicals associated with the SSCs were screened as COPCs for monitoring in the GWMP on the basis of recent groundwater concentrations of those chemicals at the DN site.

OPG executes an annual groundwater monitoring program to understand the groundwater quality beneath the DN site. Based on the results of this program, groundwater on the DN site was found to generally flow toward Lake Ontario or the Forebay. In 2020 to 2022, the groundwater monitoring program included sampling groundwater monitoring wells for tritium, and certain locations for selected hazardous substances, such as PHCs and benzene, toluene, ethylbenzene, and xylenes (BTEX). Analytical results were compared to the MECP Table 3 Standard: "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" for 2011, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition. This comparison was conducted for assessment purposes only, because the Standards are used as a best management practice in this case.

Concentrations of benzene, PHC F2, and PHC F3 in groundwater in the vicinity or downgradient of the Emergency Power Generators, Standby Generators (SGs), and the Construction Boilerhouse have been detected greater than the MECP Table 3 Site Condition Standards. The exceedances of the MECP Standards are limited and are due to naturally occurring hydrocarbons in the petroliferous calcareous shale rather than site operations. Additionally, there are no groundwater supply wells downgradient of potential source areas on-site. As water on the DN site is not used for human consumption, the only on-site pathway for human exposure to groundwater would be from ingestion of water from Lake Ontario after dilution of the groundwater in the lake. Concentrations of potential chemical stressors in off-site drinking water wells are not influenced by DN. As a result, the groundwater pathway is not carried forward for further inclusion in this Addendum.

3.1.2.5 Selection of Chemical COPCs in Lake Sediment

As in the 2020 DN ERA, no direct human health exposure pathways exist between potential chemical COPCs in sediments and the selected human receptors, so no screening of chemicals in

sediment for potential human health effects is required. Bioaccumulation of chemicals in fish is likely to be primarily driven by water exposures for the fish, since sediments in areas where human receptors catch fish, such as Lake Ontario in the vicinity of DN, are transient. Lake Ontario in the vicinity of DN is not a depositional environment, as characterized in COG (2013a). As such, the lake water screening is considered sufficient to identify COPCs for human health from fish ingestion.

Overall, exposure from sediment was not carried forward for further analysis in this Addendum.

3.1.2.6 Selection of Radionuclide COPCs

In the 2020 ERA, radiological emissions and effluent releases were identified, along with the sources and patterns over time. Radiological COPCs in air, surface water, soil, groundwater, and sediment were identified. In this Addendum, the radiological dose to the critical receptor for the year 2020, 2021, and 2022 are reported (**Table 3-6**). Supporting information in terms of COPC emissions and how doses were calculated, are specified in the Environmental Monitoring Reports (OPG, 2021c, 2022b, 2023d). Further information regarding radiological COPC screening and radiological dose calculations can be found in the 2020 ERA (Ecometrix, 2022a).

Radionuclide COPCs selected are consistent with those identified as part of the derived release limit (DRL) calculations for the DN Site. Separate medium-specific DRLs were calculated for each radionuclide released to air and to water, but some of these radionuclides were grouped to allow easier screening.

The airborne effluent groups that were used for DN are as follows:

- Elemental tritium (HT),
- Tritium oxide (HTO) as water vapour,
- Noble gas mixtures (noble gases),
- Radioiodine mixed fission products (Imfp),
- Carbon-14 (C-14) as $^{14}\text{CO}_2$
- Mixed beta-gamma emitting radionuclides (particulate), and
- Mixed alpha emitting radionuclides (gross alpha).

The liquid effluent release groups that were used for DN are:

- HTO as water,
- Mixed beta-gamma emitting radionuclides (gross beta-gamma),
- C-14 as dissolved carbonate/bicarbonate, and
- Mixed alpha emitting radionuclides (gross alpha).

The limiting radionuclides (i.e., the radionuclide with the most restrictive DRL) for particulates in air and for gross beta-gamma in water were used to represent all radionuclides in each grouping. For particulates in air, Carbon-60 was identified as the limiting radionuclide and for gross beta-gamma in water, Cesium-134 was identified as the limiting radionuclide.

Waste management operations at DN are undertaken in three locations within the DN site, including in two Fueling Facilities Auxiliary Areas (FFAAs; East and West) and the NSS-DWMF. Radiological emissions and effluent releases from the NSS-DWMF were reviewed in the 2020 ERA (Ecometrix, 2022), and the data indicated that the contribution of the NSS-DWMF to dose identified human receptors was negligible. The emissions data available from 2020 to 2022 for the NSS-DWMF and Retube Waste Storage Building (RWSB) perimeter (as reported quarterly in OPG 2020a, 2020b, 2020c, 2021e, 2021f, 2021g, 2021h, 2022e, 2022f, 2022g, 2022h) were reviewed. The average NSS-DWMF fence perimeter air kerma rate from 2016 to 2019 was 0.08 $\mu\text{Gy/h}$, and the average from 2020 to 2022 was 0.086 $\mu\text{Gy/h}$. In 2017, OPG started to transfer retube waste containers loaded with Darlington Storage Overpack from the DNGS to the RWSB as part of the Darlington Refurbishment Project. The perimeter dose rate at the RWSB was monitored from 2017 to 2019, with an average air kerma rate at 0.06 $\mu\text{Gy/h}$. The average RWSB perimeter air kerma rate was 0.067 $\mu\text{Gy/h}$ for the period 2020 to 2022. All dose rates are below the dose target rate of 0.5 $\mu\text{Gy/h}$ at the NSS-DWMF perimeter fence line.

The emissions data available from 2020 to 2022 for the NSS-DWMF and RWSB perimeter were not markedly different from those assessed in the 2020 ERA; therefore, the conclusion that the doses were negligible in the previous ERA continues to be valid. As such, the dose contribution from the NSS-DWMF was not discussed further in the 2020 ERA and is not retained for evaluation in this Addendum.

3.1.2.7 Selection of Other Stressors

Noise is the only physical stressor mentioned in N288.6:22 as a potential human stressor and is the only physical stressor associated with DN that is of potential concern to humans.

3.1.2.7.1 Noise

The noise environment in the vicinity of DN site is typical of an urban setting and is influenced by several noise sources including DN Generating Station, traffic on Highway 401 and local roads, the Canadian National (CN) rail line, and local industry (e.g., SMC plant and DYEC).

The noise monitoring locations for humans, also known as Point(s) of Reception, located in the vicinity of OPG DN are in an area best described as Class 1 as per MECP publication *"Environmental Noise Guideline, Stationary and Transportation Sources – Approval and Planning"* (NPC 300) (MECP, 2013). This designation is based on the presence of Highway 401 and its consistent contribution to background sound levels in the area. The energy equivalent sound levels for stationary sources in Class 1 areas (L_{eq}) are summarized in **Table 3-1** and used to assess compliance of a facility in accordance with NPC 300.

Table 3-1: Sound Level Limits for Class 1 Areas (MECP, 2013)

Time Period	Class 1 MECP Energy Equivalent Sound Level Limit in A-Weighted Decibels (dBA)
Daytime (07:00 – 19:00)	50
Evening (19:00 – 23:00)	47
Night-time (23:00 – 07:00)	45

2022 acoustic assessment results in support of DNNP are provided in the following two reports:

- Darlington New Nuclear Project (DNNP) Baseline Noise Monitoring – Spring 2022 (OPG, 2022e); and,
- Darlington New Nuclear Project (DNNP) Baseline Noise Monitoring – Fall Report 2022 (OPG, 2023e).

Following an assessment of the 2018/2019 noise monitoring program, the 2020 ERA concluded (see Section 3.1.2.10.1, Ecometrix 2022a) that noise emissions from the DN site are indistinguishable from other, more dominant sources of noise (e.g., Highway 401, other local traffic, and industry). As a result, noise was not considered a physical stressor in the previous human health risk assessment (Ecometrix, 2022a). Noise measurements from the 2018/2019 study (as presented in the 2020 ERA) are again presented here as a comparison to updated noise measurements from the more recent Spring and Fall 2022 studies.

During Spring of 2022, noise monitoring was conducted to update existing noise level measurements at the locations of selected receptors that are closest to the DNNP footprint. The equivalent noise level, including LAeq¹ and LAs90², were monitored per the methodology described from the methodology report (OPG, 2021d). The Spring 2022 monitoring was conducted continuously for a week between April 27, 2022, to May 4, 2022.

Acoustic monitoring continued in Fall 2022 following the same methodology as the Spring 2022 program. Points of Reception (POR) for the Fall 2022 program remained consistent with Spring 2022. Noise monitoring in the Fall occurred at the end of November 2022.

The noise receptors were selected to be representative of sensitive PORs in all directions around the DNNP site (**Figure 3-4**). Between the 2018/2019 and the 2022 monitoring events, one additional POR (POR4, also referred to as R20) was added to the monitoring program; this receptor was previously included in noise modelling assessments from the 2009 DNNP EIS (SENES & MMM, 2009). In total, four PORs were identified as sensitive receptors nearest to the DNNP site and were considered in the Noise Monitoring Program (OPG, 2022e) to be representative of sound levels to the west, northwest, north, and east of the DNNP site.

Acoustic monitoring data from Spring and Fall 2022 and a comparison with results from the 2018/2019 acoustic monitoring program are presented in **Table 3-2**. Results of the Spring and Fall 2022 monitoring determined that DNGS is not audible above other noise sources at the receptor locations. Noise impacts at all four PORs in close proximity to the DNNP are mainly

¹ LAeq: A-weighted equivalent continuous sound level, in A-weighted decibels (dBA)

² LAs90: the 90th-percentile of the statistical noise level distribution, or the noise level that is exceeded for 90% of the measurement time

attributed to traffic from Highway 401. Partial influence was also noted from local traffic volume and operation of the DNGS, St. Mary’s Cement and the Durham York Energy Centre. These findings are consistent with those determined in the 2018/2019 monitoring program.

Table 3-2: Fall and Spring 2022 and 2018/2019 Acoustic Monitoring Results

Location	Minimum Sound Measurement			Maximum Sound Measurement		
	2018/2019 (Leq)	Spring 2022 (LAeq)	Fall 2022 (LAeq)	2018/2019 (Leq)	Spring 2022 (LAeq)	Fall 2022 (LAeq)
POR1 (R15)	46.6	42.3	44.3	62.2	67.1	62.2
POR2 (R19)	51.6	59.9	55.2	69.9	75.8	71.1
POR3 (R23)	46.2	48.7	55.1	62.3	69.4	70.2
POR4 (R20)	57.8 ¹	56.3	58.2	70.4 ¹	72.3	76.4

Notes:

¹ Not measured in 2018/2019; values presented are referenced from Appendix E of the 2009 Atmospheric Environment Existing Environmental Conditions Technical Support Document New Nuclear – Darlington Environmental Assessment (SENES, 2009a)

Leq: the equivalent continuous sound level (in decibels, dB)

LAeq: the A-weighted equivalent continuous sound level (in A-weighted decibels, dBA)

POR: Point of Reception

R: Receptor

Given that noise from the DN site was not distinguishable at offsite receptor monitoring locations in both the 2018/2019 and Spring/Fall 2022 acoustic assessments and given the large contribution of noise at these receptors from roads (particularly Highway 401) and other local industry, noise was not carried forward as a physical stressor for further assessment in the HHRA.

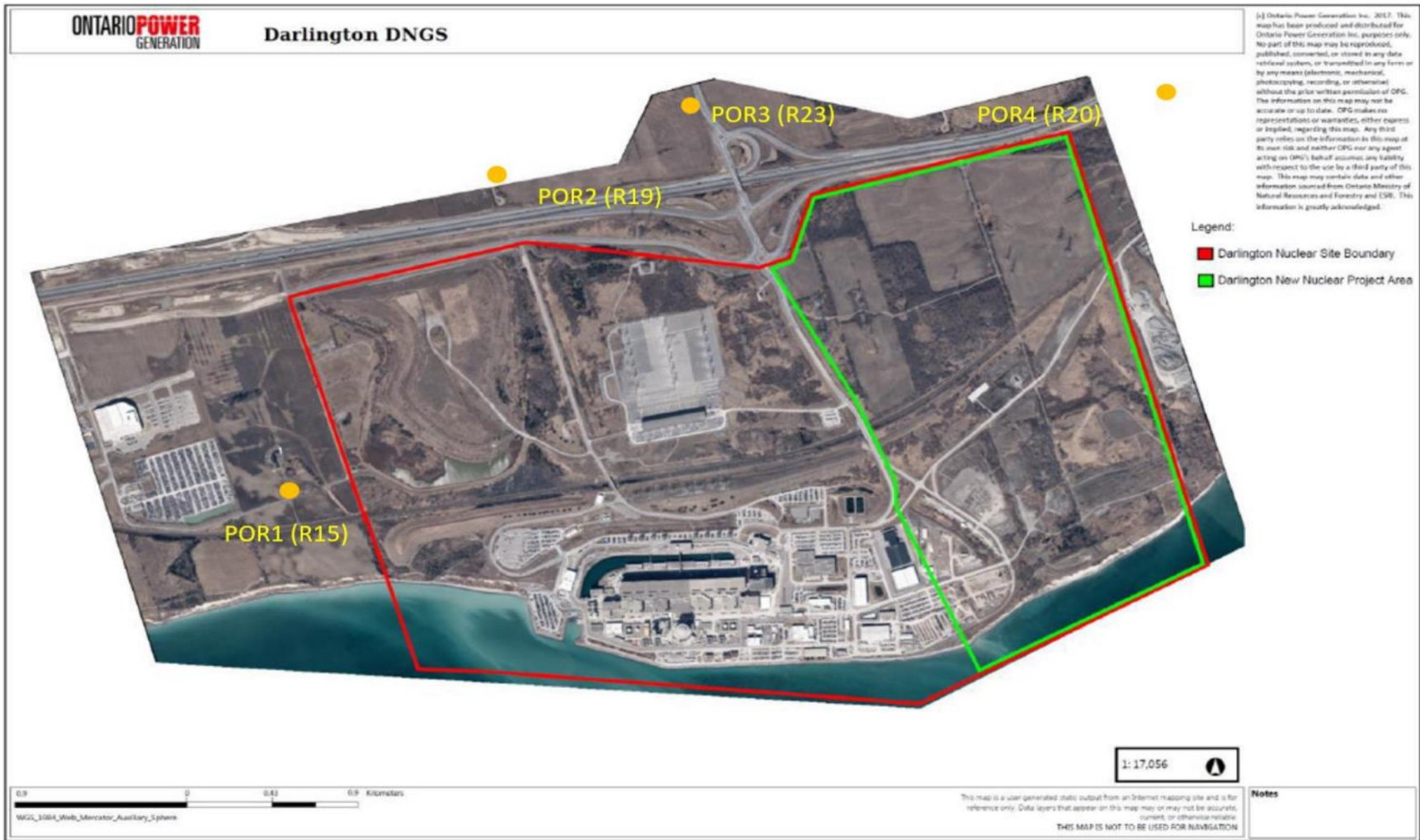


Figure 3-4: Location of Points of Reception (POR1-4)

3.1.2.8 Summary of COPC Selection

For this addendum, human health risks are only calculated if, compared to the 2020 ERA, there is a new COPC or there is a COPC with a higher maximum concentration based on the 2020 – 2022 data. The only chemical COPC retained for evaluation of human health risks is hydrazine in surface water. Radionuclides were evaluated based on the total public dose to the critical receptor. **Table 3-3** summarizes the COPCs that were carried forward to the exposure assessment in this Addendum.

Table 3-3: Summary of COPCs Selected for the HHRA

Category	Radiological COPC	Chemical COPC
Air	C-14, Co-60, HT, HTO, noble gases, Imfp	None
Surface water	C-14, Cs-134, HTO	Hydrazine
Soil	C-14, Co-60, Cs-134, HTO, I-131	None
Groundwater	HTO, I-131	None
Sediment (beach sand)	C-14, Cs-134, HTO	None
Physical Stressors	None	

3.1.3 Selection of Exposure Pathways

Based on the chemical COPC retained for quantitative evaluation in the HHRA (hydrazine in surface water), the relevant exposure pathways evaluated are ingestion of water and ingestion of fish. Dermal (skin) contact with water was not retained as a pathway given exposure via this pathway is low relative to ingestion. The relevant receptors are those that may utilize water from the Bowmanville or Oshawa Water Supply Plants (WSPs), specifically the Oshawa/Courtice Urban Resident, Bowmanville Urban Resident, West/Each Beach Urban Resident, Rural Resident, Industrial/Commercial Worker, and the Camper. Also relevant are those that may consume fish from Lake Ontario, including the Farm, Dairy Farm, Rural Resident, Sport Fisher, and Camper receptors.

Exposure pathways for radionuclides are unchanged from the 2020 ERA (Ecometrix, 2022a).

3.1.4 Human Health Conceptual Model

The conceptual model illustrates how receptors are exposed to COPCs. It represents the relationship between the source and receptors by identifying the source of contaminants, receptor locations and the exposure pathways to be considered in the assessment for each receptor. Exposure pathways represent the various routes by which radionuclides and/or chemicals may enter the body of the receptor, or (for radionuclides) how they may exert effects from outside the body.

The complete conceptual model for DN is provided in the 2020 ERA (Ecometrix, 2022a), which includes radionuclide and chemical COPCs. For this Addendum, the only chemical COPC

identified was hydrazine from the CCW effluent. As such, human health risks from this are evaluated for water ingestion and fish ingestion, which are the relevant surface water exposure pathways for CCW effluent. The human health risks assessed for radionuclides include all relevant pathways consistent with the 2020 ERA conceptual model and are evaluated based on the total dose to the critical receptor.

3.1.5 Uncertainties in the Problem Formulation

The uncertainties in the Problem Formulation remain as identified in the 2020 ERA (Ecometrix, 2022a). No new uncertainties were identified based on the new data and guidelines that were evaluated.

3.2 Exposure Assessment

The exposure assessment describes the exposure scenarios (locations, receptors), the methods used in estimating exposure concentrations and doses at the receptor locations, and the results of the exposure and dose calculations for each human receptor.

3.2.1 Exposure Locations

An exposure location is the place where the receptor comes into contact with a COPC. For both the radiological and chemical exposure assessments, the relevant human receptors are the potential critical groups defined by the EMP, as discussed in **Section 3.1**. A map of the receptor locations is provided in the 2020 ERA (Ecometrix, 2022a) and the EMP (OPG, 2023d) reports.

3.2.2 Exposure Duration and Frequency

The assumptions made for exposure duration and frequency are presented in **Section 0**.

3.2.3 Exposure and Dose Calculations

3.2.3.1 Radiological Dose Calculations

Radiological dose calculations follow the equations presented in N288.1:20 (CSA, 2020), which are not reproduced in this report.

3.2.3.2 Chemical Dose Calculations

The ingestion doses from exposure to hydrazine in drinking water and fish were calculated according to the equations presented in N288.6:22 (CSA, 2022).

3.2.4 Exposure Factors

3.2.4.1 Radiological Exposure Factors

For the radiological dose calculations, the exposure factors (e.g., intake rates, occupancy, and shielding factors, etc.) are generally those used in CSA N288.1:20. The intake rates for ingestion and inhalation are generally the central or mean intake rates provided in CSA N288.1:20 and the COG Derived Release Limits Guidance (COG, 2013b). The radiological exposure factors are provided in the 2020 ERA and not reproduced herein.

3.2.4.2 Non-Radiological Exposure Factors

Based on the results of the screening, the human exposure assessment was performed for the drinking water and fish ingestion pathways for hydrazine.

For non-radiological dose calculations, exposure factors are generally those from HC Preliminary Quantitative Risk Assessment (PQRA) guidance (HC, 2021b), as recommended by Clause 6.3.5 of CSA N288.6:22. **Table 3-4** summarizes the exposure factors used in the non-radiological dose calculations.

For surface water, each receptor was assumed to obtain a portion of their drinking water and/or fish from near the DN site. The assumed fractions of the total drinking water obtained from local WSPs and total fish obtained near DN site were based on the results of the site-specific survey (OPG, 2018). These fractions are tabulated in **Table 3-5**.

3.2.5 Dispersion Models

OPG uses IMPACT™ version 5.5.2 (IMPACT) to calculate its annual public radiological doses using a mixture of environmental monitoring data and emissions data. IMPACT represents the method of dose calculation presented in CSA N288.1:20. Where environmental monitoring data were lacking, the concentration of radionuclides in air was determined from the sector-averaged Gaussian plume atmospheric dispersion model in IMPACT, based on the release rates from DN. The 2020 ERA (Ecometrix, 2022a) shows a summary of which radionuclides and pathways were modelled and where measured data were used.

Table 3-4: Human Exposure Factors for Non-Radiological Dose Calculations

Parameter	Units	Urban Resident		Farm		Rural Resident		Industrial/ Commercial Worker	Sport Fisher		Camper		Reference
		Toddler	Adult	Toddler	Adult	Toddler	Adult	Adult	Toddler	Adult	Toddler	Adult	
Drinking Water Intake Rate	L/d	0.6	1.5	0.6	1.5	0.6	1.5	1.5	N/A	N/A	0.6	1.5	(HC, 2010)
Fish Ingestion Rate	kg/d	0.056	0.111	0.056	0.111	0.056	0.111	N/A	0.056	0.111	0.056	0.111	(HC, 2004)
Days per Week Exposed /7 days per week (D2)	d/ d	1	1	1	1	1	1	1	N/A	N/A	1	1	(OPG, 2021i)
Weeks per Year Exposed /52 weeks per year (D3)	wk/wk	1	1	1	1	1	1	0.23	N/A	N/A	0.5	0.5	(OPG, 2021i)
Years Exposed (D4)	years	N/A	30	N/A	30	N/A	30	30	N/A	30	N/A	30	(HC, 2004)
Days per year with consumption of fish	d/a	365	365	365	365	365	365	N/A	365	365	365	365	(OPG, 2021i)
Body Weight	kg	16.5	70.7	16.5	70.7	16.5	70.7	70.7	16.5	70.7	16.5	70.7	(HC, 2010)
Life Expectancy	years	N/A	70	N/A	70	N/A	70	70	N/A	70	N/A	70	(HC, 2010)
RAF _{GIT} Hydrazine	unitless	1	1	1	1	1	1	1	1	1	1	1	conservative assumption

RAF_{GIT} = Relative absorption factor for the gastrointestinal tract for hydrazine.

Table 3-5: Assumed Fractions of Drinking Water from WSPs and Fish from DN Outfall (OPG, 2021i)

Media	Urban Resident Oshawa/Courtice	Urban Resident Bowmanville	Urban Resident West/East Beach	Farm	Dairy Farm	Rural Resident	Industrial/ Commercial Worker	Sport Fisher	Camper
Water	0.834	0.785	0.142	0.05	0	0.158	1	0	1
Fish	0.1136	0.0061	0.1183	0.0518	0.0103	0.035	0	1	0.5

3.2.6 Exposure Point Concentrations and Doses

3.2.6.1 Exposure Point Concentrations and Doses for Radiological COPCs

For the radiological exposure assessment, exposure point concentrations are either based on measured data from the annual EMP or modelled from emissions data, as described in the 2020 EMP Report (OPG, 2021c). Additionally, when measurement averages or other calculations are performed, they are calculated using actual results obtained even if they are below the critical level (OPG, 2021c). As mentioned above, OPG uses IMPACT™ version 5.5.2 (IMPACT) to calculate its annual public doses using a mixture of environmental monitoring data and emissions data.

Table 3-6 presents a summary of the annual doses to the three most exposed critical groups from 2020 to 2022. These doses were calculated using annual average measured and modelled concentrations in environmental media. It is noted that these doses incorporate any emissions from the Molybdenum-99 (Mo-99)/TDS, which has been operational since 2023.

The annual average dose to the three most exposed critical groups during the three-year period of interest (2020 to 2022) ranged from 0.1 to 0.6 µSv. From 2020 to 2022, the most exposed critical groups were the dairy farm, farm, and rural residents. The dominant pathways and radionuclides that contribute significantly to the total dose are inhalation and ingestion of HTO in air and in water, plants, and animal products; external exposure to noble gases; and ingestion of C-14 in plants and animal products.

The dose to the most exposed critical groups over the 2020 to 2022 time period remained relatively consistent, and the doses have remained largely unchanged for the past ten years (OPG, 2023d).

Table 3-6: Summary of Doses to Most Exposed Critical Groups from 2020 to 2022

Year	Age Class	Radiological Dose (µSv/a)		
		Dairy Farm	Farm	Rural Resident
2020	Adult	0.2	0.4	0.3
	Child	0.2	0.4	0.2
	Infant	0.2	0.3	0.1
2021	Adult	0.2	0.6	0.3
	Child	0.1	0.6	0.3
	Infant	0.1	0.4	0.2
2022	Adult	0.2	0.6	0.3
	Child	0.3	0.5	0.2
	Infant	0.4	0.4	0.2

Sources: (OPG, 2021c, 2023f, 2023d)

3.2.6.2 Exposure Point Concentrations and Doses for Chemical COPCs

The exposure point concentrations are based on the screening conducted during problem formulation. For hydrazine, data were screened based on CCW data from the ECA from 2020 to

2022 (hydrazine). The overall maximum and mean concentration from the ECA were used for the exposure assessment. The dose to receptors due to ingestion of fish exposed to hydrazine assumes a continuous release.

3.2.6.2.1 Exposure Point Concentrations in and Doses from Surface Water

Maximum and mean measured concentrations in CCW effluent were diluted using the estimated dilution factors from OPG (2022c) in order to estimate exposure point concentrations for hydrazine, as follows:

- A dilution factor of 7 was applied to measured CCW effluent to estimate a concentration in Lake Ontario at the Outfall;
- A dilution factor of 34.7 was applied to the CCW effluent to estimate a concentration at the Bowmanville WSP; and,
- A dilution factor of 35.6 was applied to the CCW effluent to estimate a concentration at the Oshawa WSP.

The WSP dilution factors were calculated using the CSA N288.1:20 aquatic dispersion model (CSA, 2020), which is an approved method of estimating dilution factors. Additional model parameter values used in the calculations are provided in the 2020 ERA.

At a pH of 8 (representative of the typical pH observed in Lake Ontario near DN), the chemical half-life of hydrazine ranges from 0.6 to 1.31 days (EC and HC, 2011). Considering dilution along the flowpath from DN to the WSPs, and using the longer half-life for hydrazine, calculations of exposure point concentrations are carried out accounting for dilution and decay, starting from CCW concentrations of hydrazine at the discharge point (**Table 3-7**). Considering the dilution along the flowpath in Lake Ontario, the hydrazine concentration estimated at the WSPs would range from 0.003 to 0.013 µg/L at the Bowmanville and Oshawa WSPs (**Table 3-8**). The hydrazine concentration at the Oshawa WSP is slightly greater than the hydrazine drinking water benchmark of 0.01 µg/L (US EPA, 2023b).

The conditions within the Bowmanville and Oshawa WSPs during water treatment favour the degradation of hydrazine. The water treatment process involves chlorinating the process water at several distinct points through the addition of sodium hypochlorite, which is an alkaline substance expected to raise the pH at those steps. pH is then adjusted through the addition of sulfuric acid (Durham Region, 2022a, 2022b). Hydrazine degradation is highly influenced by pH; alkaline conditions favour its degradation (Choudhary and Hansen, 1998). Additionally, degradation of hydrazine occurs through oxidation in the presence of oxygen; the reaction tends to be catalyzed (i.e., sped up) in the presence of certain compounds like Copper (II) and phosphate ions, which are likely to be present in some amount in drinking water. Hydrazine degradation is also favoured in the presence of organic matter, which also is likely to be present in drinking water. Hydrazine was found to decrease by more than 90% when added to chlorinated, filtered county water after 1 day (Choudhary and Hansen, 1998). As such, it was considered reasonable to assume that 90% of the starting concentration of hydrazine at the

Bowmanville and Oshawa WSP intakes would be degraded upon use by off-site members of the public.

The maximum and mean exposure point concentrations for hydrazine are presented in **Table 3-8** using CCW data. The mean exposure point concentrations are more representative of concentrations at WSPs than the maximum concentrations because mean concentrations reflect expected exposure over the long-term. Based on these exposure point concentrations, and using the equations presented in **Section 3.2.3.2** and the receptor characteristics presented in **Section 3.2.4.2**, surface water doses were estimated for each receptor. These doses are presented in **Table 3-9** for hydrazine.

Table 3-7: Summary of Exposure Point Concentrations of Hydrazine in Surface Water

COPC	Lake Water (mg/L)		Effluent (ECA) (mg/L)		Dilution Factors ^b			
	Maximum Concentration	UCLM Concentration	Maximum Concentration	Mean ^a Concentration	Outfall	Beach	Bowmanville WSP	Oshawa WSP
Hydrazine (CCW)	-	-	0.0076	0.0019	7	10.9	34.7	35.6

Notes:

^a Hydrazine concentrations from the CCW are based on mean concentrations, since raw data to calculate UCLM concentrations were not available.

^b Dilution factors are described in Section 3.2.6.2.1.

Table 3-8: Maximum and Mean Exposure Point Concentrations for Hydrazine in Surface Water

COPC	Estimated Point of Exposure Concentrations (mg/L)							
	Outfall		Beach		Bowmanville WSP		Oshawa WSP	
	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean
Hydrazine (CCW) decayed $t_{1/2} = 1.3$ days	1.09E-03	2.70E-04	6.17E-04	1.53E-04	1.32E-05	3.29E-06	1.21E-05	3.01E-06

Table 3-9: Summary of Estimated Doses Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Surface Water

Receptor Group		Dose (mg/kg/d)	
		Hydrazine (CCW) decayed $t_{1/2} = 1.3$ days	
		Max	Mean
Urban Resident Oshawa/Courtice	Toddler	-	-
	Adult	9.19E-08	2.29E-08
Urban Resident Bowmanville	Toddler	-	-
	Adult	9.44E-08	2.35E-08
Urban Resident West/East Beach	Toddler	-	-
	Adult	1.71E-08	4.25E-09
Farm	Toddler	-	-
	Adult	6.01E-09	1.50E-09
Rural Resident	Toddler	-	-
	Adult	1.90E-08	4.73E-09
Industrial / Commercial Worker	Adult	2.77E-08	6.88E-09
Camper	Toddler	-	-
	Adult	5.51E-08	1.37E-08

3.2.6.2.2 Exposure Point Concentrations in and Doses from Fish

Hydrazine is released into the atmosphere through boiler steam releases and venting; given that hydrazine tends to degrade rapidly in the atmospheric environment, atmospheric releases are typically negligible as a contribution to aquatic exposures (EC, 2013). Hydrazine is also discharged into the aquatic environment through BB and flushing to the intake forebay. Furthermore, hydrazine is added to the feedwater for oxygen removal. For this assessment, it was conservatively assumed that hydrazine is released to the aquatic environment on an on-going basis.

The Camper, Sport Fisher, and West-East Beach resident are assumed to ingest local fish, based on site specific surveys that have been carried out (OPG, 2022c). Since several human receptors are potentially exposed to chemical COPCs through fish ingestion, the fish tissue concentrations for hydrazine were estimated using a bioconcentration factor (BCF), which has been updated based upon a detailed review of the available literature on quantitative structure-activity relationship (QSAR). The European Commission (European Commission, 2003) provides guidance on estimating uptake from water to fish for a range of log K_{ow} values; for log $K_{ow} = 1$, a log BCF of 0.15 L/kg (or BCF = 1.4 L/kg) is recommended based upon Veith et al. (Veith et al., 1979). As this value is well-supported and recommended by a leading authority on risk assessment guidance, it was selected for use in the DN ERA Addendum. It is noted that this selected value is lower than the value previously used of 3.2 L/kg (Meylan et al., 1999) by approximately 50% (thus reducing the estimated exposure doses). The use of the lower BCF is also considered to be more representative of the expected uptake and retention into tissues considering that hydrazine is released intermittently rather than steadily; therefore, there is opportunity for tissue clearance in fish in between scheduled releases of hydrazine from the outfall. A summary of exposure point concentrations of hydrazine in fish is presented in **Table 3-10**.

The resulting estimated exposure point concentrations for fish are presented in **Table 3-11**. Based on these exposure point concentrations, and using the equations presented in **Section 3.2.3.2** and the receptor characteristics presented in **Section 3.2.4.2**, fish ingestion doses were estimated for each receptor. These doses are presented in **Table 3-12**. Dose calculations are provided based on maximum and mean concentrations of hydrazine measured in the CCW.

Table 3-10: Summary of Exposure Point Concentrations of Hydrazine in Fish

COPC	Estimated Water Concentrations		Bioconcentration Factor (BCF) (L/kg)	Estimated Fish Concentrations	
	Estimated at Outfall (mg/L)			Estimated at Outfall (mg/kg)	
	Maximum Concentration	Mean Concentration		Maximum Concentration	Mean Concentration
Hydrazine (CCW) decayed $t_{1/2}$ = 1.3 days	1.09E-03	2.70E-04	1.4	1.5E-03	3.8E-04

Table 3-11: Maximum and UCLM Concentration of Hydrazine in Fish

COPC	Estimated Water Concentrations		Bioconcentration Factor (BCF) (L/kg)	Estimated Fish Concentrations	
	Estimated at Beach (mg/L)			Estimated at Beach (mg/kg)	
	Maximum Concentration	UCLM ^a Concentration		Maximum Concentration	UCLM ^a Concentration
Hydrazine (CCW) decayed $t_{1/2}$ = 1.3 days	6.17E-04	1.53E-04	1.4	8.71E-04	2.17E-04

Notes:

^a Hydrazine concentrations from the CCW are based on mean water concentrations, since raw data to calculate UCLM concentrations were not available.

Table 3-12: Summary of Estimated Doses Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Fish

Receptor Group		Dose (mg/kg/d)	
		Hydrazine (CCW) decayed $t_{1/2} = 1.3$ days	
		Max	Mean
Urban Resident West/East Beach	Toddler	-	-
	Adult	1.22E-07	3.04E-08
Sport Fisher	Toddler	-	-
	Adult	1.03E-06	2.57E-07
Camper	Toddler	-	-
	Adult	2.93E-07	7.29E-08

3.2.7 Uncertainties in the Exposure Assessment

The uncertainties in the exposure assessment remain unchanged from the 2020 ERA (Ecometrix, 2022a). There continues to be uncertainty with the approach to select and derive a water-to-fish BCF for hydrazine given that the BCF is based upon QSAR equations rather than chemical-specific uptake data. No new sources of uncertainty were introduced with the data from 2020 to 2022 that was used in the exposure assessment (**Appendix A**).

3.3 Toxicity Assessment

3.3.1 Toxicological Reference Values (TRVs)

A toxicity reference value (TRV) is a toxicological index, associating specific health effects with a level of exposure to a chemical. TRVs may include slope factors and unit risks for carcinogens, and reference doses (RfD), tolerable daily intakes (TDI), or acceptable daily intakes for non-carcinogens. TRVs are used in the risk characterization to determine Incremental Lifetime Cancer Risks (ILCRs) and Hazard Quotients (HQs), as discussed in **Section 3.4.1.2**.

Hydrazine is classified by the International Agency for Research on Cancer (IARC) as a Group 1A carcinogen and the US EPA as a Group B2 carcinogen (probable human carcinogen), and by the European Commission as Category 2 for carcinogenicity (should be regarded as if it is carcinogenic to man). Studies showed tumor induction in mice, rats and hamsters following administration of hydrazine via inhalation (1.3 and/or 6.5 mg/m³) and in mice treated orally (1.87 mg/kg bw/day (EC and HC, 2011) The US EPA (1991) has derived an oral slope factor of 3.0 (mg/kg-day)⁻¹ for human ingestion of hydrazine based on a 1970 study by Biancifiori on liver cancer in mice exposed to hydrazine sulphate orally.

3.3.2 Radiation Dose Limits and Targets

The public dose limit for radiation protection is 1 mSv/a, as described in the Radiation Protection Regulations under the *Nuclear Safety and Control Act*. This limit is defined as an incremental dose to background. It is set at a fraction of natural background exposure to radiation. Public doses arising from licensed facilities are compared to the public dose limit and higher doses are considered unacceptable.

3.3.3 Uncertainties in the Toxicity Assessment

The uncertainties in the toxicity assessment remain unchanged from the 2020 ERA (Ecometrix, 2022a). The same TRV for hydrazine was adopted, and the same public dose limit was used.

3.4 Risk Characterization

3.4.1 Risk Estimation

3.4.1.1 Risk Estimation for Radiological COPCs

For radionuclides, the total doses presented in **Table 3-6** are compared to the public dose limit of 1 mSv/a, as discussed in **Section 3.3.2** above.

3.4.1.2 Risk Estimation for Chemical COPCs

To characterize potential risks due to chemical COPCs quantitatively, the results of the exposure and toxicity assessments were used to estimate ILCRs for each receptor. For carcinogenic substances such as hydrazine, the estimated oral exposure was multiplied by a slope factor, to derive a conservative estimate of the potential ILCR, as follows:

$$\text{ILCR} = \text{Estimated Oral Exposure} \times \text{Cancer Slope Factor}$$

The estimated ILCRs were compared to a target cancer risk of 1 in 1,000,000 or 10^{-6} , as recommended by Clause 6.5.2.4 in CSA N288.6:22. This level is consistent with the acceptable risk level used by the Ontario MECP (MECP, 2011) and the US EPA (2005). At this risk level, health impacts are considered to be negligible. Other agencies, such as HC use a target cancer risk of 1 in 100,000 or 10^{-5} . However, a range of cancer risk levels between 1 in 10,000 and 1 in 1,000,000 may be considered acceptable (HC, 2021a).

Summaries of the ILCRs for surface water ingestion are presented in **Table 3-13**, and those for fish ingestion are presented in **Table 3-14**.

Table 3-13: Summary of Estimated Risk Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Surface Water

Receptor Group		Incremental Lifetime Cancer Risks (ILCR) (unitless)	
		Hydrazine (CCW) decayed $t_{1/2} = 1.3$ days	
		Max	Mean
Urban Resident Oshawa/Courtice	Toddler	-	-
	Adult	3E-07	7E-08
Urban Resident Bowmanville	Toddler	-	-
	Adult	3E-07	7E-08
Urban Resident West/East Beach	Toddler	-	-
	Adult	5E-08	1E-08
Farm	Toddler	-	-
	Adult	2E-08	4E-09
Rural Resident	Toddler	-	-
	Adult	6E-08	1E-08
Industrial / Commercial Worker	Adult	8E-08	2E-08
Camper	Toddler	-	-
	Adult	2E-07	4E-08

Table 3-14: Summary of Estimated Risk Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Fish

Receptor Group		Incremental Lifetime Cancer Risks (ILCR)	
		Hydrazine (CCW) decayed $t_{1/2} = 1.3$ days	
		Max	Mean
Urban Resident West/East Beach	Toddler	-	-
	Adult	4E-07	9E-08
Sport Fisher	Toddler	-	-
	Adult	3E-06	8E-07
Camper	Toddler	-	-
	Adult	9E-07	2E-07

Notes:

Grey shading and bold font indicates when the risk exceeds the associated target value. Cancer Risk > 1E-06.

3.4.2 Discussion of Chemical and Radiation Effects

Discussion regarding health indicators in the Durham Region was provided in the 2020 ERA (Ecometrix, 2022a). One additional study since the 2020 ERA is discussed herein. Population health assessments have been conducted by the Durham Region (DRHD, 2023), who focused on analysis by Health Neighbourhood and presented a broad range of health data. DNGS falls within the Darlington (C6) Clarington Health Neighbourhood. The C6 Health Neighbourhood follows the boundaries of the old county of Darlington, excluding the town areas of Courtice and Bowmanville. It extends from Lake Ontario in the south to the Scugog border in the north. The west side is along the City of Oshawa and the eastern boundary is Regional Road 42 (Darlington-Clarke Townline Road). **Figure 3-5** below shows the boundary of the C6 Health Neighbourhood (outlined in blue) and the approximate location of the DN site relative to the rest of the Durham Region. For the year 2016, compared to the Durham Region, residents in this Health Neighbourhood have similar or lower rates for health indicators such as asthma, diabetes, lung disease, and cardiovascular disease. The population residing in Health Neighbourhood C6 are generally found to be doing similar or better in terms of health compared to the rest of Durham Region (DRHD, 2023).

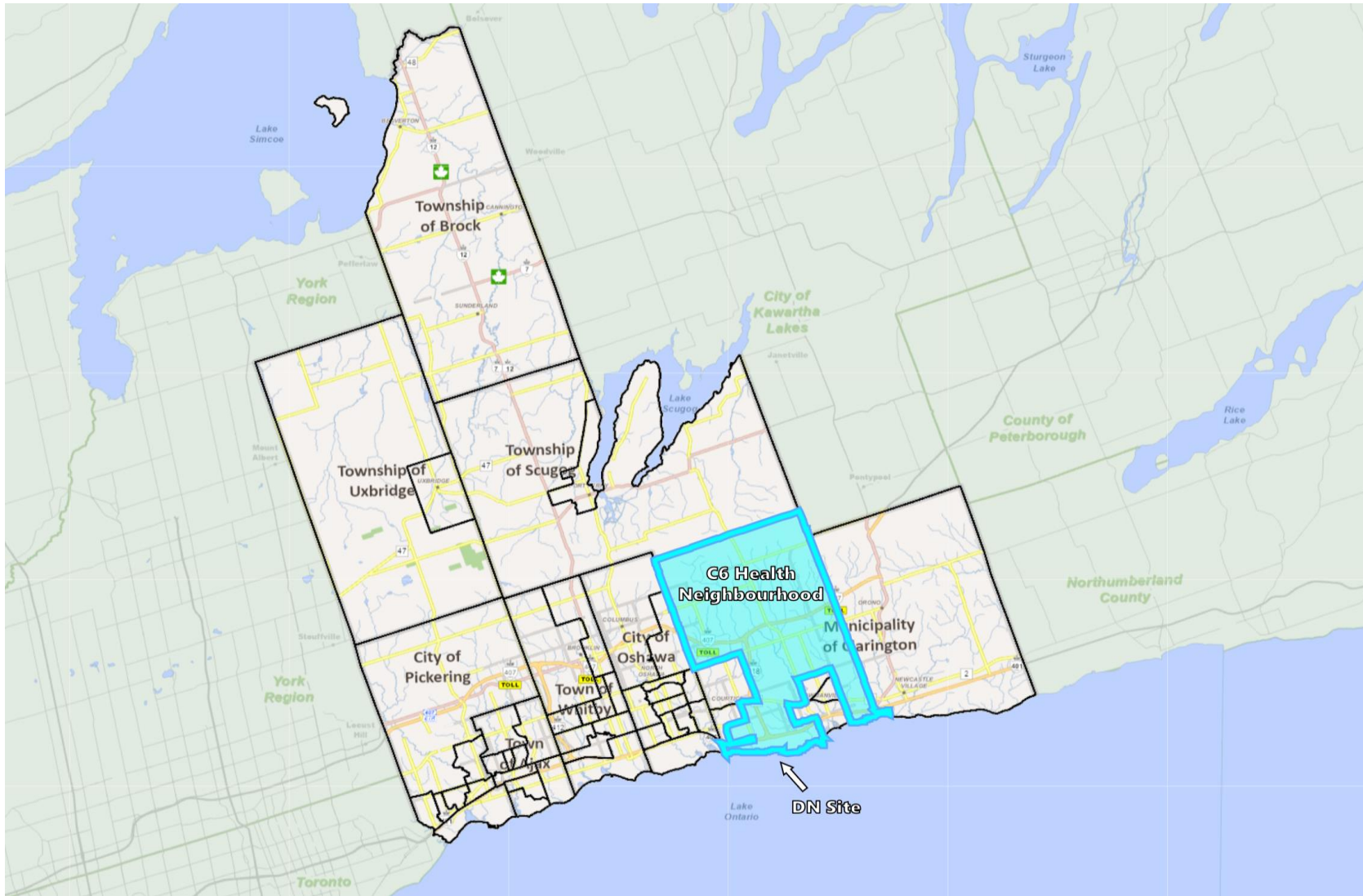


Figure 3-5: Health Neighbourhoods in Durham Region (DRHD, 2023)

3.4.2.1 Likelihood of Effects

3.4.2.1.1 Likelihood of Effects from Radiological COPCs

The 2020-2022 public dose estimates for the critical groups are at most approximately 0.06% of the regulatory public dose limit of 1 mSv/a, and at most approximately 0.04% of the dose from background radiation (1.4 mSv/a) in the vicinity of DN. In the 2020 ERA, dose estimates were 0.08% of the public dose limit and 0.06% of background. Since the critical group receives the highest dose from DN, demonstration that they are protected implies that other receptor groups near DN are also protected.

Facility releases are considered to be adequately controlled, and further optimization of DN operations is not required. Nevertheless, the ALARA (as low as reasonably achievable) principle is applied at DN to keep emissions as low as reasonably possible.

Since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential groups to radiological releases from DN.

3.4.2.1.2 Likelihood of Effects from Chemical COPCs

Surface Water – Ingestion

The estimated ILCRs for hydrazine for surface water ingestion based on mean and maximum hydrazine concentrations in the CCW were below the one in one million cancer risk level for all human receptors. Given that ILCRs for all of the receptors, based on mean and maximum hydrazine concentrations measured in the CCW, are below one in a million, adverse effects to humans due to hydrazine originating from DN through surface water ingestion are not expected. Risks are lower than in the 2020 ERA (Ecometrix, 2022a). Although the CCW concentrations were greater compared to the 2020 ERA, a 90% decay factor for hydrazine at the WSPs was applied in this assessment.

Surface Water – Fish Ingestion

The resulting estimated ILCRs did not exceed one in one million for any human receptor due to exposure to mean concentrations of hydrazine in fish.

While exposure to maximum concentrations of hydrazine in fish resulted in ILCRs greater than one in one million for the Sport Fisher, the maximum is not considered representative of long-term exposure, and results should be interpreted based on the mean. The Sport Fisher was conservatively assumed to eat all of the fish portion of their annual diet from Lake Ontario fish caught at DN. Realistically, a fisher would likely visit and harvest fish from various locations throughout the year including those unaffected by DN emissions. It is also likely that a portion of a fisher's annual diet could consist of fish that is purchased rather than locally caught. As such, adverse effects on humans due to hydrazine originating from DN through fish ingestion are not expected. Risks for fish ingestion are lower than those presented in the 2020 ERA

(Ecometrix, 2022a); while there was an increase in mean and maximum hydrazine concentrations in the CCW, an updated water-to-fish bioconcentration factor was adopted for the Addendum which resulted in a net reduction in exposure and risk.

As discussed in **Table 1-**, a recommendation from the 2020 ERA was to analyze Lake Ontario surface water samples for hydrazine with a lower detection limit (Ecometrix, 2022a). Given that the expected risks due to water and fish ingestion are negligible, no further recommendation on sampling is required. OPG will explore the availability of hydrazine analysis at a lower detection limit if future monitoring programs are identified.

3.4.3 Uncertainties in the Risk Characterization

Uncertainties in the characterization of risk remain as presented in the 2020 ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the data / information evaluated in this Addendum.

4.0 Ecological Risk Assessment (EcoRA)

The EcoRA is a process that evaluates the potential for adverse effects and risks to ecological receptors (plants, animals, etc.) that may be exposed to chemical and radiological contaminants.

Similar to the HHRA, the EcoRA consists of the following steps:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

4.1 Problem Formulation

The Problem Formulation defines the problem to be addressed in the EcoRA and the framework and general methodology by which the EcoRA will address the defined problem (FCSAP, 2012). During the problem formulation stage, decisions are made on which COPCs and receptors should be further evaluated in the EcoRA. For this Addendum, the focus is on any new contaminants or contaminants with higher maximum concentrations than in the 2020 ERA, for which ecological health risks will be evaluated.

The EcoRA focuses on the DN site and surrounding area, as shown in **Figure 4-1**. The assessment has been divided into polygons, generally consistent with past EcoRAs. The assessment also looks at nearshore Lake Ontario, generally in the area surrounding the outfall from the DN diffuser.



Figure 4-1: Area of Assessment for Ecological Risk Assessment

4.1.1 Receptor Selection and Characterization

The receptors remain unchanged from the 2020 ERA (Ecometrix, 2022a). The ecological receptors were selected based on the criteria for receptor selection identified in N288.6:22. Species were selected to represent each major plant and animal group, reflecting the main ecological exposure pathways, feeding habits, and habitats at or around the site. The criteria for selection began with the previous rationale outlined in the 2020 ERA and was supplemented with recently completed site studies (e.g., biodiversity reports) and recent regulatory information (e.g., Species at Risk status). Species that were ecologically similar to other species and could be represented by another species were not included in the assessment to reduce redundancy in the exposure calculations. Some receptors are considered as a general category or species, such as benthic invertebrates. This is common practice in EcoRAs to assess the benthic community as a single receptor rather than individual benthic invertebrate species since it is not feasible or practical to assess individual species. However, conservative toxicity benchmarks are used that are protective of the majority of species.

Table 4-1 shows the ecological receptors chosen for assessment and the assessment models used in estimating their COPC exposure, dose, and risk. These organisms are selected because they are known to exist on the site and are representative of major taxonomic groups or exposure pathways, or have a special importance or value. For the full list of species considered in the EcoRA and the rationale for the selection of Representative Species, please refer to Table 4-1 in the 2020 ERA (Ecometrix, 2022a). The 2020 ERA also includes the full list of species observed on-site and identifies which selected ecological receptor represents the observed species.

Small-bodied forage fish are not identified as a specific ecological receptor; however, all fish assessed in the EcoRA are assumed to spend 100% of their time in the vicinity of DN, near the diffuser. Therefore, the results for large-bodied fish would be applicable for small-bodied fish.

Table 4-1: Summary of Ecological Receptors and their Assessment Models used in the EcoRA

Receptor Category	Assessment Model	Major Plant or Animal Group	Representative Species
Fish	Bottom Feeding Fish	Benthopelagic forage fish	Northern Redbelly Dace
		Benthic forage fish	Round Whitefish
		Benthic forage fish	White Sucker
		Benthic predator fish	American Eel
	Pelagic Fish	Pelagic forage fish	Alewife
		Pelagic predator fish	Lake Trout
Reptiles and Amphibians	Bottom Feeding Fish	Reptile	Turtles
		Amphibian	Frogs
Aquatic Plants	Aquatic Plant	Aquatic Plants	Aquatic Plants

Receptor Category	Assessment Model	Major Plant or Animal Group	Representative Species
Aquatic Invertebrates	Benthic Invertebrate	Benthic Invertebrates	Benthic Invertebrates
Riparian Birds	Bufflehead	Diving bird - omnivore	Bufflehead
	Mallard	Dabbling bird – omnivore	Mallard
	Green Heron	Piscivore	Green Heron
Riparian Mammals	Muskrat	Herbivore	Muskrat
Terrestrial Invertebrates	Soil Invertebrate	Soil dwelling detrivore	Earthworm
Terrestrial Birds	American Robin	Ground feeding insectivore	American Robin
	Bank Swallow	Aerial insectivore	Bank Swallow
	Song Sparrow	Omnivore	Song Sparrow
	Yellow Warbler	Insectivore	Yellow Warbler
Terrestrial Plants	Terrestrial Plant	Grass	Grass
	Terrestrial Plant	Deciduous tree	Sugar Maple
Terrestrial Mammals	Eastern Cottontail	Mammalian herbivore	Eastern Cottontail
	Meadow Vole	Mammalian herbivore	Meadow Vole
	White-tailed Deer	Mammalian herbivore	White-tailed Deer
	Common Shrew	Mammalian insectivore	Common Shrew
	Raccoon	Mammalian omnivore	Raccoon
	Red Fox	Mammalian carnivore	Red Fox
	Short-tailed Weasel	Mammalian carnivore	Short-tailed Weasel

4.1.1.1 Consideration of Species at Risk

The list of identified Species at Risk from the 2020 ERA (Ecometrix, 2022a) was updated based on new data from 2020 to 2022 and is reported on in **Section 2.4.6.2**. A number of threatened and endangered species were identified within the DN Site Study Area during the 2020 to 2022 time period. If a species is listed as Endangered (i.e., a species that is facing imminent extirpation or extinction) or Threatened (i.e., a species that is likely to become an endangered species without protective action) by either COSEWIC, SARA, or Species at Risk in Ontario (SARO), this species is included in **Table 4-2**. There are both general and species-specific prohibitions outlined by SARA that apply to species designated as either Endangered or Threatened. However, as the general prohibitions under SARA do not apply to species of Special Concern, and CSA N288.6 identifies a population level risk assessment as appropriate for species of Special Concern, the status of “Special Concern” is not listed in **Table 4-2**.

Exposure models for specific assessment of these species are typically lacking due to gaps in the eco-toxicological literature. Species at Risk can be assessed by reference to representative species for the EcoRA (**Table 4-1**). The ecological receptors (or their representative species) are

selected with consideration for receptor characteristics (body weight, food ingestion rates, dietary habits) that are representative (i.e., expected to result in estimated doses that would be similar to other members of the group). Therefore, the estimated doses for the representative ecological receptor are expected to be similar to the doses for the individual species within that group. Detailed justifications for selections of each of the representative species, based on habitat, diet, and ecological niche considerations, are presented below.

Table 4-2: Representative Species for Identified Species at Risk (2020 – 2022)

Common Name (Scientific Name)	Category	Representative Species	Last Observed in Biodiversity Studies
Birds			
Bank Swallow (<i>Riparia riparia</i>)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (<i>Riparia riparia</i>)	2022
Barn Swallow (<i>Hirundo rustica</i>)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (<i>Riparia riparia</i>)	2022
Bobolink (<i>Dolichonyx oryzivorus</i>)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (<i>Turdus migratorius</i>)	2022
Canada Warbler (<i>Cardellina canadensis</i>)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (<i>Riparia riparia</i>)	2019
Chimney Swift (<i>Chaetura pelagica</i>)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (<i>Riparia riparia</i>)	2022
Eastern Meadowlark (<i>Strunella magna</i>)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (<i>Turdus migratorius</i>)	2022
Wood Thrush (<i>Hylocichla mustelina</i>)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (<i>Turdus migratorius</i>)	2022
Least Bittern (<i>Ixobrychus exilis</i>)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (<i>Turdus migratorius</i>)	2022
Mammals			
Little Brown Myotis (<i>Myotis lucifugus</i>)	Terrestrial Mammals	Common Shrew (<i>Sorex cinereus</i>)	2022
Terrestrial Invertebrates			
Monarch (<i>Danaus plexippus</i>)	Terrestrial Invertebrates	Earthworm (<i>Lumbricus</i>)	2022
Plants			
Butternut Tree (<i>Juglans cinerea</i>)	Terrestrial Plants	Sugar Maple (<i>Acer saccharum</i>)	2022
Fish			

Common Name (<i>Scientific Name</i>)	Category	Representative Species	Last Observed in Biodiversity Studies
American Eel (<i>Anguilla rostrata</i>)	Bottom Feeding Fish	American Eel (<i>Anguilla rostrata</i>)	2019 (sighting) 2022 (impingement – see Table 4-3)

Notes

1. For birds, only species possibly breeding on-Site are included. Olive-Sided Flycatcher is not identified as a species that is breeding on-site (Beacon, 2019c), therefore is not included in this table. Loggerhead Shrike and Red Knot (*Rufa* subspecies) are also not included as only one incidental sighting of each species has occurred (Beacon, 2022, 2023). The Eastern Whip-poor-will and Common Nighthawk observations were considered to be migrants and not remaining on-site (Beacon, 2022, 2023). The Yellow-breasted Chat has not been observed on the site since 2009 and there is no evidence that it is breeding on-site (Beacon, 2022, 2023) and is, therefore, not included in this table. The Chimney swift and Least bittern have conservatively been retained as a Species at Risk as they are considered “possible” breeders on the DN site (Beacon, 2022).
2. For bat species, only species roosting on-site are included. During 2020 to 2022, one new Species at Risk, the Eastern small-footed myotis, was identified during passive monitoring of the DNNP. However, results suggest this species was not roosting on the DN site (Beacon, 2022), and has not been retained as a Species at Risk for the EcoRA.
3. The federal and provincial status of a Species at Risk may change over time. The status of these species was last verified on November 24, 2023.
4. Species with Special Concern Status are not included in this table, as the general prohibitions under SARA do not apply to species of Special Concern, and CSA N288.6 does not specify this status as ecologically significant.

Eight (8) bird species, one (1) mammal species, one (1) plant species, one (1) terrestrial invertebrate, and one (1) fish species were identified as threatened or endangered at the DN site. All species, excluding the Canada Warbler were sighted between 2020 and 2022. Though not specifically identified between 2020 and 2022, the Canada Warbler was retained as Species at Risk as it was previously identified in the 2020 ERA.

The status of some species has changed since the 2020 ERA. In 2021, the Barn Swallow and Canada Warbler were newly designated "Special Concern" by COSEWIC and SARO, both previously listed as "Threatened" (Canada Warbler was re-assessed by COSEWIC in 2020). The Bobolink was also newly designated "Special Concern" by COSEWIC (previously designated as "Threatened") in 2022. The Monarch, a milkweed butterfly, was assessed and designated as "Special Concern" under SARO in 2020 and was designated as "Endangered" under SARA in late 2023. Overall, these changes in status do not affect the inclusion of these species as Species at Risk for the EcoRA. The Monarch is a migrating species that covers long distances between Ontario and Florida or central Mexico annually through four generations. In Ontario, Monarch caterpillars feed on milkweed plants and are confined to meadows and open areas with food sources. Adult butterflies are found in diverse habitats and, as a breeding species, are found in large numbers throughout the DN site. Monarch butterflies were observed annually between 2020 and 2022 (Beacon, 2023). Potential risk to Monarchs is expected to be adequately assessed by the Earthworm, as they are both terrestrial invertebrates. Both Earthworms and Monarch caterpillars are exposed to airborne emissions via soil. Earthworms dwell underground and receive more soil exposure. Therefore, using Earthworms to represent Monarch caterpillars is considered conservative.

Butternut is a medium-sized tree, belonging to the walnut family, which can reach up to 30 m in height. In Ontario, Butternut usually grows alone or in small groups in deciduous forests, in sunny openings, and near forest edges. It prefers moist, well-drained soil and is often found along streams, or on well-drained gravel sites. Two Butternut trees are located in the southeast area of the DN site, on DNNP lands. In 2019, a Butternut Health Assessment was conducted and one of the Butternut trees was assessed as non-retainable (Beacon, 2023). Potential risk to this species is expected to be adequately assessed by reference to other terrestrial plant species such as the Sugar Maple, as they receive similar exposure to airborne emissions via soil.

Bank Swallow and Barn Swallow are aerial insectivores and feed over open areas such as fields, meadows, watercourses, and waterbodies. Bank swallows nest colonially in small to large colonies where there are natural or artificial soft soil banks, such as natural river and lake bluffs, in which they create nesting burrows. The lakeshore Bank Swallow colonies at the DN site during the 2020 to 2022 period were estimated to have between 1,118 and 1,795 burrows, the majority of which were found along the eastern-most third of the shoreline of the DN site (Beacon, 2022, 2023). Bank Swallow was retained as an ecological receptor in this Addendum.

Barn Swallows, in Ontario, typically nest in small openings in man-made buildings, such as barns. Barn Swallows are annual breeders at the Site, all around the existing station. Over the 2020 to 2022 period, 43 to 98 active nests were observed in and around the buildings on the site (Beacon, 2022, 2023). Barn Swallows are typically observed foraging over lawns, open field areas,

wetlands and along the lakeshore at the DN Site. Several of the buildings on the DN site may provide a suitable habitat for birds. The Bank Swallow is considered a suitable representative species for the Barn Swallow, and the assessment of ecological risks for the Bank Swallow in this Addendum is expected to be adequate for protection of the Barn Swallow, considering their similar diet and other characteristics.

The Chimney Swift is a relatively small bird that feeds almost exclusively on flying insects, consuming flies, beetles, and moths while in flight. They tend to nest in caves and hollow trees, and in urbanized areas can be found nesting in buildings and man-made structures, including chimneys. The Chimney Swift was recorded in all years between 2020 and 2022. Though not seen breeding on the DN site since 2009, the species is considered a possible breeder (Beacon, 2022) and has conservatively been retained as a Species at Risk for this Addendum. The Bank Swallow is considered a suitable representative species for the Chimney Swift, considering their similar diet and other characteristics.

The Canada Warbler eats insects such as spiders that have been gleaned off of foliage. The Canada Warbler is a regular migrant species. The last observation of this species at the DN site was 2019 (Beacon, 2023). The Bank Swallow is also considered a suitable representative species for the Canada Warbler considering the similar diet and physical characteristics.

Bobolink and Eastern Meadowlark are omnivores which typically forage on or near the ground for insects, seeds, and berries. The Bobolink typically breeds in large agricultural grasslands or fields such as hayfields and other fields with tall, lush forb vegetation. It is a regular breeder at the DN site. After an absence of Bobolink in 2016, numbers have fluctuated between one and three pairs; two pairs were recorded in 2022 (Beacon, 2023). Eastern Meadowlark also breeds in grasslands and prairie, as well as pastures and hay fields. The Eastern Meadowlark builds its nest on the ground, covered with a roof woven from grasses. The species is an annual breeder at the DN site, though like the Bobolink, sightings have declined in recent years (Beacon, 2023). Potential risk to these species is expected to be adequately assessed by reference to other avian omnivores such as the American Robin, as they are all ground feeding birds and receive similar atmospheric exposure through food and soil.

Wood Thrush are omnivores, which typically forage on invertebrates and fruits. They prefer woodlands and are not typically found at DN. However, in June 2021, Wood Thrush were heard from the Treefrog Swamp and the East Hedge transect, though it is not clear whether these recordings were of the same individual (Beacon, 2022). Another pair was heard from the Big Hedge transect in 2022 (Beacon, 2023). American Robin is also considered a suitable representative for Wood Thrush, as they are both ground feeding insectivores, and are exposed to similar atmospheric exposure through food and soil.

Little Brown Myotis is an aerial insectivore. Like other bats, they forage during the night and roost in trees or buildings during the day. Little Brown Myotis will often select attics, abandoned buildings and barns for summer colonies to raise their young. It was recorded near the DN site in all years between 2020 and 2022, and likely has roosting habitat on site (Beacon, 2023). Potential risk to Little Brown Myotis is expected to be adequately assessed by reference to other

mammalian insectivores such as the Common Shrew considering their similar diet. Common Shrew has more soil exposure compared to Little Brown Myotis; therefore, it is a conservative representative species.

The American Eel is carnivorous, feeding on a variety of fishes and invertebrates. The American Eel is catadromous, utilizing a variety of marine and freshwater habitats over the course of its life history. It spawns in the Sargasso Sea, and during its migrations to and from spawning areas, it occurs in continental and oceanic habitats. In fresh water, its preferred habitat is in lakes and rivers including all waters to a depth of least a 10 m. The American Eel has been retained in this Addendum as an ecological receptor from the 2020 ERA as it has been periodically impinged in since 2020.

4.1.1.2 Receptor Characterization

Receptor characterization remains unchanged from the 2020 ERA (Ecometrix, 2022a). The 2020 ERA provided the habitat and feeding habits of the selected receptor species in Appendix C of the 2020 ERA.

4.1.2 Assessment and Measurement Endpoints

The assessment and measurement endpoints remain unchanged from the 2020 ERA. The 2020 ERA provided the assessment endpoints, measurement endpoints and lines of evidence in Table 4-4.

4.1.3 Selection of Chemical, Radiological, and Other Stressors

The same monitoring data sources previously screened for the HHRA (**Section 3.1.2**) were screened for the EcoRA using the more conservative of available federal and provincial guidelines and objectives protective of ecological health as screening criteria. If there was no such guideline or objective, screening criteria were obtained from available scientific literature, and/or derived using federally and/or provincially accepted methods. For COPCs where these criteria were not available, conservative toxicity benchmarks (e.g., no effects levels) or upper limit of background concentrations were used as screening criteria. Maximum measured concentrations of parameters in air, surface water, soil, and sediment were compared to the selected screening criteria. Contaminants were retained for evaluation of ecological health risks in this Addendum if they:

- Were a new COPC not previously identified in the 2020 ERA, or
- Were a COPC evaluated in the 2020 ERA and the maximum concentration in 2020 – 2022 was greater than that evaluated in the 2020 ERA (Ecometrix, 2022a).

The framework for the chemical COPC screening process used in the EcoRA is consistent with the 2020 ERA (Ecometrix, 2022a), with updated guidelines applied where available.

4.1.3.1 Selection of Chemical COPCs in Air

As per clause 7.3.4.2.5 in N288.6:22, inhalation exposures to biota are usually minor compared to the soil and food ingestion pathways, and can be ignored for most substances, except for substances that do not partition to soil (CSA, 2022). These substances may include gases such as NO_x, SO₂, hydrazine, and morpholine, of which air concentrations dominate the exposure pathway to terrestrial biota. For completeness, all chemicals modelled in the 2020-2022 ESDM reports (ORTECH, 2021, 2022a, 2022b) were screened against relevant ecological screening criteria (**Figure 4-2** and **Appendix A, Table A-8**). However, chemicals that do not partition to soil were considered for COPC selection for air. Furthermore, measured air quality data (IEC, 2023) collected from the DNNP air quality study (as described in **Section 3.1.2.1.2**) was also screened against the same ecological air quality screening criteria (**Table A-9, Appendix A**).

The modelled POI concentrations provided in the ESDM reports were typically 24-hour, or annual averages. These modelled POI concentrations were directly compared to selected screening criteria, as described below, with the same averaging periods (e.g., 24-hour, or annual), or were adjusted to meet the timeframes of the relevant screening criteria using the suggested conversion method provided by MECP (MOECC, 2017). It should be noted that POI conversion is minimized in this screening process to avoid uncertainty introduced by converting POI concentrations to different averaging periods.

The MECP AAQC was used as the preferred screening level as AAQCs are developed to be protective of health and the environment (MECP, 2023b). Where AAQCs were not available, the Effects Screening Levels (ESLs) from the Texas Commission on Environmental Quality (TCEQ, 2023) were used. ESLs are based on data for health effects, odour, and effects on vegetation and can, therefore, be applied as ecological screening levels. There are no MECP AAQC or TCEQ ESL values for hydrazine and morpholine. For these two COPCs, MECP ACBs (MECP, 2023a) are available and were utilized.

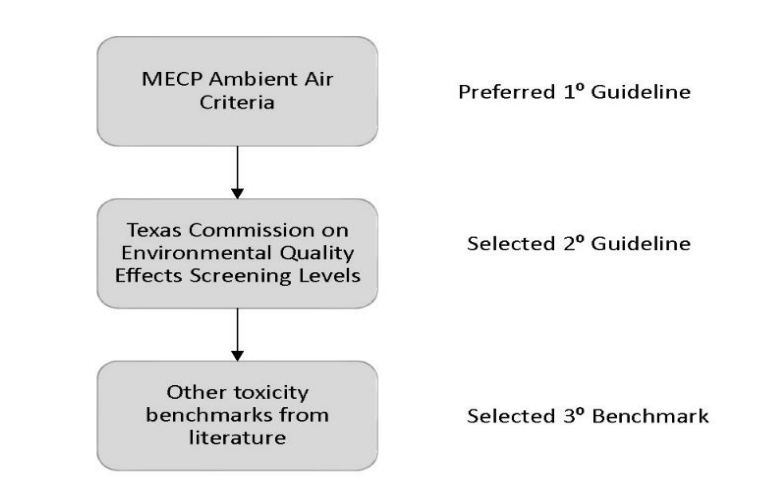


Figure 4-2: Hierarchy of Screening Criteria for Chemical COPCs in Air

Based on the POI concentration screening presented in **Table A-8** in **Appendix A**, for chemicals released to air, there were no COPCs identified for ecological effects. When considering the screening of measured DNNP air quality data in **Table A-9**, 24-hour air quality criteria were exceeded for PM_{2.5}, PM₁₀, TSP, and BAP, a surrogate for total PAHs. The 1-hour air quality criteria for SO₂ and the annual air quality criteria for benzene were also exceeded. Out of these exceedances, BAP is the only parameter that would be expected to partition to soil and is not considered further in this report, given that contaminants that partition to soil are negligible from an atmospheric perspective (as per clause 7.3.4.2.5 in N288.6:22).

Although PM_{2.5}, PM₁₀, and TSP exceed their respective air quality screening criteria, they are not retained as air COPCs with respect to ecological health. As per CSA N288.6:22, "For particulate substances released to air and accumulating over time in the soil, the steady-state soil concentration is usually high enough that the soil and food components of dose are dominant." Also, as described in **Section 3.1.2.1.3.2**, changing wind directions and differing meteorological conditions make the DNNP air quality monitoring program likely to capture sources of pollution external to the DN site from local and regional industry and traffic, thus potentially overestimating the DN site's contribution to local air quality conditions. Furthermore, many ecological receptors are mobile and are expected to move around or leave the DN site over the course of their lifetime, further reducing the likelihood that these receptors would be exposed to harmful levels of air pollution for extended periods of time.

While SO₂ exceeded its 1-hour MECP AAQC (MECP, 2023b), it did not exceed its 24-hour MECP ACB (MECP, 2023a). Generally, 24-hour air quality criteria are more protective of long-term, chronic exposures to air pollutants compared with 1-hour air quality criteria (MECP, 2023b). Both mobile and immobile receptors (e.g., vegetation) are not expected to be at risk of adverse effects from SO₂ via long-term, chronic exposure. Thus, SO₂ is not retained as an air COPC for the EcoRA.

Benzene exceeded its annual MECP AAQC; however, the maximum concentration of benzene (annual averaging period) was measured to be 0.5 µg/m³, approximately half the average concentration reported in rural areas (1.2 µg/m³) and approximately 64,000-times lower than the effects threshold of 32 mg/m³, where immunological changes were noted in laboratory rats experiencing chronic exposure to benzene (EC and HC, 1993). Furthermore, many ecological receptors such as plants and invertebrates are able to metabolize and excrete benzene as it is not considered to bioaccumulate in tissues and does not tend to concentrate to harmful levels in foodstuffs (CCME, 2004; EC and HC, 1993). Therefore, benzene is considered to be minimally toxic to terrestrial biota via the inhalation pathway and is not retained as an air COPC for the EcoRA.

Therefore, the exposure from air was not evaluated further for ecological receptors in this Addendum.

4.1.3.2 Selection of Chemical COPCs in Surface Water

The surface water screening is based primarily on measurements of constituents in Lake Ontario water, as well as Coot’s Pond and Treefrog Pond water. In addition, concentrations of chemical parameters in the CCW discharges from 2020 to 2022 and concentrations of chemical parameters in stormwater discharges to Lake Ontario in 2019 (**Section 4.1.3.2.3**) were screened to ensure that the list of chemical COPCs was complete. COPCs for surface water were only retained in this Addendum if it was a new COPC not evaluated in the 2020 ERA or if the concentration was greater than that evaluated in the 2020 ERA (Ecometrix, 2022a).

For each parameter, its maximum concentration in surface water was screened against its screening criterion, which was selected following the process illustrated in **Figure 4-3**, and detailed below.

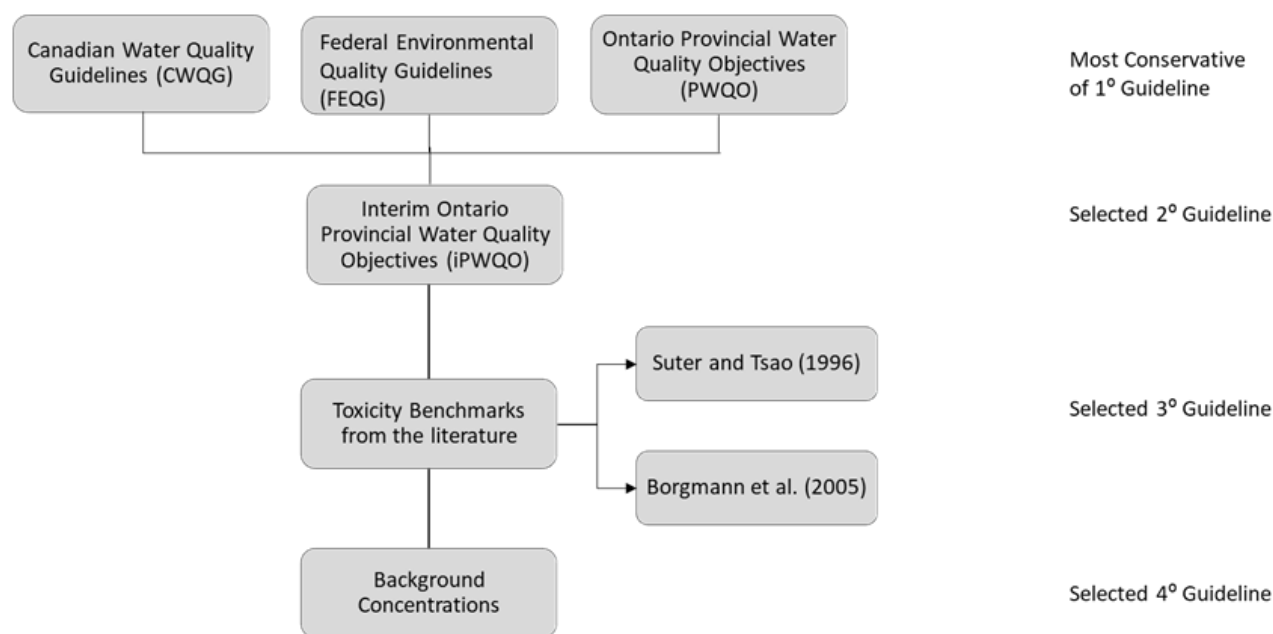


Figure 4-3: Selection of Screening Criteria for Chemical COPCs in Surface Water

The most restrictive federal or provincial guideline for surface water quality, including the CCME water quality guidelines for the protection of freshwater aquatic life (the Canadian Water Quality Guidelines, CWQG) (CCME, 2010a), the federal environmental quality guidelines (FEQG) (ECCC, 2021b), the provincial water quality objective (PWQO), or the interim PWQO (iPWQO) (MOEE, 1994) were selected as the screening criteria for most surface water parameters (**Appendix A, Table A-10**). In cases where no toxicity benchmarks were available from selected literature (e.g., Suter & Tsao (1996), Borgmann et al. (2005)), the maximum concentrations were compared to the 95th percentile of background concentrations in Lake Ontario (Ecometrix, 2022c).

4.1.3.2.1 Lake Water Sampling

Surface water sampling was conducted quarterly (spring, summer, early fall, and early winter) in 2019 (Ecometrix, 2022c). The results of this sampling program were used as the basis for the

screening of COPCs in Lake Ontario. No new data was collected since the 2020 ERA (Ecometrix, 2022a). The screening of lake water concentrations is provided in **Table A-11** in **Appendix A**, with updated guidelines as available.

Based on updated guidelines, the list of COPCs with concentrations that exceed screening criteria remains the same as for the 2020 ERA (Ecometrix, 2022a). As such, there were no COPCs retained in lake water for assessment of ecological health risks in this Addendum.

4.1.3.2.2 Liquid Effluent Sampling

As in the HHRA, information from 2020 to 2022 on the concentrations of COPCs in liquid effluents was available and was assessed to aid in COPC selection to ensure that the lake water chemical COPC selection was complete. As in the HHRA, the final discharge released from the CCW duct was evaluated. Effluent released from the CCW duct is diluted in Lake Ontario through the diffuser. Thus, the initial mixing zone in Lake Ontario represents a maximum potential exposure for ecological receptors. Effluent quality results were converted to estimated concentrations in the mixing zone using a dilution factor of 7 at the diffuser (OPG, 2022c); estimated mixing zone concentrations were considered in the screening.

4.1.3.2.2.1 Monitoring for ECA Requirements

As part of the ECA requirements, the effluent from the CCW was sampled and analyzed for compliance with effluent limits for unionized ammonia, hydrazine, morpholine, pH, and total residual chlorine (TRC) (OPG, 2021b, 2022d, 2023c). For each of these chemicals, the maximum concentration in the mixing zone was estimated based on the maximum measured concentration in the CCW and a dilution factor of 7 at the diffuser. Estimated mixing zone concentrations from 2020 to 2022 were screened against the same screening criteria as the lake water samples.

The maximum mixing zone concentrations for hydrazine, morpholine, and TRC were all below their selected screening criteria.

Based on the screening of the available 2020 – 2022 data (**Table A-12, Appendix A**), there were no COPCs identified in CCW effluent and thus further evaluation of ecological risks related to CCW effluent was not carried out in this Addendum.

4.1.3.2.2.2 2016 Effluent Characterization Study

Liquid effluent sampling and analysis were performed in 2016 to provide data for the characterization of non-radiological parameters. No additional data have been collected since 2016.

As identified in the 2020 ERA (Ecometrix, 2022a), and still the case based on updated guidelines, no exceedances of screening criteria in the initial mixing zone are expected for the 2016 CCW effluent parameters, as shown in **Table A-13a** and **A-13b** in **Appendix A**. As such, no COPCs were carried forward for further assessment of ecological health risks in this Addendum.

4.1.3.2.3 Stormwater Sampling

The Stormwater Management System, or Yard Drainage System, collects storm runoff from the entire DN site and discharges to Lake Ontario, either directly through the storm sewer drainage system or through drainage swales/creeks via culverts, which eventually discharge to the lake. There has been no new stormwater sampling subsequent to the 2020 ERA (Ecometrix, 2022a). The stormwater screening from the 2020 ERA was repeated based on the same data, but with updated ecological screening criteria, where available.

Consistent with the 2020 ERA (Ecometrix, 2022a), nearshore Lake Ontario concentrations were modelled based on the release of stormwater effluent into the lake. The estimated Lake Ontario concentrations were then screened against the same ecological screening benchmarks used in the lake water screening. The results are presented in **Table A-14** in **Appendix A**.

The list of COPCs with concentrations that exceeded screening criteria was the same as for the 2020 ERA (Ecometrix, 2022a). As there were no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.2.4 Pond Water Sampling

Pond water sampling was conducted in 2019 from Coot's Pond and Treefrog Pond (Ecometrix, 2022c). These ponds are not exposed to liquid effluent from DN, but Coot's Pond is exposed to stormwater runoff from the construction landfill. The ponds are also expected to be exposed to chemical contaminants in air, which could be deposited in surface water after release to the atmosphere from DN. No new data were collected since the 2020 ERA (Ecometrix, 2022a). Results of the pond water screening are presented in **Table A-15** in **Appendix A**.

The list of COPCs with concentrations which exceed screening criteria is the same as for the 2020 ERA (Ecometrix, 2022a). As there was no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.3 Selection of Chemical COPCs in Sediment

Sediment sampling in Lake Ontario was conducted in 2018 at the Darlington Harbour area and near-shore locations immediately west of the Darlington Harbour. In 2019, sediment sampling occurred at the Lake Ontario near-shore and off-shore locations (including the St. Mary's future embayment and proposed infill area), and at Coot's Pond and Treefrog Pond to support DNNP site preparation licence renewal. The 2018 to 2019 sediment data were screened against relevant screening criteria. The screening criteria were selected following the hierarchy illustrated in **Figure 4-4**. All regulatory and toxicity benchmarks consulted are listed in **Appendix A, Table A-16**. No new sediment data was available since the 2020 ERA (Ecometrix, 2022a).

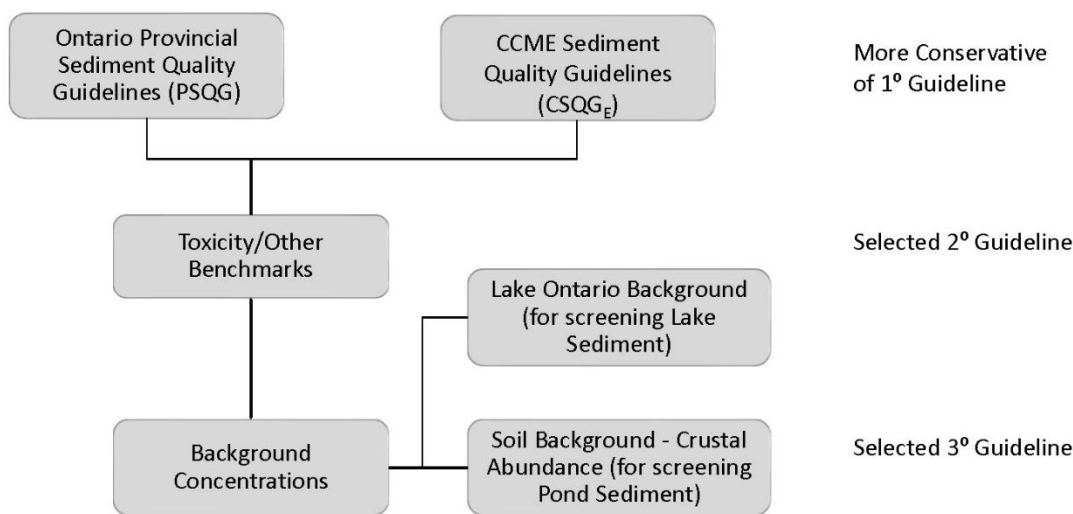


Figure 4-4: Selection of Screening Criteria for COPCs in Sediment

In particular, maximum measured concentrations of sediment parameters were compared against the more conservative values of Ontario Provincial Sediment Quality Guidelines (PSQG, (MOE, 2008)), and the CCME Sediment Quality Guidelines for the Protection of Aquatic Life (CSQG, (CCME, 2001)). If regulatory criteria were not available, values from toxicity studies and other literature were used, as detailed in **Appendix A, Table A-16**. If there were no reported toxicity values for a certain parameter analyzed in Lake Ontario, the 95th percentile of background concentrations in Lake Ontario sediment (SENES, 2009b) were used as the screening criteria for this parameter. These background values were not used to screen sediment chemicals in Coot’s Pond and Treefrog Pond as the background values are not representative of pond background concentrations. The upper end of the ranges of crustal abundance for the United States from Dragun and Chiasson (1991) were consulted to screen the pond sediment COPCs, if no toxicity-based benchmark was available.

4.1.3.3.1 Lake Ontario Sediment Sampling

Within the study area in Lake Ontario, the substrate is predominantly gravel and cobble on top of glacial till or bedrock, except in the St. Mary’s boat slip. Any finer material, mostly sand, is patchy, thin and transient. Lake Ontario in the vicinity of DN is not a depositional environment, as characterized in COG (COG, 2013a). As such, any chemical parameters in sediments in Lake Ontario due to DN’s influence are likely to be due to liquid effluents, and screening of Lake Ontario water and liquid effluents for COPCs are expected to be protective of aquatic life. However, to be complete, the sediment monitoring data were screened as an additional line of evidence for the selection of COPCs.

The screening results for Lake Ontario sediment are presented in **Appendix A, Table A-17**. The list of COPCs with concentrations that exceed screening criteria is the same as for the 2020 ERA (Ecometrix, 2022a). As there were no new concentration data, and no new COPCs based on

updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.2 Pond Sediment Sampling

The on-site ponds, including Coot's Pond and Treefrog Pond, are depositional environments. However, other than stormwater runoff, these ponds do not receive liquid effluents from DN, so the only potential transport pathway for COPCs from DN to these ponds is through airborne deposition of air emissions from DN.

The results of the pond sediment screening are presented in **Table A-18** in **Appendix A**. The list of COPCs with concentrations that exceed screening criteria is the same as for the 2020 ERA (Ecometrix, 2022a). As there were no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.4 Selection of Chemical COPCs in Soil

Soil sampling was conducted at the DN in 2019. The 2019 soil sampling program is described in more detail in the 2020 ERA (Ecometrix, 2022c).

In 2021, a soil characterization program was initiated for the DNNP to meet objectives relating to EA commitments and licensing (soil quality data is summarized in Appendix B). The program involved the drilling of 56 boreholes and the analysis of soil samples for a suite of contaminants, including VOCs, PHCs, PAHs, polychlorinated biphenyls (PCBs), metals, and other regulated parameters. The locations of the 2021 soil samples correspond with Polygon E (**Figure 4-1**).

Consistent with the methodology outlined in the CCME's *Ecological Risk Assessment Guidance Document* (CCME, 2020), only soils less than 1.5 metres below ground surface (mbgs) were screened for soil COPCs. This is considered the default depth for the analysis of ecological direct contact to surface soil contaminants, and is also consistent with the Canada-wide standard for PHCs in soil (ECCC, 2022). Soils in the top 1.5 mbgs are considered "surface soils" for the purpose of assessing soil exposure to ecological receptors, including those that live just below the ground surface in underground burrows, nests, and dens. There are no ecological receptors assessed in this Addendum that are expected to contact soils deeper than 1.5 mbgs.

Screening criteria were selected following the process illustrated in **Figure 4-5**.

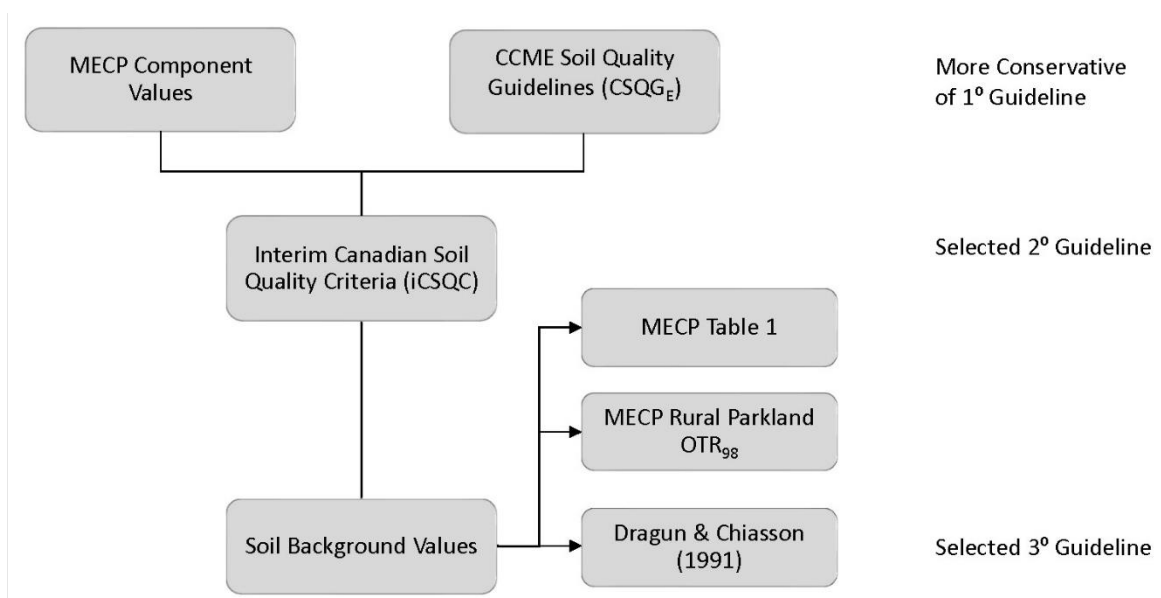


Figure 4-5: Selection of Screening Criteria for Chemical COPCs in Soil

In particular, maximum measured concentrations of soil COPCs were compared against two MECP component values (MECP, 2011), one based on protection of Plants and Soil Organisms (PSO), and the other based on protection of Birds and Mammals (BM). The residential/parkland component values were selected considering these benchmarks are protective of ecological receptors observed at the site. From a federal perspective, CCME Soil Quality Guidelines for Environmental Health (SQG_E) were consulted, as were Interim Canadian Soil Quality Criteria (ICSQC; (CCME, 1991)), if an SQG_E was not available. Agricultural SQG_E values were used because these guidelines account for bird and mammal ingestion of plants. The more conservative of these provincial and federal screening criteria were selected for the protection of plants, soil organisms, mammals, and birds. The only exception was for selected PAHs, including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene, as there were insufficient soil contact data, and the CCME SQG_E was based on the 1991 interim soil quality criteria (CCME, 2010b). For these parameters, the Ontario provincial component values were adopted, if available, prior to the CCME SQG_E, as the Ontario provincial values are considered more recent.

If none of the provincial or federal criteria, guidelines, or component values were available, background concentrations of analyzed chemicals in soil were used. The MECP Table 1 Site Condition Standards under Ontario Regulation 153/04 are derived from the Ontario Typical Range (OTR₉₈) values for the land use and are considered representative of upper limits of typical province-wide background concentrations in soils that are not contaminated by point sources (MECP, 2011). If MECP Table 1 values were not available, MECP’s Ontario Typical Range (OTR₉₈) concentrations (for rural parkland) were used instead. If background values from Ontario were not available, the upper end of the ranges of crustal abundance for the United States from Dragun and Chiasson (1991) were used to represent the background soil concentrations.

Of the screening criteria derived in this way, the benchmark for vanadium was given more detailed scrutiny because of its use by MECP in deriving a Site Condition Standard under Ontario Regulation (O.Reg.) 153/04. MECP derived a vanadium soil protection value for mammals and birds of 18 mg/kg, with the American Woodcock as the most sensitive receptor (MECP, 2011). This concentration was less than the OTR₉₈ concentration for vanadium of 86 mg/kg in rural parkland. In setting their Site Condition Standard, MECP chose the Ontario background concentration for vanadium over the mammal and bird soil protection value. A similar approach was used here, in that the Ontario background concentration for vanadium was selected as a more appropriate screening benchmark for birds and mammals. This approach is also consistent with the guidance in N288.6:22 (CSA, 2022), in that screening benchmarks should not be set below an upper limit of background.

Similarly, the CCME Soil Quality Guideline (SQG) values, for benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and pyrene, which were based on the 1991 interim soil quality criteria, were lower than the Ontario background soil concentrations (MECP Table 1). For these three compounds, the soil background values were selected as the screening criteria instead of the CCME values. The selected screening criteria are presented in **Table A-19** in **Appendix A**.

As shown in **Table A-20** in **Appendix A**, compared to the 2020 ERA (Ecometrix, 2022a), the following COPCs exceeded screening values:

- Sodium Adsorption Ratio
- PHC F1, PHC F2, PHC F3
- 2-methylnaphthalene

Of the COPCs that were already identified in the 2020 ERA (Ecometrix, 2022a), there are no new maximum concentrations based on the new soil data.

For 2-methylnaphthalene, MECP component values and CCME soil quality guidelines are not available, and the MECP Table 1 values were used for screening. However, the MECP Table 1 values are based on background conditions, and not toxicological benchmarks. The US EPA has developed Ecological Soil Screening Levels (Eco-SSLs) that are “concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil” (US EPA, 2007). For PAHs, Eco-SSLs are provided for low molecular weight compounds composed of fewer than four rings and high molecular weight compounds. 2-methylnaphthalene is a low molecular weight PAH. There was sufficient toxicological information for low molecular weight PAHs to derive an Eco-SSL for soil invertebrates (29 mg/kg) and mammals (100 mg/kg). There was insufficient toxicological information to derive Eco-SSLs for plants or avian species. For avian species, a no observed adverse effect level (NOAEL) of 5620 mg/kg was determined based on dietary exposure. For plants, the effect levels ranged from 30 to >1000 mg/kg. The maximum 2-methylnaphthalene concentration of 0.62 mg/kg was below the Eco-SSLs, was nearly 10,000 times lower than the avian NOAEL, and 50 times lower than the plant effect levels. As such, risks to ecological

receptors from soil concentrations of 2-methylnaphthalene are expected to be negligible. 2-methylnaphthalene was not retained for further quantitative assessment in this Addendum.

The soil COPCs retained for evaluation in this Addendum are Sodium Adsorption Ratio, PHC F1, PHC F2, and PHC F3.

4.1.3.5 Selection of Chemical COPCs in Groundwater

OPG executes an annual groundwater monitoring program to understand the groundwater flow and quality beneath the DN site. Based on the results of this program, groundwater on the DN site was found to generally flow toward Lake Ontario or the Forebay. From 2020 to 2022, the groundwater monitoring program included sampling groundwater monitoring wells for tritium, and certain locations for select hazardous substances, such as PHCs and BTEX.

As there is no on-site exposure of ecological receptors to groundwater, the only pathway for ecological receptors to be exposed to groundwater would be at the shoreline of Lake Ontario after dilution of the groundwater in the near shore lake. As discussed in **Section 3.1.2.4**, there is a GWPP for the DN site that evaluates groundwater concentrations against relevant criteria. As for human health, although COPCs are identified in the GWMP, the exceedances of MECP Standards are limited, not related to site activities, and not relevant to ecological health. As such, groundwater COPCs are not retained for further evaluation in this Addendum.

4.1.3.6 Selection of Radiological COPCs

The radiological COPCs that were selected to evaluate radiological dose remain unchanged from the 2020 ERA. The selection of radiological COPCs is detailed in **Sections 4.1.4.6** (Air and Water), **4.1.4.7** (Soil), **4.1.4.8** (Groundwater), and **4.1.4.9** (Sediment) of the 2020 ERA (Ecometrix, 2022a).

Radionuclide COPCs selected are consistent with those identified as part of the DRL calculations for the DN Site (see **Section 3.1.2.6**).

4.1.3.7 Selection of Other Stressors

4.1.3.7.1 Noise

As discussed in **Section 3.1.2.7.1**, the noise environment in the vicinity of DN site is typical of an urban setting and is influenced by several noise sources including the DNGS, traffic on Highway 401 and local roads, the CN rail line, and the SMC plant. Beacon Environmental noted that bird and wildlife communities at DN would likely be adjusted to the high level of noise in the vicinity of the Station (Beacon, 2009, 2011), and observed that none of the planned activities, for which the respective EAs were being conducted, were likely to increase noise to beyond levels tolerable by breeding birds from the literature. In 2018/2019, the noise at the DN vicinity was monitored again, and the results were similar to previous studies (OPG, 2022e). As described in **Section 3.1.2.7.1**, the recent Spring and Fall 2022 noise assessments (OPG, 2022e, 2023e) found similar conclusions to the 2018/2019 and past noise assessments. As indicated by the recent

noise monitoring programs, noise levels at the DN site have remained consistent over time, further supporting the notion that local birds and wildlife would be accustomed to current noise levels. As such, noise has not been considered a stressor in the EcoRA.

4.1.3.7.2 Thermal Stressors, Entrainment, Impingement

Thermal stressors, entrainment and impingement were not re-evaluated in this Addendum as new data was not available. In the 2020 ERA, effects from thermal stressors were identified as negligible.

As a condition of the Department of Fisheries and Oceans Canada (DFO) Fisheries Act Authorization for the DNGS, OPG will be required to conduct fish impingement and entrainment monitoring studies after Refurbishment is completed. Refurbishment at DNGS is currently ongoing. Fish losses due to impingement at DN were considered negligible in the 2020 ERA (Ecometrix, 2022a), when considering the Lake Ontario populations of the impinged organisms. As discussed in the 2020 ERA, losses from fish entrainment were considered too low to measurably affect Lake Ontario fish populations.

4.1.3.7.3 Bird Strikes and Wildlife Collisions

OPG tracks wildlife fatalities and injuries through an informal reporting process. For the period from 2020 to 2022, the fatalities and injuries reported through this method, not including predation deaths, are summarized in **Table 4-3**. The 2016 to 2019 fatality and injury list was reported in the 2020 ERA (Ecometrix, 2022a). The 2020 to 2022 wildlife list documented a similar number of incidents compared to the 2016 to 2019 list. Due to the small number of affected wildlife, bird strikes, and other types of physical wildlife incidents are not expected to affect populations of birds and mammals at the DN Site. Wildlife fatalities and injuries are not discussed further in this Addendum.

Table 4-3: Summary of Reported Wildlife Injuries/Fatalities at DN (2020 to 2022)

Year	Type	Number	Species	Cause
2020	Fatality	1	bird (unknown species)	Trapped / entangled under canopy
	Fatality	1	American Eel	Impingement
	Likely a fatality	1	Sparrow	Trapped in equipment
	Potentially distressed but not injured	1	bird (unknown species)	Trapped in equipment
	Injured	1	deer (unknown species)	Vehicle hit
2021	Fatality	1	Mouse (unknown species)	Unknown
	Fatality	5	American Eel	Impingement
	Fatality	1	Seagull	Entangled on fence
2022	Potentially distressed but not injured	6	bird / gull (unknown species)	Trapped in equipment
	Fatality	1	Unknown (likely mammal)	Unknown
	Fatality	1	Goose	Vehicle hit
	Fatality	4	American Eel	Impingement
	Fatality	1	Fox (species unknown)	Unknown

4.1.3.8 Summary of COPC Selection

For this addendum, ecological risks were only calculated if, compared to the 2020 ERA (Ecometrix, 2022a), there was a new COPC or a COPC with a higher maximum concentration based on the 2020 – 2022 data. Based on these criteria, the only chemical COPCs retained for evaluation of ecological risks are Sodium Adsorption Ratio (SAR), PHC F1, PHC F2, and PHC F3 in soil. Radionuclides will be evaluated based on the total dose due to all combined exposure pathways and all COPCs to each receptor. **Table 4-4** summarizes the radiological COPCs that were carried forward to the exposure assessment in this Addendum.

Table 4-4: Summary of COPCs Selected for the EcoRA

Category	Radiological COPC	Chemical COPC
Air	C-14, Co-60, HT, HTO, noble gases, Imfp	None
Surface water	C-14, Cs-134, HTO	None
Soil	C-14, Co-60, Cs-134, HTO, I-131	SAR, PHC F1, PHC F2, PHC F3
Groundwater	HTO, I-131	None
Sediment	C-14, Cs-134, HTO	None
Physical Stressors	None	

4.1.4 Selection of Exposure Pathways

There were new non-radiological COPCs identified in soil for polygon E: SAR, PHC F1, PHC F2, and PHC F3. There were no COPCs retained for evaluation in other media, as there were no new COPCs and COPC concentrations were not greater than in the 2020 ERA (Ecometrix, 2022a).

The relevant exposure pathway for the identified soil COPCs is direct contact with soil by plants and soil invertebrates. The SAR parameter is relevant to osmotic effects in soil organisms, which refers to an altered ability for soil organisms to take up nutrients from the soil. Thus, the SAR parameter only affects soil organisms and is not evaluated for terrestrial vertebrates. As described by CCME (2008), PHCs are “readily metabolized by vertebrates, modified into a more readily excretable form, and thus do not tend to accumulate in tissues”. As such, risks to mammals and birds based on SAR and PHC exposure are considered negligible and not evaluated herein.

All radionuclides retained in the 2020 ERA (Ecometrix, 2022a) were also retained for the Addendum. As such, the same exposure pathways that were evaluated in the 2020 ERA for exposure to radiological COPCs are relevant for this ERA Addendum. These pathways are detailed in **Table 4-5** below.

Table 4-5: Complete Exposure Pathways for All Selected Ecological Receptors

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
Bottom Feeding Fish	Northern Redbelly Dace	Coot's Pond (AB)	Direct Contact	In Water On Sediment
	Round Whitefish	Lake Ontario	Direct Contact	In Water On Sediment
	White Sucker		Direct Contact	In Water On Sediment
	American Eel		Direct Contact	In Water On Sediment
Pelagic Fish	Alewife	Lake Ontario	Direct Contact	In Water
	Lake Trout		Direct Contact	In Water
Reptiles and Amphibians	Turtle	Coot's Pond (AB), Treefrog/Dragonfly/ Polliwog Pond (D)	Direct Contact	In Water On Sediment
	Frog		Direct Contact	In Water On Sediment
Aquatic Plants	Aquatic Plant	Coot's Pond (AB), Treefrog/ Dragonfly/ Polliwog Pond (D)	Direct Contact	In Water
Benthic Invertebrates	Benthic Invertebrate	Lake Ontario, Coot's Pond (AB)	Direct Contact	In Water In Sediment
Riparian Birds	Bufflehead	Lake Ontario	Direct Contact	On Sediment
			Ingestion	Water Sediment Benthic Invertebrates
		Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment Aquatic Plants Benthic Invertebrates
	Mallard	Lake Ontario	Direct Contact	On Sediment
			Ingestion	Water Sediment Benthic Invertebrates
		Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment Aquatic Plants Benthic Invertebrates
	Green Heron	Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media	
				Bottom-Feeding Fish (Northern Redbelly Dace)	
Riparian Mammals	Muskrat	Coot's Pond (AB)	Direct Contact	On Sediment	
			Ingestion	Water Sediment Aquatic Plants	
Terrestrial Invertebrates	Earthworm	AB, C, D, E	Direct Contact	In Soil	
Terrestrial Birds	American Robin	AB, C, D, E	Direct Contact	On Soil	
			Ingestion	Water Soil Earthworms Fruit	
	Bank Swallow	AB, E	Direct Contact	On Soil	
			Ingestion	Water Soil Caterpillars	
	Song Sparrow	AB, C, D, E	Direct Contact	On Soil	
			Ingestion	Water Soil Fruit Caterpillars	
	Yellow Warbler	AB, C, D, E	Direct Contact	On Soil	
			Ingestion	Water Soil Fruit Caterpillars	
	Terrestrial Plants	Grasses	AB, C, D, E	Direct Contact	On Soil
		Sugar Maple	D, E	Direct Contact	On Soil
	Terrestrial Mammals	Eastern Cottontail	AB, C, D, E	Direct Contact	On Soil
				Ingestion	Water Soil Grasses
Meadow Vole		AB, C, D, E	Direct Contact	On Soil	
			Ingestion	Water Soil Grasses	
White-tailed Deer		AB, C	Direct Contact	On Soil	
			Ingestion	Water	

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
		D, E		Soil Grasses
			Direct Contact	On Soil
			Ingestion	Water Soil Grasses Sugar Maple trees
	Common Shrew	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Caterpillars
	Raccoon	AB	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Fruit Caterpillar Benthic Invertebrates Meadow Voles
		C	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Fruit Caterpillars Meadow Voles
		D, E	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Sugar Maple trees Fruit Caterpillars Meadow Voles
	Red Fox	AB	Direct Contact	In and on Soil
			Ingestion	Water Soil Grasses Bufflehead Mallard Eastern Cottontail Rabbits Meadow Voles
		C, D, E	Direct Contact	In and on Soil

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
			Ingestion	Water Soil Grasses Eastern Cottontail Rabbits Meadow Voles
	Short-tailed Weasel	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Meadow Voles

4.1.5 Ecological Health Conceptual Model

The Ecological Health Conceptual Site model remains unchanged from the 2020 ERA (Ecometrix, 2022a). In this Addendum, for non-radiological COPCs, only exposure pathways related to soil were evaluated. For radiological COPCs, all exposure pathways and receptors identified in the 2020 ERA were evaluated.

4.1.6 Uncertainties in the Problem Formulation

The uncertainties in the Problem Formulation remain unchanged from the 2020 ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the new data and new guidelines that were used.

4.2 Exposure Assessment

4.2.1 Exposure Points

The measured soil concentrations for non-radiological COPCs were utilized from soil characterization work (soil quality data summarized in **Appendix B**) and the 2019 Environmental Studies report (Ecometrix, 2022c) for Polygon E.

The exposure points for radiological COPCs were obtained from the same general sources as those used in the 2020 ERA (Ecometrix, 2022a) as described below, unless otherwise noted:

- Air emissions: OPG regularly monitors its radiological emissions from the DN site; therefore, there are updated air emissions data for the period 2020 to 2023. At the time of the writing of this report, weekly air emissions data were available for the period 2020 up to Q2 of 2023 as reported in OPG’s quarterly safety performance indicator (SPI) reports.
- Fish tissue (white sucker in Lake Ontario): White sucker samples are collected on a quarterly basis from Lake Ontario and reported in OPG’s EMP reports. The data from 2020, 2021, and 2022 were used to update the radiological doses.

- Water data for Lake Ontario are also available for the period 2020 to 2022. However, as the previous ERA relied upon data collected from a comprehensive 2019 report by Ecometrix (Ecometrix, 2022c), those data were relied upon for the Addendum as they were collected close to the DN site and are still considered representative of current conditions.
- The most up to date lake sediment, pond water, pond sediment, soil, vegetation, and fish tissue data (with the exception of White Sucker) were collected as part of a comprehensive environmental study carried out by Ecometrix in 2019 (Ecometrix, 2022c). Therefore, no updates were required to those media.

4.2.2 Exposure Averaging

For soil, the upper confidence limit of the mean (UCLM) was calculated for Polygon E based on the relevant soil data (i.e., 2019 and 2021 soil sampling studies). Both UCLM and maximum concentrations were used as exposure values.

The UCLM is a reasonably conservative estimate of the exposure concentration for a mobile organism. For less mobile organisms such as plants and invertebrates, both average and upper limit concentrations represent exposures that would be experienced by some organisms on a long-term basis.

4.2.3 Exposure and Dose Calculations

Exposure and dose calculations were performed for each radiological COPC for each ecological receptor for each receptor location. For non-radiological COPCs, dose calculations were not necessary as birds and mammals were not retained for evaluation based on the negligible toxicity of the identified COPCs to terrestrial vertebrates. For other receptors, the concentrations of COPCs at exposure points were used as exposure values, as the toxicity benchmark values are typically expressed as concentrations (CSA, 2022).

4.2.3.1 Radiological Dose Calculations

Radiological dose calculations were estimated using the Ecometrix software IMPACT™ DRL Version 5.5.2 (IMPACT), which is the same version that was used for the 2020 ERA (Ecometrix, 2022a). IMPACT™ is consistent with the equations outlined in CSA N288.1 and the methods outlined in CSA N288.6 (CSA, 2020, 2022). IMPACT™ uses the specific activity model for tritium and C-14 as per CSA N288.1 and as recommended by CSA N288.6 (CSA, 2020, 2022).

4.2.4 Exposure Factors

No changes were required to any of the exposure factors used in the non-radiological or radiological exposure assessment (see Tables 4-9 to 4-12 in the 2020 DN ERA (Ecometrix, 2022a)), with the exception of two specific activity model values for C-14 and the occupancy factors for aquatic and terrestrial plants. In the 2020 update to CSA N288.1 (the 2020 ERA cited

the previous 2014 iteration of N288.1), the stable carbon content for freshwater invertebrates was updated from 111 to 120 gC/kg fw. Furthermore, a stable carbon content for aquatic plants was set at 500 gC/kg dw or 125 gC/kg fw; note that this update did not result in any changes from the 2020 ERA given that this is the same value used for terrestrial plants, and the value for terrestrial plants had been adopted for aquatic plants. The occupancy factors for aquatic and terrestrial plants were updated to better reflect expected occupancy times for sediment surface, soil surface, and water column residency times. As such, the occupancy factors for aquatic plants were changed from 0 to 0.5 (fraction of time spent on the sediment surface) and from 1 to 0.5 (fraction of time spent in the water column). The occupancy factors for terrestrial plants were changed from 0.5 to 0 (fraction of plant immersed in soil) and 0.5 to 1 (fraction of plant above the soil surface).

4.2.5 Dispersion Models

No changes to the dispersion models were needed to support this ERA Addendum and as such, no additional calibrations of IMPACT™ version 5.5.2 since the 2020 ERA (Ecometrix, 2022a) were required.

4.2.6 Exposure Point Concentrations and Doses

4.2.6.1 Exposure Point Concentrations

The measured concentrations of non-radionuclide COPCs used for the exposure evaluation for Polygon E are presented in **Table 4-6**.

Table 4-6: Exposure Point Concentrations for Soil COPCs in Polygon E

	Units	Maximum	UCLM
PHC F1	mg/kg	270	18
PHC F2	mg/kg	460	32
PHC F3	mg/kg	1000	103
Sodium Adsorption Ratio	-	6.70	0.78

The measured concentrations of radionuclides used for the exposure evaluation for the different polygons are listed in **Table 4-7** through **Table 4-11**. In cases where a measured concentration is not provided, the concentration is modelled using exposure factors discussed in **Section 4.2.4**. The emissions used for modelling are provided in **Table 4-12**.

Table 4-7: Exposure Point Concentrations for Radionuclides in Lake Ontario

		Surface Water ¹		Sediment ²		Round Whitefish ³		White Sucker ⁴		Alewife ⁵		Mussels ⁶	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides													
	Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14		2.30E-01	3.13E-02	9.89E-01	2.47E-01	3.40E+01	3.24E+01	3.36E+01	3.10E+01	3.46E+01	3.37E+01	3.79E+01	3.49E+01
Cobalt-60		3.14E-01	3.46E-02	2.08E-01	8.01E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134		5.75E-01	9.41E-02	5.44E-01	1.86E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137		7.25E-01	1.42E-01	1.11E+00	3.19E-01	3.00E-01	2.42E-01	3.00E-01	1.89E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium		1.54E+01	1.72E+00	1.35E+01	5.96E+00	5.00E+00	4.92E+00	5.60E+00	3.09E+00	2.30E+01	2.19E+01	1.00E+01	1.00E+01
Iodine-131		1.10E+00	4.10E-01	1.32E+00	6.48E-01	8.00E+00	8.00E+00	3.00E+00	3.00E+00	1.30E+01	1.30E+01	1.04E+02	1.04E+02

Notes:

- ¹ 2019 Environmental Study (Ecometrix, 2022c) (C-14, Co-60, Cs-134, Cs-137, HTO, I-131).
- ² 2019, 2018 Environmental Study (Ecometrix, 2018, 2019, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131); C-14 was converted from Bq/kg-C using a measured carbon content of 1.75%
- ³ (SENES, 2009b) (I-131); EMP 2011 (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO). C-14 was converted from Bq/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)
- ⁴ (SENES, 2009b) (I-131); REMP 2011-2015 (Cobalt -60); EMP 2020-2022 (C-14, Cesium-134, Cesium-137, HTO). C-14 was converted from Bq/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)
- ⁵ (SENES, 2009b). C-14 was converted from Bq/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)
- ⁶ (SENES, 2009b); mussels used to represent aquatic invertebrates. C-14 was converted from Bq/kg-C using an aquatic invertebrate tissue of 120 gC/kg fw (CSA, 2020)

Table 4-8: Exposure Point Concentrations for Radionuclides in Polygon AB

		Surface Water ¹		Sediment ²		Northern Redbelly Dace ³		Aquatic Plants ⁴		Soil ⁵		Earthworm ⁶		Caterpillar ⁶		Terrestrial Vegetation ⁷		Fruit ⁸	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	Mean	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides	Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14		7.00E-02	6.16E-02	7.10E+00	7.08E+00	3.49E+01	3.18E+01	3.89E+01	3.51E+01	2.35E+00	2.35E+00	3.31E+01	3.17E+01	3.34E+01	2.89E+01	2.88E+01	2.80E+01	1.18E+01	1.18E+01
Cobalt-60		1.19E-01	9.03E-02	1.21E-01	1.09E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134		1.46E-01	1.46E-01	3.38E-01	3.38E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	2.00E-01	2.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137		2.09E-01	1.95E-01	1.51E+00	1.50E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	5.50E+00	5.50E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium		4.68E+01	4.05E+01	4.29E+01	4.13E+01	7.70E+01	7.25E+01	4.30E+01	4.16E+01	1.72E+02	1.72E+02	1.50E+01	1.50E+01	5.30E+01	5.15E+01	4.95E+02	3.15E+02	8.60E+01	8.60E+01
Iodine-131		3.85E+00	2.31E+00	8.68E-01	8.36E-01	3.18E+02	3.18E+02	2.00E+00	2.00E+00	2.20E+00	2.20E+00	1.00E+01	1.00E+01	6.00E+00	6.00E+00	1.70E+01	1.70E+01	2.00E+00	2.00E+00

Notes:

All data obtained from SENES (2009b), unless otherwise indicated.

- ¹ 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131).
 - ² 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bq/kg-C using a measured carbon content of 24 g C /kg
 - ³ C-14 was converted from Bq/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)
 - ⁴ C-14 was converted from Bq/kg-C using an aquatic plant tissue of 125 gC/kg fw (CSA, 2020)
 - ⁵ 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bq/kg-C using a measured carbon content of 1.75%.
 - ⁶ C-14 was converted from Bq/kg-C using an aquatic invertebrate tissue of 120 gC/kg fw (CSA, 2020)
 - ⁷ C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (forage) of 100 gC/kg fw (CSA, 2020). A dry to fresh weight ratio of 0.2 was used to convert non-radionuclide terrestrial vegetation concentrations reported on a dry weight to a wet weight basis (CSA, 2020).
 - ⁸ C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020)
- *indicates negative value

Table 4-9: Exposure Point Concentrations for Polygon C

	Soil ¹		Earthworm ²		Caterpillar ²		Terrestrial Vegetation ³		Fruit ⁴		
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	
Radionuclides											
	Unit	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14		6.69E-01	6.69E-01	3.79E+01	3.79E+01	5.22E+01	5.22E+01	5.77E+01	5.77E+01	1.27E+01	1.27E+01
Cobalt-60		0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134		1.00E-01	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137		7.00E-01	7.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium		2.80E+00	2.80E+00	3.70E+01	3.70E+01	1.85E+02	1.85E+02	2.66E+02	2.66E+02	1.51E+02	1.51E+02
Iodine-131		2.40E+00	2.40E+00	9.00E+00	9.00E+00	8.00E+00	8.00E+00	1.40E+01	1.40E+01	2.00E+00	2.00E+00

Notes:

All data obtained from SENES (2009b), unless otherwise indicated.

¹ 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bq/kg-C with a measured carbon content of 1.99%

² C-14 was converted from Bq/kg-C using an aquatic invertebrate tissue of 120 gC/kg fw (CSA, 2020)

³ C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (forage) of 100 gC/kg fw (CSA, 2020)

⁴ C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020)

* negative value

Table 4-10: Exposure Point Concentrations for Polygon D

	Surface Water ¹		Sediment ²		Frogs ³		Aquatic Plants ⁴		Soil ^{1,5}		Earthworm ⁶		Caterpillar ⁶		Terrestrial Vegetation ⁷		Fruit ⁸		
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	
Radionuclides																			
	Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14		8.90E-02	8.90E-02	6.75E+01	6.75E+01	3.38E+01	3.38E+01	5.75E+01	5.75E+01	7.17E+00	7.17E+00	3.84E+01	3.84E+01	3.53E+01	3.53E+01	5.68E+01	4.87E+01	1.46E+01	1.42E+01
Cobalt-60		5.55E-02	5.55E-02	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134		7.11E-02	7.11E-02	3.35E-01	3.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	2.00E-01	2.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137		6.69E-02	6.69E-02	7.03E+00	6.71E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.30E+00	6.30E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium		5.80E+01	5.80E+01	5.01E+01	4.77E+01	3.80E+01	3.80E+01	5.80E+01	5.80E+01	3.00E+01	3.00E+01	1.90E+01	1.90E+01	9.20E+01	9.20E+01	5.50E+01	4.25E+01	9.30E+01	8.80E+01
Iodine-131		2.21E-01	2.21E-01	5.30E-01	5.26E-01	2.20E+01	2.20E+01	3.00E+00	3.00E+00	3.00E-01	3.00E-01	1.20E+01	1.20E+01	4.00E+00	4.00E+00	2.30E+01	2.30E+01	2.00E+00	2.00E+00

Notes:

All data obtained from SENES (2009b), unless otherwise indicated.

¹ 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131).

² 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bq/kg-C with a measured carbon content of 144 g C/kg

³ C-14 was converted from Bq/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)

⁴ C-14 was converted from Bq/kg-C using an aquatic plant tissue of 125 gC/kg fw (CSA, 2020)

⁵ C-14 was converted from Bq/kg-C with a measured carbon content of 2.77%

⁶ C-14 was converted from Bq/kg-C using an aquatic invertebrate tissue of 111 gC/kg fw (CSA, 2020)

⁷ C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (forage) of 100 gC/kg fw (CSA, 2020). A dry to fresh weight ratio of 0.2 was used to convert non-radionuclide terrestrial vegetation concentrations reported on a dry weight to a wet weight basis (CSA, 2020)

⁸ C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020)

* negative value

Table 4-11: Exposure Point Concentrations for Polygon E

		Surface Water ¹		Soil ^{2,3}		Fruit ⁴	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides							
	Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14		2.30E-01	3.13E-02	1.86E+00	4.46E-01	1.49E+01	1.49E+01
Cobalt-60		3.14E-01	3.46E-02	6.00E-01	8.50E-02	1.00E+00	1.00E+00
Cesium-134		5.75E-01	9.41E-02	4.00E-01	1.82E-01	1.00E+00	1.00E+00
Cesium-137		7.25E-01	1.42E-01	4.60E+00	9.00E-01	1.00E+00	1.00E+00
Tritium		1.54E+01	1.72E+00	1.67E+02	5.31E+01	1.86E+02	1.86E+02
Iodine-131		4.03E+01	7.03E+00	2.20E+00	5.65E-01	2.00E+00	2.00E+00

Notes:

¹ 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131).

² 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bg/kg-C with a measured carbon content of 0.79%.

³C-14 was converted from Bg/kg-C assuming a carbon content of 5%.

⁴C-14 was converted from Bg/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020).

Table 4-12: Emissions to Air used to Model Exposure Point Concentrations

		Air ¹	
		Maximum	UCLM
Radionuclides			
	Unit	Bq/s	Bq/s
Carbon-14		8.60E+04	6.21E+04
Cobalt-60		1.65E-01	1.34E-01
Cesium-134		*	*
Cesium-137		*	*
Tritium Oxide (HTO)		1.82E+07	1.13E+07
Elemental Tritium (HT)		7.94E+07	3.30E+07
Iodine-131		6.45E+00	5.30E+00

Notes:

¹ Maximum and UCLM were determined based on weekly air emission reporting data between Q1 2020 and Q2 2023 (CNSC, 2020a, 2020b, 2020c, 2020d, 2021a, 2021b, 2021c, 2021d, 2022a, 2022b, 2022c, 2022d, 2023a, 2023b). UCLM was calculated as mean+2×standard error.

* The particulate emissions data was used to represent gross beta radionuclides (Cobalt-60, Cesium-134, and Cesium-137). Cobalt-60 is used as the surrogate for gross beta.

4.2.6.2 Exposure Doses for Radionuclides

The estimated radiological doses are presented in **Table 4-13** to **Table 4-17** for receptors at Lake Ontario and Polygons AB, C, D, and E. It is noted that these doses incorporate any emissions from the Mo-99/TDS, which was placed in operation starting in 2023.

The dose rate for ecological receptors in close proximity to the NSS-DWMF (approximately 5 m from any wall) could be up to 1 $\mu\text{Gy/h}$ (0.024 mGy/d), assuming full capacity of the Darlington Waste Management Facility (DWMF) (OPG, 2016).

The dose rate to any ecological receptor at the NSS-DWMF property boundary could be up to 0.5 $\mu\text{Gy/h}$ (0.012 mGy/d), assuming full capacity of the NSS-DWMF (OPG, 2016). Based on measured dose rates at the NSS-DWMF property boundary from Q1 2020 to Q2 2023 (OPG, 2020a, 2020b, 2020c, 2021e, 2021f, 2021g, 2021h, 2022f, 2022g, 2022h, 2022i, 2023g), the average dose rate was 0.087 $\mu\text{Gy/h}$ (0.002 mGy/d). The average dose rate at the RWSB perimeter was 0.067 $\mu\text{Gy/h}$ (0.0016 mGy/d), based on the Q1 2020 to Q2 2023 monitoring results.

The above dose rates estimated for ecological receptors are conservative as it assumes the receptor is always located at the NSS-DWMF and does not incorporate an occupancy factor based on the fraction of time a receptor is likely to be in close proximity to the NSS-DWMF. Based on expected radiological dose rates to ecological receptors in Polygon E located on the DN site (**Table 4-17**), the dose from the NSS-DWMF at full capacity would be the largest contributor to total dose for receptors in Polygon E.

Table 4-13: Estimated Radiation Doses for Aquatic and Riparian Receptors for Lake Ontario (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		Organically bound tritium (OBT)		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Round Whitefish	2.31E-05	2.20E-05	5.10E-07	5.10E-07	4.90E-07	4.90E-07	1.32E-06	1.06E-06	6.91E-07	6.80E-07	2.98E-07	3.33E-08	2.64E-05	2.64E-05	5.28E-05	5.12E-05
White Sucker	2.28E-05	2.11E-05	5.10E-07	5.10E-07	4.90E-07	5.44E-07	1.32E-06	8.32E-07	7.74E-07	4.27E-07	2.98E-07	3.33E-08	9.90E-06	9.90E-06	3.61E-05	3.33E-05
Alewife	2.35E-05	2.29E-05	5.10E-06	5.10E-06	4.90E-06	4.90E-06	4.40E-06	4.40E-06	3.18E-06	3.03E-06	2.98E-07	3.33E-08	4.29E-05	4.29E-05	8.43E-05	8.33E-05
Lake Trout	8.91E-04	1.21E-04	9.62E-05	1.06E-05	9.87E-03	1.62E-03	1.12E-02	2.19E-03	1.60E-06	1.78E-07	2.98E-07	3.33E-08	2.68E-05	1.00E-05	2.21E-02	3.95E-03
American Eel	8.91E-04	1.21E-04	9.41E-05	1.05E-05	9.87E-03	1.62E-03	1.12E-02	2.19E-03	1.60E-06	1.78E-07	2.98E-07	3.33E-08	2.59E-05	9.68E-06	2.21E-02	3.94E-03
Benthic Invertebrates	2.55E-05	2.35E-05	1.25E-06	1.25E-06	1.73E-06	1.73E-06	2.35E-06	2.35E-06	1.39E-06	1.39E-06	2.99E-07	3.34E-08	2.17E-04	2.17E-04	2.50E-04	2.47E-04
Bufflehead	2.83E-05	2.61E-05	1.45E-06	1.25E-06	3.78E-06	3.20E-06	3.28E-06	2.72E-06	2.19E-06	1.37E-06	1.95E-07	1.05E-07	8.42E-07	7.43E-07	4.00E-05	3.55E-05
Mallard	2.83E-05	2.61E-05	1.37E-06	1.18E-06	3.58E-06	3.02E-06	3.10E-06	2.57E-06	2.19E-06	1.37E-06	1.95E-07	1.05E-07	8.03E-07	7.04E-07	3.96E-05	3.50E-05

Note:

No values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Table 4-14: Estimated Radiation Doses for Aquatic and Terrestrial Receptors for Polygon AB (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Northern Redbelly Dace	2.38E-05	2.16E-05	5.10E-06	5.10E-06	4.90E-06	4.90E-06	4.40E-06	4.40E-06	1.06E-05	1.00E-05	9.06E-07	7.84E-07	1.05E-03	1.05E-03	1.10E-03	1.10E-03
Turtles	2.71E-04	2.39E-04	1.29E-05	9.80E-06	1.18E-03	1.18E-03	2.34E-03	2.19E-03	4.85E-06	4.20E-06	9.06E-07	7.84E-07	7.36E-05	4.42E-05	3.88E-03	3.66E-03
Frogs	2.71E-04	2.39E-04	1.29E-05	9.80E-06	1.18E-03	1.18E-03	2.34E-03	2.19E-03	4.85E-06	4.20E-06	9.06E-07	7.84E-07	7.36E-05	4.42E-05	3.88E-03	3.66E-03
Aquatic Plants	2.64E-05	2.39E-05	2.10E-06	2.10E-06	2.70E-06	2.70E-06	3.30E-06	3.30E-06	5.94E-06	5.75E-06	7.12E-07	6.16E-07	5.40E-06	5.40E-06	4.66E-05	4.37E-05
Benthic Invertebrates	2.45E-04	2.15E-04	1.71E-05	1.31E-05	2.65E-05	2.65E-05	5.13E-05	4.81E-05	4.86E-06	4.21E-06	9.08E-07	7.86E-07	7.82E-05	4.73E-05	4.24E-04	3.55E-04
Bufflehead	2.47E-04	2.18E-04	1.40E-05	1.07E-05	3.99E-05	3.99E-05	4.85E-05	4.53E-05	3.08E-06	2.38E-06	1.75E-07	1.17E-07	3.41E-07	2.51E-07	3.53E-04	3.16E-04
Mallard	2.10E-04	1.85E-04	1.12E-05	8.58E-06	3.18E-05	3.18E-05	3.85E-05	3.60E-05	3.13E-06	2.45E-06	1.75E-07	1.17E-07	2.97E-07	2.25E-07	2.96E-04	2.65E-04
Muskrat	4.25E-05	3.84E-05	2.98E-07	2.74E-07	3.99E-06	3.99E-06	4.36E-06	4.34E-06	6.27E-06	5.23E-06	4.28E-07	3.13E-07	2.83E-06	2.43E-06	6.07E-05	5.49E-05
Earthworm	2.25E-05	2.16E-05	1.80E-06	1.80E-06	2.60E-06	2.60E-06	3.40E-06	3.40E-06	2.07E-06	2.07E-06	1.37E-05	7.66E-06	2.70E-05	2.70E-05	7.31E-05	6.61E-05
American Robin	2.23E-05	2.18E-05	3.00E-06	2.99E-06	1.09E-05	1.09E-05	3.79E-05	3.79E-05	3.29E-06	2.77E-06	2.54E-07	1.97E-07	8.37E-06	8.37E-06	8.60E-05	8.49E-05
Bank Swallow	2.50E-05	2.16E-05	2.46E-06	2.45E-06	7.97E-06	7.97E-06	2.11E-05	2.11E-05	3.58E-06	3.00E-06	2.68E-07	2.08E-07	4.23E-06	4.22E-06	6.46E-05	6.06E-05
Song Sparrow	3.27E-05	3.18E-05	5.99E-06	5.98E-06	2.05E-05	2.05E-05	6.29E-05	6.29E-05	7.06E-06	6.22E-06	4.90E-07	3.98E-07	1.33E-05	1.33E-05	1.43E-04	1.41E-04
Yellow Warbler	2.46E-05	2.15E-05	2.66E-06	2.65E-06	8.48E-06	8.48E-06	2.16E-05	2.15E-05	3.64E-06	3.07E-06	2.70E-07	2.11E-07	4.23E-06	4.22E-06	6.55E-05	6.16E-05
Green Heron	2.38E-05	2.17E-05	1.44E-06	1.42E-06	3.66E-06	3.66E-06	3.32E-06	3.31E-06	4.79E-06	4.09E-06	1.75E-07	1.17E-07	2.33E-06	2.32E-06	3.95E-05	3.66E-05
Terrestrial Plants (Grass)	1.96E-05	1.90E-05	1.80E-06	1.80E-06	2.50E-06	2.50E-06	3.40E-06	3.40E-06	6.84E-05	4.35E-05	1.29E-09	7.21E-10	4.42E-05	4.42E-05	1.40E-04	1.14E-04
Eastern Cottontail	3.94E-05	3.83E-05	7.52E-08	7.46E-08	1.02E-05	1.02E-05	6.87E-05	6.86E-05	3.28E-05	2.12E-05	1.74E-06	1.15E-06	3.24E-05	3.20E-05	1.85E-04	1.72E-04
Meadow Vole	3.94E-05	3.83E-05	3.04E-08	3.01E-08	7.85E-06	7.85E-06	6.60E-05	6.60E-05	3.28E-05	2.12E-05	1.74E-06	1.15E-06	2.38E-05	2.35E-05	1.72E-04	1.58E-04
White-tailed Deer	3.94E-05	3.83E-05	5.27E-07	5.21E-07	2.36E-05	2.36E-05	4.31E-05	4.31E-05	3.66E-05	2.36E-05	1.88E-06	1.23E-06	4.90E-05	4.75E-05	1.94E-04	1.78E-04
Common Shrew	4.11E-05	3.56E-05	1.06E-07	1.05E-07	1.18E-05	1.18E-05	7.00E-05	7.00E-05	6.58E-06	5.54E-06	5.63E-07	4.45E-07	2.51E-05	2.49E-05	1.55E-04	1.48E-04
Raccoon	3.29E-05	3.00E-05	1.82E-07	1.55E-07	1.66E-05	1.66E-05	7.80E-05	7.74E-05	1.31E-05	9.17E-06	8.49E-07	6.03E-07	2.95E-05	2.75E-05	1.71E-04	1.62E-04
Red Fox	8.19E-05	7.44E-05	2.14E-08	1.74E-08	8.81E-06	8.81E-06	1.30E-04	1.30E-04	1.62E-05	1.08E-05	7.00E-07	4.88E-07	1.86E-05	1.81E-05	2.57E-04	2.43E-04
Short-tailed Weasel	3.94E-05	3.83E-05	2.22E-09	1.76E-09	7.24E-06	7.24E-06	6.56E-05	6.56E-05	1.96E-05	1.30E-05	5.87E-07	4.18E-07	1.95E-05	1.92E-05	1.52E-04	1.44E-04

Note:
No values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Table 4-15: Estimated Radiation Doses for Terrestrial Receptors for Polygon C (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Earthworm	2.58E-05	2.58E-05	1.80E-06	1.80E-06	2.60E-06	2.60E-06	3.40E-06	3.40E-06	5.11E-06	5.11E-06	9.63E-06	5.39E-06	2.43E-05	2.43E-05	7.26E-05	6.84E-05
American Robin	2.49E-05	2.49E-05	2.96E-06	2.96E-06	9.22E-06	9.22E-06	1.05E-05	1.05E-05	9.59E-06	6.93E-06	8.52E-07	5.59E-07	9.12E-06	9.12E-06	6.71E-05	6.41E-05
Song Sparrow	3.82E-05	3.82E-05	5.92E-06	5.92E-06	1.78E-05	1.78E-05	1.93E-05	1.93E-05	1.90E-05	1.48E-05	1.54E-06	1.07E-06	1.45E-05	1.45E-05	1.16E-04	1.12E-04
Yellow Warbler	3.79E-05	3.79E-05	2.61E-06	2.61E-06	7.54E-06	7.54E-06	7.73E-06	7.73E-06	1.32E-05	1.06E-05	1.02E-06	7.30E-07	4.62E-06	4.62E-06	7.47E-05	7.18E-05
Terrestrial Plants (Grass)	3.92E-05	3.92E-05	1.80E-06	1.80E-06	2.50E-06	2.50E-06	3.40E-06	3.40E-06	3.68E-05	3.68E-05	9.06E-10	5.07E-10	3.64E-05	3.64E-05	1.20E-04	1.20E-04
Eastern Cottontail	7.89E-05	7.89E-05	7.26E-08	7.26E-08	6.93E-06	6.93E-06	1.20E-05	1.20E-05	3.80E-05	2.87E-05	3.38E-06	2.27E-06	3.07E-05	3.07E-05	1.70E-04	1.60E-04
Meadow Vole	7.89E-05	7.89E-05	2.90E-08	2.90E-08	4.64E-06	4.64E-06	9.71E-06	9.71E-06	3.80E-05	2.87E-05	3.38E-06	2.27E-06	2.39E-05	2.39E-05	1.58E-04	1.48E-04
White-tailed Deer	7.89E-05	7.89E-05	5.02E-07	5.02E-07	2.09E-05	2.09E-05	1.46E-05	1.46E-05	3.60E-05	2.85E-05	2.97E-06	2.07E-06	3.97E-05	3.97E-05	1.93E-04	1.85E-04
Common Shrew	6.43E-05	6.43E-05	1.04E-07	1.04E-07	8.59E-06	8.59E-06	1.37E-05	1.37E-05	3.28E-05	2.35E-05	3.15E-06	2.03E-06	2.86E-05	2.86E-05	1.51E-04	1.41E-04
Raccoon	6.29E-05	6.29E-05	8.15E-08	8.15E-08	7.57E-06	7.57E-06	1.27E-05	1.27E-05	3.41E-05	2.44E-05	3.15E-06	2.03E-06	2.74E-05	2.74E-05	1.48E-04	1.37E-04
Red Fox	7.44E-05	7.44E-05	4.59E-09	4.59E-09	3.73E-06	3.73E-06	1.69E-05	1.69E-05	3.94E-05	2.65E-05	3.02E-06	1.83E-06	1.88E-05	1.88E-05	1.56E-04	1.42E-04
Short-tailed Weasel	7.89E-05	7.89E-05	3.05E-10	3.05E-10	3.94E-06	3.94E-06	9.04E-06	9.04E-06	4.09E-05	2.70E-05	2.98E-06	1.77E-06	2.01E-05	2.01E-05	1.56E-04	1.41E-04

Note:

No values exceed the terrestrial benchmark of 2.4 mGy/d.

Table 4-16: Estimated Radiation Doses for Aquatic and Terrestrial Receptors for Polygon D (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Turtles	3.45E-04	3.45E-04	5.91E-06	5.91E-06	5.74E-04	5.74E-04	7.52E-04	7.52E-04	6.01E-06	6.01E-06	1.12E-06	1.12E-06	4.35E-06	4.35E-06	1.69E-03	1.69E-03
Frogs	2.30E-05	2.30E-05	1.50E-06	1.50E-06	2.30E-06	2.30E-06	3.20E-06	3.20E-06	5.25E-06	5.25E-06	1.12E-06	1.12E-06	5.50E-05	5.50E-05	9.14E-05	9.14E-05
Aquatic Plants	3.91E-05	3.91E-05	2.10E-06	2.10E-06	2.70E-06	2.70E-06	3.30E-06	3.30E-06	8.02E-06	8.02E-06	8.82E-07	8.82E-07	8.10E-06	8.10E-06	6.42E-05	6.42E-05
Earthworm	2.61E-05	2.61E-05	1.80E-06	1.80E-06	2.60E-06	2.60E-06	3.40E-06	3.40E-06	2.63E-06	2.63E-06	8.64E-06	4.83E-06	3.24E-05	3.24E-05	7.76E-05	7.38E-05
American Robin	2.66E-05	2.63E-05	2.98E-06	2.98E-06	1.09E-05	1.09E-05	4.23E-05	4.23E-05	3.20E-06	2.83E-06	2.32E-07	1.97E-07	1.22E-06	1.22E-06	8.73E-05	8.67E-05
Song Sparrow	3.92E-05	3.84E-05	5.95E-06	5.95E-06	2.04E-05	2.04E-05	6.99E-05	6.99E-05	7.31E-06	6.62E-06	4.73E-07	4.12E-07	1.87E-06	1.87E-06	1.45E-04	1.44E-04
Yellow Warbler	2.62E-05	2.62E-05	2.63E-06	2.63E-06	8.40E-06	8.40E-06	2.37E-05	2.37E-05	4.75E-06	4.46E-06	3.04E-07	2.72E-07	6.15E-07	6.15E-07	6.67E-05	6.63E-05
Terrestrial Plants (Grass)	3.86E-05	3.31E-05	1.80E-06	1.80E-06	2.50E-06	2.50E-06	3.40E-06	3.40E-06	7.60E-06	5.88E-06	8.13E-10	4.55E-10	5.98E-05	5.98E-05	1.14E-04	1.06E-04
Terrestrial Plants (Sugar Maple)	3.86E-05	3.31E-05	1.80E-05	1.80E-05	1.40E-05	1.40E-05	7.80E-06	7.80E-06	7.60E-06	5.88E-06	8.13E-06	4.55E-06	1.36E-04	1.36E-04	2.30E-04	2.19E-04
Eastern Cottontail	7.76E-05	6.66E-05	7.38E-08	7.38E-08	1.01E-05	1.01E-05	7.79E-05	7.79E-05	6.64E-06	5.45E-06	5.53E-07	4.66E-07	2.10E-05	2.10E-05	1.94E-04	1.82E-04
Meadow Vole	7.76E-05	6.66E-05	2.97E-08	2.97E-08	7.81E-06	7.81E-06	7.53E-05	7.53E-05	6.64E-06	5.45E-06	5.53E-07	4.66E-07	9.83E-06	9.83E-06	1.78E-04	1.65E-04
White-tailed Deer	7.76E-05	6.66E-05	5.14E-07	5.14E-07	2.30E-05	2.30E-05	4.71E-05	4.71E-05	6.64E-06	5.35E-06	5.17E-07	4.26E-07	5.09E-05	5.09E-05	2.06E-04	1.94E-04
Common Shrew	4.35E-05	4.35E-05	1.05E-07	1.05E-07	1.17E-05	1.17E-05	7.93E-05	7.93E-05	8.63E-06	8.18E-06	6.42E-07	5.89E-07	7.07E-06	7.07E-06	1.51E-04	1.50E-04
Raccoon	5.31E-05	4.88E-05	8.30E-08	8.30E-08	1.08E-05	1.08E-05	7.88E-05	7.88E-05	7.47E-06	6.74E-06	5.81E-07	5.16E-07	1.08E-05	1.08E-05	1.62E-04	1.57E-04
Red Fox	7.32E-05	6.28E-05	6.03E-09	6.03E-09	6.71E-06	6.71E-06	1.46E-04	1.46E-04	4.13E-06	3.11E-06	1.90E-07	1.25E-07	4.29E-06	4.29E-06	2.34E-04	2.23E-04
Short-tailed Weasel	7.76E-05	6.66E-05	1.20E-09	1.20E-09	7.15E-06	7.15E-06	7.48E-05	7.48E-05	6.63E-06	5.61E-06	4.57E-07	3.96E-07	3.68E-06	3.68E-06	1.70E-04	1.58E-04

Note:

No values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Table 4-17: Estimated Radiation Doses for Terrestrial Receptors for Polygon E (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Earthworm	1.83E-05	1.32E-05	1.86E-05	2.64E-06	8.09E-06	3.68E-06	3.50E-05	6.84E-06	1.56E-04	8.72E-05	1.56E-05	8.75E-06	1.11E-05	2.85E-06	2.62E-04	1.25E-04
American Robin	2.23E-05	1.93E-05	1.60E-05	3.78E-06	1.15E-05	7.59E-06	3.16E-05	9.33E-06	2.69E-05	1.64E-05	1.35E-06	8.10E-07	8.31E-06	2.15E-06	1.18E-04	5.93E-05
Bank Swallow	2.02E-05	1.46E-05	7.18E-06	1.01E-06	4.01E-06	1.64E-06	1.59E-05	3.12E-06	4.38E-05	2.45E-05	2.13E-06	1.19E-06	4.15E-06	1.07E-06	9.74E-05	4.71E-05
Song Sparrow	3.83E-05	3.69E-05	2.80E-05	8.54E-06	2.47E-05	1.85E-05	5.47E-05	2.01E-05	2.17E-05	1.59E-05	1.16E-06	8.18E-07	1.33E-05	3.46E-06	1.82E-04	1.04E-04
Yellow Warbler	2.04E-05	1.52E-05	7.42E-06	1.27E-06	4.61E-06	2.29E-06	1.64E-05	3.66E-06	4.17E-05	2.34E-05	2.03E-06	1.14E-06	4.16E-06	1.07E-06	9.67E-05	4.80E-05
Terrestrial Plants (Grass)	2.36E-05	1.70E-05	6.71E-05	9.51E-06	3.02E-05	1.37E-05	1.32E-04	2.58E-05	1.50E-04	8.41E-05	1.47E-09	8.24E-10	4.26E-05	1.10E-05	4.45E-04	1.61E-04
Terrestrial Plants (Sugar maple)	2.36E-05	1.70E-05	2.04E-05	2.89E-06	9.00E-06	4.10E-06	3.75E-05	7.33E-06	1.50E-04	8.40E-05	1.47E-05	8.24E-06	1.28E-05	3.30E-06	2.68E-04	1.27E-04
Eastern Cottontail	4.74E-05	3.43E-05	2.96E-05	4.20E-06	1.32E-05	5.80E-06	5.50E-05	1.08E-05	6.67E-05	3.71E-05	3.19E-06	1.76E-06	1.81E-05	4.71E-06	2.33E-04	9.86E-05
Meadow Vole	4.74E-05	3.43E-05	2.96E-05	4.20E-06	1.29E-05	5.74E-06	5.44E-05	1.06E-05	6.67E-05	3.71E-05	3.19E-06	1.76E-06	1.79E-05	4.64E-06	2.32E-04	9.84E-05
White-tailed Deer	4.74E-05	3.43E-05	1.52E-05	2.15E-06	1.11E-05	3.69E-06	3.02E-05	5.91E-06	7.58E-05	4.23E-05	3.59E-06	1.99E-06	9.80E-06	2.69E-06	1.93E-04	9.29E-05
Common Shrew	3.32E-05	2.40E-05	2.96E-05	4.20E-06	1.30E-05	5.82E-06	5.65E-05	1.11E-05	6.67E-05	3.71E-05	3.19E-06	1.76E-06	1.83E-05	4.71E-06	2.20E-04	8.86E-05
Raccoon	3.69E-05	2.75E-05	2.97E-05	4.21E-06	1.42E-05	6.58E-06	5.70E-05	1.17E-05	5.47E-05	3.07E-05	2.53E-06	1.41E-06	1.86E-05	5.06E-06	2.14E-04	8.73E-05
Red Fox	4.47E-05	3.23E-05	2.72E-05	3.85E-06	1.24E-05	5.39E-06	1.07E-04	2.09E-05	3.78E-05	2.08E-05	9.52E-07	5.03E-07	1.65E-05	4.27E-06	2.46E-04	8.81E-05
Short-tailed Weasel	4.74E-05	3.43E-05	2.96E-05	4.20E-06	1.32E-05	5.80E-06	5.49E-05	1.07E-05	3.51E-05	1.93E-05	5.98E-07	3.05E-07	1.80E-05	4.65E-06	1.99E-04	7.93E-05

Note:

No values exceed the terrestrial benchmark of 2.4 mGy/d.

4.2.7 Uncertainties in Exposure Assessment

Uncertainties in the exposure assessment remain as reported in the 2020 DN ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the new data / information that was utilized (**Appendix A**).

4.3 Toxicity Assessment

4.3.1 Toxicological Benchmarks

Terrestrial plant and soil invertebrate benchmarks are based on soil concentrations. For the selected COPCs, the TRVs used are Canadian soil quality guidelines (agricultural soil contact values) (CCME, 1999).

Table 4-18: Toxicological Benchmarks for Soil for Terrestrial Invertebrates and Plants

Parameter	Soil Organism TRV mg/kg dw	Reference	Plant TRV mg/kg dw	Reference
PHC F1	210	CCME, 1999	210	CCME, 1999
PHC F2	150	CCME, 1999	150	CCME, 1999
PHC F3	300	CCME, 1999	300	CCME, 1999
SAR	5	CCME, 1999	5	CCME, 1999

4.3.2 Radiation Benchmarks

Radiation dose benchmarks of 400 µGy/h (9.6 mGy/d) and 100 µGy/h (2.4 mGy/d) (UNSCEAR, 2008) were selected for this assessment of effects on aquatic biota and terrestrial biota, respectively, as recommended in the CSA N288.6 standard. This is a total dose benchmark; therefore, the doses to biota due to each radionuclide of concern are summed to compare against this benchmark.

4.3.3 Uncertainties in the Toxicity Assessment

The uncertainties in the toxicity assessment remain unchanged from the 2020 ERA (Ecometrix, 2022a). No new uncertainties were identified based on the new toxicity benchmarks identified.

4.4 Risk Characterization

4.4.1 Risk Estimation

Ecological risk from radiological COPCs is assessed through comparison with the benchmarks of 2.4 mGy/d and 9.6 mGy/d for terrestrial and aquatic biota, respectively. The dose to ecological receptors from all pathways is presented in **Table 4-19**.

Table 4-19: Summary of Total Radiation Dose Estimates for Ecological Receptors for Lake Ontario, Polygon AB, C, D, and E (mGy/d)

Receptor	Lake Ontario		AB		C		D		E		Percent Benchmark at Maximum Location	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Round Whitefish	5.28E-05	5.12E-05	-	-	-	-	-	-	-	-	0.001%	0.001%
White Sucker	3.61E-05	3.33E-05	-	-	-	-	-	-	-	-	0.000%	0.000%
Alewife	8.43E-05	8.33E-05	-	-	-	-	-	-	-	-	0.001%	0.001%
Lake Trout	2.21E-02	3.95E-03	-	-	-	-	-	-	-	-	0.230%	0.041%
American Eel	2.21E-02	3.94E-03	-	-	-	-	-	-	-	-	0.230%	0.041%
Northern Redbelly Dace	-	-	1.10E-03	1.10E-03	-	-	-	-	-	-	0.011%	0.011%
Turtles	-	-	3.88E-03	3.66E-03	-	-	3.38E-03	3.38E-03	-	-	0.040%	0.038%
Frogs	-	-	3.88E-03	3.66E-03	-	-	1.83E-04	1.83E-04	-	-	0.040%	0.038%
Aquatic Plants	-	-	4.66E-05	4.37E-05	-	-	1.28E-04	1.28E-04	-	-	0.001%	0.001%
Benthic Invertebrates	2.50E-04	2.47E-04	4.24E-04	3.55E-04	-	-	-	-	-	-	0.004%	0.004%
Bufflehead	4.00E-05	3.55E-05	3.53E-04	3.16E-04	-	-	-	-	-	-	0.015%	0.013%
Mallard	3.96E-05	3.50E-05	2.96E-04	2.65E-04	-	-	-	-	-	-	0.012%	0.011%
Muskrat	-	-	6.07E-05	5.49E-05	-	-	-	-	-	-	0.003%	0.002%
Earthworm	-	-	7.31E-05	6.61E-05	7.26E-05	6.84E-05	7.76E-05	7.38E-05	2.62E-04	1.25E-04	0.011%	0.005%
American Robin	-	-	8.60E-05	8.49E-05	6.71E-05	6.41E-05	8.73E-05	8.67E-05	1.18E-04	5.93E-05	0.005%	0.004%
Bank Swallow	-	-	6.46E-05	6.06E-05	-	-	-	-	9.74E-05	4.71E-05	0.004%	0.003%
Song Sparrow	-	-	1.43E-04	1.41E-04	1.16E-04	1.12E-04	1.45E-04	1.44E-04	1.82E-04	1.04E-04	0.008%	0.006%
Yellow Warbler	-	-	6.55E-05	6.16E-05	7.47E-05	7.18E-05	6.67E-05	6.63E-05	9.67E-05	4.80E-05	0.004%	0.003%
Green Heron	-	-	3.95E-05	3.66E-05	-	-	-	-	-	-	0.002%	0.002%
Terrestrial Plants (Grass)	-	-	1.40E-04	1.14E-04	1.20E-04	1.20E-04	1.14E-04	1.06E-04	4.45E-04	1.61E-04	0.019%	0.007%
Terrestrial Plants (Sugar Maple)	-	-	-	-	-	-	2.30E-04	2.19E-04	2.68E-04	1.27E-04	0.011%	0.009%
Eastern Cottontail	-	-	1.85E-04	1.72E-04	1.70E-04	1.60E-04	1.94E-04	1.82E-04	2.33E-04	9.86E-05	0.010%	0.008%
Meadow Vole	-	-	1.72E-04	1.58E-04	1.58E-04	1.48E-04	1.78E-04	1.65E-04	2.32E-04	9.84E-05	0.010%	0.007%
White-tailed Deer	-	-	1.94E-04	1.78E-04	1.93E-04	1.85E-04	2.06E-04	1.94E-04	1.93E-04	9.29E-05	0.009%	0.008%
Common Shrew	-	-	1.55E-04	1.48E-04	1.51E-04	1.41E-04	1.51E-04	1.50E-04	2.20E-04	8.86E-05	0.009%	0.006%
Raccoon	-	-	1.71E-04	1.62E-04	1.48E-04	1.37E-04	1.62E-04	1.57E-04	2.14E-04	8.73E-05	0.009%	0.007%
Red Fox	-	-	2.57E-04	2.43E-04	1.56E-04	1.42E-04	2.34E-04	2.23E-04	2.46E-04	8.81E-05	0.011%	0.010%
Short-tailed Weasel	-	-	1.52E-04	1.44E-04	1.56E-04	1.41E-04	1.70E-04	1.58E-04	1.99E-04	7.93E-05	0.008%	0.007%

Note:
There are no exceedances of the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d

For non-radiological COPCs, the ecological risk is estimated by dividing the exposure point concentration by the toxicological benchmark, yielding a HQ. The benchmark is based on direct contact by plants and soil invertebrates. When the HQ is greater than 1, a potential for adverse ecological effects is inferred, with bolded/shaded values indicating benchmark exceedances. Hazard quotients are provided in **Table 4-20**.

Table 4-20: Hazard Quotients for Polygon E

COPC	HQ for Terrestrial Invertebrates and Plants	
	Maximum	UCLM
PHC F1	1.3	0.09
PHC F2	3.1	0.21
PHC F3	3.3	0.34
SAR	1.3	0.16

While the HQs based on maximum concentrations were greater than 1, the UCLM represents the concentration that a greater proportion of the terrestrial invertebrate and plant communities would be exposed to.

4.4.2 Discussion of Chemical and Radiation Effects

4.4.2.1 Effects Monitoring Evidence

Data used for the problem formulations, screening, and ecological risk assessment were taken from the most recent environmental studies at the site and subsequent to the 2020 ERA (Ecometrix, 2022a), including annual EMP reports (from years 2020 to 2022) and ECA reports (from years 2020 to 2022) prepared for the DN site. No additional data are available beyond what is presented at this time to clarify potential effects at the site.

4.4.2.2 Likelihood of Effects

For radiological COPCs, there were no exceedances of the 9.6 mGy/d radiation benchmark for aquatic biota at any location, nor any exceedances of the 2.4 mGy/d radiation benchmark for terrestrial or riparian biota at any location.

For non-radiological COPCs, the assessment focused on plants and soil invertebrates in Polygon E. The following is a summary of results:

- Maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 exceeded benchmarks for ecological health. However, maximum concentrations assume that the entire ecological population of each receptor is only exposed to the maximum, and not to a range of concentrations. Therefore, comparison to the UCLM, is more representative of expected risks.

- Based on UCLM exposure concentrations, the HQs were below 1, indicating that there are no unacceptable risks for plants and soil organisms.
- Additionally, the terrestrial habitat in Polygon E is minimal with limited vegetation; therefore, any toxic effects at these discrete locations would have little population or community level impact.

The Monarch and the Butternut tree were identified as the only terrestrial invertebrate and plant Species at Risk, respectively, on the DN site that may be exposed to chemical COPCs; as Species at Risk, the assessment endpoint for these receptors is the health of the individual. The maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 occur in the southwest portion of the DNNP lands, where the land is highly disturbed with limited to no vegetation. Given the lack of vegetation, Monarchs would not feed in this area. Additionally, there are no Butternut trees in the vicinity of the locations where soil concentrations exceed toxicity benchmarks; the closest soil sample to the Butternuts had concentrations less than toxicity benchmarks. As such, risks to Species at Risk on the DN site are considered acceptable.

4.4.3 Uncertainties in the Risk Characterization

The uncertainties in the risk characterization remain as presented in the 2020 ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the assessment in this Addendum.

5.0 Conclusions and Recommendations

5.1 Conclusions

5.1.1 Conclusions of the Human Health Risk Assessment (HHRA)

5.1.1.1 Radiological HHRA

In summary, consistent with the 2020 DN ERA (Ecometrix, 2022a), there are no health risks for human receptors as a result of radiological exposure.

The 2020 to 2022 public dose estimates for the critical groups are at most approximately 0.06% of the regulatory public dose limit of 1 mSv/a, and at most approximately 0.04% of the dose from background radiation in the vicinity of DN (1.4 mSv/year excluding medical doses). Demonstration that these critical groups are protected implies that other receptor groups near DN with anticipated lower exposure are also protected.

5.1.1.2 Non-Radiological HHRA

Following the initial COPC screening process, the only COPC (and relevant exposure pathways) retained for further assessment in the non-radiological HHRA was hydrazine in water and fish. Potential risks to human receptors were characterized quantitatively in terms of ILCRs for potential carcinogens (hydrazine). The target risk level is 10^{-6} for cancer risk (ILCR).

The results of the quantitative HHRA are as follows.

- No health risks to human receptors are expected due to exposure to hydrazine in drinking water. The acceptable cancer risk level was not exceeded for any of the receptors based on exposure to the maximum or mean hydrazine concentration in drinking water (based on hydrazine released with the CCW effluent). This is different than the conclusions of the 2020 DN ERA as in this Addendum, risks were calculated incorporating the understanding that hydrazine is known to degrade rapidly under chlorinated conditions typically used for treatment/distribution of drinking water (EC and HC, 2011).
- No health risks to human receptors are expected due to exposure to hydrazine in fish tissue. The acceptable cancer risk level was not exceeded for any receptors based on exposure to mean hydrazine concentration in fish tissue (based on hydrazine released with the CCW effluent). This is different than the conclusions of the 2020 DN ERA (Ecometrix, 2022a) as in this Addendum, risks were calculated using an updated water-to-fish bioconcentration factor which is considered to be more representative of the limited opportunity for fish to be exposed on a continuous basis to hydrazine, given hydrazine releases from the CCW are intermittent. As such, adverse effects on humans due to hydrazine originating from DN through fish ingestion are not expected.

In summary, health risks are not expected for human receptors due to exposure to hydrazine, in drinking water and in fish.

5.1.2 Conclusions of the Ecological Risk Assessment (EcoRA)

5.1.2.1 Radiological EcoRA

For radiological COPCs, there were no exceedances of the 9.6 mGy/d radiation benchmark for aquatic biota at any location, nor any exceedances of the 2.4 mGy/d radiation benchmark for terrestrial or riparian biota at any location. Additionally, dose rates to receptors due to the NSS-DWMF are similar to those assessed in the previous EcoRA, and were well below their respective benchmarks. Since there were no exceedances of the dose benchmarks, Species at Risk would be also protected.

Therefore, adverse effects to ecological receptors based on exposure to radiological COPCs are not expected for any assessed receptors or locations on the DN site based on updated radiological data collected between 2020 and 2022.

5.1.2.2 Non-Radiological EcoRA

The potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks and characterized quantitatively in terms of HQs. A HQ greater than 1 indicates a need to more closely assess the risk to the receptor.

The assessment focused on plants and soil invertebrates in polygon E, based on recent soil data not available during the 2020 DN ERA (Ecometrix, 2022a).

Although the maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 exceeded benchmarks for ecological health, a comparison to UCLM concentrations to benchmarks that are protective of plants and soil invertebrates were below benchmarks for all COPCs (SAR, PHC F1, PHC F2, and PHC F3). Given that the objective of the EcoRA is to protect ecological populations, comparison to a UCLM statistic rather than the maximum is defensible for the purposes of drawing conclusions related to risk. Therefore, risks were considered to be negligible for all ecological receptors, including plants and soil invertebrates. For Species at Risk, comparison to the maximum concentration is appropriate; however, the location of maximum concentrations is limited to an area that is highly disturbed with little to no vegetation, no Butternut trees, and would not serve as habitat or a food source for the Monarch. As such, risks to Species at Risk on the DN site are considered acceptable. As such, adverse effects to ecological receptors based on exposure to non-radiological COPCs are not expected for these COPCs / exposure pathways. Other COPCs / exposure pathways were not evaluated in this Addendum as concentrations were either unchanged or less than those in the 2020 ERA (Ecometrix, 2022a).

Overall, Darlington Nuclear is operating in a manner that is protective of human and ecological receptors residing in the surrounding area.

5.2 Cumulative Effects from On-Site Sources

Consideration of cumulative effects is focused on sources within the DN Site and includes the DNGS, TRF, NSS-DWFM, DNNP lands, and other OPG site activities within the DN property boundary. Environmental monitoring data collected at DN would include the contribution, if any, from PNGS effluent and emissions. However, considering the DN site is approximately 34 km east of the PN Site, the influence from Pickering Nuclear Generating Station emissions at DN would be small.

Air and soil quality studies have been completed to support the future DNNP development on the east side of the DN Site (**Figure 2-1**).

The information from these studies has been incorporated into the ERA Addendum as appropriate and screened for potential COPCs.

DNNP site preparation has been ongoing since 2022. DNNP Construction Phase activities are expected to commence in 2025 once the Licence to Construct has been obtained. When new and relevant on-site data become available in the future, they will be incorporated into the next full ERA update currently scheduled for completion in 2026.

The combined effects of DNNP site preparation activities in conjunction with DNGS operations do not represent a risk to human and ecological receptors.

5.3 Climate Change Considerations

OPG's Climate Change Plan outlines goals to be a net-zero carbon company by 2040 and be a catalyst for a net zero carbon economy by 2050. These goals are supported by advancing initiatives under the four pillars of Mitigate, Adapt, Innovate, and Lead. OPG's adaptation commitment is to ensure climate risks have been considered and appropriately addressed in OPG's operations and asset management processes. OPG continues to advance these processes.

The climate change portfolio draws authority from OPG's environmental management system.

OPG's internal adaptation strategy describes priority work areas for advancing reliability, including the completion of climate-related assessments on existing generation assets to identify risk areas. OPG has collected data, generated projection maps, and performed studies to projected climatic variables, including ensemble of model-generated projected changes in precipitation and air temperature on annual and seasonal basis. OPG will continue building climate assessment considerations into existing processes and programs at DNGS and will continue efforts to foster industry collaboration and develop sector-specific adaptation strategies and best practices.

Furthermore, the DN site continues to be maintained using engineering best practices which account for considerations of extreme weather events. OPG's existing Emergency Management Program addresses actions to be taken to respond to emergencies due to extreme weather events.

This ERA Addendum has relied on data collected between 2020 and 2022, which is updated from the previous iteration. The data reflects changes to climate over this time period. Each subsequent ERA update will continue to use updated data, where relevant, which are similarly expected to reflect climate change impacts during that period.

5.4 Recommendations for the Monitoring Program

Risks were deemed negligible for human and ecological receptors due to exposure to both radiological and non-radiological COPCs. OPG will look for opportunities to decrease the detection limits of hydrazine in water if, in the future, it is recommended that hydrazine is measured in lake water to better quantify actual exposure concentrations rather than have the dataset masked by elevated detection limits. A hydrazine detection limit of 0.05 µg/L in surface water is recommended for any future sampling programs.

5.5 Risk Management Recommendations

There are no risk management recommendations based on the outcome of this ERA Addendum.

The 2020 ERA (Ecometrix, 2022a) noted that a soil characterization study of the yard waste and building materials storage area was being undertaken by OPG, with a recommendation to use those results to determine next steps for management of soil from the yard waste and building material storage area. The soil samples collected at the DNNP site in 2021 included analysis of non-radiological substances and some of the samples include concentrations of SAR, PHC F1, PHC F2, and/or PHC F3 that are greater than the plant and soil invertebrate benchmarks identified in **Section 4.3.1** of this report, which correspond to HQs greater than 1. Therefore, soils at the DNNP site associated with these exceedances should be managed in accordance with the soil management practice developed to support DNNP.

6.0 Quality Assurance/Quality Control

The ERA Addendum makes extensive use of effluent and environmental monitoring data. These data are derived from chemical and radiochemical analyses of samples collected from effluent streams and environmental media around the DN site. The environmental data provided by OPG were collected by qualified staff and analyzed by qualified performing laboratories, such as the station chemistry laboratory and the Whitby Health Physics Laboratory. The EMP has its own quality assurance (QA) program that encompasses activities such as sample collection, laboratory analysis, laboratory quality control, and external laboratory comparison (OPG, 2019). Other samples such as air and soil samples were collected as part of the environmental sampling program for DNNP. These samples were collected and analyzed in accordance with the CSA N288.4 QA requirements for the project. Each sampling campaign involved preparation of a Sampling and Analysis Plan that outlined the data quality objectives, sampling and analysis protocol, required detection limits, roles and responsibilities, quality assurance and health and safety requirements. An inspection and test plan was completed at certain stages throughout the program to verify that work was being completed as specified.

Throughout the planning and preparation of the ERA Addendum, all Ecometrix staff worked under an International Organization for Standardization (ISO) 9001:2015 certified Quality Management System. All work was internally reviewed and verified. Reviews included verification of data and calculations, as well as review of report content and formatting. Comments have been dispositioned and addressed as appropriate by report revisions. The review process has been documented through an electronic paper trail of review comments and dispositions.

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Appendix A Screening Tables for Chemical COPCs

Table A-1: Non-Radiological Screening of Air COPCs for Human Health (ESDM Modelling)

Parameter	Maximum POI Concentration in 2020 ERA		COPC in 2020 ERA?	ESDM Modelling					Equivalent Max POI Concentration for Screening		Selected Human Health Screening Criteria	Screening Criteria Averaging Period	Source / Regulation Schedule Number ^b	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
	Concentration (µg/m ³)	Averaging Period		Maximum POI Concentration Yearly (µg/m ³)			Maximum POI Concentration 2020-2022 (µg/m ³)	Averaging Period	Concentration (µg/m ³)	Averaging Period ^a							
				2020 ¹	2021 ²	2022 ³											
Armeen hdt (tallow alkyl)	0.30	24 hr	No	0.28	0.28	0.28	0.28	24 hr	0.28	24 hr	20	24 hr	Sch. 3	Health	MECP ACB ⁴	Yes	No
Ammonia	17	24 hr	No	9.9	9.9	9.9	9.9	24 hr	9.9	24 hr	100	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Benzo(a)pyrene (sum of PAH)	3.70E-05	24 hr	No	3.60E-05	3.60E-05	3.60E-05	3.60E-05	24 hr	3.60E-05	24 hr	5.00E-05	24 hr	-	Health	MECP AAQC ⁵	Yes	No
	3.60E-06	Annual	No	3.60E-06	3.60E-06	3.60E-06	3.60E-06	Annual	3.60E-06	Annual	1.00E-05	Annual	Sch. 3	Health	MECP ACB	Yes	No
Cadmium	2.60E-04	24 hr	No	2.50E-04	2.50E-04	2.50E-04	2.50E-04	24 hr	2.50E-04	24 hr	2.50E-02	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Carbon Dioxide	16,228	24 hr	No	15,947	15,947	15,947	15,947	24 hr	15,947	24 hr	255,800	24 hr	SL-PA	Health	MECP ACB	Yes	No
Chloride (as hydrogen chloride)	0.23	24 hr	No	0.22	0.22	0.22	0.22	24 hr	0.22	24 hr	20	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Chromium (VI)	4.30E-04	24 hr	No	1.60E-04	1.60E-04	1.60E-04	1.60E-04	24 hr	1.60E-04	24 hr	3.50E-04	24 hr	-	Health	MECP AAQC (as PM ₁₀)	Yes	No
	3.70E-05	Annual	No	1.60E-05	1.60E-05	1.60E-05	1.60E-05	Annual	1.60E-05	Annual	1.40E-04	Annual	Sch. 3	Health	MECP ACB	Yes	No
Cobalt	0.0039	24 hr	No	0.0038	0.0038	0.0038	0.0038	24 hr	0.0038	24 hr	0.1	24 hr	-	Health	MECP AAQC	Yes	No
Fluoride	0.02	24 hr	No	0.02	2.0E-02	0.02	0.02	24 hr	0.02	24 hr	No Health-Based Guideline Available			-	No ^f	No ^f	
	0.0061	30 day	No	0.0060	0.0060	0.0060	0.0060	30 day	0.0060	30 day	No Health-Based Guideline Available			-	No ^f	No ^f	
Hydrazine	3.90E-04	Annual	No	1.42E-04	1.42E-04	1.42E-04	1.42E-04	Annual	1.42E-04	Annual	1.00E-03	Annual	SL-JSL	Health	MECP ACB	Yes	No
Iron	0.27	24 hr	No	0.15	0.15	0.15	0.15	24 hr	0.15	24 hr	4	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Manganese	0.07	24 hr	No	0.03	0.03	0.03	0.03	24 hr	0.03	24 hr	0.4	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Morpholine	3.6	24 hr	No	3.2	3.2	3.2	3.2	24 hr	3.2	24 hr	200	24 hr	SL-JSL	Health	MECP ACB	Yes	No
Nickel	0.06	24 hr	No	0.05	0.05	0.05	0.05	24hr	0.05	24hr	0.10	24 hr	-	Health	MECP AAQC (as PM ₁₀)	Yes	No
	0.0057	Annual	No	0.0054	0.0054	0.0054	0.0054	Annual	0.0054	Annual	0.04	Annual	Sch. 3	Health	MECP ACB	Yes	No
Nitrogen Oxides ^c	205	1 hr	Yes	205	205	205	205	1 hr	205	1 hr	113 ^d	1 hr	-	Health	CCME CAAQS ⁶	Yes	No ⁹
	30.2	24 hr	No	30.2	30.2	30.2	30.2	24 hr	30.2	24 hr	200	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Phosphorus	0.0061	24 hr	No	0.0060	0.0060	0.0060	0.0060	24 hr	0.006	24 hr	0.5	24 hr	SL-MD	Health	MECP ACB	Yes	No
Sodium Hypochlorite	1.24	24 hr	No	0.84	0.84	0.84	0.84	24 hr	0.84	24 hr	9	24 hr	SL-PA	Health	MECP ACB	Yes	No
Sodium Sulfite	0.07	24 hr	No	0.07	0.07	0.07	0.07	24 hr	0.07	24 hr	0.14	24 hr	SL-JSL	Health	MECP ACB	Yes	No
Sulphur Dioxide	0.1	24 hr	No	0.14	0.14	0.14	0.14	24 hr	0.14	24 hr	275	24 hr	Sch. 3	Health & Vegetation	MECP ACB	Yes	No
									0.027	Annual	13 ^e	Annual	-	Health	CCME CAAQS	No	No
	1	1 hr	No	1.1	1.1	1.1	1.1	1 hr	1.1	1 hr	183 ^e	1 hr	-	Health	CCME CAAQS	Yes	No
Vanadium	0.02	24 hr	No	0.02	0.02	0.02	0.02	24 hr	0.02	24 hr	2	24 hr	Sch. 3	Health	MECP ACB	Yes	No

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Notes

- ^a The max POI concentrations were converted to the averaging period of benchmarks by following instruction provided in Section 4.4 of the document "Air Dispersion Modelling Guideline for Ontario, Version 3.0" by MOECC.
- ^b Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
- ^c Nitrogen oxides (NO_x) are defined as the sum of nitrogen dioxide (NO₂) and nitric oxide (NO). Emissions of NO_x consist mainly of NO, with some NO₂. In ambient air, NO converts to NO₂. NO₂ has adverse health effects at much lower concentrations than NO. Therefore, air quality guidelines are typically based on the health effects of NO₂.
- ^d The 1-hour and Annual CAAQS's for nitrogen dioxide are 60 and 17 ppb, respectively. These values were converted to µg/m³ using the ratio 1 ppb NO₂ = 1.88 µg/m³
- ^e The 1-hour and Annual CAAQS's for sulphur dioxide are 70 and 5 ppb, respectively. These values were converted to µg/m³ using the ratio 1 ppb SO₂ = 2.62 µg/m³
- ^f There is limited information available concerning inhalation exposure to particulates of inorganic fluoride compounds. Air standards are driven by effects on vegetation and will be considered in the EcoRA.
- ⁹ Refer to Section 3.1.2.1 of the Addendum report for further discussion
- POI - Point of Impingement
 SL-JSL - Jurisdictional Screening Level
 SL-MD - Ministry-derived Screening Levels
 SL-PA - Previously Accepted Screening Level
 PM₁₀ - Particulate matter with a particle diameter of 10 µm or less.

Value Indicates parameter exceeded screening benchmark

Table A-2: Non-Radiological Screening of Air COPCs for Human Health (DNNP Air Monitoring)

Parameter	Maximum Measured Concentration ($\mu\text{g}/\text{m}^3$) ^{1, a}	Averaging Period	Selected Human Health Screening Criteria	Screening Criteria Averaging Period	Source / Regulation Schedule Number ^b	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Particulate Matter (PM)									
Total Suspended Particulates (TSP)	348.2	24 hr	120	24 hr	-	Visibility	MECP AAQC ²	Yes	No ^h
PM _{2.5}	113.6	1 hr	-	-	-	-	-	-	-
	51.7	24 hr	27	24 hr	-	Health	MECP AAQC	Yes	No ^h
PM ₁₀	726.7	1 hr	-	-	-	-	-	-	-
	271.1	24 hr	50	24 hr	-	Health	MECP AAQC	Yes	No ^h
Gases									
Nitrogen Dioxide (NO ₂)	127	1 hr	113 ^c	1 hr	-	Health	CCME CAAQS ³	Yes	No ^h
	44	24 hr	200	24 hr	Sch. 3	Health	MECP ACB ⁴	No	No
Sulphur Dioxide (SO ₂)	402	1 hr	183 ^d	1 hr	-	Health	CCME CAAQS	Yes	No ^h
	59	24 hr	275	24 hr	Sch. 3	Health & Vegetation	MECP ACB	No	No
Volatile Organic Compounds (VOCs)									
2-Propanone (Acetone)	22.2	24 hr	11,880	24 hr	-	Health	MECP AAQC	Yes	No
Dichlorodifluoromethane (FREON 12)	2.9	24 hr	500,000	24 hr	-	Health	MECP AAQC	Yes	No
Chloromethane	2.4	24 hr	320	24 hr	-	Health	MECP AAQC	Yes	No
Trichlorofluoromethane (FREON 11)	2.5	24 hr	6,000	24 hr	-	Health	MECP AAQC	Yes	No
2-propanol	13.3	24 hr	7,300	24 hr	-	Health	MECP AAQC	Yes	No
Methyl Ethyl Ketone (2-Butanone)	5.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	Yes	No
1,1-Dichloroethylene	6.2	24 hr	10	24 hr	-	Health	MECP AAQC	No	No
Methylene Chloride (Dichloromethane)	4.6	24 hr	220	24 hr	-	Health	MECP AAQC	Yes	No
	2.1	Annual ^f	44	Annual	-	Health	MECP AAQC	No	No
Carbon Tetrachloride	1.4	24 hr	2.4	24 hr	-	Health	MECP AAQC	Yes	No
1,1-Dichloroethane	2.5	24 hr	165	24 hr	-	Health	MECP AAQC	No	No
1,2-Dichloroethane	0.9	24 hr	2	24 hr	-	Health	MECP AAQC	No	No
	0.4	Annual ^f	0.4	Annual	-	Health	MECP AAQC	No	No
1,1,1-Trichloroethane	35.3	24 hr	115,000	24 hr	-	Health	MECP AAQC	No	No
Tetrachloroethylene (PCE)	7.1	24 hr	360	24 hr	-	Health	MECP AAQC	Yes	No
	1.1	Annual ^f	2.3	Annual	-	Health	MECP AAQC	No	No
Benzene	1.2	24 hr	2.3	24 hr	-	Health	MECP AAQC	Yes	No
	0.5	Annual^f	0.45	Annual	-	Health	MECP AAQC	Yes^g	No ^h
Toluene	17.6	24 hr	2,000	24 hr	-	Odour	MECP AAQC	Yes	No
Ethylbenzene	1.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	Yes	No
p+m-Xylene	9.7	24 hr	730	24 hr	-	Health	MECP AAQC	Yes	No
o-Xylene	7.5	24 hr	730	24 hr	-	Health	MECP AAQC	Yes	No
Styrene	0.9	24 hr	400	24 hr	-	Health	MECP AAQC	Yes	No
1,3,5-Trimethylbenzene	5.4	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
1,2,4-Trimethylbenzene	28.5	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
Hexane	633	24 hr	7,500	24 hr	-	Health	MECP AAQC	Yes	No
Heptane	6.1	24 hr	11,000	24 hr	-	Health	MECP AAQC	Yes	No
Cyclohexane	1.5	24 hr	6,100	24 hr	-	Health	MECP AAQC	Yes	No
Naphthalene	5.2	24 hr	22.5	24 hr	-	Health	MECP AAQC	Yes	No
Total Xylenes	17.2	24 hr	730	24 hr	-	Health	MECP AAQC	Yes	No
Propene	2.4	24 hr	4,000	24 hr	-	Health	MECP AAQC	Yes	No
Polycyclic Aromatic Hydrocarbons (PAHs)									
Benzo(a)pyrene (BAP) ^e	2.28E-04	24 hr	5.0E-05	24 hr	-	Health	MECP AAQC	Yes	No ^h

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- MECP Ambient Air Quality Criteria (AAQC). Accessed in November 2023 from <https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria>
- Canadian Council of Ministers of the Environment (CCME), Canadian Ambient Air Quality Standards (CAAQS). Available from: <https://ccme.ca/en/air-quality-report#slide-7>.
- Ministry of the Environment, Conservation and Parks (MECP), Ontario. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants.

Notes

- ^a The concentrations of NO₂ and SO₂ were converted from ppb to $\mu\text{g}/\text{m}^3$ using the following ratios: 1 ppb NO₂ = 1.88 $\mu\text{g}/\text{m}^3$ and 1 ppb SO₂ = 2.62 $\mu\text{g}/\text{m}^3$.
- ^b Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
- ^c The 1-hour and Annual CAAQS's for nitrogen dioxide are 60 and 17 ppb, respectively. These values were converted to $\mu\text{g}/\text{m}^3$ using the ratio 1 ppb NO₂ = 1.88 $\mu\text{g}/\text{m}^3$.
- ^d The 1-hour and Annual CAAQS's for sulphur dioxide are 70 and 5 ppb, respectively. These values were converted to $\mu\text{g}/\text{m}^3$ using the ratio 1 ppb SO₂ = 2.62 $\mu\text{g}/\text{m}^3$.
- ^e The screening of PAHs is represented by benzo(a)pyrene, as it has the lowest AAQC of 5.0E-05 $\mu\text{g}/\text{m}^3$.
- ^f Represents weighted averages, where the non-detectable samples in the average are equal to the detection limit
- ^g Note, over 50% of benzene samples were reported as non-detects (i.e. below the laboratory detection limit)
- ^h Refer to Section 3.1.2.1 of the Addendum report for further discussion

Table A-3: Human Health Screening Criteria for Screening Surface Water COPCs

Parameter	Unit	Drinking Water CWQG (1)	ODWS/MOE GW1 Component Value (2)	Guideline from Other Source		95th Percentile Background, 2019 Environmental Study (3)	Detection Limit (3)	Selected Human Health Screening Criteria	Reference
				Value	Source				
Physical/Conventional Characteristics									
Field Temperature	Celsius	-	-	-	-	21.64	-	-	- ^a
Field pH	pH	None	-	-	-	8.99	-	None	- ^a
pH	pH	None	-	-	-	8.42	-	None	- ^a
Field Sp. Conductance	µS/cm	-	-	-	-	569.4	-	-	- ^a
Conductivity	umho/cm	-	-	-	-	570.5	1	-	- ^a
Field Turbidity	NTU	-	-	-	-	-	-	-	- ^a
Turbidity	NTU	-	-	-	-	6.08	0.1	-	- ^a
Alkalinity (Total as CaCO3)	mg/L	-	-	-	-	200.0	1	-	- ^a
Total Hardness (CaCO3)	mg/L	-	-	-	-	266.9	0.5 - 1	-	- ^a
Total Suspended Solids	mg/L	-	-	-	-	11.15	1 - 10	-	- ^a
Total Residual Chlorine	mg/L	Not Required	-	-	-	0.019	0.0012	Not Required	- ^a
Nutrients									
Dissolved Organic Carbon	mg/L	-	-	-	-	8.105	0.5	-	- ^a
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	-	-	0.453	0.1	-	- ^a
Total Ammonia-N	mg/L	None required	-	-	-	0.191	0.01 - 1	None required	- ^a
Total Un-ionized Ammonia	mg/L	-	-	-	-	0.0211	0.00051 - 0.044	None required	- ^a
Total BOD	mg/L	-	-	-	-	<2	2	-	- ^a
Total Chemical Oxygen Demand (COD)	mg/L	-	-	-	-	18.1	4	-	- ^a
Orthophosphate (P)	mg/L	-	-	-	-	0.009013 ^g	0.01	-	- ^a
Total Phosphorus	mg/L	-	-	-	-	0.045	0.02 - 2.51	-	- ^a
Anion									
Chloride (Cl)	mg/L	-	250000	-	-	-	-	250000	(2)
Nitrate (N)	mg/L	10	-	-	-	0.58	0.1	10	(1)
Nitrite (N)	mg/L	1	-	-	-	0.00612 ^g	0.01	1	(1)
Hydrocarbons									
Benzene	µg/L	5	5	-	-	0 ^g	0.1 - 0.5	5	(1,2)
Ethylbenzene	µg/L	140	2.4	-	-	0 ^g	0.1 - 0.5	2.4	(2)
Toluene	µg/L	60	24	-	-	-	-	24	(2)
m,p-xylene	µg/L	-	-	-	-	-	-	90	(1)
o-xylene	µg/L	-	-	-	-	-	-	90	(1)
Xylene, Total	µg/L	90	300	-	-	-	-	90	(1)
F1 (C6-C10)	µg/L	-	820	-	-	0 ^g	25	820	(2)
F1 (C6-C10) - BTEX	µg/L	-	820	-	-	-	-	820	(2)
F2 (C10-C16 Hydrocarbons)	µg/L	-	300	-	-	0 ^g	100	300	(2)
F3 (C16-C34 Hydrocarbons)	µg/L	-	1000	-	-	142.51 ^g	200	1000	(2)
F4 (C34-C50 Hydrocarbons)	µg/L	-	1100	-	-	-	-	1100	(2)
Ethylene Glycol	mg/L	-	-	3.2	US EPA (4)	-	-	2	(4)
Propylene Glycol	mg/L	-	-	80	US EPA (4)	-	-	10	(4)
Biological									
Chlorophyll	µg/L	-	-	-	-	3.09	0.1 - 0.2	-	- ^a
Background	CFU/100mL	-	-	-	-	-	-	-	- ^a
Total Coliforms	CFU/100mL	Non detectable	-	-	-	220	10	Non detectable	(1)
Fecal coliform	CFU/100mL	-	-	-	-	20.5	10	Non detectable	(1) ^b
Escherichia coli	CFU/100mL	Non detectable	-	-	-	20	10	Non detectable	(1)
Metals									
Total Aluminum (Al)	µg/L	2900	-	9500	BC CSR (5)	84.3	0.5 - 5	2900	(5)
Dissolved (0.2u) Aluminum (Al)	µg/L	-	-	-	-	6.05	5	2900	(5) ^f
Total Antimony (Sb)	µg/L	6	6	-	-	0.1846 ^g	0.02 - 0.5	6	(1,2)
Total Arsenic (As)	µg/L	10	25	-	-	0.829	0.02 - 1	10	(1)
Total Barium (Ba)	µg/L	2000	1000	-	-	38.64	0.02 - 2	1000	(2)
Total Beryllium (Be)	µg/L	-	4	-	-	0.007 ^g	0.01 - 0.5	4	(2)
Total Bismuth (Bi)	µg/L	-	-	-	-	0.0038 ^g	0.005 - 1	-	- ^a
Total Boron (B)	µg/L	5000	5000	-	-	158	10 - 50	5000	(1,2)
Total Cadmium (Cd)	µg/L	7	5	-	-	0.00788 ^g	0.005 - 0.1	5	(2)
Total Calcium (Ca)	µg/L	Not Required	-	-	-	70680	0.05 - 250	None required	- ^a
Total Cesium (Cs)	µg/L	-	-	1	ATSDR (6)	0.0124 ^g	0.05 - 0.2	1	(6)
Total Chromium (Cr)	µg/L	50	50	-	-	0.9694 ^g	0.1 - 5	50	(1,2)
Chromium (+3)	µg/L	None	-	-	-	0 ^g	0.5 - 5	None	- ^a
Chromium (VI)	µg/L	50	25	-	-	0.31525 ^g	0.5	25	(2)
Total Cobalt (Co)	µg/L	-	3	-	-	0.121 ^g	0.005 - 0.5	3	(2)
Total Copper (Cu)	µg/L	2000	1000	-	-	0.8516 ^g	0.05 - 1	1000	(2)
Gadolinium (Gd)	µg/L	-	-	140	US EPA (7)	-	-	140	(7)
Total Iron (Fe)	µg/L	None	-	-	-	174.6	1 - 100	None	(1)
Total Lead (Pb)	µg/L	5	10	-	-	0.1174 ^g	0.005 - 0.5	5	(1)
Total Lithium (Li)	µg/L	-	-	8	US EPA (4)	4.714	0.5 - 5	4	(4)
Total Magnesium (Mg)	µg/L	None required	-	-	-	25840	0.05 - 250	None required	- ^a
Total Manganese (Mn)	µg/L	120	-	-	-	20.8	0.05 - 2	120	(1)
Mercury (Hg)	µg/L	1	1	-	-	0.002405 ^g	0.01	1	(1,2)
Total Molybdenum (Mo)	µg/L	-	70	-	-	1.238	0.05 - 1	70	(2)
Total Nickel (Ni)	µg/L	-	100	-	-	0.6306 ^g	0.02 - 1	100	(2)
Total Potassium (K)	µg/L	-	-	-	-	5528	0.05 - 1000	-	- ^a
Total Selenium (Se)	µg/L	50	10	-	-	0.1616 ^g	0.04 - 2	10	(2)
Total Silicon (Si)	µg/L	-	-	-	-	1943	50	1943	(3)
Total Silver (Ag)	µg/L	-	100	-	-	0.00282 ^g	0.005 - 0.1	100	(2)
Total Sodium (Na)	µg/L	-	200000	-	-	25480	0.05 - 250	200000	(2)
Total Strontium (Sr)	µg/L	7000	-	-	-	453.8	0.05 - 1	7000	(1)
Total Tellurium (Te)	µg/L	-	-	-	-	-	-	-	- ^a
Total Thallium (Tl)	µg/L	-	2	-	-	0.0088 ^g	0.002 - 0.05	2	(2)
Total Thorium (Th)	µg/L	-	-	250	WHO (8)	0.0094 ^g	0.005 - 1	250	(8)
Total Tin (Sn)	µg/L	-	-	2400	US EPA (4)	0.09528 ^g	0.2 - 5	2400	(4)
Total Titanium (Ti)	µg/L	-	-	15	WHO (9)	4.7056 ^g	0.5 - 5	15	(9)
Total Tungsten (W)	µg/L	-	-	3.2	US EPA (4)	0.11595 ^g	0.01 - 1	3.2	(4)
Total Uranium (U)	µg/L	20	20	-	-	0.9486	0.002 - 0.1	20	(1,2)
Total Vanadium (V)	µg/L	-	6.2	-	-	0.9878 ^g	0.2 - 5	6.2	(2)
Total Zinc (Zn)	µg/L	-	5000	-	-	2.7904 ^g	0.1 - 5	5000	(2)
Dissolved Zinc (Zn)	µg/L	-	-	-	-	2.9245 ^g	5	5000	(2) ^f
Total Zirconium (Zr)	µg/L	-	-	0.32	US EPA (4)	0.0668 ^g	0.1 - 1	0.32	(4)
Other									
Hydrazine	µg/L	-	-	0.01	US EPA IRIS (10)	<0.1	0.1	0.01	(10)
Morpholine	µg/L	-	-	1700	HC (11)	1 ^g	4	1700	(11)
Alcohol ethoxylates	µg/L	-	-	-	-	See Table A-5b	-	- ^e	-
Polychlorinated Biphenyls	µg/L	-	3	-	-	-	-	3	(2)
Bromoform	µg/L	-	25	-	-	0 ^g	0.2 - 1	25	(2)
Chloroform	µg/L	-	25	-	-	0 ^g	0.1 - 0.5	25	(2)
Bromodichloromethane	µg/L	-	16	-	-	0 ^g	0.1 - 0.5	16	(2)
Trihalomethanes (THMs)	µg/L	100 ^d	-	-	-	-	-	100	(1) ^g

References:

- Health Canada. 2022. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.
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Notes:

- ^a The parameter is not considered of human health concern, and therefore no screening benchmark is necessary.
- ^b The CWQG value for E.coli and total coliforms is used to screen fecal coliforms.
- ^c IPWQO values for both 1,2- and 1,3- propylene glycol were available. The lower value for 1,3-propylene glycol is illustrated here for a conservative approach.
- ^d Refers to the total of chlorodibromomethane, chloroform, bromodichloromethane and bromoform.
- ^e Screening criteria selection for alcohol ethoxylates is detailed in Table A.6b, c.
- ^f Total metal guideline is applied to dissolved.
- ^g Values are stats results using un-detected uncensored data.

Table A-4 Screening of Lake Water for Human Health (no new data since 2020 ERA)

Parameter	Unit	Selected Benchmark	Reference	2020 ERA Max ¹²	COPC in the 2020 ERA?	Exceeds Screening Criteria	Carried Forward as COPC for Addendum?
Nutrients							
Nitrate (N)	mg/L	10	(1)	2.2	No	No	No
Nitrite (N)	mg/L	1	(1)	0.013	No	No	No
Hydrocarbons							
Benzene	µg/L	5	(1,2)	0.14	No	No	No
Ethylbenzene	µg/L	2.4	(2)	0	No	No	No
F1 (C6-C10)	µg/L	820	(2)	0	No	No	No
F1 (C6-C10) - BTEX	µg/L	820	(2)	0	No	No	No
F2 (C10-C16 Hydrocarbons)	µg/L	300	(2)	0	No	No	No
F3 (C16-C34 Hydrocarbons)	µg/L	1000	(2)	170	No	No	No
F4 (C34-C50 Hydrocarbons)	µg/L	1100	(2)	0	No	No	No
Biological							
Total Coliforms	CFU/100mL	Non detectable	(1)	2100	No ^b	Yes	No ^b
Fecal coliform	CFU/100mL	Non detectable	(1)	2000	No ^b	Yes	No ^b
Escherichia coli	CFU/100mL	Non detectable	(1)	2000	No ^b	Yes	No ^b
Metals							
Total Aluminum (Al)	µg/L	2900	(5)	142	No	No	No
Dissolved (0.2u) Aluminum (Al)	µg/L	2900	(5) ^c	21	No	No	No
Total Antimony (Sb)	µg/L	6	(1,2)	0.176	No	No	No
Total Arsenic (As)	µg/L	10	(1)	0.841	No	No	No
Total Barium (Ba)	µg/L	1000	(1,2)	32.3	No	No	No
Total Beryllium (Be)	µg/L	4	(2)	0.007	No	No	No
Total Boron (B)	µg/L	5000	(1,2)	27	No	No	No
Total Cadmium (Cd)	µg/L	5	(1,2)	0.016	No	No	No
Total Cesium (Cs)	µg/L	1	(6)	0.087	No	No	No
Total Chromium (Cr)	µg/L	50	(1,2)	1.346	No	No	No
Chromium (+3)	µg/L	None	-	0	No	No	No
Chromium (VI)	µg/L	25	(2)	0.34	No	No	No
Total Cobalt (Co)	µg/L	3	(2)	0.091	No	No	No
Total Copper (Cu)	µg/L	1000	(2)	1	No	No	No
Total Iron (Fe)	µg/L	None	(1)	178	No	No	No
Total Lead (Pb)	µg/L	5	(1)	0.157	No	No	No
Total Lithium (Li)	µg/L	4	(4)	10.2	Yes	Yes	No ^e
Total Manganese (Mn)	µg/L	120	(1)	18.1	No	No	No
Mercury (Hg)	µg/L	1	(1,2)	0.0031	No	No	No
Total Molybdenum (Mo)	µg/L	70	(2)	1.35	No	No	No
Total Nickel (Ni)	µg/L	100	(2)	0.703	No	No	No
Total Selenium (Se)	µg/L	10	(2)	0.189	No	No	No
Total Silicon (Si)	µg/L	1943	(3)	932	No	No	No
Total Silver (Ag)	µg/L	100	(2)	0.006	No	No	No
Total Sodium (Na)	µg/L	200000	(2)	39600	No	No	No
Total Strontium (Sr)	µg/L	7000	(1)	625	No	No	No
Total Thallium (Tl)	µg/L	2	(2)	0.014	No	No	No
Total Thorium (Th)	µg/L	250	(8)	0.014	No	No	No
Total Tin (Sn)	µg/L	2400	(4)	0.405	No	No	No
Total Titanium (Ti)	µg/L	15	(9)	5.2	No	No	No
Total Tungsten (W)	µg/L	3.2	(4)	0.134	No	No	No
Total Uranium (U)	µg/L	20	(1,2)	0.61	No	No	No
Total Vanadium (V)	µg/L	6.2	(2)	0.64	No	No	No
Total Zinc (Zn)	µg/L	5000	(2)	3.138	No	No	No
Dissolved Zinc (Zn)	µg/L	5000	(2) ^c	13	No	No	No
Total Zirconium (Zr)	µg/L	0.32	(4)	0.34	Yes	Yes	No ^e
Other							
Hydrazine	µg/L	0.01	(10)	0.11	Yes	Yes	No ^e
Morpholine	µg/L	1700	(11)	2	No	No	No
Bromoform	µg/L	25	(2)	0	No	No	No
Chloroform	µg/L	25	(2)	0	No	No	No
Bromodichloromethane	µg/L	16	(2)	0	No	No	No

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- Health Canada. 2022. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.
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- Health Canada (2002). A Summary of the Health Hazard Assessment of Morpholine in Wax Coatings of Apples. <https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/information-product/summary-health-hazard-assessment-morpholine-coatings-apples.html>. [Converted TDI (0.48 mg/kgBW/day) to DW criterion.]
- OPG (Ontario Power Generation), 2022. 2020 Environmental Risk Assessment for the Darlington Nuclear Site. Report No. D-REP-07701-00001-R002. April.

Notes:

- ^a ND: No Data
- ^b Not considered to be nuclear or hazardous substance, so are not COPCs under CSA N288.6 and not associated with Darlington Nuclear. The rationale for not carrying these parameters forward as COPCs is discussed in Section 3.1.2.2.1.
- ^c Total metal guideline is applied to dissolved.
- ^d There is no expected human health concern for silicon, so it was not carried forward as a COPC. See Section 3.1.2.2.1.
- ^e Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value Indicates parameter exceeded screening benchmark

Table A-5: Screening of CCW Effluent (ECA Data) for Human Health

Parameter	Unit	Human Health Screening Criteria ^a	Source / Basis	2020 DN ERA			Measured Maximum Concentrations from ECAs			Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	Carried forward as COPC for Addendum?
				Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	COPC in 2020 ERA?	2020	2021	2022			
Un-ionized Ammonia	mg/L	None required	CDWQ (1) ^b	0.01	0.0014	No	<0.01	0.01	0.01	0.01	0.0014	No
Hydrazine	mg/L	0.00001	US EPA IRIS (10)	0.006	0.0009	Yes	0.004	0.003	0.0076	0.0076	0.0011	Yes
Morpholine	mg/L	1.7	HC (11)	0.006	0.0009	No	0.009	0.002	0.003	0.009	0.0013	No
pH	pH units	None	CDWQ (1) ^c	7.9-8.6	7.9-8.6 ^e	No	7.8-8.3	8.5	7.7-8.4	7.8-8.5	7.8-8.5 ^e	No
TRC	mg/L	Not Required	CDWQ (1) ^d	0.01	0.0014	No	0.009	0.01	0.01	0.01	0.0014	No

Notes:

^a See Table A-2 for references of selected screening benchmarks.

^b A maximum allowable concentration for ammonia is not required according to the HC CWQG. Ammonia is naturally occurring or added as part of chloramination for drinking water disinfection.

^c HC (2022) recommends a range of 7.0-10.5; the control of pH is important to maximize treatment effectiveness, control corrosion and reduce leaching from distribution system and plumbing components.

^d Free chlorine concentrations in most Canadian drinking water distribution systems range from 0.04 to 2.0 mg/L (HC, 2022).

^e The maximum pH in the CCW was directly compared, representing the possibly maximum mixing zone pH value.

TRC - Total Residual Chlorine

Value Indicates parameter exceeded screening benchmark

Table A-6a: Screening of 2016 CCW Effluent for Human Health

Parameter	Units	Selected Human Health Screening Criteria ^a	Measured Stream Concentrations					Estimated Max Mixing Zone Concentrations	Carried Forward as a COPC for Addendum?
			RLW	BB	IAD	WTP	CCW		
			Max Value	Max Value	Max Value	Max Value	Max Value		
Morpholine	µg/L	1700	6	-	-	-	-	-	No
Gadolinium (Gd)	µg/L	140	46	-	-	-	9.6	1.37	No
Mercury (Hg)	µg/L	1	<0.1	-	-	-	<0.1	<0.014	No
Total Aluminum (Al)	µg/L	2900	59.9	-	19.2	0.012	150	21.43	No
Total Cadmium (Cd)	µg/L	5	0.257	0.013	0.008	4.76	0.015	0.002	No
Total Chromium (Cr)	µg/L	50	6.97	0.44	0.64	9.91	0.79	0.11	No
Total Copper (Cu)	µg/L	1000	15.5	0.914	3.25	13.8	1.92	0.27	No
Total Iron (Fe)	µg/L	None	32	13.1	37.7	-	250	35.71	No
Total Lead (Pb)	µg/L	5	19.8	0.213	0.086	0.199	0.335	0.05	No
Total Lithium (Li)	µg/L	4	330	-	-	-	3.82	0.55	No
Total Molybdenum (Mo)	µg/L	70	7.78	-	-	65.6	1.59	0.23	No
Total Nickel (Ni)	µg/L	100	50.6	0.087	0.752	1.83	0.932	0.13	No
Total Selenium (Se)	µg/L	10	1	0.04	0.141	2.05	0.199	0.03	No
Total Zinc (Zn)	µg/L	5000	25.5	2.95	-	21.2	8.79	1.26	No
Nitrate (N)	mg/L	10	-	-	-	4.88	0.44	0.06	No
Total Phosphorus	mg/L	-	0.177	-	-	-	0.029	0.004	No
Ethylene Glycol	mg/L	2	<20	-	<5	-	<5	<0.71	No
Propylene Glycol	mg/L	10	<20	-	<5	-	<5	<0.71	No
F1 (C6-C10)	µg/L	820	<25	-	-	<25	<25	<3.57	No
F1 (C6-C10) - BTEX	µg/L	820	<25	-	-	<25	<25	<3.57	No
F2 (C10-C16 Hydrocarbons)	µg/L	300	<100	-	-	<100	<100	<14.29	No
F3 (C16-C34 Hydrocarbons)	µg/L	1000	<200	-	-	<200	<200	<28.57	No
Total Residual Chlorine (TRC)	µg/L	Not Required	-	-	-	4	-	-	No

Notes:

^a See Table A-2 for references for these selected screening benchmarks.

- RLW - Radioactive Liquid Waste
- BB - Boiler Blowdown
- IAD - Inactive Drainage
- WTP - Water Treatment Plant
- CCW - Condenser Cooling Water

Value Indicates parameter exceeded screening benchmark

Table A-6b: Screening of 2016 CCW Effluent for Human Health

Parameter	Unit	Detection Limit	Derived DW Screening Criteria (1)	Maximum Concentration in CCW (EcoMetrix, 2016)	Estimated Max Mixing Zone Concentrations	Carried forward to detailed screening?
Alcohol Ethoxylates C8-9	µg/L	0.03	None	ND	ND	No
Alcohol Ethoxylates C10-11	µg/L	0.03	None	ND	ND	No
Alcohol Ethoxylates C12 -13	µg/L	0.03	None	108.7	15.5	No
Alcohol Ethoxylates C14-15	µg/L	0.03	None	16	2.3	No
Alcohol Ethoxylates C16-18	µg/L	0.03	None	1	0.1	No
Total Alcohol Ethoxylates	µg/L	0.03	512500 ^b	121	17.3	No
Nonylphenol Ethoxycarboxylate	µg/L	0.01	None	ND	ND	No
Linear Alkylbenzene Sulphonates C10	µg/L	0.06	None	1.1	0.2	No
Linear Alkylbenzene Sulphonates C12	µg/L	0.06	None	15.3	2.2	No
Total Linear Alkylbenzene Sulphonates	µg/L	0.06	929333 ^b	15.3	2.2	No

Reference

1. Revised Human and Environmental Risk Assessment (HERA) Report - Linear Alkylbenzene Sulphonate, Table 10 (HERA, 2013)

Notes:

^a ND = non-detect

Value Indicates parameter exceeded screening benchmark

Table A-7 Screening of Analytes in 2019 Stormwater for Human Health

Parameter	Maximum Stormwater Loading		Modeled Diluted Concentration in Lake Water		Human Health Screening Benchmark ^a	Exceeds Screening Benchmark?	Carried Forward as COPC for Addendum?
	Value	Unit	Value	Unit			
Biological							
Escherichia coli	80,972	CFU/s	0.83	CFU/100 ml	Non detectable	Yes	No ^b
Fecal Coliform	2,746,200	CFU/s	28.25	CFU/100 ml	Non detectable	Yes	No ^b
Total Coliform	120,152	CFU/s	1.24	CFU/100 ml	Non detectable	Yes	No ^b
Anions							
Chloride	630792	mg/s	64.90	mg/L	250000	No	No
Nitrate as N	188.838	mg/s	0.02	mg/L	10	No	No
Nitrite as N	7.32036	mg/s	0.0008	mg/L	1	No	No
Dissolved Phosphorus	31.2144	mg/s	0.0032	Tab	0.02	No	No
Metals and Inorganics							
Total Aluminum (Al)	765085.14	µg/s	78.71	µg/L	2900	No	No
Dissolved Aluminum (Al)	24208.22944	µg/s	2.4906	µg/L	2900	No	No
Dissolved (0.2u) Aluminum (Al)	8896.86	µg/s	0.9153	µg/L	2900	No	No
Total Antimony (Sb)	211.83	µg/s	0.0218	µg/L	6	No	No
Dissolved Antimony (Sb)	211.83	µg/s	0.0218	µg/L	6	No	No
Total Arsenic (As)	423.66	µg/s	0.0436	µg/L	10	No	No
Dissolved Arsenic (As)	423.66	µg/s	0.0436	µg/L	10	No	No
Total Barium (Ba)	42052.8	µg/s	4.3264	µg/L	1000	No	No
Dissolved Barium (Ba)	39424.5	µg/s	4.0560	µg/L	1000	No	No
Total Beryllium (Be)	<211.83	µg/s	<0.0218	µg/L	4	No	No
Dissolved Beryllium (Be)	<211.83	µg/s	<0.0218	µg/L	4	No	No
Total Boron (B)	31214.4	µg/s	3.21	µg/L	5000	No	No
Dissolved Boron (B)	26755.2	µg/s	2.75	µg/L	5000	No	No
Total Cadmium (Cd)	85.8624	µg/s	0.0088	µg/L	5	No	No
Dissolved Cadmium (Cd)	42.366	µg/s	0.0044	µg/L	5	No	No
Total Chromium (Cr)	2540.096	µg/s	0.261	µg/L	50	No	No
Dissolved Chromium (Cr)	2118.3	µg/s	0.218	µg/L	50	No	No
Total Cobalt (Co)	465.088	µg/s	0.048	µg/L	3	No	No
Dissolved Cobalt (Co)	211.83	µg/s	0.022	µg/L	3	No	No
Total Copper (Cu)	5276.96	µg/s	0.543	µg/L	1000	No	No
Dissolved Copper (Cu)	1694.64	µg/s	0.174	µg/L	1000	No	No
Hexavalent Chromium	416.546354	µg/s	0.043	µg/L	25	No	No
Total Lead (Pb)	2879.968	µg/s	0.296	µg/L	5	No	No
Dissolved Lead (Pb)	211.83	µg/s	0.022	µg/L	5	No	No
Total Lithium (Li)	2499.594	µg/s	0.257	µg/L	4	No	No
Dissolved Lithium (Li)	2118.3	µg/s	0.218	µg/L	4	No	No
Total Manganese (Mn)	45435.52	µg/s	4.67	µg/L	120	No	No
Dissolved Manganese (Mn)	30245.6	µg/s	3.11	µg/L	120	No	No
Total Mercury (Hg)	4.2366	µg/s	0.00044	µg/L	1	No	No
Total Molybdenum (Mo)	402.477	µg/s	0.0414	µg/L	70	No	No
Dissolved Molybdenum (Mo)	377.0574	µg/s	0.0388	µg/L	70	No	No
Total Nickel (Ni)	1252.16	µg/s	0.1288	µg/L	100	No	No
Dissolved Nickel (Ni)	423.66	µg/s	0.0436	µg/L	100	No	No
Total Selenium (Se)	847.32	µg/s	0.087	µg/L	10	No	No
Dissolved Selenium (Se)	137.31	µg/s	0.014	µg/L	10	No	No
Total Silicon (Si)	1275141.9	µg/s	131.2	µg/L	1943	No	No
Dissolved Silicon (Si)	630792	µg/s	64.9	µg/L	1943	No	No
Total Silver (Ag)	42.366	µg/s	0.0044	µg/L	100	No	No
Dissolved Silver (Ag)	42.366	µg/s	0.0044	µg/L	100	No	No
Total Sodium (Na)	367962000	µg/s	37856	µg/L	200000	No	No
Dissolved Sodium (Na)	341679000	µg/s	35152	µg/L	200000	No	No
Total Strontium (Sr)	473094	µg/s	48.67	µg/L	7000	No	No
Dissolved Strontium (Sr)	473094	µg/s	48.67	µg/L	7000	No	No
Total Thallium (Tl)	21.183	µg/s	0.00218	µg/L	2	No	No
Dissolved Thallium (Tl)	21.183	µg/s	0.00218	µg/L	2	No	No
Dissolved Thorium (Th)	<137.31	µg/s	<0.014	µg/L	250	No	No
Total Thorium (Th)	847.32	µg/s	0.087	µg/L	250	No	No
Total Tin (Sn)	423.66	µg/s	0.044	µg/L	2400	No	No
Dissolved Tin (Sn)	423.66	µg/s	0.044	µg/L	2400	No	No
Total Titanium (Ti)	22952.5542	µg/s	2.36	µg/L	15	No	No
Dissolved Titanium (Ti)	2118.3	µg/s	0.2179	µg/L	15	No	No
Dissolved Tungsten (W)	423.66	µg/s	0.0436	µg/L	3.2	No	No
Total Tungsten (W)	438.048	µg/s	0.0451	µg/L	3.2	No	No
Total Vanadium (Va)	1341.6	µg/s	0.1380	µg/L	6.2	No	No
Dissolved Vanadium (Va)	353.217	µg/s	0.0363	µg/L	6.2	No	No
Total Uranium (U)	237.644	µg/s	0.0244	µg/L	20	No	No
Dissolved Uranium (U)	233.9187	µg/s	0.0241	µg/L	20	No	No
Total Zinc (Zn)	134160	µg/s	13.80	µg/L	5000	No	No
Dissolved Zinc (Zn)	23654.7	µg/s	2.43	µg/L	5000	No	No
Dissolved Zirconium (Zr)	423.66	µg/s	0.044	µg/L	0.32	No	No
Total Zirconium (Zr)	423.66	µg/s	0.044	µg/L	0.32	No	No
PCB							
Aroclor 1016	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1221	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1232	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1242	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1248	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1254	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1260	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1262	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Aroclor 1268	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-
Polychlorinated Biphenyls	<21.183	µg/s	<0.0022	µg/L	3	No	No
PHC							
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	<10591.5	µg/s	<1.09	µg/L	820	No	No
Petroleum Hydrocarbons - F1 (C6-C10)	<10591.5	µg/s	<1.09	µg/L	820	No	No
Petroleum Hydrocarbons - F2 (C10-C16)	<42366	µg/s	<4.36	µg/L	300	No	No
Petroleum Hydrocarbons - F3 (C16-C34)	84732	µg/s	8.72	µg/L	1000	No	No
Petroleum Hydrocarbons - F4 (C34-C50)	<84732	µg/s	<8.72	µg/L	1100	No	No
Oil & Grease, Total Rec	445.92	mg/s	0.05	mg/L	- ^c	-	-
Benzene	<84.732	µg/s	<0.0087	µg/L	5	No	No
Ethylbenzene	<84.732	µg/s	<0.0087	µg/L	2.4	No	No
m,p-Xylenes	231.2904	µg/s	0.024	µg/L	90	No	No
o-Xylene	84.732	µg/s	0.009	µg/L	90	No	No
Toluene	420.368	µg/s	0.043	µg/L	24	No	No
Xylenes, Total	289.113	µg/s	0.030	µg/L	90	No	No

^a See Table A-2 for references for these selected screening benchmarks. For all metals, the screening criteria for total metal and inorganics were also used to screen concentration of the dissolved metal ions.
^b Not considered to be a nuclear or hazardous substance, so are not COPCs under CSA N288.6 and not associated with Darlington Nuclear.
^c Individual polychlorinated biphenyl (PCB) congeners as well as total oil and grease are displayed, but without benchmarks since these parameters are encompassed by screenings of other parameters.

Value Indicates parameter exceeded screening benchmark

Table A-8: Screening of Air Quality for Ecological Health (ESDM Modelling)

Parameter	Maximum POI Concentration in 2020 ERA ($\mu\text{g}/\text{m}^3$)		COPC in 2020 ERA?	ESDM Modelling				Maximum POI Concentration, 2020-2022 ($\mu\text{g}/\text{m}^3$)		Selected Ecological Screening Criteria	Screening Criteria Averaging period	Source / Regulation Schedule Number ^b	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
	Concentration	Averaging Period ^a		Maximum POI Concentration Yearly ($\mu\text{g}/\text{m}^3$)			Averaging Period	Concentration	Averaging Period ^a							
				2020 ¹	2021 ²	2022 ³										
Armeen hdt (tallow alkyl)	0.058	Annual	No	0.28	0.28	0.28	24hr	0.054	Annual	40	Annual	-	Health	TCEQ ⁴	No	No
Ammonia	11.1	24hr	No	9.9	9.9	9.9	24hr	9.9	24hr	100	24hr	-	Health	MECP AAQC ⁵	No	No
Benzo(a)pyrene (sum of PAH)	3.70E-05	24hr	No	3.6E-05	3.6E-05	3.6E-05	24hr	3.60E-05	24hr	5.00E-05	24hr	-	Health	MECP AAQC	No	No
	3.60E-06	Annual	No	3.6E-06	3.6E-06	3.6E-06	Annual	3.60E-06	Annual	1.00E-05	Annual	-	Health	MECP AAQC	No	No
Cadmium	2.60E-04	24hr	No	2.50E-04	2.50E-04	2.50E-04	24hr	2.50E-04	24hr	2.50E-02	24hr	-	Health	MECP AAQC	No	No
Carbon Dioxide	39,451	24hr	No	15,947	15,947	15,947	24hr	15,947	24hr	Not applicable - major component of air						
Chloride (as hydrogen chloride)	0.23	24hr	No	0.22	0.22	0.22	24hr	0.22	24hr	20	24hr	-	Health	MECP AAQC	No	No
Chromium (VI)	4.30E-04	24hr	No	1.60E-04	1.60E-04	1.60E-04	24hr	1.60E-04	24hr	1.40E-04	24hr	-	Health	MECP AAQC	Yes	No ^c
	3.70E-05	Annual	No	1.60E-05	1.60E-05	1.60E-05	Annual	1.60E-05	Annual	7.00E-05	Annual	-	Health	MECP AAQC	No	No
Cobalt	0.0039	24hr	No	3.80E-03	3.80E-03	3.80E-03	24hr	0.0038	24hr	0.1	24hr	-	Health	MECP AAQC	No	No
Fluoride	0.02	24hr	No	0.02	0.02	0.02	24hr	0.02	24hr	1.72	24hr	-	Vegetation	MECP AAQC	No	No
	0.006	30 day	No	0.006	0.006	0.006	30 day	0.006	30 day	0.69	30 day	-	Vegetation	MECP AAQC	No	No
Hydrazine	3.90E-04	Annual	No	1.42E-04	1.42E-04	1.42E-04	Annual	7.41E-04	24hr	1.00E-03	24hr	SL-JSL	Health	MECP ACB ⁶	No	No
Iron	0.27	24hr	No	0.15	0.15	0.15	24hr	0.15	24hr	4	24hr	-	Health	MECP AAQC	No	No
Manganese	0.07	24hr	No	0.03	0.03	0.03	24hr	0.03	24hr	0.4	24hr	-	Health	MECP AAQC	No	No
Morpholine	3.60	24hr	No	3.2	3.2	3.2	24hr	3.2	24hr	200	24hr	SL-JSL	Health	MECP ACB ⁶	No	No
Nickel	0.06	11.37	No	0.05	0.05	0.05	24hr	0.05	11.37	0.2	24hr	-	Health	MECP AAQC	No	No
	0.0057	Annual	No	0.0054	0.0054	0.0054	Annual	0.0054	Annual	0.04	Annual	-	Health	MECP AAQC	No	No
Nitrogen Oxides	205	1hr	No	205	205	205	1hr	205	1hr	400	1hr	-	Health	MECP AAQC	No	No
	30.2	24hr	No	30.2	30.2	30.2	24hr	30.20	24hr	200	24hr	-	Health	MECP AAQC	No	No
Phosphorus	1.17E-03	Annual	No	6.00E-03	6.00E-03	6.00E-03	24hr	1.15E-03	Annual	1.00E-01	Annual	-	Health	TCEQ	No	No
Sodium Hydroxide	0.122	24hr ^f	No	-	-	-	-	0.122 ^d	24hr	10	24 hr	-	Corrosion ^e	MECP AAQC	No	No
Sodium Hypochlorite	0.238	Annual	No	0.84	0.84	0.84	24hr	0.161	Annual	5	Annual	-	Health	TCEQ	No	No
Sodium Sulfite	0.070	24hr	No	0.07	0.07	0.07	24hr	0.070	24hr	Not applicable - species of limited concern (per description of the TCEQ)						
Suspended Particulate Matter (Total)	1.573	24hr ^f	No	-	-	-	-	1.573 ^d	24hr	120	24 hr	-	Visibility ^g	MECP AAQC	No	No
Sulphur Dioxide	0.1	24hr	No	0.14	0.14	0.14	24hr	0.14	24hr	275	24hr	Sch. 3	Health & Vegetation	MECP ACB	No	No
	1	1hr	No	1.1	1.1	1.1	1hr	1.1	1hr	105	1hr	-	Health	MECP AAQC	No	No
Sulphuric Acid	0.068	24hr ^h	No	-	-	-	-	0.068 ^d	24hr	5	24 hr	-	Health - URT ^h	MECP AAQC	No	No
Vanadium	0.02	24hr	No	0.02	0.02	0.02	24hr	0.02	24hr	2	24 hr	-	Health	MECP AAQC	No	No

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- Canadian Council of Ministers of the Environment (CCME). Canadian Ambient Air Quality Standards (CAAQS).

Notes

- The max POI concentrations were converted to the averaging period of benchmarks by following instructions provided in Section 4.4 of the document "Air Dispersion Modelling Guideline for Ontario, Version 3.0" by MOECC.
 - Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
 - Chromium (VI) partitions to soil, and therefore the inhalation pathway is negligible compared to the soil and food ingestion pathways. It is not carried forward as a COPC in air.
 - In the absence of new ESDM modelling data between 2020-2022, the maximum POI concentration from the 2020 ERA was used for screening purposes.
 - In the absence of a health based guideline, the MECP corrosion guideline was used for sodium hydroxide, and the MECP visibility guideline was used for total particulate matter.
 - Converted from a 0.5hr averaging period to the noted averaging period.
 - Converted from an annual averaging period to 24hr averaging period.
 - URT - Upper Risk Threshold. URTs listed in Schedule 6 of O. Reg. 419/05 are not standards. URTs have separate and distinct regulatory and notification requirements. These requirements are set out in section 30 of O. Reg. 419/05.
- POI - Point of Impingement
 SL-JSL - Jurisdictional Screening Level
 SL-MD - Ministry-derived Screening Levels

Value Indicates parameter exceeded screening criteria.

Table A-9: Non-Radiological Screening of Air COPCs for Ecological Health (DNNP Air Monitoring)

Parameter	Maximum Measured Concentration (µg/m ³) ^{1, a}	Averaging Period	Selected Human Health Screening Criteria	Screening Criteria Averaging Period	Source / Regulation Schedule Number ^b	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Particulate Matter (PM)									
Total Suspended Particulates (TSP)	348.2	24 hr	120	24 hr	-	Visibility ^d	MECP AAQC ²	Yes	No ⁹
PM _{2.5}	113.6	1 hr	-	-	-	-	-	-	No
	51.7	24 hr	27	24 hr	-	Health	MECP AAQC	Yes	No ⁹
PM ₁₀	726.7	1 hr	-	-	-	-	-	-	No
	271.1	24 hr	50	24 hr	-	Health	MECP AAQC	Yes	No ⁹
Gases									
Nitrogen Dioxide (NO ₂)	127	1 hr	400	1hr	-	Health	MECP AAQC	No	No
	44	24 hr	200	24hr	-	Health	MECP AAQC	No	No
Sulphur Dioxide (SO ₂)	402	1 hr	104.8 ^c	1hr	-	Health	MECP AAQC	Yes	No ⁹
	59	24 hr	275	24hr	Sch. 3	Health & Vegetation	MECP ACB ³	No	No
Volatile Organic Compounds (VOCs)									
2-Propanone (Acetone)	22.2	24 hr	11,880	24 hr	-	Health	MECP AAQC	No	No
Dichlorodifluoromethane (FREON 12)	2.9	24 hr	500,000	24 hr	-	Health	MECP AAQC	No	No
Chloromethane	2.4	24 hr	320	24 hr	-	Health	MECP AAQC	No	No
Trichlorofluoromethane (FREON 11)	2.5	24 hr	6,000	24 hr	-	Health	MECP AAQC	No	No
2-propanol	13.3	24 hr	7,300	24 hr	-	Health	MECP AAQC	No	No
Methyl Ethyl Ketone (2-Butanone)	5.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	No	No
1,1-Dichloroethylene	6.2	24 hr	10	24 hr	-	Health	MECP AAQC	No	No
Methylene Chloride (Dichloromethane)	4.6	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
	2.1	Annual ^f	44	Annual	-	Health	MECP AAQC	No	No
Carbon Tetrachloride	1.4	24 hr	2.4	24 hr	-	Health	MECP AAQC	No	No
1,1-Dichloroethane	2.5	24 hr	165	24 hr	-	Health	MECP AAQC	No	No
1,2-Dichloroethane	0.9	24 hr	2	24 hr	-	Health	MECP AAQC	No	No
	0.4	Annual ^f	0.4	Annual	-	Health	MECP AAQC	No	No
1,1,1-Trichloroethane	35.3	24 hr	115,000	24 hr	-	Health	MECP AAQC	No	No
Tetrachloroethylene (PCE)	7.1	24 hr	360	24 hr	-	Health	MECP AAQC	No	No
	1.1	Annual ^f	2.3	Annual	-	Health	MECP AAQC	No	No
Benzene	1.2	24 hr	2.3	24 hr	-	Health	MECP AAQC	No	No
	0.5	Annual ^f	0.45	Annual	-	Health	MECP AAQC	Yes	No ⁹
Toluene	17.6	24 hr	2,000	24 hr	-	Odour	MECP AAQC	No	No
Ethylbenzene	1.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	No	No
p+m-Xylene	9.7	24 hr	730	24 hr	-	Health	MECP AAQC	No	No
o-Xylene	7.5	24 hr	730	24 hr	-	Health	MECP AAQC	No	No
Styrene	0.9	24 hr	400	24 hr	-	Health	MECP AAQC	No	No
1,3,5-Trimethylbenzene	5.4	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
1,2,4-Trimethylbenzene	28.5	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
Hexane	633	24 hr	7,500	24 hr	-	Health	MECP AAQC	No	No
Heptane	6.1	24 hr	11,000	24 hr	-	Health	MECP AAQC	No	No
Cyclohexane	1.5	24 hr	6,100	24 hr	-	Health	MECP AAQC	No	No
Naphthalene	5.2	24 hr	22.5	24 hr	-	Health	MECP AAQC	No	No
Total Xylenes	17.2	24 hr	730	24 hr	-	Health	MECP AAQC	No	No
Propene	2.4	24 hr	4,000	24 hr	-	Health	MECP AAQC	No	No
Polycyclic Aromatic Hydrocarbons (PAHs)									
Benzo(a)pyrene (BAP) ^e	2.28E-04	24 hr	5.00E-05	24 hr	-	Health	MECP AAQC	Yes	No ⁹

References

- Darlington New Nuclear Project Baseline Air Quality Monitoring 2021-2022 Annual Report. Report No. NK054-REP-07730-1281633.
- MECP Ambient Air Quality Criteria (AAQC). Accessed in November 2023 from <https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria>
- Ministry of the Environment, Conservation and Parks (MECP), Ontario. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants.

Notes

- The concentrations of NO₂ and SO₂ were converted from ppb to µg/m³ using the following ratios: 1 ppb NO₂ = 1.88 µg/m³ and 1 ppb SO₂ = 2.62 µg/m³.
- Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
- The 1-hour AAQC for sulphur dioxide is 40 ppb. This value was converted to µg/m³ using the ratio 1 ppb SO₂ = 2.62 µg/m³.
- In the absence of a health based guideline, the MECP visibility guideline was used for total particulate matter.
- The screening of PAHs is represented by benzo(a)pyrene, as it has the lowest AAQC of 5.0E-05 µg/m³.
- Represents weighted averages, where the non-detectable samples in the average are equal to the detection limit
- Refer to Section 4.1.3.1 of the Addendum report for further information.

Value Indicates parameter exceeded screening criteria.

Table A-10: Ecological Screening Criteria for Surface Water COPCs

Parameter	Units	CCME CWQG (1)	FEQG (6-10)	PWQO (2)	Interim PWQO (2)	Suter and Tsao, 1996 (3) ^a	Borgmann et al. 2005 (4) ^b	Other Sources	95 th Percentile Background, 2019 Environmental Study (5)	Detection Limit (5)	Selected Ecological Screening Criteria	Reference
Physical/Conventional Characteristics												
Field Temperature	Celsius	-	-	-	-	-	-	-	21.64	-	-	- ^j
Field pH	pH	6.5-9.0	-	6.5-8.5	-	-	-	-	8.99	-	6.5-8.5	(2)
pH	pH	6.5-9.0	-	6.5-8.5	-	-	-	-	8.42	-	6.5-8.5	(2)
Field Sp. Conductance	µS/cm	-	-	-	-	-	-	-	569.4	-	-	- ^j
Conductivity	umho/cm	-	-	-	-	-	-	-	570.5	1	-	- ^j
Field Turbidity	NTU	-	-	-	-	-	-	-	-	-	-	- ^j
Turbidity	NTU	-	-	-	-	-	-	-	6.08	0.1	-	- ^j
Alkalinity (Total as CaCO3)	mg/L	-	-	-	-	-	-	-	200.0	1	-	- ^j
Total Hardness (CaCO3)	mg/L	-	-	-	-	-	-	-	266.9	0.5 - 1	-	- ^j
Total Suspended Solids	mg/L	5 mg/L above the background value ^e	-	-	-	-	-	-	11.15	1 - 10	16.15	(1)
Total Residual Chlorine	mg/L	0.0005	-	0.002	-	-	-	-	0.019	0.0012	0.002 ^f	(2)
Nutrients												
Dissolved Organic Carbon	mg/L	-	-	-	-	-	-	-	8.105	0.5	-	- ^j
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	-	-	-	-	-	0.453	0.1	-	- ^j
Total Ammonia-N	mg/L	0.044 ^d	-	-	-	-	-	-	0.191	0.01 - 1	0.044	(1)
Total Un-ionized Ammonia	mg/L	0.019	-	0.02	-	-	-	-	0.0211	0.00051 - 0.044	0.019	(1)
Total BOD	mg/L	-	-	-	-	-	-	-	<2	2	-	- ^j
Total Chemical Oxygen Demand (COD)	mg/L	-	-	-	-	-	-	-	18.1	4	-	- ^j
Orthophosphate (P)	mg/L	-	-	-	-	-	-	-	0.009013 ⁿ	0.01	-	- ^j
Total Phosphorus	mg/L	-	-	-	0.02	-	-	-	0.045	0.02 - 2.51	0.02	(2)
Anion												
Fluoride (F)	mg/L	0.12	-	-	-	-	-	-	-	-	0.12	(1)
Chloride (Cl)	mg/L	640	-	-	-	-	-	-	-	-	640	(1)
Nitrate (N)	mg/L	13	-	-	-	-	-	-	0.58	0.1	13	(1)
Nitrite (N)	mg/L	0.06	-	-	-	-	-	-	0.00612 ⁿ	0.01	0.06	(1)
Hydrocarbons												
Benzene	µg/L	370	-	-	100	-	-	-	0 ⁿ	0.1 - 0.5	370	(1)
Ethylbenzene	µg/L	90	-	-	8	-	-	-	0 ⁿ	0.1 - 0.5	90	(1)
Toluene	µg/L	2	-	-	0.8	-	-	-	-	-	2	(1)
m,p-xylene	µg/L	-	-	-	2 ⁱ	-	-	-	-	-	2	(2)
o-xylene	µg/L	-	-	-	40	-	-	-	-	-	40	(2)
Xylene, Total	µg/L	-	-	-	2 ⁱ	-	-	-	-	-	2	(2)
F1 (C6-C10)	µg/L	167	-	-	-	-	-	-	0 ⁿ	25	167	(1)
F1 (C6-C10) - BTEX	µg/L	167	-	-	-	-	-	-	-	-	167	(1)
F2 (C10-C16 Hydrocarbons)	µg/L	42	-	-	-	-	-	-	0 ⁿ	100	42	(1)
F3 (C16-C34 Hydrocarbons)	µg/L	-	-	-	-	-	-	-	142.51 ⁿ	200	200	(5) ^g
F4 (C34-C50 Hydrocarbons)	µg/L	-	-	-	-	-	-	-	-	-	200	(5) ^g
Ethylene Glycol	mg/L	192	-	-	2	-	-	-	-	-	192	(1)
Propylene Glycol	mg/L	500	-	-	10 ^j	-	-	-	-	-	500	(1)
Biological												
Chlorophyll	µg/L	-	-	-	-	-	-	-	3.09	0.1 - 0.2	-	- ^j
Background	CFU/100mL	-	-	-	-	-	-	-	-	-	-	- ^j
Total Coliforms	CFU/100mL	-	-	100	-	-	-	-	220	10	100	(2) ^h
Fecal coliform	CFU/100mL	-	-	100	-	-	-	-	20.5	10	100	(2) ^h
Escherichia coli	CFU/100mL	-	-	100	-	-	-	-	20	10	100	(2)
Metals												
Total Aluminum (Al)	µg/L	100	2000	-	-	-	-	-	84.3	0.5 - 5	100	(1)
Dissolved (0.2u) Aluminum (Al)	µg/L	-	-	-	75	-	-	-	6.05	5	75	(2)
Total Antimony (Sb)	µg/L	-	-	20	-	-	-	-	0.1846 ⁿ	0.02 - 0.5	20	(2)
Total Arsenic (As)	µg/L	5	-	100	5	-	-	-	0.829	0.02 - 1	5	(1)
Total Barium (Ba)	µg/L	-	-	-	-	4	315	1000 (12)	38.64	0.02 - 2	1000	(12)
Total Beryllium (Be)	µg/L	-	1100	-	-	-	-	-	0.007 ⁿ	0.01 - 0.5	1100	(2)
Total Bismuth (Bi)	µg/L	-	-	-	-	-	2.5	-	0.0038 ⁿ	0.005 - 1	2.5	(4)
Total Boron (B)	µg/L	1500	-	-	200	-	-	-	158	10 - 50	1500	(1)
Total Cadmium (Cd)	µg/L	0.17 ^o	-	0.2	0.5	-	-	-	0.00788 ⁿ	0.005 - 0.1	0.17	(1)
Total Calcium (Ca)	µg/L	-	-	-	-	11,600	-	-	70680	0.05 - 250	11,600	(3)
Total Cesium (Cs)	µg/L	-	-	-	-	-	315	-	0.0124 ⁿ	0.05 - 0.2	315	(4)
Total Chromium (Cr)	µg/L	8.9	-	8.9	-	-	-	-	0.9694 ⁿ	0.1 - 5	8.9	(1)
Chromium (+3)	µg/L	8.9	-	8.9	-	-	-	-	0 ⁿ	0.5 - 5	8.9	(1)
Chromium (VI)	µg/L	1	5	1	-	-	-	-	0.31525 ⁿ	0.5	1	(1)
Total Cobalt (Co)	µg/L	-	1	-	0.9	-	-	-	0.121 ⁿ	0.005 - 0.5	1	(6)
Total Copper (Cu)	µg/L	2.57 ^p	Biotic Ligand Model ^q	5	5	-	-	-	0.8516 ⁿ	0.05 - 1	2.57	(1)
Gadolinium (Gd)	µg/L	-	-	-	-	-	15	-	-	-	15	(4)
Total Iron (Fe)	µg/L	300	-	300	-	-	-	-	174.6	1 - 100	300	(1)
Total Lead (Pb)	µg/L	3.59 ^o	10	25	5	-	-	-	0.1174 ⁿ	0.005 - 0.5	3.59	(1)
Total Lithium (Li)	µg/L	-	-	-	-	14	65	-	4.714	0.5 - 5	14	(3)
Total Magnesium (Mg)	µg/L	-	-	-	-	8,200	-	-	25840	0.05 - 250	8,200	(3)
Total Manganese (Mn)	µg/L	120 ^{d,e}	-	-	-	-	-	-	20.8	0.05 - 2	120	(1)
Mercury (Hg)	µg/L	0.026	-	0.2	-	-	-	-	0.002405 ⁿ	0.01	0.026	(1)
Total Molybdenum (Mo)	µg/L	73,000	-	-	40	-	-	-	1.238	0.05 - 1	40	(2)
Total Nickel (Ni)	µg/L	103 ^o	-	25	-	-	-	-	0.6306 ⁿ	0.02 - 1	25	(2)
Total Potassium (K)	µg/L	-	-	-	-	5,300	-	-	5528	0.05 - 1000	5,300	(3)
Total Selenium (Se)	µg/L	1	-	100	-	-	-	-	0.1616 ⁿ	0.04 - 2	1	(1)
Total Silicon (Si)	µg/L	-	-	-	-	-	-	-	1943	50	-	- ^j
Total Silver (Ag)	µg/L	0.25	-	0.1	-	-	-	-	0.00282 ⁿ	0.005 - 0.1	0.1	(2)
Total Sodium (Na)	µg/L	-	-	-	-	68,000	-	-	25480	0.05 - 250	68,000	(3)
Total Strontium (Sr)	µg/L	-	2500	-	-	-	-	-	453.8	0.05 - 1	2500	(7)
Total Tellurium (Te)	µg/L	-	-	-	-	-	151.9	-	-	-	151.9	(4)
Total Thallium (Tl)	µg/L	0.8	-	-	0.3	-	-	-	0.0088 ⁿ	0.002 - 0.05	0.8	(1)
Total Thorium (Th)	µg/L	-	-	-	-	-	0.52	-	0.0094 ⁿ	0.005 - 1	0.52	(4)
Total Tin (Sn)	µg/L	-	-	-	-	73	315	-	0.09528 ⁿ	0.2 - 5	73	(3)
Total Titanium (Ti)	µg/L	-	-	-	-	-	27.2	-	4.7056 ⁿ	0.5 - 5	27.2	(4)
Total Tungsten (W)	µg/L	-	-	-	30	-	-	-	0.11595 ⁿ	0.01 - 1	30	(2)
Total Uranium (U)	µg/L	15	-	-	5	-	-	-	0.9486	0.002 - 0.1	15	(1)
Total Vanadium (V)	µg/L	-	120	-	6	-	-	-	0.9878 ⁿ	0.2 - 5	120	(8)
Total Zinc (Zn)	µg/L	7 ^k	-	30	20	-	-	-	2.7904 ⁿ	0.1 - 5	7	(1)
Dissolved Zinc (Zn)	µg/L	7	-	-	-	-	-	-	2.9245 ⁿ	5	7	(1)
Total Zirconium (Zr)	µg/L	-	-	-	4	-	-	-	0.0668 ⁿ	0.1 - 1	4	(2)
Other												
Hydrazine	µg/L	-	2.6	-	-	-	-	-	<0.1	0.1	2.6	(9)
Morpholine	µg/L	-	-	-	4	-	-	-	1 ⁿ	4	4	(2)
Bromoform	µg/L	-	-	-	60	-	-	-	0 ⁿ	0.2 - 1	60	(2)
Chloroform	µg/L	1.8	-	-	-	-	-	-	0 ⁿ	0.1 - 0.5	1.8	(1)
Bromodichloromethane	µg/L	-	-	-	200	-	-	-	0 ⁿ	0.1 - 0.5	200	(2)
Alcohol ethoxylates	µg/L	-	-	-	-	-	-	-	See Table A-13b	-	- ^m	-
bis(2-Ethylhexyl)phthalate	µg/L	-	-	60	-	-	-	-	-	-	60	(2)

Table A-10: Ecological Screening Criteria for Surface Water COPCs

References:

1. CCME Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in November 2023.
2. MOECC: Water management: policies, guidelines, provincial water quality objectives (1994).
3. Suter and Tsao, (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.
4. Borgmann et al., (2005). Toxicity of Sixty-Three Metals and Metalloids to *Hyalella azteca* at Two Levels of Water Hardness.
5. Ecometrix. (2020). Darlington New Nuclear Project Supporting Environmental Studies – Environment. Report prepared for OPG. Report No. NK054-REP-01210-0001. May.
6. Environment Canada (2017). Canadian Environmental Quality Guidelines, Cobalt, May.
7. ECCC (2020). Federal Environmental Quality Guidelines - Strontium. July.
8. ECCC (2006). Federal Environmental Quality Guidelines, Vanadium. May.
9. Environment Canada (2013). Federal Environmental Quality Guidelines, Hydrazine. May.
10. ECCC (2022). Federal Environmental Quality Guidelines, Aluminium. August.
11. British Columbia, (2021). British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Feb 2021.

Notes:

- ^a Secondary Chronic Values (SCV) were selected for COPCs. If the SCV was not available, the lowest LC50 value was modified by a safety factor of 10.
- ^b To be conservative, the measured LC50 values of *H. azteca* (software or hardware) was divided by a safety factor of 10. If there is no measured value, the tap water LC50 (nominal) values were adjusted by a safety factor of 10, considering the
- ^c 5 mg/L above the mean background value was used according to the CCME CWQG "narrative" for clear flow.
- ^d pH 9 assumed to determine CWQG value for all pH dependent parameters.
- ^e Hardness of 110 mg/L CaCO3 was used to calculate hardness dependent CWQG values.
- ^f PWQO is selected as the benchmark for TRC, as there is no current methodology to reach the CCME guideline of 0.0005 mg/L.
- ^g If the 95th percentile background value is less than the detection limit (as uncensored data was used in the 2019 study), the detection limit was selected as the selected criteria. Otherwise, the 95 percentile value was used as the screening
- ^h The PWQO value for *E.coli* is used to screen total and fecal coliforms
- ⁱ To be conservative, the lowest iPWQO value for xylene isomer, m-xylene, is represented as the iPWQO value for m,p-xylene and total xylene.
- ^j The Analyte is not considered of ecological health concern, and therefore no screening criteria are necessary.
- ^k The CCME CWQG value is for dissolved zinc. This value is also applied to screen the total zinc concentration.
- ^l iPWQO values for both 1,2- and 1,3- propylene glycol was available. The lower value for 1,3-propylene glycol is illustrated here for conservative approach.
- ^m Screening criteria selection for alcohol ethoxylates is detailed in Table A-13b,c.
- ⁿ Values are stats results using un-detected uncensored data.
- ^o Copper Biotic Ligand Model has been requested from ECCC; will be run with site-specific water quality data once available.

Table A-11: Screening of Lake Water Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Ecological Screening Criteria	Reference	2020 ERA Max	COPC in the 2020 ERA?	Exceeds Screening Criteria	Carried Forward as COPC for Addendum?
Physical/Conventional Characteristics							
Field Temperature	Celsius	-	-	22.67	-	-	-
Field pH	pH	6.5-8.5	(2)	6.69-9.21	Yes	Yes	No ⁱ
pH	pH	6.5-8.5	(2)	8.02-8.44	No	No	No
Field Sp. Conductance	µS/cm	-	-	860	-	-	-
Conductivity	umho/cm	-	-	570	-	-	-
Field Turbidity	NTU	-	-	26.1	-	-	-
Turbidity	NTU	-	-	11	-	-	-
Alkalinity (Total as CaCO ₃)	mg/L	-	-	150	-	-	-
Total Hardness (CaCO ₃)	mg/L	-	-	270	-	-	-
Total Suspended Solids	mg/L	16.15	(1)	33	Yes	Yes	No ⁱ
Total Residual Chlorine	mg/L	0.002	(2)	<0.0012 ^a	No	No	No
Nutrients							
Dissolved Organic Carbon	mg/L	-	-	6	-	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	0.48	-	-	-
Total Ammonia-N	mg/L	0.044	(1)	0.26^b	Yes	Yes	No ⁱ
Total Un-ionized Ammonia	mg/L	0.019	(1)	0.051^c	Yes	Yes	No ⁱ
Nitrate (N)	mg/L	13	(1)	2.2	No	No	No
Nitrite (N)	mg/L	0.06	(1)	0.013	No	No	No
Total BOD	mg/L	-	-	2	-	-	-
Total Chemical Oxygen Demand (COD)	mg/L	-	-	13	-	-	-
Orthophosphate (P)	mg/L	-	-	0.013	No	No	No
Total Phosphorus	mg/L	0.02	(2)	0.059	No ^d	Yes	No ^d
Hydrocarbons							
Benzene	µg/L	370	(1)	0.14	No	No	No
Ethylbenzene	µg/L	90	(1)	0	No	No	No
F1 (C6-C10)	µg/L	167	(1)	0	No	No	No
F1 (C6-C10) - BTEX	µg/L	167	(1)	0	No	No	No
F2 (C10-C16 Hydrocarbons)	µg/L	42	(1)	0	No	No	No
F3 (C16-C34 Hydrocarbons)	µg/L	200	(5)	170	No	No	No
F4 (C34-C50 Hydrocarbons)	µg/L	200	(5)	0	No	No	No
Biological							
Chlorophyll	µg/L	-	-	9.08	-	-	-
Background	CFU/100mL	-	-	9600	-	-	-
Total Coliforms	CFU/100mL	100	(2)	2100	No ^e	Yes	No ^e
Fecal coliform	CFU/100mL	100	(2)	2000	No ^e	Yes	No ^e
Escherichia coli	CFU/100mL	100	(2)	2000	No ^e	Yes	No ^e
Metals							
Total Aluminum (Al)	µg/L	100	(1)	142	No ^f	Yes	No ^f
Dissolved (0.2µ) Aluminum (Al)	µg/L	75	(2)	21	No	No	No
Total Antimony (Sb)	µg/L	20	(2)	0.176	No	No	No
Total Arsenic (As)	µg/L	5	(1)	0.841	No	No	No
Total Barium (Ba)	µg/L	1000	(12)	32.3	Yes ^g	No	No
Total Beryllium (Be)	µg/L	1100	(2)	0.007	No	No	No
Total Bismuth (Bi)	µg/L	2.5	(4)	0.027	No	No	No
Total Boron (B)	µg/L	1500	(1)	27	No	No	No
Total Cadmium (Cd)	µg/L	0.17	(1)	0.016	No	No	No
Total Calcium (Ca)	µg/L	11,600	(3)	62,100	No ^h	Yes	No ^h
Total Cesium (Cs)	µg/L	315	(4)	0.087	No	No	No
Total Chromium (Cr)	µg/L	8.9	(1)	1.346	No	No	No
Chromium (+3)	µg/L	8.9	(1)	0	No	No	No
Chromium (VI)	µg/L	1	(1)	0.34	No	No	No
Total Cobalt (Co)	µg/L	1	(6)	0.091	No	No	No
Total Copper (Cu)	µg/L	2.57	(1)	1	No	No	No
Total Iron (Fe)	µg/L	300	(1)	178	No	No	No
Total Lead (Pb)	µg/L	3.59	(1)	0.157	No	No	No
Total Lithium (Li)	µg/L	14	(3)	10.2	No	No	No
Total Magnesium (Mg)	µg/L	8,200	(3)	11,400	No ^h	Yes	No ^h
Total Manganese (Mn)	µg/L	120	(1)	18.1	No	No	No
Mercury (Hg)	µg/L	0.026	(1)	0.0031	No	No	No
Total Molybdenum (Mo)	µg/L	40	(2)	1.35	No	No	No
Total Nickel (Ni)	µg/L	25	(2)	0.703	No	No	No
Total Potassium (K)	µg/L	5,300	(3)	6,500	No ^h	Yes	No ^h
Total Selenium (Se)	µg/L	1	(1)	0.189	No	No	No
Total Silicon (Si)	µg/L	-	-	932	-	-	-
Total Silver (Ag)	µg/L	0.1	(2)	0.006	No	No	No
Total Sodium (Na)	µg/L	68,000	(3)	39,600	No	No	No
Total Strontium (Sr)	µg/L	2500	(6)	625	No	No	No
Total Thallium (Tl)	µg/L	0.8	(1)	0.014	No	No	No
Total Thorium (Th)	µg/L	0.52	(4)	0.014	No	No	No
Total Tin (Sn)	µg/L	73	(3)	0.405	No	No	No
Total Titanium (Ti)	µg/L	27.2	(4)	5.2	No	No	No
Total Tungsten (W)	µg/L	30	(2)	0.134	No	No	No
Total Uranium (U)	µg/L	15	(1)	0.61	No	No	No
Total Vanadium (V)	µg/L	120	(8)	0.64	No	No	No
Total Zinc (Zn)	µg/L	7	(1)	3.138	No	No	No
Dissolved Zinc (Zn)	µg/L	7	(1)	13	Yes	Yes	No ⁱ
Total Zirconium (Zr)	µg/L	4	(2)	0.34	No	No	No
Other							
Hydrazine	µg/L	2.6	(7)	0.11	No	No	No
Morpholine	µg/L	4	(2)	2	No	No	No
Bromoform	µg/L	60	(2)	0	No	No	No
Chloroform	µg/L	1.8	(1)	0	No	No	No
Bromodichloromethane	µg/L	200	(2)	0	No	No	No

References:

1. CCME Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in July 2020.
2. MOECC: Water management: policies, guidelines, provincial water quality objectives (1994).
3. Suter and Tsao, (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.
4. Borgmann et al., (2005). Toxicity of Sixty-Three Metals and Metalloids to Hyalella Azteca at Two Levels of Water Hardness.
5. Ecometrix. (2020). Darlington New Nuclear Project Supporting Environment Studies – Environment. Report prepared for OPG. Report No. NK054-REP-01210-0001. May.
6. ECCC (2020). Federal Environmental Quality Guidelines - Strontium. July.
7. Environment Canada (2013). Federal Environmental Quality Guidelines, Vanadium. May.

Notes:

- ^a Due to machine calibration issues in the summer, the maximum observed concentration for TRC was 0.028 mg/L. The problematic results were removed from the screening dataset.
- ^b The maximum observed concentration during the 2019 study was 0.40 mg/L due to the lab contamination during the spring sampling season. Problematic results were removed from the screening dataset.
- ^c The maximum observed concentration during the 2019 study was 0.081 mg/L due to the lab contamination during the spring sampling season. Problematic results were removed from the screening dataset.
- ^d Phosphorus is a nutrient and not a toxicant. Therefore it was not carried forward as a COPC.
- ^e E.coli and other coliforms are not of concern for ecological health. They are not carried forward as COPCs.
- ^f Although the concentration of total aluminum exceeded the selected screening criteria, its more bioavailable form, dissolved aluminum, did not exceed. Therefore, aluminum was not carried forward as a COPC.
- ^g Barium exceeded screening and was retained as a COPC in the 2020 DN ERA. Due to a change in the screening criteria, barium no longer screens in as a COPC.
- ^h Major ions (Ca, Mg, K) are not considered toxic at environmental concentrations. They are not carried forward as COPCs.
- ⁱ Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value Indicates parameter exceeded screening criteria.

Table A-12: Screening of CCW Effluent (ECA Data) for Ecological Health

Parameter	Unit	Ecological Surface Water Screening Criteria ^a	2020 DN ERA			Measured Maximum Concentrations from ECAs			Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	Carried forward as COPC for Addendum?
			Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	COPC in 2020 ERA?	2020	2021	2022			
Un-ionized Ammonia	mg/L	0.019	0.01	0.0014	No	<0.01	0.01	0.01	0.01	0.0014	No
Hydrazine	mg/L	0.0026	0.006	0.0009	No	0.004	0.003	0.0076	0.0076	0.0011	No
Morpholine	mg/L	0.004	0.006	0.0009	No	0.009	0.002	0.003	0.009	0.0013	No
pH	pH units	6.5 - 8.5	7.9-8.6	7.9-8.6 ^b	No	7.8-8.3	8.5	7.7-8.4	7.8-8.5	7.8-8.5 ^b	No
TRC	mg/L	0.002	0.01	0.0014	No	0.009	0.01	0.01	0.01	0.0014	No

Notes:

^a See Table A-10 for references of selected screening criteria.

^b The maximum pH in the CCW was directly compared, representing the possibly maximum mixing zone pH value.

TRC - Total Residual Chlorine

Value Indicates parameter exceeded screening criteria.

Table A-13a: Screening of 2016 CCW Effluent for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Selected Surface Water Screening Criteria ^a	Measured Stream Concentrations					Estimated Max Mixing Zone Concentrations	Carried Forward as COPC for Addendum?
			RLW	BB	IAD	WTP	CCW		
			Max Value	Max Value	Max Value	Max Value	Max Value		
Morpholine	µg/L	4	6	-	-	-	-	-	No ^b
Gadolinium (Gd)	µg/L	15	46	-	-	-	9.6	1.37	No
Mercury (Hg)	µg/L	0.026	<0.1	-	-	-	<0.1	<0.014	No ^b
Total Aluminum (Al)	µg/L	100	59.9	-	19.2	0.012	150	21.43	No ^b
Total Cadmium (Cd)	µg/L	0.17	0.257	0.013	0.008	4.76	0.015	0.002	No ^b
Total Chromium (Cr)	µg/L	8.9	6.97	0.44	0.64	9.91	0.79	0.11	No ^b
Total Copper (Cu)	µg/L	2.57	15.5	0.914	3.25	13.8	1.92	0.27	No ^b
Total Iron (Fe)	µg/L	300	32	13.1	37.7	-	250	35.71	No
Total Lead (Pb)	µg/L	3.59	19.8	0.213	0.086	0.199	0.335	0.05	No ^b
Total Lithium (Li)	µg/L	14	330	-	-	-	3.82	0.55	No ^b
Total Molybdenum (Mo)	µg/L	40	7.78	-	-	65.6	1.59	0.23	No ^b
Total Nickel (Ni)	µg/L	25	50.6	0.087	0.752	1.83	0.932	0.13	No ^b
Total Selenium (Se)	µg/L	1	1	0.04	0.141	2.05	0.199	0.03	No ^b
Total Zinc (Zn)	µg/L	7	25.5	2.95	-	21.2	8.79	1.26	No ^b
Nitrate (N)	mg/L	13	-	-	-	4.88	0.44	0.06	No
Total Phosphorus	mg/L	0.02	0.177	-	-	-	0.029	0.004	No ^b
Ethylene Glycol	mg/L	192	<20	-	<5	-	<5	<0.71	No
Propylene Glycol	mg/L	500	<20	-	<5	-	<5	<0.71	No
F1 (C6-C10)	µg/L	167	<25	-	-	<25	<25	<3.57	No
F1 (C6-C10) - BTEX	µg/L	167	<25	-	-	<25	<25	<3.57	No
F2 (C10-C16 Hydrocarbons)	µg/L	42	<100	-	-	<100	<100	<14.29	No ^b
F3 (C16-C34 Hydrocarbons)	µg/L	200	<200	-	-	<200	<200	<28.57	No
Total Residual Chlorine (TRC)	µg/L	2	-	-	-	4	-	-	No ^b

Notes:

^a See Table A-10 for references for these selected screening benchmarks.

^b See discussion in Section 4.1.3.2.2.2.

RLW - Radioactive Liquid Waste

BB - Boiler Blowdown

IAD - Inactive Drainage

WTP - Water Treatment Plant

CCW - Condenser Cooling Water

Value Indicates parameter exceeded screening criteria.

Table A-13b: Screening of 2016 CCW Effluent for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Detection Limit	FEQG (1)	CWQG (2)	HERA (3)	Selected Surface Water Screening Criteria	Reference	Maximum Concentration in CCW (EcoMetrix, 2016)	Estimated Max Mixing Zone Concentrations	Carried forward to detailed screening?
Alcohol Ethoxylates C8-9	µg/L	0.03	179	-	-	179	(1)	ND	ND	No
Alcohol Ethoxylates C10-11	µg/L	0.03	80	-	-	80	(1)	ND	ND	No
Alcohol Ethoxylates C12 -13	µg/L	0.03	32	-	-	32	(1)	108.7	15.5	No ^b
Alcohol Ethoxylates C14-15	µg/L	0.03	11	-	-	11	(1)	16	2.3	No ^b
Alcohol Ethoxylates C16-18	µg/L	0.03	2	-	-	2	(1)	1	0.1	No
Total Alcohol Ethoxylates	µg/L	0.03	-	-	-	None	-	121	17.3	No ^b
Nonylphenol Ethoxycarboxylate	µg/L	0.01	-	1	-	1	(2)	ND	ND	No
Linear Alkylbenzene Sulphonates C10	µg/L	0.06	-	-	1700	1700	(3)	1.1	0.2	No
Linear Alkylbenzene Sulphonates C12	µg/L	0.06	-	-	320	320	(3)	15.3	2.2	No
Total Linear Alkylbenzene Sulphonates	µg/L	0.06	-	-	-	None	-	15.3	2.2	No ^b

References:

1. Federal Environmental Quality Guidelines - Alcohol Ethoxylates, n = 0 (EC, 2013b)
2. Canadian Water Quality Guideline for the Protection of Aquatic Life (CCME, 2002)
3. Revised Human and Environmental Risk Assessment (HERA) Report - Linear Alkylbenzene Sulphonate, Table 10 (HERA, 2013)

Notes:

^a ND = non-detect

^b See discussion in Section 4.1.3.2.2.2.

Value Indicates parameter exceeded screening criteria.

Table A-13c: Screening of 2016 CCW Effluent for Ecological Health (no new data since 2020 ERA)

AEO Fraction	Ethoxylate Number	FEQG (1)	Maximum Concentration in CCW (EcoMetrix, 2016)	Estimated Max Mixing Zone Concentrations	Carried Forward as COPC for Addendum?
		(ng/L)			
C12 (ng/L)	E4	128000	80253	11465	No
	E5	158000	5136	734	No
	E6	193000	5164	738	No
	E7	233000	4847	692	No
	E8	279000	5568	795	No
	E9	332000	4268	610	No
C13 (ng/L)	E10	392000	3375	482	No
	E3	62000	1674	239	No
	E4	78000	1762	252	No
	E5	96000	224	32	No
	E6	118000	93	13	No
	E7	142000	14	2	No
C14 (ng/L)	E8	170000	32	5	No
	E9	203000	14	2	No
	E10	240000	39	6	No
	E3	37000	11832	1690	No
	E4	46000	2692	385	No
	E5	57000	2278	325	No
C15 (ng/L)	E6	70000	2094	299	No
	E7	84000	1601	229	No
	E8	102000	1257	180	No
	E9	121000	1377	197	No
	E10	144000	829	118	No
	C15 (ng/L)	E3	21000	202	29
E4		26000	2176	311	No
E5		33000	943	135	No
E6		40000	830	119	No
E7		49000	461	66	No
E8		59000	752	107	No
C15 (ng/L)	E9	71000	625	89	No
	E10	84000	128	18	No

References:

1. Federal Environmental Quality Guidelines - Alcohol Ethoxylates (EC, 2013b)

Notes:

AEO Fraction - alcohol ethoxylates fraction

Value Indicates parameter exceeded screening criteria.

Table A-14: Screening of Stormwater Quality for Ecological Health (no new data since 2020 ERA)

Parameter	2020 ERA Stormwater Loadings and Diluted Concentrations				Selected Surface Water Screening Criteria ^a	COPC in 2020 ERA?	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
	Maximum Stormwater Loading		Estimated Diluted Concentration in Lake Water					
	Value	Units	Value	Units				
Physical/Conventional Characteristics								
Alkalinity, Bicarbonate (HCO3)	54010	mg/s	5.56	mg/L	- ^b	-	-	No
Alkalinity, Carbonate (CO3)	1015.388	mg/s	0.10	mg/L	- ^b	-	-	No
Alkalinity, Hydroxide (OH)	423.66	mg/s	0.04	mg/L	- ^b	-	-	No
Alkalinity, Total	54010	mg/s	5.56	mg/L	- ^b	-	-	No
Conductivity	7.64	mS/cm	7.64	mS/cm	- ^b	-	-	No
Hardness, Calcium Carbonate, Total	147184800	µg/s	15142	µg/L	- ^b	-	-	No
pH	8.36	pH	8.36	pH	6.5-8.5	No	No	No
pH, field measured	8.97	pH	8.97	pH	6.5-8.5	No ^d	Yes	No ^d
Temperature, field measured	25.3	Celsius	25.30	Celsius	- ^b	-	-	No
Total Dissolved Solids	1080231.3	mg/s	111.1	mg/L	- ^b	-	-	No
Total Suspended Solids	68868.8	mg/s	7.09	mg/L	8.35	No	No	No
Nutrients								
Ammonia Nitrogen	757.77	mg/s	0.08	mg/L	0.44	No	No	No
Un-ionized Ammonia, calculated	57.486	mg/s	0.0059	mg/L	0.019	No	No	No
Biochemical Oxygen Demand, 5 Day	1270.98	mg/s	0.13	mg/L	- ^b	-	-	No
Biological								
Background Colonies	300380	CFU/s	3.09	CFU/100 ml	- ^b	-	-	No
Escherichia coli	80972	CFU/s	0.83	CFU/100 ml	100	No	No	No
Fecal Coliform	2746200	CFU/s	28.25	CFU/100 ml	100	No	No	No
Total Coliform	120152	CFU/s	1.24	CFU/100 ml	100	No	No	No
Anions								
Chloride	630792	mg/s	64.90	mg/L	640	No	No	No
Nitrate as N	188.838	mg/s	0.02	mg/L	13	No	No	No
Nitrite as N	7.32036	mg/s	0.0008	mg/L	0.06	No	No	No
Nitrogen, Nitrate-Nitrite	190.2906	mg/s	0.02	mg/L	-	-	-	No
Total Phosphorus	60.8192	mg/s	0.0063	mg/L	0.02	No	No	No
Dissolved Phosphorus	31.2144	mg/s	0.0032	mg/L	0.02	No	No	No
Radionuclides								
Gross Gamma Activity	2118.3	Bq/s	0.2179	mg/L	-	-	-	Yes ^g
Tritium (Hydrogen-3)	168291.2	µg/s	17.3139	mg/L	-	-	-	Yes ^g
Cesium-134	423.66	Bq/s	0.0436	mg/L	-	-	-	Yes ^g
Cesium-137	423.66	Bq/s	0.0436	mg/L	-	-	-	Yes ^g
Cobalt-60	423.66	Bq/s	0.0436	mg/L	-	-	-	Yes ^g
Iodine-131	423.66	µg/s	0.0436	mg/L	-	-	-	Yes ^g
Metals and Inorganics								
Total Aluminum (Al)	765085.14	µg/s	78.71	µg/L	100	No	No	No
Dissolved Aluminum (Al)	24208.22944	µg/s	2.49	µg/L	75	No	No	No
Dissolved (0.2u) Aluminum (Al)	8896.86	µg/s	0.92	µg/L	75	No	No	No
Total Antimony (Sb)	211.83	µg/s	0.022	µg/L	20	No	No	No
Dissolved Antimony (Sb)	211.83	µg/s	0.022	µg/L	20	No	No	No
Total Arsenic (As)	423.66	µg/s	0.044	µg/L	5	No	No	No
Dissolved Arsenic (As)	423.66	µg/s	0.044	µg/L	5	No	No	No
Total Barium (Ba)	42052.8	µg/s	4.3264	µg/L	1000	Yes ^f	No	No
Dissolved Barium (Ba)	39424.5	µg/s	4.0560	µg/L	1000	Yes ^f	No	No
Total Beryllium (Be)	<211.83	µg/s	<0.022	µg/L	1100	No	No	No
Dissolved Beryllium (Be)	<211.83	µg/s	<0.022	µg/L	1100	No	No	No
Total Bismuth (Bi)	<423.66	µg/s	<0.044	µg/L	2.5	No	No	No
Dissolved Bismuth (Bi)	423.66	µg/s	0.044	µg/L	2.5	No	No	No
Total Boron (B)	31214.4	µg/s	3.21	µg/L	1500	No	No	No
Dissolved Boron (B)	26755.2	µg/s	2.75	µg/L	1500	No	No	No
Total Cadmium (Cd)	85.8624	µg/s	0.0088	µg/L	0.17	No	No	No
Dissolved Cadmium (Cd)	42.366	µg/s	0.0044	µg/L	0.17	No	No	No
Total Calcium (Ca)	38129400	µg/s	3923	µg/L	11,600	No	No	No
Dissolved Calcium (Ca)	42052800	µg/s	4326	µg/L	11,600	No	No	No
Total Chromium (Cr)	2540.096	µg/s	0.26	µg/L	8.9	No	No	No
Dissolved Chromium (Cr)	2118.3	µg/s	0.22	µg/L	8.9	No	No	No
Total Cobalt (Co)	465.088	µg/s	0.048	µg/L	1	No	No	No
Dissolved Cobalt (Co)	211.83	µg/s	0.022	µg/L	1	No	No	No
Total Copper (Cu)	5276.96	µg/s	0.54	µg/L	2.57	No	No	No
Dissolved Copper (Cu)	1694.64	µg/s	0.17	µg/L	2.57	No	No	No
Hexavalent Chromium	416.546354	µg/s	0.043	µg/L	1	No	No	No
Total Iron (Fe)	1144832	µg/s	117.8	µg/L	300	No	No	No
Dissolved Iron (Fe)	42366	µg/s	4.4	µg/L	300	No	No	No
Total Lead (Pb)	2879.968	µg/s	0.30	µg/L	3.59	No	No	No
Dissolved Lead (Pb)	211.83	µg/s	0.022	µg/L	3.59	No	No	No
Total Lithium (Li)	2499.594	µg/s	0.26	µg/L	14	No	No	No
Dissolved Lithium (Li)	2118.3	µg/s	0.22	µg/L	14	No	No	No
Total Magnesium (Mg)	9987540	µg/s	1028	µg/L	8,200	No	No	No
Dissolved Magnesium	9987540	µg/s	1028	µg/L	8,200	No	No	No
Total Manganese (Mn)	45435.52	µg/s	4.67	µg/L	220	No	No	No
Dissolved Manganese (Mn)	30245.6	µg/s	3.11	µg/L	220	No	No	No
Total Mercury (Hg)	4.2366	µg/s	0.00044	µg/L	0.026	No	No	No
Total Molybdenum (Mo)	402.477	µg/s	0.041	µg/L	40	No	No	No
Dissolved Molybdenum (Mo)	377.0574	µg/s	0.039	µg/L	40	No	No	No
Total Nickel (Ni)	1252.16	µg/s	0.13	µg/L	25	No	No	No
Dissolved Nickel (Ni)	423.66	µg/s	0.044	µg/L	25	No	No	No
Total Potassium (K)	1355712	µg/s	139.48	µg/L	5,300	No	No	No
Dissolved Potassium (K)	1182735	µg/s	121.68	µg/L	5,300	No	No	No
Total Selenium (Se)	847.32	µg/s	0.087	µg/L	1	No	No	No
Dissolved Selenium (Se)	137.31	µg/s	0.014	µg/L	1	No	No	No
Total Silicon (Si)	1275141.9	µg/s	131.2	µg/L	- ^b	-	-	No
Dissolved Silicon (Si)	630792	µg/s	64.9	µg/L	- ^b	-	-	No
Total Silver (Ag)	42.366	µg/s	0.0044	µg/L	0.1	No	No	No
Dissolved Silver (Ag)	42.366	µg/s	0.0044	µg/L	0.1	No	No	No
Total Sodium (Na)	367962000	µg/s	37.856	µg/L	68,000	No	No	No
Dissolved Sodium (Na)	341679000	µg/s	35.152	µg/L	68,000	No	No	No
Total Strontium (Sr)	473094	µg/s	48.67	µg/L	2500	No	No	No
Dissolved Strontium (Sr)	473094	µg/s	48.67	µg/L	2500	No	No	No
Total Thallium (Tl)	21.183	µg/s	0.0022	µg/L	0.8	No	No	No
Dissolved Thallium (Tl)	21.183	µg/s	0.0022	µg/L	0.8	No	No	No
Dissolved Tellurium (Te)	<423.66	µg/s	<0.044	µg/L	151.9	No	No	No
Total Tellurium (Te)	<423.66	µg/s	<0.044	µg/L	151.9	No	No	No
Dissolved Thorium (Th)	<137.31	µg/s	<0.014	µg/L	0.52	No	No	No
Total Thorium (Th)	847.32	µg/s	0.087	µg/L	0.52	No	No	No
Total Tin (Sn)	423.66	µg/s	0.044	µg/L	73	No	No	No
Dissolved Tin (Sn)	423.66	µg/s	0.044	µg/L	73	No	No	No
Total Titanium (Ti)	22952.5542	µg/s	2.36	µg/L	27.2	No	No	No
Dissolved Titanium (Ti)	2118.3	µg/s	0.218	µg/L	27.2	No	No	No
Dissolved Tungsten (W)	423.66	µg/s	0.044	µg/L	30	No	No	No
Total Tungsten (W)	438.048	µg/s	0.045	µg/L	30	No	No	No
Total Vanadium (Va)	1341.6	µg/s	0.138	µg/L	120	No	No	No
Dissolved Vanadium (Va)	353.217	µg/s	0.036	µg/L	120	No	No	No
Total Uranium (U)	237.644	µg/s	0.024	µg/L	15	No	No	No
Dissolved Uranium (U)	233.9187	µg/s	0.024	µg/L	15	No	No	No
Total Zinc (Zn)	134160	µg/s	13.80	µg/L	7	No	No ^e	No ^e
Dissolved Zinc (Zn)	23654.7	µg/s	2.43	µg/L	7	No	No	No
Dissolved Zirconium (Zr)	423.66	µg/s	0.044	µg/L	4	No	No	No
Total Zirconium (Zr)	423.66	µg/s	0.044	µg/L	4	No	No	No
PCB								
Aroclor 1016	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1221	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1232	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1242	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1248	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1254	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1260	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1262	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Aroclor 1268	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
Polychlorinated Biphenyls	<21.183	µg/s	<0.0022	µg/L	- ^c	-	-	No
PHC								
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	<10591.5	µg/s	<1.09	µg/L	167	No	-	No
Petroleum Hydrocarbons - F1 (C6-C10)	<10591.5	µg/s	<1.09	µg/L	167	No	-	No
Petroleum Hydrocarbons - F2 (C10-C16)	<42366	µg/s	<4.36	µg/L	42	No	-	No
Petroleum Hydrocarbons - F3 (C16-C34)	84732	µg/s	8.72	µg/L	200	No	-	No
Petroleum Hydrocarbons - F4 (C34-C50)	<84732	µg/s	<8.72	µg/L	200	No	-	No
Oil & Grease, Total Rec	445.92	mg/s	0.05	mg/L	-	-	-	No
Benzene	<84.732	µg/s	<0.0087	µg/L	370	No	-	No
Ethylbenzene	<84.732	µg/s	<0.0087	µg/L	90	No	-	No
m,p-Xylenes	231.2904	µg/s	0.024	µg/L	2	No	-	No
o-Xylene	84.732	µg/s	0.009	µg/L	40	No	-	No
Toluene	420.368	µg/s	0.043	µg/L	0.8	No	-	No
Xylenes, Total	289.113	µg/s	0.030	µg/L	2	No	-	No

Notes:
^a See Table A-10 for references for these selected screening criteria. For all metals, the screening criteria for total metal and inorganics were also used to screen concentration of the dissolved metal ions.
^b Parameters not of ecological health concern. Screening was considered not necessary.
^c PCBs do not partition in water, and they are not COPCs from nuclear stations. Therefore these parameters were not screened.
^d The pH value was exceeding the PWQO guideline, but within the range of the CCME guideline. The range from 6.5-9.0 was considered not harmful to fish and benthic invertebrates. Not carried forward.
^e The selected benchmark was defined for dissolved zinc. As the estimated concentration of dissolved zinc concentration did not exceed the guideline, total zinc was not carried forward.
^f Barium exceeded screening and was retained as a COPC in the 2020 DN ERA. Due to a change in the screening criteria, barium no longer screens in as a COPC.
^g Radionuclides are not screened, and are automatically carried forward as COPCs.

Value Indicates parameter exceeded screening criteria.

Table A-15: Screening of Pond Water Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Unit	Selected Screening Criteria	Reference	Coot's Pond			Treefrog Pond		
				2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?	2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?
Physical/Conventional Characteristics									
Field Temperature	Celsius	-	-	22.95	-	-	21.63	-	-
Field pH	pH	6.5-8.5	(2)	7.39-9.62	Yes	No ^f	6.88-8.26	No	No
pH	pH	6.5-8.5	(2)	8.18-9.4	Yes	No ^f	7.55-7.99	No	No
Field Sp. Conductance	µS/cm	-	-	583	-	-	528	-	-
Conductivity	umho/cm	-	-	650	-	-	580	-	-
Field Turbidity	NTU	-	-	15.2	-	-	3.6	-	-
Alkalinity (Total as CaCO ₃)	mg/L	-	-	200	-	-	270	-	-
Total Hardness (CaCO ₃)	mg/L	-	-	297	-	-	285	-	-
Nutrients									
Dissolved Organic Carbon	mg/L	-	-	9.8	-	-	11	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	0.72	-	-	1.1	-	-
Total Ammonia-N	mg/L	0.044	(1)	0.18	Yes	No ^f	0.21	Yes	No ^f
Total Un-ionized Ammonia	mg/L	0.019	(1)	0.048	Yes	No ^f	0.005	No	No
Nitrate (N)	mg/L	13	(1)	0	No	No	0	No	No
Nitrite (N)	mg/L	0.06	(1)	0.003	No	No	0.004	No	No
Total BOD	mg/L	-	-	5	-	-	2	-	-
Total Chemical Oxygen Demand (COD)	mg/L	-	-	48	-	-	34	-	-
Orthophosphate (P)	mg/L	-	-	0.011	-	-	0.066	No	No
Total Phosphorus	mg/L	0.02	(2)	0.099	No ^a	No ^a	0.18	No ^a	No ^a
Hydrocarbons									
Benzene	µg/L	370	(1)	0	No	No	0	No	No
Ethylbenzene	µg/L	90	(1)	0	No	No	0	No	No
F1 (C6-C10)	µg/L	167	(1)	0	No	No	0	No	No
F1 (C6-C10) - BTEX	µg/L	167	(1)	0	No	No	0	No	No
F2 (C10-C16 Hydrocarbons)	µg/L	42	(1)	0	No	No	0	No	No
F3 (C16-C34 Hydrocarbons)	µg/L	200	(5)	160	No	No	89	No	No
F4 (C34-C50 Hydrocarbons)	µg/L	200	(5)	0	No	No	0	No	No
Biological									
Chlorophyll	µg/L	-	-	26.4	-	-	6.94	-	-
Background	CFU/100mL	-	-	12000	-	-	8400	-	-
Total Coliforms	CFU/100mL	100	(2)	280	No ^b	No ^b	640	No ^b	No ^b
Fecal coliform	CFU/100mL	100	(2)	40	No ^b	No ^b	350	No ^b	No ^b
Escherichia coli	CFU/100mL	100	(2)	40	No ^a	No ^a	340	No ^b	No ^b
Metals									
Total Aluminum (Al)	µg/L	100	(1)	369	No ^c	No ^c	18.2	No	No
Dissolved (0.2µ) Aluminum (Al)	µg/L	75	(2)	25	No	No	11	No	No
Total Antimony (Sb)	µg/L	20	(2)	0.268	No	No	0.063	No	No
Total Arsenic (As)	µg/L	5	(1)	1.32	No	No	0.298	No	No
Total Barium (Ba)	µg/L	1000	(12)	56.5	Yes ^d	No	39.8	Yes ^d	No
Total Beryllium (Be)	µg/L	1100	(2)	0.017	No	No	0.003	No	No
Total Bismuth (Bi)	µg/L	2.5	(4)	0.006	No	No	0.003	No	No
Total Boron (B)	µg/L	1500	(1)	230	No	No	21	No	No
Total Cadmium (Cd)	µg/L	0.17	(1)	0.0095	No	No	0.005	No	No
Total Calcium (Ca)	µg/L	11,600	(3)	74,500	No ^e	No ^e	97,900	No ^e	No ^e
Total Cesium (Cs)	µg/L	315	(4)	0.018	No	No	0.011	No	No
Total Chromium (Cr)	µg/L	8.9	(1)	1.58	No	No	1.2	No	No
Chromium (+3)	µg/L	8.9	(1)	0	No	No	0	No	No
Chromium (VI)	µg/L	1	(1)	0.31	No	No	0.24	No	No
Total Cobalt (Co)	µg/L	1	(6)	0.235	No	No	0.24	No	No
Total Copper (Cu)	µg/L	2.57	(1)	1.72	No	No	0.388	No	No
Total Iron (Fe)	µg/L	300	(1)	433	Yes	No ^f	520	Yes	No ^f
Total Lead (Pb)	µg/L	3.59	(1)	0.614	No	No	0.07	No	No
Total Lithium (Li)	µg/L	14	(3)	5.92	No	No	0.4046	No	No
Total Magnesium (Mg)	µg/L	8,200	(3)	30,000	No ^e	No ^e	9,900	No ^e	No ^e
Total Manganese (Mn)	µg/L	220	(1)	68.5	No	No	310	No	No
Mercury (Hg)	µg/L	0.026	(1)	0.0029	No	No	0.0038	No	No
Total Molybdenum (Mo)	µg/L	40	(2)	1.04	No	No	0.15	No	No
Total Nickel (Ni)	µg/L	25	(2)	0.88	No	No	0.271	No	No
Total Potassium (K)	µg/L	5,300	(3)	7,030	No ^e	No ^e	5,870	No ^e	No ^e
Total Selenium (Se)	µg/L	1	(1)	0.079	No	No	0.114	No	No
Total Silicon (Si)	µg/L	-	-	2270	-	-	4440	-	-
Total Silver (Ag)	µg/L	0.1	(2)	0.003	No	No	0.002	No	No
Total Sodium (Na)	µg/L	68,000	(3)	21,400	No	No	4,860	No	No
Total Strontium (Sr)	µg/L	2500	(6)	506	No	No	225	No	No
Total Thallium (Tl)	µg/L	0.8	(1)	0.0058	No	No	0.01	No	No
Total Thorium (Th)	µg/L	0.52	(4)	0.013	No	No	0.002	No	No
Total Tin (Sn)	µg/L	73	(3)	0.52	No	No	0.0361	No	No
Total Titanium (Ti)	µg/L	27.2	(4)	19	No	No	1.592	No	No
Total Tungsten (W)	µg/L	30	(2)	0.06	No	No	0.007	No	No
Total Uranium (U)	µg/L	15	(1)	1.48	No	No	0.672	No	No
Total Vanadium (V)	µg/L	120	(8)	2.53	No	No	0.4	No	No
Total Zinc (Zn)	µg/L	7	(1)	3.75	No	No	3.1	No	No
Dissolved Zinc (Zn)	µg/L	7	(1)	2.615	No	No	3.502	No	No
Total Zirconium (Zr)	µg/L	4	(2)	0.19	No	No	0.065	No	No
Other									
Morpholine	µg/L	4	(2)	1	No	No	0	No	No
Bromoform	µg/L	60	(2)	0	No	No	0	No	No
Chloroform	µg/L	1.8	(1)	0	No	No	0	No	No
Bromodichloromethane	µg/L	200	(2)	0	No	No	0	No	No

References:

1. CCME Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in July 2020.
2. MOECC: Water management: policies, guidelines, provincial water quality objectives (1994).
3. Suter and Tsao, (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.
4. Borgmann et al., (2005). Toxicity of Sixty-Three Metals and Metalloids to *Hyalella Azteca* at Two Levels of Water Hardness.
5. Ecometrix. (2020). Darlington New Nuclear Project Supporting Environment Studies – Environment. Report prepared for OPG. Report No. NK054-REP-01210-0001. May.
6. ECC (2020). Federal Environmental Quality Guidelines - Strontium. July.
7. Environment Canada (2013). Federal Environmental Quality Guidelines, Vanadium. May.

Notes:

- ^a Phosphorus is a nutrient and not a toxicant. Therefore it was not carried forward as a COPC.
- ^b E.coli and other coliforms are not of concern of ecological health. They are not carried forward as COPCs.
- ^c Although the concentration of total aluminum exceeded the selected screening criteria, its more bioavailable form, dissolved aluminum, did not exceed. Therefore, aluminum was not carried forward as a COPC.
- ^d Barium exceeded screening and was retained as a COPC in the 2020 DN ERA. Due to a change in the screening criteria used, barium no longer screens in as a COPC.
- ^e Parameter found to exceed screening, but is not carried forward as a COPC. Major ions (Ca, Mg, K) are not considered toxic at environmental concentrations.
- ^f Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value Indicates parameter exceeded screening criteria.

Table A-16: Ecological Screening Criteria for Sediment COPCs

Parameter	Units	Sediment Quality Guidelines				Background Values		Lake Ontario Sediment		Pond Sediment	
		PSQG (LEL) (1)	CSQG (2)	Toxicity / Other Benchmark (3-6)	Toxicity / Other Benchmark Reference for Sediment	95th Percentile Background Value, Lake Ontario (7)	Dragun & Chiasson, 1991 (8)	Selected Screening Criteria, Lake Ontario	Reference	Selected Screening Criteria, Pond ^c	Reference
Physical/Conventional Parameters											
Moisture	%	-	-	-	-	-	-	-	- ^d	-	- ^d
Nutrients											
Calculated Total Kjeldahl Nitrogen	mg/kg	550	550	-	-	-	-	550	(1)	550	(1)
Total Organic Carbon	mg/kg	10000	-	-	-	-	-	10,000	(1)	10,000	(1)
Total Phosphorus (P)	mg/kg	600	-	-	-	-	-	600	(1)	600	(1)
Metals											
Total Aluminum (Al)	mg/kg	-	-	58030	(3)	-	-	58,030	(3)	58,030	(3)
Total Antimony (Sb)	mg/kg	-	-	2	(6)	-	-	2	(6)	2	(6)
Total Arsenic (As)	mg/kg	6	5.9	-	-	-	-	5.9	(2)	5.9	(2)
Total Barium (Ba)	mg/kg	-	-	-	-	264.3	10-5000	264.3	(7) ^a	10-5000	(8)
Total Beryllium (Be)	mg/kg	-	-	-	-	1.17	<1.0-15	1.17	(7) ^a	<1.0-15	(8)
Total Bismuth (Bi)	mg/kg	-	-	-	-	<0.5	<10-15	0.5	(7) ^a	<10-15	(8)
Total Boron (B)	mg/kg	-	-	-	-	7.1	<20-300	7.1	(7) ^a	<20-300	(8)
Hot Water Ext. Boron (B)	mg/kg	-	-	-	-	0.5	-	0.5	(7) ^b	-	-
Total Cadmium (Cd)	mg/kg	0.6	0.6	-	-	-	-	0.6	(1)	0.6	(1)
Total Calcium (Ca)	mg/kg	-	-	-	-	107,576	100-320,000	107,576	(7) ^a	100-320,000	(8)
Total Cesium (Cs)	mg/kg	-	-	-	-	0.21	0.25-25	0.21	(7) ^a	0.25-25	(8)
Total Chromium (Cr)	mg/kg	26	37.3	-	-	-	-	26	(1)	26	(1)
Total Cobalt (Co)	mg/kg	-	-	50	(4)	-	-	50	(4)	50	(4)
Total Copper (Cu)	mg/kg	16	35.7	-	-	-	-	16	(1)	16	(1)
Total Iron (Fe)	mg/kg	20000	-	-	-	-	-	20,000	(1)	20,000	(1)
Total Lead (Pb)	mg/kg	31	35	-	-	-	-	31	(1)	31	(1)
Total Lithium (Li)	mg/kg	-	-	-	-	7.2	<5.0-140	7.2	(7) ^a	<5.0-140	(8)
Total Magnesium (Mg)	mg/kg	-	-	-	-	10,501	50->100,000	10,501	(7) ^a	50->100,000	(8)
Total Manganese (Mn)	mg/kg	460	-	-	-	-	-	460	(1)	460	(1)
Total Mercury (Hg)	mg/kg	0.2	0.17	-	-	-	-	0.17	(2)	0.17	(2)
Total Molybdenum (Mo)	mg/kg	-	-	13.8	(5)	-	-	13.8	(5)	13.8	(5)
Total Nickel (Ni)	mg/kg	16	-	-	-	-	-	16	(1)	16	(1)
Total Potassium (K)	mg/kg	-	-	-	-	8,494	50-63,000	8,494	(7) ^a	50-63,000	(8)
Total Selenium (Se)	mg/kg	-	-	1.9	(5)	-	-	1.9	(5)	1.9	(5)
Total Silver (Ag)	mg/kg	-	-	0.5	(4)	-	-	0.5	(4)	0.5	(4)
Total Sodium (Na)	mg/kg	-	-	-	-	9,154	<500-100,000	9,154	(7) ^a	<500-100,000	(8)
Total Strontium (Sr)	mg/kg	-	-	-	-	270	<5-3000	270	(7) ^a	<5-3000	(8)
Total Thallium (Tl)	mg/kg	-	-	-	-	0.17	<0.25-10	0.17	(7) ^a	<0.25-10	(8)
Total Thorium (Th)	mg/kg	-	-	-	-	4.34	2.2-31	4.34	(7) ^a	2.2-31	(8)
Total Tin (Sn)	mg/kg	-	-	-	-	3.01	<0.1-10	3.01	(7) ^a	<0.1-10	(8)
Total Titanium (Ti)	mg/kg	-	-	-	-	3534	70-20,000	3,534	(7) ^a	70-20,000	(8)
Total Tungsten (W)	mg/kg	-	-	-	-	0.58	<100-1000	0.58	(7) ^a	<100-1000	(8)
Total Uranium (U)	mg/kg	-	-	104.4	(5)	-	-	104.4	(5)	104.4	(5)
Total Vanadium (V)	mg/kg	-	-	35.2	(5)	-	-	35.2	(5)	35.2	(5)
Total Zinc (Zn)	mg/kg	120	123	-	-	-	-	120	(1)	120	(1)
Total Zirconium (Zr)	mg/kg	-	-	-	-	122.2	<20-2000	85.68	(7) ^a	<20-2000	(8)
PHCs											
F1 (C6-C10)	mg/kg	-	-	-	-	10	-	10	(7) ^a	-	-
F1 (C6-C10) - BTEX	mg/kg	-	-	-	-	10	-	10	(7) ^a	-	-
F2 (C10-C16 Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) ^a	-	-
F3 (C16-C34 Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) ^a	-	-
F4 (C34-C50 Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) ^a	-	-
F4G-sg (Grav. Heavy Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) ^a	-	-
PAHs											
Anthracene	mg/kg	0.22	0.0469	-	-	-	-	0.0469	(2)	0.0469	(2)
Benzo(a)anthracene	mg/kg	0.32	0.317	-	-	-	-	0.317	(2)	0.317	(2)
Benzo(a)pyrene	mg/kg	0.37	0.0319	-	-	-	-	0.0319	(2)	0.0319	(2)
Benzo(g,h,i)perylene	mg/kg	0.17	-	-	-	-	-	0.17	(1)	0.17	(1)
Benzo(k)fluoranthene	mg/kg	0.24	-	-	-	-	-	0.24	(1)	0.24	(1)
Chrysene	mg/kg	0.34	0.0571	-	-	-	-	0.0571	(2)	0.0571	(2)
Dibenzo(a,h)anthracene	mg/kg	0.06	0.00622	-	-	-	-	0.00622	(2)	0.00622	(2)
Fluoranthene	mg/kg	0.75	0.111	-	-	-	-	0.111	(2)	0.111	(2)
Fluorene	mg/kg	0.19	0.0212	-	-	-	-	0.0212	(2)	0.0212	(2)
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	-	-	-	-	-	0.2	(1)	0.2	(1)
Phenanthrene	mg/kg	0.56	0.0419	-	-	-	-	0.0419	(2)	0.0419	(2)
Pyrene	mg/kg	0.49	0.053	-	-	-	-	0.053	(2)	0.053	(2)
Total PAHs	mg/kg	4	-	-	-	-	-	4	(1)	4	(1)
Pesticides and PCBs											
Chlordane (Total)	mg/kg	0.007	0.0045	-	-	-	-	0.0045	(2)	0.0045	(2)
Aldrin	mg/kg	0.0020	-	-	-	-	-	0.002	(1)	0.002	(1)
Total (α-, β-, γ-) BHC	mg/kg	0.003	-	-	-	-	-	0.003	(1)	0.003	(1)
alpha-BHC	mg/kg	0.006	-	-	-	-	-	0.006	(1)	0.006	(1)
beta-BHC	mg/kg	0.005	-	-	-	-	-	0.005	(1)	0.005	(1)
gamma-BHC (Lindane)	mg/kg	0.003	-	-	-	-	-	0.003	(1)	0.003	(1)
Dieldrin	mg/kg	0.002	0.00285	-	-	-	-	0.002	(1)	0.002	(1)
Endrin	mg/kg	0.003	0.00267	-	-	-	-	0.00267	(2)	0.00267	(2)
Hexachlorobenzene	mg/kg	0.02	-	-	-	-	-	0.02	(1)	0.02	(1)
Heptachlor	mg/kg	0.0003	0.0006	-	-	-	-	0.0003	(1)	0.0003	(1)
Heptachlor epoxide	mg/kg	0.005	0.003	-	-	-	-	0.003	(2)	0.003	(2)
Mirex	mg/kg	0.007	-	-	-	-	-	0.007	(1)	0.007	(1)
o,p-DDT + p,p-DDT	mg/kg	0.008	-	-	-	-	-	0.008	(1)	0.008	(1)
p,p-DDD	mg/kg	0.008	-	-	-	-	-	0.008	(1)	0.008	(1)
p,p-DDE	mg/kg	0.005	-	-	-	-	-	0.005	(1)	0.005	(1)
Aroclor 1016	mg/kg	0.007	-	-	-	-	-	0.007	(1)	0.007	(1)
Aroclor 1248	mg/kg	0.03	-	-	-	-	-	0.03	(1)	0.03	(1)
Aroclor 1254	mg/kg	0.06	-	-	-	-	-	0.06	(1)	0.06	(1)
Aroclor 1260	mg/kg	0.005	-	-	-	-	-	0.005	(1)	0.005	(1)
Total PCB	mg/kg	0.07	0.0341	-	-	-	-	0.0341	(2)	0.0341	(2)

References:

1. Ministry of the Environment, Conservation and Parks (2019). Guidelines for identifying, assessing and managing contaminated sediments in Ontario.
2. CCME (1999). Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect concentration was adopted.
4. MOEE (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok. 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.
6. Long, E. R. and Morgan L. G. (1991). The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.
7. OPG (2009). Ecological Risk Assessment and Assessment of Effects on Non-Human Biota Technical Support Document New Nuclear - Darlington Environmental Assessment. Report No. NK054-REP-07730-00022-R000. September.

Notes:

- ^a If the 95th percentile of the background value is greater than the detection limit, the background value is selected as the screening criteria. Otherwise, detection limit was selected as the screening criteria.
- ^b The concentration of hot water extracted boron collected in the local study area (off-site) in the 2009 ERA was used to screen this parameter.
- ^c As the aquatic environment in ponds are very different from Lake Ontario, it is considered not appropriate to use the lake sediment background value to screen pond parameters. For pond sediment, the upper crustal values in the continental USA was used as the background concentration.
- ^d The Analyte is not considered of ecological health concern, and therefore no screening benchmark is necessary.

Table A-17: Screening of Lake Ontario Sediment Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Selected Ecological Screening Criteria	Reference	Max Concentration in 2020 ERA	COPC in 2020 ERA?	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Physical/Conventional Parameters							
Moisture	%	-	-	37	-	-	No
Nutrients							
Calculated Total Kjeldahl Nitrogen	mg/kg	550	(1)	944	Yes	Yes	No ^a
Total Organic Carbon	mg/kg	10,000	(1)	9100	No	No	No
Total Phosphorus (P)	mg/kg	600	(1)	1010	Yes	Yes	No ^a
Metals							
Total Aluminum (Al)	mg/kg	58,030	(3)	4860	No	No	No
Total Antimony (Sb)	mg/kg	2	(6)	0.15	No	No	No
Total Arsenic (As)	mg/kg	5.9	(2)	1.86	No	No	No
Total Barium (Ba)	mg/kg	264.3	(7) ^a	42.2	No	No	No
Total Beryllium (Be)	mg/kg	1.17	(7)	0.24	No	No	No
Total Bismuth (Bi)	mg/kg	0.5	(7)	0.04438	No	No	No
Total Boron (B)	mg/kg	7.1	(7)	5.4	No	No	No
Hot Water Ext. Boron (B)	mg/kg	0.5	(7)	0.46	No	No	No
Total Cadmium (Cd)	mg/kg	0.6	(1)	0.149	No	No	No
Total Calcium (Ca)	mg/kg	107,576	(7)	173,000	No ^a	Yes	No ^a
Total Cesium (Cs)	mg/kg	0.21	(7)	0.39409	Yes	Yes	No ^a
Total Chromium (Cr)	mg/kg	26	(1)	9.5	No	No	No
Total Cobalt (Co)	mg/kg	50	(4)	2.91	No	No	No
Total Copper (Cu)	mg/kg	16	(1)	6.31	No	No	No
Total Iron (Fe)	mg/kg	20,000	(1)	18,100	No	No	No
Total Lead (Pb)	mg/kg	31	(1)	23.6	No	No	No
Total Lithium (Li)	mg/kg	7.2	(7)	5.3	No	No	No
Total Magnesium (Mg)	mg/kg	10,501	(7)	6950	No	No	No
Total Manganese (Mn)	mg/kg	460	(1)	296	No	No	No
Total Mercury (Hg)	mg/kg	0.17	(2)	0.01488	No	No	No
Total Molybdenum (Mo)	mg/kg	13.8	(5)	0.19	No	No	No
Total Nickel (Ni)	mg/kg	16	(1)	6.24	No	No	No
Total Potassium (K)	mg/kg	8,494	(7)	1010	No	No	No
Total Selenium (Se)	mg/kg	1.9	(5)	0.24486	No	No	No
Total Silver (Ag)	mg/kg	0.5	(4)	0.02449	No	No	No
Total Sodium (Na)	mg/kg	9,154	(7)	211	No	No	No
Total Strontium (Sr)	mg/kg	270	(7)	276	Yes	Yes	No ^a
Total Thallium (Tl)	mg/kg	0.17	(7)	0.064	No	No	No
Total Thorium (Th)	mg/kg	4.34	(7)	3.67	No	No	No
Total Tin (Sn)	mg/kg	3.01	(7)	0.68	No	No	No
Total Titanium (Ti)	mg/kg	3,534	(7)	469	No	No	No
Total Tungsten (W)	mg/kg	0.58	(7)	0.13889	No	No	No
Total Uranium (U)	mg/kg	104.4	(5)	1.05	No	No	No
Total Vanadium (V)	mg/kg	35.2	(5)	33.9	No	No	No
Total Zinc (Zn)	mg/kg	120	(1)	25.9	No	No	No
Total Zirconium (Zr)	mg/kg	85.68	(7)	2.27	No	No	No
PHCs							
F1 (C6-C10)	mg/kg	10	(7)	0	No	No	No
F1 (C6-C10) - BTEX	mg/kg	10	(7)	0	No	No	No
F2 (C10-C16 Hydrocarbons)	mg/kg	10	(7)	0	No	No	No
F3 (C16-C34 Hydrocarbons)	mg/kg	10	(7)	64	Yes	Yes	No ^a
F4 (C34-C50 Hydrocarbons)	mg/kg	10	(7)	0	No	No	No
PAHs							
Anthracene	mg/kg	0.0469	(2)	0.03	No	No	No
Benzo(a)anthracene	mg/kg	0.317	(2)	0.07	No	No	No
Benzo(a)pyrene	mg/kg	0.0319	(2)	0.06	Yes	Yes	No ^a
Benzo(a,h)perylene	mg/kg	0.17	(1)	0.03	No	No	No
Benzo(k)fluoranthene	mg/kg	0.24	(1)	0.03	No	No	No
Chrysene	mg/kg	0.0571	(2)	0.06	Yes	Yes	No ^a
Dibenz(a,h)anthracene	mg/kg	0.00622	(2)	0.007	Yes	Yes	No ^a
Fluoranthene	mg/kg	0.111	(2)	0.1	No	No	No
Fluorene	mg/kg	0.0212	(2)	0.02	No	No	No
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	(1)	0.04	No	No	No
Phenanthrene	mg/kg	0.0419	(2)	0.1	Yes	Yes	No ^a
Pyrene	mg/kg	0.053	(2)	0.09	Yes	Yes	No ^a
Total PAHs	mg/kg	4	(1)	0.7	No	No	No
Pesticides and PCBs							
Chlordane (Total)	mg/kg	0.0045	(2)	<0.002	No	No	No
Aldrin	mg/kg	0.002	(1)	<0.002	No	No	No
Total (α, β, γ) BHC	mg/kg	0.003	(1)	<0.002	No	No	No
alpha-BHC	mg/kg	0.006	(1)	<0.002	No	No	No
beta-BHC	mg/kg	0.005	(1)	<0.002	No	No	No
gamma-BHC (Lindane)	mg/kg	0.003	(1)	<0.002	No	No	No
Dieldrin	mg/kg	0.002	(1)	<0.002	No	No	No
Endrin	mg/kg	0.00267	(2)	<0.002	No	No	No
Hexachlorobenzene	mg/kg	0.02	(1)	<0.002	No	No	No
Heptachlor	mg/kg	0.0003	(1)	<0.002	No ^b	Yes	No ^b
Heptachlor epoxide	mg/kg	0.003	(2)	<0.002	No	No	No
Mirex	mg/kg	0.007	(1)	<0.002	No	No	No
o,p-DDT + p,p-DDT	mg/kg	0.008	(1)	<0.002	No	No	No
p,p-DDD	mg/kg	0.008	(1)	<0.002	No	No	No
p,p-DDE	mg/kg	0.005	(1)	<0.002	No	No	No
Aroclor 1016	mg/kg	0.007	(1)	<0.05	No ^b	Yes	No ^b
Aroclor 1248	mg/kg	0.03	(1)	<0.05	No ^b	Yes	No ^b
Aroclor 1254	mg/kg	0.06	(1)	<0.02	No	No	No
Aroclor 1260	mg/kg	0.005	(1)	<0.02	No ^b	Yes	No ^b
Total PCB	mg/kg	0.0341	(2)	<0.05	No ^b	Yes	No ^b

References:

1. Ministry of the Environment, Conservation and Parks (2019). Guidelines for identifying, assessing and managing contaminated sediments in Ontario.
2. CCME (1999). Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect concentration was adopted.
4. MOEE (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok. 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. Weighted method was adopted in the table.
6. Long, E. R. and Morgan L. G. (1991). The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.
7. OPG (2009). Ecological Risk Assessment and Assessment of Effects on Non-Human Biota Technical Support Document New Nuclear - Darlington Environmental Assessment. Report No. NK054-REP-07730-00022-R000. September.

Notes:

- ^a Calcium is a natural component in soil, and is an essential nutrient for life. It is not a toxicant for ecological receptors and therefore is not carried forward as a COPC.
- ^b All PCB concentrations in the 2018-2019 sampling events were below detection. Also, there is no known source of PCBs at the Darlington site. Therefore, PCBs were not carried forward as COPCs for sediment.
- ^c Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value Indicates parameter exceeded screening criteria.

Table A-18: Screening of Pond Sediment Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Selected Screening Criteria	Reference	Coot's Pond			Treefrog Pond		
				2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?	2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?
Physical/Conventional Parameters									
Moisture	%	-	-	68	-	-	85	-	-
Nutrients									
Calculated Total Kjeldahl Nitrogen	mg/kg	550	(1)	3780	Yes	No ^a	21200	Yes	No ^a
Total Organic Carbon	mg/kg	10,000	(1)	31,000	Yes	No ^a	260,000	Yes	No ^a
Total Phosphorus (P)	mg/kg	600	(1)	812	Yes	No ^a	1420	Yes	No ^a
Metals									
Total Aluminum (Al)	mg/kg	58,030	(3)	20,300	No	No	17,900	No	No
Total Antimony (Sb)	mg/kg	2	(6)	0.64	No	No	0.4	No	No
Total Arsenic (As)	mg/kg	5.9	(2)	2.74	No	No	2.46	No	No
Total Beryllium (Be)	mg/kg	<1.0-15	(8)	0.81	No	No	0.77	No	No
Total Bismuth (Bi)	mg/kg	<10-15	(8)	0.15	No	No	0.2	No	No
Total Boron (B)	mg/kg	<20-300	(8)	18.3	No	No	10	No	No
Hot Water Ext. Boron (B)	mg/kg	-	-	1.6	-	-	2.4	-	-
Total Cadmium (Cd)	mg/kg	0.6	(1)	1.6	Yes	No ^a	1.21	Yes	No ^a
Total Calcium (Ca)	mg/kg	100-320,000	(8)	186,000	No	No	21,800	No	No
Total Cesium (Cs)	mg/kg	0.25-25	(8)	1.4	No	No	0.90	No	No
Total Chromium (Cr)	mg/kg	26	(1)	30.7	Yes	No ^a	25.7	No	No
Total Cobalt (Co)	mg/kg	50	(4)	17.3	No	No	6.02	No	No
Total Copper (Cu)	mg/kg	16	(1)	40.5	Yes	No ^a	54.8	Yes	No ^a
Total Iron (Fe)	mg/kg	20,000	(1)	23,700	Yes	No ^a	17,300	No	No
Total Lead (Pb)	mg/kg	31	(1)	13.2	No	No	30	No	No
Total Lithium (Li)	mg/kg	<5.0-140	(8)	21.8	No	No	15.8	No	No
Total Magnesium (Mg)	mg/kg	50->100,000	(8)	12,400	No	No	4,550	No	No
Total Manganese (Mn)	mg/kg	460	(1)	540	Yes	No ^a	181	No	No
Total Mercury (Hg)	mg/kg	0.17	(2)	0.065	No	No	0.17	No	No
Total Molybdenum (Mo)	mg/kg	13.8	(5)	5.96	No	No	1.43	No	No
Total Nickel (Ni)	mg/kg	16	(1)	20.2	Yes	No ^a	14.2	No	No
Total Potassium (K)	mg/kg	50-63,000	(8)	3,940	No	No	1,980	-	-
Total Selenium (Se)	mg/kg	1.9	(5)	0.36	No	No	3.07	Yes	No ^a
Total Silver (Ag)	mg/kg	0.5	(4)	0.06	No	No	0.15	No	No
Total Sodium (Na)	mg/kg	<500-100,000	(8)	550	No	No	167	No	No
Total Strontium (Sr)	mg/kg	<5-3000	(8)	453	No	No	53.5	No	No
Total Thallium (Tl)	mg/kg	<0.25-10	(8)	0.23	No	No	0.16	No	No
Total Thorium (Th)	mg/kg	2.2-31	(8)	3.68	No	No	2.3	No	No
Total Tin (Sn)	mg/kg	<0.1-10	(8)	1.25	No	No	1.31	No	No
Total Titanium (Ti)	mg/kg	70-20,000	(8)	795	No	No	591	No	No
Total Tungsten (W)	mg/kg	<100-1000	(8)	0.23	No	No	0.12	No	No
Total Uranium (U)	mg/kg	104.4	(5)	1.34	No	No	6.96	No	No
Total Vanadium (V)	mg/kg	35.2	(5)	59.6	Yes	No ^a	37.5	Yes	No ^a
Total Zinc (Zn)	mg/kg	120	(1)	170	Yes	No ^a	119	No	No
Total Zirconium (Zr)	mg/kg	<20-2000	(8)	2.11	No	No	3.56	No	No
PHCs									
F1 (C6-C10)	mg/kg	-	-	0	-	No	0	-	No
F1 (C6-C10) - BTEX	mg/kg	-	-	0	-	No	0	-	No
F2 (C10-C16 Hydrocarbons)	mg/kg	-	-	46	-	No	34.07	-	No
F3 (C16-C34 Hydrocarbons)	mg/kg	-	-	460	-	No	410	-	No
F4 (C34-C50 Hydrocarbons)	mg/kg	-	-	160	-	No	147.95	-	No
PAHs									
Anthracene	mg/kg	0.0469	(2)	0	No	No	0	No	No
Benzo(a)anthracene	mg/kg	0.317	(2)	0	No	No	0.018	No	No
Benzo(a)pyrene	mg/kg	0.0319	(2)	0	No	No	0.025	No	No
Benzo(g,h,i)perylene	mg/kg	0.17	(1)	0.014	No	No	0.035	No	No
Benzo(k)fluoranthene	mg/kg	0.24	(1)	0.0040	No	No	0.010	No	No
Chrysene	mg/kg	0.0571	(2)	0.0073	No	No	0.022	No	No
Dibenzo(a,h)anthracene	mg/kg	0.00622	(2)	0	No	No	0	No	No
Fluoranthene	mg/kg	0.111	(2)	0.015	No	No	0.037	No	No
Fluorene	mg/kg	0.0212	(2)	0	No	No	0	No	No
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	(1)	0.0088	No	No	0.027	No	No
Phenanthrene	mg/kg	0.0419	(2)	0.0071	No	No	0.023	No	No
Pyrene	mg/kg	0.053	(2)	0.014	No	No	0.034	No	No

References:

1. Ministry of the Environment, Conservation and Parks (2019). Guidelines for identifying, assessing and managing contaminated sediments in Ontario.
2. CCME (1999). Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect
4. MOEE (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment
6. Long, E. R. and Morgan L. G. (1991), The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.

Notes:

^a Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value Indicates parameter exceeded screening criteria.

Table A-19: Ecological Screening Criteria for Soil COPCs

Parameter	Units	PSO Component Value (1) ^a	BM Component Value (1) ^b	CCME SQG Agricultural (2)	MOE Table 1 (Residential / Parkland, 1)	Rural Parkland OTR ₉₈ (1) ^c	Dragun & Chiasson (1991, 3)	Selected Screening Criteria, Plants and Soil Invertebrates	PSO Reference	Selected Screening Criteria, Birds and Mammals	BM Reference
Physical/Conventional Parameters											
Conductivity	µmho/cm	700	-	2000	0.57	-	-	700	(1)	2000	(2)
pH	pH	-	-	6-8	5-9	-	-	5-9	(2)	5-9	(2)
TOC	%	-	-	-	-	-	-	-	-	-	-
Moisture	%	-	-	-	-	-	-	-	-	-	-
Sodium Adsorption Ratio	N/A	5	-	5	2.4	-	-	5	(2)	5	(2)
Metals											
Hot Water Ext. Boron (B)	mg/kg	1.5	-	2	-	-	-	1.5	(1)	2	(2)
Total Aluminum (Al)	mg/kg	-	-	-	-	30,000	-	30,000	(1)	30,000	(1)
Total Antimony (Sb)	mg/kg	20	25	20	1.3	-	-	20	(2)	20	(2)
Total Arsenic (As)	mg/kg	20	51	12	18	-	-	12	(2)	12	(2)
Total Barium (Ba)	mg/kg	750	390	750	220	-	-	750	(1)	390	(1)
Total Beryllium (Be)	mg/kg	4	13	4	2.5	-	-	4	(2)	4	(2)
Total Bismuth (Bi)	mg/kg	-	-	-	-	-	<10-15	<10-15	(3)	<10-15	(3)
Total Boron (B)	mg/kg	-	120	-	36	-	-	36	(1)	120	(1)
Total Cadmium (Cd)	mg/kg	12	1.9	1.4	1.2	-	-	1.4	(2)	1.4	(2)
Total Calcium (Ca)	mg/kg	-	-	-	-	54,000	-	54,000	(1)	54,000	(1)
Total Cesium (Cs)	mg/kg	-	-	-	-	-	0.25-25	0.25-25	(3)	0.25-25	(3)
Total Chromium (Cr)	mg/kg	310	160	64	70	-	-	64	(2)	64	(2)
Total Cobalt (Co)	mg/kg	40	180	40	21	-	-	40	(2)	40	(2)
Total Copper (Cu)	mg/kg	140	770	63	92	-	-	63	(2)	63	(2)
Total Iron (Fe)	mg/kg	-	-	-	-	36,000	-	36,000	(2)	36,000	(2)
Total Lead (Pb)	mg/kg	250	32	70	120	-	-	70	(2)	32	(1)
Total Lithium (Li)	mg/kg	-	-	-	-	-	<5.0-140	<5.0-140	(3)	<5.0-140	(3)
Total Magnesium (Mg)	mg/kg	-	-	-	-	19,000	-	19,000	(1)	19,000	(1)
Total Manganese (Mn)	mg/kg	-	-	-	-	1900	-	1900	(1)	1900	(1)
Total Mercury (Hg)	mg/kg	10	20	6.6	0.27	-	-	6.6	(2)	6.6	(2)
Total Molybdenum (Mo)	mg/kg	40	6.9	5	2	-	-	5	(2)	5	(2)
Total Nickel (Ni)	mg/kg	100	5000	45	82	-	-	45	(2)	45	(2)
Total Potassium (K)	mg/kg	-	-	-	-	6500	-	6500	(1)	6500	(1)
Total Selenium (Se)	mg/kg	10	2.4	1	1.5	-	-	1	(2)	1	(2)
Total Silver (Ag)	mg/kg	20	-	20	0.5	-	-	20	(2)	20	(2)
Total Sodium (Na)	mg/kg	-	-	-	-	690	-	690	(1)	690	(1)
Total Strontium (Sr)	mg/kg	-	-	-	-	63	-	63	(1)	63	(1)
Total Thallium (Tl)	mg/kg	1.4	3.9	1	1	-	-	1	(1)	1	(1)
Total Thorium (Th)	mg/kg	-	-	-	-	-	2.2-31	2.2-31	(3)	2.2-31	(3)
Total Tin (Sn)	mg/kg	-	-	5	-	-	-	5	(2)	5	(2)
Total Titanium (Ti)	mg/kg	-	-	-	-	5500	-	5500	(1)	5500	(1)
Total Tungsten (W)	mg/kg	-	-	-	-	-	<100-1000	<100-1000	(3)	<100-1000	(3)
Total Uranium (U)	mg/kg	500	33	23	2.5	-	-	23	(2)	23	(2)
Total Vanadium (V)	mg/kg	200	18	130	86	86	-	130	(2)	86	(1) ^e
Total Zinc (Zn)	mg/kg	400	340	250	290	-	-	250	(2)	250	(2)
Total Zirconium (Zr)	mg/kg	-	-	-	-	-	<20-2000	<20-2000	(3)	<20-2000	(3)
PHC											
F1 (C6-C10) - BTEX	mg/kg	210	-	210	25	-	-	210	(2)	210	(2)
F1 (C6-C10)	mg/kg	210	-	210	25	-	-	210	(2)	210	(2)
F2 (C10-C16 Hydrocarbons)	mg/kg	150	-	150	10	-	-	150	(2)	150	(2)
F3 (C16-C34 Hydrocarbons)	mg/kg	300	-	300	240	-	-	300	(2)	300	(2)
F4 (C34-C50 Hydrocarbons)	mg/kg	2800	-	2800	120	-	-	2800	(2)	2800	(2)
F4G-sg (Grav. Heavy Hydrocarbons)	mg/kg	2800	-	2800	120	-	-	2800	(2)	2800	(2)
VOC											
1,1,1,2-Tetrachloroethane	mg/kg	-	-	-	0.05	-	-	0.05	(1)	0.05	(1)
1,1-Dichloroethane	mg/kg	8.4	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,1-Dichloroethylene	mg/kg	50	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,2-Dibromoethane (ethylene dibromide)	mg/kg	-	-	-	0.05	-	-	0.05	(1)	0.05	(1)
1,2-Dichlorobenzene	mg/kg	3.4	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,2-Dichloroethane	mg/kg	48	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,2-Dichloropropane	mg/kg	25	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,3-Dichlorobenzene	mg/kg	4.8	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,3-Dichloropropene (cis+trans)	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
1,4-Dichlorobenzene	mg/kg	3.6	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
2-Butanone (Methyl Ethyl Ketone)	mg/kg	35	9900	-	0.5	-	-	35	(1)	9900	(1)
Methyl Isobutyl Ketone	mg/kg	-	-	-	0.5	-	-	0.5	(1)	0.5	(1)
Acetone (2-Propanone)	mg/kg	-	56	-	0.5	-	-	0.5	(1)	56	(1)
Benzene	mg/kg	25	370	0.03	0.02	-	-	0.03	(2)	0.03	(2)
Bromodichloromethane	mg/kg	-	-	-	0.05	-	-	0.05	(1)	0.05	(1)
Bromoform	mg/kg	-	-	-	0.05	0.00027	-	0.05	(1)	0.05	(1)
Bromomethane	mg/kg	-	-	-	0.05	0.0011	-	0.05	(1)	0.05	(1)
Carbon Tetrachloride	mg/kg	5.8	7.6	0.1	0.05	-	-	0.1	(2)	0.1	(2)
Chlorobenzene	mg/kg	6	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
Chloroform	mg/kg	34	81	0.1	0.05	-	-	0.1	(2)	0.1	(2)
cis-1,2-Dichloroethylene	mg/kg	-	84	-	0.05	-	-	0.05	(1)	84	(1)
cis-1,3-Dichloropropene ^d	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
Dibromochloromethane	mg/kg	-	-	-	0.05	0.00019	-	0.05	(1)	0.05	(1)
Dichlorodifluoromethane (FREON 12)	mg/kg	40	-	-	0.05	-	-	40	(1)	0.05	(1)
Ethylbenzene	mg/kg	55	90	0.082	0.05	-	-	0.082	(2)	0.082	(2)
Methyl t-butyl ether (MTBE)	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
Methylene Chloride(Dichloromethane)	mg/kg	0.78	350	0.1	-	-	-	0.1	(2)	0.1	(2)
Styrene	mg/kg	17	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
trans-1,2-Dichloroethylene	mg/kg	-	84	-	0.05	-	-	0.05	(1)	84	(1)
trans-1,3-Dichloropropene ^d	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
Trichloroethylene	mg/kg	100	8.1	-	0.05	-	-	100	(1)	8.1	(1)
Trichlorofluoromethane (FREON 11)	mg/kg	16	-	-	0.25	-	-	16	(1)	0.25	(1)
Vinyl Chloride	mg/kg	3.4	12	-	0.25	-	-	3.4	(1)	12	(1)
Total Xylenes	mg/kg	95	96	11	0.05	-	-	11	(2)	11	(2)
Hexane	mg/kg	-	-	0.49	0.05	-	-	0.49	(2)	0.49	(2)
PAHs											
1-Methylnaphthalene	mg/kg	-	-	-	0.59	0.006	-	0.59	(1)	0.59	(1)
2-Methylnaphthalene	mg/kg	-	-	-	0.59	0.006	-	0.59	(1)	0.59	(1)
Acenaphthene	mg/kg	-	6600	-	0.072	-	-	0.072	(1)	6600	(1)
Acenaphthylene	mg/kg	-	-	-	0.093	0.093	-	0.093	(1)	0.093	(1)
Anthracene	mg/kg	2.5	38000	2.5	0.16	-	-	2.5	(2)	2.5	(2)
Benzo(b)fluoranthene	mg/kg	-	-	0.1 ^f	0.47	-	-	0.1	(2)	0.1	(2)
Benzo(a)anthracene	mg/kg	0.5	-	0.1 ^f	0.36	-	-	0.5	(1)	0.1	(2)
Benzo(a)pyrene	mg/kg	20	1600	20	0.3	-	-	20	(2)	20	(2)
Benzo(g,h,i)perylene	mg/kg	6.6	-	-	0.68	-	-	6.6	(1)	0.68	(1)
Benzo(k)fluoranthene	mg/kg	7.6	-	0.1 ^f	0.48	-	-	7.6	(1)	0.48	(2)
Chrysene	mg/kg	7	-	-	2.8	-	-	7	(1)	2.8	(1)
Dibenzo(a,h)anthracene	mg/kg	-	-	0.1 ^f	0.1	-	-	0.1	(2)	0.1	(2)
Fluoranthene	mg/kg	50	0.69	50	0.56	-	-	50	(1)	0.69	(1)
Fluorene	mg/kg	-	-	-	0.12	0.0094	-	0.12	(1)	0.12	(1)
Indeno(1,2,3-cd)pyrene	mg/kg	0.38	-	0.1 ^f	0.23	-	-	0.38	(1)	0.23	(2)
Naphthalene	mg/kg	0.6	380	0.6	0.09	-	-	0.6	(1)	380	(1)
Phenanthrene	mg/kg	6.2	2700	0.1 ^f	0.69	-	-	6.2	(1)	2700	(1)
Pyrene	mg/kg	-	4700	0.1 ^f	1	-	-	1	(2)	4700	(1)
PCBs											
Polychlorinated Biphenyls	mg/kg	33	1.1	0.5	0.3	-	-	0.5	(2)	1.1	(1)
Other											
Cyanide (free)	mg/kg	0.9	0.11	0.9	0.051	-	-	0.9	(2)	0.11	(1)
Total Phosphorus	mg/kg	-	-	-	-	1100	-	1100	(1)	1100	(1)

Reference:

- Standards Development Branch, Ontario Ministry of the Environment, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario. April.
- CCME. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Accessed on July 2020.
- Dragun and Chiasson (1991). Elements in North American Soils.

Notes:

- Plant and Soil Organisms (PSO) component values for agricultural/other land use was adopted in this table.
- Bird and mammal (BM) component values derived for residential/parkland were adopted in this table.
- If there are multiple OTR₉₈ values in different sampling regions, values from region 3 (central) was selected considering the DN facility resides in region 3.
- Screening Criteria selected to screen 1,3-dichloropropene was also applied to screen cis- and trans-1,3-dichloropropene.
- OTR₉₈ was selected for vanadium for protection of mammal and birds, considering the background concentration in Ontario is more elevated than the component value. See discussion in Section 4.1.4.3.
- Insufficient direct soil contact data available. This value is based on the interim CSQG. Ontario component value, if available, is selected prior to this value.

Table A-20: Screening of Soil Quality for Ecological Health

Parameter	Units	Selected Screening Criteria, Plants and Soil Invertebrates		Selected Screening Criteria, Birds and Mammals		2020 ERA Max Concentrations Within Each Terrestrial Polygon				2021 DNNP Soil Characterization Study	Plants and Soil		Birds and Mammals	
		Screening Criteria	Reference	Screening Criteria	Reference	AB	C	D	E	E	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?
Physical/Conventional Parameters														
Conductivity	µmho/cm	700	(1)	2000	(2)	265	230	256	407	530	No	No	No	No
pH	pH	5-9	(2)	5-9	(2)	7.55	7.59	7.55	8.12	6.83 - 8.11	No	No	No	No
TOC	%	-	-	-	-	2.57	2.43	3.41	2.12	-	No	No	No	No
Moisture	%	-	-	-	-	33	24	26	42	49	No	No	No	No
Sodium Adsorption Ratio	N/A	5	(2)	5	(2)	0.24	0.3	0.19	0.51	6.70	No	Yes (E)	No	Yes (E)
Metals														
Hot Water Ext. Boron (B)	mg/kg	1.5	(1)	2	(2)	0.65	0.29	0.44	0.75	0.87	No	No	No	No
Total Aluminum (Al)	mg/kg	30000	(1)	30000	(1)	13900	12800	11800	13600	-	No	No	No	No
Total Antimony (Sb)	mg/kg	20	(2)	20	(2)	0.18	0.06972	0.13	15.4	2.00	No	No	No	No
Total Arsenic (As)	mg/kg	12	(2)	12	(2)	6.77	1.8	2	133	20	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Barium (Ba)	mg/kg	750	(1)	390	(1)	104	92.9	107	110	170	No	No	No	No
Total Beryllium (Be)	mg/kg	4	(2)	4	(2)	0.55	0.55	0.48	0.68	0.8	No	No	No	No
Total Bismuth (Bi)	mg/kg	<10-15	(4)	<10-15	(4)	0.075	0.07324	0.0747	0.73	-	No	No	No	No
Total Boron (B)	mg/kg	36	(1)	120	(1)	6.9	6.5	7.7	13.2	14	No	No	No	No
Total Cadmium (Cd)	mg/kg	1.4	(2)	1.4	(2)	0.285	0.129	0.274	3.75	0.33	Yes (E)	No ^b	Yes (E)	No ^{b,c}
Total Calcium (Ca)	mg/kg	54,000	(1)	54,000	(1)	106,000	74,500	86,000	277,000	-	No ^a	No ^a	No ^a	No ^a
Total Cesium (Cs)	mg/kg	0.25-25	(4)	0.25-25	(4)	0.72709	0.64941	0.76087	0.96806	-	No	No	No	No
Total Chromium (Cr)	mg/kg	64	(2)	64	(2)	22.2	20.9	20.8	74.8	30	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Cobalt (Co)	mg/kg	40	(2)	40	(2)	7.06	7.1	6.98	159	28	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Copper (Cu)	mg/kg	63	(2)	63	(2)	16.8	15.2	15.1	2230	370	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Iron (Fe)	mg/kg	36,000	(2)	36,000	(2)	18,500	17,800	17,300	94,900	-	Yes (E)	No ^b	Yes (E)	No ^b
Total Lead (Pb)	mg/kg	70	(2)	32	(1)	23.6	8.14	9.83	589	77	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Lithium (Li)	mg/kg	<5.0-140	(4)	<5.0-140	(4)	11	12.6	10.5	11.3	-	No	No	No	No
Total Magnesium (Mg)	mg/kg	19,000	(1)	19,000	(1)	7,660	6,060	7,740	15,900	-	No	No	No	No
Total Manganese (Mn)	mg/kg	1,900	(1)	1,900	(1)	443	408	446	572	-	No	No	No	No
Total Mercury (Hg)	mg/kg	6.6	(2)	6.6	(2)	0.045	0.02441	0.04482	0.03497	0.067	No	No	No	No
Total Molybdenum (Mo)	mg/kg	5	(2)	5	(2)	0.39	0.24	0.95	42.3	1.6	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Nickel (Ni)	mg/kg	45	(2)	45	(2)	13	15.1	13.7	129	24	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Potassium (K)	mg/kg	6,500	(1)	6,500	(1)	2,010	2,310	2,770	2,400	-	No	No	No	No
Total Selenium (Se)	mg/kg	1	(2)	1	(2)	0.334	0.12695	0.29382	6.12	1.40	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Silver (Ag)	mg/kg	20	(2)	20	(2)	0.055	0.03906	0.553	1.85	0.26	No	No	No	No
Total Sodium (Na)	mg/kg	690	(1)	690	(1)	205	168	266	1920	-	Yes (E)	No ^b	Yes (E)	No ^b
Total Strontium (Sr)	mg/kg	63	(1)	63	(1)	174	122	142	755	-	Yes (AB, C, D, E)	No ^b	Yes (AB, C, D, E)	No ^b
Total Thallium (Tl)	mg/kg	1	(1)	1	(1)	0.144	0.137	0.148	0.139	0.2	No	No	No	No
Total Thorium (Th)	mg/kg	2.2-31	(4)	2.2-31	(4)	3.78	3.87	3.56	4.01	-	No	No	No	No
Total Tin (Sn)	mg/kg	5	(2)	5	(2)	0.91	0.58	0.69	108	-	Yes (E)	No ^b	Yes (E)	No ^b
Total Titanium (Ti)	mg/kg	5500	(1)	5500	(1)	874	434	639	719	-	No	No	No	No
Total Tungsten (W)	mg/kg	<100-1000	(4)	<100-1000	(4)	0.095	0.08789	7.04	1.91	-	No	No	No	No
Total Uranium (U)	mg/kg	23	(2)	23	(2)	0.642	0.454	0.583	1.16	1.4	No	No	No	No
Total Vanadium (V)	mg/kg	130	(2)	86	(1)	36.7	27.5	30.2	31.2	45	No	No	No	No
Total Zinc (Zn)	mg/kg	250	(2)	250	(2)	63	44	53.5	9320	1200	Yes (E)	No ^{b,c}	Yes (E)	No ^{b,c}
Total Zirconium (Zr)	mg/kg	<20-2000	(4)	<20-2000	(4)	1.85	2.12	1.81	14.5	-	No	No	No	No
PHCs														
F1 (C6-C10) - BTEX	mg/kg	210	(2)	210	(2)	0	0	0	0	-	No	No	No	No
F1 (C6-C10)	mg/kg	210	(2)	210	(2)	0	0	0	0	270	No	Yes (E)	No	Yes (E)
F2 (C10-C16 Hydrocarbons)	mg/kg	150	(2)	150	(2)	0	0	0	12	460	No	Yes (E)	No	Yes (E)
F3 (C16-C34 Hydrocarbons)	mg/kg	300	(2)	300	(2)	30.09146	62	44.34857	250	1000	No	Yes (E)	No	Yes (E)
F4 (C34-C50 Hydrocarbons)	mg/kg	2800	(2)	2800	(2)	0	0	0	750	350	No	No	No	No
F4G-sg (Grav. Heavy Hydrocarbons)	mg/kg	2800	(2)	2800	(2)	0	0	0	3900	-	Yes (E)	No ^b	Yes (E)	No ^b
VOCS														
1,1,1,2-Tetrachloroethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
1,1-Dichloroethane	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,1-Dichloroethylene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,2-Dibromoethane (ethylene dibromide)	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
1,2-Dichlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,2-Dichloroethane	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.049	No	No	No	No
1,2-Dichloropropane	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,3-Dichlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,3-Dichloropropene (cis+trans)	mg/kg	25	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
1,4-Dichlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
2-Butanone (Methyl Ethyl Ketone)	mg/kg	35	(1)	9900	(1)	0	0	0	0	<0.4	No	No	No	No
Methyl Isobutyl Ketone	mg/kg	0.5	(1)	0.5	(1)	0	0	0	0	-	No	No	No	No
Acetone (2-Propanone)	mg/kg	0.5	(1)	56	(1)	0	0	0	0	<0.49	No	No	No	No
Benzene	mg/kg	31	(2)	25	(2)	0	0	0	0	0.21	No	No	No	No
Bromodichloromethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
Bromoform	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
Bromomethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Carbon Tetrachloride	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
Chlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
Chloroform	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
cis-1,2-Dichloroethylene	mg/kg	0.05	(1)	84	(1)	0	0	0	0	<0.04	No	No	No	No
cis-1,3-Dichloropropene	mg/kg	25	(1)	0.05	(1)	0	0	0	0	<0.03	No	No	No	No
Dibromochloromethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
Dichlorodifluoromethane (FREON 12)	mg/kg	40	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Ethylbenzene	mg/kg	110	(2)	110	(2)	0	0	0	0	0.56	No	No	No	No
Methyl t-butyl ether (MTBE)	mg/kg	25	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Methylene Chloride (Dichloromethane)	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.049	No	No	No	No
Styrene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
trans-1,2-Dichloroethylene	mg/kg	0.05	(1)	84	(1)	0	0	0	0	<0.04	No	No	No	No
trans-1,3-Dichloropropene	mg/kg	25	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Trichloroethylene	mg/kg	100	(1)	8.1	(1)	0	0	0	0	<0.01	No	No	No	No
Trichlorofluoromethane (FREON 11)	mg/kg	16	(1)	0.25	(1)	0	0	0	0	<0.04	No	No	No	No
Vinyl Chloride	mg/kg	3.4	(1)	12	(1)	0	0	0	0	<0.019	No	No	No	No
Total Xylenes	mg/kg	11	(2)	11	(2)	0	0	0	0	5.2	No	No	No	No
Hexane	mg/kg	0.49	(2)	0.49	(2)	0	0	0	0	-	No	No	No	No
PAHs														
1-Methylnaphthalene	mg/kg	0.59	(1)	0.59	(1)	0	0	0.0091	0.0056	0.52	No	No	No	No
2-Methylnaphthalene	mg/kg	0.59	(1)	0.59	(1)	0	0	0.0092	0.0058	0.62	No	No ^d	No	No ^d
Acenaphthene	mg/kg	0.072	(1)	6600	(1)	0	0	0	0.041823	0.023	No	No	No	No
Acenaphthylene	mg/kg	0.093	(1)	0.093	(1)	0	0	0	0	0.016	No	No	No	No
Anthracene	mg/kg	2.5	(2)	2.5	(2)	0	0	0	0.048847	0.077	No	No	No	No
Benzo(b)fluoranthene	mg/kg	0.1	(2)	0.1	(2)	0.01	0.004163	0.0089	0.1	0.078	No	No	No	No
Benzo(a)anthracene	mg/kg	0.5	(1)	0.1	(2)	0.0052	0	0.004761	0.086	0.045	No	No	No	No
Benzo(a)pyrene	mg/kg													

Appendix B Soil Characterization Data Summary Table

Table B-1: Soil Summary Statistics

Parameter	Summary Statistics								
	N	N > DL	Units	DL	Min	25th-%	50th-%	75th-%	Max
Physical/Conventional Parameters									
Conductivity	106	106	mS/cm	<0.082	<0.082	0.13	0.15	0.22	0.53
Cyanide (Weak Acid Dissociable)	106	15	mg/kg	<0.01	<0.01	0.01	0.01	0.01	0.04
pH	107	107	Unitless	<6.83	<6.84	7.5	7.71	7.89	8.11
Sodium Adsorption Ratio	106	106	Unitless	<0.19	<0.20	0.26	0.295	0.375	6.7
Moisture	157	156	%	<1	<1	7.2	9.9	15	49
Metals									
Antimony	106	10	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	2
Arsenic	106	78	mg/kg	<1	<1	<1	1.3	1.7	20
Barium	106	106	mg/kg	<10	<10	30.25	39.5	66.25	170
Beryllium	106	70	mg/kg	<0.2	<0.2	<0.2	0.23	0.390	0.8
Boron	106	45	mg/kg	<5	<5	<5	<5	6.2	14
Boron (Hot Water Soluble)	106	91	mg/kg	<0.05	<0.05	0.073	0.12	0.21	0.87
Cadmium	106	45	mg/kg	<0.1	<0.1	<0.1	<0.1	0.138	0.33
Chromium	106	106	mg/kg	<5.3	<5.3	8.325	10	14.75	30
Chromium (VI)	106	0	mg/kg	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18
Cobalt	106	106	mg/kg	<1.4	<1.4	2.7	3.4	4.6	28
Copper	106	106	mg/kg	<1.6	<1.6	5.325	8.4	13	370
Lead	106	106	mg/kg	<1.4	<1.4	3.325	4.8	7.78	77
Mercury	106	3	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.067
Molybdenum	106	22	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Nickel	106	106	mg/kg	<2.6	<2.6	5.325	7.4	11	24
Selenium	106	3	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	1.4
Silver	106	1	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	0.26
Thallium	106	79	mg/kg	<0.05	<0.05	<0.05	0.067	0.095	0.2
Uranium	106	106	mg/kg	<0.32	<0.32	0.4325	0.485	0.57	1.4
Vanadium	106	106	mg/kg	<11	<11	15.25	18	24	45
Zinc	106	106	mg/kg	<6.9	<6.9	26	35.5	50	1200
Petroleum Hydrocarbons (PHCs) & BTEX									
Petroleum Hydrocarbons - F1 (C6-C10)	151	16	mg/kg	<10	<10	<10	<10	<10	270
Petroleum Hydrocarbons - F2 (C10-C16)	151	28	mg/kg	<10	<10	<10	<10	<10	460
Petroleum Hydrocarbons - F3 (C16-C34)	151	37	mg/kg	<50	<50	<50	<50	51	1000
Petroleum Hydrocarbons - F4 (C34-C50)	151	18	mg/kg	<50	<50	<50	<50	<50	350
Benzene	151	9	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.21
Toluene	151	10	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.45
Ethylbenzene	151	13	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.56
Xylenes, Total	151	17	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	5.2
Volatile Organic Compounds (VOCs)									

Table B-1: Soil Summary Statistics

Parameter	Summary Statistics								
	N	N > DL	Units	DL	Min	25th-%	50th-%	75th-%	Max
2-Chlorophenol	10	0	mg/kg	<0.08	<0.08	<0.08	<0.08	<0.08	<0.2
2,4-Dichlorophenol	10	0	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Pentachlorophenol	10	0	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
2,4,5-Trichlorophenol	10	0	mg/kg	<0.08	<0.08	<0.08	<0.08	<0.08	<0.2
2,4,6-Trichlorophenol	10	0	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Acetone	3	0	mg/kg	<0.49	<0.49	<0.49	<0.49	<0.49	<0.49
trans-1,3-Dichloropropene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
cis-1,3-Dichloropropene	3	0	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Bromomethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,2-Dibromoethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Carbon Tetrachloride	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
n-Hexane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Chlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
2-Butanone	3	0	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloroform	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
4-Methyl-2-pentanone	3	0	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,2-Dichlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Methyl tert-Butyl Ether	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,3-Dichlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Methylene Chloride	3	0	mg/kg	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049
1,4-Dichlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Styrene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Dichlorodifluoromethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Tetrachloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1-Dichloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1,1,2-Tetrachloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,2-Dichloroethane	3	0	mg/kg	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049
1,1,2,2-Tetrachloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1-Dichloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1,1-Trichloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
trans-1,2-Dichloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1,2-Trichloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
cis-1,2-Dichloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Trichloroethene	3	0	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table B-1: Soil Summary Statistics

Parameter	Summary Statistics								
	N	N > DL	Units	DL	Min	25th-%	50th-%	75th-%	Max
1,2-Dichloropropane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Trichlorofluoromethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Vinyl Chloride	3	0	mg/kg	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
Polycyclic Aromatic Hydrocarbons (PAHs)									
Acenaphthene	88	1	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.4
Benzo[g,h,i]perylene	88	19	mg/kg	<0.005	<0.005	<0.005	<0.005	0.008	0.2
Indeno[1,2,3-cd]pyrene	88	9	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
Acenaphthylene	88	2	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Benzo[k]fluoranthene	88	3	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.06
1- & 2-Methylnaphthalene	88	22	mg/kg	<0.0071	<0.0071	<0.0071	<0.0071	0.031	1.1
Anthracene	88	9	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.077
Chrysene	88	18	mg/kg	<0.005	<0.005	<0.005	<0.005	0.010	0.1
Naphthalene	88	8	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.12
Benzo[a]anthracene	88	5	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Dibenzo[a,h]anthracene	88	2	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Phenanthrene	88	27	mg/kg	<0.005	<0.005	<0.005	<0.005	0.015	0.27
Benzo[a]pyrene	88	10	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Fluoranthene	88	14	mg/kg	<0.005	<0.005	<0.005	<0.005	0.010	0.13
Pyrene	88	15	mg/kg	<0.005	<0.005	<0.005	<0.005	0.009	0.1
Fluorene	88	1	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.07
Polychlorinated Biphenyls (PCBs)									
Polychlorinated Biphenyls (PCBs)	81	0	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.015	<0.04

Notes:

N = Total count
 N > DL = Total count of samples above the laboratory detection limit
 DL = Laboratory detection limit. If multiple DLs were reported, the lowest is presented.
 Min = Minimum concentration

25th-% = 25th-percentile concentration
 50th-% = 50th-percentile concentration
 75th-% = 75th-percentile concentration
 Max = Maximum concentration

Appendix C Modelled Concentrations for Ecological Receptors

Table C.1: Modelled Radiation Concentration for Aquatic Biota for Polygon Lake Ontario

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Lake Trout	Bq/kg (fw)	1.31E+03	1.78E+02	1.70E+01	1.87E+00	2.01E+03	3.29E+02	2.54E+03	4.97E+02	1.16E+01	1.29E+00	6.60E+00	2.46E+00	2.16E+00	2.41E-01
American Eel	Bq/kg (fw)	1.31E+03	1.78E+02	1.70E+01	1.87E+00	2.01E+03	3.29E+02	2.54E+03	4.97E+02	1.16E+01	1.29E+00	6.60E+00	2.46E+00	2.16E+00	2.41E-01
Bufflehead	Bq/kg (fw)	4.17E+01	3.84E+01	2.21E-01	2.06E-01	6.52E-01	5.83E-01	6.75E-01	5.90E-01	1.58E+01	9.92E+00	1.91E-01	1.91E-01	1.41E+00	7.60E-01
Mallard	Bq/kg (fw)	4.17E+01	3.84E+01	2.08E-01	1.94E-01	6.14E-01	5.48E-01	6.36E-01	5.55E-01	1.58E+01	9.92E+00	1.80E-01	1.79E-01	1.41E+00	7.60E-01

Table C.2: Modelled Radiation Concentration for Media and Ecological Receptors for Polygon AB

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Loam Pore Water	Bq/L	1.17E-01	1.17E-01	0.00E+00	0.00E+00	5.40E-04	5.40E-04	1.49E-02	1.49E-02	7.50E+02	4.38E+02	1.22E-01	1.22E-01	0.00E+00	0.00E+00
Turtles	Bq/kg (fw)	3.99E+02	3.51E+02	6.43E+00	4.88E+00	5.11E+02	5.11E+02	7.32E+02	6.83E+02	3.51E+01	3.04E+01	2.31E+01	1.39E+01	6.55E+00	5.67E+00
Frogs	Bq/kg (fw)	3.99E+02	3.51E+02	6.43E+00	4.88E+00	5.11E+02	5.11E+02	7.32E+02	6.83E+02	3.51E+01	3.04E+01	2.31E+01	13.86	6.55E+00	5.67E+00
Aquatic Plants	Bq/kg (fw)	3.89E+01	3.51E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.30E+01	4.16E+01	2.00E+00	2.00E+00	6.31E+00	6.10E+00
Benthic Invertebrates	Bq/kg (fw)	3.64E+02	3.20E+02	1.31E+01	9.93E+00	1.45E+01	1.45E+01	2.07E+01	1.93E+01	3.51E+01	3.04E+01	3.70E+01	2.22E+01	6.55E+00	5.67E+00
Bufflehead	Bq/kg (fw)	3.64E+02	3.20E+02	2.44E+00	1.86E+00	7.50E+00	7.50E+00	1.07E+01	1.00E+01	2.23E+01	0.00E+00	6.33E-02	3.81E-02	0.00E+00	0.00E+00
Mallard	Bq/kg (fw)	3.10E+02	2.73E+02	1.95E+00	1.49E+00	5.97E+00	5.97E+00	8.49E+00	7.93E+00	2.26E+01	0.00E+00	5.04E-02	3.06E-02	0.00E+00	0.00E+00
Muskrat	Bq/kg (fw)	6.25E+01	5.64E+01	1.69E-02	1.67E-02	8.73E-01	8.73E-01	8.99E-01	8.95E-01	4.54E+01	3.78E+01	8.26E-01	6.99E-01	3.09E+00	2.26E+00
Green Heron	Bq/kg (fw)	3.50E+01	3.19E+01	2.33E-01	2.31E-01	6.53E-01	6.53E-01	6.66E-01	6.64E-01	3.47E+01	2.96E+01	6.47E-01	6.46E-01	1.26E+00	8.49E-01
American Robin	Bq/kg (fw)	3.28E+01	3.20E+01	5.26E-01	5.24E-01	1.47E+00	1.47E+00	1.58E+00	1.58E+00	2.38E+01	2.00E+01	2.44E-02	2.36E-02	1.84E+00	1.42E+00
Bank Swallow	Bq/kg (fw)	3.67E+01	3.18E+01	4.32E-01	4.30E-01	1.21E+00	1.21E+00	1.28E+00	1.27E+00	2.59E+01	2.17E+01	2.36E-02	2.25E-02	1.94E+00	1.50E+00
Song Sparrow	Bq/kg (fw)	4.81E+01	4.68E+01	1.05E+00	1.05E+00	2.94E+00	2.94E+00	3.04E+00	3.03E+00	5.11E+01	4.50E+01	2.42E-02	2.28E-02	3.55E+00	2.88E+00
Yellow Warbler	Bq/kg (fw)	3.62E+01	3.16E+01	4.67E-01	4.65E-01	1.31E+00	1.31E+00	1.37E+00	1.37E+00	2.63E+01	2.22E+01	2.36E-02	2.27E-02	1.96E+00	1.52E+00
Eastern Cottontail	Bq/kg (fw)	5.79E+01	5.63E+01	1.88E-02	1.86E-02	9.71E-01	9.71E-01	1.05E+00	1.05E+00	2.37E+02	1.54E+02	4.74E+00	4.61E+00	1.26E+01	8.32E+00
Meadow Vole	Bq/kg (fw)	5.79E+01	5.63E+01	7.61E-03	7.52E-03	3.94E-01	3.94E-01	4.13E-01	4.11E-01	2.37E+02	1.54E+02	1.95E+00	1.87E+00	1.26E+01	8.32E+00
White-tailed Deer	Bq/kg (fw)	5.79E+01	5.63E+01	2.64E-02	2.61E-02	1.36E+00	1.36E+00	1.43E+00	1.42E+00	2.65E+02	1.70E+02	6.73E+00	6.48E+00	1.36E+01	8.89E+00
Common Shrew	Bq/kg (fw)	6.05E+01	5.23E+01	2.64E-02	2.63E-02	1.35E+00	1.35E+00	1.39E+00	1.38E+00	4.76E+01	4.01E+01	2.38E+00	2.32E+00	4.08E+00	3.22E+00
Raccoon	Bq/kg (fw)	4.84E+01	4.42E+01	4.55E-02	3.87E-02	2.53E+00	2.53E+00	3.34E+00	3.18E+00	9.47E+01	0.00E+00	3.81E+00	3.16E+00	0.00E+00	0.00E+00
Red Fox	Bq/kg (fw)	1.20E+02	1.09E+02	5.34E-03	4.34E-03	7.45E-01	7.45E-01	1.02E+00	9.59E-01	1.17E+02	0.00E+00	8.03E-01	6.43E-01	0.00E+00	0.00E+00
Short-tailed Weasel	Bq/kg (fw)	5.79E+01	5.63E+01	5.55E-04	4.40E-04	2.44E-01	2.44E-01	3.08E-01	3.04E-01	1.42E+02	9.38E+01	5.64E-01	4.56E-01	4.25E+00	3.02E+00

Table C.3: Modelled Radiation Concentration for Media and Ecological Receptors for Polygon C

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Loam Pore Water	Bq/L	3.33E-02	3.33E-02	0.00E+00	0.00E+00	2.70E-04	2.70E-04	1.89E-03	1.89E-03	5.28E+02	3.08E+02	1.33E-01	1.33E-01	0.00E+00	0.00E+00
American Robin	Bq/kg (fw)	3.66E+01	3.66E+01	5.19E-01	5.19E-01	1.45E+00	1.45E+00	1.46E+00	1.46E+00	6.93E+01	5.01E+01	2.07E-02	2.07E-02	6.16E+00	4.04E+00
Song Sparrow	Bq/kg (fw)	5.61E+01	5.61E+01	1.04E+00	1.04E+00	2.89E+00	2.89E+00	2.90E+00	2.90E+00	1.38E+02	1.07E+02	2.25E-02	2.25E-02	1.11E+01	7.72E+00
Yellow Warbler	Bq/kg (fw)	5.58E+01	5.58E+01	4.58E-01	4.58E-01	1.28E+00	1.28E+00	1.28E+00	1.28E+00	9.58E+01	7.66E+01	2.81E-02	2.81E-02	7.40E+00	5.28E+00
Eastern Cottontail	Bq/kg (fw)	1.16E+02	1.16E+02	1.82E-02	1.82E-02	9.30E-01	9.30E-01	9.38E-01	9.38E-01	2.75E+02	2.08E+02	3.65E+00	3.65E+00	2.45E+01	1.64E+01
Meadow Vole	Bq/kg (fw)	1.16E+02	1.16E+02	7.24E-03	7.24E-03	3.70E-01	3.70E-01	3.72E-01	3.72E-01	2.75E+02	2.08E+02	1.46E+00	1.46E+00	2.45E+01	1.64E+01
White-tailed Deer	Bq/kg (fw)	1.16E+02	1.16E+02	2.51E-02	2.51E-02	1.28E+00	1.28E+00	1.29E+00	1.29E+00	2.61E+02	2.06E+02	5.05E+00	5.05E+00	2.15E+01	1.50E+01
Common Shrew	Bq/kg (fw)	9.45E+01	9.45E+01	2.61E-02	2.61E-02	1.34E+00	1.34E+00	1.34E+00	1.34E+00	2.37E+02	1.70E+02	2.99E+00	2.99E+00	2.28E+01	1.47E+01
Raccoon	Bq/kg (fw)	9.26E+01	9.26E+01	2.04E-02	2.04E-02	1.09E+00	1.09E+00	1.10E+00	1.10E+00	2.47E+02	1.76E+02	2.60E+00	2.60E+00	0.00E+00	0.00E+00
Red Fox	Bq/kg (fw)	1.09E+02	1.09E+02	1.15E-03	1.15E-03	2.07E-01	2.07E-01	2.10E-01	2.10E-01	2.85E+02	1.92E+02	4.14E-01	4.14E-01	0.00E+00	0.00E+00
Short-tailed Weasel	Bq/kg (fw)	1.16E+02	1.16E+02	7.63E-05	7.63E-05	2.01E-01	2.01E-01	2.06E-01	2.06E-01	2.96E+02	1.96E+02	2.53E-01	2.53E-01	2.16E+01	1.28E+01

Table C.4: Modelled Radiation Concentration for Media and Ecological Receptors for Polygon D

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Loam Pore Water	Bq/L	3.57E-01	3.57E-01	0.00E+00	0.00E+00	5.40E-04	5.40E-04	1.70E-02	1.70E-02	4.74E+02	2.76E+02	1.66E-02	1.66E-02	0.00E+00	0.00E+00
Turtles	Bq/kg (fw)	5.07E+02	5.07E+02	3.00E+00	3.00E+00	2.49E+02	2.49E+02	2.34E+02	2.34E+02	4.35E+01	4.35E+01	1.33E+00	1.33E+00	8.12E+00	8.12E+00
Aquatic Plants	Bq/kg (fw)	5.75E+01	5.75E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	5.80E+01	5.80E+01	3.00E+00	3.00E+00	8.51E+00	8.51E+00
American Robin	Bq/kg (fw)	3.91E+01	3.87E+01	5.22E-01	5.22E-01	1.46E+00	1.46E+00	1.57E+00	1.57E+00	2.32E+01	2.05E+01	2.57E-02	2.57E-02	1.68E+00	1.42E+00
Song Sparrow	Bq/kg (fw)	5.76E+01	5.65E+01	1.04E+00	1.04E+00	2.91E+00	2.91E+00	3.01E+00	3.01E+00	5.29E+01	4.79E+01	1.90E-02	1.90E-02	3.42E+00	2.98E+00
Yellow Warbler	Bq/kg (fw)	3.86E+01	3.86E+01	4.62E-01	4.62E-01	1.29E+00	1.29E+00	1.35E+00	1.35E+00	3.44E+01	3.22E+01	1.45E-02	1.45E-02	2.20E+00	1.97E+00
Eastern Cottontail	Bq/kg (fw)	1.14E+02	9.79E+01	1.85E-02	1.85E-02	9.50E-01	9.50E-01	1.02E+00	1.02E+00	4.80E+01	3.94E+01	5.99E+00	5.99E+00	4.00E+00	3.37E+00
Meadow Vole	Bq/kg (fw)	1.14E+02	9.79E+01	7.41E-03	7.41E-03	3.82E-01	3.82E-01	3.92E-01	3.92E-01	4.80E+01	3.94E+01	2.39E+00	2.39E+00	4.00E+00	3.37E+00
White-tailed Deer	Bq/kg (fw)	1.14E+02	9.79E+01	2.57E-02	2.57E-02	1.32E+00	1.32E+00	1.35E+00	1.35E+00	4.80E+01	3.87E+01	8.29E+00	8.29E+00	3.74E+00	3.08E+00
Common Shrew	Bq/kg (fw)	6.39E+01	6.39E+01	2.62E-02	2.62E-02	1.34E+00	1.34E+00	1.37E+00	1.37E+00	6.24E+01	5.92E+01	1.50E+00	1.50E+00	4.64E+00	4.26E+00
Raccoon	Bq/kg (fw)	7.81E+01	7.18E+01	2.07E-02	2.07E-02	1.11E+00	1.11E+00	1.23E+00	1.23E+00	5.41E+01	4.88E+01	2.71E+00	2.71E+00	0.00E+00	0.00E+00
Red Fox	Bq/kg (fw)	1.08E+02	9.23E+01	1.51E-03	1.51E-03	2.35E-01	2.35E-01	2.56E-01	2.56E-01	2.99E+01	2.25E+01	6.78E-01	6.78E-01	0.00E+00	0.00E+00
Short-tailed Weasel	Bq/kg (fw)	1.14E+02	9.79E+01	3.00E-04	3.00E-04	2.22E-01	2.22E-01	2.74E-01	2.74E-01	4.80E+01	4.06E+01	4.07E-01	4.07E-01	3.31E+00	2.86E+00

Appendix D Sample Calculations

Table D.1: Sample Calculation for Oshawa Urban Resident (Adult) Drinking Water Exposure and Risk to Hydrazine with Decay ($t_{1/2} = 1.3$ days)

Parameter Description	Parameter Symbol	Hydrazine		
		Value	Unit	Source
Environmental Media Concentration				
Maximum Effluent Water Concentration	A	7.60E-03	mg/L	Table 3-8
Dilution Factor (Oshawa WSP)	B	35.6	unitless	Table 3-8
Half-life hydrazine ($t_{1/2}$)	C	1.3	days	Section 3.2.6.1
Hydrazine Decay Constant (λ)	$D = \ln(2)/C$	0.53	unitless	Calculation
Distance to Oshawa WSP	E	7800	m	2020 DN ERA (Ecometrix, 2022a)
Current Velocity to the West	F	0.085	m/s	2020 DN ERA (Ecometrix, 2022a)
Travel Time	$G = E/F / (60\text{sec} * 60\text{min} * 24\text{hr})$	1.06	days	Calculation
Hydrazine Decayed Concentration $t_{1/2} = 1.3$ days	$H = A * \text{EXP}(-D * G)$	4.31E-03	mg/L	Calculation
Degradation of hydrazine during water treatment	I	0.1	fraction	Section 3.2.6.2.1
Estimated at Oshawa WSP (mg/L)	$J = (H * I) / B$	1.21E-05	mg/L	Calculation
Human Exposure Factors (Adult)				
Drinking Water Intake	K	1.5	L/d	Table 3-5
Days per Week/7 (D2)	L	1	d/d	Table 3-5
Weeks per Year/52 (D3)	M	1	wk/wk	Table 3-5
Years Exposed (D4)	N	30	years	Table 3-5
Fraction of Water Obtained from WSP	O	0.834	unitless	Table 3-6
Body Weight	P	70.7	kg	Table 3-5
Life Expectancy	Q	70	years	Table 3-5
RAF _{GIT}	R	1	unitless	Table 3-5
TRV (Oral Slope Factor)	S	3	(mg/kg d) ⁻¹	Section 3.3.1
Human Dose and ILCR				
Ingestion Dose	$T = (J * K * L * R * M * N * O) / (P * Q)$	9.19E-08	mg/kg d	Calculation
ILCR	$U = S * T$	3E-07	unitless	Calculation

Table D.2: Sample Calculation for Sport Fisher Fish Consumption Exposure and Risk to Hydrazine

<u>Parameter Description</u>	<u>Parameter Symbol</u>	<u>Hydrazine</u>		
Environmental Media Concentration		Value	Unit	Source
Maximum Outfall Water Concentration	A	1.09E-03	mg/L	Table 3-11
Fish Concentration				
Bioaccumulation Factor (BAF)	B	3.16	L/kg fw	Table 3-11
Tissue Concentration	C=A*B	3.4E-03	mg/kg fw	Calculation
Human Exposure Factors (Adult)				
Fish Ingestion	D	0.111	kg/d	Table 3-5
Years Exposed (D4)	E	30	a	Table 3-5
D _{fish} (days in which consumption occurs)	F	365	d/a	Table 3-5
Fraction of Fish in Diet Obtained from Outfall	G	1	unitless	Table 3-6
Body Weight	H	70.7	kg	Table 3-5
Life Expectancy	I	70	years	Table 3-5
RAF _{GIT}	J	1	unitless	Table 3-5
TRV (Oral Slope Factor)	K	3	(mg/kg d) ⁻¹	Section 3.3.1
Human Dose and ILCR				
Ingestion Dose	$L = (C*D*F*G*J*E)/(H*365*I)$	2.32E-06	mg/kg d	Calculation
ILCR	$M = K*L$	7E-06	unitless	Calculation