CanNorth
Canada North Environmental Services Limited Partnership
A First Nation Environmental Services Company

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT SPEERS LAKE SITES, NUNAVUT

Final Report

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Prepared for:

Public Services and Procurement Canada
Northern Contaminated Sites Program
Western Region

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LIST OF ACRONYMS

AEC	Area of Environmental Concern
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CanNorth	Canada North Environmental Services
CCME	Canadian Council of Ministers of the Environment
CEQG	Canadian Environmental Quality Guideline
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
COC	Contaminant of Concern
COSEWIC	Committee of the Status of Endangered Wildlife in Canada
CWS	Canada Wide Standards
DMF	Decision-making framework
ECCC	Environment and Climate Change Canada
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
FCSAP	Federal Contaminated Sites Action Plan
FOC	Fraction of Organic Carbon
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
ISQG	Interim Sediment Quality Guideline
JV-60	BLM-KEL-60
LEL	Lowest Effect Level
LOE	Line of Evidence
masl	Metres Above Sea Level
mbgs	Metres Below Ground Surface
MCL	Maximum Contaminant Level
MDL	Method Detection Limit

MECP	Ontario Ministry of the Environment, Conservation and Parks
MOE	Ontario Ministry of the Environment
NCSCS	National Classification System for Contaminated Sites
PAH	Polycyclic Aromatic Hydrocarbon
PEL	Probable Effect Level
PHC	Petroleum Hydrocarbon
PSPC	Public Services and Procurement Canada
RSL	Regional Screening Level
SAR	Species at Risk
SARA	Species at Risk Act
SQG	Soil Quality Guideline
SQG_{ECO}	Soil Quality Guideline (for environmental health)
SQG_{HH}	Soil Quality Guideline (for human health)
TOC	Total Organic Carbon
TOR	Terms of Reference
TRV	Toxicity Reference Value
VOC	Volatile Organic Compound
WOE	Weight-of-evidence
WQG	Water Quality Guideline

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EXECUTIVE SUMMARY

Canada North Environmental Services (CanNorth), in partnership with BLM-KEL-60 (JV-60), was retained by Public Services and Procurement Canada (PSPC) Western Region to conduct a Human Health and Ecological Risk Assessment (HHERA) for the Speers Lake Sites (the Sites) which are six abandoned former mining exploration areas and one former fishing lodge (Kendall River WK165) located approximately 35 km to 90 km from Kugluktuk, Nunavut (NU) within the Kitikmeot district. The seven Sites include Speers Lake WK097, Asiak River WK154, Coppermine WK199, Impact Lake WK176, Tahiapik River WK170 , Kendall River WK165, and Coppermine WK210.

This work was completed in response to the terms of reference (TOR) received May 15, 2023, and revised May 24 and June 23, 2023: Terms of Reference (TOR), Consulting Services for Speers Lake Sites, Nunavut. The work was completed on behalf of PSPC's client Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC).

The HHERA is based on field work conducted at the Sites in 2023 since previous data collected at the Sites in 2004 and 2008 are no longer considered relevant.

The objective of the HHERA is to evaluate whether contaminants of concern (COCs) at the Sites pose unacceptable risks to humans and/or ecological receptors. The use of this Site-specific risk-based approach ensures that rational decisions are made with respect to the evaluation of remedial options.

The Human Health Risk Assessment (HHRA) evaluated the risks to people who may be present at the Sites. It is noted that people rarely visit the Sites as they are difficult to access. The qualitative analysis of human health at all the Sites, which involved a comparison of the maximum measured concentrations in soil at the Sites to human health guidelines, indicated that there were no exceedances of the soil guidelines, or exceedances were localized and therefore there are no risks to people from soil pathways at the Site. There are no exceedances of drinking water guidelines within any of the lakes present at Coppermine WK199, Coppermine WK210, Kendall River WK165, Speers Lake WK097, and Tahiapik River WK170 indicating that the water is safe to drink.

The Ecological Risk Assessment (ERA) evaluated the risks to vegetation, soil invertebrates, and wildlife, that may forage at the Sites. A qualitative evaluation was undertaken for these receptors at all the Sites as the maximum measured concentrations were below ecological guidelines or exceedances were localized. Maximum concentrations of contaminants in

surface water at Coppermine WK199, Coppermine WK210, Kendall River WK165, Speers Lake WK097, and Tahiapik River WK170 were below guidelines protective of aquatic guidelines and do not represent a risk. Similarly, it was determined that benthic communities were not at risk at these five Sites. It was determined that ecological populations are not at risk at any of the seven Sites. It is noted that surface water and sediment samples were not collected at Impact Lake due to time constraints, however, as there was only one localized area of contamination it is unlikely to be mobilized into the surface water body.

Table 1 provides a summary of the HHERAs carried out for each of the Sites. Chromium, cobalt, copper, nickel, and vanadium are naturally enriched, therefore do not represent a risk at any of the Sites.

Climate change is unlikely to result in increased risks to human or ecological receptors at the Sites.

From a chemical perspective, there is no human or ecological risk-driven need for remediation at the Speers Lake Sites as long as the future land use and time on Site remain as described in the HHERA. However, at Speers Lake WK097 and Impact Lake WK176 there are several barrels that contain product which should be removed as they are potential sources of contamination. At all the other Sites, the barrels are dry and while they represent a physical risk, they do not represent a source of chemical contamination.

Table 1 Summary of the HHERA

Site	Media	HHRA Results	ERA Results	Need for Remediation
Asiak River WK154	*Soil*	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified.*	*No*
Coppermine WK199	*Soil*	*Qualitative assessment – no risks identified. Lead and PHC F2 exceed human health guidelines but are localized and do not represent a risk to human health.*	*Qualitative assessment – no risks identified. Boron (hot water soluble), lead, naphthalene, and PHCs F1, F2, and F3 exceed ecological guidelines but are localized (one location) and do not represent a risk to ecological populations.*	*No*
	Surface Water	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified.*	
	Sediment	*N/A*	*Only background samples available - no risks from background.*	
Coppermine WK210	*Soil*	*Qualitative assessment – no risks identified.*	*Screening identified barium and PHC F3 for further evaluation. Qualitative comparison to toxicity derived soil concentrations indicated that ecological populations are not at risk. Additionally, naphthalene, and PHC F2 exceed guidelines but are localized and do not represent a risk to ecological populations.*	*No*
	Surface Water	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified.*	
	Sediment	*N/A*	*Qualitative assessment – no risks identified. Arsenic concentration is above the sediment quality guideline but below the probable effects level and so benthic communities are not at risk. Similarly, PHC F2, PHC F3, and PHC F4 were below toxicity benchmarks and do not represent a risk for benthic communities.*	
Impact Lake WK176	*Soil*	*Qualitative assessment – no risks identified. PHC F2 exceeds human health guidelines but is localized and does not represent a risk to human health.*	*Qualitative assessment – no risks identified. Acenaphthene, fluorene, naphthalene, phenanthrene, and PHCs F1, F2, and F3 exceed guidelines but are localized and do not represent a risk to ecological populations.*	*No*

Site	Media	HHRA Results	ERA Results	Need for Remediation
Kendall River WK165	*Soil*	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified. Barium exceeds ecological guidelines but is localized and does not represent a risk to ecological populations.*	*No*
	Surface Water	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified. Aluminum exceeds ecological guidelines but is not bioavailable and does not represent a risk to ecological populations.*	
	Sediment	*N/A*	*Qualitative assessment – no risks identified.*	
Speers Lake WK097	*Soil*	*Qualitative assessment – no risks identified. PHC F2 and PHC F3 exceed human health guidelines but are localized exceedances and do not represent a risk to human health.*	*Qualitative assessment – no risks identified Acenaphthene, benzo[a]anthracene, fluorene, naphthalene, phenanthrene PHC F2 , PHC F3, and PHC F4 exceed ecological guidelines but are localized mainly in the south area of the Site and vegetation is growing abundantly.*	*No*
	Surface Water	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified.*	
	Sediment	*N/A*	*Qualitative assessment – no risks identified. PHC F3 maximum concentration is below background. Arsenic and zinc concentrations are above the sediment quality guidelines but below the probable effects levels and so benthic communities are not at risk.*	
Tahiapik River WK170	*Soil*	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified. Zinc exceeds the ecological guideline but is localized and does not represent a risk to ecological communities.*	*No*
	Surface Water	*Qualitative assessment – no risks identified.*	*Qualitative assessment – no risks identified.*	
	Sediment	*N/A*	*Qualitative assessment – no risks identified.*	

1.0 INTRODUCTION

1.1 Terms of Reference

Canada North Environmental Services (CanNorth), in partnership with BLM-KEL-60 (JV-60), was retained by Public Services and Procurement Canada (PSPC) Western Region to conduct a Human Health and Ecological Risk Assessment (HHERA) for the Speers Lake Sites (the Sites). The seven Sites include Speers Lake WK097, Asiak River WK154, Coppermine WK199, Impact Lake WK176 , Tahiapik River WK170, Kendall River WK165 (, and Coppermine WK210. All Sites lie in proximity to Kugluktuk, Nunavut (NU) within the Kitikmeot district.

This work was completed in response to the terms of reference (TOR) dated May 15, 2023, and amended May 24 and June 23, 2023. The work was completed on behalf of PSPC's client Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC).

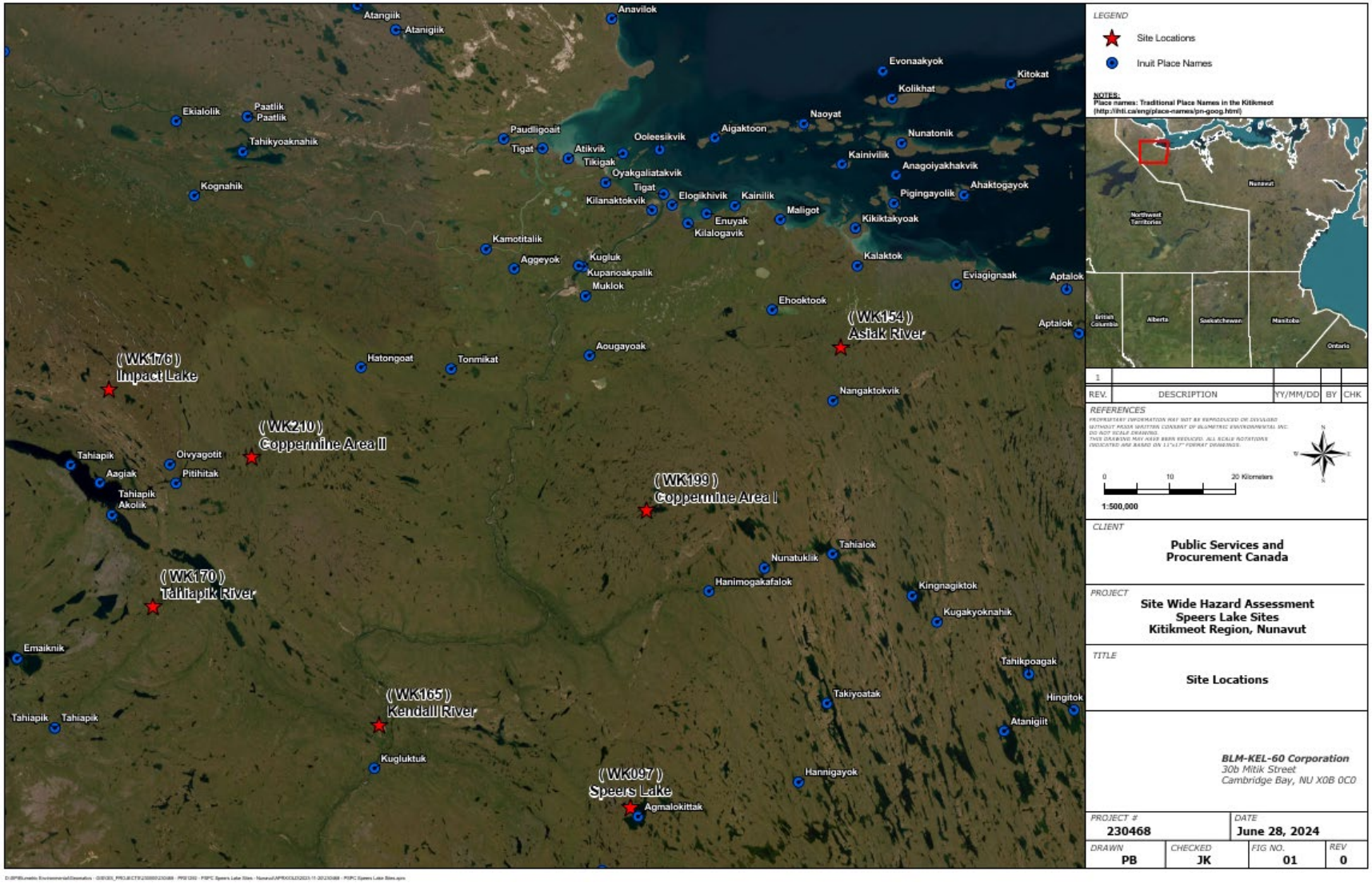
The HHERA is based on field work conducted at the Sites in 2023.

1.2 Background Information

The Sites are located near Speers Lake in the Kitikmeot region, NU (Figure 1.1). The Sites are all abandoned former mining exploration areas at the exception of Kendall River WK165; a former fishing lodge. General information applicable to the Sites is discussed collectively, while Human Health Risk Assessments (HHRAs) and Ecological Risk Assessments (ERAs) for the Sites are separated into seven Site-specific chapters.

Eight previous studies and reports were completed for the Site, as discussed further in Section 1.3. Phase I and II Environmental Site Assessments (ESAs) were completed in 2004 for Speers Lake WK097 (Golder 2005a) and Coppermine WK210 (Golder 2005b), and in 2008 for Asiak River WK154 (WESA 2009a), Coppermine WK199 (WESA 2009b), Impact Lake WK176 (WESA 2009c), Kendall River WK165 (WESA 2009d), and Tahiapik River WK170 (WESA 2009e). A Phase III ESA for all seven Sites was commenced in 2023 (JV-60 2024a).

Figure 1.1 Site location



Note: From Phase III ESA (JV-60 2024a).

1.3 Summary of Previous Studies

The following section provides an overview of the ESAs previously carried out for the Sites. Integrated Phase I and limited Phase II ESAs were completed independently for each of the seven Sites, while the collective Phase III ESA report includes all seven Sites and is based on field work completed in 2023.

1.3.1 Summary of Reports Reviewed

Table 1.1 provides a summary of the reports that were reviewed as part of the development of the Problem Formulation for the HHERA.

Table 1.1 Summary of previous reports reviewed for the Speers Lake Sites

Report Type	Report (Title, Author, Publish Year, Submitted to)	Scope/Type of Work Completed
ESA	Integrated Phase I and Limited Phase II Environmental Site Assessment, WK154 – Asiak River 2009 Water and Earth Science Associates Ltd. Prepared for Indian and Northern Affairs Canada, Contaminated Sites Program, Iqaluit, Nunavut	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.
ESA	Integrated Phase I and Limited Phase II Environmental Site Assessment, WK199 – Coppermine Area 2009 Water and Earth Science Associates Ltd. Prepared for Indian and Northern Affairs Canada, Contaminated Sites Program, Iqaluit, Nunavut	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.
ESA	Phase I/II Environmental Site Assessment, Coppermine Area, Nunavut 2005 Golder Associates Ltd. Prepared for Public Works & Government Services Canada, Edmonton, Alberta	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.
ESA	Integrated Phase I and Limited Phase II Environmental Site Assessment, WK176 – Impact Lake 2009 Water and Earth Science Associates Ltd. Prepared for Indian and Northern Affairs Canada, Contaminated Sites Program, Iqaluit, Nunavut	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.
ESA	Integrated Phase I and Limited Phase II Environmental Site Assessment, WK165 – Kendall River 2009 Water and Earth Science Associates Ltd. Prepared for Indian and Northern Affairs Canada, Contaminated Sites Program, Iqaluit, Nunavut	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.
ESA	Phase I/II Environmental Site Assessment, Speers Lake, Nunavut 2005 Golder Associates Ltd. Prepared for Public Works & Government Services Canada, Edmonton, Alberta	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.

Report Type	Report (Title, Author, Publish Year, Submitted to)	Scope/Type of Work Completed
ESA	Integrated Phase I and Limited Phase II Environmental Site Assessment, WK170 – Tahiapik River 2009 Water and Earth Science Associates Ltd. Prepared for Indian and Northern Affairs Canada, Contaminated Sites Program, Iqaluit, Nunavut	Phase I and Phase II ESA – historical review, detailed environmental Site investigation, sample collection, and reporting.
ESA	Draft Phase III Environmental Site Assessment, Speers Lake Sites, Kitikmeot Region, Nunavut 2023 BLM-KEL-60 Corporation Prepared for Public Services and Procurement Canada (PSPC)	Phase III ESA – Intrusive studies of soil, surface water, sediments, and vegetation in support of the risk assessment and remedial options analysis for the Site.

1.3.2 Integrated Phase I and Limited Phase II Environmental Site Assessments

1.3.2.1 Asiak River WK154

An integrated Phase I and limited Phase II ESA (WESA 2009a) was carried out for the Site. WESA completed investigations in 2008 and found an old drill rig and tent motor, drilling rods, a water basin, a stove, ten (10) 45-gallon drums (9 empty, 1 half full of water), metal, and wood debris.

The objective of the integrated Phase I and limited Phase II ESA was to provide a historical records review, interviews, Site visit, develop a sampling plan, assess environmental impacts, photograph and collect samples at the Site, and quantify materials at the Site. In addition, the ESA facilitated classification under the National Classification System for Contaminated Sites (NCSCS) and provided recommendations for future assessment and remedial options.

The sampling program for the Site included two soil samples submitted for analyses of metals, petroleum hydrocarbons (PHCs), benzene, toluene, ethylbenzene, and xylene (BTEX), and polycyclic aromatic hydrocarbons (PAHs). Results indicated approximately 2 m^3 of soil near the drill rig was impacted by PHCs (F3 and F4) and metals.

An NCSCS score of 56.6 designated the Site as a Class 2 Site, Moderate Priority for Action.

Further investigation at the Site was recommended to assess PHC and metal contamination and further delineate known and potential areas of environmental concern (AECs/APECs).

Remedial recommendations from the integrated Phase I and limited Phase II ESA included excavating and transporting affected soils for disposal, unpainted wood be incinerated on Site, remaining debris be moved off site for disposal, and the partially full drum be further investigated.

1.3.2.2 Coppermine WK199

An integrated Phase I and limited Phase II ESA (WESA 2009b) was carried out for the Site. WESA completed investigations in 2008 and found metal debris, drill cores, propane cylinders, the footprint of a former structure, a concrete pad, a suspected water tank, and some potentially archaeologically significant features.

The objective of the integrated Phase I and limited Phase II ESA was to provide a historical records review, interviews, Site visit, develop a sampling plan, assess environmental impact, photograph and collect samples at the Site, and quantify materials at the Site. In addition, the ESA facilitated classification under the NCSCS and provided recommendations for future assessment and remedial options.

The sampling program for the Site included three soil samples submitted for analyses of metals, PHCs, and BTEX. Results indicated approximately 1.2 m^3 of soil downgradient from a drill core and area of stained oil was impacted by zinc.

An NCSCS score of 48.7 designated the Site as a Class 3 Site, Low Priority for Action.

Further investigation at the Site was recommended to assess the source of the zinc contamination and confirm the contents of the suspected water tank.

Remedial recommendations from the integrated Phase I and limited Phase II ESA included excavating and transporting affected soils for disposal, unpainted wood be incinerated on Site, and remaining debris be moved off site for disposal.

1.3.2.3 Coppermine WK210

An integrated Phase I and limited Phase II ESA (Golder 2005b) was carried out for the Site. Golder completed investigations in 2004 and found: six (6) 4,500 L storage tanks that likely contained jet fuel; two (2) 2,300 L storage tanks, that likely contained heating oil; and eleven (11) 205 L drums, containing 510 L of oily water. The storage tanks had been purged and punctured and contained approximately 2,150 L of oily water.

The objective of the integrated Phase I and limited Phase II ESA was to review historical information, conduct a Site visit, collect samples, quantify and classify waste, collect ecological Site information, associated reporting, and classify the Site under the NCSCS.

The sampling program for the Site included eight soil samples, one surface water sample, and one sediment sample, all submitted for analyses of metals, PHCs, and BTEX. Results indicated elevated PHC F3 in sediment in excess of guidelines, which were assessed using soil guidelines in a volume of approximately 12.5 m^3.

An NCSCS score of 49.5 designated the Site as a Class 3 Site, Low Priority for Action.

Remedial recommendations from the integrated Phase I and limited Phase II ESA included testing and disposing of liquid in the drums, and disposing of storage tanks, emptied drums, and metal debris off site.

1.3.2.4 Impact Lake WK176

An integrated Phase I and limited Phase II ESA (WESA 2009c) was carried out for the Site, which was not designated in the Northwest Territories/Nunavut contaminated site database. WESA completed investigations in 2008 and found a partially intact structure, wood and metal debris, and forty-two (42) 45-gallon drums (approximately half were full or partially full, and the other half empty; markings indicate former property of Imperial Oil).

The objective of the integrated Phase I and limited Phase II ESA was to provide a historical records review, interviews, Site visit, develop a sampling plan, assess environmental impact, photograph and collect samples at the Site, and quantify materials at the Site. In addition, the ESA facilitated classification under the NCSCS and provided recommendations for future assessment and remedial options.

The sampling program for the Site included nine soil samples and one surface water sample submitted for analyses of metals, PHCs, BTEX, and/or PAHs. Results indicated approximately 4 m^3 of soil were impacted by metals, including molybdenum, and an area of approximately 9 m^3 was impacted by PHCs/BTEX. Metal impacts were suspected to be from historical storage and burning of metal objects; the source of molybdenum impact was unknown. PHC/BTEX impact was suspected to be a result of historic release of hydrocarbons from a drum(s).

An NCSCS score of 59.4 designated the Site as a Class 2 Site, Moderate Priority for Action.

Remedial recommendations from the integrated Phase I and limited Phase II ESA included excavating and transporting affected soils for disposal, non-hazardous wood debris and a dangerous roof structure being dismantled and incinerated, and remaining debris be moved off site for disposal.

1.3.2.5 Kendall River WK165

An integrated Phase I and limited Phase II ESA (WESA 2009d) was carried out for the Site. WESA completed investigations in 2008 and found two tent platforms, a burn pit, four jerry cans (two full and two empty), and wood and metal debris.

The objective of the integrated Phase I and limited Phase II ESA was to provide a historical records review, interviews, Site visit, develop a sampling plan, assess environmental impact, photograph and collect samples at the Site, and quantify materials at the Site. In addition, the ESA facilitated classification under the NCSCS and provided recommendations for future assessment and remedial options.

The sampling program for the Site included three soil samples submitted for analyses of metals, PHCs, BTEX, and PAHs. Results indicated approximately 0.6 m^3 of soil near the jerry cans was impacted by cadmium and lead, suspected to be from historical fuel and material storage. Barium, copper, zinc, benzene, toluene, and xylene impacted an area of approximately 0.2 m^3 suspected to be from burning metal containing debris.

An NCSCS score of 58.8 designated the Site as a Class 2 Site, Moderate Priority for Action.

Remedial recommendations from the integrated Phase I and limited Phase II ESA included excavating and transporting affected soils for disposal, unpainted wood be incinerated on Site, and remaining debris be moved off site for disposal.

1.3.2.6 Speers Lake WK097

An integrated Phase I and limited Phase II ESA (Golder 2005a) was carried out for the Site, which was not designated in the Northwest Territories/Nunavut contaminated site database. Golder completed investigations in 2004 and found a total of 374 drums with a combined volume of liquid equivalent to approximately 36.5 drums full of liquid. Samples of three drums were collected and likely contained gasoline, diesel, heating oil, or a combination of liquids. The North Site consisted of a dock, large drum cache and drums, two buildings of aluminum and wood construction with pink insulation, core samples, and metal debris. The South Site consisted of drilling rods, drum caches and drums, and wood debris.

The objective of the integrated Phase I and limited Phase II ESA was to provide a historical records review, interviews, Site visit, develop a sampling plan, assess environmental impact, photograph and collect samples at the Site, and quantify materials at the Site. In addition, the ESA facilitated classification under the NCSCS and provided recommendations for future assessment and remedial options.

The sampling program for the Site included fourteen soil samples, submitted for analyses of PHCs and BTEX, and one surface water sample and two sediment samples submitted for analyses of metals, PHCs, and BTEX. Results indicated approximately 387.5 m^3 of soil was impacted by PHCs in or around drum storage areas and one near a Site building. One sediment sample exceeded guidelines for chromium near a drum cache.

An NCSCS score of 53.4 designated the Site as a Class 2 Site, Moderate Priority for Action.

Further investigation at the Site was recommended to assess landfill location and borrow sources, to conduct PHC impacted soil delineation, and conduct metal impacted soil delineation and background concentration.

Remedial recommendations from the integrated Phase I and limited Phase II ESA included construction of an on Site landfill for disposal of debris, testing of the liquid contents of the drums, excavating and disposing of affected soils in the on Site landfill, demolition of buildings, and incineration or disposal of building materials, wood, and metal debris.

1.3.2.7 Tahiapik River WK170

An integrated Phase I and limited Phase II ESA (WESA 2009e) was carried out for the Site. WESA completed investigations in 2008 and found wood debris, pallets of drilling salt, remains of a floor platform, a burn pit, a 45-gallon drum, and several drill holes. Additional debris areas were observed from the air but not accessed during the 2008 field investigation.

The objective of the integrated Phase I and limited Phase II ESA was to provide a historical records review, interviews, Site visit, develop a sampling plan, assess environmental impact, photograph and collect samples at the Site, and quantify materials at the Site. In addition, the ESA facilitated classification under the NCSCS and provided recommendations for future assessment and remedial options.

The sampling program for the Site included five soil samples and one surface water sample submitted for analyses of metals, PHCs, BTEX, and PAHs. Results indicated approximately 2 m^3 of soil at the burn pit was impacted by zinc. Two areas of surface water were impacted by copper but were suspected to be naturally occurring.

An NCSCS score of 43.9 designated the Site as a Class 2 Site, Low Priority for Action.

Remedial recommendations from the integrated Phase I and limited Phase II ESA included excavating and transporting affected soils for disposal, unpainted wood be incinerated on Site, remaining debris be moved off site for disposal, and the drums that were not assessed during the 2008 Site visit be further investigated.

1.3.3 2023 Phase III Environmental Site Assessment

JV-60 completed field work at the Sites in support of a Phase III ESA report from August 29, 2023 to September 8, 2023 (JV-60 2024a). The objectives of the assessment were to identify and confirm potential contamination sources and delineate impacted areas. This work included a gap analysis, site survey and access evaluation, a geotechnical investigation, an Archaeological Impact Assessment for the Speers Lake Sites, a desktop Archaeological Overview Assessment for the remaining six Sites, a Site Wide Hazard Assessment (SWHA), an intrusive sampling plan, and all associated reporting. Field sampling included collection of soil, surface water, sediment, vegetation, hazardous materials, building materials, and barrel and tank liquid samples. Table 1.2 provides a summary of exceedances of applicable environmental guidelines at the Site.

Table 1.2 AECs/APECs and guideline exceedances at each Site

Location	Areas of Environmental Concern	Guideline Exceedances	Figure #
Asiak River WK154	AEC 1 – Drill Rig and Drum Cache Area	Soil: metals (Cu), BTEX (benzene, ethylbenzene, toluene), VOCs (methylene chloride)	Figure 1.2
	APEC 2 – Barrel Area 1	N/A*	
	APEC 3 – Barrel Area 2	None	
Coppermine WK199	APEC 1 – Core Area	None	Figure 1.3
	APEC 2 – Tank 3	N/A*	
	AEC 3 – Debris and Burn Pile Area	Soil: metals (Cr, Cu, Ni, V), BTEX (benzene, ethylbenzene, toluene), PHCs (F3)	
	APEC 4 – Snowmobile Parts	None	
	AEC 5 – Tank 2	Soil: metals (hot water soluble B, Cr, Cu, Cd, Pb, Ni), BTEX (benzene, toluene, ethylbenzene), PHCs (F1, F2, F3)	
	AEC 6 – Historic Tank Area	Soil: metals (hot water soluble B, Cu) Surface water: metals (Cu)	
Coppermine WK210	AEC 1 – Tank Cache 1	Soil: metals (hot water soluble B, Cr, Cu, Ni), PAHs (acenaphthene, naphthalene, phenanthrene), BTEX (benzene, toluene, ethylbenzene, xylene), PHC (F1, F2, F3)	Figure 1.4
	AEC 2 – Tank Cache 2	Soil: BTEX (toluene), PHC (F3)	
	AEC 3 – Camp Dump	Soil: metals (Cd, Cr, Ni, Sn)	
	AEC 4 – Site Runoff	Surface Water: metals (Al) Sediment: metals (As, Cu), PHCs (F2, F3, F4)	
	APEC 5 – West Side of the Unnamed Lake	N/A*	
Impact Lake WK176	AEC 1 – Historical Debris and Burning	N/A*	Figure 1.5
	APEC 2 – Barrel Contents	Soil: Benzene	
	AEC 3 – Barrel Cache Area	Soil: PHCs (F1, F2, F3), PAHs (acenaphthene, fluorene, naphthalene, phenanthrene), BTEX (benzene, ethylbenzene, xylene), metals (hot water soluble B)	
	APEC 4 – Historical Structures and Debris Area	Soil: metals (Cr, Co, Ni)	
	APEC 5 – Western Barrel Area	None	
Kendall River WK165	AEC 1 – Jerry Can Storage Area	N/A	Figure 1.6
	AEC 2 – Burn Pit	Soil: BTEX (benzene)	
	APEC 3 – Debris Area 1	N/A	
	APEC 4 – Debris Area 2	Soil: metals (Ba, Cr, Ni, V)	

Location	Areas of Environmental Concern	Guideline Exceedances	Figure #
Speers Lake WK097	APEC 1 – Intact Core Shack (North Building)	Soil: metals (Cr, Co, Ni), PHCs (F2, F3)	Figure 1.7 and Figure 1.8
	AEC 2 – Collapsed Core Shack (South Building)	Soil: metals (Cr, Co, Ni), PHCs (F2, F3)	
	AEC 3 – North Beach Area	Soil: metals (Cr, Co, Ni) Surface water: metals (Al) Sediment: metals (Cr, Ni, Zn)	
	APEC 4 – Wood/Metal Debris Area	Soil: metals: (hot water soluble B, Cr, Co, Cu, Ni), PAHs (benzo[a]anthracene, phenanthrene, pyrene, quinoline), PHCs (F2, F3, F4)	
	APEC 5 – South Camp	Soil: metals: (Cr, Co, Cu, Ni), PAHs (acenaphthene, fluorene, naphthalene, phenanthrene), PHCs (F1, F2, F3)	
	APEC 6 – South Beach Area	Soil: metals (Cr, Co, Cu, Ni), PAHs (quinoline), PHCs (F2, F3), BTEX (ethylbenzene) Surface Water: metals (Al) Sediment: metals (As, Cr, Cu, Ni)	
Tahiapik River WK170	APEC 1 – Debris Area 1	None	Figure 1.9
	AEC 2 – Burn Pit	Soil: metals (Zn)	
	APEC 3 – Core Pile	None	
	AEC 4 – Debris Area 2	Soil: VOCs (methylene chloride)	
	AEC 5 – Debris Area 3	Soil: VOCs (methylene chloride) Surface Water: metals (Al, Cu)	
	APEC 6	N/A*	

Note: *not visited during the field investigation, no samples taken, or sampled but not tested.

Background samples at the Sites were analyzed for metals, total organic carbon (TOC), fraction of organic carbon (FOC), and pH in soil; metals, PHCs, PAHs, and BTEX in sediment and surface water; and metals in vegetation.

Table 1.3 Sampling program at each Site

Location	Soil	Surface Water	Sediment	Vegetation	Other	Background
Asiak River WK154	22 samples	None	None	6 samples	Debris inventoried; 1 paint sample collected	2 soil, 2 vegetation
Coppermine WK199	33 samples	2 samples	2 samples	2 samples	Debris inventoried; no samples collected	2 soil, 1 surface water, 1 sediment, 2 vegetation
Coppermine WK210	36 samples	2 samples	4 samples	5 samples	Debris inventoried; 3 building material samples collected, 1 paint sample, 4 tank/barrel samples	2 soil, 1 surface water, 1 sediment, 2 vegetation
Impact Lake WK176	16 samples	None	None	6 samples	Debris inventoried; no samples collected	2 soil, 2 vegetation
Kendall River WK165	11 samples	2 samples	2 samples	3 samples	Debris inventoried; 1 paint sample, two fuel samples collected	2 soil, 1 surface water, 2 vegetation
Speers Lake WK097	79 samples	4 samples	5 samples	3 samples	Debris inventoried; 1 fuel sample collected	4 soil, 4 surface water, 4 sediment, 4 vegetation
Tahiapik River WK170	12 samples	2 samples	1 sample	5 samples	Debris inventoried; no samples collected	2 soil, 1 surface water, 1 vegetation

Asiak River WK154

Exceedances at Asiak River WK154 occurred at AEC 1 for copper, benzene, ethylbenzene, toluene, and methylene chloride. The exceedance of copper was attributed to natural occurrence in the area. BTEX and VOC exceedances were attributed to historical mining activities. The total volume of impacted soil was an estimated 21.5 m^3. The paint sample collected was in exceedance of applicable guidelines for lead and considered hazardous. More debris was noted at Asiak River WK154 in addition to that found during the 2009 Site visit, including additional barrels, and batteries. The total volume of debris was estimated to be 10.7 m^3.

Coppermine WK199

Exceedances at Coppermine WK199 occurred in soil at AEC 3, 5, and 6 for metals (hot water soluble boron, cadmium, chromium, copper, lead, nickel, and vanadium), BTEX (benzene, toluene, ethylbenzene), and PHCs (F1, F2, and F3) and copper in surface water. Exceedances of chromium, copper, nickel, and vanadium in all media were attributed to natural occurrence. PHC and BTEX exceedances were attributed to historical Site activities and historical fuel spills. Items found at the Site included core piles, household items, plastic waste, snowmobile pieces, a concrete pad, metal, empty propane tanks, a water tank, and a mini barrel, for a total of approximately 10.7 m^3 of debris.

Coppermine 210

Exceedances at Coppermine WK210 occurred in AEC 1, 2, and 3 soils for metals (hot water soluble boron, cadmium, chromium, copper, nickel, tin), PAHs (acenaphthene, naphthalene, phenanthrene), BTEX (benzene, toluene, ethylbenzene, xylene), and PHCs (F1, F2, F3). Metals (aluminum) in surface water and metals (arsenic, copper) and PHCs (F2, F3, F4) in sediments exceeded guidelines in AEC 4. Chromium, copper, and nickel exceedances in all media were attributed to background enrichment. Cadmium and tin exceedances were attributed to dumping and exposure of metallic materials to the elements. BTEX, PHCs, and PAH exceedances were expected to be localized and attributed to historical leaks and spills. The aluminum exceedance was anticipated to be from upgradient runoff from the Site. Boron and arsenic impacts were localized. The volume of impact was estimated to be 118 m^3 in soil and 79 m^3 in sediment. Results from the fuel tank sample indicated it was significantly diluted with water and therefore not considered fuel. Debris remaining at the Site included wood, metal, a jerry can, barrels, and tanks, with an approximate volume of 8 m^3.

Impact Lake WK176

Exceedances at Impact Lake WK176 occurred at AECs 1 and 3 and APECs 2 and 4. Soil exceedances included metals (barium, copper, zinc, hot water soluble boron, chromium, cobalt, and nickel), BTEX (benzene, ethylbenzene, and xylene), and PAHs (acenaphthene, fluorene, naphthalene, phenanthrene). PAH exceedances were attributed to localized areas of residual fuel. Metals exceedances were considered to be a result of site activities. Due to the high levels of metals, it was concluded they were unlikely to be attributed to natural enrichment. An estimated 412.7 m^3 of soil was estimated to be impacted. A total debris volume of approximately 52.5 m^3 was inventoried at the Impact Lake WK176 Site consisting of wood, barrels (both empty and containing unidentified liquid), and an empty jerry can.

Kendall River WK165

Exceedances at Kendall River WK165 occurred in AEC 2 and APEC 4 in soil included barium, chromium, nickel, vanadium, and benzene. Aluminum exceeded applicable guidelines in surface water. The benzene exceedance is attributed to historical burning activities and anticipated to be localized. Metal exceedances occurred in a single test pit and are assumed to be due to historical activities related to the debris pile. The total of contaminated soil is estimated to be 24.6 m^3. The paint sample that was tested did contain lead in concentrations above applicable guidelines but was not considered hazardous waste. The samples from the jerry cans indicated the liquid was significantly diluted with water and therefore not considered fuel. Debris found at the Site was an estimated volume of 12.4 m^3 and included jerry cans (two with liquid, two were empty), remains of a barrel, tent pads, household waste, wood, and metal.

Speers Lake WK097

Exceedances at Speers Lake WK097occurred in all AECs/APECs and included metals (chromium, cobalt, copper, nickel), PHCs (F1, F2, F3, F4), PAHs (acenaphthene, benzo[a]anthracene, fluorene, naphthalene, phenanthrene, pyrene, quinoline), and BTEX (ethylbenzene) in soil; aluminum in surface water; and arsenic, chromium, copper, and nickel in sediment. Chromium, cobalt, copper, and nickel exceedances in all media were attributed to natural enrichment. PAH exceedances were attributed to leaks and spills from tanks. PHC exceedances were attributed to historical Site activities and historical spills. The volume of contaminated soil on Site was estimated to be 318.5 m^3. The liquid sample from the jerry can was significantly diluted with water and therefore not considered fuel.

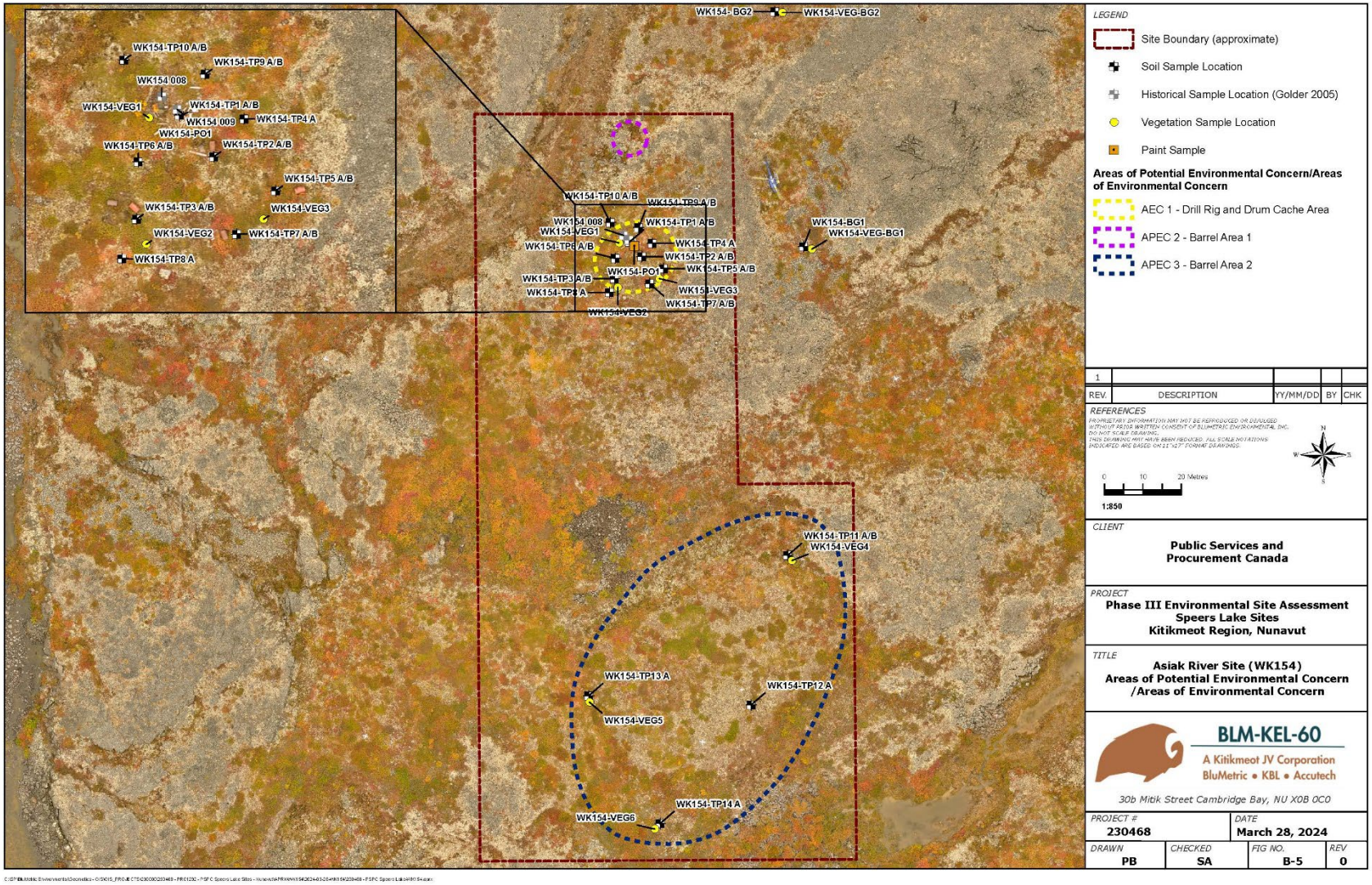
Debris on Site included empty 45-gallon barrels, a coring drill, a saw, coring rods, a stove, a water basin, and wood and metal debris for a total of 173 m^3.

Tahiapik River WK170

Exceedances at Tahiapik River WK170 occurred at AECs 2, 4 and 5. Soil exceedances included zinc, and methylene chloride, and surface water exceedances included aluminum and copper. VOC exceedances were attributed to use and storage of products on Site, and metals were attributed to historical burning of zinc-containing metals. A total debris volume of approximately 32 m^3 was inventoried at the Tahiapik River WK170 Site consisting of metal, wood, food and beverage containers, glass shards, canvas scraps, drill casings, core, and barrels.

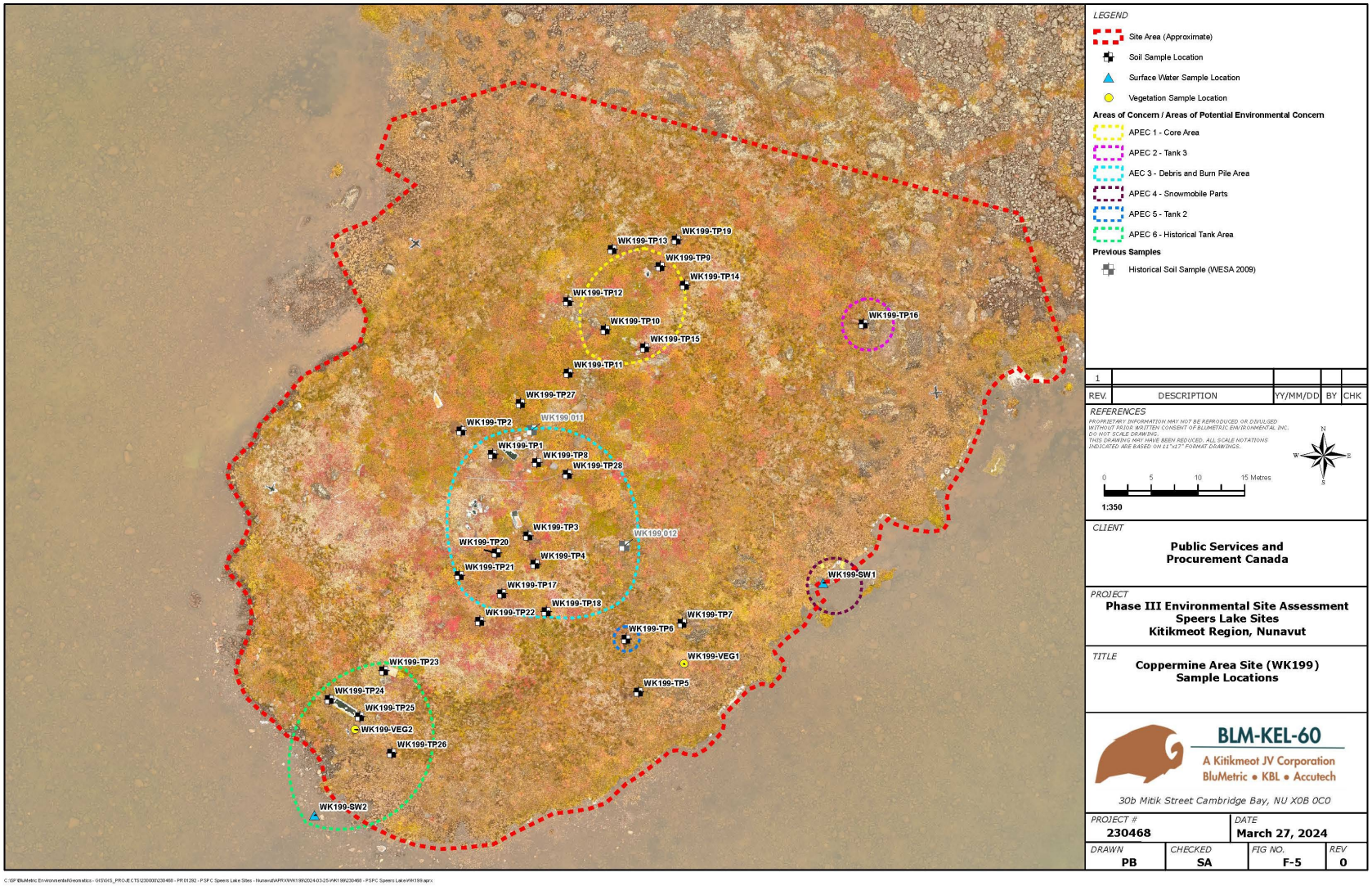
Figure 1.2 to Figure 1.9 show the sampling locations and AEC/APECs at each of the Sites.

Figure 1.2 Asiak River WK154 sampling locations in AEC/APEC 1-3



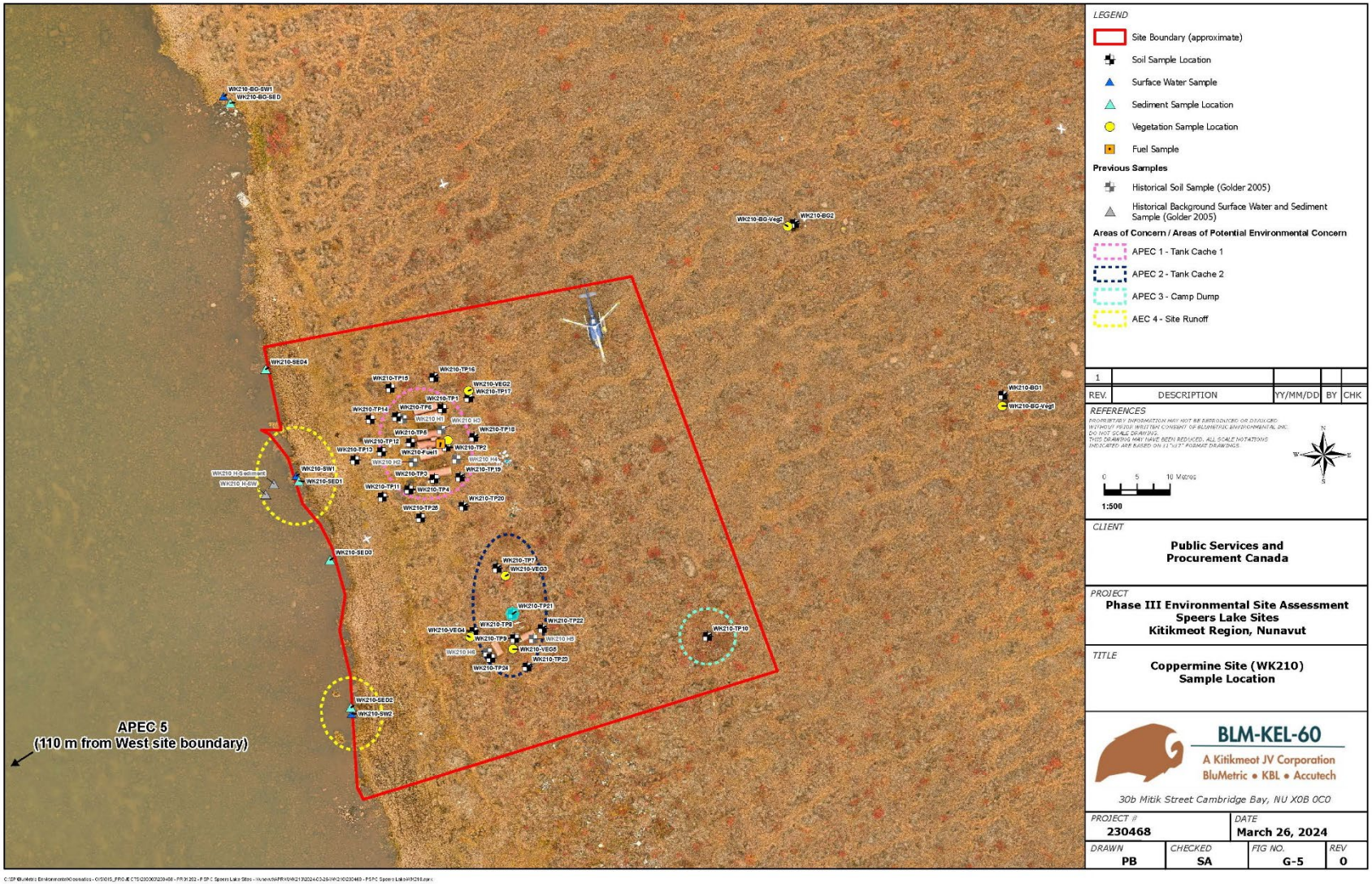
Note: From Phase III ESA (JV-60 2024a).

Figure 1.3 Coppermine WK199 sampling locations in AEC/APEC 1-6



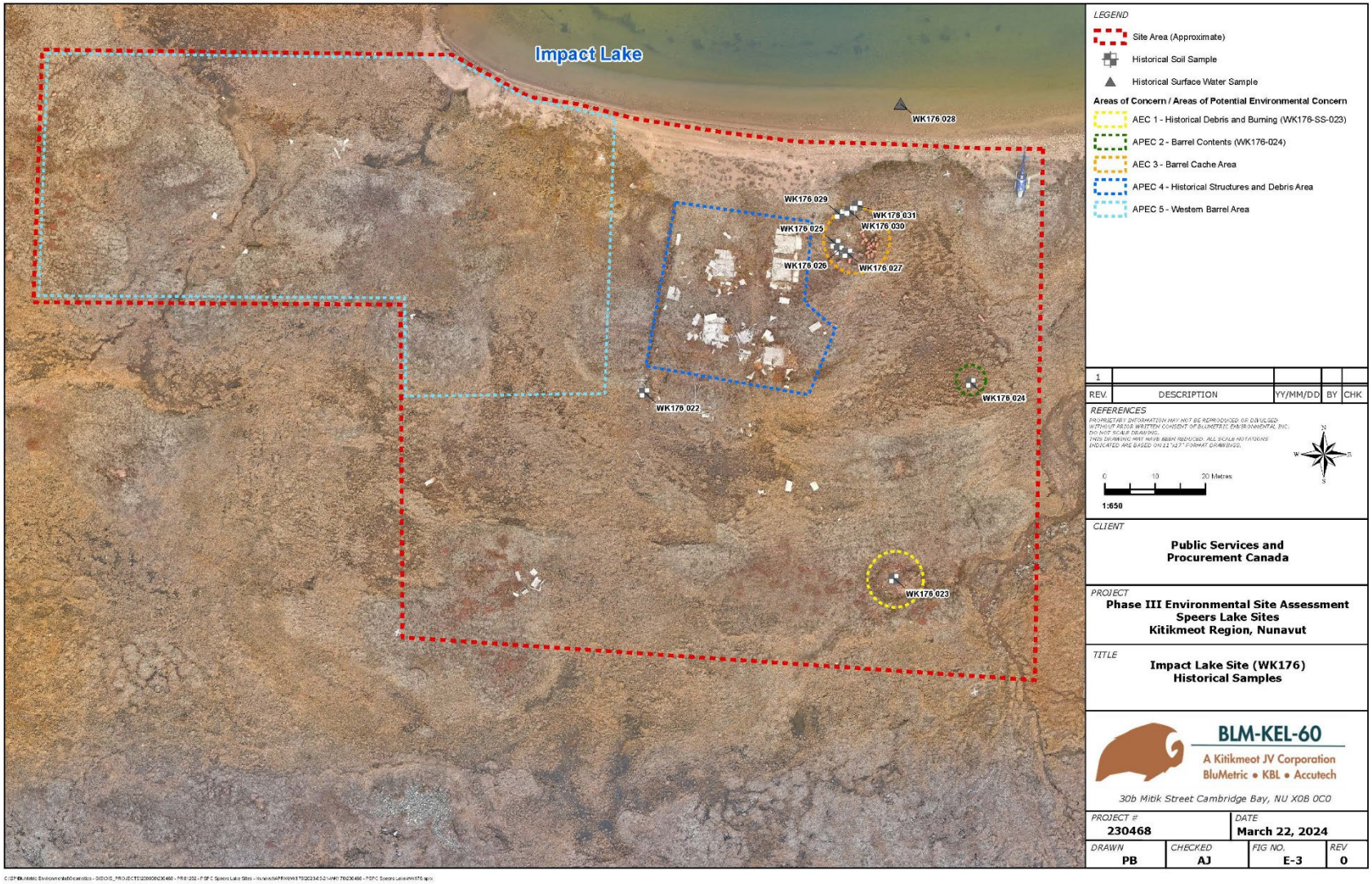
Note: From Phase III ESA (JV-60 2024a).

Figure 1.4 Coppermine WK210 sampling locations in AEC/APEC 1-4



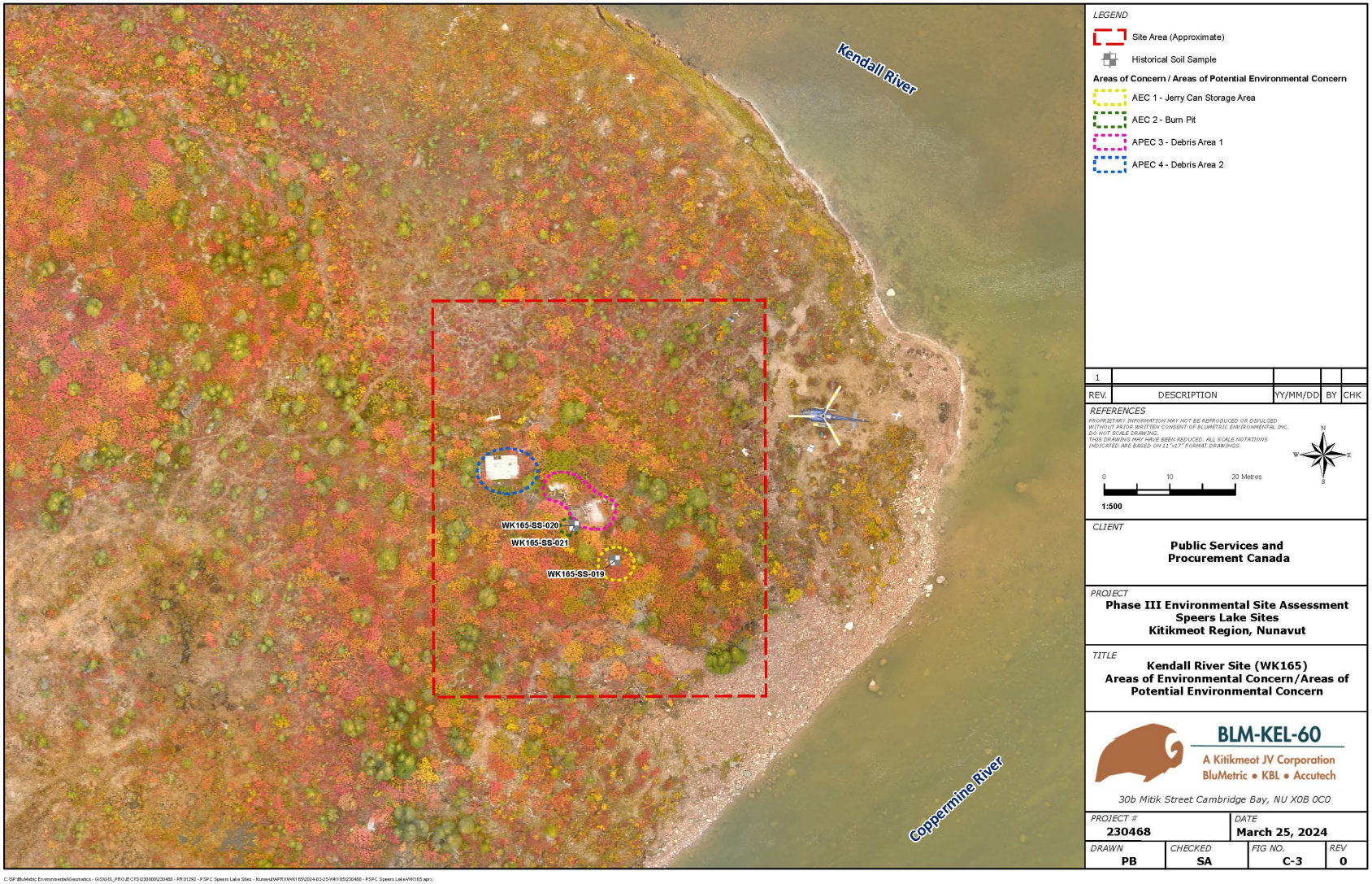
Note: From Phase III ESA (JV-60 2024a).

Figure 1.5 Impact Lake WK176 sampling locations in AEC/APEC 1-5



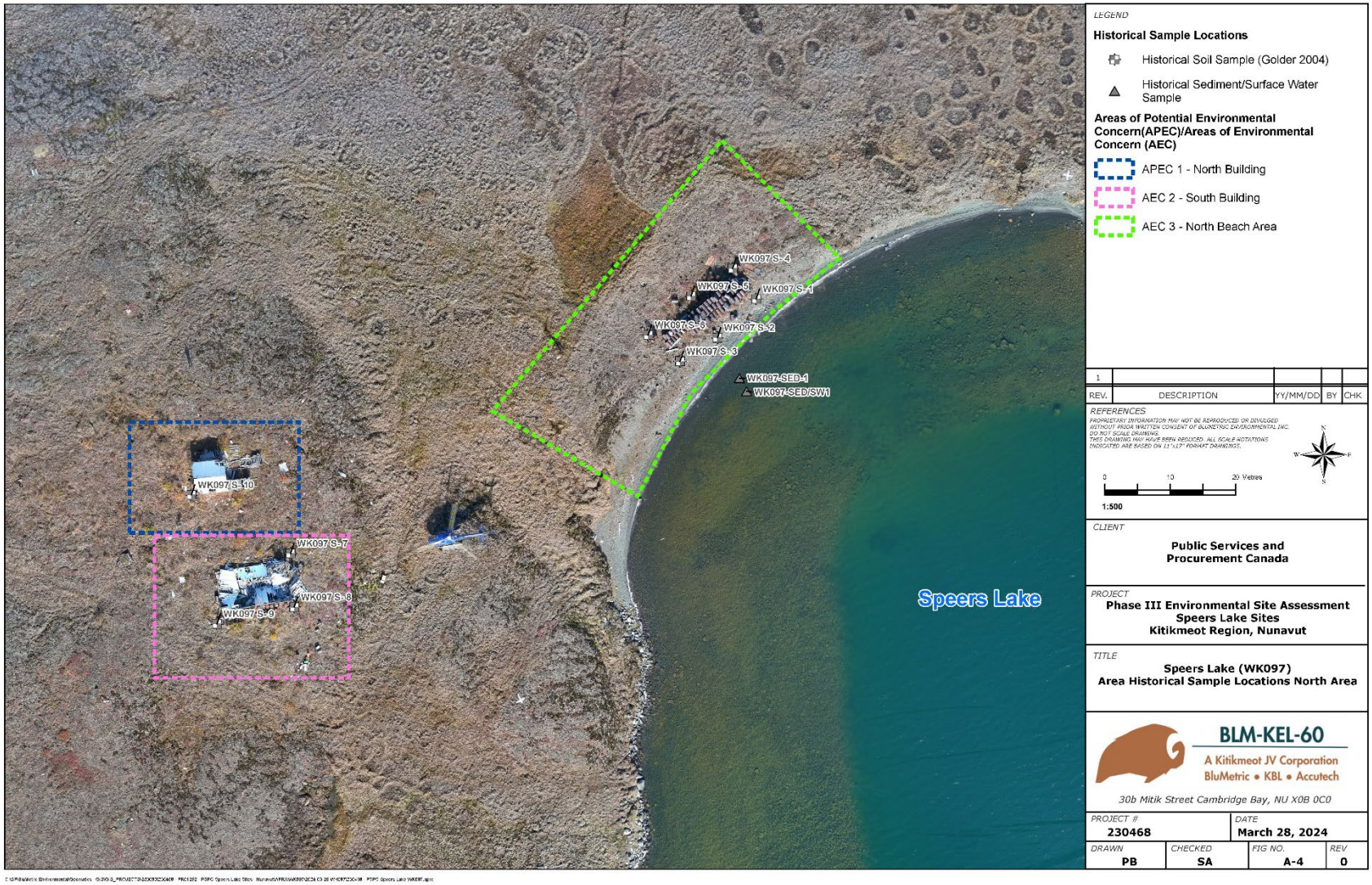
Note: From Phase III ESA (JV-60 2024a).

Figure 1.6 Kendall River WK165 sampling locations in AEC/APEC 1-4



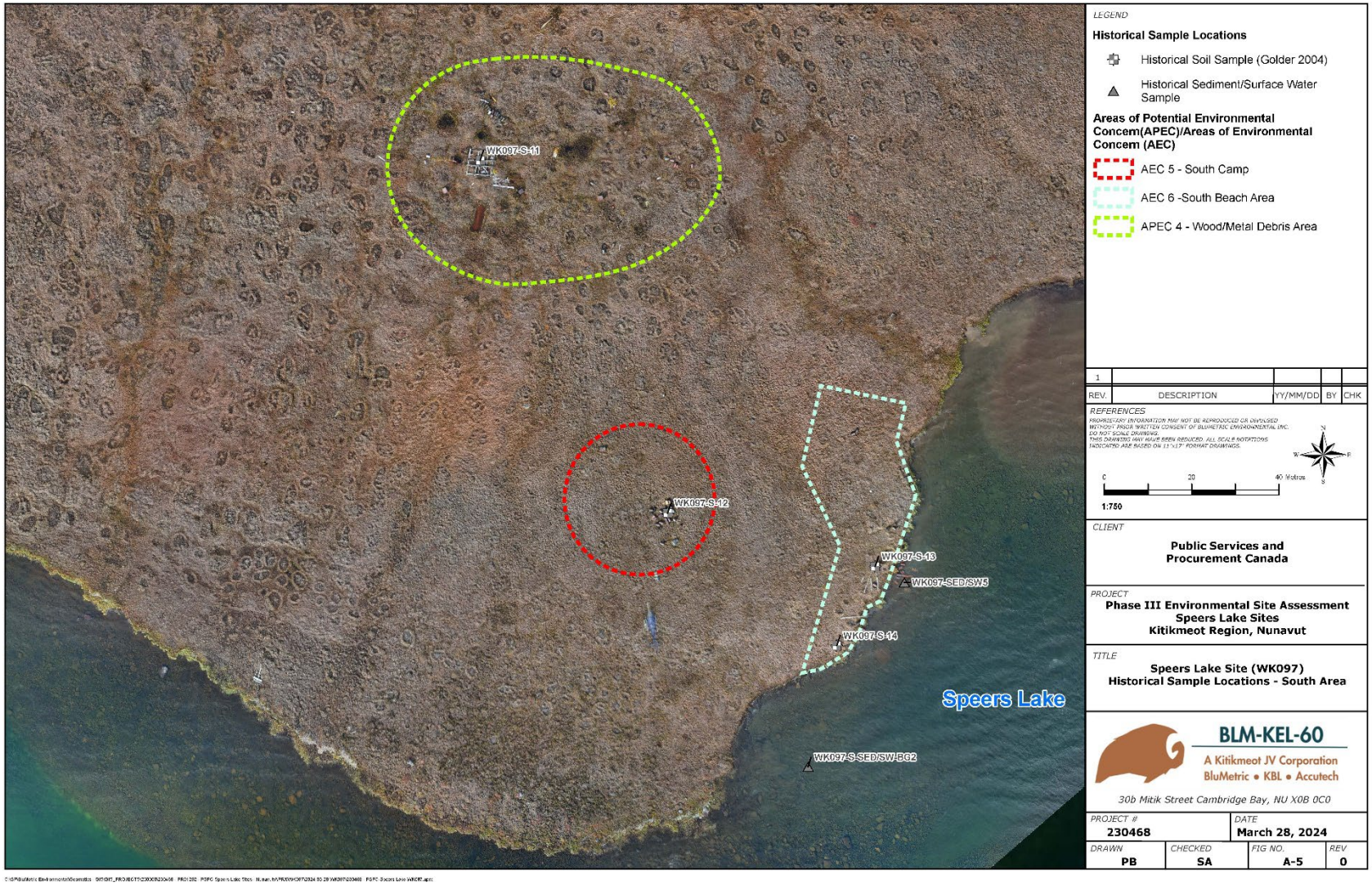
Note: From Phase III ESA (JV-60 2024a).

Figure 1.7 Speers Lake WK097 North sampling locations in AEC/APEC 1-3



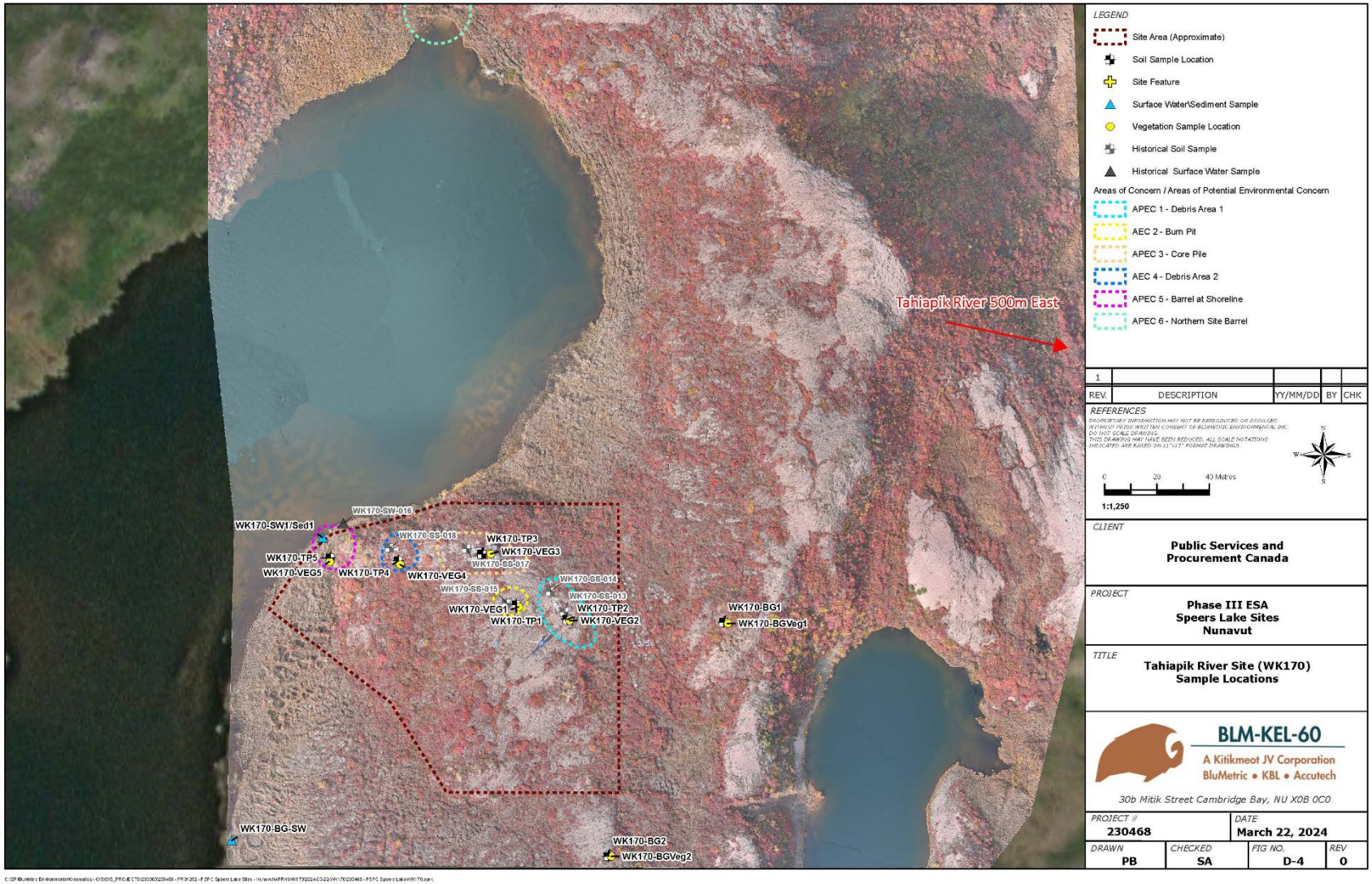
Note: From Phase III ESA (JV-60 2024a).

Figure 1.8 Speers Lake WK097 South sampling locations in AEC/APEC 4-6



Note: From Phase III ESA (JV-60 2024a).

Figure 1.9 Tahiapik River WK170 sampling locations in AEC/APEC 1-6



Note: From Phase III ESA (JV-60 2024a)

1.4 Risk Assessment Objectives

The objectives of the HHERA are as follows:

- to evaluate whether contaminants present on Site at concentrations above guidelines (associated with sources of contamination identified and assessed by the previous studies) pose unacceptable risks to human and/or ecological receptors;
- if warranted, develop Site-specific criteria to support remediation/risk management work that will be suitable to protect both humans and ecological receptors who use the Site (the details of any risk management measures identified by the HHERA will be provided in the Remedial Options Analysis, under separate cover); and
- to prepare an HHERA report summarizing the methodology and results.

The development of a Site-specific risk-based approach will ensure rational decisions are made with respect to the evaluation of remedial options (if necessary) at the Sites.

2.0 PROPERTY INFORMATION

2.1 Site Description

2.1.1 Physical Setting and Surrounding Land Use

The Speers Lake Sites are located on Crown land in the Kitikmeot region of Nunavut (Figure 1.1). The Sites are uninhabited with varying amounts of recreation and subsistence use by locals and visitors.

Asiak River WK154

The Asiak River WK154 Site appeared to be inactive at the time of both the 2008 and the 2023 Site visits. While there was historical mineral claims on the land (which have since lapsed), no mining activity appears to have been conducted (WESA 2009a). During the 2023 Site visit, it was noted people use the nearby river as a travel route, fish during the spring and winter at nearby Aptalok Lake east of the Site, seven km east there is a timber crane on the land, and 3 km south is an abandoned exploration camp (JV-60 2023, 2024a).

Coppermine WK199

While the Coppermine WK199 Site is uninhabited, it is used by locals for harvesting and travel routes during spring, late fall, and winter (JV-60 2023, 2024a). Animal bones and garbage noted at Site indicate local resident may use the Site occasionally for recreational purposes (WESA 2009b). Coppermine WK199's historical occupancy and operations are unknown. Site conditions suggest a mineral exploration camp was present and there was a historic mineral claim on the Site but it has since expired (WESA 2009b).

Coppermine WK210

Coppermine WK210 is not a regular hunting or travel route and showed minimal signs of human use during the 2023 field investigation, however, local harvesters use the cabin at the nearby Hope Lake (property of the Hunters and Trappers Organization). Hope Lake Mining Exploration Camp is 9 km south of Coppermine WK210, and a second mineral exploration camp is situated at the foot of the Coppermine Mountains (JV-60 2024a). Coppermine WK210 has a long-term history (back to pre World War I) of mineral exploration (JV-60 2024a), including a permit for exploration for unknown dates (Golder 2005b).

Impact Lake WK176

Impact Lake WK176 is not on a typical hunting travel route, and is therefore not commonly used for such activities, however some locals utilize the area for subsistence hunting, fishing, camping, or drum caching (JV-60 2024a). While Impact Lake WK176's historical occupancy and operations are largely unknown, there was a lapsed mineral lease owned by Cameco Corporation from 2006-2008 (WESA 2009c).

Kendall River WK165

Kendall River WK165 showed no signs of human activity during neither the 2009 nor the 2023 Site visits. It was previously occupied by a fishing outpost camp in the 1980s (WESA 2009d). It is an important area for travelling, hunting (caribou, moose, wolves, muskox, and wolverine), and fishing during late fall and spring (JV-60 2023), and has a long-term (pre-World War I) history of mineral exploration (JV-60 2024a).

Speers Lake WK097

There were no signs of human use at the Site during the 2023 visit, however Speers Lake WK097 is a travel route and part of a traditional fishing and gathering area, known for hunting wolf and arctic hare, along with caribou, moose, wolves, muskox, and wolverine) in the spring, late fall, and winter, and Dismal lake is considered a historical caribou hunting ground (JV-60 2023, 2024a). Speers Lake WK097consists of two distinct areas – the "North Site" and "South Site", approximately 550 m apart from each other. There was a former exploration camp on the western shore of Speers Lake (Golder 2005a) for which the length of operation and year of abandonment is unknown (JV-60 2024a).

Tahiapik River WK170

The Tahiapik River WK170 Site showed minimal signs of human use during the 2023 Site visit aside from a placed caribou skull. The Site is an important harvesting area as a traditional caribou hunting ground (JV-60 2024a). There are seven documented gathering sites in the area, including one in close proximity (approximately 6 km east) to the site (JV-60 2024a). The Tahiapik River WK170 is considered a travelling, hunting (caribou, moose, wolves, muskox, wolverine), and fishing area used during late fall and spring (JV-60 2023). The area is known for historical (pre World War I) mineral exploration (JV-60 2024a).

2.1.2 Site Access

The Sites were accessed by helicopter during the field investigations in 2023. Access to the Site is by helicopter during the summer months and snowmobile during the winter months (JV-60 2024a).

2.1.3 Climate

The Sites are located in the Arctic region and experience extreme daily temperatures varying from -27.8 degrees Celsius (°C) in January and 10.7°C in July, with wind chill resulting in temperatures below -40°C in winter. The daily average temperature in the Kugluktuk area is only above 0°C from June to September. Rainfall occurs between April and October, averaging 0.6 millimetres (mm) in April and 40.8 mm rainfall in August. With an average of 34.1 centimetres (cm), October typically sees the most snowfall (Golder 2005b; JV-60 2024a; WESA 2009a, 2009b, 2009d).

The closest meteorological data collection point to Speers Lake is Lupin Mine. Yearly temperatures at this location range from -30.4°C in January to 11.5°C in July. Including rainfall and snowfall, annual average precipitation is 299.2 mm (Golder 2005a).

2.1.4 Nearest Community

The nearest community to the Speers Lake Sites is the hamlet of Kugluktuk, Nu. Asiak River WK154 is 35 km southeast of the community, Tahiapik is 100 km southwest, Impact Lake WK176 is 90 km west, Coppermine WK199 is 45 km south, and Kendall River WK165 is 90 km southwest of the community. Coppermine WK210 is 75 km southwest of Kugluktuk, 135 km northeast of Port Radium, and 500 km north of Yellowknife, Northwest Territories (NT), while Speers Lake WK097is 35 km southeast of Kugluktuk, 150 km northeast of port radium, and 485 km north of Yellowknife, NT (JV-60 2024a).

2.2 Site Plan and Hydrogeological Interpretation

2.2.1 Geology and Soil Texture

The Sites are located in an area of continuous permafrost where summer active layer depth is dependant upon vegetative cover, type of subsurface material, and moisture conditions. Typically, the active layer ranges from 15 cm deep to over 120 cm deep, in areas of thick organic mat to areas where vegetative cover is thin, respectively (JV-60 2024a; WESA 2009a, 2009b, 2009d).

The local geology of the Kitikmeot region is part of the Muskox Intrusion (WESA 2009a), an ultramafic layered pluton associated with sulphide phases and chromite-rich horizons Some of the marginal sulfides may contain 3 to 10% Ni+Cu. Serpentinization of the Muskox olivine-bearing rocks resulted in the formation of minerals such as wairauite (CoFe) and awaruite (NiFe), among others. strong traces of vanadium have been reported in analyses of chromite associated with the layered Muskox igneous complex of the Coppermine River area. A chromite-sulphide layer of 8–15 inches thick occurs in pyroxenite near the upper part of the central layered series.

Given the proximity to the Coppermine River area and that Speers Lake is recognized to be within the layered series that shows locations of chromite-sulphide layers, it is likely that the area is naturally enriched with vanadium.

Therefore, it is logical that the soils in the area may be enriched with Cr, Co, Ni, Cu, and V. The mining/exploration camp activity can have contributed to the enrichment of the soils in the study area.

Asiak River WK154

The active layer at Asiak River WK154 is likely shallow due to thick vegetative cover and coarse overburden. Surficial deposits are of glacial or post-glacial origin. Glaciofluvial sediments consisting of rounded gravel, pebbles, and sand, are approximately 5 to 50 m thick (WESA 2009a). Surficial material is underlain by a lower volcanic formation with a sedimentary upper layer (JV-60 2024a). Groundwater seepage and permafrost were not encountered during the 2023 Site visit (JV-60 2024a).

Coppermine WK199

At Coppermine WK199, the active layer is likely shallow due to extensive vegetation and well drained soils consisting of a thin layer of organics over gravelly sand and cobbles. Surficial materials are underlain by the Coppermine River Group of rocks (lower volcanic formation with thickness approximately 3000 m, and an upper mostly sedimentary formation with a minimum thickness of approximately 1200m (JV-60 2024a; WESA 2009b)).

Coppermine WK210 and Speers Lake WK097

Coppermine WK210 and Speers Lake WK097are comprised of a dominant soil of cryosols underlain by continuous permafrost with shallow active layers that are usually moist or wet throughout summer. Permafrost was not encountered at either Site during neither the 2005

nor the 2023 Site visit. The area is mostly surrounded by discontinuous morainal deposits, except near the coasts where fine-textured marine sediments cover the surface. There are exposures of bedrock and cretaceous shales covered by thick glacial drift deposits (Golder 2005a, 2005b). Coppermine WK210 consists of organics rich soil underlain by sand, clay, and boulders (JV-60 2024a). There is an exposed bedrock ridge on the west side of the Speers Site, with colluvium downslope from the ridge, partially covering the till (JV-60 2024a).

Impact Lake WK176, Tahiapik River WK170, and Kendall River WK165

Soil and geological conditions at Impact Lake WK176 and Tahiapik River WK170 were noted during the 2023 ESA visit (JV-60 2024a) and at Kendall River WK165 during the 2008 Site visit (WESA 2009d). Surficial deposits at the Sites are glacial deltaic sediments, consisting of sand, gravel, and cobbles (5-20 m thick), and underlain by Paleozoic sandstone (JV-60 2024a; WESA 2009d). Located within two fault bounded areas, it unconformably overlies sedimentary units including siltstones, shales, mudstones, sandstones, and calcareous bed of limestone and dolomites (JV-60 2024a).

The active layer at Tahiapik River WK170 is likely shallow due to the coarse-grained soil and abundant vegetation (JV-60 2024a). The active layer at Kendall River WK165 is evidently deep enough to support the root system of spruce trees. This active layer is expected to be deep and get shallower further from the river, such is the case in the upper part of the Site. Permafrost slumping in some areas of the Site indicates permafrost characteristics may be changing in the area (WESA 2009d). Permafrost was not encountered at Kendall River WK165 during the 2023 field investigation. (JV-60 2024a).

2.2.2 Topography

The Sites lie at various elevations within the region, and amongst varying geographical features.

Asiak River WK154

The Asiak River WK154 Site lies 280 metres above sea level (masl) in an undulating valley where the terrain slopes up to the north. The Site sits on a ridge parallel to the Coronation Gulf, with the Asiak River WK154 to the west (WESA 2009a).

Coppermine WK199

Coppermine WK199 is located on a generally flat area with localized depressions at approximately 380 masl. The Site lies on the northwest shore on an unnamed lake, east of Coppermine River, and south of a boulder field. Some steep slopes occur toward the shoreline of the unnamed lake, with increasing topography south of the lake and to the north of the Site (WESA 2009b).

Coppermine WK210

Coppermine WK210 is a generally flat area, lying at approximately 329 masl, sloping gently southwest toward an unnamed lake. The region contains rolling uplands and lowlands, discontinuous morainal deposits, sinuous eskers, and several small lakes (Golder 2005b; JV-60 2024a).

Impact Lake WK176

Impact Lake WK176 lies at an elevation of approximately 415 masl on relatively flat land sloping gently toward the shore of Impact Lake WK176 to the north (JV-60 2024a).

Kendall River WK165

Kendall River WK165 is located at an elevation of approximately 240 masl. Part of the Site is on a ridge at the convergence of Coppermine River and Kendall River WK165, with the land sloping steeply in some areas towards these waterbodies (WESA 2009d).

Speers Lake WK097

The Speers Lake WK097 Site consists of undulating landscape on a low plateau and slopes toward Speers Lake to the east with a bedrock ridge along its western limit (Golder 2005a; TREK 2023).

Tahiapik River WK170

Tahiapik River WK170 sits at an elevation of 310 masl and slopes steeply northwest toward the shore of Fran Lake, with bedrock outcrops and rolling hills present on all sides of the Site (JV-60 2024a).

2.2.3 Hydrogeology and Surface Water Hydrology

Asiak River WK154

The Asiak River WK154 Site is located at a topographic low surrounded by rolling hills, and approximately 4 km east of the Asiak River WK154 and 10 km south of the Coronation Gulf. Contours of the permafrost are expected to mimic local topography, resulting in groundwater flow of south to southwest where the land slopes toward several ponds. Surficial runoff resulting from precipitation events is expected to flow in the same direction. Groundwater is not a source of drinking water at the Site (WESA 2009a).

Coppermine WK199

At the Coppermine WK199 Site, the movement of groundwater and infiltration surface water would be expected to follow permafrost contours. Shallow groundwater from debris areas would drain east toward the steep slopes, and west toward the unnamed lake. Runoff from precipitation and melt events would flow toward the unnamed lake and some would collect in localized depressions between areas of bedrock outcrop. Groundwater is not a source of drinking water at the Site (WESA 2009b) and groundwater seepage was not observed during the 2023 field visit (JV-60 2024a).

Coppermine WK210

Coppermine WK210 is part of the Arctic Ocean seaboard drainage basin and surrounded by small lakes and rivers that feed the Coppermine River, which flows into the Coronation Gulf. Some streams in the area follow eskers and other glacial landforms (Golder 2005b). Groundwater is expected to follow contours of permafrost and flow south toward the lake. During precipitation or melt events, when the Site is frozen, surficial runoff is also expected to flow southwest toward the unnamed lake. Groundwater seepage was observed in test pits on Site but not in background test pits during the 2023 field investigation (JV-60 2024a).

Impact Lake WK176

The Impact Lake WK176 Site lies amongst many small ponds and streams and is located less than 30 m away from Impact Lake WK176, which lies topographically low. The contours of permafrost are expected to mimic local topography trending north toward the lake, causing groundwater to flow in the same direction, as well as surficial runoff during precipitation or melt events. During the 2023 field investigation, groundwater was

not observed in background test pits, but was observed in the active layer of 5 of the 13 test pits at the Site between 0.0 and 0.4 metres below ground surface (mbgs) (JV-60 2024a).

Kendall River WK165

The Kendall River WK165 Site is located adjacent to Kendall River and Coppermine River. Heat retained due to the large size of the Coppermine River discourages permafrost formation. Groundwater and infiltrating surface water are expected to follow local contours of permafrost, where present. Shallow groundwater from the upper ridge is expected to drain north and west toward Kendall or Coppermine Rivers. Drainage in the central area of the upper ridge flows southwest toward an area of ponded water. Surficial runoff during precipitation and melt events is expected to follow local topography and flow north to Kendall River, east to Coppermine River, or southwest to a low-lying area of the Site. Groundwater is not a source of drinking water at the Site but surface water may be for wildlife and human visitors (WESA 2009d).

Speers Lake WK097

Speers Lake is part of the Arctic Ocean seaboard drainage basin and surrounded by small lakes and rivers that feed the Coppermine River, which flows into the Coronation Gulf. Some streams in the area follow eskers and other glacial landforms (Golder 2005a). Speers Lake WK097 lies between a bedrock ridge and shoreline, with drainage occurring through numerous channels in a radial pattern toward Speers Lake. Two smaller lakes drain into Speers Lake through these channels (TREK 2023). Speers Lake feeds Coppermine River and flows north into the Coronation Gulf. Several small ponds are located in the area with the closest being 80 m south. Shallow groundwater is expected to flow in the direction of local topography toward Speers Lake. Groundwater seepage was encountered in several test pits up to 0.4 mbgs, but was not encountered in background test pits (JV-60 2024a).

Tahiapik River WK170

The Tahiapik River WK170 Site is surrounded by small ponds and streams and lies between the topographically low Fran Lake to the west, and an unnamed waterbody to the east. The permafrost below the active layer creates a barrier below the groundwater table. The groundwater and surface water, as well as surficial runoff from precipitation and melt events, are expected to follow the local contours of the permafrost, which slopes northwest toward Fran Lake. Groundwater seepage was observed in one of five test pits at 0.4 mbgs but was not observed in background test pits (JV-60 2024a).

2.2.4 Flora and Fauna

Mammals observed during the 2008 Site visits included grizzly bear, grey wolf, muskoxen, caribou, ground squirrel, arctic hare, and ermine (WESA 2009a, 2009b, 2009c, 2009d, 2009e). In addition, and according to *Terrestrial Mammals of Nunavut*, barren ground caribou, moose, arctic fox, red fox, barren ground grizzly bear, wolverines, least weasels, mink, brown lemmings, and northern red-backed voles can also be found in the area (WESA 2009a, 2009b, 2009c, 2009d, 2009e). Additional species noted as typical of the region include raptor, ptarmigan, Lapland longspur, horned lark, herring gull, and common loon (Golder 2005a, 2005b).

During the 2023 Site reconnaissance, Canadian geese and caribou were observed on or near all Sites. Swans were observed at Asiak River WK154, Coppermine WK199, Coppermine WK210, and Tahiapik River WK170. A bear was observed near each Asiak River WK154, Coppermine WK199, and Kendall River WK165. At Kendall River WK165, wolves were also noted along with muskoxen scat. Arctic hare, lemmings, and ptarmigan were noted at the Speers Lake WK097 Site, along with skulls of wolves and fox (JV-60 2024a).

The Kugluktuk area is well vegetated with small shrubs (willow, larch, blueberries, and cranberries), mushrooms, mosses, lichens, and grasses. Small tress can be found in areas with a thicker active layer (near the banks of Coppermine River and some of its tributaries). Asiak River WK154, Coppermine WK199, and Kendall River WK165 are located in a well vegetated areas (WESA 2009a, 2009b, 2009d).

Coppermine WK210 and Speers Lake WK097 are located in an area within northern treeless tundra with carex, salix, dryas, blueberry, bearberry, heather, moss, reindeer lichen, moss campion, potentilla, lupin, dwarf birch, grass and sedge, willow, and mountain avens (Golder 2005a, 2005b).

2.2.5 Species at Risk

There are 26 non-marine animal and plant species at risk (SAR) known to be present in Nunavut (Government of Canada 2023). Ten of these species are potentially within the study area, comprised of five birds and five mammals, as summarized in Table 2.1.

Table 2.1 Species at Risk that may occur at the Sites

Common Name	Scientific Name	Population	COSEWIC status	SARA status
Eskimo Curlew	*Numenius borealis*	—	Endangered	Endangered
Short-eared Owl	*Asio flammeus*	—	Threatened	Special Concern
Red-necked Phalarope	*Phalaropus lobatus*	—	Special Concern	Special Concern
Harris' Sparrow	*Zonotrichia querula*	—	Special Concern	Special Concern
Lesser Yellowlegs	*Tringa flavipes*	—	Threatened	No Status
Caribou	*Rangifer tarandus*	Barren-ground Population	Threatened	No Status
		Dolphin and Union Population	Endangered	Special Concern
Peary Caribou	*Rangifer tarandus pearyi*	—	Threatened	Threatened
Grizzly Bear	*Ursus arctos*	Western Population	Special Concern	Special Concern
Polar Bear	*Ursus maritimus*	—	Special Concern	Special Concern
Wolverine	*Gulo gulo*	—	Special Concern	Special Concern

Note: Grizzly bear is identified in the WESA (WESA 2009a, 2009b, 2009c, 2009d, 2009e) report as 'grizzly bear' and 'barren ground grizzly bear,' but listed as the Western population in COSEWIC/SARA.

2.3 Selection of Environmental Guidelines

The Site is located on Crown Land and falls under federal jurisdiction. Therefore, the Canadian Environmental Quality Guidelines (CEQGs) from the Canadian Council of Ministers of the Environment (CCME) are applicable when identifying COCs at the Site.

2.3.1 Soil

Guideline levels for concentrations of contaminants in soil are based on specific land uses: agricultural, residential, commercial, and industrial. The CCME agricultural land use guidelines provide the most stringent criteria of the four land uses. Agricultural land use is defined as land where the primary land use is growing crops or tending livestock; however, this also includes agricultural lands that provide habitat for resident and transitory wildlife and native flora. Agricultural soil guidelines have been selected for use in the assessment of the Site as they have been deemed to allow for unlimited use at the Site. The assumption is that someone could have a farm at the Site with crops and livestock year-round.

The primary guidelines for the initial screening of soil quality data for on-site COCs are the *Canadian Environmental Quality Guidelines,* which are available online through a searchable database (CCME 2023), and the *Canada-Wide Standards for Petroleum Hydrocarbons* (CCME 2008). These soil quality guidelines (SQGs) apply regardless of sampled depth.

2.3.2 Surface Water

Different surface water guidelines exist that are protective of both human health and the environment.

For the protection of human health, the *Health Canada Drinking Water Guidelines* (Health Canada 2022) are used for screening the surface water quality data.

For the protection of the environment, the *Canadian Environmental Quality Guidelines,* which are available through a searchable database (CCME 2023), specifically, the water quality guidelines (WQGs) for the long-term protection of freshwater organisms are used for screening the surface water quality data.

2.3.3 Sediment

No sediment quality guidelines exist that are protective of human health. The main concern related to sediment quality is exposure to COCs of benthic organisms, which serve as food sources for a number of species. Thus, the sediment quality guidelines are developed to be protective of benthic communities. The CEQGs*,* which are available online through a searchable database (CCME 2023), are used in selecting COCs for the protection of aquatic life. Specifically, the interim sediment quality guidelines (ISQGs) are used in this screening, when available. The probable effect levels (PELs) from the CCME were also considered when appropriate.

In the absence of ISQGs, guidelines and benchmarks from other provinces, such as British Columbia and Ontario, are used as available.

2.3.4 Vegetation

There are no guidelines available for contaminant concentrations in plants.

3.0 PROBLEM FORMULATION FOR HHERA

3.1 Scope and Regulatory Context

The purpose of the HHERA is to develop a Site-specific risk-based approach to ensure that rational decisions are made with respect to evaluating remedial options at the seven Sites.

The goals for the HHRA are as follows:

1. To assess the potential risks to human receptors posed by the presence of contamination at the Sites.
2. To support recommendations for remediation or risk management to mitigate or reduce risks to acceptable levels (if unacceptable risks were identified).
3. If warranted, establish Site-specific criteria that will adequately protect human receptors at the Sites.

The HHRA is carried out for evaluation of risks for a current land use scenario which evaluates risks associated with the current land use and the current configuration of the Sites. This approach to the HHRA followed guidance outlined by Health Canada (2021).

The goals for the ERA are as follows:

1. To assess the potential risks to ecological receptors posed by the presence of contamination at the Sites.
2. To support recommendations for remediation or risk management to mitigate or reduce risks to acceptable levels (if unacceptable risks are identified).
3. If warranted, establish Site-specific criteria that will adequately protect ecological receptors at the Sites.

The ERA has been prepared in accordance with ERA guidance from the Federal Contaminated Sites Action Plan (FCSAP 2012) and the CCME (2020). The category of ERA is not defined in the FCSAP guidance according to scope or level of detail. Included in the guidance are weight-of-evidence (WOE) and line of evidence (LOE) approaches to determine the potential ecological risks.

3.2 Problem Formulation for HHRA

In the Problem Formulation, COCs specific to human receptors are screened, and the receptors and exposure pathways considered further in the HHRA are identified.

3.2.1 Identification of Contaminants of Concern for Human Health

A tiered process was carried out to identify COCs in soil and surface water to be considered further in the HHRAs for each of the Sites. Soil and surface water data from the data sets described in Sections 4.0 through 10.0 were used in the screening process. Contaminants with the majority of values (i.e., 90% or more) below the method detection limit (MDL) were not considered further as they were considered highly censored (i.e., not considered to be present at the Site).

A concentration above a guideline does not mean that there is an actual risk to human health. Therefore, comparisons to background concentrations were also completed. Only contaminants present in soils, surface water, or sediment above guidelines or background were selected to be evaluated in the HHRAs for each of the Sites as described in the separate Chapters.

The selection process for identifying COCs for human health at the Sites involved the following steps:

1. If approximately 90% or more of measured concentrations of soil or surface water from the Site were reported as below the MDL, then the data were considered to be heavily censored (meaning that the constituents are not present) and were not considered further.

2. Maximum soil and surface water concentrations from the Site were compared to background concentrations. If the maximum concentration was below the average from background locations, then the constituent was not considered further.

3. Maximum soil and surface water concentrations at the Site were compared to the applicable guidelines. These guidelines are discussed in Section 3.2.1.1 and Section 3.2.1.2. Constituents with concentrations lower than the SQG for human health (SQGHH) were dropped from further assessment, while those with maximum concentrations exceeding the guideline values were carried forward to the HHRA.

3.2.1.1 Soil

Soil data from each of the Sites were screened against the CCME guideline values developed for the protection of human health:

- CCME SQGs for human health (SQG_{HH}) (agricultural land use and coarse soil) – component values for protection of human receptors (CCME 2023):

  - Direct soil contact – soil ingestion, dermal contact and inhalation of soil particulates; the lowest human health guideline based on soil contact, dermal contact or inhalation was used for screening purposes.
- CCME Canada Wide Standards (CWS) for PHCs in Soil (agricultural land use and coarse soil) – Tier 1 human health component values (CCME 2008):
  - Direct soil contact – soil ingestion and dermal contact.

In the absence of a CCME SQG_{HH}, then a guideline from another jurisdiction, specific for the protection of human health, was used as follows in order of preference:

- Alberta Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil (Alberta Environment and Parks 2019):
  - Direct soil contact – soil ingestion and dermal contact.
- Ontario Ministry of the Environment, Conservation and Parks (MECP; formerly Ontario Ministry of the Environment [MOE]) Table 3 Site Condition Standards: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition (residential/parkland land use and coarse soil) – human health component values (MOE 2011a):
  - Soil Contact (S1) – representing a high-frequency, high-intensity human health exposure scenario to soil for an agricultural land use where toddlers and pregnant women are present.
- Human health guidelines from British Columbia Regulation 375/96 (Schedule 3, Part 2) (Government of British Columbia 2023).
- United States Environmental Protection Agency (U.S. EPA 2023):
  - Regional screening levels (RSLs) for residential soil and tap water, adjusted to cancer risk of 10^{-5} or hazard quotient of 0.2.

3.2.1.2 Surface Water

The human health component values for surface water related exposure pathways applicable to the Sites are as follows:

- Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada 2022).
- U.S. EPA (2023) human health guidelines for water:
  - RSLs for residential soil and tap water, adjusted to cancer risk of 10^{-5} or hazard quotient of 0.2;

- Maximum contaminant levels (MCLs) for drinking water for human health;
- Human health guidelines from British Columbia Regulation 375/96 (Schedule 3.2) (Government of British Columbia 2023).

3.2.1.3 Sediment

There are no Federal or Provincial sediment quality guidelines for the protection of human health. Human contact with sediments is considered to be minimal at the Sites.

3.2.2 Receptor Identification and Assumptions

The Sites can only be accessed by airplane during the summer months or by snowmobile in winter months. The area around the Speers Lakes Sites is uninhabited.

The guidelines used in the screening process for soil in Section 3.2.1.1 assumed that the Sites would be used for agricultural purposes. This means that someone would live at the Sites year-round and have a farm, grow crops and raise livestock. In addition, they would use the waterbodies on Sites as a drinking water source. This is a very conservative assumption as the Sites are rarely used.

3.3 Problem Formulation for the ERA

In the Problem Formulation for the ERA, COCs specific to ecological receptors are screened, and the receptors and exposure pathways considered further are identified.

3.3.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil, surface water, and sediment at the Sites. The general approach followed for selecting the COCs for consideration in the ERA involved using measured contaminant concentrations in soil, surface water, and sediment. In the first tier of screening, contaminants with the majority of values (i.e., 90% or more) below the MDL were not considered further as they were considered highly censored meaning that the contaminant is not considered to be present at the Sites. Of the remaining contaminants, maximum measured concentrations were then compared to soil, surface water, and sediment quality guidelines.

A concentration above a guideline does not mean that there is an actual risk to the environment. Therefore, comparisons to background concentrations were also completed.

Only contaminants present in soils, surface water, or sediment above guidelines or background were selected to be evaluated in the ERAs for each of the Sites.

The selection process for identifying COCs for the ERA at the Sites involved the following steps:

1. If approximately 90% or more of measured concentrations of soil, surface water, or sediments from the Site were reported as below the MDL, then the data were considered to be heavily censored (meaning that the constituents are not present) and were not considered further.

2. Maximum soil, surface water and sediment concentrations from the Site were compared to background concentrations. If the maximum concentration was below the average from background locations, then the constituent was not considered further.

3. Maximum soil, surface water and sediment concentrations at the Site were compared to the applicable guidelines. These guidelines are discussed in Section 2.3.1, Section 2.3.2 and Section 2.3.3. Constituents with concentrations lower than the applicable guidelines were dropped from further assessment, while those with maximum concentrations exceeding the guideline values were carried forward to the ERA.

3.3.2 Receptors of Concern

Ecological receptors are ecological entities exposed to a COC. This term may refer to plants and animals (including endangered and threatened species), habitats, or ecosystems. Thus, an ERA evaluates one or more of the following groups of ecological receptors, depending on the types of animals that are likely to be present at the Sites:

- Aquatic community receptors: Fish, benthic invertebrates, plankton, aquatic plants;
- Semi-aquatic receptors: Amphibians, birds (piscivorous, herbivorous, insectivorous, omnivorous), mammals (piscivorous, herbivorous, insectivorous, omnivorous), plants;
- Terrestrial receptors: Insects (e.g., pollinators such as honeybees), small mammals, large mammals, birds, soil organisms (plants, soil invertebrates, soil microbes).

It is neither practical, nor necessary, to individually assess each wildlife species that may potentially occupy, visit, or live near areas impacted by the Sites. Instead, a subset of

terrestrial and aquatic wildlife receptors of concern that may experience a range of possible exposures were selected by focusing on receptors that are:

- Indigenous to the area and would potentially be exposed to COCs associated with the Sites;
- most likely to receive the greatest exposure to COCs due to their habitat, behavioural traits, and home range;
- representative of various levels in the trophic web (e.g., carnivore, herbivore, insectivore);
- potentially at risk because they have been classified as being rare or endangered (i.e., species of conservation concern); and
- culturally important.

3.3.2.1 Species at Risk

There are 26 non-marine animal and plant SAR known to be present in Nunavut. There are ten SAR potentially present within the study area, comprised of five birds, and five mammals.

Eskimo Curlew (*Numenius borealis)* are listed as an *Endangered* species by both Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and under the Species at Risk Act (SARA). This species nests in grassy tundra vegetation, as well as grassy meadows and shoreline habitat. According to COSEWIC, there have been no confirmed nesting sites found in Nunavut, with potential and probable breeding areas limited to the Northwest Territories, Yukon, and Alaksa. Thus, their presence on the Site is unlikely.

Short-eared owl (*Asio flammeus*) is listed as *Threatened* under COSEWIC and *Special Concern* under SARA. The breeding range of the short-eared owl ranges throughout Canada. The short-eared owl breeds in open grasslands, tundra, and wetland habitats. They nest on dry land amid grasses and other vegetation, often on knolls, ridges, or hummocks. The prey on mice, voles, other small mammals, and birds.

Red-necked phalaropes (*Phalaropus lobatus)* are listed as a species of *Special Concern* by COSEWIC and under SARA. Red-necked phalarope have sufficiently specialized habitats that they are likely to nest in the same habitat patch each year, if present in the study area. The study area is within the breeding range of red-necked phalarope. Red-necked phalaropes breed in wetlands or in vegetation near other sources of freshwater. Their home

ranges are dominated by grasses and sedges, emergent aquatic vegetation, and open freshwater. Red-necked phalarope nests on the edge of natural and anthropogenic ponds, where there are abundant insects on the surface of the water to feed on. They feed on invertebrates in ponds and wetlands.

Harris's sparrows (*Zonotrichia querula)* are listed as a species of *Special Concern* by COSEWIC and under SARA. They breed along the treeline of northern Canada and migrate to the United States for the winter. Nesting habitat usually includes more densely vegetated areas in Nunavut. They have a general diet of seeds, berries, terrestrial and flying insects that they eat from the ground.

Lesser yellowlegs (*Tringa flavipes*) are listed as *Threatened* by COSEWIC but have no status under SARA. They breed in the boreal forests of Canada and nest on dry ground near peatlands, marshes, ponds, and other wetlands in the boreal forest and taiga. They also nest in altered habitats including mine clearings. They primarily feed on invertebrates from both water and land.

There are five mammal species at risk that potentially occur in the study area. As the Sites are small, mammal SAR may only move through them and are generally unlikely to remain in the area long enough to acquire significant amounts of contaminants.

Two populations of Caribou (*Rangifer tarandus)* may occur in the area. The barren-ground population are listed as *Threatened* by COSEWIC but are not listed under the SARA. They roam over Nunavut, and likely occasionally pass through the study area. Barren-ground caribou tend to migrate further south during the summer and north to the Arctic coast to calve. They forage on vegetation and may drink water from the wetlands at the Site. The Dolphin and Union population are listed as *Endangered* by COSEWIC and *Special Concern* under SARA.

Peary caribou (*Rangifer tarandus pearyi)* are listed as threatened by COSEWIC and under SARA. The Site is not within the core range of this species, but there have been sightings on the banks – Victoria subpopulation on the southern half of Victoria Island.

Grizzly bears (*Ursus arctos)* are listed as a species of *Special Concern* by COSEWIC and under SARA. Grizzlies tend to migrate further south and west in the late summer to their winter denning areas. During the winter, they hibernate within their dens to survive the winter's harsh weather and lack of food. As opportunistic omnivores, grizzly bears forage

on sedges in the spring, forbs and mammals (e.g., ground squirrels, caribou) in the summer, and berries and salmon in the fall.

Polar bears (*Ursus maritimus)* are listed as a species of *Special Concern* by COSEWIC and under SARA. The study area is on the southern border of the species' range, for bears forced inland due to loss of sea ice in the summer season. Polar bear habitat is typically dependent on prey (e.g., seals) availability and consolidated pack ice. The polar bears that are forced inland during the open-water season have been known to eat berries, waterfowl eggs and young, and caribou.

Wolverines (*Gulo gulo)* are listed as a species of *Special Concern* by COSEWIC and under SARA. Wolverines roam Nunavut in search for prey species (e.g., ground squirrel, snowshoe hare) and carcasses of large mammals. Female wolverines construct den sites in talus boulders, along eskers, under debris, or in snow tunnels in the arctic tundra. Though open tundra and disturbed areas are not frequently visited by wolverines, ungulate carrion presence may lure wolverines out of the dense vegetation.

3.3.2.2 Terrestrial Environment

The Sites are small and large mammals that have large home ranges such as caribou, muskox, and wolverines have very little exposure at the Sites and thus the risks will be negligible. Therefore, the focus of the ERA for the Sites are on mammals and birds with small home ranges that would potentially be most exposed. Table 3.1 provides the ecological receptors selected for the Sites.

The goal of the ERA is to protect populations of ecological receptors.

Table 3.1 Ecological receptors selected for the terrestrial environment

Terrestrial Receptor Group	Terrestrial Receptor Type	Selected Receptor
Vegetation	Vegetation Community	Vegetation Community
Mammal	Herbivorous	Arctic Hare
	Insectivorous	None
	Carnivorous	Arctic fox
	Omnivorous	None
Bird	Herbivorous	Rock Ptarmigan
	Omnivorous	Snow Bunting
	Carnivorous	Snowy Owl

3.3.2.3 Aquatic Environment

The evaluation in the aquatic environment considered the aquatic biota in the water column and the benthic invertebrate community, as seen in Table 3.2.

Table 3.2 Ecological receptors selected for the aquatic environment

Aquatic Receptor Group	Aquatic Receptor Type	Selected Receptor
Aquatic biota	Aquatic community	Aquatic community including aquatic plants, invertebrates in the water column, fish, and amphibians
Benthic invertebrates	Benthos community	Benthic invertebrate infaunal community

3.3.3 Exposure Pathways

The ecological receptors selected for the Sites cover a range of diets and trophic levels. Table 3.3 summarizes the pathways of exposure that are considered for each of the ecological receptors. As seen from the table, the ERA is essentially a comparison of toxicity benchmarks in the soil, water, and sediment to measured concentrations. No food web calculations are completed as the toxicity benchmarks used include these calculations.

Table 3.3 Exposure pathways for the selected terrestrial ecological receptors

Group	Receptor	Direct Contact (soil)	Direct Contact (water)	Direct Contact (Sediment)	Water Ingestion	Sediment Ingestion	Soil Ingestion	Ingestion of Food	Food items
Vegetation	Vegetation community	□							-
Aquatic biota	Aquatic community		□						-
Benthic invertebrates	Benthos community			□					-
Mammals	Arctic Hare				□		□	□	Vegetation
	Arctic Fox				□		□	□	Vegetation Small mammals / birds Invertebrates
Birds	Snowy Owl				□		□	□	Small mammals / birds
	Rock ptarmigan				□		□	□	Vegetation
	Snow bunting				□		□	□	Soil invertebrates and seeds

Note:
□ Pathway of exposure explicitly included in the assessment.

3.4 Risk Assessment Framework

The HHERA for the seven Sites follows the standard risk assessment framework that is composed of the following steps:

i) Problem formulation;

ii) Exposure assessment;

iii) Hazard assessment; and,

iv) Risk characterization.

A number of these steps are repeated for the HHRA and ERA portions of the assessments since many of them are qualitative in nature. These steps are presented here and include the exposure assessment and hazard assessment steps.

3.4.1 Human Health Framework

3.4.1.1 Exposure Assessment

Exposure assessment involves estimating the potential intakes of COCs received by the human receptors via the exposure pathways retained for quantitative evaluation in the HHRA. The term "dose" refers to the amount of the COC taken into the body and is usually reported in terms of mass of COC per mass of body weight of the organism per exposure time (such as mg/kg-day).

In subsequent phases of the HHRA, the exposure estimates are combined with toxicity information to evaluate risks to human receptors. A qualitative assessment was carried out for most of the Sites by comparing the maximum concentrations measured on Site to applicable guidelines which consider the exposure pathways associated with agricultural land use at the Site. Using these very conservative guidelines, if the maximum concentrations in soil and surface water are below the guidelines then there are no human health concerns at the Site.

3.4.1.2 Toxicity Assessment

Toxicity assessment involves identifying the types of adverse health effects COCs can cause and to select toxicological reference values (TRVs) for use in risk characterization. Contaminants are typically classified according to their mechanism(s) of toxicological action, either as non-threshold toxicants or threshold toxicants. For threshold toxicants (non-carcinogens), the assumption is made that there is a threshold dose, at which or below which, effects are not expected to occur. For non-threshold toxicants (which includes carcinogens, mutagens, and teratogens), it is assumed that any dose is related to an increased probability of toxic effects occurring. Toxicity data are used by various regulatory agencies to derive the guidelines used in the screening process. As the assessments were mainly qualitative in nature, the toxicity data used in the derivation of the human health guidelines are considered to be appropriate.

3.4.2 Ecological Assessment Framework

3.4.2.1 Exposure Assessment

The evaluation of potential effects of the contaminants found at the Site on ecological receptors was based on the comparison of maximum concentrations at the Site to Agricultural guidelines. These guidelines assume that agricultural crops as well as cows and other farming animals are present at the Site year-round. These Sites are not expected to be agricultural and demonstrates the conservative nature of the guidelines and the assessment.

3.4.2.2 Effects Assessment

The effects assessment provides the concentration (or intake) of a COC that is associated with an adverse effect. These concentrations or intakes called TRVs represent the exposure that is considered to pose negligible risk of adverse effect for a given COC and were used in the derivation of the ecological guidelines used in the assessment.

4.0 ASIAK RIVER WK154

This section provides the screening for soil contaminants since this is the only medium that was collected and submitted for chemical analysis at the Asiak River WK154 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

4.1 Human Health Risk Assessment

4.1.1 Identification of Contaminants of Concern for Human Health

4.1.1.1 Soil

The screening process only considered data for soil samples collected from 0.2 mbgs to 0.2 mbgs and 0.2 mbgs to 0.3 mbgs which are the shallowest depth of samples collected. These depths are not accessible by humans but for the purposes of this assessment have been assumed to have the concentrations in soil to which humans are most likely to be exposed.

A summary of the COC screening in soil for human health is provided below in Table 4.1 (metals), Table 4.2 (PAHs), and Table 4.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium.

Contaminants were screened in soil following a tiered approach discussed in Section 3.2.

Antimony, hot water soluble boron, hexavalent chromium, mercury, selenium, silver, tin, all PAHs, and all PHCs except PHC F3 and F4 had concentrations below the MDL and were not identified as COCs. No concentrations were above the human health guidelines and thus no COC were identified for Asiak River WK154 and no quantitative assessment is required.

Table 4.1 Human health screening for COCs in soil – total metals – Asiak River WK154

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	<0.5	<0.5	10	0	No	All measurements below MDL
Arsenic	mg/kg	12	2.9	3.48	4.7	10	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	64	72.9	130	10	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	0.315	0.358	0.62	10	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	<0.1	<0.1	<0.1	10	0	No	All measurements below MDL
Cadmium	mg/kg	14	<0.05	0.071	0.21	10	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	35	28.3	59	10	0	No	Maximum < Human health guideline
Chromium (hexavalent)	mg/kg	3 [5]	<0.08	<0.08	<0.08	10	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	11.8	11.3	15	10	0	No	Maximum < Human health guideline
Copper	mg/kg	1,100	19.5	23.3	58	10	0	No	Maximum < Human health guideline
Lead	mg/kg	140	7.65	9.22	14	10	0	No	Maximum < Human health guideline
Mercury	mg/kg	6.6	<0.05	<0.05	<0.05	10	0	No	All measurements below MDL
Molybdenum	mg/kg	110 [3]	<0.4	0.308	0.9	10	0	No	Maximum < Human health guideline
Nickel	mg/kg	200	32.5	20.9	26	10	0	No	Maximum < Human health guideline
Selenium	mg/kg	80	<0.5	<0.5	<0.5	10	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	10	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	0.055	0.1	10	0	No	Maximum < Human health guideline
Tin	mg/kg	9,400 [2]	<1	<1	<1	10	0	No	All measurements below MDL
Uranium	mg/kg	23	0.565	0.718	1	10	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	42	54	76	10	10	No	Natural enrichment
Zinc	mg/kg	10,000	31	36.9	50	10	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. samples from 0.3-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of $1x10^{-6}$*; adjusted to a risk level of* $1x10^{-5}$ *(multiplied by 10) for consistency with Health Canada guidance.*-- No value available.

Table 4.2 Human health screening for COCs in soil – PAHs – Asiak River WK154

Contaminant	Units	SQG_{HH} [1]	Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
1-Methylnaphthalene	mg/kg	72[2]	<0.005	9	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	72[2]	<0.005	9	0	No	All measurements below MDL
Acenaphthene	mg/kg	3900[3]	<0.005	9	0	No	All measurements below MDL
Acenaphthylene	mg/kg	7.8[2]	<0.005	9	0	No	All measurements below MDL
Acridine	mg/kg	--	<0.01	9	0	No	All measurements below MDL
Anthracene	mg/kg	24,000[3]	<0.004	9	0	No	All measurements below MDL
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	<0.0071	9	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	<0.005	9	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	9	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500[3]	<0.005	9	0	No	All measurements below MDL
Fluorene	mg/kg	720[2]	<0.005	9	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	<0.005	9	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360[2]	<0.005	9	0	No	All measurements below MDL
Perylene	mg/kg	--	<0.005	9	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500[4]	<0.005	9	0	No	All measurements below MDL
Pyrene	mg/kg	78[2]	<0.005	9	0	No	All measurements below MDL
Quinoline	mg/kg	2.5[4]	<0.01	9	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 - Part 2).

-- No value available.

Table 4.3 Human health screening for COCs in soil – BTEX and PHCs – Asiak River WK154

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	110	-	$5.2x10^{-3}$	0.03	11	0	No	Maximum < Human health guideline
Ethylbenzene	mg/kg	10,000	-	0.02	0.13	11	0	No	Maximum < Human health guideline
Toluene	mg/kg	20,000	-	0.09	0.55	11	0	No	Maximum < Human health guideline
Xylenes, total	mg/kg	150,000	-	0.09	0.62	11	0	No	Maximum < Human health guideline
PHCs									
F1 (C6-C10)	mg/kg	12,000	-	<10	<10	9	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	6,800	-	<10	<10	9	0	No	All measurements below MDL
F3 (C16-C34)	mg/kg	15,000	-	51	150	9	0	No	Maximum < Human health guideline
F4 (C34-C50)	mg/kg	21,000	-	48	160	9	0	No	Maximum < Human health guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

4.1.2 Risk Characterization

As discussed above, the maximum measured concentrations in soils from the Site do not exceed human health guidelines indicating that the Site is safe to be used by people undertaking any type of activity.

4.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, there are some assumptions underlying the qualitive assessment as discussed below.

Table 4.4 Summary of assumptions and uncertainty associated with the HHRA – Asiak River WK154

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil were considered to be sufficiently characterized.
Use of samples collected at depths of 0.2 m to 0.2 m and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally in snow covered periods when the soil is not exposed.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

4.2 Ecological Risk Assessment

4.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Asiak River WK154 Site.

4.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. As was done for the HHRA, the screening process only considered data for soil samples collected from depths of 0.2 mbgs to 0.2 mbgs and 0.2 mbgs to 0.3 mbgs. As discussed in the HHRA, these soil depths are too deep for ecological exposure, but it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQGs for environmental health (SQG_{Eco}), agricultural land use. In the absence of CCME guidelines, alternate sources were considered; these are identified in footnotes in Table 4.5 (metals), Table 4.6 (PAHs) and Table 4.7 (BTEX and PHCs).

In the first step of the metal screening, antimony, hot water soluble boron, chromium (hexavalent), mercury, silver, thallium, tin, all PAHs, and PHCs F1 and F2 had measurements that were below the MDL and were considered not to be present at the site Additionally, all volatile organic compounds (VOCs) were measured below detection limits with the exception of methylene chloride which is discussed further below.

The second screening step involved comparison of maximum concentrations for the Site to the ecological component of the CCME agricultural guidelines. As seen in the tables below, the maximum concentrations of metals, BTEX, and PHCs F3 and F4 were below the SQG_{Eco} and thus were not identified as COCs.

Methylene chloride was measured at a depth of 0.2 m to 0.3 m at three isolated locations (TP1A, TP2A and TP4A). The concentrations were 0.13 mg/kg, 0.14 mg/kg and 0.17 mg/kg as compared to an agricultural guideline of 0.1 mg/kg. The agricultural guideline is based on exposure to indoor air for humans and therefore is not relevant. The MECP has a guideline for the protection of plants and soil organisms of 0.78 mg/kg which is higher than these measured concentrations demonstrating the methylene chloride in soil does not represent a risk to plants and soil organisms. The value for the protection of mammals and birds is 320 mg/kg which is several orders of magnitude higher than the measured concentrations demonstrating that methylene chloride in soil does not represent a risk to ecological receptors.

In summary, the maximum concentrations of all contaminants were below the ecological guidelines and do not represent a risk to the environment at the Site.

Table 4.5 ERA screening for COCs in soil – total metals – Asiak River WK154

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	<0.5	<0.5	10	0	No	All measurements below MDL
Arsenic	mg/kg	17	2.9	3.48	4.7	10	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	64	72.9	130	10	0	No	Maximum < Ecological guideline
Beryllium	mg/kg	4	0.315	0.358	0.62	10	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	<0.1	<0.1	<0.1	10	0	No	All measurements below MDL
Cadmium	mg/kg	10	<0.05	0.0711	0.21	10	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	35	28.3	59	10	0	No	Maximum < Ecological guideline
Chromium (hexavalent)	mg/kg	0.4	<0.08	<0.08	<0.08	10	0	No	All measurements below MDL
Cobalt	mg/kg	40	11.8	11.27	15	10	0	No	Maximum < Ecological guideline
Copper	mg/kg	63	19.5	23.32	58	10	0	No	Maximum < Ecological guideline
Lead	mg/kg	70	7.65	9.22	14	10	0	No	Maximum < Ecological guideline
Mercury	mg/kg	12	<0.05	<0.05	<0.05	10	0	No	All measurements below MDL
Molybdenum	mg/kg	5	<0.4	0.308	0.9	10	0	No	Maximum < Ecological guideline
Nickel	mg/kg	45	32.5	20.9	26	10	0	No	Maximum < Ecological guideline
Selenium	mg/kg	1	<0.5	<0.5	<0.5	10	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	10	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	0.055	0.1	10	0	No	Maximum < Ecological guideline
Tin	mg/kg	5	<1	<1	<1	10	0	No	All measurements below MDL
Uranium	mg/kg	33	0.565	0.718	1	10	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	42	54	76	10	0	No	Maximum = Ecological guideline
Zinc	mg/kg	250	31	36.9	50	10	0	No	Maximum < Ecological guideline

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. samples from 0.3-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 4.6 ERA screening for COCs in soil – PAHs – Asiak River WK154

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
1-Methylnaphthalene	mg/kg	--	-	<0.005	<0.005	9	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	--	-	<0.005	<0.005	9	0	No	All measurements below MDL
Acenaphthene	mg/kg	0.28	-	<0.005	<0.005	9	0	No	All measurements below MDL
Acenaphthylene	mg/kg	320	-	<0.005	<0.005	9	0	No	All measurements below MDL
Acridine	mg/kg	--	-	<0.01	<0.01	9	0	No	All measurements below MDL
Anthracene	mg/kg	2.5	-	<0.004	<0.004	9	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.1	-	<0.005	<0.005	9	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	20	-	<0.005	<0.005	9	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	9	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	9	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	9	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	-	<0.005	<0.005	9	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	9	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	-	<0.005	<0.005	9	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	-	<0.005	<0.005	9	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	-	<0.005	<0.005	9	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	-	<0.005	<0.005	9	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	-	<0.005	<0.005	9	0	No	All measurements below MDL
Naphthalene	mg/kg	0.013	-	<0.005	<0.005	9	0	No	All measurements below MDL
Perylene	mg/kg	--	-	<0.005	<0.005	9	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	-	<0.005	<0.005	9	0	No	All measurements below MDL
Pyrene	mg/kg	7.7	-	<0.005	<0.005	9	0	No	All measurements below MDL
Quinoline	mg/kg	0.1	-	<0.01	<0.01	9	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

Table 4.7 ERA screening for COCs in soil – BTEX and PHCs – Asiak River WK154

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	25	-	$5.2x10^{-3}$	0.03	11	0	No	Maximum < Ecological guideline
Ethylbenzene	mg/kg	55	-	0.02	0.13	11	0	No	Maximum < Ecological guideline
Toluene	mg/kg	75	-	0.09	0.55	11	0	No	Maximum < Ecological guideline
Xylenes, total	mg/kg	65	-	0.09	0.62	11	0	No	Maximum < Ecological guideline
PHCs									
F1 (C6-C10)	mg/kg	210	-	<10	<10	9	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	150	-	<10	<10	9	0	No	All measurements below MDL
F3 (C16-C34)	mg/kg	300	-	51	150	9	0	No	Maximum < Ecological guideline
F4 (C34-C50)	mg/kg	2800	-	48	160	9	0	No	Maximum < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

4.2.2 Risk Characterization

Risk characterization determines the potential for negative effects or risks to populations of ecological receptors. As discussed in Section 4.2.1.1, the maximum concentrations of contaminants at the Asiak River WK154 Site are below ecological guidelines and therefore do not represent a risk to ecological receptors that may be present at the Site.

4.2.3 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are adequately protected in the absence of Site-specific information. As the maximum concentrations were below guidelines, only a qualitative analysis was undertaken. Nevertheless, Table 4.8 examines the assumptions in of the ERA, underlying sampling, and use of the guidelines.

Table 4.8 Summary of assumptions and uncertainty associated with the ERA – Asiak River WK154

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Phase III investigation collected samples to delineate and capture soil contamination at the Asiak River WK154 Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, and vegetation. Background soil and vegetation samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil were considered to be sufficiently characterized.
Use of samples collected at depths of 0.2 m to 0.2 m and 0.2 m to 0.3 m,	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to ecological receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year-round and that crops are grown and farm animals are present. This is not the case and the habitat present is not sufficient to support populations of wildlife at the Site. The use of agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption used to develop the guidelines is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.
Effect Assessment			
The applicability of the selected TRVs to the various exposure pathways for soil.	Moderate	Overestimate	The TRVs applied to derive the ecological guidelines are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

5.0 COPPERMINE WK199

This section provides the screening for soil, surface water, and sediment contaminants collected and submitted for chemical analysis at the Coppermine WK199 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

5.1 Human Health Risk Assessment

5.1.1 Identification of Contaminants of Concern for Human Health

5.1.1.1 Soil

For metals, the screening process only considered data for soil samples collected from 0.0 mbgs to 0.2 mbgs, 0.0 mbgs to 0.3 mbgs, 0.1 mbgs to 0.2 mbgs, 0.1 mbgs to 0.3 mbgs, 0.2 mbgs to 0.2 mbgs and 0.2 mbgs to 0.3 mbgs which are the shallowest depth of samples collected. For PAHs, BTEX, and PHCs the screening process considered data from 0.1 mbgs to 0.2 mbgs, which is the shallowest depth of samples collected. VOCs were screened at 0.2 mbgs to 0.3 mbgs, the depth of the only sample collected. These depths are considered to be accessible by humans even though some of the depths are greater that what humans can be exposed.

A summary of the COC screening in soil for human health is provided below in Table 5.1 (metals), Table 5.2 (PAHs), and Table 5.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium.

Contaminants were screened in soil following a tiered approach discussed in Section 3.2.

Antimony, hexavalent chromium, selenium, silver, thallium, the majority of the PAHs, and all PHCs except PHC F2 and all VOCs were not identified as COCs since the analytical concentrations are all below the MDL and therefore, they are not considered present.

Lead was identified as having a maximum concentration above the human health guideline; however, only one sample (TP7A; 180 mg/kg) exceeds the guideline and is found at a depth of 0.1m to 0.2m. All other samples have lead concentrations below the guideline.

This individual sample does not represent a risk as no one would be present at that location everyday for a lifetime.

All carcinogenic PAHs were evaluated based on calculation of B[a]P total potency TPE (CCME 2010). The CCME has not developed human health guidelines for the non-carcinogenic PAHs therefore the maximum concentration in soil samples for each non-carcinogenic PAH compound was compared to the soil component values available from Alberta, British Columbia or Ontario. The majority of the PAHs were non-detectable (i.e., <MDL) and thus were not identified as COCs (see Table 5.2). The detectable PAHs were all below the human health guidelines and were not considered to be COC.

All PHCs and BTEX with the exception of PHC F2 were either non-detectable or below human health guidelines (see Table 5.3) and therefore not identified as COCs. There is a single sample of PHC F2 at a concentration of 41,000 mg/kg (TP7A) that exceeds the guideline; all other concentrations are below the MDL. It is unlikely that someone would be present every day for their lifetime at this location and therefore, this single sample is not considered to represent a risk.

Thus, no COCs were identified in soil for the HHRA and no quantitative analysis was required.

Table 5.1 Human health screening for COCs in soil – total metals – Coppermine WK199

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	<0.5	<0.5	14	0	No	All measurements below MDL
Arsenic	mg/kg	12	2.2	1.7	2.2	14	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	61	69	130	14	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	0.58	0.53	0.64	14	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	0.24	0.99	5.0	14	0	No	Maximum < Human health guideline
Cadmium	mg/kg	14	0.08	0.61	6.7	14	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	112	57	100	14	0	No	Maximum < Human health guideline
Chromium (hexavalent)	mg/kg	3[5]	<0.08	<0.08	<0.08	14	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	24	16	26	14	2	No	Site average < background average
Copper	mg/kg	1,100	127	99	420	14	0	No	Maximum < Human health guideline
Lead	mg/kg	140	10	22	180	14	1	No	Single sample; localized exceedance
Mercury	mg/kg	6.6	<0.05	0.06	0.19	14	0	No	Maximum < Human health guideline
Molybdenum	mg/kg	110 [3]	1.1	0.49	0.99	14	0	No	Maximum < Human health guideline
Nickel	mg/kg	200	72	41	67	14	0	No	Maximum < Human health guideline
Selenium	mg/kg	80	<0.5	<0.5	<0.5	14	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	14	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	<0.1	<0.1	14	0	No	All measurements below MDL
Tin	mg/kg	9,400 [2]	<1	0.79	1.0	14	0	No	Maximum < Human health guideline
Uranium	mg/kg	23	0.61	0.47	0.70	14	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	140	104	170	14	12	No	Site average < background average
Zinc	mg/kg	10,000	79	54	83	14	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; data from samples collected at an accessible depth are included (i.e. 0-0.3, 0.1-0.2, 0.2-0.2 mbgs).

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of 1x10-*6; adjusted to a risk level of 1x10-5 (multiplied by 10) for consistency with Health Canada guidance.*

-- No value available.

Table 5.2 Human health screening for COCs in soil – PAHs – Coppermine WK199

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
1-Methylnaphthalene	mg/kg	72 [2]	-	$7.8x10^{-4}$	1.8	6	0	No	Maximum < Human health guideline
2-Methylnaphthalene	mg/kg	72 [2]	-	$7.8x10^{-4}$	0.78	6	0	No	Maximum < Human health guideline
Acenaphthene	mg/kg	3900 [3]	-	$7.8x10^{-4}$	0.06	6	0	No	Maximum < Human health guideline
Acenaphthylene	mg/kg	7.8 [2]	-	$7.8x10^{-4}$	0.08	6	0	No	Maximum < Human health guideline
Acridine	mg/kg	--	-	$3.1x10^{-3}$	0.01	6	0	No	No guideline
Anthracene	mg/kg	24,000 [3]	-	<0.004	<0.004	6	0	No	All measurements below MDL
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	-	<0.0071	<0.0071	6	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500 [3]	-	<0.005	<0.005	6	0	No	All measurements below MDL
Fluorene	mg/kg	720 [2]	-	$7.8x10^{-4}$	0.04	6	0	No	Maximum < Human health guideline
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	6	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360 [2]	-	$7.8x10^{-4}$	0.40	6	0	No	Maximum < Human health guideline
Perylene	mg/kg	--	-	<0.005	<0.005	6	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500 [4]	-	<0.005	<0.005	6	0	No	All measurements below MDL
Pyrene	mg/kg	78 [2]	-	<0.005	<0.005	6	0	No	All measurements below MDL
Quinoline	mg/kg	2.5 [4]	-	<0.01	<0.01	6	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected at an accessible depth are included (i.e. 0-0.3, 0.1-0.2, 0.2-0.2 mbgs).

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 - Part 2).

-- No value available.

Table 5.3 Human health screening for COCs in soil – BTEX and PHCs – Coppermine WK199

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
BTEX									
Benzene	mg/kg	110	-	0.01	0.03	6	0	No	Maximum < Human health guideline
Ethylbenzene	mg/kg	10,000	-	0.15	0.75	6	0	No	Maximum < Human health guideline
Toluene	mg/kg	20,000	-	0.16	0.58	6	0	No	Maximum < Human health guideline
Xylenes, total	mg/kg	150,000	-	1.7	9.5	6	0	No	Maximum < Human health guideline
PHCs									
F1 (C6-C10)	mg/kg	12,000	-	355	2,100	6	0	No	Maximum < Human health guideline
F2 (C10-C16)	mg/kg	6,800	-	6,839	41,000	6	1	No	Single sample; localized exceedance
F3 (C16-C34)	mg/kg	15,000	-	537	2,700	6	0	No	Maximum < Human health guideline
F4 (C34-C50)	mg/kg	21,000	-	171	820	6	0	No	Maximum < Human health guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected at an accessible depth are included (i.e. 0-0.3, 0.1-0.2, 0.2-0.2 mbgs).

[1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

5.1.1.2 Surface Water

A summary of the surface water screening is presented for metals in Table 5.4. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs.

Contaminants were screened in surface water following a tiered approach discussed in Section 3.2.

Antimony, arsenic, beryllium, chromium, cobalt, iron, lead, lithium, manganese, mercury, molybdenum, phosphorus, potassium, strontium, thallium, tin, titanium, uranium, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX were all measured below the MDL and not identified as COCs on this basis.

Aluminum, barium, boron, copper, iron, manganese, molybdenum, selenium, and sodium had maximum concentrations below the drinking water guidelines and were not identified as COCs.

Calcium, magnesium, and sulphur concentrations were similar to background and were not identified as COCs on this basis.

Thus, no metals, PHCs, BTEX, or PAHs were identified as COCs in surface water and therefore no quantitative analysis was required for the HHRA.

Table 5.4 Human Health Surface Water COC Screen – total metals – Coppermine WK199

Contaminant	Units	Guideline [1]	Average Concentration		Maximum Concentration	N	N > WQG	COC for Human Health?	Rationale
			Back-ground	Site					
Aluminum	mg/L	2.9	$4.2x10^{-3}$	$4.0x10^{-3}$	$4.9x10^{-3}$	2	0	No	Maximum < Human health guideline
Antimony	mg/L	0.006	<0.0006	<0.0006	<0.0006	2	0	No	All measurements below MDL
Arsenic	mg/L	0.01	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Barium	mg/L	1	0.02	0.02	0.02	2	0	No	Maximum < Human health guideline
Beryllium	mg/L	0.004 [3]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	5	0.02	0.04	0.04	2	0	No	Maximum < Human health guideline
Cadmium	mg/L	0.005	<0.00002	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	--	15	14	14	2	0	No	Site average <background
Chromium	mg/L	0.05	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.14	<0.0003	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	1	$2.0x10^{-3}$	$2.0x10^{-3}$	$2.4x10^{-3}$	2	0	No	Maximum < Human health guideline
Iron	mg/L	0.3	0.06	<0.06	<0.06	2	0	No	All measurements below MDL
Lead	mg/L	0.01	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	--	8.0	7.6	7.8	2	0	No	Site average <background
Manganese	mg/L	0.12	<0.004	<0.004	<0.004	2	0	No	All measurements below MDL
Mercury	mg/L	0.001	<0.0000019	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.01 [2]	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.078 [2]	<0.0005	<0.0005	<0.0005	2	0	No	All measurements below MDL
Phosphorus	mg/L	194 [2]	<0.003	<0.1	<0.003	2	0	No	All measurements below MDL
Potassium	mg/L	--	<0.3	<0.3	<0.3	2	0	No	All measurements below MDL
Selenium	mg/L	0.05	$2.6x10^{-4}$	$2.0x10^{-4}$	$2.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Silver	mg/L	--	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	200	1.4	1.1	1.2	2	0	No	Maximum < Human health guideline
Strontium	mg/L	2.5 [4]	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	--	0.82	0.60	0.63	2	0	No	Site average <background
Thallium	mg/L	0.002 [3]	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	2.5 [4]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL

Contaminant	Units	Guideline [1]	Average Concentration		Maximum Concentration	N	N > WQG	COC for Human Health?	Rationale
			Back-ground	Site					
Titanium	mg/L	--	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Uranium	mg/L	0.02	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Vanadium	mg/L	0.0172 [2]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	5	<0.003	<0.003	<0.003	2	0	No	All measurements below MDL

Note:Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL

[1] Health Canada (2022) drinking water quality guideline.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] U.S. EPA (2023) maximum contaminant level (MCL) for drinking water for human health.

[4] Government of British Columbia (2023) Generic Numerical Water Standards, drinking water (Schedule 3.2).

5.1.1.3 Sediment

There are no Federal or Provincial sediment quality guidelines for the protection of human health. Human contact with sediments is considered to be minimal at the Site. Sediments are not discussed further for the HHRA.

5.1.2 Risk Characterization

Maximum measured concentrations in soils and surface water from the Site do not exceed human health guidelines indicating that the Site is safe to be used by people undertaking any type of activity.

5.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, there are some assumptions underlying the qualitive assessment as discussed below.

Table 5.5 Summary of assumptions and uncertainty associated with the HHRA – Coppermine WK199

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil, and surface water were considered sufficiently characterized.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Use of samples collected at depths of 0.0 m to 0.2 m, 0.0 m to 0.3 m, 0.1 m to 0.2 m, 0.1 m to 0.3 m, 0.2 m to 0.2 m, and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that in general the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change. PHC F2 and lead only exceeded guidelines at TP7A.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil and surface water.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

5.2 Ecological Risk Assessment

5.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Coppermine WK199 Site.

5.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. For metals, the screening process only considered data for soil samples collected from 0.0 mbgs to 0.2 mbgs, 0.0 mbgs to 0.3 mbgs, 0.1 mbgs to 0.2 mbgs, 0.1 mbgs to 0.3 mbgs, 0.2 mbgs to 0.2 mbgs and 0.2 mbgs to 0.3 mbgs which are the shallowest depth of samples collected. For PAHs, BTEX, and PHCs the screening process considered data from 0.1 mbgs to 0.2 mbgs, which is the shallowest depth of samples collected. VOCs were screened at 0.2 mbgs to 0.3 mbgs, the depth of the only sample collected. As discussed in the HHRA,

it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

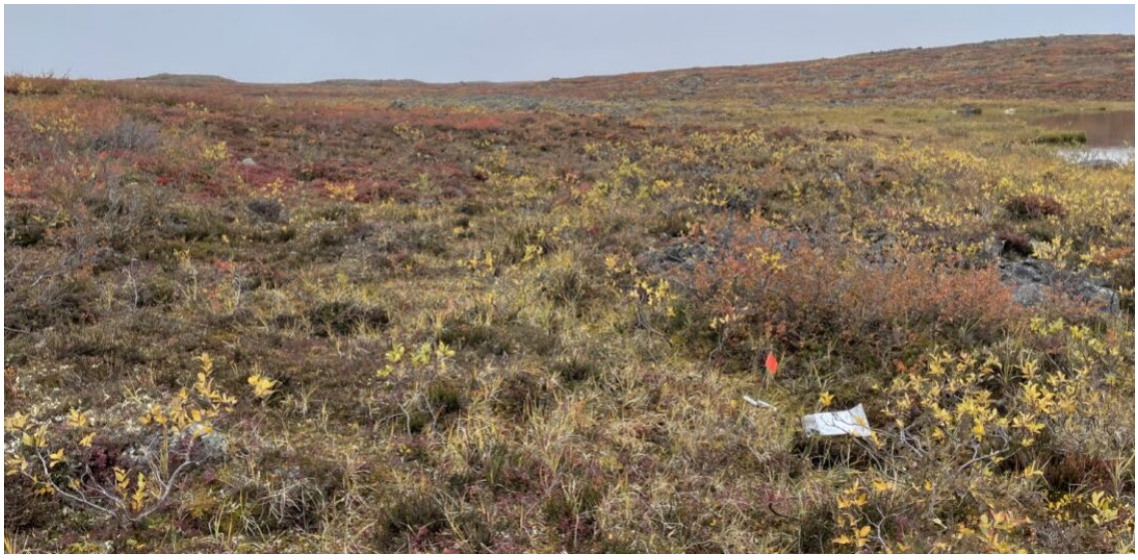
For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQG_{Eco}, agricultural land use. In the absence of CCME guidelines, alternate sources were considered; these are identified in footnotes in Table 5.6 (metals), Table 5.7 (PAHs) and Table 5.8 (BTEX and PHCs).

As discussed in Section 2.0, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium. Therefore, while copper exceeds the ecological guideline it is considered to be naturally occurring.

In the first step of the metal screening antimony, hexavalent chromium, selenium, silver, thallium, the majority of the PAHs, all PHCs except PHC F2 and all VOCs were removed from consideration as all of the measurements were below the MDL for these contaminants.

The second screening step involved comparison of maximum concentrations for the Site to the ecological component of the CCME agricultural guidelines. As seen in the tables below, the 1 localized sample of hot water soluble boron and 1 localized sample of lead had concentrations that were above the $SQG_{Eco.}$ Both samples are located at TP7A and were at a depth of 0.1m to 0.2 m and are not considered to represent a risk to populations of ecological receptors. Additionally, the photo below demonstrates the location of TP7A and shows dense vegetation in this area.

Photograph 5.1 Soil sampling location TP7A



One localized sample of naphthalene at TP7A exceeded the SQG_{Eco}. Similarly, at TP7A, PHC F1, PHC F2 and PHC F3 exceed the ecological guideline. This localized area of contamination at TP7A is not considered to represent a risk to ecological populations.

In summary, no COCs were identified in the soil screen.

Table 5.6 ERA screening for COCs in soil – total metals – Coppermine WK199

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	<0.5	<0.5	14	0	No	All measurements below MDL
Arsenic	mg/kg	17	2.2	1.7	2.2	14	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	61	69	130	14	0	No	Maximum < Ecological guideline
Beryllium	mg/kg	4	0.58	0.53	0.64	14	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	0.24	0.99	5.0	14	1	No	Single exceedance
Cadmium	mg/kg	10	0.08	0.61	6.7	14	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	112	57	100	14	6	No	Site average < Background average
Chromium (hexavalent)	mg/kg	0.4	<0.08	<0.08	<0.08	14	0	No	All measurements below MDL
Cobalt	mg/kg	40	24	16	26	14	0	No	Maximum < Ecological guideline
Copper	mg/kg	63	127	99	420	14	8	No	Site average < Background average
Lead	mg/kg	70	10	22	180	14	1	No	Single exceedance
Mercury	mg/kg	12	<0.05	0.06	0.19	14	0	No	Maximum < Ecological guideline
Molybdenum	mg/kg	5	1.1	0.49	0.99	14	0	No	Maximum < Ecological guideline
Nickel	mg/kg	45	72	41	67	14	7	No	Site average < Background average
Selenium	mg/kg	1	<0.5	<0.5	<0.5	14	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	14	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	<0.1	<0.1	14	0	No	All measurements below MDL
Tin	mg/kg	5	<1	0.79	1.0	14	0	No	Maximum < Ecological guideline
Uranium	mg/kg	33	0.61	0.47	0.70	14	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	140	104	170	14	5	No	Site average < Background average
Zinc	mg/kg	250	79	54	83	14	0	No	Maximum < Ecological guideline

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; data from samples collected at an accessible depth are included (i.e. 0-0.3, 0.1-0.2, 0.2-0.2 mbgs).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 5.7 ERA screening for COCs in soil – PAHs – Coppermine WK199

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
1-Methylnaphthalene	mg/kg	0.99 [2]	-	$7.8x10^{-4}$	1.8	6	--	No	Single measurement; all other measurements <MDL
2-Methylnaphthalene	mg/kg	0.99 [2]	-	$7.8x10^{-4}$	0.78	6	--	No	Single measurement; all other measurements <MDL Maximum < Ecological guideline
Acenaphthene	mg/kg	0.28	-	$7.8x10^{-4}$	0.06	6	0	No	Maximum < Ecological guideline
Acenaphthylene	mg/kg	320	-	$7.8x10^{-4}$	0.08	6	0	No	Maximum < Ecological guideline
Acridine	mg/kg	--	-	$3.1x10^{-3}$	0.01	6	0	No	No guideline
Anthracene	mg/kg	2.5	-	<0.004	<0.004	6	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.1	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	20	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	-	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	6	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	-	<0.005	<0.005	6	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	-	<0.005	<0.005	6	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	-	<0.005	<0.005	6	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	-	$7.8x10^{-4}$	0.04	6	0	No	Maximum < Ecological guideline
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	-	<0.005	<0.005	6	0	No	All measurements below MDL
Naphthalene	mg/kg	0.013	-	$7.8x10^{-4}$	0.40	6	1	No	Single exceedance; all other measurements <MDL
Perylene	mg/kg	--	-	<0.005	<0.005	6	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	-	<0.005	<0.005	6	0	No	All measurements below MDL
Pyrene	mg/kg	7.7	-	<0.005	<0.005	6	0	No	All measurements below MDL
Quinoline	mg/kg	0.1	-	<0.01	<0.01	6	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected at an accessible depth are included (i.e. 0-0.3, 0.1-0.2, 0.2-0.2 mbgs).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

Table 5.8 ERA screening for COCs in soil – BTEX and PHCs – Coppermine WK199

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
BTEX									
Benzene	mg/kg	25	-	0.01	0.03	6	0	No	Maximum < Ecological guideline
Ethylbenzene	mg/kg	55	-	0.15	0.75	6	0	No	Maximum < Ecological guideline
Toluene	mg/kg	75	-	0.16	0.58	6	0	No	Maximum < Ecological guideline
Xylenes, total	mg/kg	65	-	1.7	9.5	6	0	No	Maximum < Ecological guideline
PHCs									
F1 (C6-C10)	mg/kg	210	-	355	2,100	6	1	No	Single exceedance; all other measurements <MDL
F2 (C10-C16)	mg/kg	150	-	6,839	$4.1x10^4$	6	1	No	Single exceedance; all other measurements <MDL
F3 (C16-C34)	mg/kg	300	-	537	2,700	6	1	No	Single exceedance
F4 (C34-C50)	mg/kg	2800	-	171	820	6	0	No	Maximum < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected at an accessible depth are included (i.e. 0-0.3, 0.1-0.2, 0.2-0.2 mbgs).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

5.2.1.2 Surface Water

The surface water COC screening process identified the COCs in the adjacent unnamed lake to be considered further in the aquatic ERA. The CCME (2023) long term WQGs for the protection of freshwater aquatic life were used as the screening criteria.

The surface water screening for metals is shown in Table 5.9. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs.

All samples were below the MDL for antimony, arsenic, beryllium, chromium, cobalt, iron, lead, lithium, manganese, mercury, molybdenum, phosphorus, potassium, strontium, thallium, tin, titanium, uranium, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX.

A comparison of maximum measured concentrations to the WQGs indicated maximum measured levels of the remaining contaminants were lower than the guidelines and therefore were not considered further as they do not present a risk to aquatic life. Only copper had concentrations that exceeded the aquatic life guideline; however, background concentrations were similar and equal to the guideline. Therefore, copper is considered to be naturally occurring in the unnamed lake.

In summary no COC were identified in surface water.

Table 5.9 ERA screening for COCs in surface water – total metals – Coppermine WK199

Contaminant	Units	WQG [1]	Background Concentration	Average Site Concentration	Maximum Concentration	N	N > WQG	COC for Ecological Health?	Rationale
Aluminum	mg/L	0.005	$4.2x10^{-3}$	$4.3x10^{-3}$	$4.9x10^{-3}$	2	0	No	Maximum < Ecological guideline
Antimony	mg/L	0.02 [2]	<0.0006	<0.0006	<0.0006	2	0	No	All measurements below MDL
Arsenic	mg/L	0.005	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Barium	mg/L	1 [3]	0.02	0.02	0.02	2	0	No	Maximum < Ecological guideline
Beryllium	mg/L	0.00013 [3]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	1.5	0.02	0.04	0.04	2	0	No	Maximum < Ecological guideline
Cadmium	mg/L	0.00011	<0.00002	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	1,000	15	14	14	2	0	No	Maximum < Ecological guideline
Chromium	mg/L	0.0089 [6]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.004 [5]	<0.0003	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	0.002 [7]	$2.0x10^{-3}$	$2.1x10^{-3}$	$2.4x10^{-3}$	2	1	No	Site average similar to background
Iron	mg/L	0.3	0.06	<0.06	<0.06	2	0	No	All measurements below MDL
Lead	mg/L	0.001 [7]	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	82 [4]	8.0	7.6	7.8	2	0	No	Maximum < Ecological guideline
Manganese	mg/L	0.2 [5]	<0.004	<0.004	<0.004	2	0	No	All measurements below MDL
Mercury	mg/L	$2.6x10^{-5}$	<0.0000019	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.073	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.025 [7]	<0.0005	<0.0005	<0.0005	2	0	No	All measurements below MDL
Phosphorus	mg/L	0.01 [2]	<0.003	<0.1	<0.003	2	0	No	All measurements below MDL
Potassium	mg/L	53 [4]	<0.3	<0.3	<0.3	2	0	No	All measurements below MDL
Selenium	mg/L	0.001	$2.6x10^{-4}$	$1.5x10^{-4}$	$2.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Silver	mg/L	0.00025	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	680 [4]	1.4	1.1	1.2	2	0	No	Maximum < Ecological guideline
Strontium	mg/L	21	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL

Contaminant	Units	WQG [1]	Background Concentration	Average Site Concentration	Maximum Concentration	N	N > WQG	COC for Ecological Health?	Rationale
Sulphur	mg/L	1,000	0.82	0.56	0.63	2	0	No	Maximum < Ecological guideline
Thallium	mg/L	0.0008	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	0.18 [4]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	1 [5]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Uranium	mg/L	0.015	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Vanadium	mg/L	0.12	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	0.03	<0.003	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) water quality guideline for the protection of aquatic life (freshwater).
[2] Ontario Provincial Water Quality Objective (MOEE 1994); interim value and should be used with caution.
[3] BC MOE (2021) working or approved water quality guidelines.
[4] U.S. EPA (2015) Region 4 supplemental risk assessment guidance, surface water screening values, chronic, Table 1a.
[5] Government of British Columbia (2023) Generic Numerical Water Standards, aquatic life (Schedule 3.2).
[6] Guideline is for trivalent chromium.
[7] Based on water hardness of less than 82 mg/L $CaCO_3$ (copper) and less than 60 mg/L $CaCO_3$ (lead, nickel).

5.2.1.3 Sediment

Only 1 sediment sample was collected at the unnamed lake due to the rocky bottom. This sample was collected at a background location and the metals data are summarized in Table 5.10. The table shows that the naturally occurring concentrations of chromium, copper and nickel are above sediment guidelines.

The rocky substrate in the lake is not conducive to growth of benthic communities and thus no assessment of COCs in sediment is necessary.

Table 5.10 ERA screening for COCs in sediment – total metals – Coppermine WK199

Contaminant	Units	ISQG [1]	Background Location Concentration
Antimony	mg/kg	25 [3]	<0.5
Arsenic	mg/kg	5.9	1.4
Barium	mg/kg	--	59
Beryllium	mg/kg	--	0.72
Boron	mg/kg	--	0.15
Cadmium	mg/kg	0.6	0.072
Chromium	mg/kg	37.3	75
Chromium (hexavalent)	mg/kg	--	<0.08
Cobalt	mg/kg	50 [4]	26
Copper	mg/kg	35.7	54
Lead	mg/kg	35	9.2
Mercury	mg/kg	0.17	<0.05
Molybdenum	mg/kg	13.8 [6]	<0.4
Nickel	mg/kg	16 [5]	55
Selenium	mg/kg	2 [3]	<0.5
Silver	mg/kg	0.5 [4]	<0.2
Thallium	mg/kg	--	<0.1
Tin	mg/kg	--	1
Uranium	mg/kg	100 [2]	0.7
Vanadium	mg/kg	--	180
Zinc	mg/kg	123	92

Note: Only 1 sample collected from a background location.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

[2] U.S. EPA (2015) Region 4 soil and freshwater sediment screening benchmarks.

[3] Nova Scotia Environment (2014), freshwater sediment

[4] MOE (2011a) Table 1 Full Depth Background Site Condition Standards Ground Water Condition.

[5] MOE (2008) lowest effect level sediment quality guideline, Table 1.

[6] Thompson et al. (2005) lowest effect level.

5.2.2 Risk Characterization

As discussed in the previous sections, the maximum concentrations of contaminants in soil and surface water at the Coppermine WK199 Site do not represent a risk for populations of ecological receptors that may be present at the Site. Comparison of the one background sediment sample to sediment guidelines indicates no effects to benthic organisms. The rocky substrate in the unnamed lake is not conducive to the presence of benthic organisms.

5.2.3 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are adequately protected in the absence of Site-specific information. As the maximum concentrations were below guidelines, only a qualitative analysis was undertaken. Nevertheless, Table 5.11 examines the assumptions in of the ERA, underlying sampling and use of the guidelines.

Table 5.11 Summary of assumptions and uncertainty associated with the ERA – Coppermine WK199

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Phase III investigation collected samples to delineate and capture soil and surface water contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, sediment, and vegetation. Background samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil, surface water, and sediment were considered to be sufficiently characterized.
Use of samples collected at depths of 0.0 m to 0.2 m, 0.0 m to 0.3 m, 0.1 m to 0.2 m, 0.1 m to 0.3m, 0.2 m to 0.2 m, and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to ecological receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that with the exception of contamination at TP7A, all the maximum soil concentrations are below the agricultural guidelines, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year round and that crops are grown and cows and other farm animals are present. This is not the case at the Site. The use of the agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption used to develop the guidelines is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.
The maximum concentrations for COCs were identified.	Low	Overestimate	Maximum concentrations were used in the screening process. The use of the maximum concentration assumes that this concentration is present across the Site and not in a localized area such as TP7A.
Effect Assessment			
The applicability of TRVs to the various exposure pathways for soil, sediments, and surface water.	Moderate	Overestimate	The TRVs applied to derive the ecological guidelines are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

6.0 COPPERMINE WK210

This section provides the screening for soil, surface water, and sediment contaminants that were collected and submitted for chemical analysis at the Coppermine WK210 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

6.1 Human Health Risk Assessment

6.1.1 Identification of Contaminants of Concern for Human Health

6.1.1.1 Soil

For metals, the screening process only considered data for soil samples collected from and 0.1 mbgs to 0.2 mbgs, 0.2 mbgs to 0.2 mbgs, and 0.2 mbgs to 0.3 mbgs which are the shallowest depths of samples collected. For PAHs, BTEX, and PHCs, the screening process only considered data for soil samples collected from and 0.1 mbgs to 0.2 mbgs and 0.2 mbgs to 0.2 mbgs, which are the shallowest depths of samples collected. For VOCs, the only available sample at a depth of 0.2 mbgs to 0.2 mbgs was screened. These depths are considered to be accessible by humans even though some of the depths are deeper that what humans can be exposed to.

A summary of the COC screening in soil for human health is provided below in Table 6.1(metals), Table 6.2 (PAHs), and Table 6.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables. For VOCs, all samples were measured below the detection limit.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium.

Contaminants were screened in soil following a tiered approach: discussed in Section 3.2.

Antimony, hexavalent chromium, mercury, selenium, silver, tin, all PAHs except for 1-methylnaphthalene, 2-methylnaphthelene, acenaphthene, acenaphthylene and naphthalene, and benzene, toluene and PHC F4 were all below the MDL and not considered to be present at the Site.

The maximum concentration of the remainder of the contaminants were below human health guidelines.

All carcinogenic PAHs were evaluated based on calculation of B[a]P TPE (CCME 2010). The CCME has not developed human health guidelines for the non-carcinogenic PAHs therefore the maximum concentration in soil samples for each non-carcinogenic PAH compound was compared to the soil component values available from Alberta, British Columbia, or Ontario. The majority of the PAHs were non-detectable (i.e., <MDL) and the maximum concentrations of 1-methylnaphthalene, 2-methylnaphthelene, acenaphthene, acenaphthylene and naphthalene were below human health guidelines. Thus no PAHs were identified as COCs (Table 6.2).All PHCs and BTEX were either non-detectable or below human health guidelines (Table 6.3) and therefore not identified as COCs.

Thus, no COCs were identified in soil for the HHRA and no quantitative analysis was required.

Table 6.1 Human health screening for COCs in soil – total metals – Coppermine WK210

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	<0.5	<0.5	11	0	No	All measurements below MDL
Arsenic	mg/kg	12	2.6	2.1	3.2	11	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	335	422	730	11	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	0.50	0.44	0.52	11	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	0.47	0.62	1.5	11	0	No	Maximum < Human health guideline
Cadmium	mg/kg	14	0.05	0.11	0.22	11	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	40	28	55	11	0	No	Maximum < Human health guideline
Chromium (hexavalent)	mg/kg	3[5]	<0.08	<0.08	<0.08	11	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	9.1	7.1	12	11	0	No	Maximum < Human health guideline
Copper	mg/kg	1,100	39	49	69	11	0	No	Maximum < Human health guideline
Lead	mg/kg	140	8.3	6.5	11	11	0	No	Maximum < Human health guideline
Mercury	mg/kg	6.6	<0.05	<0.05	<0.05	11	0	No	All measurements below MDL
Molybdenum	mg/kg	110 [3]	0.39	0.42	0.69	11	0	No	Maximum < Human health guideline
Nickel	mg/kg	200	28	24	39	11	0	No	Maximum < Human health guideline
Selenium	mg/kg	80	<0.5	<0.5	<0.5	11	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	11	0	No	All measurements below MDL
Thallium	mg/kg	1	0.12	0.11	0.14	11	0	No	Maximum < Human health guideline
Tin	mg/kg	9,400 [2]	<1	<1	<1	11	0	No	All measurements below MDL
Uranium	mg/kg	23	1.3	1.8	4.1	11	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	51	36	63	11	6	No	Site average < background average
Zinc	mg/kg	10,000	47	48	110	11	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; data from samples collected that are accessible are included (i.e. 0.1-0.2 mbgs) except background samples (0.2-0.3 mbgs).

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of 1x10-*6; adjusted to a risk level of 1x10-5 (multiplied by 10) for consistency with Health Canada guidance.*

-- No value available.

Table 6.2 Human health screening for COCs in soil – PAHs – Coppermine WK210

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
1-Methylnaphthalene	mg/kg	72 [2]	-	0.29	2.3	11	0	No	Maximum < Human health guideline
2-Methylnaphthalene	mg/kg	72 [2]	-	0.01	0.07	11	0	No	Maximum < Human health guideline
Acenaphthene	mg/kg	3900 [3]	-	$8.0x10^{-3}$	0.02	11	0	No	Maximum < Human health guideline
Acenaphthylene	mg/kg	7.8 [2]	-	0.01	0.04	11	0	No	Maximum < Human health guideline
Acridine	mg/kg	--	-	<0.01	<0.01	11	0	No	All measurements below MDL
Anthracene	mg/kg	24,000 [3]	-	<0.004	<0.004	11	0	No	All measurements below MDL
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	-	<0.007	<0.007	11	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500 [3]	-	<0.005	<0.005	11	0	No	All measurements below MDL
Fluorene	mg/kg	720 [2]	-	<0.005	<0.005	11	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	11	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360 [2]	-	0.03	0.16	11	0	No	Maximum < Human health guideline
Perylene	mg/kg	--	-	<0.005	<0.005	11	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500 [4]	-	$7.0x10^{-3}$	0.01	11	0	No	Maximum < Human health guideline
Pyrene	mg/kg	78 [2]	-	<0.005	<0.005	11	0	No	All measurements below MDL
Quinoline	mg/kg	2.5 [4]	-	<0.01	<0.01	11	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected that are accessible are included (i.e. 0.1-0.2 mbgs).

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 – Part 2).

-- No value available.

Table 6.3 Human health screening for COCs in soil – BTEX and PHCs – Coppermine WK210

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
BTEX									
Benzene	mg/kg	110	-	<0.005	<0.005	13	0	No	All measurements below MDL
Ethylbenzene	mg/kg	10,000	-	0.02	0.03	13	0	No	Maximum < Human health guideline
Toluene	mg/kg	20,000	-	<0.05	<0.05	13	0	No	All measurements below MDL
Xylenes, total	mg/kg	150,000	-	0.07	0.32	13	0	No	Maximum < Human health guideline
PHCs									
F1 (C6-C10)	mg/kg	12,000	-	19	76	13	0	No	Maximum < Human health guideline
F2 (C10-C16)	mg/kg	6,800	-	300	1,700	11	0	No	Maximum < Human health guideline
F3 (C16-C34)	mg/kg	15,000	-	252	650	11	0	No	Maximum < Human health guideline
F4 (C34-C50)	mg/kg	21,000	-	<50	<50	11	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected that are accessible are included (i.e. 0.1-0.2 mbgs).

[1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

6.1.1.2 Surface Water

A summary of the surface water screening is presented for metals in Table 6.4.

Contaminants were screened in surface water following a tiered approach discussed in Section 3.2.

Beryllium, chromium, cobalt, copper, lead, lithium, mercury, molybdenum, phosphorus, selenium, silver, strontium, thallium, uranium, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX were not identified as COCs as all concentrations were below the MDL.

Aluminium, arsenic, barium, boron, copper, iron, manganese, molybdenum, sodium, strontium, tin, and uranium were not identified as COCs as the maximum measured concentration was below the drinking water guideline.

Guidelines for the protection of human health were not available for calcium, magnesium, or potassium. These elements are generally considered innocuous to human health, are dietary elements, and have Dietary Reference Intake values assigned to them by Health Canada. It is assumed that a complete lack of guidelines is reflective of a chemical being generally innocuous or uncommon, or that there is an absence of toxicological information in the medium.

Thus, no COCs were identified in surface water and no further analysis was required for the HHRA.

Table 6.4 Human health screening for COCs in surface water – total metals – Coppermine WK210

Contaminant	Units	Guideline [1]	Average Concentration		Maximum Concentration	N	N > Guideline	COC for Human Health?	Rationale
			Back-ground	Site					
Aluminum	mg/L	2.9	-	$5.0x10^{-3}$	$6.0x10^{-3}$	2	0	No	Maximum < Human health guideline
Antimony	mg/L	0.006	-	$1.0x10^{-3}$	$9.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Arsenic	mg/L	0.01	-	$2.0x10^{-4}$	$2.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Barium	mg/L	1	-	0.13	0.13	2	0	No	Maximum < Human health guideline
Beryllium	mg/L	0.004 [3]	-	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	5	-	0.03	0.04	2	0	No	Maximum < Human health guideline
Cadmium	mg/L	0.005	-	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	--	-	16	17	2	0	No	No guideline
Chromium	mg/L	0.05	-	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.14	-	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	1	-	<0.001	<0.001	2	0	No	All measurements below MDL
Iron	mg/L	0.3	-	0.08	0.09	2	0	No	Maximum < Human health guideline
Lead	mg/L	0.01	-	<0.0002	<0.0002	2	0	No	All measurements below MDL
Lithium	mg/L	--	-	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	--	-	10	11	2	0	No	No guideline
Manganese	mg/L	0.12	-	$9.0x10^{-3}$	$9.0x10^{-3}$	2	0	No	Maximum < Human health guideline
Mercury	mg/L	0.001	-	<0.000002	<0.000002	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.01 [2]	-	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.078 [2]	-	0.0	$6.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Phosphorus	mg/L	194 [2]	-	<0.003	<0.003	2	0	No	All measurements below MDL
Potassium	mg/L	--	-	0.29	0.42	2	0	No	No guideline
Selenium	mg/L	0.05	-	<0.0002	<0.0002	2	0	No	All measurements below MDL
Silver	mg/L	--	-	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	200	-	1.3	1.4	2	0	No	Maximum < Human health guideline
Strontium	mg/L	2.5 [4]	-	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	--	-	<0.2	<0.2	2	0	No	All measurements below MDL
Thallium	mg/L	0.002 [3]	-	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	2.5 [4]	-	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	--	-	<0.001	<0.001	2	0	No	All measurements below MDL
Uranium	mg/L	0.02	-	<0.0001	<0.0001	2	0	No	All measurements below MDL
Vanadium	mg/L	0.0172 [2]	-	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	5	-	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL

[1] Health Canada (2022) drinking water quality guideline.
[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.
[3] U.S. EPA (2023) maximum contaminant level (MCL) for drinking water for human health.
[4] Government of British Columbia (2023) Generic Numerical Water Standards, drinking water (Schedule 3.2).

6.1.1.3 Sediment

There are no Federal or Provincial sediment quality guidelines for the protection of human health. Human contact with sediments is considered to be minimal at the Site. Sediments are not discussed further for the HHRA.

6.1.2 Risk Characterization

As indicated above, the maximum measured concentrations in soils and surface water from the Site do not exceed human health guidelines indicating that the Site is safe to be used by people undertaking any type of activity.

6.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, the assumptions underlying the qualitive assessment are discussed below.

Table 6.5 Summary of assumptions and uncertainty associated with the HHRA – Coppermine WK210

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil and surface water were considered to be sufficiently characterized.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Use of samples collected at depth of 0.1 m to 0.2 m, 0.2 m to 0.2 m, and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil and surface water.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

6.2 Ecological Risk Assessment

6.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Coppermine WK210 Site.

6.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. 0.1 mbgs to 0.2 mbgs, 0.2 mbgs to 0.2 mbgs, and 0.2 mbgs to 0.3 mbgs which are the shallowest depths of samples collected. For PAHs, BTEX, and PHCs, the screening process only considered data for soil samples collected from and 0.1 mbgs to 0.2 mbgs and 0.2 mbgs to 0.2 mbgs, which are the shallowest depths of samples collected. For VOCs, the only available sample at a depth of 0.2 mbgs to 0.2 mbgs was screened. As discussed in the HHRA, it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQG_{Eco}, agricultural land use. In the absence of CCME guidelines, alternate sources were considered; these are identified in footnotes in Table 6.6 (metals), Table 6.7 (PAHs) and Table 6.8 (BTEX and PHCs).

As discussed in Section 2, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium. Therefore, while copper exceeds the ecological guideline it is considered to be naturally occurring.

Antimony, chromium (hexavalent), mercury, silver, thallium, tin, all PAHs with the exception of naphthalene, benzene, toluene, and PHC F4 and all VOCs were measured below the MDL and not considered present at the Site. As seen in the tables below, the six of 11 samples of barium had concentrations that were above the SQG_{Eco} and are discussed further in the ERA.

Two samples (1 sample and its duplicate) of naphthalene at TP5A exceeded the SQG_{Eco} at a depth of 0.2m. This is one localized sample and does not represent a risk to ecological populations at the Site.

PHCs do not move up the food chain and only represent a risk to plants. Two samples (1 sample and its duplicate) of PHC F2 exceeded the SQG_{Eco}. This sample was located at TP5A a depth of 0.2 m and represents a localized sample which does not represent a risk to plant populations at the Site. . Five (5) samples of PHC F3 exceeded the SQG_{Eco} and are discussed further in the ERA.

In summary, barium and PHC F3 are identified for further consideration.

Table 6.6 ERA screening for COCs in soil – total metals – Coppermine WK210

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	<0.5	<0.5	11	0	No	All measurements below MDL
Arsenic	mg/kg	17	2.6	2.1	3.2	11	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	335	422	730	11	6	**Yes**	**Maximum > Ecological guideline**
Beryllium	mg/kg	4	0.50	0.44	0.52	11	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	0.47	0.62	1.5	11	0	No	Maximum < Ecological guideline
Cadmium	mg/kg	10	0.05	0.11	0.22	11	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	40	28	55	11	0	No	Maximum < Ecological guideline
Chromium (hexavalent)	mg/kg	0.4	<0.08	<0.08	<0.08	11	0	No	All measurements below MDL
Cobalt	mg/kg	40	9.1	7.1	12	11	0	No	Maximum < Ecological guideline
Copper	mg/kg	63	39	49	69	11	1	No	Natural enrichment
Lead	mg/kg	70	8.3	6.5	11	11	0	No	Maximum < Ecological guideline
Mercury	mg/kg	12	<0.05	<0.05	<0.05	11	0	No	All measurements below MDL
Molybdenum	mg/kg	5	0.39	0.42	0.69	11	0	No	Maximum < Ecological guideline
Nickel	mg/kg	45	28	24	39	11	0	No	Maximum < Ecological guideline
Selenium	mg/kg	1	<0.5	<0.5	<0.5	11	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	11	0	No	All measurements below MDL
Thallium	mg/kg	1	0.12	0.11	0.14	11	0	No	Maximum < Ecological guideline
Tin	mg/kg	5	<1	<1	<1	11	0	No	All measurements below MDL
Uranium	mg/kg	33	1.3	1.8	4.1	11	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	51	36	63	11	0	No	Maximum < Ecological guideline
Zinc	mg/kg	250	47	48	110	11	0	No	Maximum < Ecological guideline

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; data from samples collected that are accessible are included (i.e. 0.1-0.2 mbgs and 0.2-0.2mbgs) except background samples (0.2-0.3 mbgs).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 6.7 ERA screening for COCs in soil – PAHs – Coppermine WK210

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
1-Methylnaphthalene	mg/kg	--	-	0.29	2.3	11	--	No	Highly censored only 1 out of 11 samples >MDL
2-Methylnaphthalene	mg/kg	--	-	0.01	0.07	11	--	No	Highly censored only 1 out of 11 samples >MDL
Acenaphthene	mg/kg	0.28	-	$7.8x10^{-3}$	0.02	11	0	No	Maximum < Ecological guideline
Acenaphthylene	mg/kg	320	-	0.01	0.04	11	0	No	Maximum < Ecological guideline
Acridine	mg/kg	--	-	<0.01	<0.01	11	0	No	All measurements below MDL
Anthracene	mg/kg	2.5	-	<0.004	<0.004	11	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.1	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	20	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	-	<0.005	<0.005	11	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	11	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	-	<0.005	<0.005	11	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	-	<0.005	<0.005	11	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	-	<0.005	<0.005	11	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	-	<0.005	<0.005	11	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	-	<0.005	<0.005	11	0	No	All measurements below MDL
Naphthalene	mg/kg	0.013	-	0.03	0.16	11	2	No	Localized exceedance;of one sample at TP5A (QA/QC sample)
Perylene	mg/kg	--	-	<0.005	<0.005	11	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	-	$6.9x10^{-3}$	0.01	11	0	No	Maximum < Ecological guideline
Pyrene	mg/kg	7.7	-	<0.005	<0.005	11	0	No	All measurements below MDL
Quinoline	mg/kg	0.1	-	<0.01	<0.01	11	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected that are accessible are included (i.e. 0.1-0.2 mbgs).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

Table 6.8 ERA screening for COCs in soil – BTEX and PHCs – Coppermine WK210

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	25	-	<0.005	<0.005	13	0	No	All measurements below MDL
Ethylbenzene	mg/kg	55	-	0.02	0.03	13	0	No	Maximum < Ecological guideline
Toluene	mg/kg	75	-	<0.05	<0.05	13	0	No	All measurements below MDL
Xylenes, total	mg/kg	65	-	0.07	0.32	13	0	No	Maximum < Ecological guideline
PHCs									
F1 (C6-C10)	mg/kg	210	-	19	76	13	0	No	Maximum < Ecological guideline
F2 (C10-C16)	mg/kg	150	-	300	1,700	11	2	No	Localized exceedance at TP 5A (QA/QC sample).
F3 (C16-C34)	mg/kg	300	-	252	650	11	5	**Yes**	**Maximum > Ecological guideline**
F4 (C34-C50)	mg/kg	2800	-	<50	<50	11	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; data from samples collected that are accessible are included (i.e. 0.1-0.2 mbgs).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

6.2.1.2 Surface Water

The surface water COC screening process identified the COCs in the adjacent unnamed lake to be considered further in the aquatic ERA. The CCME (2023) long term WQGs for the protection of freshwater aquatic life were used as the screening criteria.

The surface water screening for metals is shown in Table 6.9. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs and are not included herein.

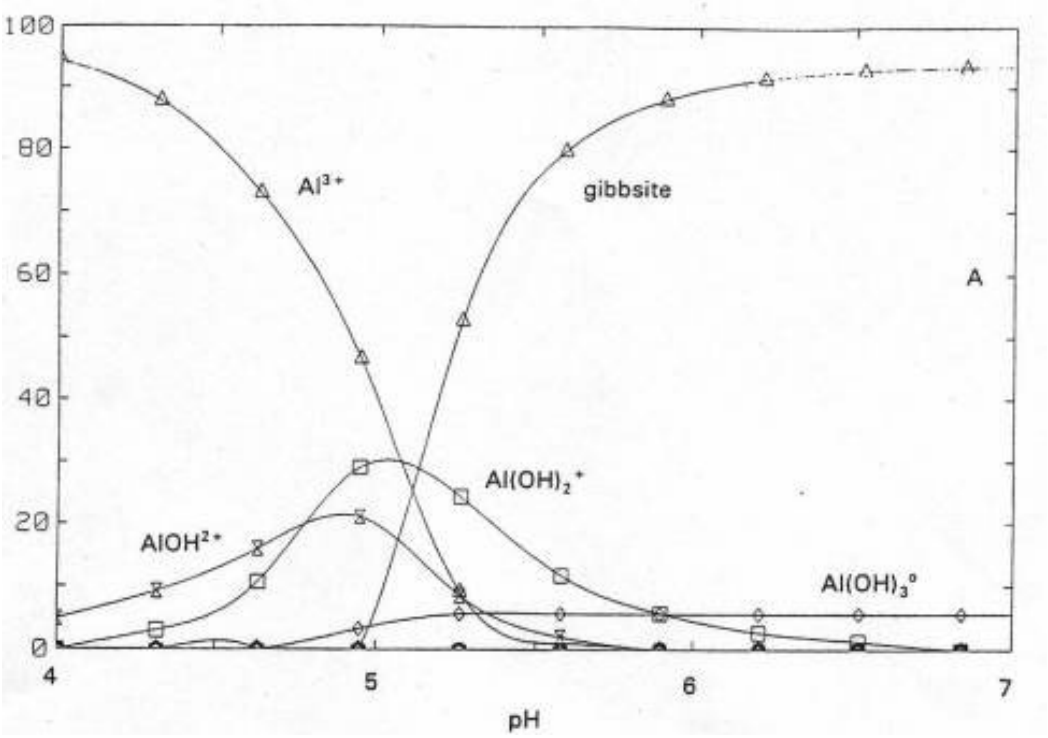
All samples were below the MDL for beryllium, chromium, cobalt, copper, lead, lithium, mercury, molybdenum, phosphorus, selenium, silver, strontium, thallium, uranium, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX.

A comparison of maximum measured concentrations to the WQGs indicated that arsenic, barium, boron, calcium, iron, magnesium, manganese, molybdenum, potassium, sodium, strontium, sulphur, tin, titanium, and uranium had maximum measured levels that were lower than the guidelines and therefore were not considered further as they do not present a risk to aquatic life.

Although the maximum concentration of aluminum is above the guideline, additional considerations were included in the final determination for whether aluminum was a COC. Aluminum is complexed by both inorganic and organic ligands in water (Figure 6.1). Below a pH of 6, organic complexes and the hydrated free ion tend to be the principal forms. At higher pH values, the dissolved species are only a small fraction of the total aluminum present since most of the aluminum is in a particulate form, which is inaccessible and therefore much less toxic than dissolved aluminum. At pH values between 5.5 and 9, there is very little aluminum that is in true solution and available for uptake by biological species (Gardner et al. 2002). Since the pH values from four samples in the lake ranged from 6.33 to 6.67, aluminum is not present in an available (toxic) form and was not considered to be a COC.

In summary, no COCs were identified for further evaluation in the ERA for surface water.

Figure 6.1 Aluminum speciation in water from pH 4 to 7



Note: from Gensemer and Playle (1999).

Table 6.9 ERA screening for COCs in surface water – total metals – Coppermine WK210

Contaminant	Units	WQG [1]	Concentration			N	N > WQG	COC for Ecological Health?	Rationale
			Background	Site Average	Maximum				
Aluminum	mg/L	0.005	$3.2x10^{-3}$	$5.0x10^{-3}$	$6.0x10^{-3}$	2	1	No	Not bioavailable
Antimony	mg/L	0.02 [2]	<0.0006	$1.0x10^{-3}$	$9.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Arsenic	mg/L	0.005	<0.0002	0.0	$2.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Barium	mg/L	1 [3]	0.12	0.13	0.13	2	0	No	Maximum < Ecological guideline
Beryllium	mg/L	0.00013 [3]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	1.5	0.04	0.03	0.04	2	0	No	Maximum < Ecological guideline
Cadmium	mg/L	0.00011	<0.00002	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	1,000	15	16	17	2	0	No	Maximum < Ecological guideline
Chromium	mg/L	0.0089 [6]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.004 [5]	<0.0003	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	0.002 [7]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Iron	mg/L	0.3	<0.06	0.08	0.09	2	0	No	Maximum < Ecological guideline
Lead	mg/L	0.001 [7]	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	82 [4]	9.5	10	11	2	0	No	Maximum < Ecological guideline
Manganese	mg/L	0.2 [5]	$5.5x10^{-3}$	$9.0x10^{-3}$	$9.3x10^{-3}$	2	0	No	Maximum < Ecological guideline
Mercury	mg/L	$2.6x10^{-5}$	<0.0000019	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.073	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.025 [7]	<0.0005	0.0	$6.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Phosphorus	mg/L	0.01 [2]	<0.1	<0.003	<0.003	2	0	No	All measurements below MDL
Potassium	mg/L	53 [4]	0.35	0.29	0.42	2	0	No	Maximum < Ecological guideline
Selenium	mg/L	0.001	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Silver	mg/L	0.00025	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	680 [4]	1.2	1.3	1.4	2	0	No	Maximum < Ecological guideline
Strontium	mg/L	21	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	1,000	<0.2	<0.2	<0.2	2	0	No	All measurements below MDL
Thallium	mg/L	0.0008	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	0.18 [4]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	1 [5]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Uranium	mg/L	0.015	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Vanadium	mg/L	0.12	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	0.03	<0.003	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) water quality guideline for the protection of aquatic life (freshwater).

[2] Ontario Provincial Water Quality Objective (MOEE 1994); interim value and should be used with caution.
[3] BC MOE (2021) working or approved water quality guidelines.
[4] U.S. EPA (2015) Region 4 supplemental risk assessment guidance, surface water screening values, chronic, Table 1a.
[5] Government of British Columbia (2023) Generic Numerical Water Standards, aquatic life (Schedule 3.2).
[6] Guideline is for trivalent chromium.
[7] Based on water hardness of less than 82 mg/L $CaCO_3$ (copper) and less than 60 mg/L $CaCO_3$ (lead, nickel).

6.2.1.3 Sediment

Four sediment samples were collected along the shore of the waterbody at the Site.

The sediment screening process is summarized for metals in Table 6.10 (metals), Table 6.11 (PAHs), and Table 6.12 (PHCs and BTEX). For the screening process the CCME (2023) ISQGs were used as the screening criteria. In the absence of an ISQG, available sediment criteria from other jurisdictions were used as indicated in the footnotes to the tables.

A comparison to the MDL indicated that antimony, beryllium, chromium (hexavalent), mercury, selenium, silver, thallium, tin, zinc, all PAHs, BTEX, and PHC F1 had all measurements less than the MDL and were not considered further.

The concentrations of cadmium, cobalt, iron, lead, nickel, and uranium were all below the ISQG and were also not considered further.

Two contaminants were measured at detectable concentrations but had no ISQG available, including barium, and boron (hot water soluble). Since none of these contaminants are associated with historical Site activities and were not identified as COCs in soil or surface water, they are also not expected to be a concern to benthic invertebrate communities and were not identified as COCs in sediment.

The maximum concentration of arsenic (8.4 mg/kg) was above the ISQG. However, as the concentration is below the PEL of 17 mg/kg it is not considered a COC in sediment.

The maximum concentration of PHC F2 exceeded the guideline at the Sed2 location and the maximum concentrations of PHC F3 and F4 exceeded the guidelines at Sed4. Thus, PHC F2, F3 and F4 in sediments are discussed further.

Table 6.10 ERA screening for COCs in sediment – total metals – Coppermine WK210

Contaminant	Units	ISQG [1]	Concentration			N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background Average	Average Site	Maximum				
Antimony	mg/kg	25 [3]	<0.5	<2	<2	4	0	No	All measurements below MDL
Arsenic	mg/kg	5.9	1.3	5.6	8.4	4	2	No	Below PEL
Barium	mg/kg	--	85	643	720	4	0	No	No guideline
Beryllium	mg/kg	--	<0.4	<1.6	<1.6	4	0	No	All measurements below MDL
Boron, hot water soluble	mg/kg	--	0.31	3.8	4.2	4	0	No	No guideline
Cadmium	mg/kg	0.6	<0.05	0.16	0.23	4	0	No	Maximum < Ecological guideline
Chromium	mg/kg	37.3	24	2.7	4.9	4	0	No	Maximum < Ecological guideline
Chromium (hexavalent)	mg/kg	--	<0.08	0.30	<0.66	4	0	No	All measurements below MDL
Cobalt	mg/kg	50 [4]	8.0	5.5	9.2	4	0	No	Maximum < Ecological guideline
Copper	mg/kg	35.7	26	31	38	4	1	No	Naturally occurring
Lead	mg/kg	35	5.2	2.6	5.3	4	0	No	Maximum < Ecological guideline
Mercury	mg/kg	0.17	<0.05	<0.2	<0.2	4	0	No	All measurements below MDL
Molybdenum	mg/kg	13.8 [6]	<0.4	<1.6	<1.6	4	0	No	All measurements below MDL
Nickel	mg/kg	16 [5]	21	7.6	9.8	4	0	No	Maximum < Ecological guideline
Selenium	mg/kg	2 [3]	<0.5	<2	<2	4	0	No	All measurements below MDL
Silver	mg/kg	0.5 [4]	<0.2	<0.8	<0.8	4	0	No	All measurements below MDL
Thallium	mg/kg	--	<0.1	<0.4	<0.4	4	0	No	All measurements below MDL
Tin	mg/kg	--	<1	<4	<4	4	0	No	All measurements below MDL
Uranium	mg/kg	100 [2]	0.44	1.6	2.0	4	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	--	51	13	17	4	0	No	Site average < background average
Zinc	mg/kg	123	36	<40	<40	4	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

[2] U.S. EPA (2015) Region 4 soil and freshwater sediment screening benchmarks.

[3] Nova Scotia Environment (2014), freshwater sediment

[4] MOE (2011a) Table 1 Full Depth Background Site Condition Standards Ground Water Condition.

[5] MOE (2008) lowest effect level sediment quality guideline, Table 1.

[6] Thompson et al. (2005) lowest effect level.

Table 6.11 ERA screening for COCs in sediment – PAHs – Coppermine WK210

Contaminant	Units	ISQG [1]	Concentration			N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background Average	Site Average	Maximum				
1-Methylnaphthalene	mg/kg	0.0202	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	0.0202	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Acenaphthene	mg/kg	0.00671	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Acenaphthylene	mg/kg	0.00587	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Acridine	mg/kg	--	<0.01	0.03	<0.071	4	0	No	All measurements below MDL
Anthracene	mg/kg	0.0469	<0.004	0.01	<0.028	4	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.0317	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	0.0319	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	--	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	0.02	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	--	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Chrysene	mg/kg	0.0571	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.00622	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Fluoranthene	mg/kg	0.111	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Fluorene	mg/kg	0.0212	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	0.02	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Naphthalene	mg/kg	0.0346	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.0419	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Pyrene	mg/kg	0.053	<0.005	0.02	<0.036	4	0	No	All measurements below MDL
Quinoline	mg/kg	--	<0.005	0.02	<0.036	4	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

Table 6.12 ERA screening for COCs in sediment – BTEX and PHCs – Coppermine WK210

Contaminant	Units	ISQG [1]	Concentration			N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background Average	Site Average	Maximum				
BTEX									
Benzene	mg/kg	1.2	<0.005	0.03	<0.063	4	0	No	All measurements below MDL
Ethylbenzene	mg/kg	1.2	<0.01	0.04	<0.095	4	0	No	All measurements below MDL
Toluene	mg/kg	1.4	<0.05	0.11	<0.24	4	0	No	All measurements below MDL
Xylenes, total	mg/kg	1.3	<0.045	0.28	<0.59	4	0	No	All measurements below MDL
Petroleum Hydrocarbons									
F1 (C6-C10)-BTEX	mg/kg	15	<10	46	<98	4	4	No	All measurements below MDL
F1 (C6-C10)	mg/kg	15	<10	46	<98	4	4	No	All measurements below MDL
F2 (C10-C16)	mg/kg	25	<10	70	160	4	3	**Yes**	**Maximum > ecological guideline**
F3 (C16-C34)	mg/kg	43	41	1,325	2,000	4	4	**Yes**	**Maximum > ecological guideline**
F4 (C34-C50)	mg/kg	43	<50	363	590	4	4	**Yes**	**Maximum > ecological guideline**

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] Atlantic Risk Based Corrective Action (Atlantic RBCA 2023) Ecological Tier I environmental quality standards for freshwater sediment.

6.2.1.4 Summary

In summary, barium and PHC F3 concentrations in soil are discussed further in the ERA. As there is a limited spatial extent of these COC in soil (only at TP7A and 8A), no SAR are considered to be at risk from exposure at the Site.

No COCs were identified in the surface water and thus there is no exposure or risk to aquatic receptors.

PHC F2, F3 and F4 in sediments are discussed further in the ERA.

6.2.2 Exposure Assessment

The evaluation of potential effects of barium and PHC on terrestrial plants is based on soil concentrations as well as site observations.

Food web transfer does not occur in the PHC fractions. Most PHCs do not accumulate in animal tissues as they are metabolized by vertebrates and modified into a more readily excretable form. In addition, PHCs are not readily absorbed and accumulated into plant tissues. Therefore, the consumption of plants or other biota does not tend to constitute the major component of exposure to PHCs in wildlife (CCME 2008) and PHCs were only evaluated for their impacts on plants/earthworms and sediment dwelling benthic invertebrates.

For wildlife, the soil quality guideline which is based on a food chain model is used to determine whether barium poses a risk to wildlife.

6.2.2.1 Soil Concentrations

For the evaluation of barium, the maximum measured concentration in soil was compared to the CCME soil quality guideline which is a provisional guideline from 1991 as there is insufficient data to calculate an ecological guideline. Only shallow samples were considered as vegetation and wildlife are not exposed to the deeper contamination. Only 2 of the samples at shallow depth exceed the guideline. These are located at TP7A and TP8A. Similarly, the PHC F3 concentrations at TP7A and 8A exceeds the ecological guidelines for the protection of plants and invertebrates. It is noted that the guideline is based on the protection of crops such as corn, alfalfa, oats and barley, which are not representative of the native species found at the Site.

6.2.3 Effects Assessment

6.2.3.1 Effects Assessment Methods

The effects assessment provides the concentration (or intake) of a COC that is associated with an adverse effect. These concentrations or intakes (i.e., TRVs) represent the exposure that is considered to pose negligible risk of adverse effect for a given COC. This section discusses the TRVs that are used in this assessment.

Vegetation and Invertebrates

Potential effects from exposure to barium in the soil for terrestrial biota were evaluated through comparison of measured concentrations in soil to the soil concentrations from ecological toxicity studies on plants and invertebrates based on soil contact using data from toxicity studies on plants. Potential effects from exposure to barium in the soil for terrestrial biota were evaluated through comparison of measured concentrations in soil to the plant and earthworm component of the Ontario Ministry of Environment Conservation and Parks (MOE 2011b). These values are deemed appropriate because they represent the 25th percentile of the toxicity values of the literature based studies. The MECP toxicity studies were for crops such as corn, alfalfa, oats and barley which are not native to the Speers Lake area. The value that is protective of plants and earthworms for barium is 1000 mg/kg. For PHC F3, the ecological protection of plants (crops) is 300 mg/kg for coarse textured soil and 1300 mg/kg for fine textured soil.

Mammals and Birds

Potential effects from exposure to barium in the soil for mammals and birds were evaluated through comparison of measured concentrations in soil to the mammal and bird component of the Ontario Ministry of Environment Conservation and Parks (MOE 2011b). These values are deemed appropriate since the CCME did not derive soil concentrations protective of mammals and birds. Soil protection levels for 3 mammalian species and 3 bird species are provided in Table 6.13.

Table 6.13 Barium TRVs for mammals and birds

Species	TRV (mg/kg soil)	Source
Mammals		
Short-tailed shrew	390	(MOE 2011b)
Meadow Vole	4950	(MOE 2011b)
Red fox	6750	(MOE 2011b)
Birds		
Redwing blackbird	672	(MOE 2011b)
American woodcock	689	(MOE 2011b)
Red tailed hawk	11,900	(MOE 2011b)

Sediment Toxicity Benchmarks

For the evaluation of PHCs in sediment, benchmarks were derived based on a sediment toxicity study prepared for the Massachusetts Department of Environmental Protection (MADEP) by BATTELLE (BATTELLE 2007). The approach used for the PHC fractions is similar to the approach used for the BTEX whereby an equilibrium partitioning model was used. The approach for the PHC fractions involved the use of chronic toxicity values from surface water, K_{oc} and f_{oc}. Sediment partitioning benchmarks for four aliphatic and four aromatic fractions were derived based on a f_{oc} of 0.001. The four hydrocarbon fractions were C5 to C8, C9 to C12, C13 to C18 and C19 to C36. For the purposes of this assessment the values were adjusted for the site-specific f_{oc} of 0.5 and the aromatic and aliphatic fractions were combined to derive values for the F2 and F3 fractions. Thus, the benchmarks associated with the BATELLE study were multiplied by a factor of 500. There are no benchmarks for PHC F4. F2 was assumed to encompass C13 to C18 and F3 encompassed C19 to C36. It is acknowledged that not all the carbon fractions have been accounted for in the assumption for the fractions, but the major ones are covered.

Table 6.14 Sediment benchmarks for PHCs

COPC	Sediment Benchmark (mg/kg)
PHC F2	2280
PHC F3	3960

Notes: derived from information provided in BATTELLE (2007).

6.2.4 Risk Characterization

Risk characterization determines the potential for negative health effects or risks to populations of ecological receptors. This is done by combining the findings of the exposure assessment with the findings of the toxicity assessment to determine potential risk.

6.2.4.1 Terrestrial Plants and Invertebrates

The evaluation for terrestrial vegetation is based on comparison of barium and PHC F2 soil concentrations to appropriate benchmarks considered to be protective of vegetation and invertebrates.

Soil Chemistry

As discussed earlier, the maximum concentration in barium in soil exceeded the CCME agricultural guideline. This guideline is a provisional guideline as there were not enough toxicity data to derive an ecological guideline protective of vegetation. The barium soil concentrations at locations which exceed the agricultural guideline range from 510 mg/kg to 730 mg/kg. These concentrations are below the toxicity value of 1000 mg/kg which represents the 25th percentile of the toxicity values of the literature based on the protection of crops such as corn, alfalfa, oats and barley.

For PHC F3, concentrations at 5 locations exceed the CCME ecological guidelines for the protection of plants and invertebrates. The concentrations range from 310 mg/kg to 650 mg/kg, which are above the ecological guideline of 300 mg/kg. These concentrations in some samples are not much higher than the guideline for coarse soil texture of 300 mg/kg and below the protection value for fine textured soil of 1300 mg/kg. The photographs below show an example of the vegetation present at the location of TP7A. As seen from the photos, there is tundra type vegetation growing where the sample was taken. This indicates that vegetation is not being affected by the PHC F3 present in the soil at TP7A which is where the highest PHC F3 was found in shallow soil. This indicates that vegetation populations are not being affected by the PHC F3 concentrations measured in soil.

Photograph 6.1 Soil sampling location TP8A

Summary

Table 6.15 summarizes the information from the barium and PHC F2 in soil chemistry to determine a potential effect on vegetation and soil invertebrates at the Site.

Table 6.15 Summary of evaluation for vegetation and soil invertebrates – Coppermine WK210

Assessment Endpoint	Line of Evidence	Measurement Endpoint
Maintenance of the health and ecological integrity of vegetation and soil invertebrate communities.	Soil Chemistry	The maximum soil concentration for barium is below the ecological toxicity value for crops such as corn, alfalfa, oats and barley. For PHC F3, the maximum PHC F3 concentration is above the ecological toxicity value for crops. However, site observations demonstrate that vegetation is growing well in the sampling locations at TP7A and TP8A.
Overall Assessment: The information presented indicates that barium and PHC F3 concentrations in soil that exceed the CCME guidelines at the Site do not result in adverse effects to vegetation or soil invertebrate communities present at the Site.		

6.2.4.2 Mammals and Birds

The evaluation of mammals and birds was only undertaken for barium as PHC F3 does not transfer up the food chain. The maximum concentration of barium in soil is 570 mg/kg. Table 6.16 provides a comparison of the maximum barium soil concentration against soil concentrations that are protective of different mammal and bird species. As seen in the table, the maximum barium concentration is below all the soil protection levels with the exception of the short-tailed shrew. It is noted that the TRV used to derive the protective soil concentration for the short-tailed shrew has a protection factor of 10 associated with it and therefore it is not expected that populations of shrews present at the Site will be at risk

from the limited area of barium in soil at TP7A and TP8A. Thus, populations of mammals and birds at the Site are not at risk.

Table 6.16 Comparison of maximum barium concentration in soil to TRVs for mammals and birds – Coppermine WK210

Species	TRV (mg/kg soil)	Maximum Barium Concentration (mg/kg soil)
Mammals		
Short-tailed shrew	390	570
Meadow Vole	4950	
Red fox	6750	
Birds		
Redwing blackbird	672	570
American woodcock	689	
Red tailed hawk	11,900	

Summary

Table 6.17 summarizes the information from the barium in soil chemistry to the soil protection value based on food chain calculations to determine a potential effect in wildlife at the Site.

Table 6.17 Summary of evaluation for wildlife – Coppermine WK210

Assessment Endpoint	Line of Evidence	Measurement Endpoint
Maintenance of the health and ecological integrity of wildlife that use the terrestrial areas across the Site.	Food chain model	The maximum soil concentration for barium is below the guideline protective for mammals and birds which was developed using a food chain model, with the exception of the short-tailed shrew. The localized area of barium exceedances at TP7A and TP8A are not expected to affect populations of shrews at the Site. In addition, there is a protection factor of 10 applied to the TRV used to develop the soil protection level.
Overall Assessment: The information presented indicates that barium concentrations in soil found at the Site do not result in adverse effects to wildlife populations present at the Site.		

6.2.4.3 Benthic Invertebrate Community

The quantitative assessment of the benthic invertebrate community along the shore of the unnamed lake was evaluated using a comparison of the maximum measured concentrations of PHC F2 and PHC F3 to sediment toxicity benchmarks. There are no sediment toxicity values available for PHC F4 as they have very low solubility and are likely not toxic to benthic organisms. For the purposes of this report, the maximum PHC F4 concentration in

sediments is compared to the toxicity of PHC F3. This is a conservative comparison as the PHC F3 fraction is considered to be more soluble than PHC F4.

The photos below show the nature of the sediment at Sed4 in the unnamed lake. As seen from the photos, the sediment is fairly coarse with cobbles and does not represent a great substrate for benthic organisms.

Photograph 6.2 Sediment sampling location Sed4

Figure 6.2 shows the four sediment sampling locations along with the one historical sediment sample location which is around the Sed1 location. A comparison of the historical sediment concentrations of PHC F2, PHC F3 and PHC F4 shows that the sediment concentrations have decreased since 2005. This is expected as weathering has occurred. Concentrations at Sed2 have the highest PHC concentrations. Site observations indicated that there may have been a drainage path from the tank area to the lake. PHC F2 concentrations at Sed3 and Sed4 are similar to the historical sediment sample and PHC F3 concentrations are similar to the historical sediment sample. PHC F4 concentrations are all lower than historical samples. It is noted that the organic content of these sediments is high as the f_{oc} is 0.46 as compared to typical sediment values which range from 0.001 to 0.01. The organic content could contribute to the PHC F3 and PHC F4 concentrations found at the Site.

Figure 6.2 Sediment sampling locations at Coppermine WK210

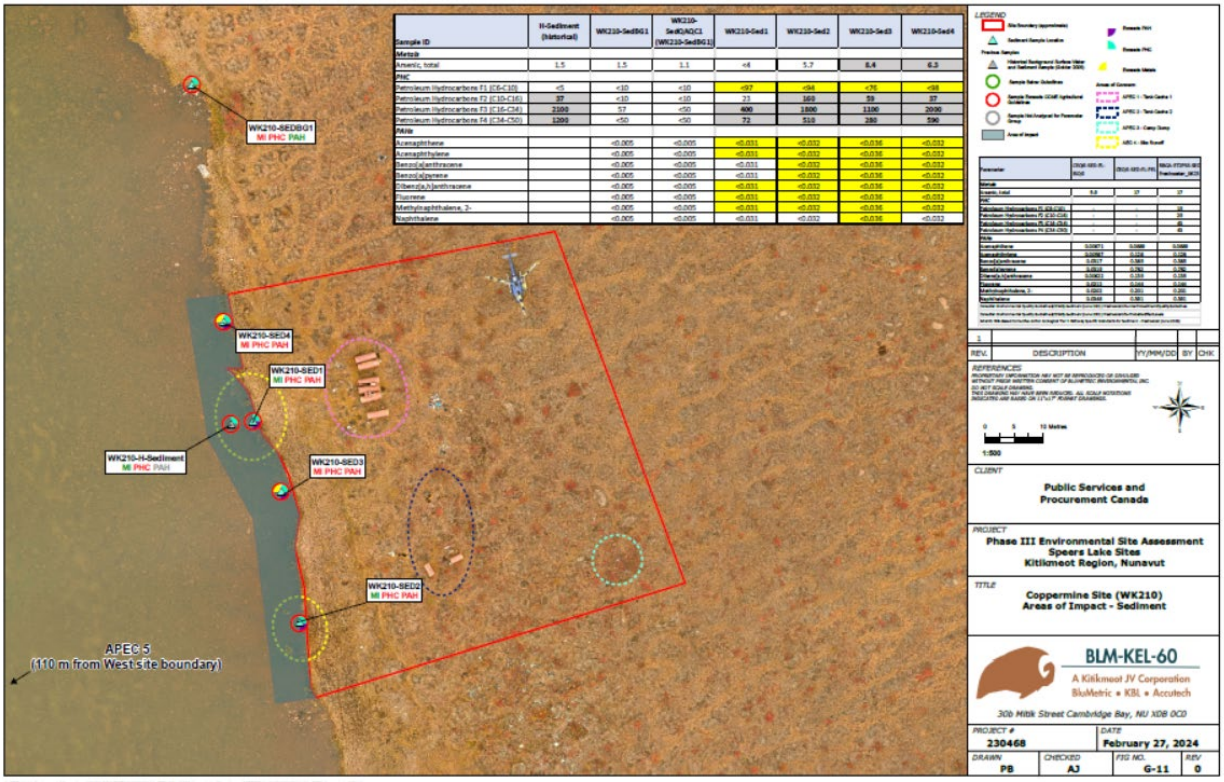


Table 6.18 shows a comparison of the maximum measured PHC concentrations to sediment benchmarks that have been adjusted for the organic carbon content. As seen from the table, the maximum measured concentrations are below the sediment benchmarks indicating that benthic communities (if present) are not at risk from PHC concentrations in sediment.

Table 6.18 Comparison of PHC sediment concentrations to sediment benchmarks – Coppermine WK210

COPC	Sediment Benchmark (mg/kg)	Maximum Sediment Concentration
PHC F2	2280	160
PHC F3	3960	2000
PHC F4	3960*	590

Notes: derived from information provided in BATTELLE 2007 adjusted for an f_{oc} of 0.46.
*Assumed that the sediment benchmark for PHC F4 was equivalent to PHC F3 in the absence of data

Summary

Table 6.19 summarizes the information from PHC sediment measurements to sediment benchmarks as well as site observations to determine a potential effect in benthic communities in the unnamed lake at the Site.

Table 6.19 Summary of Evaluation for Benthic Communities – Coppermine WK210

Assessment Endpoint	Line of Evidence	Measurement Endpoint
Maintenance of the health and ecological integrity of benthic communities in Unnamed Lake.	Sediment Chemistry	Concentrations of PHC in sediments have decreased since 2005 and are expected to continue decreasing as there is really no source at the Site. There is high organic content in the sediments which may account for some of the PHC measurements especially of F3 and F4. The maximum measured concentrations of PHC F2, F3 and F4 are below sediment benchmarks that have been adjusted for organic content.
Overall Assessment: The information presented indicates that PHC concentrations in sediment in Unnamed Lake at the Site do not result in adverse effects to benthic communities present.		

6.2.4.4 Overall Summary

Table 6.20 provides an overall summary of the assessment endpoints. The results show that there will be no risks to terrestrial wildlife, vegetation, or soil invertebrates at the Site. Additionally, there will be no risk to benthic communities in sediment in the Unnamed Lake.

Table 6.20 Summary of Results of ERA – Coppermine WK210

Assessment Endpoint	Result
Maintenance of the health and ecological integrity of vegetation and soil invertebrate communities.	Barium and PHC F3 concentrations in soil found at the Site do not result in adverse effects to vegetation or soil invertebrate communities present at the Site.
Maintenance of the health and ecological integrity of wildlife that use the terrestrial areas across the Site.	Barium concentrations in soil found at the Site do not result in adverse effects to wildlife populations present at the Site.
Maintenance of the health and ecological integrity of benthic communities in Unnamed Lake.	Concentrations of PHC in sediments have decreased since 2005 and are expected to continue decreasing as there is really no source at the Site. Benthic communities in sediments are not considered to be at risk in the Unnamed Lake.

6.2.5 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are

adequately protected in the absence of Site-specific information. Table 6.21 examines the assumptions in the ERA, comments on the level of uncertainty that should be assigned to findings and helps identify areas where future work may be required to reduce uncertainties. The conservative assumptions result in an overall overestimation of risk in this ERA; therefore, the associated uncertainties do not affect the conclusions of the assessment. The level of uncertainty is considered acceptable for the scope of this ERA.

Table 6.21 Summary of assumptions and uncertainty associated with the ERA – Coppermine WK210

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Phase III investigation collected samples to delineate and capture contamination at the Coppermine WK210 Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, sediment, and vegetation. Background soil and vegetation samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil, surface water, and sediment were considered to be sufficiently characterized.
Use of samples collected at depths of 0.1 m to 0.2 m, and 0.2 m to 0.2 m, and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally, contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. It is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening.	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year round and that crops are grown and cows and other farm animals are present. This is not the case at the Site. The use of the agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
The maximum concentrations for COCs were identified.	Low	Overestimate	Maximum concentrations were used in the screening process. The use of the maximum concentration assumes that this concentration is present across the Site and not in a localized area.
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Effects Assessment			
The applicability of the selected TRVs to the various exposure pathways for soil, sediments, and surface water.	Moderate	Overestimate	The TRVs applied in the ERA are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

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7.0 IMPACT LAKE WK176

This section provides the screening for soil contaminants since this is the only medium that was collected at the Impact Lake WK176 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

7.1 Human Health Risk Assessment

7.1.1 Identification if Contaminants of Concern for Human Health

7.1.1.1 Soil

The screening process only considered data for soil samples collected from 0.1 mbgs to 0.2 mbgs and 0.2 mbgs to 0.3 mbgs which are the shallowest depths of samples collected. Some of these depths are not accessible by humans but have been assumed to have the concentrations in soil to which humans are most likely to be exposed.

A summary of the COC screening in soil for human health is provided below in Table 7.1 (metals), Table 7.2 (PAHs), and Table 7.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables.

All carcinogenic PAHs were evaluated based on calculation of B[a]P TPE (CCME 2010). The CCME has not developed human health guidelines for the non-carcinogenic PAHs therefore the maximum concentration in soil samples for each non-carcinogenic PAH compound was compared to the soil component values available from Alberta, British Columbia, or Ontario.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium.

Contaminants were screened in soil following a tiered approach as discussed in Section 3.2.

Antimony, hexavalent chromium, mercury, selenium, silver, tin, B[a]P TPE, benzo[c]phenanthrene, benzo[e]pyrene, fluoranthene, perylene, pyrene, quinoline, benzene, and toluene were all measured below the MDL and were not identified as COCs.

Maximum concentrations of arsenic, barium, beryllium, hot water soluble boron, cadmium, chromium, cobalt, lead, molybdenum, nickel, thallium, uranium, zinc, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, acridine, anthracene, fluorene, naphthalene, phenanthrene, ethylbenzene, total xylenes, and PHCs F1, F2, and F3, all below the human health guidelines and were not identified as COCs.

PHC F2 was identified as having a maximum concentration above the human health guideline. The exceedance of PHC F2 occurred at one location (TP3A) identified as the site of an overturned barrel (JV-60 2024a), therefore this localized exceedance is not expected to be a risk for human health.

Thus, no COCs were identified in soil for the HHRA and no quantitative analysis was needed.

Table 7.1 Human health screening for COCs in soil – total metals – Impact Lake WK176

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	<0.5	<0.5	12	0	No	All measurements below MDL
Arsenic	mg/kg	12	2.9	1.3	2.1	12	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	220	83	200	12	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	0.44	0.22	0.42	12	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	0.13	0.26	2.1	12	0	No	Maximum < Human health guideline
Cadmium	mg/kg	14	0.05	0.03	0.12	12	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	45	25	56	12	0	No	Maximum < Human health guideline
Chromium (hexavalent)	mg/kg	3[5]	<0.08	<0.08	<0.08	12	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	12	6.7	9.3	12	0	No	Maximum < Human health guideline
Copper	mg/kg	1,100	40	12	25	12	0	No	Maximum < Human health guideline
Lead	mg/kg	140	8.2	4.1	5.0	12	0	No	Maximum < Human health guideline
Mercury	mg/kg	6.6	<0.05	<0.05	<0.05	12	0	No	All measurements below MDL
Molybdenum	mg/kg	110 [3]	0.34	0.25	0.75	12	0	No	Maximum < Human health guideline
Nickel	mg/kg	200	32	19	30	12	0	No	Maximum < Human health guideline
Selenium	mg/kg	80	<0.5	<0.5	<0.5	12	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	12	0	No	All measurements below MDL
Thallium	mg/kg	1	0.09	<0.1	<0.1	12	0	No	Maximum < Human health guideline
Tin	mg/kg	9,400 [2]	<1	<1	<1	12	0	No	All measurements below MDL
Uranium	mg/kg	23	0.86	0.48	1.3	12	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	60	39	52	12	5	No	Natural enrichment
Zinc	mg/kg	10,000	63	38	50	12	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples collected from 0.1-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of 1x10-*6; adjusted to a risk level of 1x10-5 (multiplied by 10) for consistency with Health Canada guidance.*

-- No value available.

Table 7.2 Human health screening for COCs in soil – PAHs – Impact Lake WK176

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	72 [2]	<0.005	1.3	16	12	0	No	Maximum < Human health guideline
2-Methylnaphthalene	mg/kg	72 [2]	<0.005	1.3	15	12	0	No	Maximum < Human health guideline
Acenaphthene	mg/kg	3900 [3]	<0.005	0.054	0.62	12	0	No	Maximum < Human health guideline
Acenaphthylene	mg/kg	7.8 [2]	<0.005	0.035	0.39	12	0	No	Maximum < Human health guideline
Acridine	mg/kg	--	<0.01	0.049	0.52	12	0	No	No guideline
Anthracene	mg/kg	24,000 [3]	<0.004	$8.0x10^{-3}$	0.07	12	0	No	Maximum < Human health guideline
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	<0.0071	<0.0071	<0.0071	12	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500 [3]	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Fluorene	mg/kg	720 [2]	<0.005	0.14	1.6	12	0	No	Maximum < Human health guideline
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	12	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360 [2]	<0.005	0.23	2.7	12	0	No	Maximum < Human health guideline
Perylene	mg/kg	--	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500 [4]	<0.005	0.094	1.1	12	0	No	Maximum < Human health guideline
Pyrene	mg/kg	78 [2]	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Quinoline	mg/kg	2.5 [4]	<0.01	<0.01	<0.01	12	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples collected from 0.1-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 - Part 2).

-- No value available.

Table 7.3 Human health screening for COCs in soil – BTEX and PHCs – Impact Lake WK176

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	110	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Ethylbenzene	mg/kg	10,000	<0.01	0.13	1.5	12	0	No	Maximum < Human health guideline
Toluene	mg/kg	20,000	<0.05	<0.05	<0.05	12	0	No	All measurements below MDL
Xylenes, total	mg/kg	150,000	<0.045	1.0	12	12	0	No	Maximum < Human health guideline
PHCs									
F1 (C6-C10)	mg/kg	12,000	<10	110	1,200	12	0	No	Maximum < Human health guideline
F2 (C10-C16)	mg/kg	6,800	<10	620	7,300	12	1	No	Single localized exceedance
F3 (C16-C34)	mg/kg	15,000	<50	240	1,500	12	0	No	Maximum < Human health guideline
F4 (C34-C50)	mg/kg	21,000	<50	57	410	12	0	No	Maximum < Human health guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples collected from 0.1-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

7.1.2 Risk Characterization

Risks to humans from exposure at the Site were qualitatively evaluated through the screening process in Section 7.1.1. As indicated in this section, the maximum measured concentrations of contaminants in soils from the Site do not exceed human health guidelines or background concentrations for all contaminants except PHC F2 which only exceeds at one location (TP3A) and does not represent a human health risk Therefore, the Site is safe to be used by people undertaking any type of activity.

7.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, there are some assumptions underlying the qualitive assessment as discussed below.

Table 7.4 Summary of assumptions and uncertainty associated with the HHRA – Impact Lake WK176

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil were considered to be sufficiently characterized. No surface water or sediment sampling was carried out in the nearby waterbody. Given that no COCs were identified in the soil screen it is unlikely that any contamination will be mobilized to the nearby waterbody.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Use of samples collected at depths of 0.1 m to 0.2 m and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the human health guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

7.2 Ecological Risk Assessment

7.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Impact Lake WK176 Site.

7.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. As was done for the HHRA, the screening process only considered data for soil samples collected from a depth of 0.1 mbgs to 0.2 mbgs and 0.2 mbgs to 0.3 mbgs. As discussed in the HHRA, this soil depth is too deep for ecological exposure, but it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQG_{Eco}, agricultural land use. In the absence of CCME guidelines, alternate sources were considered; these are identified in footnotes in Table 7.5 (metals), Table 7.6 (PAHs) and Table 7.7 (BTEX and PHCs).

Antimony, chromium (hexavalent), mercury, selenium, silver, tin, anthracene, benz[a]anthracene, benzo[a]pyrene, benzo[b,j]fluoranthene, benzo[c]phenanthrene, benzo[e]pyrene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-c,d]pyrene, perylene, pyrene, quinoline, benzene, and toluene were all measured below the MDL and were not considered to be COCs. Additionally, all VOCs were also measured below detection limits.

The maximum concentrations of the remaining metals, acenaphthylene, anthracene, ethylbenzene, total xylenes, and PHC F4 were below the SQG_{Eco} and thus were not identified as COCs. Acenaphthene, fluorene, naphthalene, phenanthrene, and PHCs F1 andF2 all exceeded ecological guidelines only at one location and PHC F3 exceeded ecological guidelines only at two locations at the site of an overturned barrel. These localized exceedances are not expected to be a risk for ecological populations.

In summary, the maximum concentrations of all contaminants were below the ecological guidelines or at localized areas, and do not represent a risk to the environment at the Site.

Table 7.5 ERA Soil COC Screen – total metals – Impact Lake WK176

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Ecological Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	<0.5	<0.5	12	0	No	All measurements below MDL
Arsenic	mg/kg	17	2.9	1.3	2.1	12	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	220	83	200	12	0	No	Maximum < Ecological guideline
Beryllium	mg/kg	4	0.44	0.22	0.42	12	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	0.13	0.26	2.1	12	0	No	Maximum < Ecological guideline
Cadmium	mg/kg	10	0.05	0.03	0.12	12	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	45	25	56	12	0	No	Maximum < Ecological guideline
Chromium (hexavalent)	mg/kg	0.4	<0.08	<0.08	<0.08	12	0	No	All measurements below MDL
Cobalt	mg/kg	40	12	6.7	9.3	12	0	No	Maximum < Ecological guideline
Copper	mg/kg	63	40	12	25	12	0	No	Maximum < Ecological guideline
Lead	mg/kg	70	8.2	4.1	5.0	12	0	No	Maximum < Ecological guideline
Mercury	mg/kg	12	<0.05	<0.05	<0.05	12	0	No	All measurements below MDL
Molybdenum	mg/kg	5	0.34	0.25	0.75	12	0	No	Maximum < Ecological guideline
Nickel	mg/kg	45	32	19	30	12	0	No	Maximum < Ecological guideline
Selenium	mg/kg	1	<0.5	<0.5	<0.5	12	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	12	0	No	All measurements below MDL
Thallium	mg/kg	1	0.09	<0.1	<0.1	12	0	No	Maximum < Ecological guideline
Tin	mg/kg	5	<1	<1	<1	12	0	No	All measurements below MDL
Uranium	mg/kg	33	0.86	0.48	1.3	12	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	60	39	52	12	0	No	Maximum < Ecological guideline
Zinc	mg/kg	250	63	38	50	12	0	No	Maximum < Ecological guideline

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples collected from 0.1-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 7.6 ERA Soil COC Screen – PAHs – Impact Lake WK176

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	--	<0.005	1.3	16	12	0	No	No guideline
2-Methylnaphthalene	mg/kg	--	<0.005	1.3	15	12	0	No	No guideline
Acenaphthene	mg/kg	0.28	<0.005	0.054	0.62	12	1	No	Localized exceedance
Acenaphthylene	mg/kg	320	<0.005	0.035	0.39	12	0	No	Maximum < Ecological guideline
Acridine	mg/kg	--	<0.01	0.049	0.52	12	0	No	Heavily censored
Anthracene	mg/kg	2.5	<0.004	$8.0x10^{-3}$	0.07	12	0	No	Maximum < Ecological guideline
Benz[a]anthracene	mg/kg	0.1	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	20	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	0.1	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	<0.005	0.14	1.6	12	1	No	Localized exceedance
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Naphthalene	mg/kg	0.013	<0.005	0.23	2.7	12	1	No	Localized exceedance
Perylene	mg/kg	--	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	<0.005	0.094	1.1	12	1	No	Localized exceedance
Pyrene	mg/kg	7.7	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Quinoline	mg/kg	0.1	<0.01	<0.01	<0.01	12	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

Table 7.7 ERA Soil COC Screen – BTEX and PHCs – Impact Lake WK176

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	25	<0.005	<0.005	<0.005	12	0	No	All measurements below MDL
Ethylbenzene	mg/kg	55	<0.01	0.13	1.5	12	0	No	Maximum < Ecological guideline
Toluene	mg/kg	75	<0.05	<0.05	<0.05	12	0	No	All measurements below MDL
Xylenes, total	mg/kg	65	<0.045	1.0	12	12	0	No	Maximum < Ecological guideline
PHCs									
F1 (C6-C10)	mg/kg	210	<10	110	1,200	12	1	No	Localized exceedance
F2 (C10-C16)	mg/kg	150	<10	620	7,300	12	1	No	Localized exceedance
F3 (C16-C34)	mg/kg	300	<50	240	1,500	12	2	No	Localized exceedance
F4 (C34-C50)	mg/kg	2800	<50	57	410	12	0	No	Maximum < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

7.2.2 Risk Characterization

As discussed in Section 7.2.1, the maximum concentrations of contaminants at the Impact Lake WK176 Site are below ecological guidelines or found to be localized and therefore do not represent a risk to populations of ecological receptors that may be present at the Site.

7.2.3 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are adequately protected in the absence of Site-specific information. As the maximum concentrations were below guidelines or at inaccessible depths, only a qualitative analysis was undertaken. Nevertheless, Table 7.8 examines the assumptions in of the ERA, underlying sampling and use of the guidelines.

Table 7.8 Summary of assumptions and uncertainty associated with the ERA – Impact Lake WK176

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Phase III investigation collected samples to delineate and capture soil contamination at the Impact Lake WK176 Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, and vegetation. Background soil and vegetation samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil were considered to be sufficiently characterized. No surface water or sediment sampling was carried out in the nearby waterbody. Given that there was only one area of localized impact it is unlikely that any contamination will be mobilized to the nearby waterbody.
Use of samples collected at depth of 0.1 m to 0.2 m and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to ecological receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening.	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year round, that crops are grown, and that farm animals are present. This is not the case at the Site. The use of agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption used to develop the guidelines is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.
Effect Assessment			
The applicability of the selected TRVs to the various exposure pathways for soil.	Moderate	Overestimate	The TRVs applied to derive the ecological guidelines are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

8.0 KENDALL RIVER WK165

This section provides the screening for soil, surface water, and sediment contaminants at the Kendall River WK165 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

8.1 Human Health Risk Assessment

8.1.1 Identification of Contaminants of Concern for Human Health

8.1.1.1 Soil

For all contaminants, the screening process considered data for soil samples collected at 0.2 mbgs to 0.3 mbgs, as well as a single sample from 0.4 mbgs to 0.5 mbgs for metals. These depths are not accessible by humans but have been assumed to have the concentrations in soil to which humans are most likely to be exposed.

A summary of the COC screening in soil for human health is provided below in Table 8.1(metals), Table 8.2 (PAHs), and Table 8.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium.

Contaminants were screened in soil following a tiered approach as discussed in Section 3.2.

Hexavalent chromium, mercury, molybdenum, selenium, and silver, all PAHs (except naphthalene), and PHC F1 were not identified as COCs as they were all measured below the MDL.

The maximum concentrations of the remaining contaminants were below the human health soil guidelines.

No COCs were identified in soil for the HHRA and therefore no quantitative analysis was required.

Table 8.1 Human health screening for COCs in soil – total metals – Kendall River WK165

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	0.44	1.1	12	0	No	Maximum < Human health guideline
Arsenic	mg/kg	12	2.0	3.8	11	12	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	131	393	820	12	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	<0.4	0.68	2.1	12	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	0.09	0.25	1.1	12	0	No	Maximum < Human health guideline
Cadmium	mg/kg	14	<0.05	0.04	0.07	12	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	21	32	92	12	0	No	Maximum < Human health guideline
Chromium (hexavalent)	mg/kg	3[5]	<0.08	<0.08	<0.08	12	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	6.7	11	34	12	1	No	Natural enrichment
Copper	mg/kg	1,100	8.5	14	40	12	0	No	Maximum < Human health guideline
Lead	mg/kg	140	5.6	10	26	12	0	No	Maximum < Human health guideline
Mercury	mg/kg	6.6	<0.05	<0.05	<0.05	12	0	No	All measurements below MDL
Molybdenum	mg/kg	110 [3]	<0.4	<0.4	<0.4	12	0	No	All measurements below MDL
Nickel	mg/kg	200	17	27	91	12	0	No	Maximum < Human health guideline
Selenium	mg/kg	80	<0.5	<0.5	<0.5	12	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	12	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	0.07	0.11	12	0	No	Maximum < Human health guideline
Tin	mg/kg	9,400 [2]	<1	0.68	1.1	12	0	No	Maximum < Human health guideline
Uranium	mg/kg	23	0.67	0.89	2.5	12	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	26	49	150	12	4	No	Natural enrichment
Zinc	mg/kg	10,000	37	57	150	12	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of 1x10-*6; adjusted to a risk level of 1x10-5 (multiplied by 10) for consistency with Health Canada guidance.*

-- No value available.

Table 8.2 Human health screening for COCs in soil – PAHs – Kendall River WK165

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	72 [2]	-	<0.005	<0.005	10	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	72 [2]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Acenaphthene	mg/kg	3900 [3]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Acenaphthylene	mg/kg	7.8 [2]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Acridine	mg/kg	--	-	<0.01	<0.01	10	0	No	All measurements below MDL
Anthracene	mg/kg	24,000 [3]	-	<0.004	<0.004	10	0	No	All measurements below MDL
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	-	<0.0071	<0.0071	10	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500 [3]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Fluorene	mg/kg	720 [2]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	10	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360 [2]	-	$3.4x10^{-3}$	$8.0x10^{-3}$	10	0	No	Maximum < Human health guideline
Perylene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500 [4]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Pyrene	mg/kg	78 [2]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Quinoline	mg/kg	2.5 [4]	-	<0.01	<0.01	10	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 - Part 2).

-- No value available.

Table 8.3 Human health screening for COCs in soil – BTEX and PHCs – Kendall River WK165

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	110	-	$8.5x10^{-3}$	0.04	10	0	No	Maximum < Human health guideline
Ethylbenzene	mg/kg	10,000	-	$6.3x10^{-3}$	0.02	10	0	No	Maximum < Human health guideline
Toluene	mg/kg	20,000	-	0.03	0.07	10	0	No	Maximum < Human health guideline
Xylenes, total	mg/kg	150,000	-	0.03	0.05	10	0	No	Maximum < Human health guideline
PHCs									
F1 (C6-C10)	mg/kg	12,000	-	<10	<10	10	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	6,800	-	6.1	16	10	0	No	Maximum < Human health guideline
F3 (C16-C34)	mg/kg	15,000	-	45	140	10	0	No	Maximum < Human health guideline
F4 (C34-C50)	mg/kg	21,000	-	31	55	10	0	No	Maximum < Human health guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

8.1.1.2 Surface Water

A summary of the surface water screening is presented for metals in Table 8.4.

Contaminants were screened in surface water following a tiered approach:

Antimony, beryllium, boron, cadmium, chromium, cobalt, lithium, mercury, molybdenum, selenium, silver, strontium, thallium, tin, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX were not identified as COCs as all concentrations were below the MDL.

Aluminum, arsenic, barium, copper, iron, lead, manganese, nickel, phosphorus, sodium, and uranium all had maximum concentrations that were below the drinking water guideline and were not identified as COCs.

The average concentration of magnesium was below background and thus was not identified as COCs.

Guidelines for the protection of human health were not available calcium, magnesium, or potassium. These elements are generally considered innocuous to human health, are dietary elements, and have Dietary Reference Intake values assigned to them by Health Canada. Similarly, guidelines are not available for sulphur and titanium. It is assumed that a complete lack of guidelines is reflective of a chemical being generally innocuous or uncommon, or that there is an absence of toxicological information in the medium.

Thus, no metals, PHCs, BTEX, or PAHs were identified as COCs in surface water and no further analysis was required for the HHRA.

Table 8.4 Human health screening for COCs in surface water – total metals – Kendall River WK165

Contaminant	Units	Guideline [1]	Concentration		Maximum Concentration	N	N > Guideline	COC for Human Health?	Rationale
			Background	Site Average					
Aluminum	mg/L	2.9	0.05	0.14	0.16	2	0	No	Maximum < Human health guideline
Antimony	mg/L	0.006	<0.0006	<0.0006	<0.0006	2	0	No	All measurements below MDL
Arsenic	mg/L	0.01	<0.0002	0.0	$4.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Barium	mg/L	1	0.11	0.01	0.01	2	0	No	Maximum < Human health guideline
Beryllium	mg/L	0.004 [3]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	5	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Cadmium	mg/L	0.005	<0.00002	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	--	12	7.6	7.7	2	0	No	Site average < background
Chromium	mg/L	0.05	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.14	<0.0003	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	1	<0.001	$1.0x10^{-3}$	$1.3x10^{-3}$	2	0	No	Maximum < Human health guideline
Iron	mg/L	0.3	0.06	0.18	0.22	2	0	No	Maximum < Human health guideline
Lead	mg/L	0.01	<0.0002	0.0	$2.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Lithium	mg/L	--	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	--	7.8	3.3	3.3	2	0	No	Site average < background
Manganese	mg/L	0.12	0.01	0.01	0.01	2	0	No	Maximum < Human health guideline
Mercury	mg/L	0.001	<0.0000019	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.01 [2]	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.078 [2]	$5.8x10^{-4}$	$1.0x10^{-3}$	$9.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Phosphorus	mg/L	194 [2]	$3.2x10^{-3}$	$5.0x10^{-3}$	$4.8x10^{-3}$	2	0	No	Maximum < Human health guideline
Potassium	mg/L	--	0.58	1.2	1.2	2	0	No	No guideline
Selenium	mg/L	0.05	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Silver	mg/L	--	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	200	0.97	1.8	1.9	2	0	No	Maximum < Human health guideline
Strontium	mg/L	2.5 [4]	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	--	0.34	0.90	0.92	2	0	No	No guideline
Thallium	mg/L	0.002 [3]	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	2.5 [4]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	--	<0.001	$5.0x10^{-3}$	$6.0x10^{-3}$	2	0	No	No guideline
Uranium	mg/L	0.02	$1.9x10^{-4}$	0.0	$2.0x10^{-4}$	2	0	No	Maximum < Human health guideline
Vanadium	mg/L	0.0172 [2]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	5	<0.003	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] Health Canada (2022) drinking water quality guideline.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.
[3] U.S. EPA (2023) maximum contaminant level (MCL) for drinking water for human health.
[4] Government of British Columbia (2023) Generic Numerical Water Standards, drinking water (Schedule 3.2).

8.1.1.3 Sediment

There are no Federal or Provincial sediment quality guidelines for the protection of human health. Human contact with sediments is considered to be minimal at the Site. Sediments are not discussed further for the HHRA.

8.1.2 Risk Characterization

The maximum measured concentrations in soils or surface water from the Site do not exceed human health guidelines or background concentrations for all contaminants. This indicates that the Site is safe to be used by people undertaking any type of activity.

8.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, there are some assumptions underlying the qualitive assessment as discussed below.

Table 8.5 Summary of assumptions and uncertainty associated with the HHRA – Kendall River WK165

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil and surface water were considered to be sufficiently characterized.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Use of samples collected at depth of 0.2 m to 0.3 m and 0.4 m to 0.5 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the human health guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil and surface water.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

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8.2 Ecological Risk Assessment

8.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Kendall River WK165 Site.

8.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. As was done for all contaminants for the HHRA, the screening process considered data for soil samples collected from a depth of 0.2 mbgs to 0.3 mbgs, as well as a single sample from 0.4 mbgs to 0.5 mbgs for metals. Similar to the HHRA, these soil depths are too deep for ecological exposure but it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQG_{Eco}, agricultural land use. In the absence of CCME guidelines, alternate sources

were considered; these are identified in footnotes in Table 8.6 (metals), Table 8.7 (PAHs) and Table 8.8 (BTEX and PHCs).

Chromium (hexavalent), mercury, molybdenum, selenium, and silver, all PAHs except naphthalene, and PHC F1 were not considered COC as all of the measurements were below the MDL for these contaminants. Additionally, all VOCs were measured below detection limits.

The maximum concentrations of antimony, arsenic, beryllium, hot water soluble boron, cadmium, cobalt, copper, lead, thallium, tin, uranium, zinc, naphthalene, BTEX, and PHCs F2, F3, and F4 were below the SQG_{Eco} and thus were not identified as COCs.

The maximum concentrations of barium, chromium, nickel, and vanadium were above ecological guidelines. As previously discussed, chromium, nickel, and vanadium are naturally occurring in the area, thus were not identified as COCs. There are two locationswhere barium concentrations exceeded the ecological guideline of 500 mg/kg at TP1A (660 mg/kg) and TP11A (820 mg/kg). These are localized areas and do not represent a risk to ecological populations. Therefore, barium is not considered to be a COC.

In summary, there are no risks to the environment at the Site.

Table 8.6 ERA screening for COCs in soil – total metals – Kendall River WK165

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	0.44	1.1	12	0	No	Maximum < Ecological guideline
Arsenic	mg/kg	17	2.0	3.8	11	12	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	131	393	820	12	1	No	1 sample - localized area
Beryllium	mg/kg	4	<0.4	0.68	2.1	12	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	0.09	0.25	1.1	12	0	No	Maximum < Ecological guideline
Cadmium	mg/kg	10	<0.05	0.04	0.07	12	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	21	32	92	12	1	No	Natural enrichment
Chromium (hexavalent)	mg/kg	0.4	<0.08	<0.08	<0.08	12	0	No	All measurements below MDL
Cobalt	mg/kg	40	6.7	11	34	12	0	No	Maximum < Ecological guideline
Copper	mg/kg	63	8.5	14	40	12	0	No	Maximum < Ecological guideline
Lead	mg/kg	70	5.6	10	26	12	0	No	Maximum < Ecological guideline
Mercury	mg/kg	12	<0.05	<0.05	<0.05	12	0	No	All measurements below MDL
Molybdenum	mg/kg	5	<0.4	<0.4	<0.4	12	0	No	All measurements below MDL
Nickel	mg/kg	45	17	27	91	12	1	No	Natural enrichment
Selenium	mg/kg	1	<0.5	<0.5	<0.5	12	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	12	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	0.07	0.11	12	0	No	Maximum < Ecological guideline
Tin	mg/kg	5	<1	0.68	1.1	12	0	No	Maximum < Ecological guideline
Uranium	mg/kg	33	0.67	0.89	2.5	12	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	26	49	150	12	1	No	Natural enrichment
Zinc	mg/kg	250	37	57	150	12	0	No	Maximum < Ecological guideline

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 8.7 ERA screening for COCs in soil – PAHs – Kendall River WK165

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Acenaphthene	mg/kg	0.28	-	<0.005	<0.005	10	0	No	All measurements below MDL
Acenaphthylene	mg/kg	320	-	<0.005	<0.005	10	0	No	All measurements below MDL
Acridine	mg/kg	--	-	<0.01	<0.01	10	0	No	All measurements below MDL
Anthracene	mg/kg	2.5	-	<0.004	<0.004	10	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.1	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	20	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	-	<0.005	<0.005	10	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	10	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	-	<0.005	<0.005	10	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	-	<0.005	<0.005	10	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	-	<0.005	<0.005	10	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	-	<0.005	<0.005	10	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	-	<0.005	<0.005	10	0	No	All measurements below MDL
Naphthalene	mg/kg	0.013	-	$3.4x10^{-3}$	$8.0x10^{-3}$	10	0	No	Maximum < Ecological guideline
Perylene	mg/kg	--	-	<0.005	<0.005	10	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	-	<0.005	<0.005	10	0	No	All measurements below MDL
Pyrene	mg/kg	7.7	-	<0.005	<0.005	10	0	No	All measurements below MDL
Quinoline	mg/kg	0.1	-	<0.01	<0.01	10	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

Table 8.8 ERA screening for COCs in soil – BTEX and PHCs – Kendall River WK165

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	25	-	$8.5x10^{-3}$	0.04	10	0	No	Maximum < Ecological guideline
Ethylbenzene	mg/kg	55	-	$6.3x10^{-3}$	0.02	10	0	No	Maximum < Ecological guideline
Toluene	mg/kg	75	-	0.03	0.07	10	0	No	Maximum < Ecological guideline
Xylenes, total	mg/kg	65	-	0.03	0.05	10	0	No	Maximum < Ecological guideline
PHCs									
F1 (C6-C10)	mg/kg	210	-	<10	<10	10	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	150	-	6.1	16	10	0	No	Maximum < Ecological guideline
F3 (C16-C34)	mg/kg	300	-	45	140	10	0	No	Maximum < Ecological guideline
F4 (C34-C50)	mg/kg	2800	-	31	55	10	0	No	Maximum < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

8.2.1.2 Surface water

The CCME (2023) long term WQGs for the protection of freshwater aquatic life were used as the screening criteria.

The surface water screening for metals is shown in Table 8.9. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs.

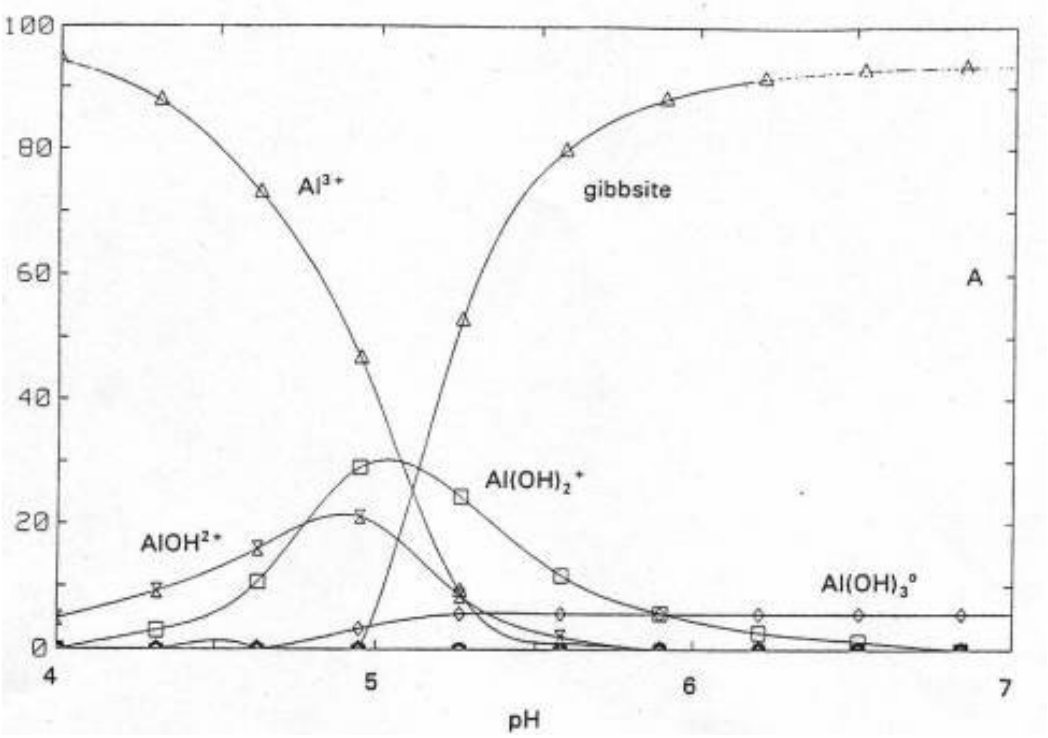
All samples were below the MDL for antimony, beryllium, boron, cadmium, chromium, cobalt, lithium, mercury, molybdenum, selenium, silver, strontium, thallium, tin, vanadium, and zinc.

A comparison of maximum measured concentrations to the WQGs indicated that arsenic, barium, calcium, copper, iron, lead, magnesium, manganese, nickel, phosphorous, potassium, sodium, sulphur, titanium, and uranium had maximum measured levels that were lower than the guidelines and therefore were not considered further as they do not present a risk to aquatic life.

Although the maximum concentration of aluminum is above the guideline, additional considerations were included in the final determination for whether aluminum was a COC. Aluminum is complexed by both inorganic and organic ligands in water (Figure 8.1). Below a pH of 6, organic complexes and the hydrated free ion tend to be the principal forms. At higher pH values, the dissolved species are only a small fraction of the total aluminum present since most of the aluminum is in a particulate form, which is inaccessible and therefore much less toxic than dissolved aluminum. At pH values between 5.5 and 9, there is very little aluminum that is in true solution and available for uptake by biological species (Gardner et al. 2002). Since the pH values from the two samples at the Kendall River WK165 Site were 6.3 and 6.24, aluminum is not present in an available (toxic) form and was not considered to be a COC.

In summary, no COCs were identified for further evaluation in the ERA for surface water.

Figure 8.1 Aluminum speciation in water from pH 4 to 7



Note: from Gensemer and Playle (1999).

Table 8.9 ERA screening for COCs in surface water – total metals – Kendall River WK165

Contaminant	Units	WQG [1]	Concentration			N	N > WQG	COC for Ecological Health?	Rationale
			Background	Site Average	Maximum				
Aluminum	mg/L	0.005	0.05	0.14	0.16	2	2	No	Not bioavailable
Antimony	mg/L	0.02 [2]	<0.0006	<0.0006	<0.0006	2	0	No	All measurements below MDL
Arsenic	mg/L	0.005	<0.0002	0.0	$4.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Barium	mg/L	1 [3]	0.11	0.01	0.01	2	0	No	Maximum < Ecological guideline
Beryllium	mg/L	0.00013 [3]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	1.5	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Cadmium	mg/L	0.00011	<0.00002	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	1,000	12	7.6	7.7	2	0	No	Maximum < Ecological guideline
Chromium	mg/L	0.0089 [6]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.004 [5]	<0.0003	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	0.002 [7]	<0.001	$1.0x10^{-3}$	$1.3x10^{-3}$	2	0	No	Maximum < Ecological guideline
Iron	mg/L	0.3	0.06	0.18	0.22	2	0	No	Maximum < Ecological guideline
Lead	mg/L	0.001 [7]	<0.0002	0.0	$2.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Lithium	mg/L	--	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	82 [4]	7.8	3.3	3.3	2	0	No	Maximum < Ecological guideline
Manganese	mg/L	0.2 [5]	0.01	0.01	0.01	2	0	No	Maximum < Ecological guideline
Mercury	mg/L	$2.6x10^{-5}$	<0.0000019	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.073	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.025 [7]	$5.8x10^{-4}$	$1.0x10^{-3}$	$9.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Phosphorus	mg/L	0.01 [2]	$3.2x10^{-3}$	$5.0x10^{-3}$	$4.8x10^{-3}$	2	0	No	Maximum < Ecological guideline
Potassium	mg/L	53 [4]	0.58	1.2	1.2	2	0	No	Maximum < Ecological guideline
Selenium	mg/L	0.001	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Silver	mg/L	0.00025	<0.0001	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	680 [4]	0.97	1.8	1.9	2	0	No	Maximum < Ecological guideline
Strontium	mg/L	21	<0.02	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	1,000	0.34	0.90	0.92	2	0	No	Maximum < Ecological guideline
Thallium	mg/L	0.0008	<0.0002	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	0.18 [4]	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	1 [5]	<0.001	$5.0x10^{-3}$	$6.0x10^{-3}$	2	0	No	Maximum < Ecological guideline
Uranium	mg/L	0.015	$1.9x10^{-4}$	0.0	$2.0x10^{-4}$	2	0	No	Maximum < Ecological guideline
Vanadium	mg/L	0.12	<0.001	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	0.03	<0.003	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) water quality guideline for the protection of aquatic life (freshwater).

[2] Ontario Provincial Water Quality Objective (MOEE 1994); interim value and should be used with caution.
[3] BC MOE (2021) working or approved water quality guidelines.
[4] U.S. EPA (2015) Region 4 supplemental risk assessment guidance, surface water screening values, chronic, Table 1a.
[5] Government of British Columbia (2023) Generic Numerical Water Standards, aquatic life (Schedule 3.2).
[6] Guideline is for trivalent chromium.
[7] Based on water hardness of less than 82 mg/L $CaCO_3$ (copper) and less than 60 mg/L $CaCO_3$ (lead, nickel).

8.2.1.3 Sediment

Two sediment samples and one background sample were collected at the Site.

The sediment screening process is summarized for metals in Table 8.10. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs and are not included herein. For the screening process the CCME (2023) ISQGs were used as the screening criteria. In the absence of an ISQG, available sediment criteria from other jurisdictions were used as indicated in the footnotes to the tables.

A comparison to the MDL indicated that antimony, chromium (hexavalent), mercury, molybdenum, selenium, silver, tin, all PAHs, BTEX, and PHCs had all measurements less than the MDL and were not considered further.

The concentrations of arsenic, cadmium, chromium, cobalt, copper, lead, uranium, and zinc were all below the ISQG or respective guidelines and were not considered further.

Five contaminants were measured at detectable concentrations but had no ISQG available, including barium, beryllium, boron (hot water soluble), thallium, and vanadium. Beryllium, boron and thallium are similar to background and are not considered to be COCs in sediment. Barium and vanadium concentrations are higher than background but are localized areas and are not expected to result in any adverse effects on benthic populations.

The maximum concentration of nickel was above the MOE lowest effect level (LEL) SQG. However, as identified above, this is due to natural enrichment and nickel is therefore not identified as a COC in sediment.

No COCs were identified in sediments.

Table 8.10 ERA screening for COCs in sediment – total metals – Kendall River WK165

Contaminant	Units	ISQG [1]	Concentration			N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background	Average Site	Maximum				
Antimony	mg/kg	25 [3]	<0.5	<0.5	<0.5	2	0	No	All measurements below MDL
Arsenic	mg/kg	5.9	1.5	3.8	5.2	2	0	No	Maximum < Ecological guideline
Barium	mg/kg	--	75	162	250	2	0	No	No guideline
Beryllium	mg/kg	--	<0.4	0.44	0.67	2	0	No	Similar to background
Boron, hot water soluble	mg/kg	--	<0.1	0.10	0.14	2	0	No	Similar to background
Cadmium	mg/kg	0.6	<0.05	0.06	0.09	2	0	No	Maximum < Ecological guideline
Chromium	mg/kg	37.3	8.7	28	37	2	0	No	Maximum < Ecological guideline
Chromium (hexavalent)	mg/kg	--	<0.08	<0.08	<0.08	2	0	No	All measurements below MDL
Cobalt	mg/kg	50 [4]	3.2	10	13	2	0	No	Maximum < Ecological guideline
Copper	mg/kg	35.7	5.6	24	33	2	0	No	Maximum < Ecological guideline
Lead	mg/kg	35	3.3	9.7	14	2	0	No	Maximum < Ecological guideline
Mercury	mg/kg	0.17	<0.05	<0.05	<0.05	2	0	No	All measurements below MDL
Molybdenum	mg/kg	13.8 [6]	<0.4	<0.4	<0.4	2	0	No	All measurements below MDL
Nickel	mg/kg	16 [5]	8.8	26	35	2	1	No	Natural enrichment
Selenium	mg/kg	2 [3]	<0.5	<0.5	<0.5	2	0	No	All measurements below MDL
Silver	mg/kg	0.5 [4]	<0.2	<0.2	<0.2	2	0	No	All measurements below MDL
Thallium	mg/kg	--	<0.1	0.10	0.15	2	0	No	Similar to background
Tin	mg/kg	--	<1	<1	<1	2	0	No	All measurements below MDL
Uranium	mg/kg	100 [2]	0.65	1.1	1.5	2	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	--	15	35	38	2	0	No	No guideline
Zinc	mg/kg	123	28	55	71	2	0	No	Maximum < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

[2] U.S. EPA (2015) Region 4 soil and freshwater sediment screening benchmarks.

[3] Nova Scotia Environment (2014), freshwater sediment

[4] MOE (2011a) Table 1 Full Depth Background Site Condition Standards Ground Water Condition.

[5] MOE (2008) lowest effect level sediment quality guideline, Table 1.

[6] Thompson et al. (2005) lowest effect level.

8.2.2 Risk Characterization

The maximum concentrations of contaminants at the Kendall River WK165 Site are below ecological guidelines or background concentrations or localized (barium) and therefore do not represent a risk to the environment at the Kendall River WK165 Site.

8.2.3 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are adequately protected in the absence of Site-specific information. As indicated above, only a qualitative analysis was undertaken. Nevertheless, Table 8.11 examines the assumptions in the ERA, underlying sampling and use of the guidelines.

Table 8.11 Summary of assumptions and uncertainty associated with the ERA – Kendall River WK165

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2023) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, sediment, and vegetation. Background samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil, water, and sediment were considered to be sufficiently characterized.
Use of samples collected at depth of 0.2 m to 0.3 m and 0.4 m to 0.5 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to ecological receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year round, that crops are grown, and that farm animals are present. This is not the case at the Site. The use of agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption used to develop the guidelines is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.
Effect Assessment			
The applicability of the selected TRVs to the various exposure pathways for soil, sediments, and surface water.	Moderate	Overestimate	The TRVs applied to derive the ecological guidelines are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

9.0 SPEERS LAKE WK097

This section provides the screening for soil, surface water, and sediment contaminants collected and submitted for chemical analysis at the Speers Lake WK097 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

9.1 Human Health Risk Assessment

9.1.1 Identification of Contaminants of Concern for Human Health

9.1.1.1 Soil

The screening process only considered data for soil samples collected from and 0.0 mbgs to 0.1 mbgs, 0.0 mbgs to 0.2 mbgs, 0.0 mbgs to 0.3 mbgs, 0.1 mbgs to 0.2 mbgs, and 0.2 mbgs to 0.3 mbgs, as well as 0.2 mbgs to 0.2 mbgs for metals, which are the shallowest depth of samples collected. For VOCs, soil samples at depths of 0.0 mbgs to 0.3 mbgs and 0.2 mbgs to 0.3 mbgs were considered, as they are the shallowest depths collected. These depths are considered to be accessible by humans even though some of the depths are greater than what humans can reasonably be expected to be exposed to.

A summary of the COC screening in soil for human health is provided below in Table 9.1(metals), Table 9.2 (PAHs), and Table 9.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium.

Contaminants were screened in soil following a tiered approach as discussed in Section 3.2.

Hexavalent chromium, mercury, selenium, and silver as well as VOCs were not identified as COCs since all the concentrations were below the MDL.

The maximum concentration of the remainder of the contaminants were below human health guidelines.

All carcinogenic PAHs were evaluated based on calculation of B[a]P total potency equivalents (TPE) (CCME 2010). The CCME has not developed human health guidelines for the non-carcinogenic PAHs therefore the maximum concentration in soil samples for each non-carcinogenic PAH compound was compared to the soil component values available from Alberta, British Columbia, or Ontario. No PAHs were identified as COCs (see Table 9.2). All PHCs except for PHC F2 at 2 locations and BTEX were either non-detectable or below human health guidelines (see Table 9.3) and therefore not identified as COCs.

There are two samples (out of 39) with concentrations of PHC F2 that exceed the human health guideline. These are located at TP32A at a concentration of 9400 mg/kg and TP46A at a concentration of 8900 mg/kg. These samples are in two localized areas and thus do not represent a risk to human health as people are not expected to spend all of their time over a lifetime at these two areas, thus PHC F2 is not considered to be a COC.

No COCs were identified in soil for the HHRA and therefore no further analysis was required.

Table 9.1 Human health screening for COCs in soil – total metals – Speers Lake WK097

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	0.28	0.68	49	0	No	Maximum < Human health guideline
Arsenic	mg/kg	12	4.3	4.6	9.7	49	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	81	61	250	49	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	0.31	0.30	0.60	49	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	1.9	0.70	5.3	49	0	No	Maximum < Human health guideline
Cadmium	mg/kg	14	0.19	0.14	0.64	49	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	178	217	390	49	20	No	Natural enrichment
Chromium (hexavalent)	mg/kg	3[5]	<0.18	<0.08	<0.08	49	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	38	63	130	49	46	No	Naturally enrichment
Copper	mg/kg	1,100	69	44	90	49	0	No	Maximum < Human health guideline
Lead	mg/kg	140	14	16	24	49	0	No	Maximum < Human health guideline
Mercury	mg/kg	6.6	<0.05	<0.05	<0.05	49	0	No	All measurements below MDL
Molybdenum	mg/kg	110 [3]	<0.4	0.30	1.6	49	0	No	Maximum < Human health guideline
Nickel	mg/kg	200	518	765	1,600	49	45	No	Natural enrichment
Selenium	mg/kg	80	<0.5	<0.5	<0.5	49	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	49	0	No	All measurements below MDL
Thallium	mg/kg	1	0.08	0.11	0.23	49	0	No	Maximum < Human health guideline
Tin	mg/kg	9,400 [2]	<1	0.61	3.5	49	0	No	Maximum < Human health guideline
Uranium	mg/kg	23	1.5	1.2	2.5	49	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	26	24	46	49	1	No	Site average < background average
Zinc	mg/kg	10,000	63	81	150	49	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples up to 0.3 mbgs are included (i.e. samples including depths >0.3 mbgs are not included).

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of 1x10-*6; adjusted to a risk level of 1x10-5 (multiplied by 10) for consistency with Health Canada guidance.*

-- No value available.

Table 9.2 Human health screening for COCs in soil – PAHs – Speers Lake WK097

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
1-Methylnaphthalene	mg/kg	72 [2]	-	0.04	1.4	38	0	No	Maximum < Human health guideline
2-Methylnaphthalene	mg/kg	72 [2]	-	0.01	0.31	38	0	No	Maximum < Human health guideline
Acenaphthene	mg/kg	3900 [3]	-	0.01	0.37	38	0	No	Maximum < Human health guideline
Acenaphthylene	mg/kg	7.8 [2]	-	0.01	0.21	38	0	No	Maximum < Human health guideline
Acridine	mg/kg	--	-	0.11	3.0	38	0	No	No guideline
Anthracene	mg/kg	24,000 [3]	-	0.04	1.2	38	0	No	Maximum < Human health guideline
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	-	$7.4x10^{-3}$	0.08	38	0	No	Maximum < Human health guideline
Benz[a]anthracene	mg/kg	BaP TPE	-	$8.5x10^{-3}$	0.18	38	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	-	<0.005	<0.005	38	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	38	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	38	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	$6.3x10^{-3}$	0.10	38	0	No	Heavily censored
Benzo[g,h,i]perylene	mg/kg	BaP TPE	-	$6.1x10^{-3}$	0.09	38	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	-	<0.005	<0.005	38	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	-	<0.005	<0.005	38	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	-	<0.005	<0.005	38	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500 [3]	-	<0.005	<0.005	38	0	No	All measurements below MDL
Fluorene	mg/kg	720 [2]	-	0.02	0.47	38	0	No	Maximum < Human health guideline
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	-	$4.6x10^{-3}$	$7.8x10^{-3}$	38	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360 [2]	-	0.02	0.38	38	0	No	Maximum < Human health guideline
Perylene	mg/kg	--	-	<0.005	<0.005	38	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500 [4]	-	0.04	1.1	38	0	No	Maximum < Human health guideline
Pyrene	mg/kg	78 [2]	-	$6.7x10^{-3}$	0.11	38	0	No	Maximum < Human health guideline
Quinoline	mg/kg	2.5 [4]	-	0.04	0.30	37	0	No	Maximum < Human health guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples up to 0.3 mbgs are included (i.e. samples including depths >0.3 mbgs are not included).

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 - Part 2).

-- No value available.

Table 9.3 Human health screening for COCs in soil – BTEX and PHCs – Speers Lake WK097

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	110	-	<0.005	<0.005	38	0	No	All measurements below MDL
Ethylbenzene	mg/kg	10,000	-	<0.01	<0.01	38	0	No	All measurements below MDL
Toluene	mg/kg	20,000	-	<0.05	<0.05	38	0	No	All measurements below MDL
Xylenes, total	mg/kg	150,000	-	0.07	0.83	38	0	No	Maximum < Human health guideline
PHCs									
F1 (C6-C10)	mg/kg	12,000	-	15	180	38	0	No	Maximum < Human health guideline
F2 (C10-C16)	mg/kg	6,800	-	498	9,400	39	2	No	Localized exceedance
F3 (C16-C34)	mg/kg	15,000	-	1,556	$3.7x10^4$	39	1	No	Localized exceedance
F4 (C34-C50)	mg/kg	21,000	-	519	$1.4x10^4$	39	0	No	Maximum < Human health guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples up to 0.3 mbgs are included (i.e. samples including depths >0.3 mbgs are not included). [1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

9.1.1.2 Surface Water

A summary of the surface water screening is presented for metals in Table 9.9.

Contaminants were screened in surface water following a tiered approach

Antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, mercury, molybdenum, selenium, silver, strontium, uranium, vanadium, and zinc, as well as all PAHs, PHCs (with the exception of PHC F3 at SW2), VOCs and BTEX were not identified as COCs as they all had measured concentrations below the MDL.

Aluminum, iron, manganese, nickel, phosphorous, and sodium had maximum concentrations that were below the drinking water guideline and were not considered to be COC.

Calcium, magnesium, potassium, and sulphur concentrations were similar to background concentrations and were not identified as COCs.

There were two measurements of titanium in surface water that were marginally above the method detection limit. Titanium in drinking water is not considered to be toxic. NSF International (2005),a global Health and Safety organization that works in conjunction with the World Health Organization, developed a tolerable allowable concentration for titanium in drinking water of 90mg/L. The two measured concentrations are well below this value and titanium is not considered to be a COC.

PHC F3 was detected in surface water at SW2. This sample is believed to be an anomaly since there was no sheen in the water sample and although there are a number of barrels on the beach, they are all empty and there was no sign of leaking. Additionally, the PHC F3 concentration in sediments was below the detection limit, thus PHC F3 in surface water at SW2 is not considered a COC.

No metals, PHCs, BTEX, VOCs, or PAHs were identified as COCs in surface water and therefore no further analysis was required for the HHRA.

Table 9.4 Human health screening for COCs in surface water – total metals – Speers Lake WK097

Contaminant	Units	Guideline [1]	Concentration		Maximum	N	N > Guideline	COC for Human Health?	Rationale
			Background	Site					
Aluminum	mg/L	2.9	$8.6x10^{-3}$	0.02	0.05	5	0	No	Maximum < Human health guideline
Antimony	mg/L	0.006	<0.0006	<0.0006	<0.0006	5	0	No	All measurements below MDL
Arsenic	mg/L	0.01	$1.9x10^{-4}$	<0.0002	<0.0002	5	0	No	All measurements below MDL
Barium	mg/L	1	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL
Beryllium	mg/L	0.004 [3]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Boron	mg/L	5	<0.02	<0.02	<0.02	5	0	No	All measurements below MDL
Cadmium	mg/L	0.005	<0.00002	<0.00002	<0.00002	5	0	No	All measurements below MDL
Calcium	mg/L	--	6.6	6.7	6.8	5	0	No	Site similar to background
Chromium	mg/L	0.05	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Cobalt	mg/L	0.14	<0.0003	<0.0003	<0.0003	5	0	No	All measurements below MDL
Copper	mg/L	1	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Iron	mg/L	0.3	0.04	0.10	0.20	5	0	No	Maximum < Human health guideline
Lead	mg/L	0.01	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	<0.02	5	0	No	All measurements below MDL
Magnesium	mg/L	--	10	11	11	5	0	No	Site similar to background
Manganese	mg/L	0.12	$9.8x10^{-3}$	0.01	0.02	5	0	No	Maximum < Human health guideline
Mercury	mg/L	0.001	<0.0000019	<0.0000019	<0.0000019	4	0	No	All measurements below MDL
Molybdenum	mg/L	0.01 [2]	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Nickel	mg/L	0.078 [2]	$3.4x10^{-3}$	$3.0x10^{-3}$	$4.0x10^{-3}$	5	0	No	Maximum < Human health guideline
Phosphorus	mg/L	194 [2]	<0.003	0.03	$3.0x10^{-3}$	5	0	No	Maximum < Human health guideline
Potassium	mg/L	--	0.47	0.43	0.48	5	0	No	Site average < background average
Selenium	mg/L	0.05	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Silver	mg/L	--	<0.0001	<0.0001	<0.0001	5	0	No	All measurements below MDL
Sodium	mg/L	200	0.43	0.49	0.93	5	0	No	Maximum < Human health guideline
Strontium	mg/L	2.5 [4]	<0.02	<0.02	<0.02	5	0	No	All measurements below MDL
Sulphur	mg/L	--	0.50	0.52	0.56	5	0	No	Site similar to background
Thallium	mg/L	0.002 [3]	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Tin	mg/L	2.5 [4]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Titanium	mg/L	--	<0.001	$1.0x10^{-3}$	$2.0x10^{-3}$	5	0	No	Site similar to background
Uranium	mg/L	0.02	<0.0001	<0.0001	<0.0001	5	0	No	All measurements below MDL
Vanadium	mg/L	0.0172 [2]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Zinc	mg/L	5	$2.4x10^{-3}$	<0.003	<0.003	5	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] Health Canada (2022) drinking water quality guideline.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.
[3] U.S. EPA (2023) maximum contaminant level (MCL) for drinking water for human health.
[4] Government of British Columbia (2023) Generic Numerical Water Standards, drinking water (Schedule 3.2).

9.1.1.3 Sediment

There are no Federal or Provincial sediment quality guidelines for the protection of human health. Human contact with sediments is considered to be minimal at the Site. Sediments are not discussed further for the HHRA.

9.1.2 Risk Characterization

Risks to humans from exposure at the Site were qualitatively evaluated through the screening process described above. As indicated in this section the maximum measured concentrations in soils and surface water from the Site do not exceed human health guidelines indicating that the Site is safe to be used by people undertaking any type of activity.

9.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, there are some assumptions underlying the qualitive assessment as discussed below.

Table 9.5 Summary of assumptions and uncertainty associated with the HHRA – Speers Lake WK097

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil, and surface were considered to be sufficiently characterized.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Use of samples collected at depth of 0.0 m to 0.1 m, 0.0 m to 0.2 m, 0.0 m to 0.3 m, 0.1 m to 0.2 m, 0.2 m to 0.2 m, and 0.2 m to 0.3.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil and surface water.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

9.2 Ecological Risk Assessment

9.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Speers Lake WK097 Site.

9.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. The screening process only considered data for soil samples collected from and 0.0 mbgs to 0.1 mbgs, 0.0 mbgs to 0.2 mbgs, 0.0 mbgs to 0.3 mbgs, 0.1 mbgs to 0.2 mbgs, and 0.2 mbgs to 0.3 mbgs, as well as 0.2 mbgs to 0.2 mbgs for metals, which are the shallowest depth of samples collected. For VOCs, soil samples at depths of 0.0 mbgs to 0.3 mbgs and 0.2 mbgs to 0.3 mbgs were considered, as they are the shallowest depths collected. As discussed in the HHRA, it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQG_{Eco}, agricultural land use. In the absence of CCME guidelines, alternate sources were considered; these are identified in footnotes in Table 9.6 (metals), Table 9.7(PAHs) and Table 9.8 (BTEX and PHCs).

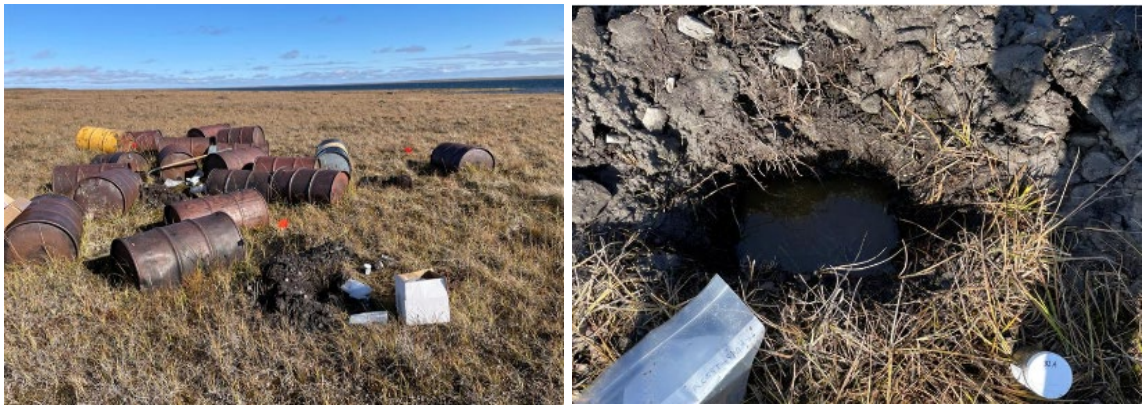
As discussed in Section 2, the composition of the native material is enriched with chromium, cobalt, copper, nickel, and vanadium and are considered to be naturally occurring.

Chromium (hexavalent), mercury, selenium, and silver were all below the MDL. All VOCs were also measured below the MDL. The PAHs benzo[a]pyrene, benzo[b,j]fluoranthene, benzo[c]phenanthrene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, and perylene had measurements below the MDL. Therefore, these contaminants were not considered to be COCs.

BTEX and PHC F1 concentrations were either non-detectable or below the ecological guidelines (see Table 9.8) and therefore not identified as COCs.

No metals have concentrations above the ecological guidelines. There was one localized exceedance of acenaphthene, benz[a]anthracene, fluorene, naphthalene, and phenanthrene; this localized exceedance does not represent a risk to ecological populations and these PAHs were not identified as COC. PHC F2, PHC F3 and PHC F4 exceed the guidelines. There are 3 exceedances of PHC F2, these occur at three locations within the south area of the Site (TP32A, TP39A, and TP46A). PHC F4 was only measured above guidelines at TP46A. The photographs of these three areas of PHC F2 exceedances are shown below. As seen from the photographs, these three locations are small, isolated areas with lots of vegetation growing. As the endpoint for PHC exposure is effects on vegetation, it is clearly demonstrated that these three areas support vegetation and PHC F2 contamination is not considered to represent a risk to vegetation populations. PHC F4 concentrations exceed the generic guideline for the protection of vegetation at isolated areas near fuel drums and is discussed in more detail in Section 9.2.2.

Photograph 9.1 Soil sampling location TP32



Photograph 9.2 Soil sampling locations TP29A

Photograph 9.3 Soil sampling location TP46

Table 9.6 ERA screening for COCs in soil – total metals – Speers Lake WK097

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	0.28	0.68	49	0	No	Maximum < Ecological guideline
Arsenic	mg/kg	17	4.3	4.6	9.7	49	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	81	61	250	49	0	No	Maximum < Ecological guideline
Beryllium	mg/kg	4	0.31	0.30	0.60	49	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	1.9	0.70	5.3	49	1	No	Site average < background average
Cadmium	mg/kg	10	0.19	0.14	0.64	49	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	178	217	390	49	47	No	Natural enrichment
Chromium (hexavalent)	mg/kg	0.4	<0.18	<0.08	<0.08	49	0	No	All measurements below MDL
Cobalt	mg/kg	40	38	63	130	49	35	No	Natural enrichment
Copper	mg/kg	63	69	44	90	49	4	No	Site average < background average
Lead	mg/kg	70	14	16	24	49	0	No	Maximum < Ecological guideline
Mercury	mg/kg	12	<0.05	<0.05	<0.05	49	0	No	All measurements below MDL
Molybdenum	mg/kg	5	<0.4	0.30	1.6	49	0	No	Maximum < Ecological guideline
Nickel	mg/kg	45	518	765	1,600	49	49	No	Natural enrichment
Selenium	mg/kg	1	<0.5	<0.5	<0.5	49	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	49	0	No	All measurements below MDL
Thallium	mg/kg	1	0.08	0.11	0.23	49	0	No	Maximum < Ecological guideline
Tin	mg/kg	5	<1	0.61	3.5	49	0	No	Maximum < Ecological guideline
Uranium	mg/kg	33	1.5	1.2	2.5	49	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	26	24	46	49	0	No	Maximum < Ecological guideline
Zinc	mg/kg	250	63	81	150	49	0	No	Maximum < Ecological guideline

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples up to 0.3 mbgs are included (i.e. samples including depths >0.3 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 9.7 ERA screening for COCs in soil – PAHs – Speers Lake WK097

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	--	-	0.04	1.4	38	0	No	No guideline
2-Methylnaphthalene	mg/kg	--	-	0.01	0.31	38	0	No	No guideline
Acenaphthene	mg/kg	0.28	-	0.01	0.37	38	1	No	Single localized exceedance
Acenaphthylene	mg/kg	320	-	0.01	0.21	38	0	No	Maximum < Ecological guideline
Acridine	mg/kg	--	-	0.11	3.0	38	0	No	No guideline
Anthracene	mg/kg	2.5	-	0.04	1.2	38	0	No	Maximum < Ecological guideline
Benz[a]anthracene	mg/kg	0.1	-	$8.5x10^{-3}$	0.18	38	1	No	Single localized exceedance
Benzo[a]pyrene	mg/kg	20	-	<0.005	<0.005	38	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	38	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	-	<0.005	<0.005	38	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	-	$6.3x10^{-3}$	0.10	38	0	No	No guideline
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	-	$6.1x10^{-3}$	0.09	38	0	No	Maximum < Ecological guideline
Benzo[k]fluoranthene	mg/kg	0.1	-	<0.005	<0.005	38	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	-	<0.005	<0.005	38	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	-	<0.005	<0.005	38	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	-	<0.005	<0.005	38	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	-	0.02	0.47	38	1	No	Single localized exceedance
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	-	$4.6x10^{-3}$	$7.8x10^{-3}$	38	0	No	Maximum < Ecological guideline
Naphthalene	mg/kg	0.013	-	0.02	0.38	38	2	No	Localized exceedance
Perylene	mg/kg	--	-	<0.005	<0.005	38	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	-	0.04	1.1	38	2	No	Localized exceedance
Pyrene	mg/kg	7.7	-	$6.7x10^{-3}$	0.11	38	0	No	Maximum < Ecological guideline
Quinoline	mg/kg	1.6[3]	-	0.04	0.30	37	0	No	Maximum < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples up to 0.3 mbgs are included (i.e. samples including depths >0.3 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

3 FEQG (2020) – Federal soil quality guidelines for quinoline.

-- No value available.

Table 9.8 ERA screening for COCs in soil – BTEX and PHCs – Speers Lake WK097

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	25	-	<0.005	<0.005	38	0	No	All measurements below MDL
Ethylbenzene	mg/kg	55	-	<0.01	<0.01	38	0	No	All measurements below MDL
Toluene	mg/kg	75	-	<0.05	<0.05	38	0	No	All measurements below MDL
Xylenes, total	mg/kg	65	-	0.07	0.83	38	0	No	Maximum < Ecological guideline
PHCs									
F1 (C6-C10)	mg/kg	210	-	15	180	38	0	No	Maximum < Ecological guideline
F2 (C10-C16)	mg/kg	150	-	498	9,400	39	3	No	Three separate Localized Exceedances
F3 (C16-C34)	mg/kg	300	-	1,556	$3.7x10^4$	39	12	**Yes**	**Maximum > Ecological guideline**
F4 (C34-C50)	mg/kg	2800	-	519	$1.4x10^4$	39	1	No	Single Localized Exceedance

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples up to 0.3 mbgs are included (i.e. samples including depths >0.3 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

9.2.1.2 Surface Water

The surface water COC screening process identified the COCs in the adjacent unnamed lake to be considered further in the aquatic ERA. The CCME (2023) long term WQGs for the protection of freshwater aquatic life were used as the screening criteria.

The surface water screening for metals is shown in Table 9.9. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs and are not included herein.

PHC F3 was detected in surface water at SW2. This sample is believed to be an anomaly since there was no sheen in the water sample and although there are a number of barrels on the beach, they are all empty and there was no sign of leaking. Additionally, the PHC F3 concentration in sediments was below the detection limit, Thus PHC F3 in surface water at SW2 is not considered a COC.

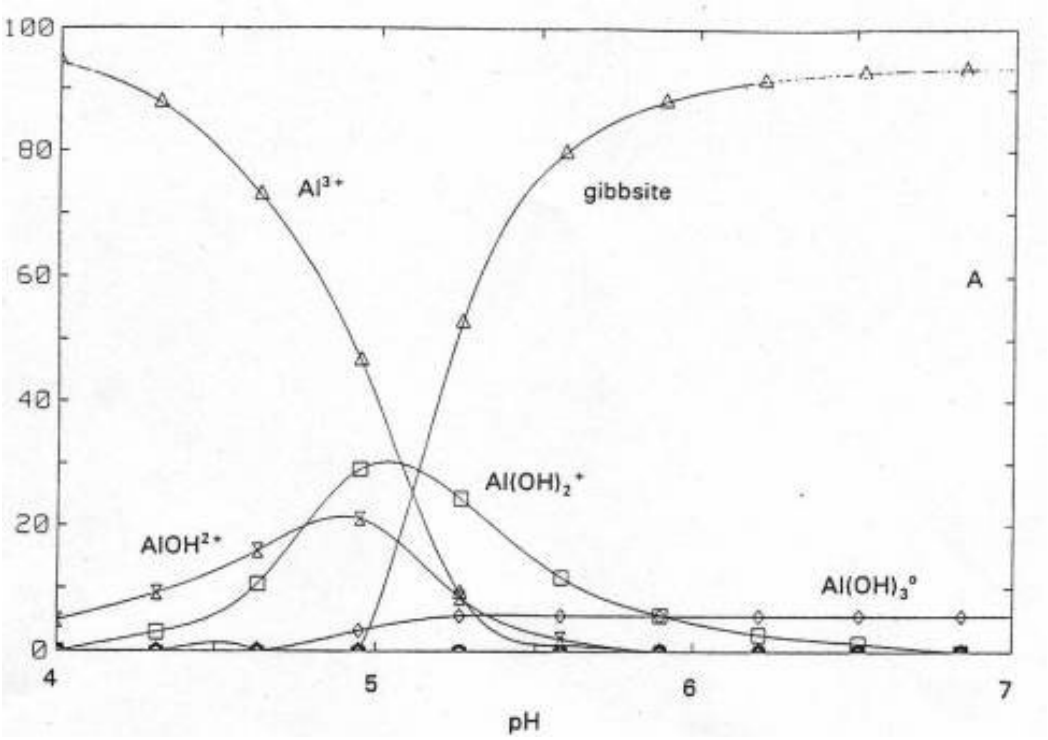
All samples were below the MDL for antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, mercury, molybdenum, selenium, silver, strontium, uranium, vanadium, and zinc, as well as all PAHs, PHCs, VOCs and BTEX.

A comparison of maximum measured concentrations to the WQGs indicated that calcium, iron, magnesium, manganese, nickel, phosphorus, potassium, sodium, sulphur, and titanium had maximum measured levels that were lower than the guidelines and therefore were not considered further as they do not present a risk to aquatic life.

Although the maximum concentration of aluminum is above the guideline, additional considerations were included in the final determination for whether aluminum was a COC. Aluminum is complexed by both inorganic and organic ligands in water (Figure 9.1). Below a pH of 6, organic complexes and the hydrated free ion tend to be the principal forms. At higher pH values, the dissolved species are only a small fraction of the total aluminum present since most of the aluminum is in a particulate form, which is inaccessible and therefore much less toxic than dissolved aluminum. At pH values between 5.5 and 9, there is very little aluminum that is in true solution and available for uptake by biological species (Gardner et al. 2002). Since the pH values from nine samples in the lake ranged from 6.2 to 6.57, aluminum is not present in an available (toxic) form and was not considered to be a COC.

In summary, no COCs were identified for further evaluation in the ERA for surface water.

Figure 9.1 Aluminum speciation in water from pH 4 to 7



Note: from Gensemer and Playle (1999).

Table 9.9 ERA screening for COCs in surface water – total metals – Speers Lake WK097

Contaminant	Units	WQG [1]	Average Concentration		Maximum	N	N > WQG	COC for Ecological Health?	Rationale
			Back-ground	Site					
Aluminum	mg/L	0.005	$8.6x10^{-3}$	0.02	0.05	5	3	No	Not bioavailable
Antimony	mg/L	0.02 [2]	<0.0006	<0.0006	<0.0006	5	0	No	All measurements below MDL
Arsenic	mg/L	0.005	$1.9x10^{-4}$	<0.0002	<0.0002	5	0	No	All measurements below MDL
Barium	mg/L	1 [3]	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL
Beryllium	mg/L	0.00013 [3]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Boron	mg/L	1.5	<0.02	<0.02	<0.02	5	0	No	All measurements below MDL
Cadmium	mg/L	0.00011	<0.00002	<0.00002	<0.00002	5	0	No	All measurements below MDL
Calcium	mg/L	1,000	6.6	6.7	6.8	5	0	No	Maximum < Ecological guideline
Chromium	mg/L	0.0089 [6]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Cobalt	mg/L	0.004 [5]	<0.0003	<0.0003	<0.0003	5	0	No	All measurements below MDL
Copper	mg/L	0.002 [7]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Iron	mg/L	0.3	0.04	0.10	0.20	5	0	No	Maximum < Ecological guideline
Lead	mg/L	0.001 [7]	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	<0.02	5	0	No	All measurements below MDL
Magnesium	mg/L	82 [4]	10	11	11	5	0	No	Maximum < Ecological guideline
Manganese	mg/L	0.2 [5]	$9.8x10^{-3}$	0.01	0.02	5	0	No	Maximum < Ecological guideline
Mercury	mg/L	$2.6x10^{-5}$	<0.0000019	<0.0000019	<0.0000019	4	0	No	All measurements below MDL
Molybdenum	mg/L	0.073	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Nickel	mg/L	0.025 [7]	$3.4x10^{-3}$	$3.0x10^{-3}$	$4.0x10^{-3}$	5	0	No	Maximum < Ecological guideline
Phosphorus	mg/L	0.01 [2]	<0.003	0.03	$3.0x10^{-3}$	5	0	No	Maximum < Ecological guideline
Potassium	mg/L	53 [4]	0.47	0.43	0.48	5	0	No	Maximum < Ecological guideline
Selenium	mg/L	0.001	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Silver	mg/L	0.00025	<0.0001	<0.0001	<0.0001	5	0	No	All measurements below MDL
Sodium	mg/L	680 [4]	0.43	0.49	0.93	5	0	No	Maximum < Ecological guideline
Strontium	mg/L	21	<0.02	<0.02	<0.02	5	0	No	All measurements below MDL
Sulphur	mg/L	1,000	0.50	0.52	0.56	5	0	No	Maximum < Ecological guideline
Thallium	mg/L	0.0008	<0.0002	<0.0002	<0.0002	5	0	No	All measurements below MDL
Tin	mg/L	0.18 [4]	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Titanium	mg/L	1 [5]	<0.001	$1.0x10^{-3}$	$2.0x10^{-3}$	5	0	No	Maximum < Ecological guideline
Uranium	mg/L	0.015	<0.0001	<0.0001	<0.0001	5	0	No	All measurements below MDL
Vanadium	mg/L	0.12	<0.001	<0.001	<0.001	5	0	No	All measurements below MDL
Zinc	mg/L	0.03	$2.4x10^{-3}$	<0.003	<0.003	5	0	No	All measurements below MDL

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) water quality guideline for the protection of aquatic life (freshwater).

[2] Ontario Provincial Water Quality Objective (MOEE 1994); interim value and should be used with caution.
[3] BC MOE (2021) working or approved water quality guidelines.
[4] U.S. EPA (2015) Region 4 supplemental risk assessment guidance, surface water screening values, chronic, Table 1a.
[5] Government of British Columbia (2023) Generic Numerical Water Standards, aquatic life (Schedule 3.2).
[6] Guideline is for trivalent chromium.
[7] Based on water hardness of less than 82 mg/L $CaCO_3$ (copper) and less than 60 mg/L $CaCO_3$ (lead, nickel).

9.2.1.3 Sediment

Four background sediment samples and five sediment samples from exposure areas were collected along the shore of the lake at the Site.

The sediment screening process is summarized for metals in Table 9.10 (metals), Table 9.11 (PAHs), and Table 9.12 (PHCs and BTEX). For the screening process the CCME (2023) ISQGs were used as the screening criteria. In the absence of an ISQG, available sediment criteria from other jurisdictions were used as indicated in the footnotes.

A comparison to the MDL indicated that antimony, chromium (hexavalent), mercury, selenium, silver, tin, all PAHs, and BTEX all had measurements less than the MDL and were not considered further.

The concentrations of cadmium, lead, molybdenum, and uranium were all below sediment guidelines and were also not considered further.

Chromium, cobalt, copper, nickel and vanadium sediment concentrations were all considered to be naturally occurring. Additionally, thallium sediment concentrations (0.13 mg/kg) were considered to be similar to background (0.11 mg/kg). Average beryllium concentrations of 0.28 mg/kg were similar to background concentrations of 0.2 mg/kg.

PHC F1,PHC F2, and PHC F4 in sediments were measured below detection limits. However, the detection limits are high due to the moisture content of the samples. While the detection limits are elevated, they are below the sediment guidelines and are not considered to be COC. Background concentrations of PHC F3 ranged from 57mg/kg to 110 mg/kg. The maximum measured sediment concentration of 52 mg/kg is within this range and not expected to result in any risk to benthic communities in the sediments in the lake.

The maximum concentration of arsenic (10 mg/kg) was above the ISQG. Background concentrations also exceed the guideline in 2 samples (6.3 mg/kg and 6.7 mg/kg). With the exception of Sed 4 which has the maximum concentration, all the other samples have arsenic concentrations similar to background as shown in the table below. The maximum concentration is below the PEL of 17 mg/kg. Therefore, arsenic is not considered a COC in sediment. There is a single exceedance of the zinc sediment guideline at Sed2 (180 mg/kg vs 123 mg/kg). However, as the concentration is below the PEL of 315 mg/kg, zinc is not considered a COC in sediment as it is unlikely to affect benthic communities in the lake.

In summary no COC were identified in sediment.

Table 9.10 ERA screening for COCs in sediment – total metals – Speers Lake WK097

Contaminant	Units	Sediment Guideline [1]	Average Concentration		Maximum	N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background	Site					
Antimony	mg/kg	25 [3]	<0.5	<0.5	<0.5	6	0	No	All measurements below MDL
Arsenic	mg/kg	5.9	5.3	5.5	10	6	3	No	Below PEL of 17 mg/kg
Barium	mg/kg	--	58	35	60	6	0	No	Site average < background average
Beryllium	mg/kg	--	<0.4	0.28	0.45	6	0	No	No guideline
Boron, hot water soluble	mg/kg	--	0.30	0.06	0.10	6	0	No	Site average < background average
Cadmium	mg/kg	0.6	0.13	0.10	0.11	6	0	No	Maximum < Ecological guideline
Chromium	mg/kg	37.3	313	267	500	6	6	No	Site average < background average
Chromium (hexavalent)	mg/kg	--	<0.08	<0.08	<0.08	6	0	No	All measurements below MDL
Cobalt	mg/kg	50 [4]	78	74	120	6	3	No	Site average < background average
Copper	mg/kg	35.7	32	32	49	6	3	No	Natural enrichment
Lead	mg/kg	35	12	15	18	6	0	No	Maximum < Ecological guideline
Mercury	mg/kg	0.17	<0.05	<0.05	<0.05	6	0	No	All measurements below MDL
Molybdenum	mg/kg	13.8 [6]	<0.4	0.24	0.45	6	0	No	Maximum < Ecological guideline
Nickel	mg/kg	16 [5]	1,060	920	1,500	6	6	No	Site average < background average
Selenium	mg/kg	2 [3]	<0.5	<0.5	<0.5	6	0	No	All measurements below MDL
Silver	mg/kg	0.5 [4]	<0.2	<0.2	<0.2	6	0	No	All measurements below MDL
Thallium	mg/kg	--	0.07	0.08	0.13	6	0	No	No guideline
Tin	mg/kg	--	<1	<1	<1	6	0	No	All measurements below MDL
Uranium	mg/kg	100 [2]	1.2	1.3	2.0	6	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	--	26	24	35	6	0	No	Site average < background average
Zinc	mg/kg	123	81	97	180	6	1	No	Below PEL of 315 mg/kg

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

[2] U.S. EPA (2015) Region 4 soil and freshwater sediment screening benchmarks.

[3] Nova Scotia Environment (2014), freshwater sediment

[4] MOE (2011a) Table 1 Full Depth Background Site Condition Standards Ground Water Condition.

[5] MOE (2008) lowest effect level sediment quality guideline, Table 1.

[6] Thompson et al. (2005) lowest effect level.

Table 9.11 ERA screening for COCs in sediment – PAHs – Speers Lake WK097

Contaminant	Units	ISQG [1]	Average Concentration		Maximum	N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	0.0202	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	0.0202	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Acenaphthene	mg/kg	0.00671	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Acenaphthylene	mg/kg	0.00587	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Acridine	mg/kg	--	<0.01	<0.01	<0.01	6	0	No	All measurements below MDL
Anthracene	mg/kg	0.0469	<0.004	<0.004	<0.004	6	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.0317	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	0.0319	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	--	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	0.02	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	--	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Chrysene	mg/kg	0.0571	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.00622	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Fluoranthene	mg/kg	0.111	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Fluorene	mg/kg	0.0212	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	0.02	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Naphthalene	mg/kg	0.0346	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.0419	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Pyrene	mg/kg	0.053	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Quinoline	mg/kg	--	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

Table 9.12 ERA screening for COCs in sediment – BTEX and PHCs – Speers Lake WK097

Contaminant	Units	ISQG [1]	Average Concentration		Maximum	N	N > $ISQG_{Eco}$	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	1.2	<0.005	<0.005	<0.005	6	0	No	All measurements below MDL
Ethylbenzene	mg/kg	1.2	<0.01	<0.01	<0.01	6	0	No	All measurements below MDL
Toluene	mg/kg	1.4	<0.05	<0.05	<0.05	6	0	No	All measurements below MDL
Xylenes, total	mg/kg	1.3	<0.045	<0.045	<0.045	6	0	No	All measurements below MDL
Petroleum Hydrocarbons									
F1 (C6-C10)	mg/kg	15	<10	<10	<10	6	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	25	6.8	<10	<10	6	0	No	All measurements below MDL
F3 (C16-C34)	mg/kg	43	54	30	52	6	6	No	Site average < background average
F4 (C34-C50)	mg/kg	43	<50	<50	<50	6	6	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] Atlantic Risk Based Corrective Action (Atlantic RBCA 2023) Ecological Tier I environmental quality standards for freshwater sediment.

9.2.2 Risk Characterization

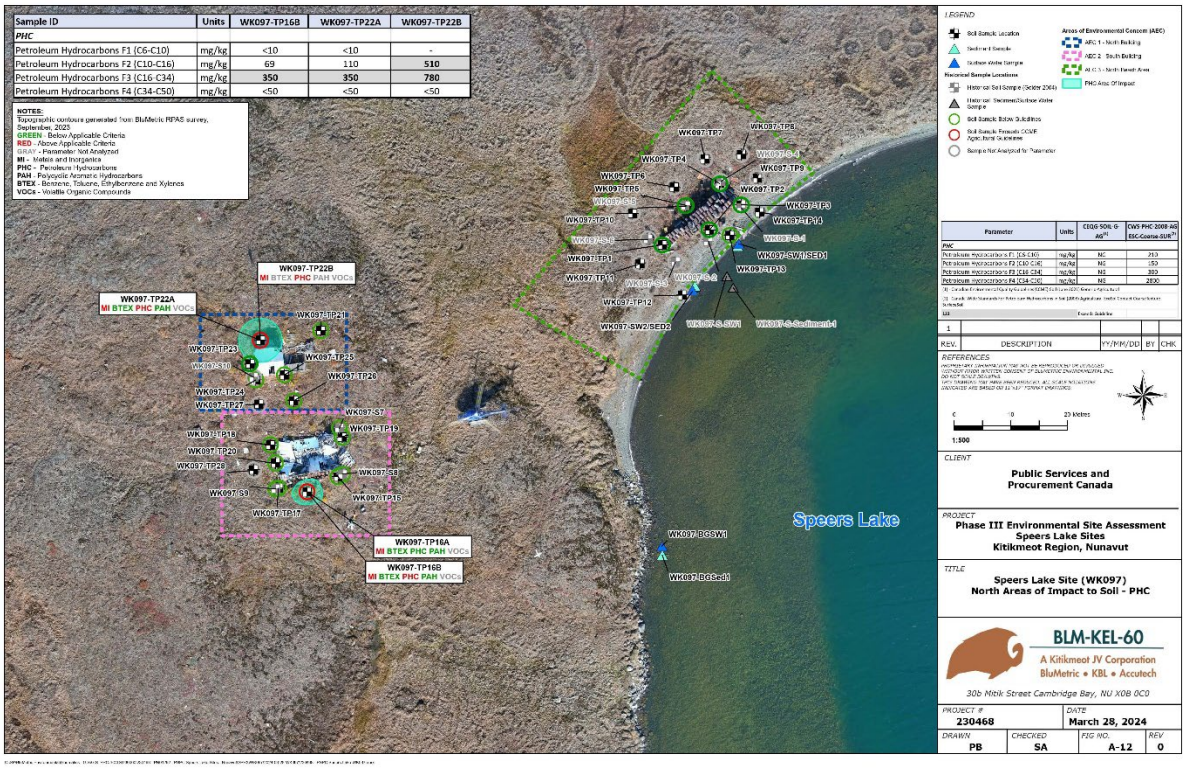
The maximum concentrations of contaminants in surface water at the Speers Lake WK097 Site are below ecological guidelines and therefore do not represent a risk to aquatic receptors that may be present at the Site. Arsenic and zinc concentrations in sediments are localized and maximum concentrations are below the PEL and thus no effects on benthic communities are expected.

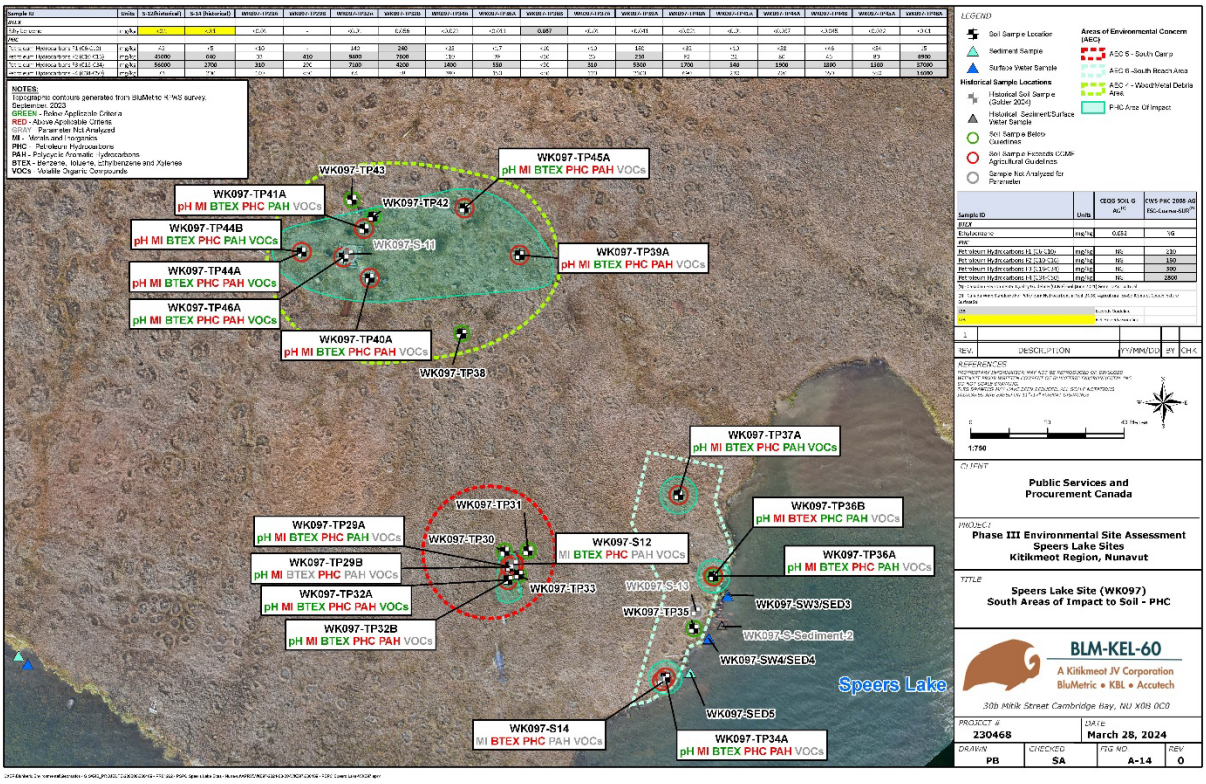
In terms of soil contamination, maximum metal, PAH and VOC concentrations are below guidelines. There are a few localized exceedances of PHC F2 and PHC F4 at the site that do not represent a risk to vegetation populations. For PHC F3, there are a number of localized exceedances of the generic guideline for the protection of vegetation as demonstrated in Table 9.13. These exceedances generally occur around barrels that are scattered around the south area of the Site as shown in Figure 9.2. There is one isolated location in the north end of the Site at TP22A around the former core shack and that does not represent a risk to vegetation populations. The pictures below show an example of some of the sampling locations and demonstrate that vegetation is growing well around all of the sampling locations. Therefore, the presence of PHC F3 in the soil around debris barrels do not represent a risk to vegetation populations at the Speers Lake (WK097) Site.

Table 9.13 PHC F3 exceedances of ecological guidelines – Speers Lake WK097

Contaminant	Location	Concentration (mg/kg)
PHC F3	TP22A	350
	TP29A	310
	TP32A	7100
	TP34A	1400
	TP36A	550
	TP37A	310
	TP39A	5300
	TP40A	1700
	TP41A	540
	TP44A	1900
	TP45A	1500
	TP46A	37000

Figure 9.2 Sampling locationsof PHC F3 Exceedances – Speers Lake WK097





Photograph 9.4 Example soil sampling locations with PHC F3 exceedances

9.2.3 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are adequately protected in the absence of Site-specific information. As demonstrated above, only a qualitative analysis was undertaken. Nevertheless, Table 9.14 examines the assumptions in of the ERA, underlying sampling and use of the guidelines.

Table 9.14 Summary of assumptions and uncertainty associated with the ERA – Speers Lake WK097

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Phase III investigation collected samples to delineate and capture soil and surface water contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, sediment, and vegetation. Background samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil, surface water, and sediment were considered to be sufficiently characterized.
Use of samples collected at depth of 0.0 m to 0.1 m, 0.0 m to 0.2 m, 0.0 m to 0.3 m, 0.1 m to 0.2 m, and 0.2 m to 0.2 m, and 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to ecological receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening.	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year round and that crops are grown and cows and other farm animals are present. This is not the case at the Site. The use of the agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption used to develop the guidelines is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.
The maximum concentrations for COCs were identified.	Low	Overestimate	Maximum concentrations were used in the screening process. The use of the maximum concentration assumes that this concentration is present across the Site and not in a localized area.
Effect Assessment			
The applicability of TRVs to the various exposure pathways for soil, sediments, and surface water.	Moderate	Overestimate	The TRVs applied to derive the ecological guidelines are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

10.0 TAHIAPIK RIVER WK170

This section provides the screening for soil, surface water, and sediment contaminants at the Tahiapik River WK170 Site. A qualitative human health and ecological assessment is carried out for the Site. Data included herein for the HHRA and ERA were individually presented in the Phase III ESA (JV-60 2024b) and supplemental data are included in Appendix A. These data are considered to represent current conditions at the Site.

10.1 Human Health Risk Assessment

10.1.1 Identification of Contaminants of Concern for Human Health

10.1.1.1 Soil

For all contaminants, the screening process considered data for soil samples collected at 0.2 mbgs to 0.3 mbgs. This depth is not accessible by humans but has been assumed to have the concentrations in soil to which humans are most likely to be exposed.

A summary of the COC screening in soil for human health is provided below in Table 10.1 (metals), Table 10.2 (PAHs), and Table 10.3 (BTEX and PHCs), along with indications of their status as an identified COC. Alternate guideline sources used in the absence of CCME guidelines are identified in the footnotes of the screening tables.

As discussed in Section 2.2.1, the composition of the native material is enriched with chromium, cobalt, copper, nickel and vanadium.

Contaminants were screened in soil following a tiered approach as discussed in Section 3.2.

Hexavalent chromium, mercury, molybdenum, selenium, silver, thallium, all PAHs except 2-methylnaphthalene and naphthalene, and all BTEX and PHCs except PHC F2 were not identified as COCs since their concentrations were all below the MDL. Additionally, all VOCs were measured below MDL except methylene chloride, and also not identified as COCs on this basis.

Antimony, arsenic, barium, beryllium, hot water soluble boron, cadmium, chromium, cobalt, copper, lead, nickel, tin, uranium, vanadium, zinc, 2-methylnaphthalene, methylene chloride, naphthalene, and PHC F2 were identified as having a maximum concentration below the human health guideline and not identified as COCs on this basis.

Thus, no COCs were identified in soil for the HHRA and no further analysis was needed.

Table 10.1 Human health screening for COCs in soil – total metals – Tahiapik River WK170

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Back-ground	Site					
Antimony	mg/kg	7.5 [3]	<0.5	0.33	0.64	5	0	No	Maximum < Human health guideline
Arsenic	mg/kg	12	2.8	2.9	3.1	5	0	No	Maximum < Human health guideline
Barium	mg/kg	6,800	397	262	340	5	0	No	Maximum < Human health guideline
Beryllium	mg/kg	75	<0.4	0.24	0.40	5	0	No	Maximum < Human health guideline
Boron, hot water soluble	mg/kg	2,500 [4]	0.15	0.09	0.19	5	0	No	Maximum < Human health guideline
Cadmium	mg/kg	14	<0.05	0.03	0.05	5	0	No	Maximum < Human health guideline
Chromium	mg/kg	220	13	14	17	5	0	No	Maximum < Human health guideline
Chromium (hexavalent)	mg/kg	3[5]	<0.08	<0.08	<0.08	5	0	No	All measurements below MDL
Cobalt	mg/kg	22 [3]	4.3	4.9	5.7	5	0	No	Maximum < Human health guideline
Copper	mg/kg	1,100	14	9.7	13	5	0	No	Maximum < Human health guideline
Lead	mg/kg	140	4.2	6.0	10	5	0	No	Maximum < Human health guideline
Mercury	mg/kg	6.6	<0.05	<0.05	<0.05	5	0	No	All measurements below MDL
Molybdenum	mg/kg	110 [3]	<0.4	<0.4	<0.4	5	0	No	All measurements below MDL
Nickel	mg/kg	200	11	11	13	5	0	No	Maximum < Human health guideline
Selenium	mg/kg	80	<0.5	<0.5	<0.5	5	0	No	All measurements below MDL
Silver	mg/kg	77 [3]	<0.2	<0.2	<0.2	5	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	<0.1	<0.1	5	0	No	All measurements below MDL
Tin	mg/kg	9,400 [2]	<1	0.78	1.9	5	0	No	Maximum < Human health guideline
Uranium	mg/kg	23	1.2	0.69	0.87	5	0	No	Maximum < Human health guideline
Vanadium	mg/kg	39 [3]	20	26	30	5	0	No	Maximum < Human health guideline
Zinc	mg/kg	10,000	25	73	270	5	0	No	Maximum < Human health guideline

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.

[3] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[4] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[5] U.S. EPA (2023) regional screening level (RSL) for residential land use and risk level of 1x10-*6; adjusted to a risk level of 1x10-5 (multiplied by 10) for consistency with Health Canada guidance.*

-- No value available.

Table 10.2 Human health screening for COCs in soil – PAHs – Tahiapik River WK170

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	72 [2]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	72 [2]	<0.005	$3.2x10^{-3}$	$5.8x10^{-3}$	5	0	No	Maximum < Human health guideline
Acenaphthene	mg/kg	3900 [3]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Acenaphthylene	mg/kg	7.8 [2]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Acridine	mg/kg	--	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL
Anthracene	mg/kg	24,000 [3]	<0.004	<0.004	<0.004	5	0	No	All measurements below MDL
B[a]P TPE Total Potency Equivalents	mg/kg	5.3	<0.0071	<0.0071	<0.0071	5	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Benzo[a]pyrene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Benzo[b,j]fluoranthene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Benzo[c]phenanthrene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Benzo[k]fluoranthene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Chrysene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Dibenz[a,h]anthracene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Fluoranthene	mg/kg	3500 [3]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Fluorene	mg/kg	720 [2]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	BaP TPE	<0.005	<0.005	<0.005	5	0	No	N/A; evaluated as BaP TPE
Naphthalene	mg/kg	360 [2]	<0.005	$3.7x10^{-3}$	$8.7x10^{-3}$	5	0	No	Maximum < Human health guideline
Perylene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Phenanthrene	mg/kg	1500 [4]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Pyrene	mg/kg	78 [2]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Quinoline	mg/kg	2.5 [4]	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2010) soil quality guideline for human health (SQG_{HH}), agricultural land use, coarse-grained soil. Human health component is direct soil contact.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Human health component is S1 Contact.

[3] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

[4] Government of British Columbia (2023) Generic Numerical Soil Standards to Protect Human Health, residential low density, (Schedule 3.1 - Part 2).

-- No value available.

Table 10.3 Human health screening for COCs in soil – BTEX and PHCs – Tahiapik River WK170

Contaminant	Units	SQG_{HH} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{HH}	COC for Human Health?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	110	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Ethylbenzene	mg/kg	10,000	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL
Toluene	mg/kg	20,000	<0.05	<0.05	<0.05	5	0	No	All measurements below MDL
Xylenes, total	mg/kg	150,000	<0.045	<0.045	<0.045	5	0	No	All measurements below MDL
PHCs									
F1 (C6-C10)	mg/kg	12,000	<10	<10	<10	5	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	6,800	<10	6.0	10	5	0	No	Maximum < Human health guideline
F3 (C16-C34)	mg/kg	15,000	<50	<50	<50	5	0	No	All measurements below MDL
F4 (C34-C50)	mg/kg	21,000	<50	<50	<50	5	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2008) Canada wide standards (CWS) for PHCs in soil, agricultural land use, coarse-grained soil. Tier 1 human health component values for direct soil contact.

10.1.1.2 Surface Water

A summary of the surface water screening is presented for metals in Table 10.9. Data for all samples (Appendix A) individually were presented in the Phase III report for the Tahiapik River WK170 Site (JV-60 2024a).

Contaminants were screened in surface water following a tiered approach:

Antimony, beryllium, boron, cadmium, chromium, cobalt, lead, lithium, mercury, molybdenum, selenium, silver, strontium, thallium, tin, titanium, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX were not identified as COCs since all measured concentrations were below the MDL.

Aluminum, arsenic, barium, manganese, nickel, phosphorus, sodium, and uranium had maximum concentrations below the drinking water guideline and were not identified as COCs on this basis.

Concentrations off calcium, magnesium, potassium, and sulphur were below or similar to the average background concentrations and thus was not identified as COCs.

Thus, no COCs were identified in surface water and no further analysis was required for the HHRA.

Table 10.4 Human health screening for COCs in surface water – total metals – Tahiapik River WK170

Contaminant	Units	Guideline [1]	Concentration		N	N > Guideline	COC for Human Health?	Rationale
			Background	Site				
Aluminum	mg/L	2.9	0.01	0.02	2	0	No	Site < Human health guideline
Antimony	mg/L	0.006	<0.0006	<0.0006	2	0	No	All measurements below MDL
Arsenic	mg/L	0.01	$4.6x10^{-4}$	$6.6x10^{-4}$	2	0	No	Site < Human health guideline
Barium	mg/L	1	0.50	0.49	2	0	No	Site < Human health guideline
Beryllium	mg/L	0.004 [3]	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	5	<0.02	<0.02	2	0	No	All measurements below MDL
Cadmium	mg/L	0.005	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	--	6.7	6.6	2	0	No	Site < background
Chromium	mg/L	0.05	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.14	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	1	$4.0x10^{-3}$	$4.5x10^{-3}$	2	0	No	Site < Human health guideline
Iron	mg/L	0.3	0.12	0.15	2	0	No	Site < Human health guideline
Lead	mg/L	0.01	<0.0002	<0.0002	2	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	--	3.8	3.7	2	0	No	Site < background
Manganese	mg/L	0.12	0.01	0.02	2	0	No	Site < Human health guideline
Mercury	mg/L	0.001	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.01 [2]	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.078 [2]	$5.1x10^{-4}$	$6.9x10^{-4}$	2	0	No	Site < Human health guideline
Phosphorus	mg/L	194 [2]	<0.003	$3.5x10^{-3}$	2	0	No	Site < Human health guideline
Potassium	mg/L	--	0.36	0.30	2	0	No	Site < background
Selenium	mg/L	0.05	<0.0002	<0.0002	2	0	No	All measurements below MDL
Silver	mg/L	--	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	200	0.54	0.55	2	0	No	Site < Human health guideline
Strontium	mg/L	2.5 [4]	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	--	0.29	0.24	2	0	No	Site < background
Thallium	mg/L	0.002 [3]	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	2.5 [4]	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	--	<0.001	<0.001	2	0	No	All measurements below MDL
Uranium	mg/L	0.02	$1.1x10^{-3}$	$1.2x10^{-3}$	2	0	No	Site < Human health guideline
Vanadium	mg/L	0.0172 [2]	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	5	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] Health Canada (2022) drinking water quality guideline.

[2] U.S. EPA (2023) regional screening level (RSL) for residential land use and hazard quotient of 0.1; adjusted to a hazard quotient of 0.2 (multiplied by 2) for consistency with Health Canada guidance.
[3] U.S. EPA (2023) maximum contaminant level (MCL) for drinking water for human health.
[4] Government of British Columbia (2023) Generic Numerical Water Standards, drinking water (Schedule 3.2).

10.1.1.3 Sediment

There are no Federal or Provincial sediment quality guidelines for the protection of human health. Human contact with sediments is considered to be minimal at the Site. Sediments are not discussed further for the HHRA.

10.1.2 Risk Characterization

The maximum measured concentrations in soils and surface water from the Site do not exceed human health guidelines or background concentrations for all contaminants, indicating that the Site is safe to be used by people undertaking any type of activity.

10.1.3 Uncertainty Analysis

A degree of uncertainty is an accepted part of the risk assessment process. Several sources of uncertainty contribute to the overall uncertainty of the conclusions. It is necessary to assess uncertainty to ensure that the assumptions made in the risk assessment process will not underestimate the risk to humans and to ensure that the conclusion produced has a high degree of confidence. The HHRA was a qualitative assessment using regulatory guidelines. Nonetheless, there are some assumptions underlying the qualitive assessment as discussed below.

Table 10.5 Summary of assumptions and uncertainty associated with the HHRA – Tahiapik River WK170

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, and vegetation. Background samples were also collected to evaluate naturally elevated levels at the Site. COCs in soil and surface water were considered to be sufficiently characterized.

Assumption	Uncertainty	Under/Over Estimate Risk	Rationale
Use of samples collected at depth of 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to human receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the human health guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Exposure Concentrations			
The maximum concentrations for COCs were identified.	Low	Neutral	Maximum concentrations were used in the screening process.
Exposure Assumptions			
Receptor assumptions	Low	Overestimate	Agricultural guidelines were used in the screening process. This assumes that the Site is used year-round for farming. The Site is only used occasionally.
Toxicity			
The applicability of the selected TRVs to the various exposure pathways for soil and surface water.	Moderate	Neutral	TRVs are used by regulatory agencies to derive the guidelines. In many cases the TRVs have uncertainty factors applied to ensure that no adverse health outcomes will occur.

10.2 Ecological Risk Assessment

10.2.1 Identification of Contaminants of Concern for Environmental Health

A tiered screening process was carried out to identify ERA COCs in soil at the Tahiapik River WK170 Site.

10.2.1.1 Soil

The soil COC screening was based on maximum concentrations measured at the Site. As was done for all contaminants for the HHRA, the screening process only considered data for all soil samples collected from a depth of 0.2 mbgs to 0.3 mbgs. As discussed in the HHRA, this soil depth is too deep for ecological exposure, but it was assumed for the purposes of the ERA that ecological receptors could be exposed to these contaminant concentrations.

For the soil ERA COC screening, measured contaminant concentrations were compared to CCME SQG_{Eco}, agricultural land use. In the absence of CCME guidelines, alternate sources were considered; these are identified in footnotes in Table 10.6 (metals), Table 10.7 (PAHs) and Table 10.8 (BTEX and PHCs).

In the first step of the screening, chromium (hexavalent), mercury, molybdenum, selenium, silver, thallium, all PAHs except naphthalene, and all BTEX and PHCs except PHC F2 were removed from consideration as all of the measurements were below the MDL. Additionally, all VOCs were measured below detection limits.

The maximum concentrations of antimony, arsenic, barium, beryllium, hot water soluble boron, cadmium, chromium, cobalt, copper, lead, nickel, tin, uranium, vanadium, naphthalene, and PHC F2 were below the SQG_{Eco} and thus were not identified as COCs.

The maximum concentrations of zinc was above the CCME ecological guidelines. The single sample (270 mg/kg; TP1A) was collected from the burn pit site which is suspected to be from historical burning of metal objects. This is a localized exceedance and therefore, zinc is not considered to be a COC.

In summary, no COCs were identified in soil and thus do not represent a risk to the environment at the Site.

Table 10.6 ERA screening for COCs in soil – total metals – Tahiapik River WK170

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Back-ground	Site					
Antimony	mg/kg	20	<0.5	0.33	0.64	5	0	No	Maximum < Ecological guideline
Arsenic	mg/kg	17	2.8	2.9	3.1	5	0	No	Maximum < Ecological guideline
Barium	mg/kg	500	397	262	340	5	0	No	Maximum < Ecological guideline
Beryllium	mg/kg	4	<0.4	0.24	0.40	5	0	No	Maximum < Ecological guideline
Boron, hot water soluble	mg/kg	3.3 [2]	0.15	0.09	0.19	5	0	No	Maximum < Ecological guideline
Cadmium	mg/kg	10	<0.05	0.03	0.05	5	0	No	Maximum < Ecological guideline
Chromium	mg/kg	64	13	14	17	5	0	No	Maximum < Ecological guideline
Chromium (hexavalent)	mg/kg	0.4	<0.08	<0.08	<0.08	5	0	No	All measurements below MDL
Cobalt	mg/kg	40	4.3	4.9	5.7	5	0	No	Maximum < Ecological guideline
Copper	mg/kg	63	14	9.7	13	5	0	No	Maximum < Ecological guideline
Lead	mg/kg	70	4.2	6.0	10	5	0	No	Maximum < Ecological guideline
Mercury	mg/kg	12	<0.05	<0.05	<0.05	5	0	No	All measurements below MDL
Molybdenum	mg/kg	5	<0.4	<0.4	<0.4	5	0	No	All measurements below MDL
Nickel	mg/kg	45	11	11	13	5	0	No	Maximum < Ecological guideline
Selenium	mg/kg	1	<0.5	<0.5	<0.5	5	0	No	All measurements below MDL
Silver	mg/kg	20	<0.2	<0.2	<0.2	5	0	No	All measurements below MDL
Thallium	mg/kg	1	<0.1	<0.1	<0.1	5	0	No	All measurements below MDL
Tin	mg/kg	5	<1	0.78	1.9	5	0	No	Maximum < Ecological guideline
Uranium	mg/kg	33	1.2	0.69	0.87	5	0	No	Maximum < Ecological guideline
Vanadium	mg/kg	130	20	26	30	5	0	No	Maximum < Ecological guideline
Zinc	mg/kg	250	25	73	270	5	1	No	Single exceedance; localized

Note: Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] Alberta Environment and Parks (2019), Table A2 Surface Soil Remediation guidelines for agricultural, coarse-grained soil.

-- No value available.

Table 10.7 ERA screening for COCs in soil – PAHs – Tahiapik River WK170

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
1-Methylnaphthalene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
2-Methylnaphthalene	mg/kg	--	<0.005	$3.2x10^{-3}$	$5.8x10^{-3}$	5	0	No	No guideline
Acenaphthene	mg/kg	0.28	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Acenaphthylene	mg/kg	320	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Acridine	mg/kg	--	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL
Anthracene	mg/kg	2.5	<0.004	<0.004	<0.004	5	0	No	All measurements below MDL
Benz[a]anthracene	mg/kg	0.1	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[a]pyrene	mg/kg	20	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[b,j]fluoranthene	mg/kg	0.1	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[c]phenanthrene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[e]pyrene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[g,h,i]perylene	mg/kg	6.6 [2]	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Benzo[k]fluoranthene	mg/kg	0.1	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Chrysene	mg/kg	6.2	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Dibenz[a,h]anthracene	mg/kg	0.1	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Fluoranthene	mg/kg	50	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Fluorene	mg/kg	0.25	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Indeno[1,2,3-c,d]pyrene	mg/kg	0.1	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Naphthalene	mg/kg	0.013	<0.005	$3.7x10^{-3}$	$8.7x10^{-3}$	5	0	No	Maximum < Ecological guideline
Perylene	mg/kg	--	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Phenanthrene	mg/kg	0.046	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Pyrene	mg/kg	7.7	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Quinoline	mg/kg	0.1	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

Table 10.8 ERA screening for COCs in soil – BTEX and PHCs – Tahiapik River WK170

Contaminant	Units	SQG_{Eco} [1]	Average Concentration		Maximum Concentration	N	N > SQG_{Eco}	COC for Eco?	Rationale
			Background	Site					
BTEX									
Benzene	mg/kg	25	<0.005	<0.005	<0.005	5	0	No	All measurements below MDL
Ethylbenzene	mg/kg	55	<0.01	<0.01	<0.01	5	0	No	All measurements below MDL
Toluene	mg/kg	75	<0.05	<0.05	<0.05	5	0	No	All measurements below MDL
Xylenes, total	mg/kg	65	<0.045	<0.045	<0.045	5	0	No	All measurements below MDL
PHCs									
F1 (C6-C10)	mg/kg	210	<10	<10	<10	5	0	No	All measurements below MDL
F2 (C10-C16)	mg/kg	150	<10	6.0	10	5	0	No	Maximum < Ecological guideline
F3 (C16-C34)	mg/kg	300	<50	<50	<50	5	0	No	All measurements below MDL
F4 (C34-C50)	mg/kg	2800	<50	<50	<50	5	0	No	All measurements below MDL

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL; only samples collected from 0.2-0.3 mbgs are included (i.e. 0.4-0.6 mbgs are not included).

[1] CCME (2023) soil quality guideline for environmental health (SQG_{Eco}), agricultural land use, coarse-grained soil.

[2] MOE (2011a) Table 3 soil components (non-potable) for coarse-textured soil. Ecological health component is Plants and Soil Organisms.

-- No value available.

10.2.1.2 Surface water

The CCME (2023) long term WQGs for the protection of freshwater aquatic life were used as the screening criteria.

The surface water screening for metals is shown in Table 10.9. Data for all samples (Appendix A) were individually presented in the Phase III for the Tahiapik River WK170 Site (JV-60 2024a).

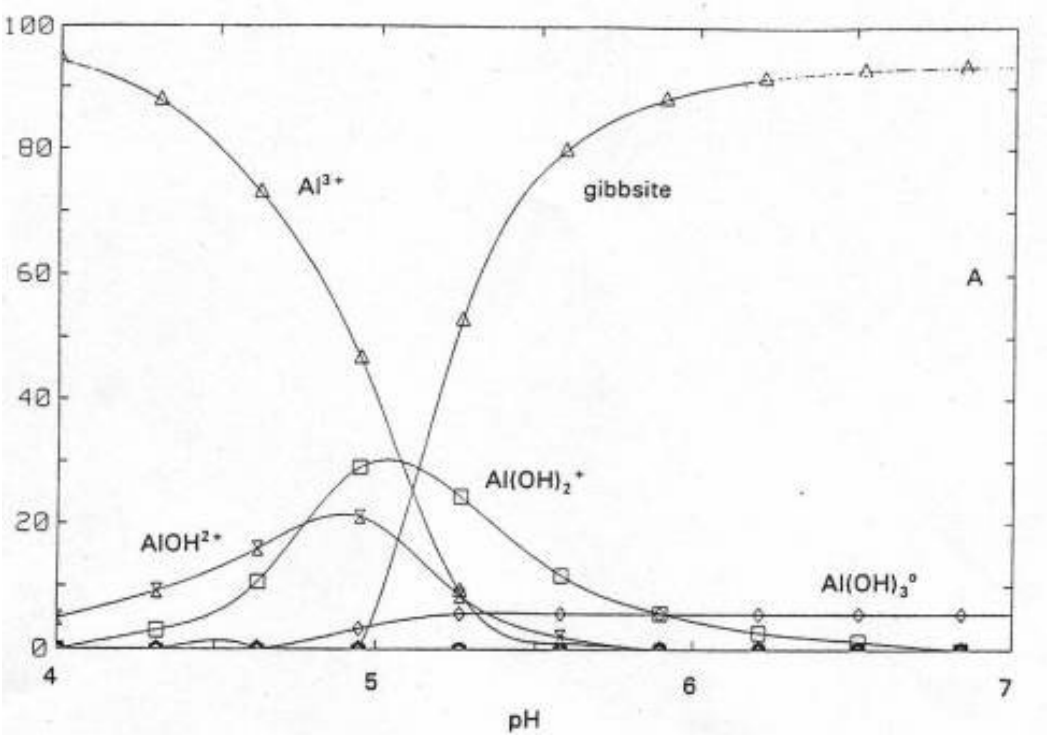
All samples were below the MDL for antimony, beryllium, boron, cadmium, chromium, cobalt, lead, lithium, mercury, molybdenum, selenium, silver, strontium, thallium, tin, titanium, vanadium, and zinc, as well as all PAHs, PHCs, and BTEX and thus these contaminants were not identified as COCs.

A comparison of maximum measured concentrations to the WQGs indicated that arsenic, barium, calcium, iron, magnesium, manganese, nickel, phosphorous, potassium, sodium, sulphur, and uranium had maximum measured levels that were lower than the guidelines and therefore were not considered further as they do not present a risk to aquatic life.

The concentration of copper at the Site is similar to background, therefore copper was not carried forward into the next tier of screening. Although the maximum concentration of aluminum is above the guideline, additional considerations were included in the final determination for whether aluminum was a COC. Aluminum is complexed by both inorganic and organic ligands in water (Figure 10.1). Below a pH of 6, organic complexes and the hydrated free ion tend to be the principal forms. At higher pH values, the dissolved species are only a small fraction of the total aluminum present since most of the aluminum is in a particulate form, which is inaccessible and therefore much less toxic than dissolved aluminum. At pH values between 5.5 and 9, there is very little aluminum that is in true solution and available for uptake by biological species (Gardner et al. 2002). Since the pH values from the sample at the Tahiapik River WK170 Site was 6.04, aluminum is not present in an available (toxic) form and was not considered to be a COC.

In summary, no COCs were identified for further evaluation in the ERA for surface water.

Figure 10.1 Aluminum speciation in water from pH 4 to 7



Note: from Gensemer and Playle (1999).

Table 10.9 ERA screening for COCs in surface water – total metals – Tahiapik River WK170

Contaminant	Units	WQG [1]	Average Concentration		N	N > WQG	COC for Ecological Health?	Rationale
			Background	Site				
Aluminum	mg/L	0.005	0.01	0.02	2	1	No	Not bioavailable
Antimony	mg/L	0.02 [2]	<0.0006	<0.0006	2	0	No	All measurements below MDL
Arsenic	mg/L	0.005	$4.6x10^{-4}$	$6.6x10^{-4}$	2	0	No	Maximum < Ecological guideline
Barium	mg/L	1 [3]	0.50	0.49	2	0	No	Maximum < Ecological guideline
Beryllium	mg/L	0.00013 [3]	<0.001	<0.001	2	0	No	All measurements below MDL
Boron	mg/L	1.5	<0.02	<0.02	2	0	No	All measurements below MDL
Cadmium	mg/L	0.00011	<0.00002	<0.00002	2	0	No	All measurements below MDL
Calcium	mg/L	1,000	6.7	6.6	2	0	No	Maximum < Ecological guideline
Chromium	mg/L	0.0089 [6]	<0.001	<0.001	2	0	No	All measurements below MDL
Cobalt	mg/L	0.004 [5]	<0.0003	<0.0003	2	0	No	All measurements below MDL
Copper	mg/L	0.002 [7]	$4.0x10^{-3}$	$4.5x10^{-3}$	2	1	No	Site similar to background
Iron	mg/L	0.3	0.12	0.15	2	0	No	Maximum < Ecological guideline
Lead	mg/L	0.001 [7]	<0.0002	<0.0002	2	0	No	All measurements below MDL
Lithium	mg/L	--	<0.02	<0.02	2	0	No	All measurements below MDL
Magnesium	mg/L	82 [4]	3.8	3.7	2	0	No	Maximum < Ecological guideline
Manganese	mg/L	0.2 [5]	0.01	0.02	2	0	No	Maximum < Ecological guideline
Mercury	mg/L	$2.6x10^{-5}$	<0.0000019	<0.0000019	2	0	No	All measurements below MDL
Molybdenum	mg/L	0.073	<0.0002	<0.0002	2	0	No	All measurements below MDL
Nickel	mg/L	0.025 [7]	$5.1x10^{-4}$	$6.9x10^{-4}$	2	0	No	Maximum < Ecological guideline
Phosphorus	mg/L	0.01 [2]	<0.003	$3.5x10^{-3}$	2	0	No	Maximum < Ecological guideline
Potassium	mg/L	53 [4]	0.36	0.30	2	0	No	Maximum < Ecological guideline
Selenium	mg/L	0.001	<0.0002	<0.0002	2	0	No	All measurements below MDL
Silver	mg/L	0.00025	<0.0001	<0.0001	2	0	No	All measurements below MDL
Sodium	mg/L	680 [4]	0.54	0.55	2	0	No	Maximum < Ecological guideline
Strontium	mg/L	21	<0.02	<0.02	2	0	No	All measurements below MDL
Sulphur	mg/L	1,000	0.29	0.24	2	0	No	Maximum < Ecological guideline
Thallium	mg/L	0.0008	<0.0002	<0.0002	2	0	No	All measurements below MDL
Tin	mg/L	0.18 [4]	<0.001	<0.001	2	0	No	All measurements below MDL
Titanium	mg/L	1 [5]	<0.001	<0.001	2	0	No	All measurements below MDL
Uranium	mg/L	0.015	$1.1x10^{-3}$	$1.2x10^{-3}$	2	0	No	Maximum < Ecological guideline
Vanadium	mg/L	0.12	<0.001	<0.001	2	0	No	All measurements below MDL
Zinc	mg/L	0.03	<0.003	<0.003	2	0	No	All measurements below MDL

Note: Average and maximum concentrations calculated after setting values below the method detection limit (<MDL) equal to half the MDL, except where all samples (N) were below the MDL in which case average is shown as<MDL.

[1] CCME (2023) water quality guideline for the protection of aquatic life (freshwater).

[2] Ontario Provincial Water Quality Objective (MOEE 1994); interim value and should be used with caution.
[3] BC MOE (2021) working or approved water quality guidelines.
[4] U.S. EPA (2015) Region 4 supplemental risk assessment guidance, surface water screening values, chronic, Table 1a.
[5] Government of British Columbia (2023) Generic Numerical Water Standards, aquatic life (Schedule 3.2).
[6] Guideline is for trivalent chromium.
[7] Based on water hardness of less than 82 mg/L $CaCO_3$ (copper) and less than 60 mg/L $CaCO_3$ (lead, nickel).

10.2.1.3 Sediment

One sediment sample was collected at the Site at the shoreline adjacent to a barrel in AEC5.

The sediment screening process is summarized for metals in Table 10.10. All measurements of PAHs, BTEX, and PHCs were below the MDL and thus were not identified as COCs and are not included herein. For the screening process the CCME (2023) ISQGs were used as the screening criteria. In the absence of an ISQG, available sediment criteria from other jurisdictions were used as indicated in the footnotes to the tables.

A comparison to the MDL indicated that antimony, beryllium, hot water soluble boron, cadmium, chromium (hexavalent), mercury, molybdenum, selenium, silver, thallium, tin, all PAHs, BTEX, and PHCs had all measurements less than the MDL and were not considered further.

The concentrations of arsenic, chromium, cobalt, copper, lead, nickel, uranium, and zinc were all below the ISQG or respective guidelines and were not considered further.

Two contaminants (barium and vanadium) were measured at detectable concentrations but had no ISQG available. These contaminants are not expected to be a concern to benthic invertebrates communities and were not identified as COCs in sediment.

In summary, no COCs were identified for further evaluation in the ERA for sediment.

Table 10.10 ERA screening for COCs in sediment – total metals – Tahiapik River WK170

Contaminant	Units	ISQG [1]	Concentration	COC for Eco?	Rationale
Antimony	mg/kg	25 [3]	<0.5	No	Concentration below MDL
Arsenic	mg/kg	5.9	1.6	No	Concentration < Ecological guideline
Barium	mg/kg	--	86	No	No guideline
Beryllium	mg/kg	--	<0.4	No	Concentration below MDL
Boron, hot water soluble	mg/kg	--	<0.1	No	Concentration below MDL
Cadmium	mg/kg	0.6	<0.05	No	Concentration below MDL
Chromium	mg/kg	37.3	9	No	Concentration < Ecological guideline
Chromium (hexavalent)	mg/kg	--	<0.08	No	Concentration below MDL
Cobalt	mg/kg	50 [4]	3.1	No	Concentration < Ecological guideline
Copper	mg/kg	35.7	19	No	Concentration < Ecological guideline
Lead	mg/kg	35	3.1	No	Concentration < Ecological guideline
Mercury	mg/kg	0.17	<0.05	No	Concentration below MDL
Molybdenum	mg/kg	13.8 [6]	<0.4	No	Concentration below MDL
Nickel	mg/kg	16 [5]	8.3	No	Concentration < Ecological guideline
Selenium	mg/kg	2 [3]	<0.5	No	Concentration below MDL
Silver	mg/kg	0.5 [4]	<0.2	No	Concentration below MDL
Thallium	mg/kg	--	<0.1	No	Concentration below MDL
Tin	mg/kg	--	<1	No	Concentration below MDL
Uranium	mg/kg	100 [2]	1.5	No	Concentration < Ecological guideline
Vanadium	mg/kg	--	16	No	No guideline
Zinc	mg/kg	123	24	No	Concentration < Ecological guideline

Note: Maximum concentration shown as less than the method detection limit (<MDL) when all samples (N) were below the MDL.

[1] CCME (2023) interim sediment quality guideline (ISQG) for the protection of aquatic life.

[2] U.S. EPA (2015) Region 4 soil and freshwater sediment screening benchmarks.

[3] Nova Scotia Environment (2014), freshwater sediment

[4] MOE (2011a) Table 1 Full Depth Background Site Condition Standards Ground Water Condition.

[5] MOE (2008) lowest effect level sediment quality guideline, Table 1.

[6] Thompson et al. (2005) lowest effect level.

10.2.2 Risk Characterization

As discussed above, a qualitative assessment was carried out and determined that ecological populations are not at risk at the Site.

10.2.3 Uncertainty Analysis

Like any ERA, there are many sources of uncertainty in this ERA. Uncertainties are often addressed by making conservative assumptions to ensure that ecological receptors are adequately protected in the absence of Site-specific information. As discussed above, only a qualitative analysis was undertaken. Nevertheless, Table 10.11 examines the assumptions in of the ERA, underlying sampling and use of the guidelines.

Table 10.11 Summary of assumptions and uncertainty associated with the ERA – Tahiapik River WK170

Assumptions	Uncertainties	Under or Over Estimate Risk	Rationale
Identification of COCs			
All potential sources of contamination on the Site were identified.	Low	Neutral	Review of previous studies and historical Site use was completed. A Phase III ESA was conducted (JV-60 2024a) to address data gaps from the historical Phase I and II assessment in addition to delineating the contamination at the Site.
The types of COCs present on Site have been characterized in all media.	Low	Neutral	The Phase III ESA investigated COCs in soil, surface water, sediment, and vegetation. Background samples were also collected to evaluate naturally elevated metals at the Site. COCs in soil, water, and sediment were considered to be sufficiently characterized.
Use of samples collected at depth of 0.2 m to 0.3 m.	Medium	Could be either an over or underestimate	The use of samples collected at depth rather than surface samples does not represent an exposure pathway to ecological receptors. Generally metal contaminant concentrations at the surface are higher than at depth. However, the contamination present in soil has been there for a long time and thus may have moved to the deeper soil through infiltration processes. Given that the maximum soil concentrations are below the agricultural guidelines and in some cases by a factor of 2 to 10, it is unlikely that if the soil concentrations were higher that the conclusions of the assessment would change.
Use of agricultural guidelines for screening.	High	Overestimate	The use of agricultural guidelines to identify COCs in soil assumes that a farm is present at the Site year round, that crops are grown, and that farm animals are present. This is not the case at the Site. The use of agricultural guidelines is very conservative and may result in the identification of COCs that do not represent a risk.
Exposure Assessment			
Assuming soil COC concentrations are 100% bioavailable to plant communities.	High	Overestimate	This assumption used to develop the guidelines is overly conservative, especially when assessing risk to plant communities using media concentrations as exposure concentrations. The exposures do not account for effects of soil pH, % organic matters, and other constituents in the soils that potentially affect the bioavailability of COCs in the environment. The bioavailability is variable in different soils (e.g., between toxicity test soils and Site soils) is often less than 100%.
Effect Assessment			
The applicability of the selected TRVs to the various exposure pathways for soil, sediments, and surface water.	Moderate	Overestimate	The TRVs applied to derive the ecological guidelines are likely to overestimate potential risk as they are developed and selected to ensure comprehensive protection to even the most sensitive species.

11.0 CLIMATE CHANGE

The changing climate has the potential to impact how the risk associated with contaminants is assessed and how effective the remedial and risk management plans are at these contaminated sites. A look ahead to future climatic conditions allows for the consideration of these impacts when assessing and remediating the Site. ECCC has developed a guidance document entitled the Federal Contaminated Sites Action Plan (FCSAP): Integrating Climate Change Adaptation Considerations into Federal Contaminated Sites Management (Version 1.0) (ECCC 2022) which details how each step of the DMF can be modified to incorporate climate change adaptation and mitigation measures. The following section describes the future climatic conditions anticipated to be experienced at the Sites based on the FCSAP guidance.

Based on climate projections, the Speers Lake area is predicted to experience an increase in precipitation, an increase in wet days, higher mean temperatures, a greater number of warmer days and a lower number of ice days.

These warming temperatures are unlikely to result in changes to the concentrations of metals at the Sites but are likely to result in decreases in organic (PAH and PHC) concentrations at the Sites due to weathering. The temperature changes will, however, result in increased water temperatures and soil temperatures resulting in less ice cover on waterbodies and less snow cover on the ground. The decrease in snow cover would result in more days when the surface soils are snow free, indicating a potential for increased exposure to the contamination by humans and ecological receptors. Given that there is no chemical risk at the Sites due either to either no contamination above applicable guidelines WK 154, WK165, WK170) or to localized contamination (WK199, WK210, WK176, WK097), the increased snow free days will not result in any risks to human health, vegetation, soil invertebrate, or wildlife populations present at any of the seven Sites. The high mean temperatures will also result in more vegetation growth and the likelihood that different animals may migrate into some of these Sites. The lack of ecological risks to populations determined in the assessments will remain unchanged as contaminants are either below applicable guidelines or localized to one or two areas at a given Site. For example, at Coppermine WK210, the localized areas of PHC contamination are likely to have lower concentrations due to climate change and any additional vegetative growth will be unaffected.

The increased precipitation will result in increased surface erosion, surface run-off and infiltration. All of these processes are likely to result in decreased concentrations of COC in the surface soils at the Sites.

The higher temperatures and greater number of warmer days may have the potential to degrade the permafrost. If this occurs it is likely that there will be slumping of the soils at the Sites as the permafrost melts which would potentially lead to covering of surficial soils and eliminating exposure pathways to soil at the Sites.

There is also likely to be increases in forest and grass fires. If a fire did occur, it is unlikely contaminant fate and transport would be affected such that it would result in human health or ecological risks.

In summary, climate change is unlikely to result in any risks to human or ecological receptors at Asiak River WK154, Coppermine WK199, Coppermine WK210, Impact Lake WK176, Kendall River WK165, Speers Lake WK097, or Tahiapak River WK170.

12.0 HHERA SUMMARY AND RECOMMENDATIONS

A Human Health and Ecological Risk Assessment (HHERA) was completed for the Speers Lake Sites (the Sites). The seven Sites include Speers Lake WK097 , Asiak River WK154, Coppermine WK199, Impact Lake WK176, Tahiapik River WK170, Kendall River WK165, and Coppermine WK210. All Sites lie in proximity to Kugluktuk, NU within the Kitikmeot district.

The HHRA evaluated the risk to people who would be present at the seven Sites within the Speers Lake Sites. It is noted that people rarely visit the Sites as they are difficult to access. The qualitative analysis of human health at all the Sites, which involved a comparison of the maximum measured concentrations in soil at the sites to human health guidelines, indicated that there were no exceedances of the soil guidelines, or the contamination was too deep to represent a pathway of exposure and therefore there is no risk to people from soil pathways at the Site. There are no exceedances of drinking water guidelines within any of the lakes present at Coppermine WK199, Coppermine WK210, Kendall River WK165, Speers Lake WK097, and Tahiapik River WK170 indicating that the water is safe to drink.

The ERA evaluated the risks to vegetation, soil invertebrates, and wildlife, that would forage at the sites. A qualitative evaluation was undertaken for these receptors at all the Sites as the maximum measured concentrations were below ecological guidelines or localized at the Sites and therefore do not represent a risk to populations of ecological receptors. Maximum concentrations of contaminants in surface water at Coppermine WK199, Coppermine WK210, Kendall River WK165, Speers Lake WK097, and Tahiapik River WK170 were below guidelines protective of aquatic guidelines and do not represent a risk. Similarly, it was determined that benthic communities were not at risk at these five Sites. It was determined that ecological populations are not at risk at any of the seven Sites. It is noted that surface water and sediment samples were not collected at Impact Lake due to time constraints, however, as there was only one localized area of contamination it is unlikely to be mobilized into the surface water body.

Climate change is unlikely to result in increased risks to human or ecological receptors at the seven Sites.

From a chemical perspective, there is no human or ecological risk-driven need for remediation at the Speers Lake Sites as long as the future land use and time on site remain as described in the HHERA. However, at Speers Lake WK097 and Impact Lake WK176 there are several barrels that contain product which should be removed as they are potential

sources of contamination. At all the other Sites, the barrels are dry and while they represent a physical risk, they do not represent a source of chemical contamination.

13.0 STATEMENT OF LIMITATIONS AND CLOSURE

The observations and results obtained during this investigation are representative of the conditions encountered at the sampling locations only. The conditions that CanNorth interprets to exist at, between, and beyond sampling points may differ from those that actually exist. The statements made in this report are based solely on the information obtained to date as part of the above referenced investigation. CanNorth has used its professional judgment in analyzing this information and formulating its conclusions. No other warranty or representation expressed or implied, as to the accuracy of the information or recommendations is included or intended in this report.

CanNorth Environmental Services makes no warranty as to the accuracy or completeness of the information provided by others, or of conclusions and recommendations predicated on the accuracy of that information.

This report has been prepared for CIRNAC and PSPC. Any use a third party makes of this report, any reliance on the report, or decisions based upon the report, are the responsibility of those third parties unless authorization is received by CanNorth Environmental Services in writing.

CanNorth Environmental Services accepts no responsibility for any loss or damages suffered by any unauthorized third party as a result of decisions made or actions taken based on this report.

Respectfully submitted,

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APPENDICES

APPENDIX A

SUPPLEMENTAL DATA

Table C4: WK154 Asiak River Analytical Chemistry Results: Semi-Volatile Organic Compounds & Volatile Organic Compounds in Soil					Location	WK154-TP1A	WK154-TP1B	WK154-TP2A	WK154-TP2B	WK154-TP3A	WK154-TP3B	WK154-TP4A	WK154-TP5B	WK154-TP6A	WK154-TP7B	WK154-TP8A	WK154-TP9A	WK154-TP10A
					Sample ID	WK154-TP1A	WK154-TP1B	WK154-TP2A	WK154-TP2B	WK154-TP3A	WK154-TP3B	WK154-TP4A	WK154-TP5B	WK154-TP6A	WK154-TP7B	WK154-TP8A	WK154-TP9A	WK154-TP10A
					Sample Date	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30	2023-Aug-30
Parameter	Units	Max Concentratio	CEQG-SOIL-G-AG	CWS-PHC-2008-AG-ESC-Coarse-	Lab Sample ID	BYS980	BYS982	BYS984	BYS985	BYS986	BYS987	BYS988	BYS990	BYS991	BYS994	BYS995	BYS998	BYT000
					Sample Depth	0.2 - 0.3	0.4 - 0.5	0.2 - 0.3	0.5 - 0.6	0.15-0.2	0.3 - 0.4	0.2 - 0.3	0.5 - 0.6	0.2 - 0.3	0.4 - 0.5	0.2-0.25	0.2 - 0.3	0.2 - 0.3
Semi-Volatile Organic Compounds					RD:													
Dichlorobenzene, 1,2-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichlorobenzene, 1,3-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichlorobenzene, 1,4-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trichlorobenzene, 1,2,4-	mg/kg	<0.04	0.05	-	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Volatile Organic Compounds																		
Bromodichloromethane	mg/kg	<0.03	-	-	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Bromoform	mg/kg	<0.05	-	-	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bromomethane	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Carbon tetrachloride	mg/kg	<0.0005	0.1	-	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chlorobenzene	mg/kg	<0.005	-	-	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	mg/kg	0.036	-	-	0.01	<0.01	<0.01	<0.01	<0.01	0.026	<0.01	0.036	0.013	<0.01	<0.01	0.013	<0.01	<0.01
Chloromethane	mg/kg	<0.03	-	-	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Dibromochloromethane	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dibromoethane, 1,2-	mg/kg	<0.002	-	-	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dichloroethane, 1,1-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloroethane, 1,2-	mg/kg	<0.002	0.1	-	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dichloroethene, 1,1-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloroethene, cis-1,2-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloroethene, trans-1,2-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloropropane, 1,2-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloropropene, cis-1,3-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloropropene, trans-1,3-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Methylene chloride	mg/kg	0.17	0.1	-	0.03	0.13	<0.03	0.17	<0.03	<0.03	<0.03	0.14	0.06	<0.03	0.07	0.053	<0.03	<0.03
Methyl methacrylate	mg/kg	<0.04	-	-	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Methyl tert-butyl ether (MTBE	mg/kg	<0.03	-	-	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Styrene	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.05	-	-	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.05	0.1	-	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tetrachloroethene	mg/kg	<0.01	0.1	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorobenzene, 1,2,3-	mg/kg	<0.04	0.05	-	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Trichlorobenzene, 1,3,5-	mg/kg	<0.04	0.05	-	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Trichloroethane, 1,1,1-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trichloroethane, 1,1,2-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trichloroethene	mg/kg	<0.001	-	-	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trimethylbenzene, 1,2,4-	mg/kg	<0.5	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trimethylbenzene, 1,3,5-	mg/kg	<0.5	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vinyl Chloride	mg/kg	<0.02	-	-	0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.02	<0.0003	<0.0003	<0.02	<0.02	<0.0003	<0.02	<0.0003	<0.0003

Notes:

RDL: Reported Detection Limit - May vary between sample locations and events

pg/g - picogram per gram

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Table C4: WK199 Coppermine Analytical Chemistry Results: Semi-Volatile Organic Compounds, Dioxins, Furans & Volatile Organic Compounds in Soil				Location	WK199-TP6A	WK199-TP17A
				Sample ID	WK199-TP6A	WK199-TP17A
				Sample Date	2023-Sep-01	2023-Sep-08
				Lab Job Number	C371640	C371862
Parameter	Units	Max Concentratio	CEQG-SOIL-G-AG	Lab Sample ID	BYT624	BYU889
				Sample Depth	0.2 - 0.3	0.1 - 0.2
Dioxins and Furans				RDL		
Hepta CDD, 1,2,3,4,6,7,8-	pg/g	0.142	-	4.99	-	0.142
Hepta CDF, 1,2,3,4,6,7,8-	pg/g	0.245	-	4.99	-	0.245
Hepta CDF, 1,2,3,4,7,8,9-	pg/g	<0.106	-	4.99	-	<0.106
Hexa CDD, 1,2,3,4,7,8-	pg/g	<0.149	-	4.99	-	<0.149
Hexa CDD, 1,2,3,6,7,8-	pg/g	<0.146	-	4.99	-	<0.146
Hexa CDD, 1,2,3,7,8,9-	pg/g	<0.142	-	4.99	-	<0.142
Hexa CDF, 1,2,3,4,7,8-	pg/g	<0.123	-	4.99	-	<0.123
Hexa CDF, 1,2,3,6,7,8-	pg/g	<0.118	-	4.99	-	<0.118
Hexa CDF, 1,2,3,7,8,9-	pg/g	<0.137	-	4.99	-	<0.137
Hexa CDF, 2,3,4,6,7,8-	pg/g	<0.112	-	4.99	-	<0.112
Octa CDD	pg/g	0.402	-	9.98	-	0.402
Octa CDF	pg/g	0.387	-	9.98	-	0.387
Penta CDD, 1,2,3,7,8-	pg/g	<0.145	-	4.99	-	<0.145
Penta CDF, 1,2,3,7,8,-	pg/g	<0.175	-	4.99	-	<0.175
Penta CDF, 2,3,4,7,8-	pg/g	<0.297	-	4.99	-	<0.297
Tetra CDD, 2,3,7,8-	pg/g	<0.14	-	0.998	-	<0.14
Tetra CDF, 2,3,7,8-	pg/g	<0.0989	-	0.998	-	<0.0989
Total Hepta CDD	pg/g	0.142	-	4.99	-	0.142
Total Hepta CDF	pg/g	0.245	-	4.99	-	0.245
Total Hexa CDD	pg/g	<0.145	-	4.99	-	<0.145
Total Hexa CDF	pg/g	<0.122	-	4.99	-	<0.122
Total Penta CDD	pg/g	<0.145	-	4.99	-	<0.145
Total Penta CDF	pg/g	<0.217	-	4.99	-	<0.217
Total Tetra CDD	pg/g	<0.14	-	0.998	-	<0.14
Total Tetra CDF	pg/g	0.103	-	0.998	-	0.103
Total Toxic Equivalency	pg/g	0.487	4	N/A	-	0.487
Semi-Volatile Organic Compounds						
Dichlorobenzene, 1,2-	mg/kg	<0.078	0.1	0.078	<0.078	-
Dichlorobenzene, 1,3-	mg/kg	<0.078	0.1	0.078	<0.078	-
Dichlorobenzene, 1,4-	mg/kg	<0.078	0.1	0.078	<0.078	-
Trichlorobenzene, 1,2,4-	mg/kg	<0.16	0.05	0.16	<0.16	-
Volatile Organic Compounds						
Bromodichloromethane	mg/kg	<0.12	-	0.12	<0.12	-
Bromoform	mg/kg	<0.19	-	0.19	<0.19	-
Bromomethane	mg/kg	<0.078	-	0.078	<0.078	-
Carbon tetrachloride	mg/kg	<0.0019	0.1	0.0019	<0.0019	-
Chlorobenzene	mg/kg	<0.019	-	0.019	<0.019	-
Chloroform	mg/kg	<0.039	-	0.039	<0.039	-
Chloromethane	mg/kg	<0.12	-	0.12	<0.12	-
Dibromochloromethane	mg/kg	<0.078	-	0.078	<0.078	-
Dibromoethane, 1,2-	mg/kg	<0.0078	-	0.0078	<0.0078	-
Dichloroethane, 1,1-	mg/kg	<0.078	0.1	0.078	<0.078	-
Dichloroethane, 1,2-	mg/kg	<0.0078	0.1	0.0078	<0.0078	-
Dichloroethene, 1,1-	mg/kg	<0.078	0.1	0.078	<0.078	-
Dichloroethene, cis-1,2-	mg/kg	<0.078	-	0.078	<0.078	-
Dichloroethene, trans-1,2-	mg/kg	<0.078	-	0.078	<0.078	-
Dichloropropane, 1,2-	mg/kg	<0.078	0.1	0.078	<0.078	-
Dichloropropene, cis-1,3-	mg/kg	<0.078	-	0.078	<0.078	-
Dichloropropene, trans-1,3-	mg/kg	<0.078	-	0.078	<0.078	-
Methylene chloride	mg/kg	<0.12	0.1	0.12	<0.12	-
Methyl methacrylate	mg/kg	<0.16	-	0.16	<0.16	-
Methyl tert-butyl ether (MTBE	mg/kg	<0.12	-	0.12	<0.12	-
Styrene	mg/kg	<0.078	0.1	0.078	<0.078	-
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.19	-	0.19	<0.19	-
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.19	0.1	0.19	<0.19	-
Tetrachloroethene	mg/kg	<0.039	0.1	0.039	<0.039	-
Trichlorobenzene, 1,2,3-	mg/kg	<0.16	0.05	0.16	<0.16	-
Trichlorobenzene, 1,3,5-	mg/kg	<0.16	0.05	0.16	<0.16	-
Trichloroethane, 1,1,1-	mg/kg	<0.078	0.1	0.078	<0.078	-
Trichloroethane, 1,1,2-	mg/kg	<0.078	0.1	0.078	<0.078	-
Trichloroethene	mg/kg	<0.0039	-	0.0039	<0.0039	-
Trichlorofluoromethane	mg/kg	<0.078	-	0.078	<0.078	-
Trimethylbenzene, 1,2,4-	mg/kg	<1.9	-	1.9	<1.9	-
Trimethylbenzene, 1,3,5-	mg/kg	<1.9	-	1.9	<1.9	-
Vinyl Chloride	mg/kg	<0.078	-	0.0012	<0.078	-

Notes:

RDL: Reported Detection Limit - May vary between sample locations and events

pg/g - picogram per gram

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG

Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Table C8 - WK199 Cooppermine Analytical Chemistry Results: Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons in Surface Water							Location	WK199-SWBG1	WK199-SW1	WK199-SW2
							Sample ID	WK199-SWBG1	WK199-SW1	WK199-SW2
							Sample Date	2023-Sep-08	2023-Sep-08	2023-Sep-08
							Lab Job Number	C371803	C371803	C371803
Parameter	Units	Max Concentratio	CEQG-WATER-FL-L	CEQG-WATER-FL-S	CEQG-WATER-AG-I	FIGQG-GW-T1-AG-	Lab Sample ID RDL	BYU450	BYU448	BYU449
Petroleum Hydrocarbons										
Benzene	mg/L	<0.0004	0.37	-	-	0.088	0.0004	<0.0004	<0.0004	<0.0004
Ethylbenzene	mg/L	<0.0004	0.09	-	-	3.2	0.0004	<0.0004	<0.0004	<0.0004
Petroleum Hydrocarbons F1 (C6-C10)	mg/L	<0.1	-	-	-	0.81	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F1-BTEX	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F2 (C10-C16)	mg/L	<0.1	-	-	-	1.3	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F3 (C16-C34)	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F4 (C34-C50)	mg/L	<0.2	-	-	-	-	0.2	<0.2	<0.2	<0.2
Toluene	mg/L	0.0011	0.002	-	-	0.083	0.0004	<0.0004	<0.0004	<0.0004
Xylene, m+p-	mg/L	<0.0008	-	-	-	-	0.0008	<0.0008	<0.0008	<0.0008
Xylene, o-	mg/L	<0.0004	-	-	-	-	0.0004	<0.0004	<0.0004	<0.0004
Xylenes, total	mg/L	<0.00089	-	-	-	3.9	0.00089	<0.00089	<0.00089	<0.00089
Polycyclic Aromatic Hydrocarbons										
Acenaphthene	mg/L	<0.0001	0.0058	-	-	0.0058	0.0001	<0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	<0.0001	-	-	-	0.046	0.0001	<0.0001	<0.0001	<0.0001
Acridine	mg/L	<0.00004	0.0044	-	-	0.00005	0.00004	<0.00004	<0.00004	<0.00004
Anthracene	mg/L	<0.00001	0.000012	-	-	0.000012	0.00001	<0.00001	<0.00001	<0.00001
B[a]P TPE Total Potency Equivalents	mg/L	<0.00001	-	-	-	-	0.00001	<0.00001	<0.00001	<0.00001
Benzo[a]anthracene	mg/L	<0.0000085	0.000018	-	-	0.000018	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[a]pyrene	mg/L	<0.0000075	0.000015	-	-	0.00001	0.0000075	<0.0000075	<0.0000075	<0.0000075
Benzo[b,j]fluoranthene	mg/L	<0.0000085	-	-	-	0.00048	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[c]phenanthrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Benzo[e]pyrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Benzo[g,h,i]perylene	mg/L	<0.0000085	-	-	-	0.00017	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[k]fluoranthene	mg/L	<0.0000085	-	-	-	0.00048	0.0000085	<0.0000085	<0.0000085	<0.0000085
Chrysene	mg/L	<0.0000085	-	-	-	0.0001	0.0000085	<0.0000085	<0.0000085	<0.0000085
Dibenz[a,h]anthracene	mg/L	<0.0000075	-	-	-	0.00026	0.0000075	<0.0000075	<0.0000075	<0.0000075
Fluoranthene	mg/L	<0.00001	0.00004	-	-	0.00004	0.00001	<0.00001	<0.00001	<0.00001
Fluorene	mg/L	<0.00005	0.003	-	-	0.003	0.00005	<0.00005	<0.00005	<0.00005
Indeno[1,2,3-cd]pyrene	mg/L	<0.0000085	-	-	-	0.00021	0.0000085	<0.0000085	<0.0000085	<0.0000085
Methylnaphthalene, 1-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001	<0.0001
Methylnaphthalene, 2-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001	<0.0001
Naphthalene	mg/L	<0.0001	0.0011	-	-	0.0011	0.0001	<0.0001	<0.0001	<0.0001
Perylene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Phenanthrene	mg/L	<0.00005	0.0004	-	-	0.0004	0.00005	<0.00005	<0.00005	<0.00005
Pyrene	mg/L	<0.00002	0.000025	-	-	0.000025	0.00002	<0.00002	<0.00002	<0.00002
Quinoline	mg/L	<0.0002	0.0034	-	-	0.0034	0.0002	<0.0002	<0.0002	<0.0002

Notes:

RDL: Reported Detection Limit — May vary between sample locations and events

mg/L: milligrams per Litre

DL exceeds criteria

Concentration exceeds CEQG-WATER-FL-L — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-LongTerm

Concentration exceeds CEQG-WATER-FL-S — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-ShortTerm

Concentration exceeds CEQG-WATER-AG-I — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) Agricultural-Irrigation

Concentration exceeds FIGQG-GW-T1-AG-Coarse — Federal Interim Groundwater Quality Guidelines (FCSAP)-Groundwater (June 2016) Tier1-Agricultural-Coarse

Table C11: WK199 Coppermine Analytical Chemistry Results: BTEX, PHCs, & PAHs in Sediment						Location	WK199-BGSed1
						Sample ID	WK199-BGSed1
						Sample Date	2023-Sep-08
						Lab Job Number	C371893
Parameter	Units	Max Concentratio	CEQG-SED-FL-ISQG	CEQG-SED-FL-PEL	RBCA-ET2PSS-SED-	Lab Sample ID	BYV024
						Sample Depth	-
Benzene, Toluene, Ethylbenzene, & Xylenes						RDL	
Benzene	mg/kg	<0.005	-	-	1.2	0.005	<0.005
Ethylbenzene	mg/kg	<0.01	-	-	1.2	0.01	<0.01
Toluene	mg/kg	<0.05	-	-	1.4	0.05	<0.05
Xylene, m+p-	mg/kg	<0.04	-	-	-	0.04	<0.04
Xylene, o-	mg/kg	<0.02	-	-	-	0.02	<0.02
Xylenes, total	mg/kg	<0.045	-	-	1.3	0.045	<0.045
Petroleum Hydrocarbons							
Petroleum Hydrocarbons F1 (C	mg/kg	<10	-	-	15	10	<10
Petroleum Hydrocarbons F1-BT	mg/kg	<10	-	-	-	10	<10
Petroleum Hydrocarbons F2 (C	mg/kg	<10	-	-	25	10	<10
Petroleum Hydrocarbons F3 (C	mg/kg	<50	-	-	43	50	<50
Petroleum Hydrocarbons F4 (C	mg/kg	<50	-	-	43	50	<50
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	<0.005	0.00671	0.0889	0.0889	0.005	<0.005
Acenaphthylene	mg/kg	<0.005	0.00587	0.128	0.128	0.005	<0.005
Acridine	mg/kg	<0.01	-	-	-	0.01	<0.01
Anthracene	mg/kg	<0.004	0.0469	0.245	0.245	0.004	<0.004
Benzo[a]anthracene	mg/kg	<0.005	0.0317	0.385	0.385	0.005	<0.005
Benzo[a]pyrene	mg/kg	<0.005	0.0319	0.782	0.782	0.005	<0.005
Benzo[b,j]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005
Benzo[c]phenanthrene	mg/kg	<0.005	-	-	-	0.005	<0.005
Benzo[e]pyrene	mg/kg	<0.005	-	-	-	0.005	<0.005
Benzo[g,h,i]perylene	mg/kg	<0.005	-	-	0.32	0.005	<0.005
Benzo[k]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005
B[a]P TPE Total Potency Equiva	mg/kg	<0.0071	-	-	-	0.0071	<0.0071
Chrysene	mg/kg	<0.005	0.0571	0.862	0.862	0.005	<0.005
Dibenz[a,h]anthracene	mg/kg	<0.005	0.00622	0.135	0.135	0.005	<0.005
Fluoranthene	mg/kg	<0.005	0.111	2.355	2355	0.005	<0.005
Fluorene	mg/kg	<0.005	0.0212	0.144	0.144	0.005	<0.005
Indeno[1,2,3-cd]pyrene	mg/kg	<0.005	-	-	3.2	0.005	<0.005
Methylnaphthalene, 1-	mg/kg	<0.005	-	-	0.201	0.005	<0.005
Methylnaphthalene, 2-	mg/kg	<0.005	0.0202	0.201	0.201	0.005	<0.005
Naphthalene	mg/kg	<0.005	0.0346	0.391	0.391	0.005	<0.005
Perylene	mg/kg	<0.005	-	-	-	0.005	<0.005
Phenanthrene	mg/kg	<0.005	0.0419	0.515	0.515	0.005	<0.005
Pyrene	mg/kg	<0.005	0.053	0.875	0.875	0.005	<0.005
Quinoline	mg/kg	<0.01	-	-	-	0.01	<0.01

Notes:

mg/kg - milligrams per kilogram

RDL: Reported Detection Limit, may vary between sample locations and events

DL exceeds criteria	
Concentration exceeds CEQG-SED-FL-ISQG	Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-InterimSedimentQualityGuidelines
Concentration exceeds CEQG-SED-FL-PEL	Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-ProbableEffectLevels
RBCA-ET2PSS-SED-Freshwater_0623	Atlantic Risk-Based Corrective Action Ecological Tier II Pathway Specific Standards for Sediment - Freshwater (June 2023)

Table C4: WK210 Coppermine Analytical Chemistry Results: Glycols, Semi-Volatile Organic Compounds and Volatile Organic				Location	WK210-TP5A
				Sample ID	WK210-TP5A
				Sample Date	2023-Sep-04
Parameter	Units	Max Concentratio	CEQG-SOIL-G-AG	Lab Sample ID	BYU290
				Sample Depth	0.2 - 0.2
Glycols				RDL	
Tetraethylene glycol	mg/kg	<10	-	10	<10
Semi-Volatile Organic Compounds					
Dichlorobenzene, 1,2-	mg/kg	<0.02	0.1	0.02	<0.02
Dichlorobenzene, 1,3-	mg/kg	<0.02	0.1	0.02	<0.02
Dichlorobenzene, 1,4-	mg/kg	<0.02	0.1	0.02	<0.02
Trichlorobenzene, 1,2,4-	mg/kg	<0.04	0.05	0.04	<0.04
Volatile Organic Compounds					
Bromodichloromethane	mg/kg	<0.03	-	0.03	<0.03
Bromoform	mg/kg	<0.05	-	0.05	<0.05
Bromomethane	mg/kg	<0.02	-	0.02	<0.02
Carbon tetrachloride	mg/kg	<0.0005	0.1	0.0005	<0.0005
Chlorobenzene	mg/kg	<0.005	-	0.005	<0.005
Chloroform	mg/kg	<0.01	-	0.01	<0.01
Chloromethane	mg/kg	<0.03	-	0.03	<0.03
Dibromochloromethane	mg/kg	<0.02	-	0.02	<0.02
Dibromoethane, 1,2-	mg/kg	<0.002	-	0.002	<0.002
Dichloroethane, 1,1-	mg/kg	<0.02	0.1	0.02	<0.02
Dichloroethane, 1,2-	mg/kg	<0.002	0.1	0.002	<0.002
Dichloroethene, 1,1-	mg/kg	<0.02	0.1	0.02	<0.02
Dichloroethene, cis-1,2-	mg/kg	<0.02	-	0.02	<0.02
Dichloroethene, trans-1,2-	mg/kg	<0.02	-	0.02	<0.02
Dichloropropane, 1,2-	mg/kg	<0.02	0.1	0.02	<0.02
Dichloropropene, cis-1,3-	mg/kg	<0.02	-	0.02	<0.02
Dichloropropene, trans-1,3-	mg/kg	<0.02	-	0.02	<0.02
Methylene chloride	mg/kg	<0.03	0.1	0.03	<0.03
Methyl methacrylate	mg/kg	<0.04	-	0.04	<0.04
Methyl tert-butyl ether (MTBE)	mg/kg	<0.03	-	0.03	<0.03
Styrene	mg/kg	<0.02	0.1	0.02	<0.02
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.05	-	0.05	<0.05
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.05	0.1	0.05	<0.05
Tetrachloroethene	mg/kg	<0.01	0.1	0.01	<0.01
Trichlorobenzene, 1,2,3-	mg/kg	<0.04	0.05	0.04	<0.04
Trichlorobenzene, 1,3,5-	mg/kg	<0.04	0.05	0.04	<0.04
Trichloroethane, 1,1,1-	mg/kg	<0.02	0.1	0.02	<0.02
Trichloroethane, 1,1,2-	mg/kg	<0.02	0.1	0.02	<0.02
Trichloroethene	mg/kg	<0.001	-	0.001	<0.001
Trichlorofluoromethane	mg/kg	<0.02	-	0.02	<0.02
Trimethylbenzene, 1,2,4-	mg/kg	<0.5	-	0.5	<0.5
Trimethylbenzene, 1,3,5-	mg/kg	<0.5	-	0.5	<0.5
Vinyl Chloride	mg/kg	<0.0003	-	0.0003	<0.0003

Notes:

RDL: Reported Detection Limit - May vary between sample locations and events

g/g - gram per gram

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG

Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Table C8: WK210 Coppermine Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene, & Xylenes, Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons in Surface Water						Location	WK210-SWBG1	WK210-SW1	WK210-SW2
						Sample ID	WK210-SWBG1	WK210-SW1	WK210-SW2
						Sample Date	2023-Sep-04	2023-Sep-04	2023-Sep-04
Parameter	Units	Max Concentratio	CEQG-WATER-FL-L	CEQG-WATER-AG-I	FIGQG-GW-T1-AG-	Lab Sample ID	BYU457	BYU455	BYU456
						Sample Depth	-	-	-
Benzene, Toluene, Ethylbenzene, & Xylenes						RDL			
Benzene	mg/L	<0.0004	0.37	-	0.088	0.0004	<0.0004	<0.0004	<0.0004
Ethylbenzene	mg/L	<0.0004	0.09	-	3.2	0.0004	<0.0004	<0.0004	<0.0004
Toluene	mg/L	0.00089	0.002	-	0.083	0.0004	<0.0004	<0.0004	<0.0004
Xylene, m+p-	mg/L	<0.0008	-	-	-	0.0008	<0.0008	<0.0008	<0.0008
Xylene, o-	mg/L	<0.0004	-	-	-	0.0004	<0.0004	<0.0004	<0.0004
Xylenes, total	mg/L	<0.00089	-	-	3.9	0.00089	<0.00089	<0.00089	<0.00089
Petroleum Hydrocarbons									
Petroleum Hydrocarbons F1 (C	mg/L	<0.1	-	-	0.81	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F1-BT	mg/L	<0.1	-	-	-	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F2 (C	mg/L	<0.1	-	-	1.3	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F3 (C	mg/L	<0.1	-	-	-	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F4 (C	mg/L	<0.2	-	-	-	0.2	<0.2	<0.2	<0.2
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	mg/L	<0.0001	0.0058	-	0.0058	0.0001	<0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	<0.0001	-	-	0.046	0.0001	<0.0001	<0.0001	<0.0001
Acridine	mg/L	<0.00004	0.0044	-	0.00005	0.00004	<0.00004	<0.00004	<0.00004
Anthracene	mg/L	<0.00001	0.000012	-	0.000012	0.00001	<0.00001	<0.00001	<0.00001
Benzo[a]anthracene	mg/L	<0.0000085	0.000018	-	0.000018	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[a]pyrene	mg/L	<0.0000075	0.000015	-	0.00001	0.0000075	<0.0000075	<0.0000075	<0.0000075
Benzo[b,j]fluoranthene	mg/L	<0.0000085	-	-	0.00048	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[c]phenanthrene	mg/L	<0.00005	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Benzo[e]pyrene	mg/L	<0.00005	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Benzo[g,h,i]perylene	mg/L	<0.0000085	-	-	0.00017	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[k]fluoranthene	mg/L	<0.0000085	-	-	0.00048	0.0000085	<0.0000085	<0.0000085	<0.0000085
B[a]P TPE Total Potency Equiva	mg/L	<0.00001	-	-	-	0.00001	<0.00001	<0.00001	<0.00001
Chrysene	mg/L	<0.0000085	-	-	0.0001	0.0000085	<0.0000085	<0.0000085	<0.0000085
Dibenz[a,h]anthracene	mg/L	<0.0000075	-	-	0.00026	0.0000075	<0.0000075	<0.0000075	<0.0000075
Fluoranthene	mg/L	<0.00001	0.00004	-	0.00004	0.00001	<0.00001	<0.00001	<0.00001
Fluorene	mg/L	<0.00005	0.003	-	0.003	0.00005	<0.00005	<0.00005	<0.00005
Indeno[1,2,3-cd]pyrene	mg/L	<0.0000085	-	-	0.00021	0.0000085	<0.0000085	<0.0000085	<0.0000085
Methylnaphthalene, 1-	mg/L	<0.0001	-	-	-	0.0001	<0.0001	<0.0001	<0.0001
Methylnaphthalene, 2-	mg/L	<0.0001	-	-	-	0.0001	<0.0001	<0.0001	<0.0001
Naphthalene	mg/L	<0.0001	0.0011	-	0.0011	0.0001	<0.0001	<0.0001	<0.0001
Perylene	mg/L	<0.00005	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Phenanthrene	mg/L	<0.00005	0.0004	-	0.0004	0.00005	<0.00005	<0.00005	<0.00005
Pyrene	mg/L	<0.00002	0.000025	-	0.000025	0.00002	<0.00002	<0.00002	<0.00002
Quinoline	mg/L	<0.0002	0.0034	-	0.0034	0.0002	<0.0002	<0.0002	<0.0002

Notes:

RDL: Reported Detection Limit, may vary between sample locations and events

mg/L: milligrams per litre

µS/cm: microsiemens/centimetre

DL exceeds criteria	
Concentration exceeds CEQG-WATER-FL-L	Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-LongTerm
Concentration exceeds CEQG-WATER-AG-I	Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) Agricultural-Irrigation
Concentration exceeds FIGQG-GW-T1-AG-Coarse	Federal Interim Groundwater Quality Guidelines (FCSAP)-Groundwater (June 2016) Tier1-Agricultural-Coarse

Table C11: WK210 Coppermine Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene, & Xylenes, Petroleum Hydrocarbons, and Polycyclic Aromatic Hydrocarbons in Sediment						Location	WK210-SedBG1		Wk210-Sed1	Wk210-Sed2	Wk210-Sed3	Wk210-Sed4
						Sample ID	WK210-SedBG1	WK210-SedQAQC1	WK210-Sed1	WK210-Sed2	WK210-Sed3	WK210-Sed4
						Sample Date	2023-Sep-04		2023-Sep-04	2023-Sep-04	2023-Sep-04	2023-Sep-04
Parameter	Units	Max Concentratio	CEQG-SED-FL-ISQG	CEQG-SED-FL-PEL	RBCA-ET2PSS-SED-	Lab Sample ID	BYV029	BYV030	BYV025	BYV026	BYV027	BYV028
						Sample Depth	-	-	-	-	-	-
Benzene, Toluene, Ethylbenzene, & Xylenes						RDL						
Benzene	mg/kg	<0.063	-	-	1.2	0.005	<0.005	<0.005	<0.063	<0.061	<0.049	<0.063
Ethylbenzene	mg/kg	<0.095	-	-	1.2	0.01	<0.01	<0.01	<0.094	<0.092	<0.073	<0.095
Toluene	mg/kg	<0.24	-	-	1.4	0.05	<0.05	<0.05	<0.24	<0.23	<0.19	<0.24
Xylene, m+p-	mg/kg	<0.53	-	-	-	0.04	<0.04	<0.04	<0.52	<0.51	<0.41	<0.53
Xylene, o-	mg/kg	<0.26	-	-	-	0.02	<0.02	<0.02	<0.26	<0.25	<0.2	<0.26
Xylenes, total	mg/kg	<0.59	-	-	1.3	0.045	<0.045	<0.045	<0.59	<0.57	<0.45	<0.59
Petroleum Hydrocarbons												
Petroleum Hydrocarbons F1 (C6-C10)	mg/kg	<98	-	-	15	10	<10	<10	<97	<94	<76	<98
Petroleum Hydrocarbons F1-BTEX	mg/kg	<98	-	-	-	10	<10	<10	<97	<94	<76	<98
Petroleum Hydrocarbons F2 (C10-C16)	mg/kg	**160**	-	-	25	10	<10	<10	23	**160**	**59**	**37**
Petroleum Hydrocarbons F3 (C16-C34)	mg/kg	**2000**	-	-	43	50	**57**	<50	**400**	**1800**	**1100**	**2000**
Petroleum Hydrocarbons F4 (C34-C50)	mg/kg	**590**	-	-	43	50	<50	<50	**72**	**510**	**280**	**590**
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	mg/kg	<0.036	0.00671	0.0889	0.0889	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Acenaphthylene	mg/kg	<0.036	0.00587	0.128	0.128	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Acridine	mg/kg	<0.071	-	-	-	0.01	<0.01	<0.01	<0.062	<0.064	<0.071	<0.063
Anthracene	mg/kg	<0.028	0.0469	0.245	0.245	0.004	<0.004	<0.004	<0.025	<0.026	<0.028	<0.025
Benzo[a]anthracene	mg/kg	<0.036	0.0317	0.385	0.385	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Benzo[a]pyrene	mg/kg	<0.036	0.0319	0.782	0.782	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Benzo[b,j]fluoranthene	mg/kg	<0.036	-	-	13.4	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Benzo[c]phenanthrene	mg/kg	<0.036	-	-	-	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Benzo[e]pyrene	mg/kg	<0.036	-	-	-	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Benzo[g,h,i]perylene	mg/kg	<0.036	-	-	0.32	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Benzo[k]fluoranthene	mg/kg	<0.036	-	-	13.4	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
B[a]P TPE Total Potency Equivalents	mg/kg	<0.051	-	-	-	0.0071	<0.0071	<0.0071	<0.044	<0.046	<0.051	<0.045
Chrysene	mg/kg	<0.036	0.0571	0.862	0.862	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Dibenz[a,h]anthracene	mg/kg	<0.036	0.00622	0.135	0.135	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Fluoranthene	mg/kg	<0.036	0.111	2.355	2355	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Fluorene	mg/kg	<0.036	0.0212	0.144	0.144	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Indeno[1,2,3-cd]pyrene	mg/kg	<0.036	-	-	3.2	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Methylnaphthalene, 1-	mg/kg	<0.036	-	-	0.201	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Methylnaphthalene, 2-	mg/kg	<0.036	0.0202	0.201	0.201	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Naphthalene	mg/kg	<0.036	0.0346	0.391	0.391	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Perylene	mg/kg	<0.036	-	-	-	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Phenanthrene	mg/kg	<0.036	0.0419	0.515	0.515	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Pyrene	mg/kg	<0.036	0.053	0.875	0.875	0.005	<0.005	<0.005	<0.031	<0.032	<0.036	<0.032
Quinoline	mg/kg	<0.071	-	-	-	0.01	<0.01	<0.01	<0.062	<0.064	<0.071	<0.063

Notes:

RDL: Reported Detection Limit - May vary between sample locations and events

g/g - gram per gram

mg/kg - milligram per kilogram

DL exceeds criteria	
Concentration exceeds CEQG-SED-FL-ISQG	Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-InterimSedimentQualityGuidelines
Concentration exceeds CEQG-SED-FL-PEL	Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-ProbableEffectLevels
Concentration exceeds RBCA-ET2PSS-SED-Freshwater_0623	Atlantic Risk-Based Corrective Action Ecological Tier II Pathway Specific Standards for Sediment - Freshwater (June 2023)

Table C4: WK176 Impact Lake Analytical Chemistry Results: Dioxins and Furans, Glycols, Semi-Volatile Organic Compounds & Volatile Organic Compounds in Soil					Location	WK176-TP1A	WK176-TP2A	WK176-TP2B	WK176-TP3A	WK176-TP9A	WK176-TP11A	WK176-TP11B
					Sample Date	2023-Sep-07	2023-Sep-07	2023-Sep-07	2023-Sep-07	2023-Sep-07	2023-Sep-07	2023-Sep-07
					Lab Job Number	C371785	C371785	C371785	C371785	C371785	C371785	C371785
Parameter	Units	Max Concentration	CEQG-SOIL-G-AG	CWS-PHC-2008-AG-ESC-Coarse-SUR	Lab Sample ID	BYU315	BYU316	BYU317	BYU318	BYU329	BYU333	BYU334
					Sample Depth	0.1 - 0.2	0.2 - 0.3	0.4 - 0.6	0.2 - 0.3	0.2 - 0.3	0.2 - 0.3	0.5 - 0.6
Dioxins and Furans					EDL							
Hepta CDD, 1,2,3,4,6,7,8-	pg/g	<0.141	-	-	0.141	-	-	-	<0.141	-	-	-
Hepta CDF, 1,2,3,4,6,7,8-	pg/g	<0.123	-	-	0.123	-	-	-	<0.123	-	-	-
Hepta CDF, 1,2,3,4,7,8,9-	pg/g	<0.138	-	-	0.138	-	-	-	<0.138	-	-	-
Hexa CDD, 1,2,3,4,7,8-	pg/g	<0.176	-	-	0.176	-	-	-	<0.176	-	-	-
Hexa CDD, 1,2,3,6,7,8-	pg/g	<0.185	-	-	0.185	-	-	-	<0.185	-	-	-
Hexa CDD, 1,2,3,7,8,9-	pg/g	<0.174	-	-	0.174	-	-	-	<0.174	-	-	-
Hexa CDF, 1,2,3,4,7,8-	pg/g	<0.108	-	-	0.108	-	-	-	<0.108	-	-	-
Hexa CDF, 1,2,3,6,7,8-	pg/g	<0.103	-	-	0.103	-	-	-	<0.103	-	-	-
Hexa CDF, 1,2,3,7,8,9-	pg/g	<0.121	-	-	0.121	-	-	-	<0.121	-	-	-
Hexa CDF, 2,3,4,6,7,8-	pg/g	<0.0953	-	-	0.0953	-	-	-	<0.0953	-	-	-
Octa CDD	pg/g	0.266	-	-	0.266	-	-	-	0.266	-	-	-
Octa CDF	pg/g	<0.15	-	-	0.15	-	-	-	<0.15	-	-	-
Penta CDD, 1,2,3,7,8-	pg/g	<0.216	-	-	0.216	-	-	-	<0.216	-	-	-
Penta CDF, 1,2,3,7,8,-	pg/g	<0.188	-	-	0.188	-	-	-	<0.188	-	-	-
Penta CDF, 2,3,4,7,8-	pg/g	<0.287	-	-	0.287	-	-	-	<0.287	-	-	-
Tetra CDD, 2,3,7,8-	pg/g	<0.177	-	-	0.177	-	-	-	<0.177	-	-	-
Tetra CDF, 2,3,7,8-	pg/g	<0.113	-	-	0.113	-	-	-	<0.113	-	-	-
Total Hepta CDD	pg/g	<0.141	-	-	0.141	-	-	-	<0.141	-	-	-
Total Hepta CDF	pg/g	<0.13	-	-	0.13	-	-	-	<0.13	-	-	-
Total Hexa CDD	pg/g	<0.178	-	-	0.178	-	-	-	<0.178	-	-	-
Total Hexa CDF	pg/g	<0.106	-	-	0.106	-	-	-	<0.106	-	-	-
Total Penta CDD	pg/g	<0.216	-	-	0.216	-	-	-	<0.216	-	-	-
Total Penta CDF	pg/g	<0.224	-	-	0.224	-	-	-	<0.224	-	-	-
Total Tetra CDD	pg/g	<0.177	-	-	0.177	-	-	-	<0.177	-	-	-
Total Tetra CDF	pg/g	<0.113	-	-	0.113	-	-	-	<0.113	-	-	-
Total Toxic Equivalency (WHO 2005)	pg/g	-	4	-	-	-	-	-	0.596	-	-	-
Glycols					RDL							
Diethylene glycol	mg/kg	<9	-	-	9	<9	-	-	<9	-	-	-
Ethylene glycol	mg/kg	<10	960	-	10	<10	-	-	<10	-	-	-
Propylene glycol	mg/kg	<10	-	-	10	<10	-	-	<10	-	-	-
Tetraethylene glycol	mg/kg	<10	-	-	10	<10	-	-	<10	-	-	-
Triethylene glycol	mg/kg	<10	-	-	10	<10	-	-	<10	-	-	-
Semi-Volatile Organic Compounds												
Dichlorobenzene, 1,2-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichlorobenzene, 1,3-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichlorobenzene, 1,4-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Hexachlorocyclopentadiene	mg/kg	<0.004	-	-	0.004	-	-	-	-	<0.004	-	-
Trichlorobenzene, 1,2,4-	mg/kg	<0.04	0.05	-	0.04	<0.04	<0.04	<0.04	-	-	<0.04	<0.04
Volatile Organic Compounds												
Bromodichloromethane	mg/kg	<0.03	-	-	0.03	<0.03	<0.03	<0.03	-	-	<0.03	<0.03
Bromoform	mg/kg	<0.05	-	-	0.05	<0.05	<0.05	<0.05	-	-	<0.05	<0.05
Bromomethane	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Carbon tetrachloride	mg/kg	<0.0005	0.1	-	0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005
Chlorobenzene	mg/kg	<0.005	-	-	0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005
Chloroform	mg/kg	<0.01	-	-	0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01
Chloromethane	mg/kg	<0.03	-	-	0.03	<0.03	<0.03	<0.03	-	-	<0.03	<0.03
Dibromochloromethane	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dibromoethane, 1,2-	mg/kg	<0.002	-	-	0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002
Dichloroethane, 1,1-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichloroethane, 1,2-	mg/kg	<0.002	0.1	-	0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002
Dichloroethene, 1,1-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichloroethene, cis-1,2-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichloroethene, trans-1,2-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichloropropane, 1,2-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichloropropene, cis-1,3-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Dichloropropene, trans-1,3-	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Methylene chloride	mg/kg	<0.03	0.1	-	0.03	<0.03	<0.03	<0.03	-	-	<0.03	<0.03
Methyl methacrylate	mg/kg	<0.04	-	-	0.04	<0.04	<0.04	<0.04	-	-	<0.04	<0.04
Methyl tert-butyl ether (MTBE)	mg/kg	<0.03	-	-	0.03	<0.03	<0.03	<0.03	-	-	<0.03	<0.03
Octachlorostyrene	mg/kg	<0.001	-	-	0.001	-	-	-	-	<0.001	-	-
Styrene	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.05	-	-	0.05	<0.05	<0.05	<0.05	-	-	<0.05	<0.05
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.05	0.1	-	0.05	<0.05	<0.05	<0.05	-	-	<0.05	<0.05
Tetrachloroethene	mg/kg	<0.01	0.1	-	0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01
Trichlorobenzene, 1,2,3-	mg/kg	<0.04	0.05	-	0.04	<0.04	<0.04	<0.04	-	-	<0.04	<0.04
Trichlorobenzene, 1,3,5-	mg/kg	<0.04	0.05	-	0.04	<0.04	<0.04	<0.04	-	-	<0.04	<0.04
Trichloroethane, 1,1,1-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Trichloroethane, 1,1,2-	mg/kg	<0.02	0.1	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Trichloroethene	mg/kg	<0.001	-	-	0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001
Trichlorofluoromethane	mg/kg	<0.02	-	-	0.02	<0.02	<0.02	<0.02	-	-	<0.02	<0.02
Trimethylbenzene, 1,2,4-	mg/kg	<0.5	-	-	0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5
Trimethylbenzene, 1,3,5-	mg/kg	<0.5	-	-	0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5
Vinyl Chloride	mg/kg	<0.02	-	-	0.0003	<0.0003	<0.0003	<0.02	-	-	<0.0003	<0.02

Notes:

EDL: Estimated Detection Limit

RDL: Reported Detection Limit - May vary between sample locations and events

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG — Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Concentration exceeds CWS-PHC-2008-AG-ESC-Coarse-SUR — Canada-Wide Standards For Petroleum Hydrocarbons in Soil (2008) Agricultural-EcoSoilContact-CoarseTexture-SurfaceSoil

Table C4: WK165 Kendall River Analytical Chemistry Results: Volatile Organic Compounds, Semi Volatile Organic Compounds, Dioxins and Furans, and Glycols in Soil				Location	WK165-TP1A	WK165-TP5A	WK165-TP6A
				Sample ID	WK165-TP1A	WK165-TP5A	WK165-TP6A
				Sample Date	31-Aug-23	31-Aug-23	31-Aug-23
Parameter	Units	Max Concentratio	CEQG-SOIL-G-AG	Lab Sample ID	BYT241	BYT249	BYT251
				Sample Depth	0.2 - 0.3	0.2 - 0.3	0.2 - 0.3
Dioxins and Furans				RDL			
Hepta CDD, 1,2,3,4,6,7,8-	pg/g	0.299	-	4.96	-	0.299	-
Hepta CDF, 1,2,3,4,6,7,8-	pg/g	<0.134	-	4.96	-	<0.134	-
Hepta CDF, 1,2,3,4,7,8,9-	pg/g	<0.156	-	4.96	-	<0.156	-
Hexa CDD, 1,2,3,4,7,8-	pg/g	<0.154	-	4.96	-	<0.154	-
Hexa CDD, 1,2,3,6,7,8-	pg/g	<0.173	-	4.96	-	<0.173	-
Hexa CDD, 1,2,3,7,8,9-	pg/g	<0.156	-	4.96	-	<0.156	-
Hexa CDF, 1,2,3,4,7,8-	pg/g	<0.151	-	4.96	-	<0.151	-
Hexa CDF, 1,2,3,6,7,8-	pg/g	<0.137	-	4.96	-	<0.137	-
Hexa CDF, 1,2,3,7,8,9-	pg/g	<0.174	-	4.96	-	<0.174	-
Hexa CDF, 2,3,4,6,7,8-	pg/g	<0.135	-	4.96	-	<0.135	-
Octa CDD	pg/g	0.711	-	9.92	-	0.711	-
Octa CDF	pg/g	<0.144	-	9.92	-	<0.144	-
Penta CDD, 1,2,3,7,8-	pg/g	<0.192	-	4.96	-	<0.192	-
Penta CDF, 1,2,3,7,8,-	pg/g	<0.147	-	4.96	-	<0.147	-
Penta CDF, 2,3,4,7,8-	pg/g	<0.126	-	4.96	-	<0.126	-
Tetra CDD, 2,3,7,8-	pg/g	<0.147	-	0.992	-	<0.147	-
Tetra CDF, 2,3,7,8-	pg/g	<0.362	-	0.992	-	<0.362	-
Total Hepta CDD	pg/g	0.597	-	4.96	-	0.597	-
Total Hepta CDF	pg/g	<0.144	-	4.96	-	<0.144	-
Total Hexa CDD	pg/g	<0.524	-	4.96	-	<0.524	-
Total Hexa CDF	pg/g	<0.148	-	4.96	-	<0.148	-
Total Penta CDD	pg/g	<0.192	-	4.96	-	<0.192	-
Total Penta CDF	pg/g	0.503	-	4.96	-	0.503	-
Total Tetra CDD	pg/g	0.483	-	0.992	-	0.483	-
Total Tetra CDF	pg/g	0.271	-	0.992	-	0.271	-
Upper Bound PCDD/F TEQ	pg/g	na	4	na	-	0.532	-
Glycols							
Diethylene glycol	mg/kg	<9	-	9	<9	-	-
Ethylene glycol	mg/kg	<10	960	10	<10	-	-
Propylene glycol	mg/kg	<10	-	10	<10	-	-
Tetraethylene glycol	mg/kg	<10	-	10	<10	-	-
Triethylene glycol	mg/kg	<10	-	10	<10	-	-
Semi-Volatile Organic Compounds							
Dichlorobenzene, 1,2-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Dichlorobenzene, 1,3-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Dichlorobenzene, 1,4-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Hexachlorocyclopentadiene	mg/kg	<0.004	-	0.004	-	-	<0.004
Trichlorobenzene, 1,2,4-	mg/kg	<0.04	0.05	0.04	<0.04	-	-
Volatile Organic Compounds							
Bromodichloromethane	mg/kg	<0.03	-	0.03	<0.03	-	-
Bromoform	mg/kg	<0.05	-	0.05	<0.05	-	-
Bromomethane	mg/kg	<0.02	-	0.02	<0.02	-	-
Carbon tetrachloride	mg/kg	<0.0005	0.1	0.0005	<0.0005	-	-
Chlorobenzene	mg/kg	<0.005	-	0.005	<0.005	-	-
Chloroform	mg/kg	<0.01	-	0.01	<0.01	-	-
Chloromethane	mg/kg	<0.03	-	0.03	<0.03	-	-
Dibromochloromethane	mg/kg	<0.02	-	0.02	<0.02	-	-
Dibromoethane, 1,2-	mg/kg	<0.002	-	0.002	<0.002	-	-
Dichloroethane, 1,1-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Dichloroethane, 1,2-	mg/kg	<0.002	0.1	0.002	<0.002	-	-
Dichloroethene, 1,1-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Dichloroethene, cis-1,2-	mg/kg	<0.02	-	0.02	<0.02	-	-
Dichloroethene, trans-1,2-	mg/kg	<0.02	-	0.02	<0.02	-	-
Dichloropropane, 1,2-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Dichloropropene, cis-1,3-	mg/kg	<0.02	-	0.02	<0.02	-	-
Dichloropropene, trans-1,3-	mg/kg	<0.02	-	0.02	<0.02	-	-
Methylene chloride	mg/kg	<0.03	0.1	0.03	<0.03	-	-
Methyl methacrylate	mg/kg	<0.04	-	0.04	<0.04	-	-
Methyl tert-butyl ether (MTBE	mg/kg	<0.03	-	0.03	<0.03	-	-
Octachlorostyrene	mg/kg	<0.001	-	0.001	-	-	<0.001
Styrene	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.05	-	0.05	<0.05	-	-
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.05	0.1	0.05	<0.05	-	-
Tetrachloroethene	mg/kg	<0.01	0.1	0.01	<0.01	-	-
Trichlorobenzene, 1,2,3-	mg/kg	<0.04	0.05	0.04	<0.04	-	-
Trichlorobenzene, 1,3,5-	mg/kg	<0.04	0.05	0.04	<0.04	-	-
Trichloroethane, 1,1,1-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Trichloroethane, 1,1,2-	mg/kg	<0.02	0.1	0.02	<0.02	-	-
Trichloroethene	mg/kg	<0.001	-	0.001	<0.001	-	-
Trichlorofluoromethane	mg/kg	<0.02	-	0.02	<0.02	-	-
Trimethylbenzene, 1,2,4-	mg/kg	<0.5	-	0.5	<0.5	-	-
Trimethylbenzene, 1,3,5-	mg/kg	<0.5	-	0.5	<0.5	-	-
Vinyl Chloride	mg/kg	<0.0003	-	0.0003	<0.0003	-	-

Notes:

RDL: Reported Detection Limit - May vary between sample locations and events

g/g - gram per gram

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG

Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Table C8: WK165 Kendall River Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene, & Xylenes, Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons in Surface Water							Location	WK165-BackSW1	WK165-SW1	WK165-SW2
							Sample ID	WK165-BackSW1	WK165-SW1	WK165-SW2
							Sample Date	2023-Aug-31	2023-Aug-31	2023-Aug-31
							Lab Job Number	C371509	C371509	C371509
Parameter	**Units**	**Max Concentration**	**CEQG-WATER-FL-L**	**CEQG-WATER-FL-S**	**CEQG-WATER-AG-I**	**FIGQG-GW-T1-AG-Coarse**	**Lab Sample ID**	**BYS950**	**BYS948**	**BYS949**
Petroleum Hydrocarbons										
Benzene	mg/L	<0.0004	0.37	-	-	0.088	0.0004	<0.0004	<0.0004	<0.0004
Ethylbenzene	mg/L	<0.0004	0.09	-	-	3.2	0.0004	<0.0004	<0.0004	<0.0004
Petroleum Hydrocarbons F1 (C6-C10)	mg/L	<0.1	-	-	-	0.81	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F1-BTEX	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F2 (C10-C16)	mg/L	<0.1	-	-	-	1.3	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F3 (C16-C34)	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F4 (C34-C50)	mg/L	<0.2	-	-	-	-	0.2	<0.2	<0.2	<0.2
Toluene	mg/L	<0.00044	0.002	-	-	0.083	0.00043	<0.00043	<0.00044	<0.00043
Xylene, m+p-	mg/L	<0.0008	-	-	-	-	0.0008	<0.0008	<0.0008	<0.0008
Xylene, o-	mg/L	<0.0004	-	-	-	-	0.0004	<0.0004	<0.0004	<0.0004
Xylenes, total	mg/L	<0.00089	-	-	-	3.9	0.00089	<0.00089	<0.00089	<0.00089
Polycyclic Aromatic Hydrocarbons										
Acenaphthene	mg/L	<0.0001	0.0058	-	-	0.0058	0.0001	<0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	<0.0001	-	-	-	0.046	0.0001	<0.0001	<0.0001	<0.0001
Acridine	mg/L	<0.00004	0.0044	-	-	0.00005	0.00004	<0.00004	<0.00004	<0.00004
Anthracene	mg/L	<0.00001	0.000012	-	-	0.000012	0.00001	<0.00001	<0.00001	<0.00001
B[a]P TPE Total Potency Equivalents	mg/L	<0.00001	-	-	-	-	0.00001	<0.00001	<0.00001	<0.00001
Benzo[a]anthracene	mg/L	<0.0000085	0.000018	-	-	0.000018	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[a]pyrene	mg/L	<0.0000075	0.000015	-	-	0.00001	0.0000075	<0.0000075	<0.0000075	<0.0000075
Benzo[b,j]fluoranthene	mg/L	<0.0000085	-	-	-	0.00048	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[c]phenanthrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Benzo[e]pyrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Benzo[g,h,i]perylene	mg/L	<0.0000085	-	-	-	0.00017	0.0000085	<0.0000085	<0.0000085	<0.0000085
Benzo[k]fluoranthene	mg/L	<0.0000085	-	-	-	0.00048	0.0000085	<0.0000085	<0.0000085	<0.0000085
Chrysene	mg/L	<0.0000085	-	-	-	0.0001	0.0000085	<0.0000085	<0.0000085	<0.0000085
Dibenz[a,h]anthracene	mg/L	<0.0000075	-	-	-	0.00026	0.0000075	<0.0000075	<0.0000075	<0.0000075
Fluoranthene	mg/L	<0.00001	0.00004	-	-	0.00004	0.00001	<0.00001	<0.00001	<0.00001
Fluorene	mg/L	<0.00005	0.003	-	-	0.003	0.00005	<0.00005	<0.00005	<0.00005
Indeno[1,2,3-cd]pyrene	mg/L	<0.0000085	-	-	-	0.00021	0.0000085	<0.0000085	<0.0000085	<0.0000085
Methylnaphthalene, 1-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001	<0.0001
Methylnaphthalene, 2-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001	<0.0001
Naphthalene	mg/L	<0.0001	0.0011	-	-	0.0011	0.0001	<0.0001	<0.0001	<0.0001
Perylene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005
Phenanthrene	mg/L	<0.00005	0.0004	-	-	0.0004	0.00005	<0.00005	<0.00005	<0.00005
Pyrene	mg/L	<0.00002	0.000025	-	-	0.000025	0.00002	<0.00002	<0.00002	<0.00002
Quinoline	mg/L	<0.0002	0.0034	-	-	0.0034	0.0002	<0.0002	<0.0002	<0.0002

Notes:

RDL: Reported Detection Limit — May vary between sample locations and events

mg/L: milligrams per Litre

DL exceeds criteria

Concentration exceeds CEQG-WATER-FL-L — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-LongTerm

Concentration exceeds CEQG-WATER-FL-S — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-ShortTerm

Concentration exceeds CEQG-WATER-AG-I — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) Agricultural-Irrigation

Concentration exceeds FIGQG-GW-T1-AG-Coarse — Federal Interim Groundwater Quality Guidelines (FCSAP)-Groundwater (June 2016) Tier1-Agricultural-Coarse

Table C10: WK165 Kendall River Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene and Xylenes, Petroleum Hydrocarbons, and Polycyclic Aromatic Hydrocarbons in Sediment						Location	WK165-Backsed1	WK165-Sed1	WK165-Sed2
						Sample ID	WK165-Backsed1	WK165-Sed1	WK165-Sed2
						Sample Date	2023-Aug-31	2023-Aug-31	2023-Aug-31
Parameter	Units	Max Concentration	CEQG-SED-FL-ISQG	CEQG-SED-FL-PEL	RBCA-ET2PSS-SED-Freshwater_0623	Lab Sample ID	BYT670	BYT668	BYT669
						Sample Depth	-	-	-
Benzene, Toluene, Ethylbenzene, & Xylenes						RDL			
Benzene	mg/kg	<0.005	-	-	1.2	0.005	<0.005	<0.005	<0.005
Ethylbenzene	mg/kg	<0.01	-	-	1.2	0.01	<0.01	<0.01	<0.01
Toluene	mg/kg	<0.05	-	-	1.4	0.05	<0.05	<0.05	<0.05
Xylene, m+p-	mg/kg	<0.04	-	-	-	0.04	<0.04	<0.04	<0.04
Xylene, o-	mg/kg	<0.02	-	-	-	0.02	<0.02	<0.02	<0.02
Xylenes, total	mg/kg	<0.045	-	-	1.3	0.045	<0.045	<0.045	<0.045
Petroleum Hydrocarbons									
Petroleum Hydrocarbons F1 (C6-C10)	mg/kg	<10	-	-	15	10	<10	<10	<10
Petroleum Hydrocarbons F1-BTEX	mg/kg	<10	-	-	-	10	<10	<10	<10
Petroleum Hydrocarbons F2 (C10-C16)	mg/kg	<10	-	-	25	10	<10	<10	<10
Petroleum Hydrocarbons F3 (C16-C34)	mg/kg	<50	-	-	43	50	<50	<50	<50
Petroleum Hydrocarbons F4 (C34-C50)	mg/kg	<50	-	-	43	50	<50	<50	<50
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	mg/kg	<0.005	0.00671	0.0889	0.0889	0.005	<0.005	<0.005	<0.005
Acenaphthylene	mg/kg	<0.005	0.00587	0.128	0.128	0.005	<0.005	<0.005	<0.005
Acridine	mg/kg	<0.01	-	-	-	0.01	<0.01	<0.01	<0.01
Anthracene	mg/kg	<0.004	0.0469	0.245	0.245	0.004	<0.004	<0.004	<0.004
Benzo[a]anthracene	mg/kg	<0.005	0.0317	0.385	0.385	0.005	<0.005	<0.005	<0.005
Benzo[a]pyrene	mg/kg	<0.005	0.0319	0.782	0.782	0.005	<0.005	<0.005	<0.005
Benzo[b,j]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005	<0.005	<0.005
Benzo[c]phenanthrene	mg/kg	<0.005	-	-	-	0.005	<0.005	<0.005	<0.005
Benzo[e]pyrene	mg/kg	<0.005	-	-	-	0.005	<0.005	<0.005	<0.005
Benzo[g,h,i]perylene	mg/kg	<0.005	-	-	0.32	0.005	<0.005	<0.005	<0.005
Benzo[k]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005	<0.005	<0.005
B[a]P TPE Total Potency Equivalents	mg/kg	<0.0071	-	-	-	0.0071	<0.0071	<0.0071	<0.0071
Chrysene	mg/kg	<0.005	0.0571	0.862	0.862	0.005	<0.005	<0.005	<0.005
Dibenz[a,h]anthracene	mg/kg	<0.005	0.00622	0.135	0.135	0.005	<0.005	<0.005	<0.005
Fluoranthene	mg/kg	<0.005	0.111	2.355	2355	0.005	<0.005	<0.005	<0.005
Fluorene	mg/kg	<0.005	0.0212	0.144	0.144	0.005	<0.005	<0.005	<0.005
Indeno[1,2,3-cd]pyrene	mg/kg	<0.005	-	-	3.2	0.005	<0.005	<0.005	<0.005
Methylnaphthalene, 1-	mg/kg	<0.005	-	-	0.201	0.005	<0.005	<0.005	<0.005
Methylnaphthalene, 2-	mg/kg	<0.005	0.0202	0.201	0.201	0.005	<0.005	<0.005	<0.005
Naphthalene	mg/kg	<0.005	0.0346	0.391	0.391	0.005	<0.005	<0.005	<0.005
Perylene	mg/kg	0.0061	-	-	-	0.005	<0.005	<0.005	0.0061
Phenanthrene	mg/kg	<0.005	0.0419	0.515	0.515	0.005	<0.005	<0.005	<0.005
Pyrene	mg/kg	<0.005	0.053	0.875	0.875	0.005	<0.005	<0.005	<0.005
Quinoline	mg/kg	<0.01	-	-	-	0.01	<0.01	<0.01	<0.01

Notes:

mg/kg - milligrams per kilogram

RDL: Reported Detection Limit, may vary between sample locations and events

DL exceeds criteria

Concentration exceeds CEQG-SED-FL-ISQG — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-InterimSedimentQualityGuidelines

Concentration exceeds CEQG-SED-FL-PEL — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-ProbableEffectLevels

RBCA-ET2PSS-SED-Freshwater_0623 — Atlantic Risk-Based Corrective Action Ecological Tier II Pathway Specific Standards for Sediment - Freshwater (June 2023)

Table C4: WK097 Speers Lake Analytical Chemistry Results: Semi-Volatile Organic Compounds and Volatile Organic Compounds in Soil					Location	WK097-TP5A	WK097-TP19A	WK097-TP25A	WK097-TP32A	WK097-TP37A	WK097-TP38A	WK097-TP44A	WK097-TP44B	WK097-TP46A
					Sample ID	WK097-TP5A	WK097-TP19A	WK097-TP25A	WK097-TP32A	WK097-TP37A	WK097-TP38A	WK097-TP44A	WK097-TP44B	WK097-TP46A
					Sample Date	2023-Aug-29	2023-Aug-29	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05
Parameter	Units	Max Concentratio	CEQG-SOIL-G-AG	CWS-PHC-2008-AG-	Lab Sample ID	BYT363	BYT390	BYU053	BYU167	BYU174	BYU175	BYU182	BYU183	BYU185
					Sample Depth	0.2 - 0.3	0.2 - 0.3	0.0 - 0.3	0.2 - 0.3	0.2 - 0.3	0.2 - 0.3	0.2 - 0.3	0.4 - 0.6	0.2 - 0.3
Semi-Volatile Organic Compounds					RDL									
Dichlorobenzene, 1,2-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichlorobenzene, 1,3-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichlorobenzene, 1,4-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Hexachlorocyclopentadiene	mg/kg	<0.004	-	-	0.004	-	<0.004	<0.004	-	-	-	-	-	-
Trichlorobenzene, 1,2,4-	mg/kg	<0.44	0.05	-	0.04	<0.04	-	-	<0.04	<0.04	<0.04	<0.44	<0.25	<0.04
Volatile Organic Compounds														
Bromodichloromethane	mg/kg	<0.33	-	-	0.03	<0.03	-	-	<0.03	<0.03	<0.03	<0.33	<0.19	<0.03
Bromoform	mg/kg	<0.55	-	-	0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.55	<0.31	<0.05
Bromomethane	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Carbon tetrachloride	mg/kg	<0.0055	0.1	-	0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0055	<0.0031	<0.0005
Chlorobenzene	mg/kg	<0.055	-	-	0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.055	<0.031	<0.005
Chloroform	mg/kg	<0.11	-	-	0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.11	<0.062	<0.01
Chloromethane	mg/kg	<0.33	-	-	0.03	<0.03	-	-	<0.03	<0.03	<0.03	<0.33	<0.19	<0.03
Dibromochloromethane	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dibromoethane, 1,2-	mg/kg	<0.022	-	-	0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.022	<0.012	<0.002
Dichloroethane, 1,1-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichloroethane, 1,2-	mg/kg	<0.022	0.1	-	0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.022	<0.012	<0.002
Dichloroethene, 1,1-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichloroethene, cis-1,2-	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichloroethene, trans-1,2-	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichloropropane, 1,2-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichloropropene, cis-1,3-	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Dichloropropene, trans-1,3-	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Methylene chloride	mg/kg	<0.33	0.1	-	0.03	<0.03	-	-	<0.03	<0.03	<0.03	<0.33	<0.19	<0.03
Methyl methacrylate	mg/kg	<0.44	-	-	0.04	<0.04	-	-	<0.04	<0.04	<0.04	<0.44	<0.25	<0.04
Methyl tert-butyl ether (MTBE)	mg/kg	<0.33	-	-	0.03	<0.03	-	-	<0.03	<0.03	<0.03	<0.33	<0.19	<0.03
Octachlorostyrene	mg/kg	<0.001	-	-	0.001	-	<0.001	<0.001	-	-	-	-	-	-
Styrene	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.55	-	-	0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.55	<0.31	<0.05
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.55	0.1	-	0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.55	<0.31	<0.05
Tetrachloroethene	mg/kg	<0.11	0.1	-	0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.11	<0.062	<0.01
Tetraethyl lead	mg/kg	<0.001	-	-	0.0002	<0.0002	-	-	<0.0002	-	-	-	-	<0.001
Trichlorobenzene, 1,2,3-	mg/kg	<0.44	0.05	-	0.04	<0.04	-	-	<0.04	<0.04	<0.04	<0.44	<0.25	<0.04
Trichlorobenzene, 1,3,5-	mg/kg	<0.44	0.05	-	0.04	<0.04	-	-	<0.04	<0.04	<0.04	<0.44	<0.25	<0.04
Trichloroethane, 1,1,1-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Trichloroethane, 1,1,2-	mg/kg	<0.22	0.1	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Trichloroethene	mg/kg	<0.11	-	-	0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.11	<0.062	<0.001
Trichlorofluoromethane	mg/kg	<0.22	-	-	0.02	<0.02	-	-	<0.02	<0.02	<0.02	<0.22	<0.12	<0.02
Trimethylbenzene, 1,2,4-	mg/kg	<5.5	-	-	0.5	<0.5	-	-	<0.5	<0.5	<0.5	<5.5	<3.1	<0.5
Trimethylbenzene, 1,3,5-	mg/kg	<5.5	-	-	0.5	<0.5	-	-	1.5	<0.5	<0.5	<5.5	<3.1	<0.5
Vinyl Chloride	mg/kg	<0.22	-	-	0.0003	<0.0003	-	-	<0.0003	<0.02	<0.0003	<0.22	<0.12	<0.0003

Notes:

RDL: Reported Detection Limit - May vary between sample locations and events

pg/g - picogram per gram

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG — Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Table C8: WK097 Speers Lake Analytical Chemistry Results: Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons							Location	WK097-SWBG1	WK097-SWBG2	WK097-SWBG3	WK097-SWBG4	WK097-SW1		WK097-SW2	WK097-SW3	WK097-SW4	WK097-SW3	WK097-SW3
							Sample ID	WK097-SW2	WK097-SWBG2	WK097-SWBG3	WK097-SWBG4	WK097-SW1	WK097-QAQCSW1	WK097-SW2	WK097-SW3	WK097-SW4	WK097-TB1	WK097-FB1
							Sample Date	2023-Aug-29	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Aug-29		2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05
Parameter	Units	Max Concentration	CEQG-WATER-FL-L	CEQG-WATER-FL-S	FIGQG-GW-T1-AG-Coarse	CEQG-WATER-AG-I	Lab Sample ID	BYS947	BYU443	BYU444	BYU445	BYS945	BYS946	BYU440	BYU441	BYU442	BYU446	BYU447
Petroleum Hydrocarbons							RDL											
Benzene	mg/L	<0.0004	0.37	-	0.088	-	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Ethylbenzene	mg/L	<0.0004	0.09	-	3.2	-	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Petroleum Hydrocarbons F1 (C6-C10)	mg/L	<0.1	-	-	0.81	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F1-BTEX	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F2 (C10-C16)	mg/L	<0.1	-	-	1.3	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F3 (C16-C34)	mg/L	0.28	-	-	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.28	<0.1	<0.1	<0.1	<0.1
Petroleum Hydrocarbons F4 (C34-C50)	mg/L	<0.2	-	-	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/L	<0.00047	0.002	-	0.083	-	0.0004	<0.00045	<0.0004	<0.0004	<0.0004	<0.00047	<0.00044	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Xylene, m+p-	mg/L	<0.0008	-	-	-	-	0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008
Xylene, o-	mg/L	<0.0004	-	-	-	-	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Xylenes, total	mg/L	<0.00089	-	-	3.9	-	0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089
Polycyclic Aromatic Hydrocarbons																		
Acenaphthene	mg/L	<0.0001	0.0058	-	0.0058	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Acenaphthylene	mg/L	<0.0001	-	-	0.046	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Acridine	mg/L	<0.00004	0.0044	-	0.00005	-	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	-	-
Anthracene	mg/L	<0.00001	0.000012	-	0.000012	-	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-
B[a]P TPE Total Potency Equivalents	mg/L	<0.00001	-	-	-	-	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-
Benzo[a]anthracene	mg/L	<0.0000085	0.000018	-	0.000018	-	0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	-	-
Benzo[a]pyrene	mg/L	<0.0000075	0.000015	-	0.00001	-	0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	-	-
Benzo[b,j]fluoranthene	mg/L	<0.0000085	-	-	0.00048	-	0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	-	-
Benzo[c]phenanthrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-	-
Benzo[e]pyrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-	-
Benzo[g,h,i]perylene	mg/L	<0.0000085	-	-	0.00017	-	0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	-	-
Benzo[k]fluoranthene	mg/L	<0.0000085	-	-	0.00048	-	0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	-	-
Chrysene	mg/L	<0.0000085	-	-	0.0001	-	0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	-	-
Dibenz[a,h]anthracene	mg/L	<0.0000075	-	-	0.00026	-	0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	-	-
Fluoranthene	mg/L	<0.00001	0.00004	-	0.00004	-	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-
Fluorene	mg/L	<0.00005	0.003	-	0.003	-	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-	-
Indeno[1,2,3-cd]pyrene	mg/L	<0.0000085	-	-	0.00021	-	0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	-	-
Methylnaphthalene, 1-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Methylnaphthalene, 2-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Naphthalene	mg/L	<0.0001	0.0011	-	0.0011	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Perylene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-	-
Phenanthrene	mg/L	<0.00005	0.0004	-	0.0004	-	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-	-
Pyrene	mg/L	<0.00002	0.000025	-	0.000025	-	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	-	-
Quinoline	mg/L	<0.0002	0.0034	-	0.0034	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-	-

Notes:

RDL: Reported Detection Limit — May vary between sample locations and events

mg/L: milligrams per Litre

DL exceeds criteria

Concentration exceeds CEQG-WATER-FL-L — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-LongTerm

Concentration exceeds CEQG-WATER-FL-S — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-ShortTerm

Concentration exceeds CEQG-WATER-AG-I — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) Agricultural-Irrigation

Concentration exceeds FIGQG-GW-T1-AG-Coarse — Federal Interim Groundwater Quality Guidelines (FCSAP)-Groundwater (June 2016) Tier1-Agricultural-Coarse

Table C9: WK097 Speers Lake Analytical Chemistry Results: Glycols, Semi-Volatile Organic Compounds, Volatile Organic Compounds							Location	WK097-SW2	WK097-SW3
							Sample ID	WK097-SW2	WK097-SW3
							Sample Date	2023-Sep-05	2023-Sep-05
Parameter	**Units**	**Max Concentration**	**CEQG-WATER-FL-L**	**CEQG-WATER-FL-S**	**FIGQG-GW-T1-AG-Coarse**	**CEQG-WATER-AG-I**	**Lab Sample ID**	**BYU440**	**BYU441**
Glycols							**RDL**		
Diethylene glycol	mg/L	<5	-	-	-	-	5	<5	<5
Ethylene glycol	mg/L	<3	192	-	190	-	3	<3	<3
Propylene glycol	mg/L	<5	500	-	500	-	5	<5	<5
Tetraethylene glycol	mg/L	<5	-	-	-	-	5	<5	<5
Triethylene glycol	mg/L	<5	-	-	-	-	5	<5	<5
Semi-Volatile Organic Compounds									
Dichlorobenzene, 1,2-	mg/L	<0.0005	0.0007	-	0.0007	-	0.0005	<0.0005	<0.0005
Dichlorobenzene, 1,3-	mg/L	<0.0005	0.15	-	0.042	-	0.0005	<0.0005	<0.0005
Dichlorobenzene, 1,4-	mg/L	<0.0005	0.026	-	0.026	-	0.0005	<0.0005	<0.0005
Trichlorobenzene, 1,2,4-	mg/L	<0.001	0.024	-	0.0054	-	0.001	<0.001	<0.001
Volatile Organic Compounds									
Bromodichloromethane	mg/L	<0.0005	-	-	8.5	-	0.0005	<0.0005	<0.0005
Bromoform	mg/L	<0.0005	-	-	0.38	-	0.0005	<0.0005	<0.0005
Bromomethane	mg/L	<0.002	-	-	0.0056	-	0.002	<0.002	<0.002
Carbon tetrachloride	mg/L	<0.0005	0.0133	-	0.00056	-	0.0005	<0.0005	<0.0005
Chlorobenzene	mg/L	<0.0005	-	-	0.0013	-	0.0005	<0.0005	<0.0005
Chloroform	mg/L	<0.0005	-	-	0.0018	-	0.0005	<0.0005	<0.0005
Chloromethane	mg/L	<0.002	-	-	-	-	0.002	<0.002	<0.002
Dibromochloromethane	mg/L	<0.001	-	-	0.1	-	0.001	<0.001	<0.001
Dibromoethane, 1,2-	mg/L	<0.0002	-	-	-	-	0.0002	<0.0002	<0.0002
Dichloroethane, 1,1-	mg/L	<0.0005	-	-	0.32	-	0.0005	<0.0005	<0.0005
Dichloroethane, 1,2-	mg/L	<0.0005	0.1	-	0.005	-	0.0005	<0.0005	<0.0005
Dichloroethene, 1,1-	mg/L	<0.0005	-	-	0.039	-	0.0005	<0.0005	<0.0005
Dichloroethene, cis-1,2-	mg/L	<0.0005	-	-	0.0016	-	0.0005	<0.0005	<0.0005
Dichloroethene, trans-1,2-	mg/L	<0.0005	-	-	0.0016	-	0.0005	<0.0005	<0.0005
Dichloropropane, 1,2-	mg/L	<0.0005	-	-	0.016	-	0.0005	<0.0005	<0.0005
Dichloropropene, cis-1,3-	mg/L	<0.0005	-	-	-	-	0.0005	<0.0005	<0.0005
Dichloropropene, trans-1,3-	mg/L	<0.0005	-	-	-	-	0.0005	<0.0005	<0.0005
Methylene chloride	mg/L	<0.002	0.0981	-	0.05	-	0.002	<0.002	<0.002
Methyl methacrylate	mg/L	<0.0005	-	-	0.84	-	0.0005	<0.0005	<0.0005
Methyl tert-butyl ether (MTBE)	mg/L	<0.0005	10	-	0.34	-	0.0005	<0.0005	<0.0005
Styrene	mg/L	<0.0005	0.072	-	0.072	-	0.0005	<0.0005	<0.0005
Tetrachloroethane, 1,1,1,2-	mg/L	<0.001	-	-	0.0033	-	0.001	<0.001	<0.001
Tetrachloroethane, 1,1,2,2-	mg/L	<0.002	-	-	0.0032	-	0.002	<0.002	<0.002
Tetrachloroethene	mg/L	<0.0005	-	-	0.11	-	0.0005	<0.0005	<0.0005
Trichlorobenzene, 1,2,3-	mg/L	<0.001	0.008	-	0.008	-	0.001	<0.001	<0.001
Trichlorobenzene, 1,3,5-	mg/L	<0.0005	-	-	0.015	-	0.0005	<0.0005	<0.0005
Trichloroethane, 1,1,1-	mg/L	<0.0005	-	-	0.64	-	0.0005	<0.0005	<0.0005
Trichloroethane, 1,1,2-	mg/L	<0.0005	-	-	0.0047	-	0.0005	<0.0005	<0.0005
Trichloroethene	mg/L	<0.0002	-	-	0.02	-	0.0002	<0.0002	<0.0002
Trichlorofluoromethane	mg/L	<0.0005	-	-	-	-	0.0005	<0.0005	<0.0005
Trihalomethanes, total	mg/L	<0.0013	-	-	-	-	0.0013	<0.0013	<0.0013
Trimethylbenzene, 1,2,4-	mg/L	<0.0005	-	-	-	-	0.0005	<0.0005	<0.0005
Trimethylbenzene, 1,3,5-	mg/L	<0.0005	-	-	-	-	0.0005	<0.0005	<0.0005
Vinyl Chloride	mg/L	<0.001	-	-	0.0011	-	0.0005	<0.001	<0.0005

Notes:

RDL: Reported Detection Limit May vary between sample locations and events

mg/L: milligrams per Litre

DL exceeds criteria

Concentration exceeds CEQG-WATER-FL-L — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-LongTerm

Concentration exceeds CEQG-WATER-FL-S — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-ShortTerm

Concentration exceeds CEQG-WATER-AG-I — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) Agricultural-Irrigation

Concentration exceeds FIGQG-GW-T1-AG-Coarse — Federal Interim Groundwater Quality Guidelines (FCSAP)-Groundwater (June 2016) Tier1-Agricultural-Coarse

Table C12: WK097 Speers Lake Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene and Xylenes, Petroleum Hydrocarbons, and Polycyclic Aromatic Hydrocarbons						Location	WK097-SedBG1	WK097-SedBG2	WK097-SedBG3	WK097-SedBG4	WK097-Sed1		WK097-Sed2	WK097-Sed3	WK097-Sed4	WK097-Sed5
						Sample ID	WK097-SedBG1	WK097-SedBG2	WK097-SedBG3	WK097-SedBG4	WK097-Sed1	WK097-SedQAQC1	WK097-Sed2	WK097-Sed3	WK097-Sed4	WK097-Sed5
						Sample Date	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05		2023-Sep-05	2023-Sep-05	2023-Sep-05	2023-Sep-05
Parameter	Units	Max Concentration	CEQG-SED-FL-ISQG	CEQG-SED-FL-PEL	RBCA-ET2PSS-SED-	Lab Sample ID	BYV020	BYV021	BYV022	BYV023	BYV014	BYV015	BYV016	BYV017	BYV018	BYV019
						Sample Depth	-	-	-	-	-	-	-	-	-	-
Benzene, Toluene, Ethylbenzene, & Xylenes						RDL										
Benzene	mg/kg	<0.005	-	-	1.2	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ethylbenzene	mg/kg	<0.01	-	-	1.2	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	mg/kg	<0.05	-	-	1.4	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylene, m+p-	mg/kg	<0.04	-	-	-	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Xylene, o-	mg/kg	<0.02	-	-	-	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Xylenes, total	mg/kg	<0.045	-	-	1.3	0.045	<0.045	<0.045	<0.045	<0.045	<0.045	<0.045	<0.045	<0.045	<0.045	<0.045
Petroleum Hydrocarbons																
Petroleum Hydrocarbons F1 (C6-C10)	mg/kg	<10	-	-	15	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons F1-BTEX	mg/kg	<10	-	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons F2 (C10-C16)	mg/kg	12	-	-	25	10	<10	<10	<10	12	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons F3 (C16-C34)	mg/kg	**110**	-	-	43	50	<50	<50	**57**	**110**	<50	<50	<50	**52**	<50	<50
Petroleum Hydrocarbons F4 (C34-C50)	mg/kg	<50	-	-	43	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Polycyclic Aromatic Hydrocarbons																
Acenaphthene	mg/kg	<0.005	0.00671	0.0889	0.0889	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acenaphthylene	mg/kg	<0.005	0.00587	0.128	0.128	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acridine	mg/kg	<0.01	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	mg/kg	<0.004	0.0469	0.245	0.245	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo[a]anthracene	mg/kg	<0.005	0.0317	0.385	0.385	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[a]pyrene	mg/kg	<0.005	0.0319	0.782	0.782	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[b,j]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[c]phenanthrene	mg/kg	<0.005	-	-	-	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[e]pyrene	mg/kg	<0.005	-	-	-	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[g,h,i]perylene	mg/kg	<0.005	-	-	0.32	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[k]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
B[a]P TPE Total Potency Equivalents	mg/kg	<0.0071	-	-	-	0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071
Chrysene	mg/kg	<0.005	0.0571	0.862	0.862	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibenz[a,h]anthracene	mg/kg	<0.005	0.00622	0.135	0.135	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoranthene	mg/kg	<0.005	0.111	2.355	2355	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluorene	mg/kg	<0.005	0.0212	0.144	0.144	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Indeno[1,2,3-cd]pyrene	mg/kg	<0.005	-	-	3.2	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methylnaphthalene, 1-	mg/kg	<0.005	-	-	0.201	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methylnaphthalene, 2-	mg/kg	<0.005	0.0202	0.201	0.201	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Naphthalene	mg/kg	<0.005	0.0346	0.391	0.391	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Perylene	mg/kg	<0.005	-	-	-	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Phenanthrene	mg/kg	<0.005	0.0419	0.515	0.515	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Pyrene	mg/kg	<0.005	0.053	0.875	0.875	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Quinoline	mg/kg	<0.01	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

mg/kg - milligrams per kilogram

RDL: Reported Detection Limit, may vary between sample locations and events

DL exceeds criteria

Concentration exceeds CEQG-SED-FL-ISQG — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-InterimSedimentQualityGuidelines

Concentration exceeds CEQG-SED-FL-PEL — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-ProbableEffectLevels

RBCA-ET2PSS-SED-Freshwater_0623 — Atlantic Risk-Based Corrective Action Ecological Tier II Pathway Specific Standards for

Table C13: WK097 Speers Lake Analytical Chemistry Results: Glycols, Semi-Volatile Organic Compounds and Volatile Organic Compounds in Sediment						Location	WK097-Sed1
						Sample ID	WK097-Sed1
						Sample Date	2023-Sep-05
Parameter	Units	Max Concentration	CEQG-SED-FL-ISQG	CEQG-SED-FL-PEL	RBCA-ET2PSS-SED-Freshwater_0623	Lab Sample ID	BYV014
						Sample Depth	-
Glycols							
Diethylene glycol	mg/kg	<9	-	-	-	9	<9
Ethylene glycol	mg/kg	<10	-	-	-	10	<10
Propylene glycol	mg/kg	<10	-	-	-	10	<10
Triethylene glycol	mg/kg	<10	-	-	-	10	<10
Semi-Volatile Organic Compounds							
Dichlorobenzene, 1,2-	mg/kg	<0.02	-	-	0.33	0.02	<0.02
Dichlorobenzene, 1,3-	mg/kg	<0.02	-	-	1.7	0.02	<0.02
Dichlorobenzene, 1,4-	mg/kg	<0.02	-	-	0.34	0.02	<0.02
Trichlorobenzene, 1,2,4-	mg/kg	<0.04	-	-	-	0.04	<0.04
Volatile Organic Compounds							
Bromodichloromethane	mg/kg	<0.03	-	-	-	0.03	<0.03
Bromoform	mg/kg	<0.05	-	-	0.65	0.05	<0.05
Bromomethane	mg/kg	<0.02	-	-	-	0.02	<0.02
Carbon tetrachloride	mg/kg	<0.0005	-	-	1.2	0.0005	<0.0005
Chlorobenzene	mg/kg	<0.005	-	-	0.41	0.005	<0.005
Chloroform	mg/kg	<0.01	-	-	-	0.01	<0.01
Chloromethane	mg/kg	<0.03	-	-	-	0.03	<0.03
Dibromochloromethane	mg/kg	<0.02	-	-	-	0.02	<0.02
Dibromoethane, 1,2-	mg/kg	<0.002	-	-	-	0.002	<0.002
Dichloroethane, 1,1-	mg/kg	<0.02	-	-	-	0.02	<0.02
Dichloroethane, 1,2-	mg/kg	<0.002	-	-	-	0.002	<0.002
Dichloroethene, 1,1-	mg/kg	<0.02	-	-	-	0.02	<0.02
Dichloroethene, cis-1,2-	mg/kg	<0.02	-	-	-	0.02	<0.02
Dichloroethene, trans-1,2-	mg/kg	<0.02	-	-	-	0.02	<0.02
Dichloropropane, 1,2-	mg/kg	<0.02	-	-	-	0.02	<0.02
Dichloropropene, cis-1,3-	mg/kg	<0.02	-	-	-	0.02	<0.02
Dichloropropene, trans-1,3-	mg/kg	<0.02	-	-	-	0.02	<0.02
Methylene chloride	mg/kg	<0.03	-	-	-	0.03	<0.03
Methyl methacrylate	mg/kg	<0.04	-	-	-	0.04	<0.04
Methyl tert-butyl ether (MTBE)	mg/kg	<0.03	-	-	-	0.03	<0.03
Styrene	mg/kg	<0.02	-	-	-	0.02	<0.02
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.05	-	-	-	0.05	<0.05
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.05	-	-	1.4	0.05	<0.05
Tetrachloroethene	mg/kg	<0.01	-	-	0.41	0.01	<0.01
Tetraethyl lead	mg/kg	<0.0002	-	-	-	0.0002	<0.0002
Trichlorobenzene, 1,2,3-	mg/kg	<0.04	-	-	-	0.04	<0.04
Trichlorobenzene, 1,3,5-	mg/kg	<0.04	-	-	-	0.04	<0.04
Trichloroethane, 1,1,1-	mg/kg	<0.02	-	-	0.03	0.02	<0.02
Trichloroethane, 1,1,2-	mg/kg	<0.02	-	-	-	0.02	<0.02
Trichloroethene	mg/kg	<0.001	-	-	0.22	0.001	<0.001
Trichlorofluoromethane	mg/kg	<0.02	-	-	-	0.02	<0.02
Trimethylbenzene, 1,2,4-	mg/kg	<0.5	-	-	-	0.5	<0.5
Trimethylbenzene, 1,3,5-	mg/kg	<0.5	-	-	-	0.5	<0.5
Vinyl Chloride	mg/kg	<0.0003	-	-	-	0.0003	<0.0003

Notes:

mg/kg - milligrams per kilogram

RDL: Reported Detection Limit, may vary between sample locations and events

DL exceeds criteria

Concentration exceeds CEQG-SED-FL-ISQG — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-InterimSedimentQualityGuidelines

Concentration exceeds CEQG-SED-FL-PEL — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-ProbableEffectLevels

Concentration exceeds RBCA-ET2PSS-SED-Freshwater_0623 — Atlantic Risk-Based Corrective Action Ecological Tier II Pathway Specific Standards for Sediment - Freshwater (June 2023)

Table C4: WK170 Tahiapik River Analytical Chemistry Results: Dioxins and Furans, Glycols, Semi-Volatile Organic Compounds &					Location	WK170-TP1A	WK170-TP4A	WK170-TP4B	WK170-TP5A	WK170-TP5B
					Sample ID	WK170-TP1A	WK170-TP4A	WK170-TP4B	WK170-TP5A	WK170-TP5B
					Sample Date	2023-Sep-07	2023-Sep-07	2023-Sep-07	2023-Sep-07	2023-Sep-07
Parameter	Units	Max Concentratio	CEQG-SOIL-G-AG	CWS-PHC-2008-AG-	Lab Sample ID	BYU120	BYU126	BYU127	BYU128	BYU129
					Sample Depth	0.2 - 0.3	0.2 - 0.3	0.5 - 0.6	0.2 - 0.3	0.4 - 0.5
Dioxins and Furans					RDL					
Hepta CDD, 1,2,3,4,6,7,8-	pg/g	<0.178	-	-	4.99	<0.178	<0.146	-	-	-
Hepta CDF, 1,2,3,4,6,7,8-	pg/g	<0.137	-	-	4.99	<0.137	<0.045	-	-	-
Hepta CDF, 1,2,3,4,7,8,9-	pg/g	<0.164	-	-	4.99	<0.164	<0.05	-	-	-
Hexa CDD, 1,2,3,4,7,8-	pg/g	<0.134	-	-	4.99	<0.0473	<0.134	-	-	-
Hexa CDD, 1,2,3,6,7,8-	pg/g	<0.131	-	-	4.99	<0.094	<0.131	-	-	-
Hexa CDD, 1,2,3,7,8,9-	pg/g	<0.127	-	-	4.99	<0.095	<0.127	-	-	-
Hexa CDF, 1,2,3,4,7,8-	pg/g	<0.159	-	-	4.99	<0.159	<0.156	-	-	-
Hexa CDF, 1,2,3,6,7,8-	pg/g	<0.143	-	-	4.99	<0.139	<0.143	-	-	-
Hexa CDF, 1,2,3,7,8,9-	pg/g	<0.19	-	-	4.99	<0.168	<0.19	-	-	-
Hexa CDF, 2,3,4,6,7,8-	pg/g	<0.139	-	-	4.99	<0.133	<0.139	-	-	-
Octa CDD	pg/g	0.557	-	-	9.98	<0.458	0.557	-	-	-
Octa CDF	pg/g	<0.139	-	-	9.98	<0.129	<0.139	-	-	-
Penta CDD, 1,2,3,7,8-	pg/g	<0.141	-	-	4.99	<0.141	<0.117	-	-	-
Penta CDF, 1,2,3,7,8,-	pg/g	<0.194	-	-	4.99	<0.182	<0.194	-	-	-
Penta CDF, 2,3,4,7,8-	pg/g	<0.174	-	-	4.99	<0.163	<0.174	-	-	-
Tetra CDD, 2,3,7,8-	pg/g	<0.141	-	-	0.998	<0.141	<0.129	-	-	-
Tetra CDF, 2,3,7,8-	pg/g	<0.156	-	-	0.998	<0.156	<0.137	-	-	-
Total Hepta CDD	pg/g	<0.176	-	-	4.99	<0.176	<0.144	-	-	-
Total Hepta CDF	pg/g	<0.149	-	-	4.99	<0.149	<0.051	-	-	-
Total Hexa CDD	pg/g	<0.357	-	-	4.99	<0.357	<0.131	-	-	-
Total Hexa CDF	pg/g	<0.155	-	-	4.99	<0.148	<0.155	-	-	-
Total Penta CDD	pg/g	<0.141	-	-	4.99	<0.141	<0.117	-	-	-
Total Penta CDF	pg/g	<0.184	-	-	4.99	<0.181	<0.184	-	-	-
Total Tetra CDD	pg/g	<0.141	-	-	0.998	<0.141	<0.129	-	-	-
Total Tetra CDF	pg/g	<0.156	-	-	0.998	<0.156	<0.137	-	-	-
Semi-Volatile Organic Compounds										
Dichlorobenzene, 1,2-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichlorobenzene, 1,3-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichlorobenzene, 1,4-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Trichlorobenzene, 1,2,4-	mg/kg	<0.04	0.05	-	0.04	-	<0.04	<0.04	<0.04	<0.04
Volatile Organic Compounds										
Bromodichloromethane	mg/kg	<0.03	-	-	0.03	-	<0.03	<0.03	<0.03	<0.03
Bromoform	mg/kg	<0.05	-	-	0.05	-	<0.05	<0.05	<0.05	<0.05
Bromomethane	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Carbon tetrachloride	mg/kg	<0.0005	0.1	-	0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005
Chlorobenzene	mg/kg	<0.005	-	-	0.005	-	<0.005	<0.005	<0.005	<0.005
Chloroform	mg/kg	<0.01	-	-	0.01	-	<0.01	<0.01	<0.01	<0.01
Chloromethane	mg/kg	<0.03	-	-	0.03	-	<0.03	<0.03	<0.03	<0.03
Dibromochloromethane	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dibromoethane, 1,2-	mg/kg	<0.002	-	-	0.002	-	<0.002	<0.002	<0.002	<0.002
Dichloroethane, 1,1-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichloroethane, 1,2-	mg/kg	0.0024	0.1	-	0.002	-	<0.002	0.0024	<0.002	<0.002
Dichloroethene, 1,1-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichloroethene, cis-1,2-	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichloroethene, trans-1,2-	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichloropropane, 1,2-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichloropropene, cis-1,3-	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Dichloropropene, trans-1,3-	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Methylene chloride	mg/kg	0.36	0.1	-	0.03	-	0.12	0.36	<0.03	0.12
Methyl methacrylate	mg/kg	<0.04	-	-	0.04	-	<0.04	<0.04	<0.04	<0.04
Methyl tert-butyl ether (MTBE	mg/kg	<0.03	-	-	0.03	-	<0.03	<0.03	<0.03	<0.03
Styrene	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Tetrachloroethane, 1,1,1,2-	mg/kg	<0.05	-	-	0.05	-	<0.05	<0.05	<0.05	<0.05
Tetrachloroethane, 1,1,2,2-	mg/kg	<0.05	0.1	-	0.05	-	<0.05	<0.05	<0.05	<0.05
Tetrachloroethene	mg/kg	<0.01	0.1	-	0.01	-	<0.01	<0.01	<0.01	<0.01
Trichlorobenzene, 1,2,3-	mg/kg	<0.04	0.05	-	0.04	-	<0.04	<0.04	<0.04	<0.04
Trichlorobenzene, 1,3,5-	mg/kg	<0.04	0.05	-	0.04	-	<0.04	<0.04	<0.04	<0.04
Trichloroethane, 1,1,1-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Trichloroethane, 1,1,2-	mg/kg	<0.02	0.1	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Trichloroethene	mg/kg	<0.001	-	-	0.001	-	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane	mg/kg	<0.02	-	-	0.02	-	<0.02	<0.02	<0.02	<0.02
Trimethylbenzene, 1,2,4-	mg/kg	<0.5	-	-	0.5	-	<0.5	<0.5	<0.5	<0.5
Trimethylbenzene, 1,3,5-	mg/kg	<0.5	-	-	0.5	-	<0.5	<0.5	<0.5	<0.5
Vinyl Chloride	mg/kg	<0.02	-	-	0.0003	-	<0.0003	<0.0003	<0.02	<0.0003

Notes:

EDL: Estimated Detection Limit

RDL: Reported Detection Limit - May vary between sample locations and events

mg/kg - milligram per kilogram

RDL exceeds criteria

Concentration exceeds CEQG-SOIL-G-AG — Canadian Environmental Quality Guidelines(CCME)-Soil (June 2021) Generic-Agricultural

Concentration exceeds CWS-PHC-2008-AG-ESC-Coarse-SUR — Canada-Wide Standards For Petroleum Hydrocarbons in Soil (2008) Agricultural-EcoSoilContact-CoarseTexture-SurfaceSoil

Table C8: WK170 Tahiapik River Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene, & Xylenes, Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons in Surface Water							Location	WK170-SW1	WK170-SWBG1
							Sample ID	WK170-SW1	WK170-SWBG1
							Sample Date	2023-Sep-07	2023-Sep-07
Parameter	Units	Max Concentratio	CEQG-WATER-FL-L	CEQG-WATER-FL-S	CEQG-WATER-AG-I	FIGQG-GW-T1-AG-	Lab Sample ID	BYU458	BYU459
							Sample Depth	-	-
Benzene, Toluene, Ethylbenzene, & Xylenes							RDL		
Benzene	mg/L	<0.0004	0.37	-	-	0.088	0.0004	<0.0004	<0.0004
Ethylbenzene	mg/L	<0.0004	0.09	-	-	3.2	0.0004	<0.0004	<0.0004
Toluene	mg/L	<0.0004	0.002	-	-	0.083	0.0004	<0.0004	<0.0004
Xylene, m+p-	mg/L	<0.0008	-	-	-	-	0.0008	<0.0008	<0.0008
Xylene, o-	mg/L	<0.0004	-	-	-	-	0.0004	<0.0004	<0.0004
Xylenes, total	mg/L	<0.00089	-	-	-	3.9	0.00089	<0.00089	<0.00089
Petroleum Hydrocarbons									
Petroleum Hydrocarbons F1 (C	mg/L	<0.1	-	-	-	0.81	0.1	<0.1	<0.1
Petroleum Hydrocarbons F1-BT	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1
Petroleum Hydrocarbons F2 (C	mg/L	<0.1	-	-	-	1.3	0.1	<0.1	<0.1
Petroleum Hydrocarbons F3 (C	mg/L	<0.1	-	-	-	-	0.1	<0.1	<0.1
Petroleum Hydrocarbons F4 (C	mg/L	<0.2	-	-	-	-	0.2	<0.2	<0.2
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	mg/L	<0.0001	0.0058	-	-	0.0058	0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	<0.0001	-	-	-	0.046	0.0001	<0.0001	<0.0001
Acridine	mg/L	<0.00004	0.0044	-	-	0.00005	0.00004	<0.00004	<0.00004
Anthracene	mg/L	<0.00001	0.000012	-	-	0.000012	0.00001	<0.00001	<0.00001
Benzo[a]anthracene	mg/L	<0.0000085	0.000018	-	-	0.000018	0.0000085	<0.0000085	<0.0000085
Benzo[a]pyrene	mg/L	<0.0000075	0.000015	-	-	0.00001	0.0000075	<0.0000075	<0.0000075
Benzo[b,j]fluoranthene	mg/L	<0.0000085	-	-	-	0.00048	0.0000085	<0.0000085	<0.0000085
Benzo[c]phenanthrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005
Benzo[e]pyrene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005
Benzo[g,h,i]perylene	mg/L	<0.0000085	-	-	-	0.00017	0.0000085	<0.0000085	<0.0000085
Benzo[k]fluoranthene	mg/L	<0.0000085	-	-	-	0.00048	0.0000085	<0.0000085	<0.0000085
B[a]P TPE Total Potency Equiva	mg/L	<0.00001	-	-	-	-	0.00001	<0.00001	<0.00001
Chrysene	mg/L	<0.0000085	-	-	-	0.0001	0.0000085	<0.0000085	<0.0000085
Dibenz[a,h]anthracene	mg/L	<0.0000075	-	-	-	0.00026	0.0000075	<0.0000075	<0.0000075
Fluoranthene	mg/L	<0.00001	0.00004	-	-	0.00004	0.00001	<0.00001	<0.00001
Fluorene	mg/L	<0.00005	0.003	-	-	0.003	0.00005	<0.00005	<0.00005
Indeno[1,2,3-cd]pyrene	mg/L	<0.0000085	-	-	-	0.00021	0.0000085	<0.0000085	<0.0000085
Methylnaphthalene, 1-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001
Methylnaphthalene, 2-	mg/L	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001
Naphthalene	mg/L	<0.0001	0.0011	-	-	0.0011	0.0001	<0.0001	<0.0001
Perylene	mg/L	<0.00005	-	-	-	-	0.00005	<0.00005	<0.00005
Phenanthrene	mg/L	<0.00005	0.0004	-	-	0.0004	0.00005	<0.00005	<0.00005
Pyrene	mg/L	<0.00002	0.000025	-	-	0.000025	0.00002	<0.00002	<0.00002
Quinoline	mg/L	<0.0002	0.0034	-	-	0.0034	0.0002	<0.0002	<0.0002

Notes:

RDL: Reported Detection Limit May vary between sample locations and events

mg/L: milligrams per Litre

DL exceeds criteria

Concentration exceeds CEQG-WATER-FL-L — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-LongTerm

Concentration exceeds CEQG-WATER-FL-S — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) FreshwaterLife-ShortTerm

Concentration exceeds CEQG-WATER-AG-I — Canadian Environmental Quality Guidelines(CCME)-Water (June 2021) Agricultural-Irrigation

Concentration exceeds FIGQG-GW-T1-AG-Coarse — Federal Interim Groundwater Quality Guidelines (FCSAP)-Groundwater (June 2016) Tier1-Agricultural-Coarse

Table C10: WK170 Tahiapik River Analytical Chemistry Results: Benzene, Toluene, Ethylbenzene and Xylenes, Petroleum Hydrocarbons, and Polycyclic Aromatic Hydrocarbons in Sediment						Location	WK170-Sed1
						Sample ID	WK170-Sed1
						Sample Date	2023-Sep-07
Parameter	Units	Max Concentratio	CEQG-SED-FL-ISQG	CEQG-SED-FL-PEL	RBCA-ET2PSS-SED-	Lab Sample ID	BYV031
						Sample Depth	-
Benzene, Toluene, Ethylbenzene, & Xylenes						RDL	
Benzene	mg/kg	<0.005	-	-	1.2	0.005	<0.005
Ethylbenzene	mg/kg	<0.01	-	-	1.2	0.01	<0.01
Toluene	mg/kg	<0.05	-	-	1.4	0.05	<0.05
Xylene, m+p-	mg/kg	<0.04	-	-	-	0.04	<0.04
Xylene, o-	mg/kg	<0.02	-	-	-	0.02	<0.02
Xylenes, total	mg/kg	<0.045	-	-	1.3	0.045	<0.045
Petroleum Hydrocarbons							
Petroleum Hydrocarbons F1 (C6-C10)	mg/kg	<10	-	-	15	10	<10
Petroleum Hydrocarbons F1-BTEX	mg/kg	<10	-	-	-	10	<10
Petroleum Hydrocarbons F2 (C10-C16)	mg/kg	<10	-	-	25	10	<10
Petroleum Hydrocarbons F3 (C16-C34)	mg/kg	<50	-	-	43	50	<50
Petroleum Hydrocarbons F4 (C34-C50)	mg/kg	<50	-	-	43	50	<50
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	<0.005	0.00671	0.0889	0.0889	0.005	<0.005
Acenaphthylene	mg/kg	<0.005	0.00587	0.128	0.128	0.005	<0.005
Acridine	mg/kg	<0.01	-	-	-	0.01	<0.01
Anthracene	mg/kg	<0.004	0.0469	0.245	0.245	0.004	<0.004
Benzo[a]anthracene	mg/kg	<0.005	0.0317	0.385	0.385	0.005	<0.005
Benzo[a]pyrene	mg/kg	<0.005	0.0319	0.782	0.782	0.005	<0.005
Benzo[b,j]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005
Benzo[c]phenanthrene	mg/kg	<0.005	-	-	-	0.005	<0.005
Benzo[e]pyrene	mg/kg	<0.005	-	-	-	0.005	<0.005
Benzo[g,h,i]perylene	mg/kg	<0.005	-	-	0.32	0.005	<0.005
Benzo[k]fluoranthene	mg/kg	<0.005	-	-	13.4	0.005	<0.005
B[a]P TPE Total Potency Equivalents	mg/kg	<0.0071	-	-	-	0.0071	<0.0071
Chrysene	mg/kg	<0.005	0.0571	0.862	0.862	0.005	<0.005
Dibenz[a,h]anthracene	mg/kg	<0.005	0.00622	0.135	0.135	0.005	<0.005
Fluoranthene	mg/kg	<0.005	0.111	2.355	2355	0.005	<0.005
Fluorene	mg/kg	<0.005	0.0212	0.144	0.144	0.005	<0.005
Indeno[1,2,3-cd]pyrene	mg/kg	<0.005	-	-	3.2	0.005	<0.005
Methylnaphthalene, 1-	mg/kg	<0.005	-	-	0.201	0.005	<0.005
Methylnaphthalene, 2-	mg/kg	<0.005	0.0202	0.201	0.201	0.005	<0.005
Naphthalene	mg/kg	<0.005	0.0346	0.391	0.391	0.005	<0.005
Perylene	mg/kg	<0.005	-	-	-	0.005	<0.005
Phenanthrene	mg/kg	<0.005	0.0419	0.515	0.515	0.005	<0.005
Pyrene	mg/kg	<0.005	0.053	0.875	0.875	0.005	<0.005
Quinoline	mg/kg	<0.01	-	-	-	0.01	<0.01

Notes:

mg/kg - milligrams per kilogram

RDL: Reported Detection Limit, may vary between sample locations and events

DL exceeds criteria

Concentration exceeds CEQG-SED-FL-ISQG — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-InterimSedimentQualityGuidelines

Concentration exceeds CEQG-SED-FL-PEL — Canadian Environmental Quality Guidelines(CCME)-Sediment (June 2021) FreshwaterLife-ProbableEffectLevels

RBCA-ET2PSS-SED-Freshwater_0623 — Atlantic Risk-Based Corrective Action Ecological Tier II Pathway Specific Standards for Sediment - Freshwater (June 2023)