



HUMAN HEALTH  
RISK ASSESSMENT  
RED MOUNTAIN  
UNDERGROUND GOLD PROJECT

*Prepared for:*

**IDM MINING LTD**

409 Granville Street, Suite 1500  
Vancouver, BC V6C 1T2

*Prepared by:*

**CORE6 ENVIRONMENTAL LTD**

777 Hornby Street, Suite 1410  
Vancouver, BC V6Z 1S4

February 2018

Project No.: 00265-03

# Table of Contents

1	INTRODUCTION.....	1
2	PROJECT DESCRIPTION.....	3
3	STUDY AREA.....	8
	3.1 Local Study Area.....	8
	3.2 Regional Study Area.....	9
4	BACKGROUND.....	15
	4.1 Location Description.....	15
	4.2 Information Sources.....	16
	4.3 Regulatory Environment.....	16
5	OBJECTIVES.....	18
6	PROBLEM FORMULATION.....	19
	6.1 Identification of COPC Sources.....	19
	6.2 Release Mechanisms, Transport Pathways.....	20
	6.3 Identification of Constituents of Potential Concern.....	21
	6.3.1 Air.....	21
	6.3.2 Soil.....	24
	6.3.3 Surface Water.....	27
	6.3.4 Groundwater.....	28
	6.3.5 Sediment.....	31
	6.3.6 Country Foods.....	32
	6.3.7 Identified COPC.....	36
	6.4 Receptors of Concern (ROCs).....	37
	6.5 Exposure Pathways.....	38
	6.6 Conceptual Site Model.....	40
7	EXPOSURE ASSESSMENT.....	44
	7.1 Estimated Environmental Concentrations.....	44
	7.1.1 Air.....	44
	7.1.2 Soil.....	44
	7.1.3 Surface Water.....	45
	7.1.4 Country Foods - Fish.....	45
	7.1.5 Country Foods - Plants.....	46
	7.1.6 Country Foods - Moose, Hare, and Grouse.....	47
	7.2 Receptor Exposure Factors.....	48
	7.2.1 Receptor Characteristics.....	49
	7.2.2 Exposure Assumptions.....	51

7.3	Dose Estimates.....	52
7.3.1	Air Exposure .....	53
7.3.2	Soil Exposure.....	54
7.3.3	Surface Water Exposures.....	55
7.3.4	Country Food Exposure.....	56
8	TOXICITY ASSESSMENT .....	57
8.1	Toxicity Profiles.....	57
8.2	Toxicity Reference Values.....	57
9	RISK CHARACTERIZATION.....	58
9.1	Risk Estimate Procedure .....	58
9.1.1	Non-carcinogenic Hazard Quotients.....	58
9.1.2	Cancer Risk.....	59
9.2	Risk Estimate Results .....	60
9.2.1	Non-Cancer .....	60
9.2.2	Cancer Risk.....	62
10	UNCERTAINTY ANALYSIS.....	70
10.1	Uncertainties from Chemicals Not Evaluated.....	70
10.2	Uncertainties from Exposure Pathways Not Evaluated.....	70
10.3	Uncertainties in Estimated Environmental Concentrations .....	71
10.4	Uncertainties in Human Exposure Parameters.....	72
10.5	Uncertainties in Toxicity Values.....	72
10.6	Uncertainties in Risk Estimates.....	72
11	CONCLUSION.....	73
12	REFERENCES.....	74

# List of Figures

- Figure 1 Project Location Plan
- Figure 2 Risk Factor Overlap Principle
- Figure 3 Project Overview
- Figure 4 Project Footprint - Mine Site
- Figure 5 Project Footprint - Bromley Humps
- Figure 6 Local and Regional Study Areas for Health Effects
- Figure 7 Air Quality Spatial Boundaries
- Figure 8 Surface Water Quality Spatial Boundaries
- Figure 9 Fish and Fish Habitat Spatial Boundaries
- Figure 10 Wildlife and Wildlife Habitat Spatial Boundaries
- Figure 11 Soil and Plant Sampling Locations

- Figure 12 Surface Water, Sediment, and Fish Tissue Sample Locations
- Figure 13 Overlap of Ecozones and Human Health Spatial Boundaries
- Figure 14 Human Health Conceptual Site Model: Red Mountain Underground Gold Project
- Figure 15 Box and line Conceptual Site Model: Red Mountain Underground Gold Project

## List of Tables

- Table 1 Seasonal Frequency of Top Ten Consumed Traditional Food Items for Consumers and Non-Consumers Combined, Based on Average Days per Year
- Table 2 Summary of COPCs in Environmental Media
- Table 3 Summary Table: Conceptual Site Model Elements
- Table 4 ROC Exposure Characteristics
- Table 5 ROC Exposure Durations and Frequency Assumptions
- Table 6 Summary of Non-Cancer Risks
- Table 7 Summary of Cancer Risks

## List of Attachments

- Attachment A Tables in Support of the Screening and Identification of Constituents of Potential Concern (COPCs)
- Attachment B Summary Statistics Tables – Soils, Surface Water, Sediment and Groundwater
- Attachment C Derivation of Predicted Future Air and Soil Quality
- Attachment D Detailed Country Food Concentration Calculations
- Attachment E Toxicity Profile Summaries
- Attachment F Detailed Risk Estimates for Soil, Air, and Surface Water
- Attachment G Detailed Risk Estimates for Sum of All Exposure Pathways
- Attachment H Example Calculations



# Acronyms and Abbreviations

AAQOs	Ambient Air Quality Objectives
AIR	Application Information Requirements
AQO	Air Quality Objectives
ATSDR	United States Agency for Toxic Substances and Disease Registry
BC CSR	British Columbia Contaminated Sites Regulation
BCEAO	British Columbia Environmental Assessment Office
BCF	Bioconcentration Factor
BCMOE	British Columbia Ministry of Environment
BTF	Biotransfer Factor
CAAQS	Canadian Ambient Air Quality Standards
CAPMoN	Canadian Air and Precipitation Monitoring Network
CCME	Canadian Council of Ministers of the Environment
CEQ	Commission on Environmental Quality
CEQG	Canadian Environmental Quality Guidelines
CIL	Carbon-In-Leach
CO	Carbon Monoxide
COPC	Constituent of Potential Concern
Core6	Core6 Environmental Ltd
CWH	Coastal Western Hemlock
DMA	Dimethylarsenic acid
DQRA	Detailed Quantitative Risk Assessment
EA	Environmental Assessment
EEC	Estimated Environmental Concentration
EMF	Electromagnetic Field
HEA	Health Effects Assessment
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IDM	IDM Mining Ltd
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
LSA	Local Study Area
MAC	Maximum Acceptable Concentration
MH	Mountain Hemlock
ML/ARD	Metal Leaching/Acid Rock Drainage
MMA	Monomethyl arsenic acid
MMBC	Métis Nation BC
MOE	Ministry of Environment
NFA	Nisga'a Final Agreement
NLG	Nisga'a Lisims Government
NO <sub>2</sub>	Nitrous Oxide
O <sub>3</sub>	Ozone

P90	90 <sup>th</sup> Percentile
PFSA	Project Footprint Study Area
PM <sub>2.5</sub>	Particulate Matter Less than 2.5 microns in diameter
PM <sub>10</sub>	Particulate Matter Less than 10 microns in diameter
Project	Red Mountain Underground Gold Project
PQRA	Preliminary Quantitative Risk Assessment
QA	Quality Assurance
QC	Quality Control
RDKS	Regional District of Kitimat-Stikine
RfC	Reference Concentration
RfD	Reference Dose
RIVM	Netherlands National Institute of Public Health and the Environment
RME	Reasonable Maximum Exposure
ROC	Receptor of Concern
RSD	Risk-specific Dose
RSA	Regional Study Area
SARA	Species at Risk Act (2002)
SO <sub>2</sub>	Sulphur Dioxide
TC	Tolerable Concentration
TDI	Tolerable Daily Intake
TMF	Tailings Management Facility
TPM	Total Particulate Matter
TRV	Toxicity Reference Value
TSKLH	Traditional Territory of Tsetsaut Skii km Lax Ha
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
VC	Valued Component
VOC	Volatile Organic Compounds
WHO	World Health Organization

# Statement of Limitations

This report was prepared by Core6 Environmental Ltd (Core6) for IDM Mining Ltd (IDM) who have been party to the development of the scope-of-work and objectives for this project and understand its limitations. This report is intended to provide information to IDM to support project permitting efforts through the British Columbia Ministry of Environment. Core6 is not a party to the various considerations underlying IDM's business decisions and does not make recommendations regarding such decisions. Core6 accepts no responsibility for any business decisions relating to the Project. Any use, reliance on, or decision made by a third-party based on this report, is the sole responsibility of the third-party. Core6 accepts no liability or responsibility for any damages that may be suffered or incurred by any third-party as a result of decisions made or actions taken based on this report.

This report has been developed in a manner consistent with the level or skill normally exercised by environmental professionals practicing under similar conditions. In preparing this report, Core6 has relied on information provided by others and has assumed that the information provided is factual and accurate. Core6 accepts no responsibility for any deficiency, misstatement, or inaccuracy in this report resulting from information provided by others. If the assumed facts or accuracy of the information relied upon are shown to be incorrect, or if new information is discovered, then modifications to this report may be necessary.

# 1 INTRODUCTION

This Human Health Risk Assessment (HHRA) was completed by Core6 Environmental Ltd. (Core6) to support the assessment of Human Health Effects, as part of the Environmental Assessment (EA) initiated by IDM Mining Ltd. (IDM) for the Red Mountain Underground Gold Project (the Project), located near the town of Stewart, in northwestern British Columbia (BC; Figure 1).

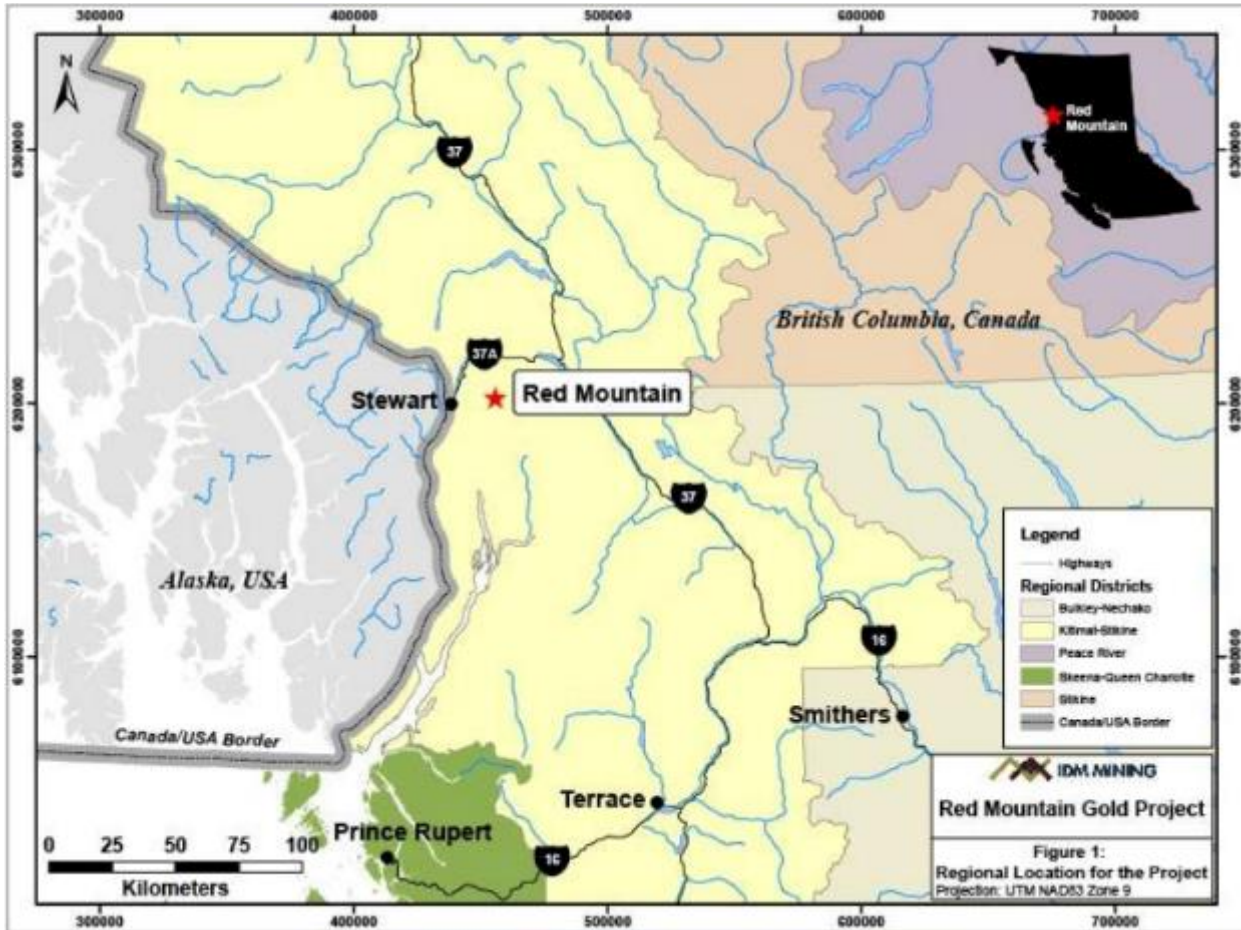


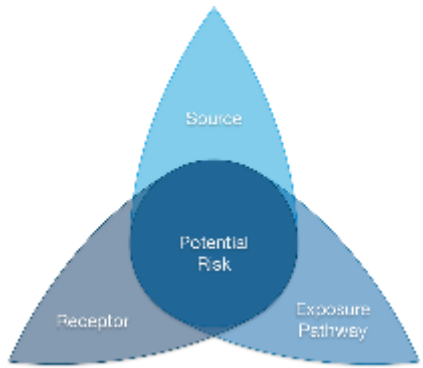
Figure 1. Project Location Plan

The development and operation of the Project have the potential to alter existing (baseline) conditions with respect to the concentrations of chemical parameters in the vicinity of the Project. Consequently, there is a potential for adverse effects in human receptors, above baseline conditions (i.e., concentrations), as a result of exposure to chemicals associated with Project activities. To evaluate potential, the practice of HHRA has evolved to provide an improved understanding of the potential for unacceptable adverse effects to human receptors.

Three key factors are considered in an HHRA:

- Sources of potential risk;
- Receptors of concern (ROCs); and
- Exposure pathways.

Depending on the jurisdiction, sources of potential risk may sometimes be referred to as hazards or stressors. This HHRA specifically focuses on exposure to chemicals as sources of potential risk. ROCs refer to the different user groups and their activities or behaviors that may result in exposure to identified sources of potential risk (e.g., hunters, hikers, residents). Exposure pathways refer to the means by which ROCs are exposed to the sources. For example, hunters may be exposed to chemicals directly through contact with soil while hunting or through dietary uptake (i.e., purposeful ingestion) of their catch. Perhaps the most important principle of risk assessment is that there can only be risk when all three of these factors coincide. If any one of these factors is not present, there is no risk (Figure 2).



Where all three factors coincide, further consideration is required to characterize the risk through a more thorough understanding of the characteristics and activity patterns of the ROCs, the spatial and temporal nature of the source(s) and associated chemical stressors, and the exposure pathways by which ROCs are exposed to the source(s). A graphical illustration of the relationships between sources, exposure pathways, and receptors - a Human Health Conceptual Site Exposure Model - is provided at the end of the Problem Formulation section.

Figure 2. Risk Factor Overlap Principle

## 2 PROJECT DESCRIPTION

IDM proposes to develop and operate the Project (Figure 3) as a 1,000 tonne per day (tpd) underground gold mine. The development area is approximately 163 hectares and is located at approximately 55.896° to 56.054° north latitude, and 129.665° to 129.802° west longitude. The Project is in the Bitter Creek watershed, within the Cambria Mountain Range, which is part of the Boundary Range (Alaska Boundary Range) that extends along the border of Alaska and British Columbia. The elevation ranges from 1,500 to 2,100 masl, with an average of approximately 1,800 masl. The Project falls within the Nass Wildlife Area as set out in Nisga'a Final Agreement (NFA), and is within the Kitimat-Stikine Regional District.

The Project has four main phases: Construction Phase, Operation Phase, Closure and Reclamation Phase, and Post-Closure Phase. Reclamation will be on-going during operations. The life of the Project is anticipated to be approximately 23 years. It is expected that the Construction Phase could begin as early as Spring 2018, and will last approximately 18 months. The Operation Phase will continue for 6 years, based on the Project plan. The Closure and Reclamation Phase will last 5 years, and the Post-Closure Phase, an additional 10 years.

Activity will be primarily contained within two main areas with interconnecting access roads:

1. Mine Site – located in the Goldslide Creek watershed, a sub-watershed of the larger Bitter Creek watershed, and is the location of the underground mine and dual portal access at the upper elevations of Red Mountain (1950 masl) (Figure 4); and
2. Bromley Humps – also situated in the Bitter Creek watershed (1500 masl), and is the location of the proposed Process Plant and Tailings Management Facility (TMF) (Figure 5).

The Process Plant will consist of the following:

- 3-stage crushing and fine ore storage;
- Primary and secondary grinding;
- Carbon-in-Leach (CIL);
- Acid Wash and Elution;
- Carbon Regeneration;
- Cyanide destruction;
- Recovery and refining; and
- Tailings disposal at the TMF.

The crushing circuit will operate at an availability of 70% while the plant will operate 24 hours per day, 365 days per year, at an availability of 92%. The tailings will undergo cyanide destruction before being delivered to the TMF. Tailings slurry from the processing plant will be discharged from the delivery pipelines into the TMF. Only water meeting effluent limits will be discharged to Bitter Creek. Water released from the TMF will be treated as necessary prior to discharge to Bitter Creek.

The material to be mined by IDM includes: mineralized zones of crudely tabular, northwesterly trending and moderately to steeply southwesterly dipping gold and silver-bearing iron sulphide stockworks. The deposit will initially be accessed from an existing portal and exploration ramp. In the first year of

operation, a lower access, to be used for haulage, will be added. Access ramps will be driven at a maximum grade of 15% at a 4.5 m x 4.5 m profile to accommodate 30-tonne haul trucks. Ore material will be hauled to the Processing Plant on a road yet to be constructed.

An existing access road from Highway 37 extends for approximately 13 km along the Bitter Creek valley, close to the location of the proposed Processing Plant, but stops short of the proposed mine site. An additional 13-km extension of the existing road is planned. Roads will not be accessible to the public. Locally-developed, geochemically-suitable borrows/rock quarries, adjacent to the proposed access road alignment, will provide the bulk of crushed rock and aggregate to build roads, lay-down areas, provide concrete aggregate and support other construction and maintenance activities.

Electrical power will be supplied to the Project through a connection to the BC Hydro electrical transmission system near Stewart, BC. Power will be delivered to both the Process Plant and the mine site by a 25 KV transmission line.

A camp will not be constructed at the mine site. Workers will likely reside in Stewart and will be transported as necessary to the Project area.



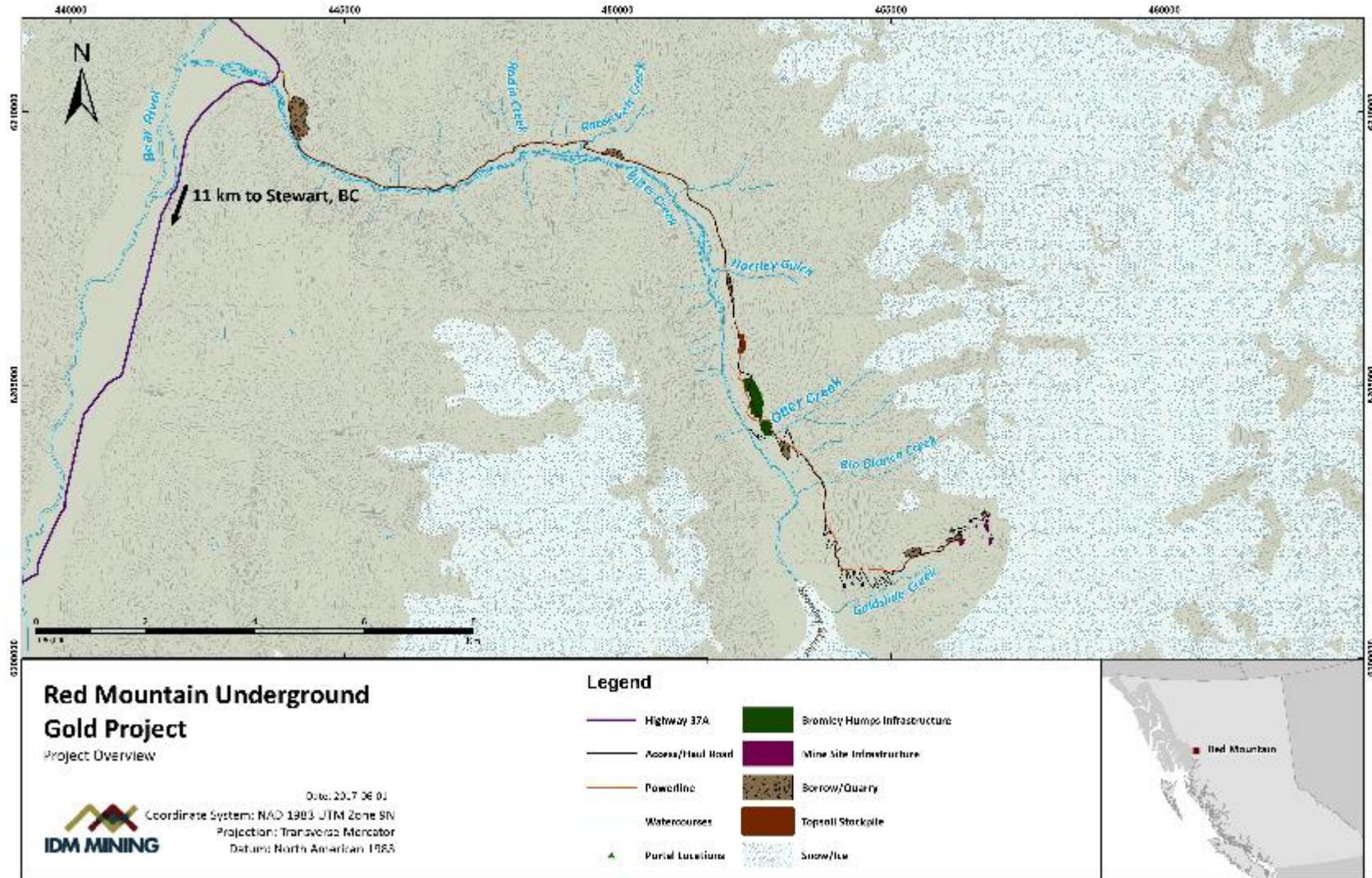


Figure 3: Project Overview



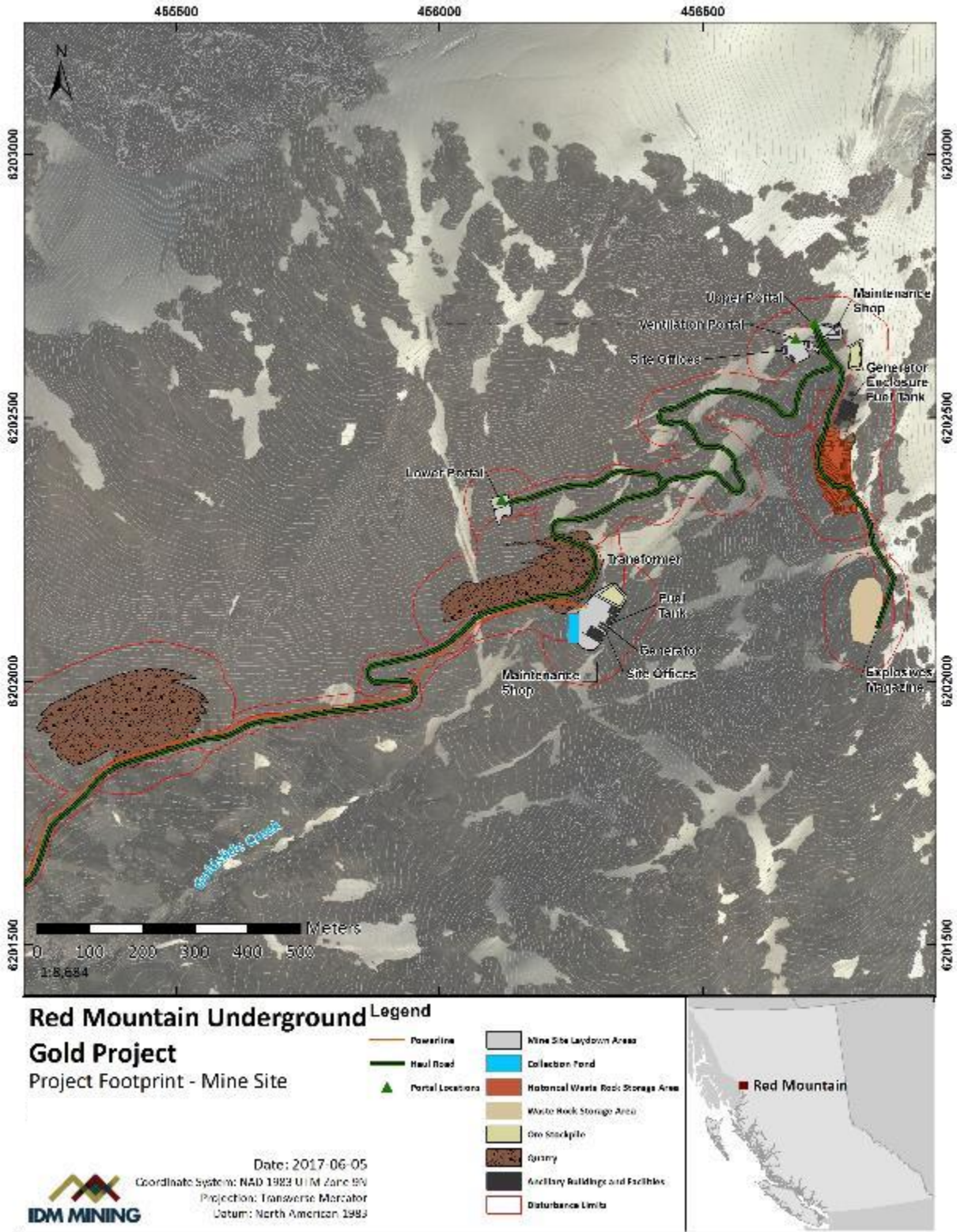


Figure 4: Project Footprint - Mine Site



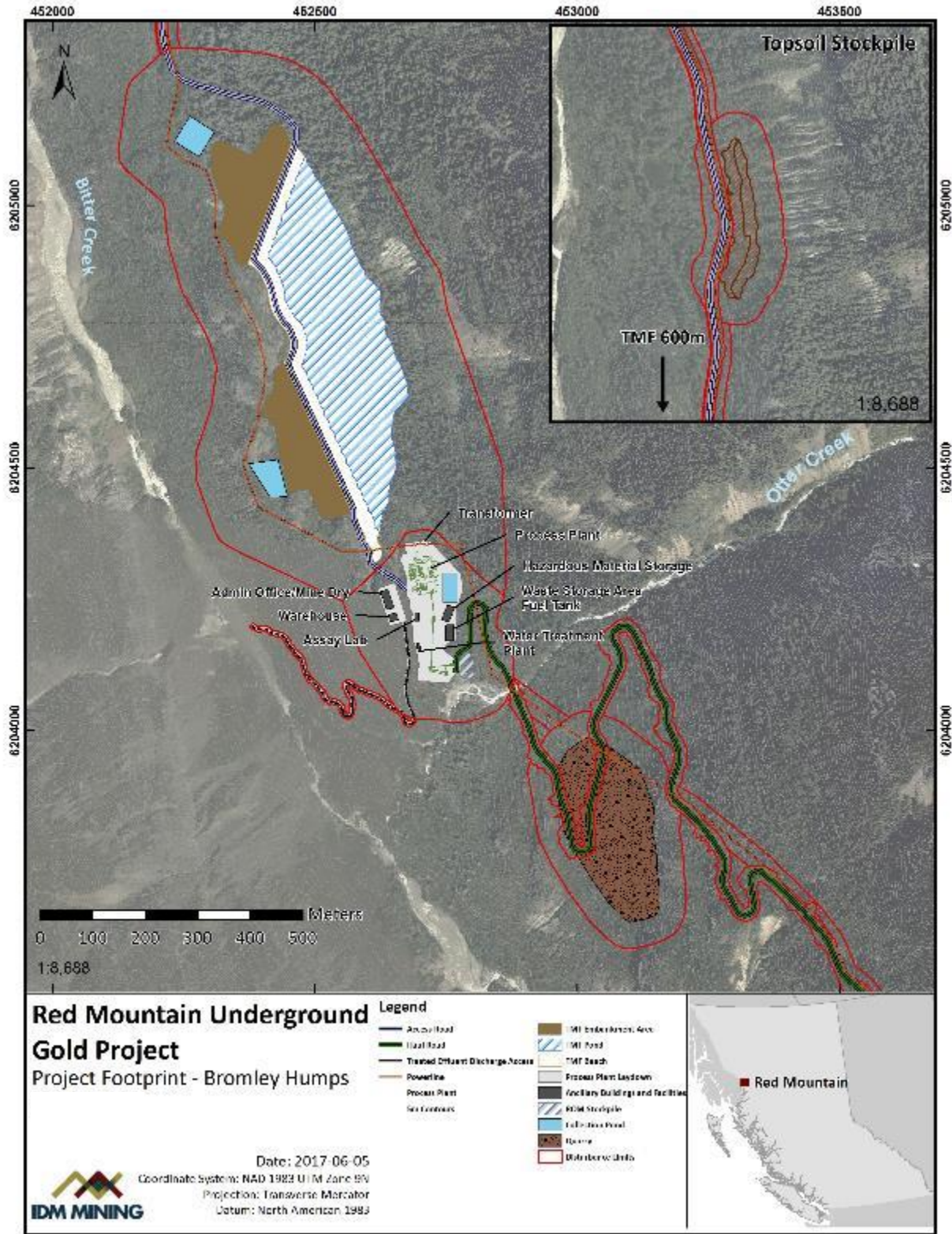


Figure 5: Project Footprint - Bromley Humps

## 3 STUDY AREA

### 3.1 Local Study Area

The Local Study Area (LSA) for the HHRA was established as an area with a radius of 50 km, which includes the following communities:

- District of Stewart;
- Village of Gitlaxt'aamiks (formerly New Aiyansh);
- Village of Gitwinksihlkw (Canyon City);
- Village of Laxgalts'ap (Greenville);
- Village of Gingolx (Kincolith);
- Meziadin Junction; and
- Bell II.

The Project is also within the Nass Area and the Nass Wildlife Area, as set out in the Nisga'a Final Agreement (NFA). Pursuant to the NFA, Nisga'a Nation, as represented by Nisga'a Lisims Government (NLG), has Treaty rights to the management and harvesting of fish, wildlife, and migratory birds within the Nass Wildlife Area and the larger Nass Area. The Project is also within the asserted traditional territory of Tsetsaut Skii km Lax Ha (TSKLH) and is within an area where Métis Nation BC (MNBC) claims Aboriginal rights.

The LSA for the HHRA (Figure 6) incorporates the zone of influence of the Project on Human Health, and considered measurement indicators that are considered to potentially interact with the Project. These include air contaminants, noise, EMFs, and constituents in surface water, sediment, fish, groundwater, soil, plants, and wildlife. LSA spatial boundary figures for the Air Quality VC (Figure 7), Surface Water Quality VC (Figure 8), Fish and Fish Habitat VC (Figure 9), and the Wildlife and Wildlife Habitat VC (Figure 10) have been included in this chapter to put the Human Health LSA into the context of the measurement indicators supporting the assessment of the Health VC.

The LSA boundary for Noise is encompassed within the Air Quality LSA boundary. Spatial boundaries for Sediment Quality, Groundwater Quality, and Hydrogeology are encompassed within the Surface Water Quality LSA boundary. Spatial boundaries for Vegetation and Ecosystems and Landforms and Natural Landscapes (including soil quality) are encompassed within the Wildlife and Wildlife Habitat LSA boundary.

All direct and indirect exposures to future Project activities will occur within the Bitter Creek watershed portion of the LSA, with the exception of ingestion of country food by person living outside the watershed. For example, someone from Village of Gitlaxt'aamiks or Stewart may be given or purchase moose caught in the Bitter Creek Watershed.

## 3.2 Regional Study Area

The Regional District of Kitimat-Stikine (RDKS) will serve as the Regional Study Area (RSA) that will be used as a baseline comparison for predicting, measuring, and monitoring the potential effects of the proposed Project on health effects (Figure 6). The RSA boundary takes into consideration the predicted habitat of select wildlife during hunting/ trapping season, such as moose, hare and grouse, and fishing areas in lower Bitter Creek. It also considers nearby communities as people from these communities are more likely to hunt, fish and recreate in the LSA (Figure 6).

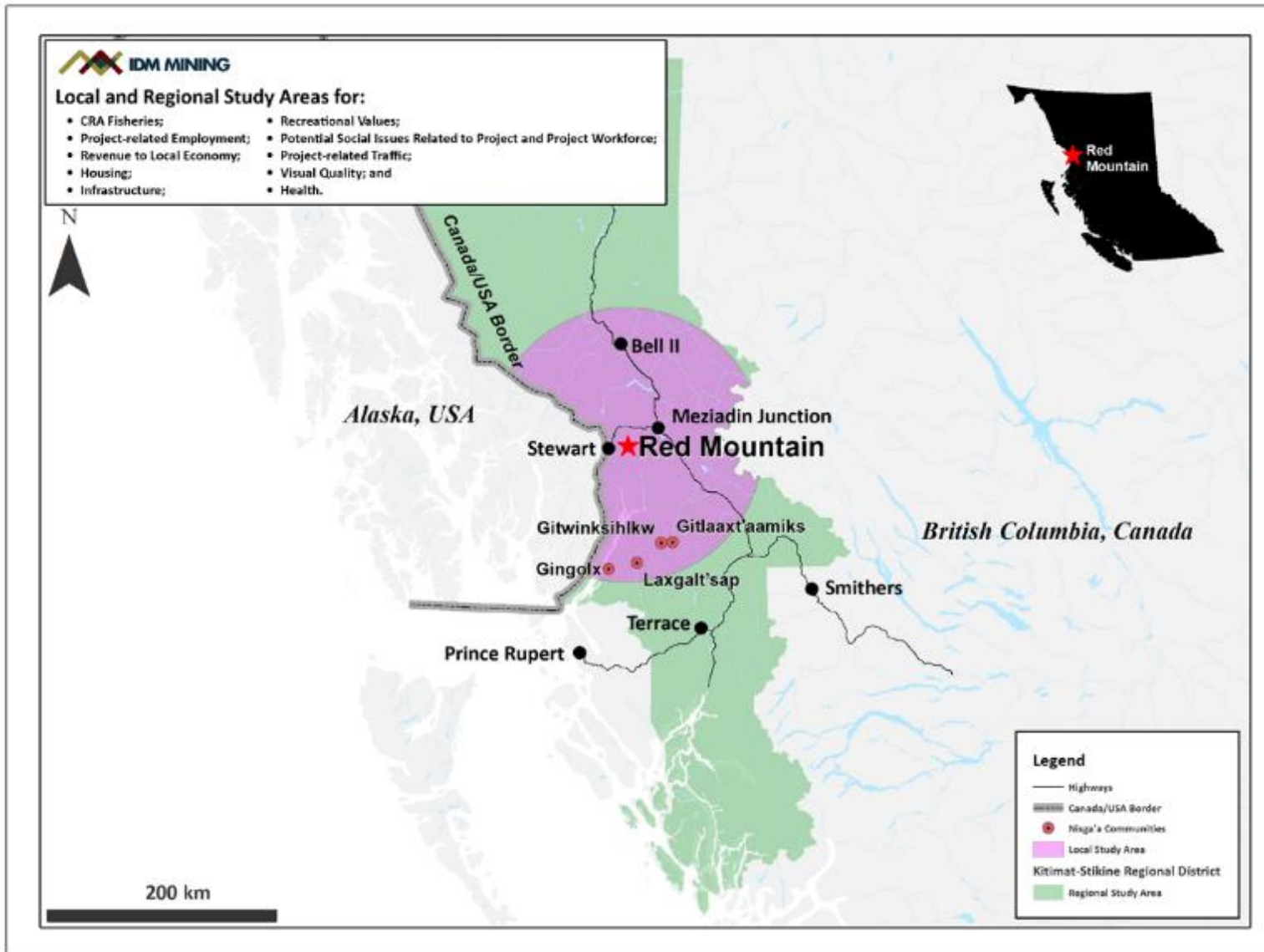


Figure 6: Local and Regional Study Areas for Health Effects



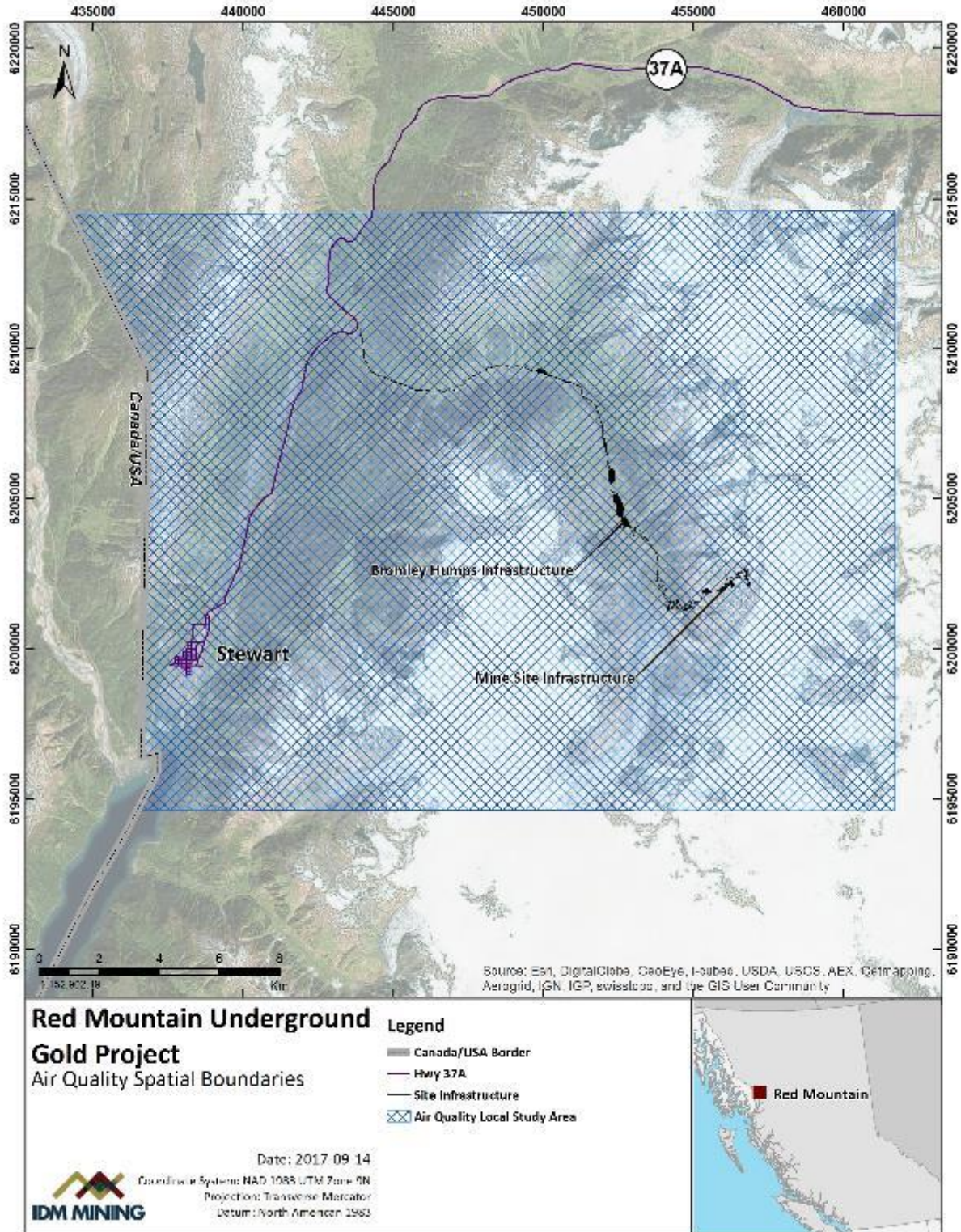


Figure 7: Air Quality Spatial Boundaries



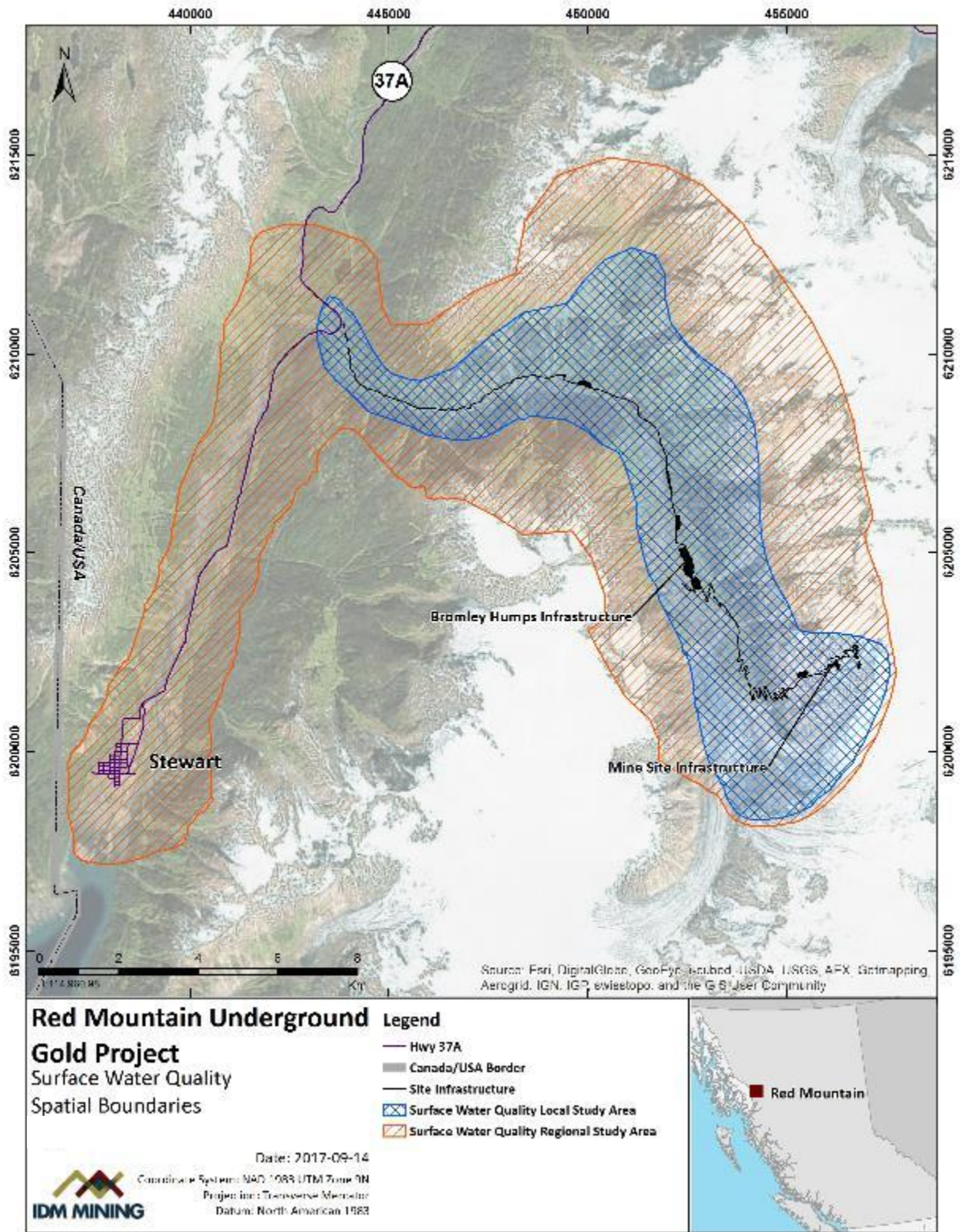


Figure 8: Surface Water Quality Spatial Boundaries



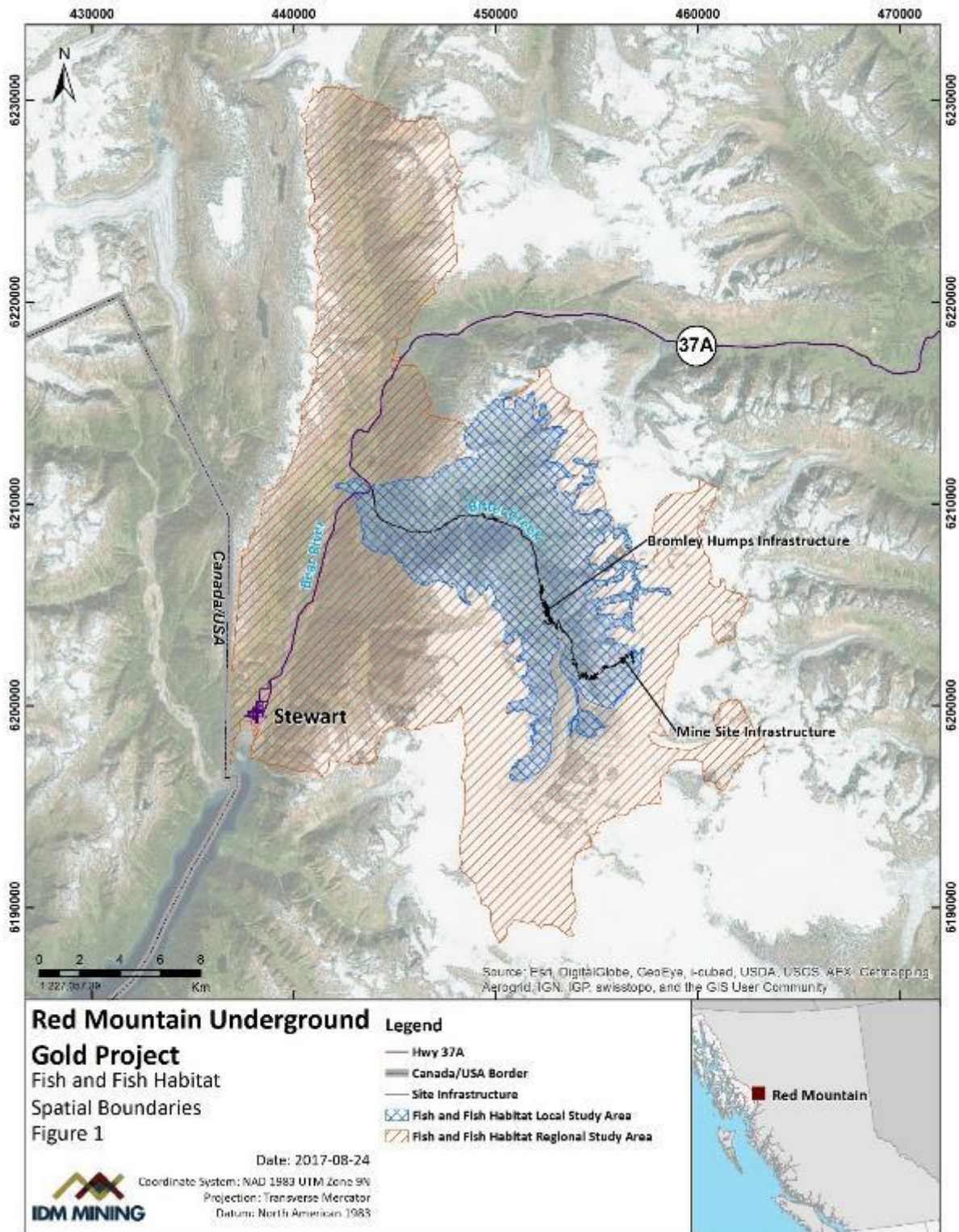


Figure 9: Fish and Fish Habitat Spatial Boundaries



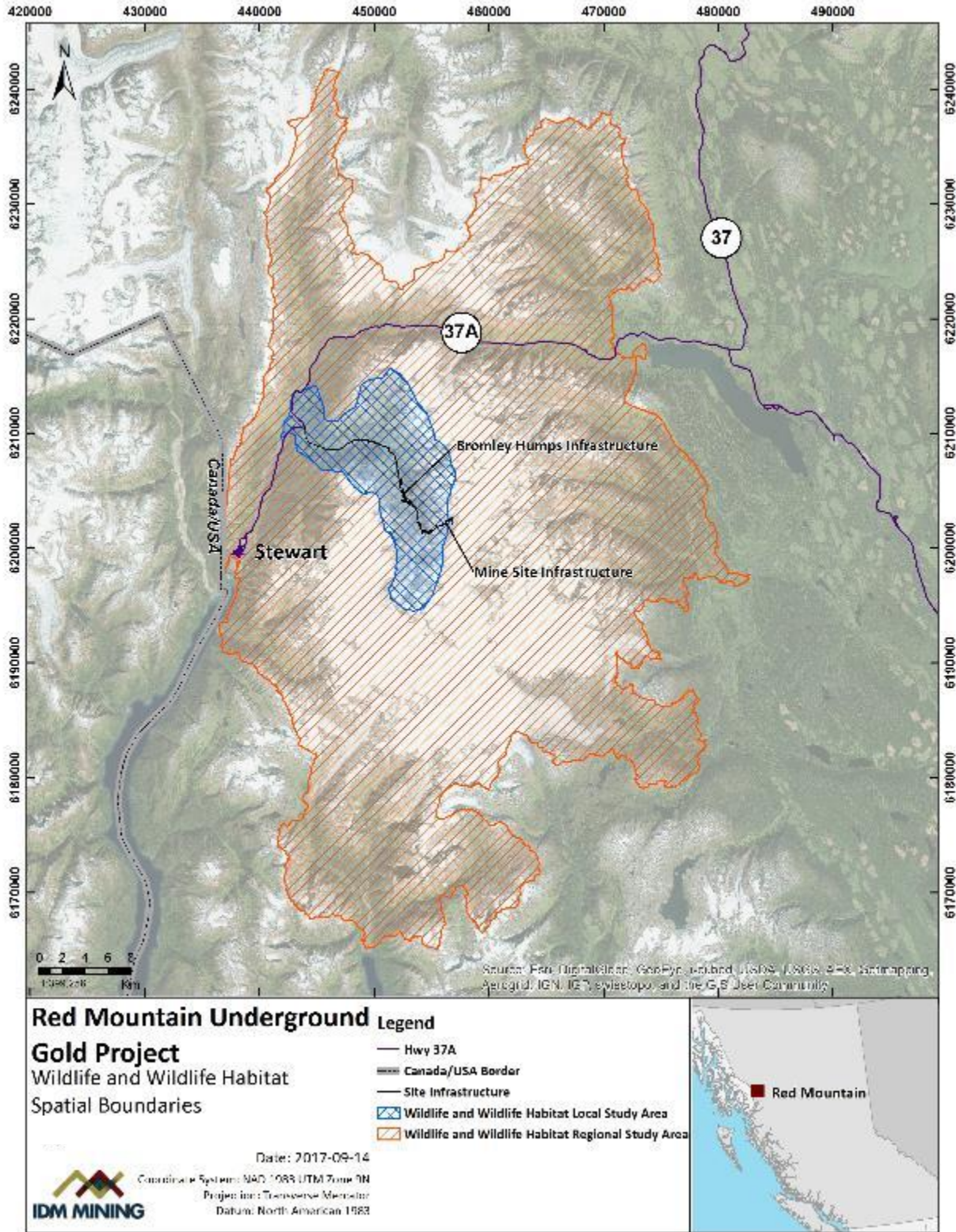


Figure 10: Wildlife and Wildlife Habitat Spatial Boundaries

## 4 BACKGROUND

### 4.1 Location Description

The Project is located within the Bitter Creek watershed, which is within the Southern Boundary Range. The watershed is a largely north-south valley that drains Bromley Glacier into the Bear River. Roosevelt Creek is also a significant drainage occupying a hanging valley in the northeast portion of the watershed, while smaller watercourses occur in deep gullies on the steep mountain slopes. The area is characterized by steep, wet slopes that contain frequent avalanche tracks. The north end of Bitter Creek Valley contains Coastal Western Hemlock (CWH) forests along the lower- and mid-slopes, including large areas of mid-slope mature and old forests. The mouth of Bitter Creek, as it drains into Bear River, is characterized by flat floodplain forests, dominated by deciduous stands adjacent to the rivers and grading into mixed forests on higher, less active floodplains. Narrow fringes of floodplain forest extend up Bitter Creek, with most of the active creek floodplain area being highly scoured rock and gravel, and occasional sparsely-vegetated areas. Mountain Hemlock (MH) forests occupy a narrow, steep band above the CWH (around 700 masl), and replace the CWH at the valley bottom as elevation increases to the southeast of Roosevelt Creek. Parkland MH forests start around 900 masl, and often contain old to very old forested stands before giving way to stunted Krummholz around 1,200 masl as the alpine zone begins.

As Bitter Creek climbs in elevation towards Bromley Glacier, lower slope forests begin to be replaced by early seral shrub communities where the soil development is limited and vegetation communities are in early stages of post-glaciation establishment. At the southern end of the valley the MH transitions into sparse parkland communities, with the majority of the area dominated by recently de-glaciated morainal deposits, along with colluvial slopes and barren alpine communities. Alpine communities are varied in the Bitter Creek Watershed, where transitional areas above the parkland forests are often diverse and contain rich herb meadow slopes, subalpine fir (*Abies lasiocarpa*) Krummholz, and expanses of alpine heath intermixed with dwarf shrub tundra-like communities. Exposed higher elevations contain extensive sparsely vegetated communities and barren rock outcrops before giving way to glaciers and icefields.

Avalanche tracks are abundant in the watershed, due to steep slopes and high snowfall. Avalanche communities are typically wet and rich and dominated by alder (*Alnus viridis* ssp. *crispa*), with lesser components of Devil's club (*Oplomanax horridus*) and various willows (*Salix* spp.). At the upper elevations, the avalanche slopes contain lush herb meadows. The edge of avalanche tracks, as they pass through forested areas, often contain slide-maintained forested communities that are irregular and fragmented in extent, and contain a high percent of dead or damaged trees.

The Bitter Creek watershed has a history of mine operation and exploration. Highway 37A and a BC Hydro powerline cross the creek near the confluence with Bear River. Much of the area near Highway 37A has been or is being, cleared or logged for various purposes. Small quarries and borrow pits associated with the highway or powerline construction occur along Highway 37A, and basic amenities have been developed for a recreation area at Clements Lake.

An old, overgrown road runs parallel to much of Bitter Creek along the northern side on old floodplains and the toe of the slope. Several smaller old roads branch off up the slopes, and there are numerous old logged areas adjacent to the road. Additional roads occur around the vicinity of the old mine portal on Red Mountain. Current exploration activities include new roads in the alpine near the old portal, along with the exploration camp, helicopter pad, and numerous temporary drill pads.

## 4.2 Information Sources

The following documents represent the sources from which information and data that was provided to Core6, originated:

- Project Overview: (Volume 2, Chapter 1);
- Geochemical Characterization of Waste Rock, Ore, and Talus (Volume 8, Appendix 1-B);
- Air Quality Modelling Report (Volume 8, Appendix 7-A);
- Ecosystems, Vegetation, Terrain and Soils Baseline Report (Volume 8, Appendix 9-A);
- Mine Area Hydrogeology Report (Volume 8, Appendix 10-A);
- Bromley Humps Baseline Hydrogeology Report (Volume 8, Appendix 10-B);
- Baseline Surface Water and Groundwater Quality Report (Volume 8, Appendix 14-A);
- Water Quality Assessment of the Reasonable Upper Limit Case (Volume 8, Appendix 14-B);
- Water and Load Balance Model Report (Volume 8, Appendix 14-C);
- Baseline Wildlife Resources Report (Volume 8, Appendix 16-A); and
- Baseline Fisheries and Aquatic Resources (Volume 8, Appendix 18-A).

## 4.3 Regulatory Environment

The British Columbia Environmental Assessment Office (BCEAO) issued a Section 10 Order to IDM confirming that the proposed Project requires an EA Certificate. As the proposed Project exceeds the minimum daily ore production threshold of 600 tpd, the Project will also require a decision pursuant to *Canadian Environmental Assessment Act 2012*.

As the Project is required to meet both provincial and federal requirements, the HHRA was completed consistent with accepted technical guidance prepared by provincial and federal regulatory bodies, as described below:

- Health Canada. 2012a. *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0*;
- Health Canada. 2010a. *Federal Contaminated Site Risk Assessment in Canada Part II: Health Canada Toxicological Reference Values*;
- Health Canada. 2012b. *Federal Contaminated Site Risk Assessment in Canada Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRA)*;
- Health Canada. 2010b. *Federal Contaminated Site Risk Assessment in Canada Supplemental Guidance on Human Health Risk Assessment for Country Foods*;
- BC MOE. 2015. *Technical Guidance on Contaminated Sites 7 - Supplemental Guidance for Risk Assessments*; and
- Northern Health. 2015. *Guidance on Human Health Risk Assessment*.

The main components of the HHRA, consistent with Canadian provincial and federal risk assessment guidance (along with that of numerous other regulatory jurisdictions worldwide), are as follows:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment;
- Risk Characterization;
- Uncertainty Assessment; and
- Discussion and Conclusions.

## 5 OBJECTIVES

The primary objective of this HHRA are to quantitatively evaluate human health risks associated with the Project. This objective is met through an evaluation of exposure to chemicals under baseline and predicted future conditions (i.e., Construction Phase, Operation Phase, Closure and Reclamation Phase, and Post-Closure Phase). Incremental differences between the baseline and predicted future conditions is considered to capture the potential changes attributable to the Project.

The HHRA was limited to non-occupational chemical exposures (with respect to the Project). Occupational health and safety is addressed elsewhere in the Environmental Assessment.



## 6 PROBLEM FORMULATION

The problem formulation is the planning stage of the HHRA. The intent of the problem formulation is to identify sources, constituents of potential concern (COPCs), ROCs, and the pathways through which the ROCs may be exposed to COPCs. When the pathways are considered complete, further quantitative evaluation is needed in the HHRA.

The HHRA evaluated baseline and the worst-case predicted future conditions when identifying COPCs and calculating risk. All future activity phases (i.e., Construction Phase, Operation Phase, Closure and Reclamation Phase, and Post-Closure Phase) were considered, and the highest predicted concentrations of COPCs were evaluated in the HHRA. Typically, the highest predicted COPC concentrations were in the Operations Phase. Evaluating the worst-case scenario is a conservative approach for evaluating future conditions since the concentrations and calculated risks in the other phases are expected to be lower.

The following information is provided in this section, as per the Project Application Information Requirements (AIR):

- Identification of potential sources and release mechanisms of COPCs (Section 6.1);
- Identification of receptors that may be exposed to COPCs, including consideration of exposure to sensitive groups (Section 6.4);
- Fate and transport assessment for each COPC (Section 6.2 and Attachment E);
- Identification of exposure pathways for all COPCs and receptors (Section 6.5); and
- Development of a conceptual site model that summarizes the above information into a diagram and flow chart (Section 6.6).

Following the problem formulation, the results of the exposure assessment (Section 7), toxicity assessment (Section 8), and risk characterization (Section 9) are presented. Uncertainties within the study are presented in Section 10.

### 6.1 Identification of COPC Sources

Three primary sources of COPCs occur within the LSA:

- Construction and operation of the mine site, which includes the following activities:
  - Construction of buildings offices, explosives storage, hazardous waste storage and fuel storage (contaminants of interest included nitrate, nitrite ammonia (nitrogen species), diesel, VOCs, dust, metals); and
  - Excavation of tunnels, shafts, and portals, exposing ore deposits and producing waste rock and stockpiles (contaminants of interest included nitrogen species, diesel, VOCs, dust, metals).
- Construction and operation of the Plant and TMF, which includes the following activities:
  - Including clearing construction of the processing plant, and construction of TMF (contaminants of interest included, dust, metals);

- Ore processing produces waste materials as a result of physical and chemical processes, including: crushing and grinding of ore material (producing dust), thickening, pre-oxidation, cyanide leaching, electrowinning, cyanide destruction and tailings disposal (reagents include sodium cyanide, hydraulic chloric acid, caustic acid, copper sulphate, and sodium metabisulphate) (contaminants of interest included, VOCs, dust, metals, sodium, cyanide, copper, sulphate, chloride, NO<sub>2</sub>, O<sub>3</sub>, SO<sub>2</sub>, CO); and
- Tailings stored in lined TMF with leak capture system (contaminants of interest included, metals, sodium, cyanide, copper, sulphate, chloride).
- Construction and use of the access and haul road, which includes the following activities:
  - Clearing and grading of the road, and excavation of material from local borrow pits and quarries for road base (contaminants of interest included, dust, metals, VOCs); and
  - Operation of vehicles on the access and haul roads (contaminants of interest included, dust, metals).

## 6.2 Release Mechanisms, Transport Pathways

Several primary mechanisms can release and transport COPCs within the LSA:

- Leaching into groundwater from the primary source mine works, ore and waste rock stockpiles;
- Migration of water through bedrock fractures;
- Migration and free water movement and discharge to the ground surface via mine portals;
- TMF release to groundwater; and
- Fugitive dust emissions from roads, waste rock and ROM stockpiles, above ground blasting during construction, and plant emissions.

Secondary and tertiary sources of groundwater and surface water contamination are anticipated to be the result of the following:

- Weathering (physical and chemical) and leaching of exposed wall rock (i.e., intact bedrock surface) and waste rock (e.g., excavated and crushed rock as boulders, cobbles); and
- Interaction of water (i.e., groundwater and surface water) and oxygen (i.e., atmospheric air) with iron sulfide ore minerals in the waste rock and bedrock.

The anticipated drainage of these secondary sources carries concentrations of elements and base metals with the potential to impact downstream groundwater and surface waters.

Secondary and tertiary sources of air contamination are anticipated to be the result of the following:

- Wind erosion of dust from roads (fugitive dust precipitated by the driving of haul trucks on the roads);
- Natural weathering of the wildlands area;
- Stockpiles of waste rock and ore material (due to the movement of materials to and from stockpiles); and
- Plant emissions, which includes a combination of particulate and non-particulate.

Secondary and tertiary sources of soil contamination are anticipated to be a result of deposition of air particulate containing fugitive dust from the Project roadways, ore material and waste rock. Sources of sediment contamination are anticipated to be the result of soil erosion, deposition of air particulate, and precipitation of contamination in surface water.

The source of contamination in plants (tertiary source and exposure medium) is the soil impacted by the deposition of air particulate. The source of contamination in moose, hare and grouse (exposure media) is plants and, to a lesser degree, soil and surface water ingestion. The source of contamination in fish (exposure medium) is surface water.

## 6.3 Identification of Constituents of Potential Concern

The COPCs evaluated in the HHRA were those constituents released from the mine as a result of mine activities, not including released during spills or other unplanned events. As mentioned in the objectives, this HHRA does not evaluate occupational exposures.

The following multi-step process was used to identify COPCs:

1. Compilation of data in each environmental media, for baseline and predicted future conditions;
2. Identification of appropriate media-specific screening levels such as the Canadian Council of Ministers of the Environment (CCME) Environmental Quality Guidelines (CCME 2017) and the British Columbia Contaminated Sites Regulation (BC CSR) Standards (BC 2017);
3. Identification of regional and local background concentrations (i.e., 95% of the baseline) in each environmental media, if available;
4. Comparison of constituent concentrations to screening levels. If the constituent concentrations were less than or equal to screening levels, the constituent was not carried forward as a COPC;
5. Comparison of constituent concentrations to regional background concentrations. If the constituent concentration were less than or equal to regional background concentrations, the constituent was not carried forward as COPC; and
6. Identification of final COPCs.

If screening levels or background concentrations were not available, then the constituent was also considered a COPC.

The identification of COPCs in each potential exposure media, air, soil, surface water (for drinking water), groundwater (for drinking water), sediment, and country foods is described in the subsections below.

### 6.3.1 Air

#### 6.3.1.1 Baseline Conditions

Air quality and dustfall data have not been collected in the LSA. Ambient air quality has previously been monitored at other locations in BC and the Northwest Territories, however, including the Saturna station of the Canadian Air and Precipitation Monitoring Network (CAPMoN), located 1,000 km south-southeast of the Project, the Diavik Diamond Mine located 300 km northeast of Yellowknife (the Project



is 920 km to the NE of Yellowknife), the Galore Creek Copper-Gold-Silver Mine Project located 280 km west of the Project, and the Kitsault Mine Project located 250 km southwest of the Project. The most representative baseline concentrations of NO<sub>2</sub>, SO<sub>2</sub>, CO, PM<sub>10</sub>, PM<sub>2.5</sub>, TPM, dustfall, and deposition were selected as baseline values for the Project. Since there were no annual PM<sub>2.5</sub> concentrations available from other locations, a 24-hour PM<sub>2.5</sub> concentration of 1.3 µg/m<sup>3</sup> from the Galore Creek Project was also adopted for the annual PM<sub>2.5</sub> baseline concentration for the Project. Source contribution, and background and predicted particulate matter concentrations are presented in Attachment C, Tables C1 and C2.

Since screening levels for metals are based on concentrations bound to PM<sub>10</sub> (particulate matter less than 10 µm in diameter) baseline data were calculated by multiplying soil concentrations of metals by the representative 24-hour PM<sub>10</sub> (3.4 µg/m<sup>3</sup>, from the Galore Creek Copper-Gold-Silver Mine Project). The methods for acquiring baseline air data are presented in Volume 3, Chapter 7, Section 7.4.4.

VOCs including diesel vapours, and process plant reagents were not carried forward from the air quality assessment because their releases were deemed to be negligible. No dispersion modelling was completed for these chemicals in the Air Quality modelling report (Volume 8, Appendix 7-A, Section 3, Table 3-2 and Table 3-3). Potential VOC emissions will be primarily a concern for workers on site during the construction and operation of the project. As such, the potential effects will be managed and mitigated in accordance with the Occupational Health and Safety Plan (Volume 5, Chapter 29, Section 29.17).

### 6.3.1.2 Predicted Future Conditions

Air quality modelling data for the Operations Phase, was determined to be the worst-case among the future Project phases. The air quality modelling completed for the Project included emissions sources located within the Project footprint.

Following the worst-case scenario approach, Operations Phase concentrations were used to represent the exposure in all other phases. The maximum predicted concentrations were estimated for priority pollutants (Volume 8, Appendix 7-A) and were used to compare to screening levels. For metals in particulate a weighted average of PM<sub>10</sub> sources (background areas, road dust, ore, and waste rock) was used to estimate the concentration of chemicals in air particulate. PM<sub>10</sub> was used to be consistent with Health Canada Guidance (Health Canada 2011). Metals concentration in air were estimated at three locations (downstream of the Tailings Management Facility, the road between Lower Portal and the Plant site, and between Lower Portal and Bitter Creek) (Figure C1, Attachment C). Metals concentrations in each source were then multiplied by the location-specific composition of source PM<sub>10</sub>, and the location-specific PM<sub>10</sub>, to calculate a 24-hour PM<sub>10</sub> concentration for each metal at each of the three locations. Refer to Attachment C, Section 1.3 for example calculations of the predicted air and soil concentrations.

### 6.3.1.3 Air Screening Levels

The air quality criteria considered in the evaluation were the BC Ambient Air Quality Objectives (AAQOs), which are a suite of ambient air quality criteria, including Provincial Air Quality Objectives (AQOs), National Ambient Air Quality Objectives (NAAQOs) and Canadian Ambient Air Quality Standards (CAAQS), with the strictest selected (Attachment A, Table A1).

Since the most recent development of NAAQOs and CAAQs for PM<sub>2.5</sub> and NO<sub>2</sub>, a body of research has been increasing that indicates that the current guidelines may not be protective of human health. Elliott and Copes (2017) estimated the burden of mortality attributable to long-term exposure to ambient fine particulate matter (PM<sub>2.5</sub>) among adults in the Interior and Northern region of British Columbia. A threshold concentration of 5 µg/m<sup>3</sup> was assumed based on this study, below which no mortality effects occur. The PM<sub>2.5</sub> of 5 µg/m<sup>3</sup> was considered when screening annual PM<sub>2.5</sub> levels. The annual maximum PM<sub>2.5</sub> estimated for the Project was 4.4 µg/m<sup>3</sup>. A review of Figure D-8 from Volume 8, Appendix 7-A illustrates isopleths of PM<sub>2.5</sub> air concentrations. Two areas had PM<sub>2.5</sub> greater than 2 µg/m<sup>3</sup>. These two areas represent less than 1% of the Bitter Creek watershed. One of the two areas was at the Mine Site and the other was near Bromley Humps between Bromley Humps and the Mine Site. Non-mine worker use of these areas is not anticipated during mine construction and operation. Therefore, non-occupational exposure to PM<sub>2.5</sub> in the Bitter Creek watershed is likely to be less than 2 µg/m<sup>3</sup>.

Health Canada (2016) and the USEPA (2016) have recently reviewed their air quality guidelines for NO<sub>2</sub> to assess whether they are still considered protective of human health. Both studies determined that “There is likely to be a causal relationship between long-term NO<sub>2</sub> exposure and respiratory effects. Evidence is suggestive of, but not sufficient to infer, a causal relationship for short-term NO<sub>2</sub> exposure with cardiovascular effects and total mortality and for long-term NO<sub>2</sub> exposure with cardiovascular effects and diabetes, poorer birth outcomes, and cancer.” USEPA (2016) indicated that while there is continued or new supporting epidemiologic evidence, a large uncertainty remains, particularly whether NO<sub>2</sub> exposure has an effect independent of traffic-related copollutants. Epidemiologic studies have not adequately accounted for confounding effects, and there is a paucity of support from experimental studies. Some recent experimental studies have shown NO<sub>2</sub>-induced increases in systemic inflammation or oxidative stress, but such changes are not consistently observed or necessarily linked to any health effect, unlike the mode of action information available for asthma (USEPA 2016). Health Canada (2016) acknowledges issues of confounding copollutants (PM<sub>2.5</sub>, SO<sub>2</sub>, and CO), but feels that evidence suggests that the NO<sub>2</sub> guideline should be updated. For this HHRA, however, the current interim guidelines, established by the province to accommodate a stepwise approach to management of SO<sub>2</sub> and NO<sub>2</sub> in anticipation of new Canadian Standards coming out for these parameters, were considered to be acceptable. There is some uncertainty with regards to how the new Canadian Standards (coming into effect in 2020) will ultimately be used and applied (e.g., between various jurisdictions, by the regulatory authorities, at a project versus airshed level).

For metals, the Texas Commission on Environmental Quality Effects Screening Levels (1-hour and annual averaging period PM<sub>10</sub>; Texas CEQ 2014) and the Ontario Ministry of the Environment Ambient Air Quality Criteria (24-hour averaging period; Ontario MOE 2012). The lowest screening level was used when more than one screening value was available for a given averaging period. The annual averaging period screening values were compared to the annual modelled air concentrations. The 24-hour averaging period screening values were compared the 24-hour modelled air concentrations. The Texas CEQ 1-hour PM<sub>10</sub> values are presented for comparison only.

#### 6.3.1.4 Air COPCs

Air COPCs were identified based on the steps listed at the beginning of Section 6.3. A comparison of the baseline and predicted future concentrations to screening levels is presented in Attachment A, Tables

A1 and A2. No air COPCs were carried forward for quantitative evaluation in the HHRA as all constituent concentrations in air were less than screening levels.

Predicted PM and NO<sub>2</sub> concentrations were compared to provincial and federal existing guidelines, and as a result were not screened into the HHRA. IDM acknowledges that even though NO<sub>2</sub> and PM exposure concentrations related to the project are low they are within the range where there is some uncertainty regarding effects. Toxicity profiles for PM and NO<sub>2</sub> have been developed and are presented Attachment E. The Air Quality and Dust Management Plan (Volume 5, Chapter 29) will include monitoring programs that will allow for real-time verification of the air quality modelling results and the effectiveness of applied mitigation measures.

## 6.3.2 Soil

### 6.3.2.1 Baseline Conditions

Soil data for baseline conditions included surface soil collected to support geochemical studies (Volume 7, Appendix 1-B, Section 3) and from more recent soil samples collected specifically to characterize the chemistry of soils in the LSA watershed (Volume 8, Appendix 9-A, Section 5.6) (Figure 11). Summary statistics for baseline soils are presented in Attachment B, Table B1.

### 6.3.2.2 Predicted Future Conditions

Project activities will result in the release of fugitive dust and Processing Plant emissions to air, some of which will have elevated concentrations of metals when compared to baseline soil concentrations. This dust (air particulate), will settle out of the air onto soil, plants, and surface water, and therefore has the potential to elevate the concentrations of metals in those media. Predicted future soil concentrations were estimated by modelling dust fall associated with fugitive dust and plant emissions during the construction and operational phases of the Project, considered to be the worst-case conditions. A more detailed explanation about how predicted future concentrations were calculated is documented in Attachment C. Tables in Attachment C present predicted dustfall, dust deposition, and soil concentrations at ten locations (Table C3). The three locations with the highest predicted soil concentrations (downstream of the Tailings Management Facility, the road between Lower Portal and the Plant site, and between Lower Portal and Bitter Creek) are tabulated in Attachment C, Table C10. Refer to Attachment C, Section 1.3 for example calculations of the predicted air and soils concentrations.

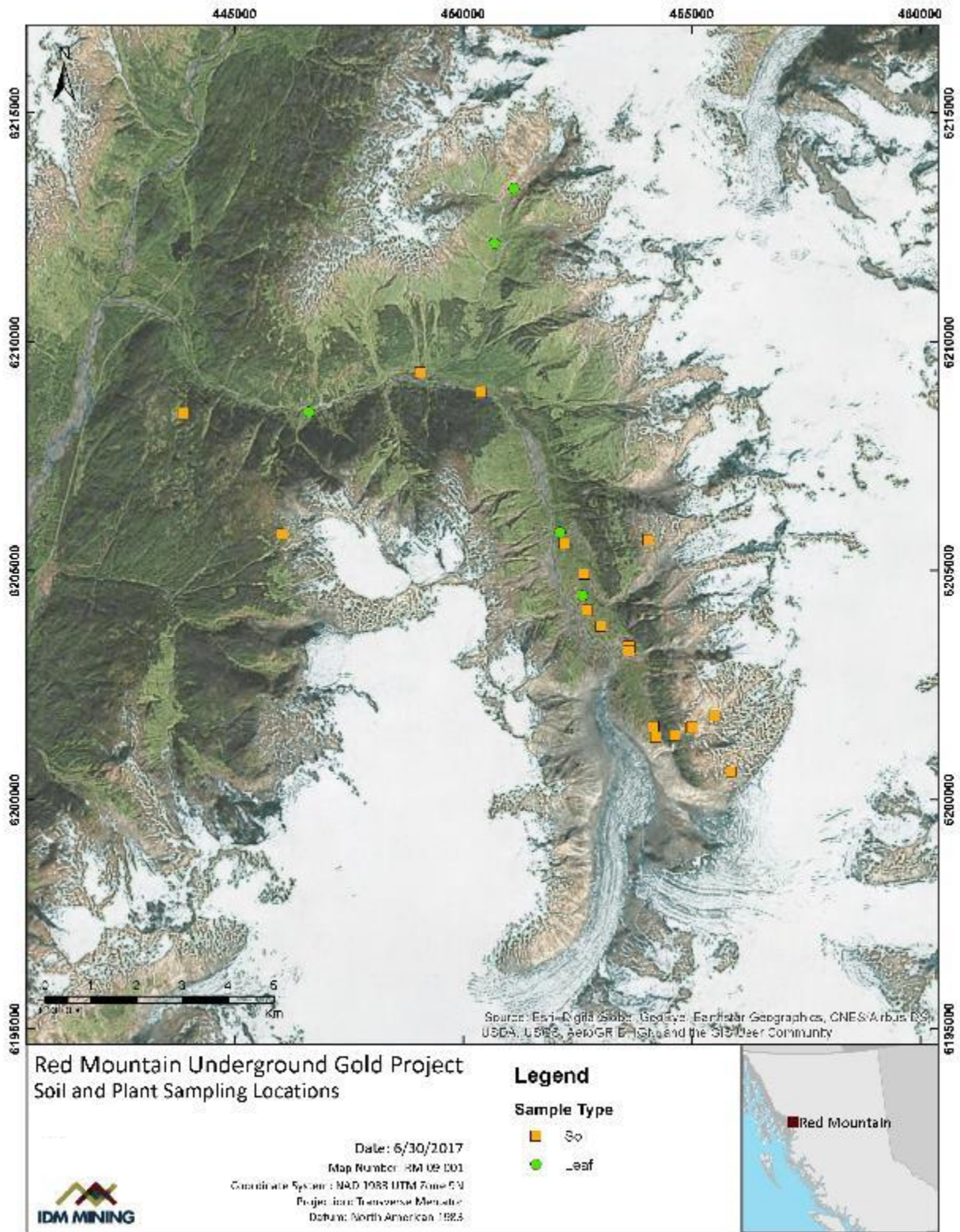


Figure 11: Soil and Plant Sampling Locations



### 6.3.2.3 Soil Screening Levels

To identify soil COPCs for quantitative evaluation in the HHRA, soil screening levels were selected from Canadian federal and BC guidelines and standards and considered published BC background concentrations (BCMOE 2017). If one of the federal or provincial guidelines were generic, that is, can serve as a screening threshold for human and ecological receptors, and the other contained specific guidelines for human receptors, then the human receptor specific guideline was used even should it be higher than the generic guideline. Should no federal or provincial guideline or standard be available for a given metal, a guideline or standard from another jurisdiction was considered for use as the screening value. If no screening value was available for a chemical, then it was carried forward as a COPC.

Guidelines, criteria, and standards considered in the development of soil screening levels included:

- Canadian Environmental Quality Guidelines (CEQGs) (CCME 2017);
- British Columbia Contaminated Sites Regulation (BC CSR 2017) – Schedule 3.1 Part 2 Generic Numerical Soil Standards to protect human health-wildlands natural, and Schedule 3.1 Part 1 Matrix Numerical Soil Standards for human health protection-wildlands natural;
- Protocol 4 for Contaminated Sites, Determining Background Soil Quality (BCMOE 2017);
- If no guideline or background concentration was available for a given chemical in soil then one could consider average the crustal abundance for a given chemical for use as a background concentration; or
- Guideline or standards from other jurisdictions including USEPA Regional Screening Levels (RSL) or (USEPA 2017a).

The soil screening level to be carried forward was selected using the following tiered approach:

- If federal (Canadian) and provincial (British Columbia) guidelines were available, the lowest of the two was selected as the soil screening level, with the overriding condition that human health specific guidelines were selected over generic guidelines;
- If only one regulatory criterion (federal or provincial) was available, then this value (provisional screening value) was selected; and
- If no federal or provincial criteria were available, then a value from another jurisdiction was selected as the soil screening level.

The selected soil screening levels are presented in Attachment A, Table A4. COPCs screened in for risk assessment are tabulated in Attachment A, Table A5.

### 6.3.2.4 Soil COPCs

Soil COPCs were identified based on the steps outlined in Section 6.1. Baseline and predicted soil concentrations are compared to screening levels and regional background levels in Attachment A, Table A5.

Arsenic and iron had baseline and predicted future concentrations that exceeded screening levels. Screening levels were not available for bismuth, calcium gallium, gold, lanthanum, magnesium, phosphorous, potassium, scandium, sulfur, tellurium, thorium, titanium, and yttrium. Essential nutrients

(calcium, magnesium, phosphorus, potassium and sodium) were not carried forward as COPCs because they are generally only toxic at extremely high concentrations. The rare earth elements gallium, lanthanum, scandium, thorium and yttrium were not carried forward as COPCs because the average concentrations in the earth's crust are considerably greater than the highest predicted future concentrations (Attachment A, Table A5). Cadmium, mercury and selenium were carried forward as COPCs because of their potential to biomagnify in the food chain.

### 6.3.3 Surface Water

#### 6.3.3.1 Baseline Conditions

Baseline surface water samples were collected from sample locations in the upper, middle, and lower Bitter Creek (4 locations), Goldslide Creek (2 locations), Rio Blanco Creek (1 location), Otter Creek (1 location), the Bear River upstream and downstream of the confluence with Bitter Creek and at Stewart (3 locations), and in American Creek (1 location) (Figure 12). Summary statistics for total and dissolved surface water for each of the 14 sample locations (AC02, BR08, BR06, BR03, BC02, BC04, BC06, BC08, GSC02, GSC09, GSC07, OC06, RBC02, and RC02) are reported in Attachment B, Tables B2 – B15. Overall summary statistics for total and dissolved surface water are presented in Tables B16 – B21. Methods for baseline surface water quality monitoring and QA/QC is presented in Volume 8, Appendix 14-A, Section 3.

#### 6.3.3.2 Predicted Future Conditions

Predictive modelling of metal surface water concentrations (50<sup>th</sup> percentile and 90<sup>th</sup> percentile) for unfiltered (total) water data from six sample stations (BR06, BC02, BC06, BC08, RBC02, and GSC02) was completed for the Operations Phase and for Post-Closure, to 150 years into the future (Volume 8, Appendix 14-B) and considered metal leaching and acid mine drainage. The most recent water load balance study data was used to represent future soil concentrations.

#### 6.3.3.3 Drinking Water Screening Levels

To identify surface water COPCs for the HHRA, surface water screening levels used for drinking water were developed from Federal and BC guidelines and standards. When no guideline or standard was available from these sources guidelines and standards from other jurisdictions were considered. The criteria considered in the development of surface water screening levels used for drinking water included the following, in order of preference:

- Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada 2017) – Maximum Acceptable Concentrations (MAC);
- British Columbia Contaminated Sites Regulation (BC CSR) – Schedule 3.2 Generic Numerical Water Standards for Drinking Water;
- Canadian Environmental Quality Guidelines (CEQGs) (CCME 2017); and
- USEPA Regional Screening Levels (USEPA RSL; USEPA 2017a).

The selected surface water screening levels used for drinking water are presented in Attachment A, Table A6.

### 6.3.3.4 Surface Water Drinking Water COPCs

The maximum baseline unfiltered surface water concentrations across 14 nodes, and the maximum of the modelled monthly 90<sup>th</sup> percentile (P90) unfiltered surface water concentrations were compared to surface water screening levels used for drinking water.

The surface water COPCs carried forward for further consideration in the HHRA (Attachment A, Table A12) included constituents that exceeded screening levels (aluminum, antimony, arsenic, cadmium, chromium, cobalt, iron, lead, manganese, mercury, selenium, thallium, and vanadium), and those that did not have screening levels (i.e., bismuth). Calcium and silicon did not have screening levels but are considered non-toxic in surface water except at very high concentrations and were therefore not retained as COPCs. Mercury was also carried forward as a COPC due to its potential to biomagnify in the food chain. The potential for biomagnification is identified in each chemical-specific toxicity profile (Attachment E).

## 6.3.4 Groundwater

### 6.3.4.1 Baseline Conditions

Data from groundwater monitoring completed at eleven locations by SRK (Volume 8, Appendix 14-A) are tabulated in Attachment A, Table A8. Summary statistics for baseline groundwater quality data are provided in Attachment B, Table B22. The 95<sup>th</sup> percentile concentration for each chemical analyzed for the baseline groundwater sampling program was used to represent the baseline condition in the HHRA. The complete groundwater quality data set is provided in the SRK report (Volume 8, Appendix 14-A). Methods for baseline groundwater quality monitoring and QA/QC is presented in Volume 8, Appendix 14-A, Section 3.

### 6.3.4.2 Predicted Future Conditions

The groundwater source term use for underground operations in the surface water model (Volume 8, Appendix 14-C) was used as the predicted future groundwater concentrations.

### 6.3.4.3 Drinking Water Screening Levels

To identify groundwater COPCs for the HHRA, drinking water screening levels were developed from Federal and BC guidelines and standards. The screening process was completed in the same manner as surface water. The selected surface water screening levels used for drinking water are presented in Attachment A, Table A6.

### 6.3.4.4 Groundwater COPCs

The maximum baseline groundwater concentrations for each constituent, and the modelled groundwater source for the predictive load balance study was compared to surface water screening levels used for drinking water. The groundwater COPCs carried forward for further consideration in the HHRA are presented in Attachment A, Table A9. Constituents whose concentrations were greater than their respective screening levels were considered to be drinking water COPCs in groundwater (nitrate,

antimony, arsenic, cadmium, cobalt, and manganese). Calcium is only toxic at extremely high concentrations and thus was not carried forward as a COPC. Bismuth, silicon, titanium, and vanadium were not detected in groundwater and, therefore, were also not carried forward as a COPC. Mercury and selenium were also carried forward as COPCs due to their potential to biomagnify in the food chain. The potential for biomagnification is identified in each chemical-specific toxicity profile (Attachment E). There are currently no drinking water wells in the LSA.



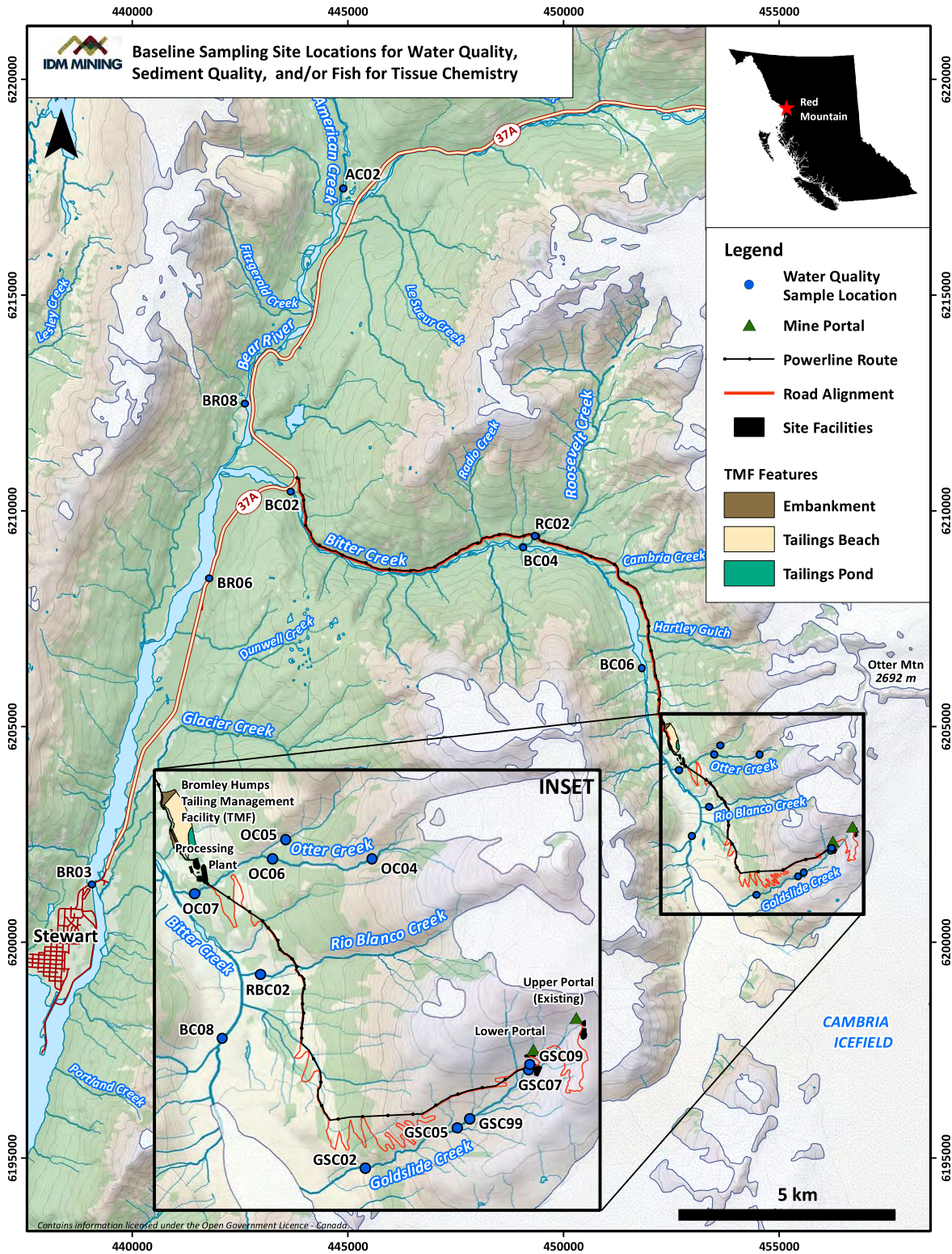


Figure 12: Surface Water, Sediment, and Fish Tissue Sample Locations

## 6.3.5 Sediment

### 6.3.5.1 Baseline Conditions

Sediment sample data were available for eight locations: AC02 in American Creek; BR06, BR08, in the Bear River; BC02, BC04, BC08, in Bitter Creek; and GCS05 and GCS02 in Goldslide Creek (Figure 12). At each location, multiple replicate samples were collected (Volume 8, Appendix 18-A). During the 2014 sampling period, completed by SNC-Lavalin, three samples were collected at each site, while for the 2016 sampling period, five replicates were collected at each location (Volume 8, Appendix 18-A). Summary statistics for sediment data are provided in Attachment B, Table B23. It should be noted that the sediment sampling program was purposely biased to depositional areas where fine sediments are present. This is because heavy metals are more likely to be present at these locations, and to be in the finer sediments. Methods for baseline sediment quality monitoring and QA/QC is presented in Volume 8, Appendix 18-A, Section 2.

### 6.3.5.2 Predicted Future Conditions

Predictive modelling of sediment concentrations was completed in two steps and followed the approach in Volume 3, Chapter 14. The first step determined the extent of change in surface water concentration from baseline conditions to the Operations Phase, and Reclamation and Closure/ Post-Closure phases. The second step involved applying that relative change to baseline sediment conditions to predict future sediment concentrations. The maximum predicted sediment concentrations from three sediment sample locations (BR06, BC02, and BC06) were used to screen sediment (Attachment A, Table A10).

### 6.3.5.3 Sediment Screening Levels

As there are no sediment screening levels for direct contact with humans, soil screening levels were used as surrogates for sediment screening levels. The soil screening levels are presented in Attachment A, Table A4.

### 6.3.5.4 Identification of Sediment COPCs

Sediment COPCs were identified by comparing the 95<sup>th</sup> percentile baseline concentrations and the maximum predicted future sediment concentrations to sediment screening levels. The essential nutrients calcium and potassium were not carried forward as COPCs since they are generally only toxic at extremely high concentrations. The concentrations of magnesium and titanium in sediment were also not carried forward as COPCs as the concentrations were much lower than the average concentrations in the earth's crust (23,300 mg/kg for magnesium and 5,650 mg/kg for titanium, respectively; Wedepohl 1995). These constituents are also known to have low toxicity. Although mercury and cadmium did not exceed their screening levels, they were included as COPCs because of their potential for biomagnification in the food chain.

The sediment COPCs carried forward for further consideration in the HHRA are presented in Attachment A, Table A10. Eleven COPCs were identified in sediment: arsenic, barium, bismuth, cadmium, cobalt, copper, iron, lead, manganese, mercury, and selenium.

### 6.3.6 Country Foods

Country foods include a wide range of animal, plant, and fungi species harvested for medicinal or nutritional use. The primary objective when assessing risk from ingestion of country foods is identifying the most relevant country foods to evaluate. Key considerations when selecting country foods included:

- Which country foods are currently hunted/harvested in the Human Health RSA;
- Whether representative country food species are co-located within areas predicted to be affected by potential Project-induced releases;
- How are the country foods used (i.e., food, medicine, or both);
- What part(s) of the country foods are consumed (i.e., specific organs, plant leaves or roots);
- What quantities of country foods are consumed; and
- What the consumption frequencies are for each country food.

The *Food Nutrition & Environment Study* by Chan *et al.* (2011) lists over 200 traditional foods that are consumed by Aboriginal Groups in British Columbia. The Human Health spatial boundaries (LSA/RSA) overlap with Ecozones 4 and 6 (Figure 13). Ecozone 4 information was used as the basis for the selection of species consumed by Aboriginal and non-Aboriginal persons. Table 1 presents a list of foods that IDM understands to be consumed by Aboriginal persons in Ecozone 4, Ecozone 6, and BC in general.

**Table 1: Seasonal frequency of top ten consumed traditional food items for consumers and non-consumers combined, based on average days per year.**

BC FN living on-reserve			Ecozone 4 BC FN living on-reserve			Ecozone 6 BC FN living on-reserve		
Traditional Food	Percent consumers	Average days per year	Traditional Food	Percent consumers	Average days per year	Traditional Food	Percent consumers	Average days per year
Salmon (any type)	92	47	Moose meat	94	86	Salmon (any type)	98	63
Moose meat	60	28	Soapberries	57	14	Salmon, Sockeye	88	33
Salmon, Sockeye	79	27	Blue huckleberry	80	14	Eulachon grease	57	21
Deer meat	52	19	Salmon (any type)	64	11	Halibut	82	16
Eulachon grease	35	12	Trout (any type)	61	9	Laver seaweed	57	15
Halibut	55	10	Balsam pitch	8	9	Moose meat	48	13
Salmon, Chinook (King/Spring)	43	9	Red willow root	7	8	Salmon, Chinook (King/Spring)	45	11

BC FN living on-reserve			Ecozone 4 BC FN living on-reserve			Ecozone 6 BC FN living on-reserve		
Traditional Food	Percent consumers	Average days per year	Traditional Food	Percent consumers	Average days per year	Traditional Food	Percent consumers	Average days per year
Laver seaweed	34	9	Poplar (cottonwood) inner bark	4	7	Blackberry, large (himalyan)	51	10
Blueberries (Alaska, oval leaved, bog)	36	7	Salmon, Sockeye	32	6	Prawn	53	9
Soapberries	34	6	Black bear fat	21	6	Clams (any type)	73	8

The top ten traditional food items consumed by Aboriginal Groups living in Ecozone 4 (Project area) as reported in the *Food Nutrition & Environment Study* by Chan *et al.* (2011) include mammals, fish, and vegetation:

1. Moose meat
2. Soapberries
3. Blue huckleberry
4. Salmon (any type)
5. Trout (any type)
6. Balsam pitch
7. Red willow root
8. Poplar (cottonwood) inner bark
9. Salmon (Sockeye)
10. Black bear fat

As it is rarely possible to assess all potential country foods, one representative species is usually selected as a surrogate from each of the following groups of foods: large mammals, small mammals, birds, fish, and vegetation. If representative foods are determined to be safe for consumption, then all other foods within the group would also be considered safe for consumption.

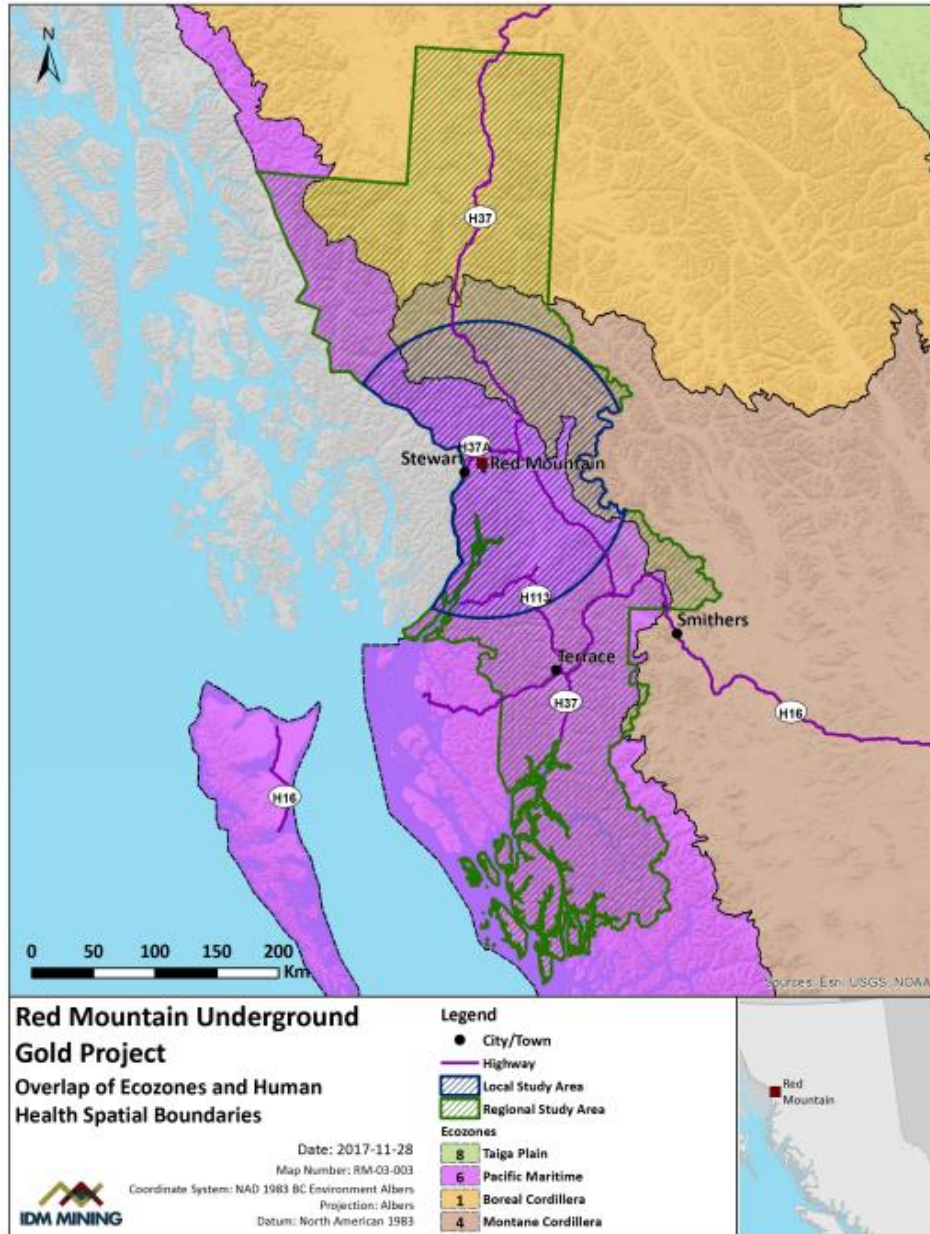
Moose, hare, and grouse, respectively, were the large mammal, small mammal, and bird country foods consumed in the greatest amount by Aboriginal Groups in Ecozone 4 (Chan *et al.*, 2011). Salmon (any type) was the fish consumed in the greatest amount by Aboriginal Groups in the RSA. Berries were the type of vegetation consumed in the greatest amount by Aboriginal Groups. All of these country foods are present in the Bitter Creek watershed portion of the LSA and it is assumed they will be exposed to COPCs released by the Project.

Based on the information presented above, moose, hare, grouse, Dolly Varden, and Sitka willow, were the surrogate country foods selected to represent food consumption by Aboriginal and non-Aboriginal



receptors for the large mammal, small mammal, bird, fish, and vegetation food groups, respectively. Sitka willow was selected based on its importance to moose as a food source and its tendency to bioaccumulate metals at higher concentrations than berries; willow and berry metal concentration data from two projects in the same geographic region (Brucejack - Rescan 2013a; KSM – Rescan 2013b) indicate that most metal concentrations in leaves tend to be at least 100% higher than concentrations in berries. Therefore, the use of willow is a more conservative estimate of human health risk than the analysis of berries.

Figure 13: Overlap of Ecozones and Human Health Spatial Boundaries.



### 6.3.6.1 Baseline Conditions

To support food chain modelling of wildlife species, plant leaves (Sitka willow) and fish (Dolly Varden) samples were collected from the LSA (Volume 8, Appendices 9-A, Section 5.7 and 18-A, Section 3.6.2). Metal concentration data from 7 plant tissue samples (Figure 11) and 56 fish tissue samples (Figure 12) formed the basis for assessing exposure to COPCs via country foods, under baseline conditions. Plant tissue, surface water, and soil sample data were used for inputs to the food chain model to estimate concentrations of metals in moose, hare, and grouse under baseline conditions. A detailed description of the modeling used to estimate country foods is provided in Section 7.1.6.

Methods for baseline plant tissue monitoring is presented in Volume 8, Appendix 9-A, Section 7.1.6. Methods for baseline fish tissue monitoring and QA/QC is presented in Volume 8, Appendix 18-A, Section 2. Whole body fish tissue analysis was completed for fish (personal communication May Mason 2017); fork lengths of sampled fish ranged from 87 to 260mm, the upper end of which are potentially consumed.

### 6.3.6.2 Predicted Future Conditions

Concentrations of plants and fish, under future conditions, were estimated from bioconcentration factors based on sample data for plants and fish; whereas, concentrations of moose, hare, and grouse, under future conditions, were estimated using biotransfer factors in the food-chain model. A summary of the bioconcentration and biotransfer factors is provided in Sections 7.1.4 to 7.1.6

### 6.3.6.3 Country Foods Screening Levels

Country foods screening levels were derived using an approach developed for deriving action levels for fish advisories (OHA 2016). Separate country foods screening levels were derived for fish and plants, given the differences in consumption rates for these two food sources. The following equation was used for determining tissue screening levels for non-carcinogenic toxicological endpoint for humans:

$$SL = 0.2 \times \frac{(TDI \times BW)}{IR}$$

Where:

- SL = Screening Level (mg/kg)
- TDI = Tolerable Daily Intake (mg/kg-day) (chemical-specific)
- BW = Body Weight (kg) = 70.7kg for adults and 16.5kg for toddlers
- IR = Fish/ Plant Ingestion Rate (kg/day) = 0.29 kg/day for adults and 0.091 kg/day for toddlers

The following equation was used for determining country foods screening levels for carcinogenic effects:

$$SL = \frac{\left(\frac{ARL}{CSF} \times BW\right)}{IR} \times ADAF$$

Where:

- SL = Screening Level (mg/kg)
- ARL = Acceptable Risk Level (unit less) =  $1 \times 10^{-5}$
- CSF = Cancer Slope Factor (mg/kg-day)<sup>-1</sup>
- ADAF = Adjusted Age Dependent Adjustment Factor<sup>1</sup>
- BW and IR are the same as above

The country foods screening levels are presented in Attachment A, Table A11.

### 6.3.6.4 Country Foods COPCs

To identify COPCs in country foods screening levels developed for country foods were compared to the maximum concentrations measured in country foods when available. If the maximum concentration for a chemical was greater than its screening level, the chemical was considered to be a country food COPC as shown in Attachment A, Table A12. This was only possible for fish and plants as no tissue data was available for the other country foods (moose, hare, and grouse). Constituents with tissue concentrations greater than their respective screening levels were considered to be country foods – fish COPCs.

For moose, hare, and grouse COPCs identified in soil, surface water, and country foods fish and plant were also carried forward as country food COPCs for moose, hare and grouse.

### 6.3.7 Identified COPC

COPCs in Environmental Media are summarized in Table 2.

**Table 2. Summary of COPCs in Environmental Media**

Constituent	Soil	Surface Water	Country Foods	Groundwater	Sediment	Air
Aluminum		X	X			
Antimony		X	X	X		
Arsenic	X	X	X	X	X	
Barium			X		X	
Bismuth	X	X	X		X	
Boron			X			
Cadmium	X	X	X	X	X	
Chromium		X	X			
Cobalt		X	X	X	X	
Copper					X	
Iron	X	X	X		X	
Lead		X	X		X	

<sup>1</sup> The ADAF adjusts the toxicity value to take into account the age-dependent sensitivity to carcinogens. Both toddler (5) and adult (1) ADAFs were used.



Constituent	Soil	Surface Water	Country Foods	Groundwater	Sediment	Air
Manganese		X	X	X	X	
Mercury	X	X	X	X	X	
Molybdenum						
Nickel			X			
Nitrate				X		
Selenium	X	X	X	X	X	
Strontium			X			
Tellurium	X		X			
Thallium		X	X			
Uranium			X			
Vanadium		X	X			
Zinc			X			

## 6.4 Receptors of Concern (ROCs)

The selection of ROCs considered the known or reasonably-anticipated types of human activities in the LSA. Although relatively close to Stewart, the Project area is quite remote, and the majority of the area is high alpine. An existing access road from Highway 37 extends for approximately 13 km along the Bitter Creek valley, close to the location of the proposed Processing Plant and TMF, but stops short of the proposed mine site, which is currently accessible by foot or helicopter. Hiking, hunting, trapping, and fishing, however, are known to occur in the LSA. Dolly Varden are present in the lower reaches of Bitter Creek and associated tributaries. Currently, the closest dwelling to the Project is in Stewart, BC. Other communities located near the Project include the following:

- Gitlaxt'aamiks: approximately 170 km from Stewart by road;
- Gitwinksihlkw: approximately 180 km from Stewart by road;
- Laxgalts'ap: approximately 215 km from Stewart by road;
- Gingolx: approximately 245 km from Stewart by road;
- Terrace: approximately 240 km from Stewart by road;
- Smithers: approximately 270 km from Stewart by road; and
- Hyder, Alaska: approximately 4 km from Stewart by road.

The NLG has indicated that that Nisga'a citizens have the right to reside in the watershed and be safe from any chemical contamination. As such, Nisga'a citizens and Aboriginal Group members in general, have been carried forward for consideration in the HHRA. Although not explicitly stated throughout the HHRA, the ROCs were identified with Aboriginal Groups members in mind, however, non-Aboriginals Group members are also included as potential ROCs.

- Hunter/Trapper/Fisher (teens and adults);
- Guide/Outfitter (teens and adults);
- Recreational User (infants, toddlers, children, teens, and adults);
- Summer Resident (infants, toddlers, children, teens, and adults);

- Year-Round Resident (toddlers and adults); and
- Country Food Consumer.

The hunter, trapper, and fisher are assumed to spend equal amounts of time in the Project area. During this period, the hunter or trapper may spend time overnight camping or may travel back to their homes. Hunters and trappers may eat the animals they catch. It is also possible that they may sell their catch to others. Fishers may do the same. No hunter or trapper cabins were identified in the watershed.

The guide/outfitter may take people into the Project area for hunting or for backcountry trekking. Outfitter cabins have been identified in the watershed. The recreational user (hiker/biker) hikes or rides the trails in the Bitter Creek watershed and are likely accompanied by guides unless they live in the area. There has been no documentation identified describing mountain biking in the watershed, but, guides are known to take hikers into the watershed. One hiking route takes people to the top of Otter Mountain.

The types of exposures for the guide/outfitter and the hunter/trapper/fisher are likely to be similar; however, the hunter/trapper/fisher are likely to spend more time in the watershed. Therefore, the hunter/trapper/fisher was carried forward as the ROC for quantitative evaluation in the HHRA. The assumption being that if the risk to the hunter/trapper/fisher resulting from exposure to Project stressors was acceptable, then the risk to the guide/outfitter would also be acceptable.

The recreational (hiker/biker) exposures may differ from those of the hunter/trapper/fisher, although of a shorter duration. As their exposure type may differ, the recreational user was carried forward for quantitative evaluation in the HHRA.

As noted above no residents, hunter cabins, or trapper cabins are present in the Bitter Creek watershed. The closest residence is located in Stewart, BC. However, based on the assertion that Nisga'a citizens should be able to hunt, trap, fish, gather food, and/or live in the Bitter Creek watershed for seasonal living in the Project vicinity, a summer and year-round resident were also included for quantitative evaluation in the HHRA. However, no known residences are present in the vicinity of the Project at this time.

## 6.5 Exposure Pathways

The potential exposure pathways and routes considered in the HHRA for both the baseline conditions and predicted future conditions in the LSA include the following:

- Inhalation of air;
- Incidental ingestion of and dermal contact with soil;
- Ingestion and dermal contact with surface water;
- Ingestion and dermal contact with groundwater;
- Incidental ingestion and dermal contact with sediment; and
- Consumption of Country Foods mammals, birds, plants, and fish.

Each of these potential exposure pathways are discussed below:

- **Exposure to contamination in air via inhalation.** Air quality in the Bitter Creek watershed portion of the LSA may be affected by the emissions of particulate (i.e., fugitive dust) from mining operations, roadways and waste rock, and emissions of particulate and non-particulate from the processing plant. However, no air COPCs were identified in predicted future conditions resulting from the Project. Therefore, the air inhalation exposure pathway was considered to be incomplete.
- **Exposure to contamination in soil via incidental ingestion, and dermal contact.** Soil quality in the Bitter Creek watershed portion of the LSA may be affected by the deposition of COPCs in air particulate that resulted from project emissions. Modelling indicates that there is a potential for air particulate deposition to increase soil COPC concentrations above their soil screening levels and at concentrations more than 1% above local background concentrations. Therefore, the exposure pathways between soil and receptors using the watershed were considered complete.
- **Exposure to contamination in surface water via incidental ingestion and dermal contact.** There are several waterbodies in the LSA that may be affected by the proposed Project. Furthermore, surface water may be used as a drinking water source in the LSA by recreational users, hunters/trappers/ fishers, and by future summer residents. Therefore, the exposure pathways between surface water and receptors were considered complete.
- **Exposure to contamination in groundwater via ingestion and dermal contact.** Groundwater at the LSA is currently not used for drinking water, and its future use as a drinking water source in the Bitter creek watershed is not anticipated in the two areas with the potential to be adversely affected by the Project (the Mine Site and the TMF). Groundwater wells installed at these two areas had relatively low hydraulic conductivity, ranging from  $7.4 \times 10^{-9}$  m/s to  $2.9 \times 10^{-5}$  m/s, with a geometric mean of  $3.0 \times 10^{-7}$  m/s, which is insufficient to provide adequate water to supply one home. Furthermore, these two high alpine locations are quite remote. It is recognized that remoteness in itself is not enough to discount future use of groundwater and that hydraulic conductivity, by itself, should not be used to determine water availability in bedrock environments. However, the combination of these factors makes it unlikely that groundwater will be used for drinking water in the area. Therefore, the exposure pathways between groundwater and receptors were considered incomplete.
- **Exposure to contamination in sediment via incidental ingestion and dermal contact.** There are several surface water bodies (creeks) in the LSA. However, it is unlikely that significant exposure between sediment and ROCs will occur. Creeks in the LSA are very cold and are unlikely to be used for swimming or wading, based on information gleaned during early and ongoing community engagement. Sediment exposure may occur as a result of harvesting shellfish. Shellfish were not identified as being present in the creeks of Bitter Creek Valley. Minor sediment dermal exposure to hands may occur when handling fish during fishing. Sediment exposure while fishing for Dolly Varden was considered to be negligible. Exposure to contaminants via sediment exposures are being evaluated via the food chain. Exposure to suspended sediment was evaluated as part of the exposure to surface water. Therefore, the exposure pathways between receptors and sediment were considered to be incomplete.
- **Exposure to contamination in country foods via ingestion.** Hunting, trapping and fishing is known to occur in the LSA. Plants, mammals, and birds may be exposed to elevated

concentrations of COPCs in soil as a result of project emissions. Fish, mammals, and birds may be exposed to elevated concentrations of COPCs in surface water in the future. The potential exists for elevated tissue concentrations in plants, fish, mammals, and birds as a result of exposure to elevated COPC concentrations in soil and surface water in the Bitter Creek watershed portion of the LSA. Furthermore, human receptors consuming these types of country foods may be exposed to these elevated concentrations of COPCs. Therefore, the exposure pathways between receptors and country foods were considered to be complete.

To address the cumulative impact of COPC exposure to Aboriginal and non-Aboriginal receptors, if a COPC was identified in one exposure media it was evaluated in all exposure media this included air. Air was eliminated as an exposure media because no chemical exceeded their air screening levels and thus there was considered to be no source. However, air exposure will contribute to the exposure to COPCs identified in soil surface water and country foods. Therefore, for COPCs identified in other media (i.e., soil, surface water, country foods) the risk associated with exposure to those COPCs in air was also evaluated.

## 6.6 Conceptual Site Model

A conceptual site model for the Project that integrates potential sources of COPCs, ROCs, and complete exposure pathways identified during the problem formulation process is illustrated in Figures 14 and 15.

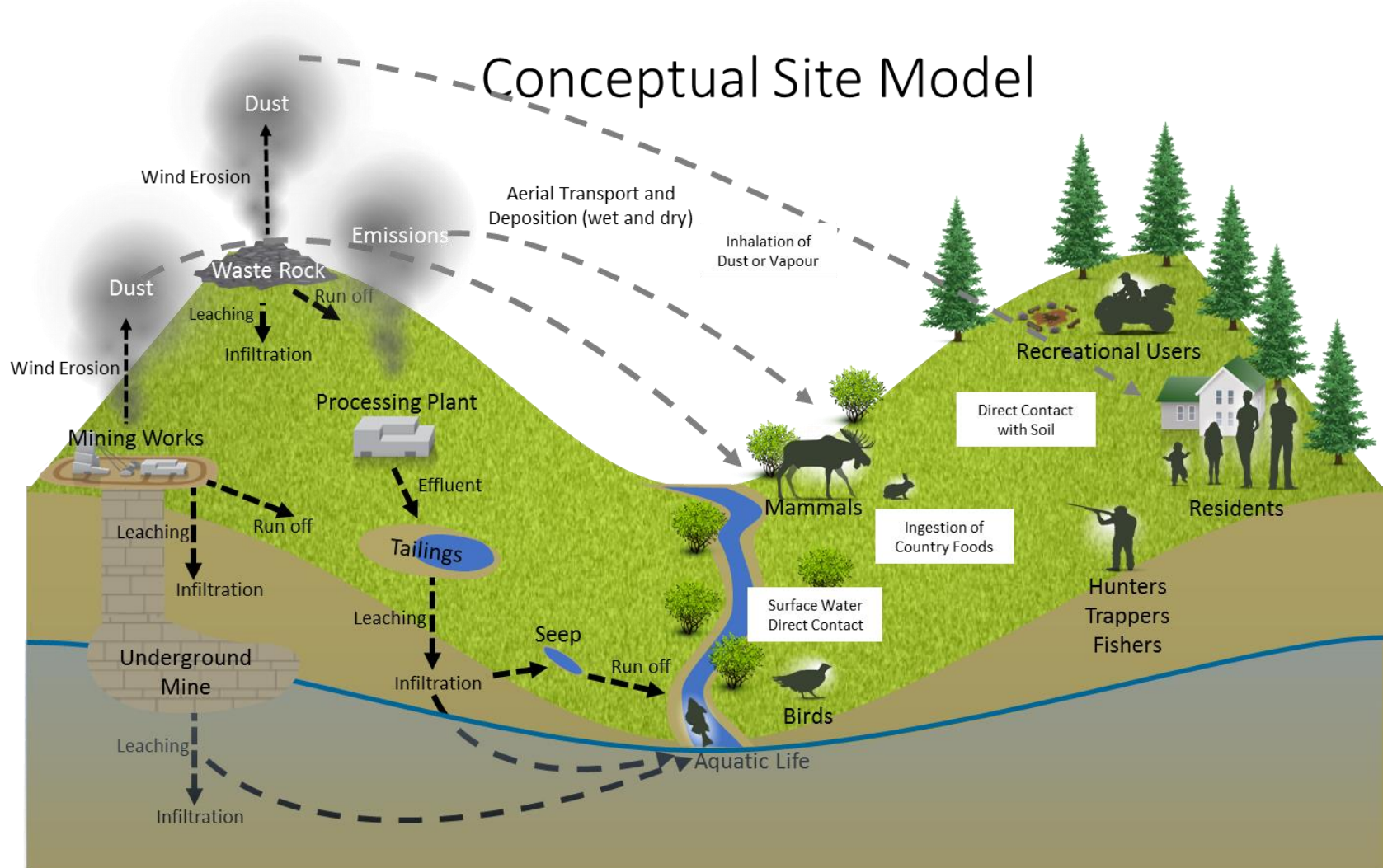
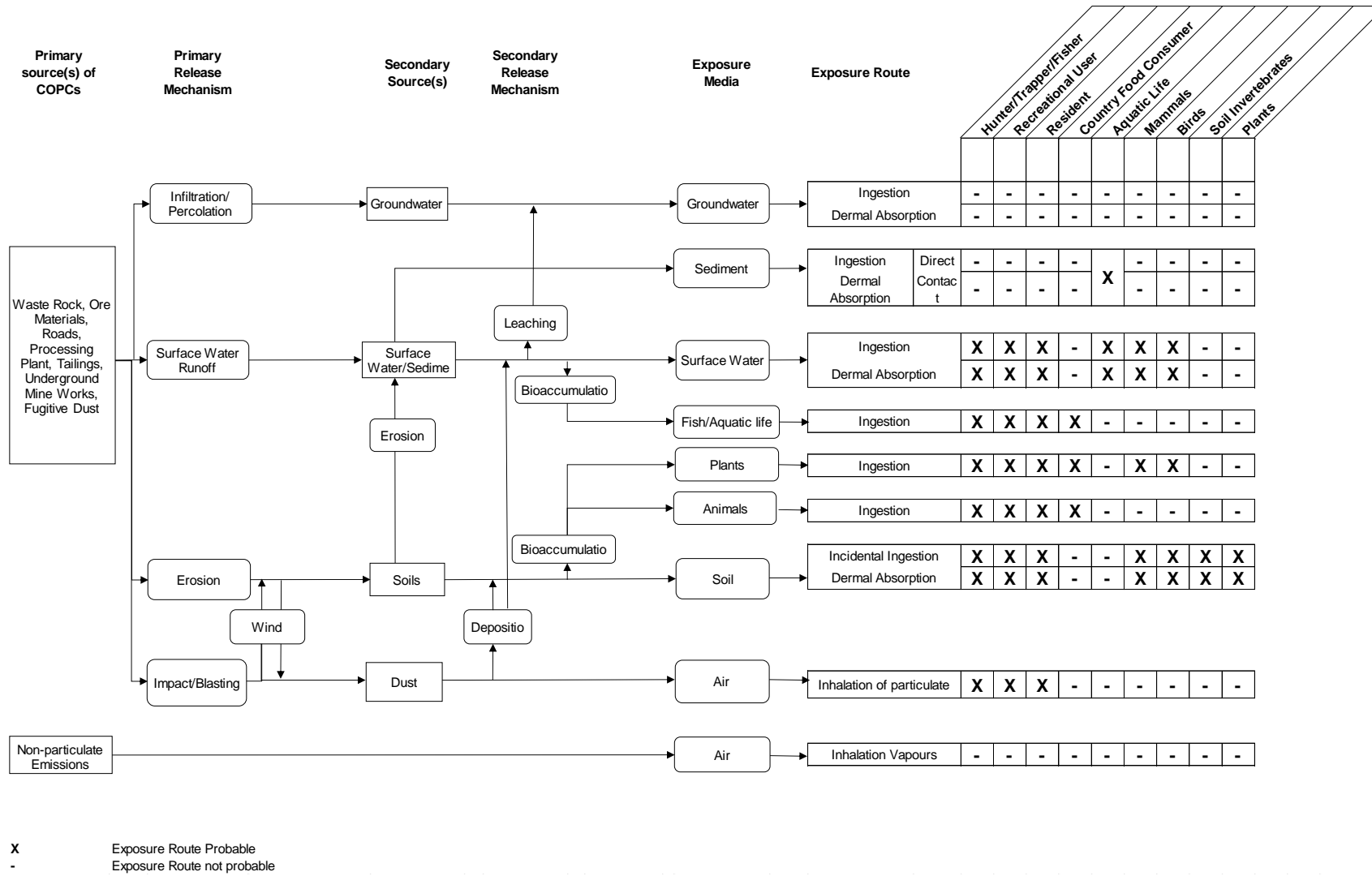


Figure 14: Human Health Conceptual Site Model: Red Mountain Underground Gold Project



X Exposure Route Probable  
 - Exposure Route not probable

Figure 15: Box and line Conceptual Site Model: Red Mountain Underground Gold Project



A summary of the problem formulation, outlining the COPCs, ROCs, and complete exposure pathways requiring further quantitative assessment in the HHRA, is presented in Table 3 (and in Attachment A, Table A13). All COPCs identified were metals.

**Table 3. Summary Table: Conceptual Site Model Elements**

Receptors of Concern	Complete Exposure Pathways	Soil COPCs	Surface Water COPCs	Country Food COPCs
Hunter/ Trapper/ Fisher, Recreational User, Summer and Year- Round Resident	Ingestion of Soil	Arsenic	Aluminum	Aluminum
	Inhalation of Air Particulate	Bismuth	Antimony	Antimony
	Dermal Contact with Soil	Cadmium	Arsenic	Arsenic
	Ingestion of Surface water	Iron	Bismuth	Barium
	Dermal Contact with Surface Water	Mercury	Cadmium	Bismuth
	Ingestion of Country foods	Selenium	Chromium	Boron
		Tellurium	Cobalt	Cadmium
			Iron	Chromium
			Lead	Cobalt
			Manganese	Iron
			Mercury	Lead
			Selenium	Manganese
			Thallium	Mercury
			Vanadium	Nickel
				Selenium
				Strontium
				Tellurium
				Thallium
				Vanadium
			Uranium	
			Zinc	

## 7 EXPOSURE ASSESSMENT

The objective of the exposure assessment was to evaluate the ways ROCs may be exposed (exposure pathways) to COPCs (source) and to what amount they could be exposed (dose). The exposure assessment follows Health Canada guidance and used reasonable maximum exposure (RME) methods. There are two primary tasks for an exposure assessment:

1. Determine the estimated environmental concentrations (EECs), at the points of potential human contact, for all identified COPCs. For the baseline condition, EECs for soil, surface water, fish, and plants were derived from measured concentrations, and EECs for air particulate and terrestrial country foods were estimated from models. Predicted future EECs for all exposure media were estimated from models.
2. Estimate the dose for operable exposure pathways of potentially exposed populations (receptor groups). The doses were estimated using EECs and RME assumptions for a variable such as exposure duration, ingestion rate and other parameters that describe human receptor group activities.

The HHRA does not consider all potential exposures to COPCs. It characterizes risk to human health associated with potential exposure to air, particulate, soil, surface water, and country foods that may be potentially contaminated as a result of the Project.

### 7.1 Estimated Environmental Concentrations

The EECs represent the chemical concentration in the exposure medium that the human receptor may potentially come into contact with during time spent in the LSA near the Project area (Bitter Creek watershed). The following section explains how the EECs were developed from measured data and models.

#### 7.1.1 Air

The baseline EECs for metals in air were based on baseline PM10 concentrations and represented by those concentrations acquired from other locations as discussed in Section 6.3.1 and presented in Attachment A, Tables A1 and A2. The predicted air concentrations were based on the maximum of the three PM10 metals in air concentrations discussed in Section 6.3.1.2 and presented in Attachment A, Table A2.

#### 7.1.2 Soil

Summary statistics (i.e., minimum, average, median, 75<sup>th</sup> percentile, 90<sup>th</sup> percentile, 95<sup>th</sup> percentile, and maximum) for the baseline soil sample data provided in the *Ecosystems, Vegetation, Terrain and Soils Baseline Report* (Volume 8, Appendix 9-A) and the *Geochemical Characterization of Waste Rock, Ore, and Talus* (Volume 7, Appendix 1-B), are provided in Attachment B, Table B1. Soil data from samples from than 0 – 2 cm and 0 - 20 cm were included in the baseline soil data set. The soil EEC for each COPC was based on the 95<sup>th</sup> percentile concentration. This is consistent with BCMOE's (2017) approach for

determining background soil quality. Predicted future soil EECs were estimated by adding predicted air particulate dustfall data to baseline EECs. The derivation of the predicted future soil EECs is provided in Attachment C, and EECs are provided in Attachment A, Table A3.

### 7.1.3 Surface Water

As noted above in section 6.3.3, surface water data provided in the *Baseline Surface Water and Ground Water Quality Report* (Volume 8, Appendix 14-A) were used to calculate baseline surface water EECs. Baseline data for 14 sample locations were available for this exercise. However, predicted unfiltered surface water concentration data were only available for 6 sample locations. Only data from these six locations were used to estimate baseline and predicted EECs, as it was only feasible to calculate incremental risk where predicted data were available. The six sample locations represent areas that may be affected by the proposed Project. The baseline EEC was the average of the P90 monthly concentrations across the six sample stations (Attachment B, Table B19). Unfiltered surface water concentrations were predicted for two scenarios: Operation Phase, and Reclamation and Closure / Post Closure Phases. The average of the monthly 90<sup>th</sup> percentile concentration across the six sample stations were predicted for each chemical, for each scenario (Attachment B, Table B20 and Table B21). The higher of the average P90 monthly concentrations for each chemical, for each scenario, was used as the predicted future EEC.

The surface water statistics are provided in Attachment B, Tables B2 to B21. The summary statistic used for the baseline EECs and predicted future EECs in surface water are provided in Attachment A, Table A14.

### 7.1.4 Country Foods – Fish

Summary statistics were developed from the baseline fish tissue data provided in the *Baseline Fisheries and Aquatic Resources* (Volume 8, Appendix 18-A). The 90<sup>th</sup> percentile COPC concentrations in Dolly Varden fish tissue were used as the EECs for the baseline condition (Attachment A, Table A15). As noted in Section 6.1.4, Dolly Varden served as a surrogate for salmon in the LSA. Exposure media concentrations used to estimate tissue concentrations for fish are presented in Attachment D, Tables D1 and D2. The predicted future EECs were estimated by multiplying fish bioconcentration factors (i.e.,  $BCF_{Fish}$ , expressed in wet-weight) by predicted future surface water EECs, as shown in the following equation:

$$C_{Fish-Predicted} = BCF_{Fishwwi} \times C_{w-Predicted}$$

Where:

$C_{Fish-Predicted}$  = Predicted future concentration of COPC “i” in fish mg COPC/kg fish; and  
 $C_{w-Predicted}$  = Predicted future concentration of COPC “i” in surface water

The  $BCF_{Fish}$  was estimated for each COPC from baseline conditions, and assumed to also apply to predicted future conditions, by dividing the mean Dolly Varden fish tissue COPC concentrations by the mean COPC surface water concentrations, as expressed by the following equation:

$$BCF_{Fishwwi} = C_{Fish} / C_{W_{Baseline}}$$

Where:

- $BCF_{Fishwwi}$  = Bioconcentration factor for COPC “i” in fish wet-weight (unitless);  
 $C_{Fish}$  = Concentration of COPC “i” in fish mg COPC/kg fish; and  
 $C_{W_{Baseline}}$  = Baseline concentration of COPC “i” in surface water

Surface water data from sample locations BR06, BR08, BC02, BC04, BC06 (Figure 12) were used to estimate the  $BCF_{Fish}$ . The fish BCFs and predicted fish tissue concentrations are provided in Attachment A, Table A16.

### 7.1.5 Country Foods – Plants

As noted above in section 6.1.4, Sitka tissue COPCs concentrations were used as a surrogate for berries. The maximum COPC concentrations in Sitka willow tissue were used as the plant tissue EEC for baseline conditions. Exposure media concentrations used to estimate tissue concentrations for plants are presented in Tables D1 and D2. The EECs for predicted plant concentrations were based on uptake from soil and direct deposition of particulate on the plants.

The contribution from soil was estimated by multiplying plant bioconcentration factors (i.e.,  $BCF_{Plant}$  in wet weight) by the predicted future soil EECs (USEPA 2005a), as expressed by the following equation:

$$C_{Plant-Predicted} = BCF_{Plantwwi} \times C_{W-Predicted}$$

Where:

- $C_{Fish-Predicted}$  = Predicted concentration of COPC “i” in plants mg COPC/kg plant; and  
 $C_{W-Predicted}$  = Predicted concentration of COPC “i” in soil.

The  $BCF_{plant}$  for each COPC was estimated from baseline conditions, and assumed to also apply to predicted future conditions, by dividing the mean Sitka willow plant tissue concentration by the mean soil concentration (Zaung 2007), as shown in the following equation:

$$BCF_{Plantwwi} = C_{Plant} / C_{Soil_{Baseline}}$$

Where:

- $BCF_{Plantwwi}$  = Bioconcentration factor for COPC “i” in plants dry-weight (unitless);  
 $C_{Plantsi}$  = Concentration of COPC “i” in plants mg COPC/kg plant; and  
 $C_{W_{Baseline}}$  = Baseline concentration of COPC “i” in soil.

Uptake from deposition of airborne particles was estimated using the following equation by USEPA (2005):

$$Pd = \frac{1000 \times D \times Rp \times (1 - \exp(-kp \times Tp))}{Yp \times kp}$$

Where:

- $Pd$  = Plant (aboveground) concentration due to direct deposition (mg/kg DW)  
 1000 = Units conversion factor (mg/kg)  
 $D$  = Annual deposition rate ( $g/m^2 \cdot y$ )  
 $Rp$  = Interception fraction of the edible portion of plant (unit-less)

kp	= Plant surface loss coefficient (yr <sup>-1</sup> )
Tp	= Length of plant exposure to deposition per harvest of the edible portion of the plant (yr)
Yp	= Yield or biomass of the edible portion of the plant (productivity) (kg DW/m <sup>2</sup> )

The annual deposition rate and concentration of metals are provided in Attachment D, Table D2. The interception fraction of the edible portion of the plant (Rp) was set 0.05, which is based on a weighted average of class-specific values as recommended by the US EPA (2005) for mixtures of plant species. The plant surface loss coefficient (kp) was set to the default value of 18 year<sup>-1</sup> recommended by the US EPA (2005). The length of plant exposure to deposition per harvest of the edible portion of the plant (Tp) was set to one month per year. The yield or standing crop biomass of the edible portion of the plant (Yp) was set to 2.24, which the US EPA (2005) recommends for exposed fruits and vegetables.

Predicted plant tissue concentrations are provided in Attachment A, Table A17. Plant BCF values are provided in Attachment D, Table D3.

### 7.1.6 Country Foods – Moose, Hare, and Grouse

Moose, hare, and grouse tissue EECs for both the baseline and predicted future conditions were calculated using a methodology described in USEPA (2005), which incorporates exposure to COPCs via wildlife consumption of soil, surface water and food items. Attachment D provides the detailed country foods calculations. For the baseline condition, measured concentrations in soil, plants and surface water were used. For predicted future conditions, concentrations in exposure media and plants were estimated based on the methodologies described in Sections 7.1.1, 7.1.2, 7.1.3, 7.1.4, and 7.1.5, respectively. To calculate the tissue EECs for moose, hare, and grouse, a COPC-specific biotransfer factor (BTF) was multiplied by the estimated daily dose of a COPC (mg of COPC/day) from food (e.g., plant food items), soil, and water:

$$C_{animal} = BTF_a \times \sum (C_{Fi} \times P_{Fi} \times F_{Fi} \times FIR) + (C_{soil} \times SIR \times P_{soil} \times BCF_{soil}) + (C_{water} \times WIR)$$

Where:

C <sub>animal</sub>	= COPC concentration in moose, hare, or grouse (mg/kg);
BTF <sub>a</sub>	= adjusted BTF for fat content of tissue ([mg/kg-tissue] / [mg/day]);
C <sub>Pi</sub>	= COPC concentration in plant food item “i” (mg/kg);
P <sub>Fi</sub>	= proportion of food item “i” in diet (unitless);
F <sub>Fi</sub>	= fraction of diet consisting of food item “i” (unitless);
FIR	= food ingestion rate (kg/day);
C <sub>soil</sub>	= COPC concentration in surficial soil (mg/kg);
SIR	= soil ingestion rate (kg/day);
P <sub>soil</sub>	= proportion of soil in diet (unitless);
BCF <sub>soil</sub>	= bioconcentration factor for COPC “i” in dry-weight (unitless);
C <sub>water</sub>	= COPC concentration in water (mg/L); and
WIR	= water ingestion rate (L/day).

Species-specific BTFs were acquired from ORNL (2017) and are provided in Attachment D, Table D3.

The proportion of plant food items in the diet was 100%, 100%, and 99% for moose, hare, and grouse, respectively. The proportion of incidental soil ingestion varied for these receptor groups. Moose and hare were reported to have 2% and 6% incidental soil ingestion, respectively (Environment Canada 2014). The incidental soil ingestion for grouse was not available; therefore, an assumption that 2% of the diet comprised incidental soil ingestion was made based on provincial (BCMELP 2000) guidance.

Moose are known to uptake contaminants into their organs at concentration than present in muscle. This is particularly true for certain metals including arsenic, cadmium and, to a lesser degree, mercury. Data from Chan et al. (2011) for arsenic, cadmium, and mercury in kidney, liver and meat were used to develop relative ratios of concentration in each organ. Modelled concentrations of these metals in moose muscle conducted for this HHRA served as the base concentration to which Chan et al. (2011) ratios were normalized. These concentrations were summed and then divided by the mass of the consumption rate of each organ to get a weighted moose meat concentration that includes the consumption of organs.

As noted in section 7.1.5, Sitka willow tissue COPCs concentrations were used as a surrogate for plants. The maximum COPC concentrations in Sitka willow tissue were used as the plant tissue EEC for baseline conditions. The EECs for predicted future conditions were estimated by multiplying plant bioconcentration factors.

As noted in section 7.1.2, the 95<sup>th</sup> percentile concentrations were used as the soil EEC for baseline conditions. The EECs for predicted future conditions were estimated by adding modelled air particulate dustfall data to baseline EECs.

As noted in section 7.1.3, the baseline and predicted future EECs in surface water were based on the 90<sup>th</sup> percentile of the COPC concentrations.

Grouse were assumed to have approximately 1.4% invertebrates in its diet. The EECs for invertebrates were estimated by multiplying invertebrate bioconcentration factors (i.e.,  $BCF_{Invert}$  in dry weight) by the baseline and predicted future soil EECs (USEPA 2005a), as expressed by the following equation:

$$C_{Invert} = BCF_{Invert} \times C_{Soil}$$

Where:

$C_{Invert}$  = Concentration of COPC "i" in invertebrates (mg COPC/kg); and  
 $C_{Soil}$  = Concentration of COPC "i" in soil.

Predicted invertebrate tissue concentrations are provided in Attachment A, Table A18. Invertebrate BCF values were acquired from USDOE (1999) and are provided in Attachment D, Table D3.

## 7.2 Receptor Exposure Factors

Receptor Exposure factors consist of receptor type and age-specific characteristics as well as exposure assumptions associated with the duration and frequency of time spent in the LSA near the Project area (Bitter Creek watershed). The following section explains how the receptors characteristics and exposure assumptions were developed and provides a summary of the values used to model exposure.



### 7.2.1 Receptor Characteristics

The receptor characteristics used for the ROCs (i.e. hunter/trapper/fisher, recreational user, and summer resident) were generally obtained from Health Canada (2012a,b) and are provided below in Table 4.

**Table 4: ROC Exposure Characteristics**

Exposure Characteristic/Receptor Type	Infant	Toddler	Child	Teen	Adult
Age group duration	0 – 6 months	7 months – 4 years	5 – 11 years	12 – 19 years	>= 20 years
Years	0.5	4.5	7	8	60
Body weight (kg)	8.2	16.5	32.9	59.7	70.7
Soil ingestion rate (kg/d)	0.00002	0.00008	0.00002	0.00002	0.00002
Inhalation rate (m <sup>3</sup> /d)	2.1	8.3	14.5	15.6	16.6
Water ingestion rate (L/d)	0.3	0.6	0.8	1	1.5
Skin surface area (cm <sup>2</sup> )					
- hands	320	430	590	800	890
- arms	550	890	1480	2230	2500
- legs	910	1690	3070	4970	5720
- hands+legs+arms	1780	3010	5140	8000	9110
Total Body	3620	6130	10140	15470	17640
Soil loading to exposed skin (kg/cm <sup>2</sup> /event)					
- hands	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
- surfaces other than hands	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08
First Nations food ingestion (kg/d)*					
- plants/berries	0	0.091	0.134	0.188	0.2903
- fish	0	0.091	0.134	0.188	0.2903
- other country foods	0	0.091	0.134	0.188	0.2903

\* Modified values based on Chan *et al.* (2011).

The ingestion rates of fish and wild game country foods were based on the 95<sup>th</sup> percentile consumption rate for adults of 290.3 grams/ person/ day provided in *Food Nutrition & Environment Study* by Chan et al. (2011), which is higher than the rate recommended by Health Canada (2012a,b). In order to include equivalent (i.e., higher) rates for the other age groups, the ratio of the adult rates (equal to 1.075) between Chan et al. (2011) and Health Canada (2012a,b) was used to adjust the Health Canada rates for the other age groups. This ratio was also used to adjust the plants/berries consumption rate from Health Canada (2012a,b). It was assumed that the infant did not eat country foods.

## 7.2.2 Exposure Assumptions

The receptor exposure assumptions used for the ROCs (i.e., hunter/trapper/fisher, recreational user, and summer and year round resident) are provided below in Table 5. The assumptions considered in the selection of the exposure assumptions were conservative to account for the variability of the ROC's exposure to COPCs, and are based on Health Canada guidance (Health Canada 2012a,b).

The hunter trapper/fisher receptor was assumed to be exposed to COPCs in soil and air particulate from the Project area while in the LSA, via the incidental ingestion, dermal contact, and inhalation of particulate pathways, for a total of 8 weeks per year, over a period of 3 months in the year. While in the LSA it was assumed that creek surface water was used for drinking water.

The recreational user, specifically, persons that utilize the watershed for recreational, hunting, fishing, camping, and hiking, among other activities, was assumed to be present in the Bitter Creek watershed for 3 weeks per year, over a period of 3 months in the year (likely associated with favourable weather). This could occur during one or over several visits. While in the LSA they have direct contact with soil via incidental ingestion, dermal contact, and inhalation of air particulate. It was assumed that camping could occur within the LSA, but not within the gated Project area, and creek surface water would be used for drinking water.

The hypothetical summer resident was assumed to live in the lower part of the Bitter Creek watershed within the LSA for up to 3 months of the year, over a period of 6 months in the year. The hypothetical year round resident was assumed to live in the lower part of the Bitter Creek watershed within the LSA for the entire year. While in the LSA they have direct contact with soil via incidental ingestion, dermal contact, and inhalation of air particulate, and creek surface water was used for drinking water.

The country food consumer does not spend any time in the Bitter Creek watershed but eats country food harvested from the watershed three times per week.

**Table 5: ROC Exposure Durations and Frequency Assumptions**

ROC	Hours per day	Hours per day outside	Days per week	Weeks per year	Dermal exposure events per day	Days/year of contaminated food ingestion
Trapper/ Hunter/Fisher	24	24	7	8	1	56
Recreational User	24	24	7	3	1	21
Summer Resident	24	24	7	13	1	91
Potential Year-Round Resident	24	24	7	52	1	365
Country Food Consumer	24	24	7	26	0	182

### 7.3 Dose Estimates

For ingestion and dermal contact exposure pathways, intake of COPCs by potentially exposed receptors was calculated by estimating the mass of COPC taken into the body per unit body weight per unit time (mg per kilogram of body weight per day [mg/kg-day]). For the inhalation exposure pathway, the intake of COPCs by potentially exposed receptors was calculated by estimating a time-weighted exposure concentration that takes into account the exposure time, frequency, and duration for each receptor as well as the period over which the exposure is averaged (i.e., the averaging time). The dose for each exposure pathway for each receptor was calculated using the media specific equation below. The equations are based on the exposure characteristics and exposure frequency and duration assumptions provided in Tables 4 and 5.

For non-cancer COPCs, the dose is averaged over the duration of the exposure to the COPC. For evaluation of carcinogenic COPCs, the dose is averaged over the entire lifetime. The calculated carcinogenic dose for the adult recreational receptor is greater than the carcinogenic dose for the toddler recreational receptor because the length of exposure is greater for the adult compared to the toddler while the averaging time term is the same. In contrast, for non-cancer exposures, the dose for the child is greater than the dose for the adult because the averaging time terms are based on the exposure duration. As a result, the non-cancer hazards are greater for the child relative to the adult.

Incidental ingestion of soil is assumed to occur daily when receptors are in the Bitter Creek watershed. Health Canada recommendations were used in calculating the chemical intake from ingestion of soil. The daily soil consumption rates ranged from 20 mg/day for the infant, child, teen, and adult to 80 mg/day for the toddler (Health Canada 2012; Table 4).

Ingestion of surface water is assumed to occur through daily water consumption when receptors are in the Bitter Creek watershed. Health Canada recommendations were used in calculating the chemical intake from ingestion of surface water. Surface water in the watershed was assumed to be the only source of water for potentially exposed populations when they are in the watershed. The daily water consumption rates ranged from 0.3 litres/day for the infant to 1.5 liters/day for the adult (Health Canada 2012a,b; Table 4).



Exposure to COPCs in air particulate, via inhalation, occurs when receptors are in the Bitter Creek watershed, and is dependent on the inhalation rate (Table 4) and the exposure duration (Table 5).

The ingestion of country foods is assumed to occur through daily country food consumption by receptors when they are present in the Bitter Creek watershed. Country foods may also be ingested by non-users of the watershed. Human receptors that hunt, fish, trap, and or gather berries in the watershed may give or sell their harvest to family, friends, or others. The exposure duration was 6 months per year, amortized over 1 year. The ingestion rates of country foods ranged from 91 to 290.3 grams/day (Table 5).

As noted above, arsenic is a COPC in fish and mammal tissue. However, the arsenic that is present in fish tissue is mostly in a relatively non-toxic, organo-arsenic form. Forms of organic arsenic include arsenobetaine, monomethylarsenic acid (MMA), dimethyl arsenic acid (DMA), arsenocholine, arsenosugars, and arsenolipids (Schoof et al. 1999). Numerous studies have measured the fraction of total arsenic in fish that exists as inorganic (toxic) arsenic (e.g., Yost et al. 1998; Schoof et al. 1999; WHO 2001; USEPA 2005b). Most measured values of inorganic arsenic in fish are below 1% (WHO 2001). However, for this HHRA, it was assumed that inorganic arsenic was 10% of the total arsenic measured in fish tissue samples (as per the work completed by the US EPA and discussed in Schoof and Yager (2007).

COPC dose estimates for each of the ROC exposure pathways were quantified using equations from Health Canada (2012a,b) and are presented below in the following sections.

Dose estimates are combined with toxicity reference values (TRVs) to evaluate hazard and risk to receptors assumed to be exposed to COPCs.

### 7.3.1 Air Exposure

#### 7.3.1.1 Dose Estimate for Inhalation of Airborne Particles (Fugitive Dust)

$$\text{Dose (mg/kg-day)} = \frac{C_{\text{Air}} \times IR_A \times RAF_{\text{Inh}} \times D_1 \times D_2 \times D_3 (\times D_4)}{BW(\times LE)}$$

Where:

Dose	= predicted chronic daily intake (mg/kg-day)
$C_{\text{Air}}$	= concentration of COPC in airborne dust (mg/m <sup>3</sup> )
$IR_A$	= ROC inhalation rate for fugitive dust (m <sup>3</sup> /hour)
$RAF_{\text{Inh}}$	= relative absorption factor from the respiratory tract (unit-less)
$D_1$	= hours per day exposed (hours/24-hour week)
$D_2$	= days per week exposed (days/7-day week)
$D_3$	= weeks per year exposed (weeks/52-week year)
$D_4$	= total years exposed (year)(for assessment of carcinogens only)
BW	= body weight (kg)
LE	= life expectancy (year) (for assessment of carcinogens only)

## 7.3.2 Soil Exposure

This section presents dose estimate equations for three soil exposure routes: inadvertent ingestion of soil, inhalation of soil particulate, and dermal contact with contaminated soil.

### 7.3.2.1 Dose Estimate for Inadvertent Soil Ingestion

$$\text{Dose (mg/kg-day)} = \frac{C_s \times IR_s \times RAF_{\text{Oral}} \times D_2 \times D_3 (\times D_4)}{BW (\times LE)}$$

Where:

Dose	= predicted chronic daily intake (mg/kg-day)
$C_s$	= concentration of COPC in soil (mg/kg)
$IR_s$	= ROC ingestion rate for soil (kg/day)
$RAF_{\text{Oral}}$	= relative absorption factor from the gastrointestinal tract (unit-less)
$D_2$	= days per week exposed (days/7-day week)
$D_3$	= weeks per year exposed (weeks/52-week year)
$D_4$	= total years exposed (year)(for assessment of carcinogens only)
BW	= body weight (kg)
LE	= life expectancy (year) (for assessment of carcinogens only)

$RAF_{\text{Oral}}$  describes the fraction of the chemical that desorbs from its matrix (e.g., soil, food) in the gastrointestinal tract and is available for absorption. The example calculation provided in Attachment H demonstrates use of this parameter for arsenic dose estimates.

### 7.3.2.2 Dose Estimate for Dermal Contact with Contaminated Soil

$$\text{Dose (mg/kg-day)} = \frac{((C_s \times SA_H \times SL_H) + (C_s \times SA_O \times SL_O)) \times RAF_{\text{Derm}} \times D_2 \times D_3 (\times D_4)}{BW (\times LE)}$$

Where:

Dose	= Predicted chronic daily intake (mg/kg-day)
$C_s$	= concentration of COPC in soil (mg/kg)
$SA_H$	= surface area of hands exposed for soil loading (cm <sup>2</sup> )
$SL_H$	= soil loading rate to exposed skin of hands (kg/cm <sup>2</sup> -event)
$SA_O$	= surface area exposed other than hands for soil loading (cm <sup>2</sup> )
$SL_O$	= soil loading rate to exposed skin other than hands (kg/cm <sup>2</sup> -event)
$RAF_{\text{Derm}}$	= relative absorption factor from the gastrointestinal tract (unit-less)
$D_2$	= days per week exposed (days/7-day week)
$D_3$	= weeks per year exposed (weeks/52-week year)
$D_4$	= total years exposed to Site (year)(for assessment of carcinogens only)
BW	= body weight (kg)
LE	= life expectancy (year) (for assessment of carcinogens only)

### 7.3.3 Surface Water Exposures

This section presents dose estimate equations for two surface water exposure routes: inadvertent ingestion of surface water and inhalation of soil particulate, and dermal contact with surface water.

#### 7.3.3.1 Dose Estimate for Ingestion of Surface Water

$$\text{Dose (mg/kg - day)} = \frac{C_W \times IR_W \times RAF_W \times D_1 \times D_2 \times D_3 (\times D_4)}{BW (\times D_4)}$$

Where:

Dose	= Predicted chronic daily intake (mg/kg-day)
$C_W$	= concentration of COPC in water (mg/L)
$IR_W$	= ROC ingestion rate for water (L/day)
$RAF_{\text{Oral}}$	= relative absorption factor from the gastrointestinal tract (unit-less)
$D_1$	= hours per day exposed (hours/24-hour week)
$D_2$	= days per week exposed (days/7-day week)
$D_3$	= weeks per year exposed (weeks/52-week year)
$D_4$	= total years exposed to Site (year)(for assessment of carcinogens only)
BW	= body weight (kg)
LE	= life expectancy (year) (for assessment of carcinogens only)

#### 7.3.3.2 Dermal Contact with Surface Water

$$\text{Dose (mg/kg - day)} = \frac{C_W \times SA \times K_p \times D_1 \times D_2 \times D_3 (\times D_4)}{BW (\times D_4)}$$

Where:

Dose	= Predicted chronic daily intake (mg/kg-day)
$C_W$	= concentration of COPC in surface water (mg/kg)
SA	= surface area of body exposed to water (cm <sup>2</sup> )
$K_p$	= dermal permeability coefficient (kg/hour)
$D_2$	= days per week exposed (days/7-day week)
$D_3$	= weeks per year exposed (weeks/52-week year)
$D_4$	= total years exposed to Site (year)(for assessment of carcinogens only)
BW	= body weight (kg)
LE	= life expectancy (year) (for assessment of carcinogens only)

### 7.3.4 Country Food Exposure

This section presents dose estimate equation for ingestion of country foods.

#### 7.3.4.1 Ingestion of Country Foods

$$\text{Dose (mg/kg – day)} = \frac{C_F \times IR_F \times RAF_{\text{Oral}} \times BAF \times D_2 \times D_3 (\times D_4)}{BW(\times LE)}$$

Where:

$C_{\text{Food } i}$	= concentration of COPC in food “i” (mg/kg wet weight)
$IR_{\text{Food } i}$	= receptor ingestion rate for food “i” (kg/day wet weight)
$RAF_{\text{Oral } i}$	= relative absorption factor from the gastrointestinal tract for COPC “i” (unitless)
BAF	= Bioaccumulation Factor
$D_i$	= days per year during which consumption of food “i” will occur
$D_4$	= total years exposed (for assessment of carcinogens only)
BW	= body weight (kg)
365	= total days per year (constant)
LE	= life expectancy (years) (for assessment of carcinogens only)

With regard to estimating dose for country foods it was assumed that receptors ate only one country food type. Using this assumption dose estimates were calculated for each country food type.

## 8 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to identify the toxic potential of the identified COPCs. Specifically, there are two major objectives:

- To identify the potential toxicological effects associated with the COPCs.
- To identify the TRVs used to estimate risk.

The TRVs can take the form of (i) a tolerable exposure (TDI: also referred to as a reference dose [RfD]), (ii) a tolerable concentration (TC: also referred to as a reference concentration [RfC]), (iii) a risk-specific dose (RSD), or (iv) a toxic potency factor such as a cancer slope factor (SF).

### 8.1 Toxicity Profiles

Toxicity profiles provide detail about the health effects for each COPCs. Toxicity profiles for each chemical are provided in Attachment E. Toxicity profiles include information about biomagnification potential of COPCs.

### 8.2 Toxicity Reference Values

As this project is under both Canadian federal jurisdiction and British Columbia provincial jurisdiction, the selection of TRVs generally followed the hierarchy outlined in BC Ministry of Environment Technical Guidance on Contaminated Sites No. 7 (November 2015). One exception was the selection of a nickel non-cancer oral TRV, which was based on a 2017 peer-reviewed article (Haber et al., 2017), rather than using available values based on studies published in 2000 (Health Canada 2010a) and 1991 (USEPA 2017b). Health Canada (2010) was the preferred source of TRVs for this HHRA, with other sources selected, in order of priority as recommended by Health Canada:

- Health Canada;
- USEPA Integrated Risk Information System (IRIS);
- Netherlands National Institute of Public Health and the Environment (RIVM) – human toxicological maximum permissible risk levels;
- World Health Organization (WHO); and,
- US Agency for Toxic Substances and Disease Registry (ATSDR) – toxicological profiles.

A summary of the TRVs used for each of the COPCs is provided in Attachment A, Table A19. Toxicity profiles provide detail about the health effects for each COPCs. Toxicity profiles for each chemical are provided in Attachment E. Toxicity profiles include information about biomagnification potential of COPCs.



## 9 RISK CHARACTERIZATION

The risk characterization section of the HHRA integrates the exposure and toxicity assessments to quantitatively estimate potential health risks to ROCs from exposure to the COPCs. Risk estimates were determined for both the baseline and future predicted conditions and considered individual routes of COPC exposures as well as additive effects. The HHRA risk characterization puts the estimated exposure into context by comparing potential Project risks to risks that are associated with baseline conditions. The numerical risk estimates presented in this section should be interpreted in the context of uncertainties and assumptions associated with each step of the HHRA process and in the context of the data and models upon which the HHRA was developed.

### 9.1 Risk Estimate Procedure

The risk characterization Section of the HHRA integrates the exposure and toxicity assessments to quantitatively estimate potential health risks to ROCs from exposure to the COPCs. Risk estimates were determined for both the baseline and future predicted conditions and considered individual routes of COPC exposures as well as additive effects. The HHRA risk characterization puts the estimated exposure into context by comparing potential Project risks to risks that are associated with baseline conditions. Risk estimates were compared to one significant digit (i.e., the differences between the risk estimates was rounded to one significant digit) (USEPA 2014, page 5-1). If the difference was greater than zero (rounded to one significant digit), the exposure concentrations were compared to the applicable guidelines (e.g., water quality guideline) to provide a context for the estimated risk. If the exposure concentrations were less than the guideline, the risks were assumed to be acceptable and no further investigation was considered necessary. If the guideline was exceeded, the risks were considered further, and factors such as the source of the toxicity information, the nature of the effects associated with toxicity, and the magnitude of the guideline exceedance, were investigated to provide a more complete understanding of the risks. The numerical risk estimates presented in this section should be interpreted in the context of uncertainties and assumptions associated with each step of the HHRA process and in the context of the data and models upon which the HHRA was developed.

The estimates of non-carcinogenic health and carcinogenic health risks were developed separately because of fundamental differences in the calculation of critical toxicity values.

#### 9.1.1 Non-carcinogenic Hazard Quotients

Non-carcinogens are considered to be threshold COPCs because a critical chemical dose must be exceeded before a health effect is observed. The likelihood of a potential adverse health effect from non-carcinogens is represented by the ratio of a COPC exposure concentration and the route-specific non-carcinogenic TRV:

$$HQ = \frac{Dose}{TRV}$$

Where:

HQ	= non-cancer hazard quotient;
Dose	= dose for each chemical of potential concern (mg/kg/day); and
TRV	= non-carcinogenic TRV

As illustrated in the conceptual site exposure model in Figures 14 and 15, ROCs were assumed to be exposed to COPCs in soil, surface water, and country foods via one or more of the following three exposure pathways:

- Ingestion (soil, surface water, and country foods);
- Dermal contact (soil and surface water); and
- Inhalation of soil particulate (dust).

Each of these pathways was initially evaluated separately for both the baseline condition and predicted future condition. Non-cancer HQs were calculated for each COPC and route-specific pathway combination. The additive hazard index (HI) was then calculated as the sum of HQs for a given COPC across all exposure routes (note: HQs were summed only when using the same TRV). The maximum country foods HQ were included in the calculation of the HI, as a conservative approach. To put the HIs into context, the Project Hazard was calculated as the difference between HIs for the baseline condition and predicted future condition. The Target Organ HI was also calculated as the sum of HIs for COPCs with similar target tissues. Only the ingestion and dermal contact Target Organ HIs are shown, since these pathways were evaluated with the same TRVs, as per Health Canada (2010).

The HQ and HI estimates for non-carcinogenic COPCs were initially compared with the Health Canada acceptable HQ threshold of 0.2 and the province of British Columbia acceptable HI threshold of 1 (BC CSR 1997, Section 18.3). The Health Canada threshold of HQ=0.2 is set for individual chemical exposure (Health Canada 2010).

### 9.1.2 Cancer Risk

For carcinogens, the risk of cancer is assumed to be proportional to the dose, and any exposure results in a non-zero probability of risk. Cancer risk probabilities were calculated by multiplying the estimated exposure level by the TRV, which, in this case, is the route-specific cancer slope factor for each carcinogen. The following formula was used to calculate risk estimates for carcinogenic adverse health effects (i.e. incremental lifetime cancer risk or ILCR):

$$ILCR_{Lifestage\ i} = LADD_i \cdot SF \cdot ADAF_i$$

Where:

ILCR	= incremental lifetime cancer risk;
LADD <sub>i</sub>	= dose received during lifestage "i" averaged over a lifetime (mg/kg/day);
SF	= Route- and chemical-specific cancer slope factor (mg/kg/day) <sup>-1</sup> ; and

ADAF<sub>i</sub> = age-dependent adjustment factors for lifestage “i”

The results of the ILCR estimates were compared with the Health Canada acceptable cancer risk threshold of  $1 \times 10^{-5}$ . In other words, no more than 1 in 100,000 people exposed to a given chemical should develop cancer as a result of the exposure. This is considered highly conservative when compared with the statistic that, on average, 1 in 3 people will develop cancer in their lifetime.

As for the evaluation of non-cancer risk, each pathway was initially evaluated separately for both the baseline condition and predicted future condition. Arsenic ILCRs were calculated for each COPC and route-specific pathway combination. ILCRs were then summed across all exposure routes, and the Project Hazard was calculated as the difference between ILCRs for the baseline condition and predicted future condition. As for non-cancer risk estimates, the maximum country foods ILCR was used to calculate the summed ILCR across all exposure pathways, as a conservative approach. Cadmium and chromium cancer risks were evaluated for the inhalation pathway only, so a summed ILCR was not necessary for these COPCs.

## 9.2 Risk Estimate Results

### 9.2.1 Non-Cancer

Attachment D provides detailed risk results for country foods exposure, and Attachment F provides detailed risk results for soil and surface water exposure. Detailed risk results for the sum of all pathways are provided in Attachment G.

Several COPCs in the country foods exposure estimates had HQs that exceeded the Health Canada acceptable HQ threshold of 0.2 and the province of British Columbia acceptable HI threshold of 1 (Attachment D), under both the baseline and predicted future conditions, and were typically higher in the baseline condition. It should be noted that the risk estimates in Attachment D assume that country foods are consumed 365 days per year. However, this annual exposure was amortized to reflect the amount of time each receptor was assumed to spend at the site, or, in the case of the country food consumer, the number of days they consumed country foods (on- and off-site).

A summary of the non-cancer risk estimate HI results, which combine exposures across all pathways for each of the ROCs, is provided in Table 6. Country foods ingestion is included in the combined exposure estimates for these ROCs, but the frequency of ingestion is amortized as described in Sections 7.2.2 and 7.3. Risk estimates for several COPCs exceeded the threshold of 0.2 under both baseline and future predicted conditions. Six COPCs exhibited predicted HIs that were detectably higher than the baseline condition (Table 6).

**Table 6: Summary of Non-Cancer Risks**

ROC	Type	COPCs with Baseline HI >0.2*	COPCs with Predicted Future HI >0.2	COPCs with detectable incremental change*
Hunter/ Trapper/ Fisher	Teen	Antimony (0.3), Boron (0.4), Cadmium (2.7), Cobalt (0.5), Iron (0.6), Manganese (1.3), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)	Antimony (0.3), Boron (0.4), Cadmium (2.7), Cobalt (0.5), Iron (0.6), Manganese (1.3), Nickel (0.4), Selenium (1.2), Thallium (0.7), Zinc (0.6)	None
Hunter/ Trapper/ Fisher	Adult	Antimony (0.4), Arsenic (0.2), Boron (0.5), Cadmium (3.5), Cobalt (0.6), Iron (0.7), Lead (0.3), Manganese (1.7), Mercury (0.2), Nickel (0.5), Selenium (1.6), Thallium (1.0), Zinc (0.8)	Antimony (0.4), Arsenic (0.3), Boron (0.5), Cadmium (3.5), Cobalt (0.6), Iron (0.7), Lead (0.3), Manganese (1.7), Mercury (0.3), Nickel (0.5), Selenium (1.6), Thallium (1.0), Zinc (0.8)	None
Recreational User	Infant	None	None	None
Recreational User	Toddler	Cadmium (1.6), Cobalt (0.3), Iron (0.5), Lead (0.4), Manganese (1.0), Selenium (0.7), Thallium (0.5), Zinc (0.4)	Cadmium (1.6), Cobalt (0.3), Iron (0.5), Lead (0.4), Manganese (1.0), Selenium (0.7), Thallium (0.5), Zinc (0.4)	None
Recreational User	Child	Cadmium (1.2), Iron (0.3), Lead (0.2), Manganese (0.6), Selenium (0.6), Thallium (0.3), Zinc (0.3)	Cadmium (1.2), Iron (1.2), Lead (0.3), Manganese (0.6), Selenium (0.6), Thallium (0.3), Zinc (0.3)	None
Recreational User	Teen	Cadmium (0.9), Manganese (0.5), Selenium (0.4), Thallium (0.3)	Cadmium (0.9), Manganese (0.5), Selenium (0.4), Thallium (0.3)	None
Recreational User	Adult	Cadmium (1.2), Iron (0.3), Manganese (0.6), Selenium (0.6), Thallium (0.3), Zinc (0.3)	Cadmium (1.2), Iron (0.3), Manganese (0.6), Selenium (0.6), Thallium (0.3), Zinc (0.3)	None
Summer Resident	Infant	Iron (0.3), Lead (0.3), Manganese (0.3)	Iron (0.4), Lead (0.3), Manganese (0.3)	None
Summer Resident	Toddler	Aluminum (0.3), Antimony (0.5), Arsenic (0.3), Boron (0.5), Cadmium (3.5), Cobalt (0.7), Iron (1.0), Lead (0.9), Manganese (2.2), Mercury (0.2), Nickel (0.4), Selenium (1.6), Thallium (1.0), Zinc (0.8)	Aluminum (0.3), Antimony (0.5), Arsenic (0.4), Boron (0.5), Cadmium (3.5), Cobalt (0.7), Iron (1.0), Lead (0.9), Manganese (2.2), Mercury (0.3), Nickel (0.4), Selenium (1.8), Thallium (1.0), Zinc (0.8)	Selenium
Summer Resident	Child	Antimony (0.4), Boron (0.6), Cadmium (2.6), Cobalt (0.5), Iron (0.6), Lead (0.5), Manganese (1.3), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)	Antimony (0.4), Boron (0.6), Cadmium (2.6), Cobalt (0.5), Iron (0.6), Lead (0.5), Manganese (1.3), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)	None



ROC	Type	COPCs with Baseline HI >0.2*	COPCs with Predicted Future HI >0.2	COPCs with detectable incremental change*
Summer Resident	Teen	Antimony (0.3), Boron (0.3), Cadmium (2.0), Cobalt (0.4), Iron (0.4), Manganese (1.0), Nickel (0.3), Selenium (0.9), Thallium (0.5), Zinc (0.4)	Antimony (0.3), Boron (0.3), Cadmium (2.0), Cobalt (0.4), Iron (0.4), Manganese (1.0), Nickel (0.3), Selenium (0.9), Thallium (0.6), Zinc (0.4)	None
Summer Resident	Adult	Antimony (0.4), Boron (0.3), Cadmium (2.6), Cobalt (0.5), Iron (0.5), Manganese (1.3), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)	Antimony (0.4), Boron (0.3), Cadmium (2.6), Cobalt (0.5), Iron (0.5), Manganese (1.3), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)c	None
Year-Round Resident	Toddler	Aluminum (0.6), Antimony (1.0), Arsenic (0.7), Barium (0.4), Boron (0.9), Cadmium (7.1), Chromium (0.5), Cobalt (1.3), Iron (1.9), Lead (1.7), Manganese (4.3), Mercury (0.5), Nickel (0.9), Selenium (3.2), Thallium (2.0), Vanadium (0.4), Zinc (1.5)	Aluminum (0.6), Antimony (1.0), Arsenic (0.7), Barium (0.4), Boron (0.9), Cadmium (7.1), Chromium (0.5), Cobalt (1.4), Iron (1.9), Lead (1.8), Manganese (4.4), Mercury (0.6), Nickel (0.9), Selenium (3.6), Strontium (0.3), Thallium (2.0), Vanadium (0.4), Zinc (1.5)	Lead, Mercury, Selenium, Strontium
Year-Round Resident	Adult	Aluminum (0.3), Antimony (0.7), Arsenic (0.4), Barium (0.3), Boron (0.7), Cadmium (5.3), Cobalt (0.9), Iron (1.1), Lead (0.4), Manganese (2.5), Mercury (0.4), Nickel (0.7), Selenium (2.4), Thallium (1.4), Zinc (1.1)	Aluminum (0.3), Antimony (0.7), Arsenic (0.4), Barium (0.3), Boron (0.7), Cadmium (5.3), Cobalt (0.9), Iron (1.1), Lead (0.4), Manganese (2.6), Mercury (0.4), Nickel (0.7), Selenium (2.4), Thallium (1.4), Zinc (1.1)	None
Country Food Consumer	Toddler	Antimony (0.4), Boron (0.5), Cadmium (3.5), Cobalt (0.6), Iron (0.5), Lead (0.5), Manganese (1.7), Mercury (0.2), Nickel (0.4), Selenium (1.6), Thallium (0.9), Zinc (0.8)	Antimony (0.4), Boron (0.5), Cadmium (3.5), Cobalt (1.0), Iron (0.6), Lead (0.9), Manganese (1.7), Mercury (0.3), Nickel (0.4), Selenium (1.8), Thallium (0.9), Zinc (0.8)	Cobalt, Iron, Lead, Selenium
Country Food Consumer	Child	Antimony (0.3), Boron (0.3), Cadmium (2.6), Cobalt (0.4), Iron (0.4), Lead (0.4), Manganese (1.2), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)	Antimony (0.3), Boron (0.3), Cadmium (2.6), Cobalt (0.8), Iron (0.5), Lead (0.6), Manganese (1.2), Nickel (0.3), Selenium (1.3), Thallium (0.7), Zinc (0.6)	Cobalt, Iron, Lead, Selenium
Country Food Consumer	Teen	Boron (0.3), Cadmium (2.0), Cobalt (0.3), Iron (0.3), Manganese (0.9), Selenium (0.9), Thallium (0.5), Zinc (0.4)	Boron (0.3), Cadmium (2.0), Cobalt (0.6), Iron (0.4), Manganese (0.9), Selenium (1.0), Thallium (0.5), Zinc (0.4)	Cobalt, Iron, Selenium

ROC	Type	COPCs with Baseline HI >0.2*	COPCs with Predicted Future HI >0.2	COPCs with detectable incremental change*
Country Food Consumer	Adult	Antimony (0.3), Boron (0.3), Cadmium (2.6), Cobalt (0.4), Iron (0.4), Lead (0.1), Manganese (1.2), Nickel (0.3), Selenium (1.2), Thallium (0.7), Zinc (0.6)	Antimony (0.3), Boron (0.3), Cadmium (2.6), Cobalt (0.8), Iron (0.5), Lead (0.3), Manganese (1.2), Nickel (0.3), Selenium (1.3), Thallium (0.7), Zinc (0.6)	Cobalt, Iron, Lead, Selenium

\*Baseline and predicted His are rounded to one significant digit, per UESPA (2014). In some cases, an apparent difference between predicted and baseline appears as a result of rounding, even if there is no detectable difference between the two values (e.g., a baseline HI of 0.64 will round to 0.6 and a predicted HI of 0.66 would round to 0.7)

Six COPCs exhibited predicted His that were detectably higher than the baseline condition: cobalt, iron, lead, mercury, selenium and strontium.

### Cobalt

Small amounts of cobalt are naturally found in most rocks, soil, water, plants, and animals, typically in small amounts. Cobalt is also found in meteorites. Cobalt is usually found in the environment combined with other elements such as oxygen, sulfur, and arsenic. The concentration of cobalt in soil varies widely, generally ranging from about 1 to 40 ppm (1 ppm=1 part of cobalt in a million parts of soil by weight), with an average level of 7 ppm. Soils containing less than about 3 ppm of cobalt are considered cobalt-deficient.

Cobalt has both beneficial and harmful effects on human health. Cobalt is beneficial for humans because it is part of vitamin B12, which is essential to maintain human health. Cobalt (0.16–1.0 mg cobalt/kg of body weight) has also been used as a treatment for anemia, including in pregnant women, because it causes red blood cells to be produced. Cobalt also increases red blood cell production in healthy people, but only at very high exposure levels.

When too much cobalt is taken into a body, however, harmful health effects can occur. Workers who breathed air containing 0.038 mg cobalt/m<sup>3</sup> (about 100,000 times the concentration normally found in ambient air) for 6 hours had trouble breathing. Serious effects on the lungs, including asthma, pneumonia, and wheezing, have been found in people exposed to 0.005 mg cobalt/m<sup>3</sup> while working with hard metal, a cobalt-tungsten carbide alloy. People exposed to 0.007 mg cobalt/m<sup>3</sup> at work have also developed allergies to cobalt that resulted in asthma and skin rashes. However, the general public is not likely to be exposed to the same type or amount of cobalt dust that caused these effects in workers.

Short term receptor exposure (2 weeks) to cobalt at 91 to 194 mg/kg/day may result in death (ATSDR 2004). For subacute exposures of 2 weeks to 13 weeks, 0.18 to 3.9 mg/kg/day resulted in effect to the gastrointestinal system at lower doses and to body weight at higher doses. The dose identified at the site (2.8x10<sup>-3</sup> mg/kg/day) was lower than any no-observed-adverse-effect-level NOAEL report by ATSDR (2004). ATSDR developed a minimum risk level of 1x10<sup>-2</sup> for stable cobalt. This is 3.5 times greater than

the predicted dose of  $2.8 \times 10^{-3}$  mg/kg/day. Therefore, no health effects are expected from predicted increases in cobalt concentrations resulting from the Project.

### Iron

Iron is an essential element found in every cell of the human body. However, at high concentrations it is also toxic and is responsible for a few deaths every year in the United States.

The HI for the country food consumer as a result of exposure to iron in country foods was predicted to be as high as 1.3 as a result of fish consumption. This was incrementally greater than the baseline HI of 1.1. Patterson and Elvehjem (1928) reported that iron levels in trout and salmon represent 0.078% and 0.083 % of total fish body weight, respectively. If this fraction is multiplied by the ingestion rate of 290 g/day the predicted iron consumption is 0.2262 grams per day. This normalizes to 48.5 mg/kg/day and is dependent on what organs of the fish are consumed and the concentration of iron in these organs. Regardless, this is much higher than the TRV used in this HHRA and would result in no risk associated with iron exposure. The Minnesota Department of Health (2018) recommends that 1-3-year-old children consume 7 mg/day of iron from food with a maximum of 40 mg/day and the adult consume 8 mg/day of iron from food with a maximum of 45 mg/day. The upper iron consumption rate results in a consumption rate (dose) of 2.4 mg/kg/day. This is 1.7 times greater than the dose of iron consumed (1.4 mg/kg/day) under the predicted scenario. Other health departments provide similar recommendations. Based on this, the predicted level of iron country foods consumed from the Bitter Creek valley does not pose a risk to the country food consumer receptor.

### Lead

People may be exposed to lead by eating food or drinking water that contains lead. The effects of lead are the same whether it enters the body through breathing or swallowing. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults to lead at work has resulted in decreased performance in some tests that measure functions of the nervous system. Lead exposure may also cause weakness in fingers, wrists, or ankles and small increases in blood pressure, particularly in middle-aged and older people. Lead exposure may also cause anemia. At high levels of exposure, lead can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production.

Children are more sensitive to the health effects of lead than adults. No safe blood lead level in children has been determined. Lead affects children in different ways depending on how much lead a child swallows. A child who swallows large amounts of lead may develop anemia, kidney damage, colic (severe "stomach ache"), muscle weakness, and brain damage

Exposure to the hypothetical future toddler year-round resident in Bitter Creek valley has an incremental hazard of 0.06 times greater than the baseline hazard. According to the USEPA (2014) this difference is not meaningful in the context of risk assessment (i.e., does not produce a meaningful and measurable health effect). For example, the Project HHRA uses a TDI of 0.0006 mg/kg is based on the most sensitive endpoint (i.e., nervous system and brain development); a HQ of 1 relates to a 1-point decrease in IQ. Therefore, the detected HQ increase from baseline (1.6) to predicted (1.7) would

translate to a decrease in IQ of 0.1. This change in IQ is unlikely to be have a measurable effect in real-life situations.

## Mercury

A person can be exposed to mercury from breathing in contaminated air, from swallowing or eating contaminated water or food, or from having skin contact with mercury. Not all forms of mercury easily enter the body, even if one comes in contact with it; hence, it is important to know which form of mercury is the basis of the exposure and the exposure pathway. Once inorganic mercury enters the body and gets into the bloodstream, it moves to many different tissues. Inorganic mercury leaves the body in the urine or feces over a period of several weeks or months. A small amount of the inorganic mercury can be changed in the body to metallic mercury and leave in the breath as a mercury vapor.

The nervous system is very sensitive to mercury. In poisoning incidents that occurred in other countries, some people who ate fish contaminated with large amounts of methylmercury or seed grains treated with methylmercury or other organic mercury compounds developed permanent damage to the brain and kidneys. Permanent damage to the brain has also been shown to occur from exposure to sufficiently high levels of metallic mercury. Whether exposure to inorganic mercury results in brain or nerve damage is not as certain, since it does not easily pass from the blood into the brain. Metallic mercury vapors or organic mercury may affect many different areas of the brain and their associated functions, resulting in a variety of symptoms. These include personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction (or narrowing) of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.

Exposure to the hypothetical future toddler year-round resident in Bitter Creek valley has an incremental hazard of 0.06 times greater than the baseline hazard. According to the USEPA (2014), this difference is not meaningful in the context of risk assessment (i.e., does not produce a meaningful and measurable health effect). In the context of assessing the potential health effects of this difference, this HHRA uses a TDI for the adult and toddler receptors of 0.0003 mg/kg/day for mercury and for methyl mercury (used for the ingestion of fish) the TDI for the toddler is 0.0002 mg/kg/day and for the adult is 0.00047 mg/kg/day. Therefore, an HQ increase from baseline (0.05) to predicted (0.056) of 0.006 relates to a change in exposure of 1.2ug/kg/day. The increase is not expected to result in a health effect resulting from mercury exposure (Poulin and Gibb 2008).

## Selenium

Selenium from the environment mainly enters the body through direct consumption. The human body easily absorbs the organic selenium compounds (e.g., selenoamino acids) when eaten, and makes them available where needed in the body. Most of the selenium that enters the body leaves the body within 24 hours. Selenium leaves mainly in the urine, and in feces and breath. Selenium can build up in the human body, however, if exposure levels are very high or if exposure occurs over a long time, human health effects can occur, such as selenosis, with symptoms that can include loss of hair and nails, acropachia (i.e., clubbing of the fingers), skin lesions (e.g., redness, swelling, blistering and ulcerations), tooth decay (e.g., mottling, erosion, and pitting), and nervous system abnormalities (e.g., peripheral anesthesia, acroparaesthesia, pain in the extremities, hyperreflexia of the tendon, numbness, convulsions, paralysis, motor disturbances, and hemiplegia)(Yang et al. 1983).

Baseline and predicted (i.e., baseline + project) exposure to selenium is being driven by exposure to fish (baseline = 2.91 mg/kg and predicted=3.23 mg/kg) and to a lesser degree plants (baseline =0.497 mg/kg and predicted 0.532 mg/kg). Health effects could potentially occur at the documented baseline concentrations; the predicted change in the level of exposure is not expected to alter these potential effects (Yang et al. 1983).

### Strontium

There are no harmful effects of stable strontium in humans at the levels typically found in the environment. The only chemical form of stable strontium that is very harmful by inhalation is strontium chromate, but this is because of toxic chromium and not strontium itself. Problems with bone growth may occur in children eating or drinking unusually high levels of strontium, especially if the diet is low in calcium and protein. As the average crustal abundance of strontium is 360 mg/kg and the predicted concentration in Bitter Creek valley is approximately 97.5 mg/kg, strontium would be considered to be at typical concentration and thus is not harmful (ASTDR 2017).

### Target Organs

Information on the potential additive effects to target organs is presented in Attachment G.

## 9.2.2 Cancer Risk

Attachment D provides detailed risk results for country foods exposure and Attachment F provides detailed risk results for soil and surface water exposure. Detailed risk results for the sum of all pathways are provided in Attachment G. The risk estimates in Attachment D assume that country foods are consumed 365 days per year.

A summary of the summed ILCR results, which combine exposures across all pathways, for each of the ROCs, is provided in Table 8. Country foods ingestion is included in the combined exposure estimates for these ROCs, but the frequency of ingestion is amortized as described in Sections 7.2.2 and 7.3. Arsenic exceeded the threshold of  $1 \times 10^{-5}$  under both baseline and future predicted conditions for at least one receptor in each ROC class, and was detectably higher in the predicted condition for 12 receptors (Table 7).



**Table 7: Summary of Cancer Risks**

ROC	Receptors	COPCs with Baseline ILCR $>1 \times 10^{-5}$	COPCs with Predicted Future ILCR $>1 \times 10^{-5}$	COPC with Detectable Incremental Change in ILCR
Hunter/ Trapper/ Fisher	Teen	Arsenic ( $1.6 \times 10^{-5}$ )	Arsenic ( $1.8 \times 10^{-5}$ )	Arsenic
Hunter/ Trapper/ Fisher	Adult	Arsenic ( $2.0 \times 10^{-5}$ )	Arsenic ( $2.1 \times 10^{-5}$ )	Arsenic
Recreational User	Infant	None	None	None
Recreational User	Toddler	Arsenic ( $2.0 \times 10^{-5}$ )	Arsenic ( $2.1 \times 10^{-5}$ )	Arsenic
Recreational User	Child	None	None	None
Recreational User	Teen	None	None	None
Recreational User	Adult	None	None	None
Summer Resident	Infant	None	None	None
Summer Resident	Toddler	Arsenic ( $1.8 \times 10^{-4}$ )	Arsenic ( $1.8 \times 10^{-4}$ )	None
Summer Resident	Child	Arsenic ( $4.8 \times 10^{-5}$ )	Arsenic ( $5.2 \times 10^{-5}$ )	Arsenic
Summer Resident	Teen	Arsenic ( $2.6 \times 10^{-5}$ )	Arsenic ( $2.9 \times 10^{-5}$ )	Arsenic
Summer Resident	Adult	Arsenic ( $4.6 \times 10^{-5}$ )	Arsenic ( $4.6 \times 10^{-5}$ )	None
Year-Round Resident	Toddler	Arsenic ( $7.1 \times 10^{-4}$ )	Arsenic ( $7.3 \times 10^{-4}$ )	Arsenic
Year-Round Resident	Adult	Arsenic ( $1.8 \times 10^{-4}$ )	Arsenic ( $1.8 \times 10^{-4}$ )	None
Country Food Consumer	Toddler	Arsenic ( $6.1 \times 10^{-5}$ )	Arsenic ( $6.1 \times 10^{-5}$ )	None
Country Food Consumer	Child	Arsenic ( $4.2 \times 10^{-5}$ )	Arsenic ( $4.2 \times 10^{-5}$ )	None
Country Food Consumer	Teen	Arsenic ( $2.5 \times 10^{-5}$ )	Arsenic ( $2.5 \times 10^{-5}$ )	None
Country Food Consumer	Adult	Arsenic ( $4.4 \times 10^{-5}$ )	Arsenic ( $4.4 \times 10^{-5}$ )	None

The baseline ILCR results exceed the Health Canada cancer risk threshold ( $1 \times 10^{-5}$ ) because of naturally elevated concentrations of arsenic in the region, regardless of whether the Project proceeds. This threshold implies that an individual's chance of developing cancer should not be greater than 1 in 100,000 as a result of exposure to arsenic at an impacted property. The baseline toddler ILCR is 0.000706 (approximately 1 in 1,415) and for the adult is 0.000183 (or approximately 1 in 5,464).

The incremental increase in arsenic cancer risk associated with the project for the year-round resident toddler (the receptor with the highest risk) is approximately 3.7 % (ILCR increase of 0.000026). This change represents a change in the probability of toxicological effects occurring with the conservative assumption that this receptor receives the full exposure described in the risk assessment. Another

conservative assumption in this assessment is the use of the 90<sup>th</sup> percentile rather than other commonly used metrics such as the 95% UCLM (e.g., Brucejack Project; Rescan 2013a). These conservative assumptions have likely resulted in an overestimation of Project-related risk due to arsenic. In addition, the relatively low incremental changes are specifically associated with the assumed exposure levels that, in turn, are based on soil sample results. The size of the predicted incremental change in arsenic concentrations falls within expected variability in estimated concentrations due to laboratory detectability (refer to Appendix 4 of Volume 8, Appendix 18-A for method reporting limits associated with fish tissue laboratory analysis) and natural variation in arsenic. In consideration of these points, it is unlikely that the Project will result in measurable changes to human health as a result of arsenic exposure.

IDM takes the baseline risk associated with arsenic very seriously and will take appropriate steps to minimize the potential for exposure to members of the public (e.g., public education, access controls).

## 10 UNCERTAINTY ANALYSIS

Quantitative evaluation of the risks to humans from environmental contamination is often limited by uncertainty arising from a number of key data inputs, such as the following:

- The concentration of COPCs in the environment,
- The true level of human contact with contaminated media, and
- The true dose-response curves for non-cancer and cancer effects.

In the HHRA, assumptions and best estimates for exposure factors and toxicity values were made based on limited data available. Accordingly, the results of risk calculations based on these assumptions and estimates are, themselves, uncertain.

The interpretation of risk estimates is subject to uncertainties because of the numerous assumptions inherent in the risk assessment process. Risk estimates can most appropriately be viewed as upper-bound estimates of risks; actual risks may be substantially lower than those calculated using quantitative risk assessment techniques. Typically, sources of uncertainty in HHRAs can be categorized into those associated with standard risk assessment procedures (e.g., uncertainty factors used for derivation of TRVs, summing hazard quotients despite dissimilar target organs or mechanisms of toxicity) and those associated with site-specific factors (i.e., variability in analytical data, modeling results, and exposure parameter assumptions). The extensive use of modelling is also a significant source of uncertainty in this HHRA. Each of the primary uncertainties in this HHRA is discussed in the subsections below.

### 10.1 Uncertainties from Chemicals Not Evaluated

Exposure and risks were quantified only for a selected subset of COPCs detected in environmental media at the LSA. While the omission of other COPCs might tend to underestimate total risks, this is not a significant source of uncertainty because:

- the COPCs that were excluded were known to be present at concentrations that are well below a level of concern (methyl mercury, for example, is unlikely to be present at elevated concentrations since total mercury was found at very low concentrations and enhanced methylating conditions are unlikely);
- the COPC that were excluded because their concentration in soil was significantly below their crustal abundance; and
- the COPCs that were considered to be innocuous.

### 10.2 Uncertainties from Exposure Pathways Not Evaluated

Humans may be exposed to Project-related COPCs by a number of pathways, but not all of these pathways were evaluated quantitatively in this HHRA. This was because the contributions of the omitted pathways were believed to be minor compared to the other pathways evaluated. Omitted pathways

may result in a small underestimation of exposure and risk, but the magnitude of this underestimation is expected to be insignificant.

### 10.3 Uncertainties in Estimated Environmental Concentrations

In all exposure calculations the desired input parameter is the true mean concentration of a contaminant within a medium, averaged over the area where random exposure occurs. Due to the limited data set, the 90th percentile concentration was used, which may result in an overestimate of the true mean. Underestimation of the true mean is unlikely.

Modeling was used to estimate EECs. For the baseline condition, EECs for air particulate and terrestrial country foods were estimated from models. Predicted future EECs for all exposure media were estimated from models. The models include several parameters and assumptions regarding input values, some of which are discussed elsewhere, that lead to uncertainties in the estimated concentrations. In some cases, this may lead to artifacts in the results. For example, for ingestion of country foods, the predicted exposure concentrations calculated using modelling and their subsequent risk estimates were often lower baseline exposures and risks estimates. This is an artifact of the modelled and literature based BCFs used to predict future constituent concentrations in food that may occur when the baseline and predicted concentrations are so similar. BCF estimates for COPCs were based on soil analytical data and plant (e.g., Sitka willow) analytical data from samples collected in the Bitter Creek watershed. Predicted plant tissue concentrations were based on predicted soil concentrations, and predicted country food (moose, hare, and grouse) tissue concentrations were based on plant concentrations. Calculations of BCFs for fish also resulted in predicted concentrations that were in some instances lower than baseline concentrations. Variability in three factors contributed to this result: how much time Dolly Varden spent in Bitter Creek versus other creeks in the area; how many Dolly Varden in Bitter Creek are anadromous; and how many Dolly Varden overwinter in Bitter Creek. The less time Dolly Varden spend in Bitter Creek the weaker the relationship between Bitter Creek water chemistry and Dolly Varden fish tissue chemistry. In all cases where the predicted risk is less than the baseline risk, we suggest that it implies that, effectively, there is no difference in the concentrations (i.e. no detectable incremental change).

The intent of the modeling is to be both predictive and protective, but actual conditions in the future may be significantly different. By using conservative assumptions, it is more likely that the risks are over-estimated than under-estimated.

Consumption of COPCs in fish is the main pathway causing baseline and future risk to human receptors. For this Project, it was assumed to be due to consumption of Dolly Varden. However, anecdotal information tells us that Sockeye and other types of salmon are much preferred to Dolly Varden. The Food Nutrition & Environment Study by Chan *et al.* (2011) lists over 200 traditional foods that are consumed by Aboriginal Groups in British Columbia, and Dolly Varden are only eaten by approximately 35% of the Aboriginal population in the area, whereas 99% consume salmon. Furthermore, even among those who eat Dolly Varden, receptors generally eat 15 to 50 times more salmon as they do Dolly Varden. This is an important consideration, as salmon do not reside in Bitter Creek, thus the only fish species available for consumption in the Bitter Creek watershed, is Dolly Varden. It is unlikely that Aboriginal receptors and non-Aboriginal receptors will only eat Dolly Varden, when salmon can be

caught for consumption, nearby. The assumption that receptors eat significant amounts of Dolly Varden is unlikely, resulting in a more conservative estimate of potential human health risk associated with fish consumption.

## 10.4 Uncertainties in Human Exposure Parameters

Accurate calculation of risk values requires accurate estimates of the level of human exposure that is occurring. Many of the required exposure parameters are not known with certainty and must be estimated from limited data or knowledge. For example, little information was available about the frequency of use of the Bitter Creek watershed for recreational activities. The local population within 50 km of Bitter Creek is small and the Bitter Creek watershed is not known to be a destination location for potential recreational receptors. In general, when exposure data were limited or absent, the exposure parameters were chosen in a way that was intended to be conservative. Because of this generally conservative approach, the values selected are thought to be more likely to overestimate than to underestimate actual exposure and risk. It was assumed that the bioavailability of most COPCs via the ingestion and inhalation routes of exposure was assumed to be 100 percent. This assumption would likely result in a conservatively high dose for the COPCs.

## 10.5 Uncertainties in Toxicity Values

Toxicity information for many chemicals is often limited. Therefore, there are varying degrees of uncertainty associated with TRVs (i.e., cancer slope factors, tolerable daily intakes). For example, uncertainties can arise from the following sources:

- Extrapolation from animal studies to humans;
- Extrapolation from high dose to low dose;
- Extrapolation from continuous exposure to intermittent exposure; and
- Limited availability of toxicity studies.

Uncertainty in TRVs is one of the largest sources of uncertainty in risk estimates. Because of the conservative methods Health Canada uses in dealing with uncertainties, it is much more likely that the uncertainty will result in an overestimation rather than an underestimation of risk.

## 10.6 Uncertainties in Risk Estimates

Because risk estimates for a COPC are derived by combining uncertain estimates of exposure and toxicity (see above), the risk estimates for each COPC are more uncertain than either the exposure estimate or the toxicity estimate alone. Additional uncertainty arises from the issue of how to combine risk estimates across different chemicals. In some cases, the effects caused by one COPC do not influence the effects caused by other COPCs. In other cases, the effects of one chemical may interact with effects of other COPCs, causing responses that are approximately additive, greater than additive (synergistic), or less than additive (antagonistic). In most cases, available toxicity data are not sufficient



to define what type of interaction is expected, so Health Canada assumes effects are additive for non-carcinogens that act on the same target organ.

## 11 CONCLUSION

Human Health was identified as a VC and the potential for change in Human Health due to interactions with the Project was evaluated. This HHRA was conducted to determine the predicted risk to Human Health as a result of the Project from exposure to COPCs within the Human Health LSA.

The potential interactions between Human Health and Project infrastructure, activities, or components were identified. Project activities that could affect air quality, water quality, soil quality, vegetation quality and country foods quality, also have the potential to cause a change in Human Health. Predictive models were developed to estimate concentrations of COPCs in air, water, soil, vegetation, and country foods. The results of the predictive modeling were used as inputs into the predicted future risk estimates, which used the same methodologies, approaches, study area, and assumptions as the baseline risk estimates.

Incremental changes in non-cancer risks resulting from the Project were identified for several COPCs (cobalt, iron, lead, mercury, selenium, strontium), However, none of these incremental changes are anticipated to result in an increase in human health effects. Similarly, Project-related incremental increases in COPCs associated with cancer risk (i.e., arsenic) are not anticipated to result in a detectable increase in risk.

The risk estimates incorporate multiple conservative assumptions, which suggests that risks under the predicted conditions are likely overestimated, in particular those associated with consumption of fish. The potential for adverse health effects resulting from the Project is considered negligible.

Monitoring of air, air particulate deposition, soil, surface water, sediment, groundwater, mammal tissue, fish tissue, and plant tissue should be completed during mine development, operations and closure to confirm key exposure assumptions made in the risk assessment.

## 12 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological Profile for Cobalt. Online (<https://www.atsdr.cdc.gov/toxprofiles/TP.asp?id=373&tid=64>)

Agency for Toxic Substances and Disease Registry (ATSDR). 2017. Toxicological Profile for Strontium. Online (<https://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=656&tid=120>).

BC CSR. 2017. Contaminated Sites Regulation. BC Reg 375/96. Victoria, BC.

- BCMELP. 2000. Tier 1 Ecological Risk Assessment Policy Decision Summary. Environment and Resource Management Department, Pollution Prevention and Remediation Branch, Risk Assessment and Integrated Pesticide Management.
- BCMOE. 2010. Protocol 4 for Contaminated Sites. Determining Background Soil Quality.
- BCMOE. 2015. Technical Guidance on Contaminated Sites 7 - Supplemental Guidance for Risk Assessments.
- Canadian Environmental Assessment Act, 2012.
- CCME. 2017. Canadian Environmental Quality Guidelines. Available online at: [http://www.ccme.ca/en/resources/canadian\\_environmental\\_quality\\_guidelines/](http://www.ccme.ca/en/resources/canadian_environmental_quality_guidelines/)
- Chan, L., O. Receveur, D. Sharp, H. Schwartz, A. Ing, and C. Tikhonov. 2011. First Nations Food, Nutrition & Environment Study (FNFNES): Results from British Columbia (2008/2009). University of Northern British Columbia: Prince George, BC.
- Elliott, C.T. and Copes, R., 2011. Burden of mortality due to ambient fine particulate air pollution (PM 2.5) in interior and Northern BC. *Canadian Journal of Public Health/Revue Canadienne de Sante' e Publique*, pp.390-393.
- Environment Canada. 2012. Federal Contaminated Sites Action Plan (FCSAP). Ecological Risk Assessment Guidance. Module C: Standardization of Wildlife Receptor Characteristics. March 2012.
- Laurie Chan, Olivier Receveur, Donald Sharp, Harold Schwartz, Amy Ing, and Constantine Tikhonov. 2011. First Nations Food, Nutrition and Environment Study (FNFNES): Results from British Columbia (2008/2009). Prince George: University of Northern British Columbia.
- Haber LT, Bates HK, Allen BC, Vincent MJ, Oler AR. 2017. Derivation of an oral toxicity reference value for nickel. *Regulatory Toxicology and Pharmacology*. 87: S1-S18.
- Health Canada. 2010a. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values. Ottawa, Ontario
- Health Canada. 2010b. Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods. Ottawa, Ontario.
- Health Canada. 2012a. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0. Ottawa, Ontario.
- Health Canada. 2012b. Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRA). Ottawa, Ontario.
- Health Canada. 2016. Human Health Risk Assessment Ambient Nitrogen Dioxide. Ottawa, Ontario.
- Health Canada. 2017. Guidelines for Canadian Drinking Water Quality – Summary Table.
- IRIS (Integrated Risk Information System). 2017b. Available online at: <https://www.epa.gov/iris>. Last accessed on Aug. 30, 2017.
- Minnesota Department of Health. 2018. Nutrition Facts: Iron. Online. <http://www.health.state.mn.us/divs/hpcd/chp/cdr/nutrition/facts/iron.html>
- Northern Health. 2015. *Guidance on Human Health Risk Assessment*.
- Oak Ridge National Laboratory (ORNL). 2017. *Risk Assessment Information System Chemical Specific Parameters*. Oak Ridge National Laboratory. Available online at: [https://rais.ornl.gov/cgi-bin/tools/TOX\\_search](https://rais.ornl.gov/cgi-bin/tools/TOX_search). Last accessed on June 14, 2017
- Ontario MOE.2017. Ontario's Ambient Air Quality Criteria. Standards Development Branch. Ontario Ministry of Environment. Available at: <https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria-sorted-chemical-abstracts-service-registry-number>

- Oregon Health Authority. 2016. Technical Report: Oregon Statewide Bass Fish Consumption Advisory Due to Mercury Contamination. Available online at: <http://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/FISHCONSUMPTION/DOCUMENTS/TechnicalReport-StatewideBassFishConsumptionAdvisory.pdf>.
- Peterson W.H., and Elvehjem C.A. 1928. The Iron Content of Plant and Animal Foods. Online. <http://www.jbc.org/content/78/1/215.full.pdf>
- Poulin J, and Gibb H. 2008 Mercury: Assessing the environmental burden of disease at national and local levels. Editor, Prüss-Üstün A. World Health Organization, Geneva, 2008. (WHO Environmental Burden of Disease Series No. 16).
- Rescan. 2013a. Brucejack Gold Mine Project: Country Foods Baseline Assessment. Prepared for Pretium Resources Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.
- Rescan. 2013b. KSM Project: Country Foods Screening Level Risk Assessment for the Processing and Tailings Management Area. Prepared for Seabridge Gold Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.
- Schoof, RA and JW Yager. 2007. Variation of total and speciated arsenic in commonly consumed fish and seafood. *Human and Ecological Risk Assessment* 13: 946-965.
- Schoof RA, Yost LJ, Eickhoff J, Crecelius EA, Cragin DW, Meacher DM, and Menzel DB. 1999. A market basket Survey of Inorganic Arsenic in Food. *Food Chem. Toxicol.* 37:839:846.
- Texas CEQ. 2017. Effects Screening Levels. Available at [https://www.tceq.texas.gov/toxicology/esl/list\\_main.html/](https://www.tceq.texas.gov/toxicology/esl/list_main.html/)
- USDOE (United States Department of Energy). 1999. *Protocol: Bioaccumulation and Bioconcentration Screening*. Environmental Restoration Division. August 1999.
- USEPA (United States Environmental Protection Agency). 2005a. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.
- USEPA. 2005b. Toxicity and Exposure Concerns Related to Arsenic in Seafood: An Arsenic Literature Review for Risk Assessments. Part 1: Exposure Concerns. Draft report prepared for U.S. Environmental Protection Agency, Office of Superfund Remediation and Technical Innovation, by Syracuse Research Corporation. SRC-TR-04-048. May 2005.
- USEPA. 2007. *Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1: Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs*. Revised April 2007.
- USEPA. 2014. *Region 4 Human Health Risk Assessment Supplemental Guidance*. Draft Final. Technical Services Section, Superfund Division, EPA Region 4. Available online at: <http://www.epa.gov/region04/superfund/programs/riskassess/riskassess.html>. Last accessed February 2018.
- USEPA. 2016. Integrated Science Assessment (ISA) for Oxides of Nitrogen – Health Criteria (Final Report, 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016.
- USEPA. 2017a. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017>. Last accessed: June 2017.
- WHO (World Health Organization). 2001. Exposure and health effects. United Nations Synthesis Report on Arsenic in Drinking Water. Geneva: World Health Organization. Available at: [http://www.who.int/water\\_sanitation\\_health/dwq/arsenicun3.pdf](http://www.who.int/water_sanitation_health/dwq/arsenicun3.pdf). Last accessed on September 9, 2017.
- Yang, G., S. Wang, R. Zhou and S. Sun. 1983. Endemic selenium intoxication of humans in China. *Am. J. Clin. Nutr.* 37: 872-881.

Yost LJ, Schoof RA, and Aucoin R. 1998. Intake of Inorganic Arsenic in the North American Diet. Human and Ecological Risk Assessment 4:137:152.



Attachment A  
Tables in support of the screening and identification of  
COPCs

**Table A1: Air Screening (Particulate Matter and Non-Metals)**

<b>Constituent</b>	<b>Calculation Basis &amp; Averaging Time</b>	<b>Ambient Air Quality Objectives (<math>\mu\text{g}/\text{m}^3</math>)</b>	<b>Baseline (<math>\mu\text{g}/\text{m}^3</math>)</b>	<b>Maximum Future Predicted (<math>\mu\text{g}/\text{m}^3</math>)</b>
Nitrogen Dioxide (NO <sub>2</sub> ; Ozone Limiting Method)	98th Percentile of Daily 1-hour Maximum	188	21.0	187
Nitrogen Dioxide (NO <sub>2</sub> ; 100%)	Annual Maximum	60	5.0	47
Sulphur Dioxide (SO <sub>2</sub> )	99th Percentile of Daily 1-hour Maximum	196	4.0	78
	Annual Maximum	13	2.0	6.5
Carbon Monoxide (CO)	1-hour Maximum	14300	100.0	605
	8-hour Block Maximum	5500	100.0	471
Particulate Matter (PM <sub>2.5</sub> )	98th Percentile of 24-hour Block Averages	25	1.3	18.6
	Annual Maximum	8 (5)	1.3	4.4
Particulate Matter (PM <sub>10</sub> )	24-hour Block Maximum	50	3.4	42.7
Total Particulate Matters (TPM)	24-hour Block Maximum	120	10.0	91.3
	Annual Maximum	60	10.0	24.6
Total Dustfall	Annual Maximum	1.7 mg/dm <sup>2</sup> /day	0.56	0.98
Wet Deposition	Annual Maximum			0.61
Dry Deposition	Annual Maximum			0.95

Table A2: Air Screening (Metals)

Chemical	Texas CEQ 1-Hour ESL ( $\mu\text{g}/\text{m}^3$ )	Texas CEQ Annual ESL ( $\mu\text{g}/\text{m}^3$ )	Ontario MOECC AAQCs: 24-hour averaging period ( $\mu\text{g}/\text{m}^3$ )	Baseline 24-hour PM10 ( $\mu\text{g}/\text{m}^3$ )	PM10 Max ( $\mu\text{g}/\text{m}^3$ )	Future Predicted Maximum Annual PM10 ( $\mu\text{g}/\text{m}^3$ )			Future Predicted Maximum 24-hour PM10 ( $\mu\text{g}/\text{m}^3$ )		
						Bitter Crk. Down Stream of Tailings Management Facility (PMTotal)	Between Lower Portal and Bitter Creek (PM10)	Between Lower Portal and Bitter Creek (Total)	Bitter Creek Downstream of Tailings Management Facility (PM10)	Between Lower Portal and Bitter Creek (PM10)	Road Between lower portal and Plant site (PM10)
Aluminum	50	5	4.8	0.10	0.85	4.34E-01	2.88E-01	4.04E-01	0.53	0.32	0.71
Antimony	5	0.5	25	0.000025	0.000267	1.23E-04	6.82E-05	9.56E-05	0.00016	0.00012	0.00019
Arsenic	3	0.067	0.3	0.00025	0.00485	1.25E-03	6.94E-04	9.74E-04	0.0016	0.0012	0.0019
Barium	5	0.5	10	0.0016	0.0093	6.30E-03	4.46E-03	6.26E-03	0.0083	0.0052	0.0114
Beryllium	0.02	0.002	0.01	0.0000023	0.0000188	9.01E-06	6.18E-06	8.67E-06	0.000012	0.000008	0.000017
Bismuth	50	5		0.0000011	0.0000249	9.79E-06	4.70E-06	6.59E-06	0.000012	0.000014	0.000012
Boron	50	5	120**	Not Available	0.0009	2.94E-04	1.90E-04	2.67E-04	0.00002	0.00006	0.00003
Cadmium	5.4	0.0033	0.025	0.000005	0.000079	2.41E-05	1.24E-05	1.74E-05	0.00003	0.00003	0.00004
Calcium				0.067	0.415	2.85E-01	2.03E-01	2.85E-01	0.34	0.21	0.48
Chromium	3.6 (III)	0.041 (III)	0.5 (divalent)	0.00037	0.00229	1.45E-03	1.02E-03	1.44E-03	0.0019	0.0012	0.0026
Cobalt	0.2	0.02	0.1	0.000078	0.000656	3.25E-04	2.23E-04	3.13E-04	0.00041	0.00025	0.00056
Copper	10	1	120**	0.00036	0.00407	1.69E-03	1.08E-03	1.51E-03	0.0021	0.0014	0.0027
Gallium				0.000041	0.000311	1.70E-04	1.14E-04	1.59E-04	0.00020	0.00011	0.00028
Gold	25	2.5		0.00000016	0.00000049	2.03E-07	1.35E-07	1.89E-07	0.0000008	0.0000004	0.0000011
Iron	50	50	120**	0.19	1.69	8.56E-01	5.79E-01	8.12E-01	1.02	0.63	1.38
Lanthanum				0.000044	0.000309	1.93E-04	1.40E-04	1.96E-04	0.00022	0.00014	0.00032
Lead			0.5	0.00015	0.00108	6.17E-04	3.97E-04	5.58E-04	0.0008	0.0005	0.0010
Magnesium *		50		0.10	0.74	4.26E-01	2.80E-01	3.93E-01	0.52	0.29	0.70
Manganese	2	0.2	0.4	0.0031	0.0285	1.35E-02	9.71E-03	1.36E-02	0.016	0.011	0.023
Mercury	0.25	0.025	2	0.00000031	0.00013731	4.40E-05	9.10E-06	1.28E-05	0.00005	0.00008	0.00003
Molybdenum	30	3	120**	0.00011	0.00054	4.37E-04	2.89E-04	4.05E-04	0.0006	0.0003	0.0008

Chemical	Texas CEQ 1-Hour ESL ( $\mu\text{g}/\text{m}^3$ )	Texas CEQ Annual ESL ( $\mu\text{g}/\text{m}^3$ )	Ontario MOECC AAQCs: 24-hour averaging period ( $\mu\text{g}/\text{m}^3$ )	Baseline 24-hour PM10 ( $\mu\text{g}/\text{m}^3$ )	PM10 Max ( $\mu\text{g}/\text{m}^3$ )	Future Predicted Maximum Annual PM10 ( $\mu\text{g}/\text{m}^3$ )			Future Predicted Maximum 24-hour PM10 ( $\mu\text{g}/\text{m}^3$ )		
						Bitter Crk. Down Stream of Tailings Management Facility (PMTotal)	Between Lower Portal and Bitter Creek (PM10)	Between Lower Portal and Bitter Creek (Total)	Bitter Creek Downstream of Tailings Management Facility (PM10)	Between Lower Portal and Bitter Creek (PM10)	Road Between lower portal and Plant site (PM10)
Nickel	0.33	0.059	0.1	0.00019	0.00147	7.70E-04	5.38E-04	7.54E-04	0.0010	0.0006	0.0013
Phosphorus	1	0.1		0.0077	0.0528	3.35E-02	2.23E-02	3.14E-02	0.039	0.023	0.054
Potassium	20	2	8	0.0056	0.0768	3.12E-02	1.96E-02	2.75E-02	0.037	0.033	0.046
Scandium				0.000023	0.000209	9.63E-05	7.03E-05	9.86E-05	0.00012	0.00007	0.00016
Selenium	2	0.2	10	0.000016	0.000142	7.16E-05	4.53E-05	6.35E-05	0.00009	0.00006	0.00012
Silver	0.1	0.01	1	0.0000054	0.0000584	1.97E-05	1.11E-05	1.55E-05	0.00003	0.00003	0.00004
Sodium				0.0021	0.0230	1.02E-02	6.90E-03	9.67E-03	0.012	0.009	0.016
Strontium	20	2	120**	0.00032	0.00204	1.42E-03	9.58E-04	1.34E-03	0.0017	0.0010	0.0023
Sulfur	50	5	20	0.040	0.179	1.70E-01	1.13E-01	1.58E-01	0.20	0.11	0.27
Tellurium	1	0.1	10	0.0000024	0.0000826	1.32E-05	4.60E-06	6.46E-06	0.000023	0.000023	0.000022
Thallium	2	0.1	0.24	0.0000011	0.0000110	5.09E-06	2.94E-06	4.12E-06	0.0000065	0.0000046	0.0000080
Thorium				0.0000056	0.0000609	2.58E-05	3.16E-05	4.43E-05	0.000028	0.000031	0.000051
Tin	20	2	10	0.0000021	0.0000489	1.17E-05	6.14E-06	8.61E-06	0.00001	0.00001	0.00002
Titanium	50	5	120**	0.0076	0.0474	3.35E-02	2.27E-02	3.19E-02	0.039	0.024	0.054
Tungsten	50	5		0.000068	0.000195	6.01E-05	3.79E-05	5.32E-05	0.00035	0.00018	0.00046
Uranium	0.5	0.05	0.15	0.0000040	0.0000459	2.02E-05	1.32E-05	1.85E-05	0.000024	0.000018	0.000031
Vanadium	20	2	2	0.00038	0.00342	1.61E-03	1.10E-03	1.55E-03	0.0020	0.0013	0.0027
Yttrium	10	1	2.4	Not Available	0.0000	2.81E-06	5.47E-07	7.67E-07	0.0000034	0.0000055	0.0000020
Zinc	20	2	120	0.00081	0.00707	2.77E-03	1.53E-03	2.15E-03	0.0050	0.0036	0.0060

\* The screening level for magnesium is based on the reference concentration from the Michigan Department of Environmental Quality (MDEQ); \*\* Where the Ontario MOECC AAQCs exceeded the British Columbia PM10 guideline of 50  $\mu\text{g}/\text{m}^3$ , 50  $\mu\text{g}/\text{m}^3$  was used as 24-hour particulate cutoff value; TCEQ - Texas Commission on Environmental Quality, 2018.

<http://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome>; TCEQ, 2017. Download Effects Screening Levels (ESLs) Used in the Review of Air Permitting Data; ESL - Effects Screening Levels; Ontario Ministry of Environment and Climate Change (MOECC). 2017. Ontario's Ambient Air Quality Criteria; AAQCs - Ambient Air Quality Criteria; PM10 - PM10 is particulate matter 10 micrometers or less in diameter

Table A3: Predicted Soil Concentration

Constituent	Background (mg/kg)	Road	Ore (mg/kg)	Waste Rock (mg/kg)	Background Plus Deposition Road Between lower portal and Plant site Root Zone (mg/kg)	Background Plus Deposition Between Lower Portal and Bitter Creek Root Zone (mg/kg)	Background Plus Deposition Bitter Creek Downstream of TMF Root Zone (mg/kg)	Predicted Soil Concentration at Bitter Creek Down Stream of TMF (mg COPC/kg soil)	Predicted Soil Concentration at Road Between Lower Portal and Plant site (mg COPC/kg soil)	Predicted Soil Concentration Between Lower Portal and Bitter Creek (mg COPC/kg soil)
Aluminum	29240	19900	85800	32800	29315.928	29317.314	29458.085	29397.780	29398.973	29436.011
Antimony	7.4	2.6	117	35	6.864	6.864	6.905	7.447	7.443	7.474
Arsenic	72.92	27.6	793	788.4	69.561	69.562	69.976	73.393	73.345	73.665
Barium	468.76	453.3	984	226.4	428.796	428.829	430.853	471.257	471.329	471.895
Beryllium	0.69	0.57	1.38	1.5	0.600	0.600	0.603	0.694	0.694	0.695
Bismuth	0.319	0.546	19.2	10	0.328	0.328	0.331	0.323	0.322	0.328
Boron		20	10.2	59	20.011	20.011	20.107	0.006	0.008	0.036
Cadmium	1.3485	0.82	22.78	26.4	1.098	1.098	1.106	1.359	1.357	1.367
Calcium	19640	20460	17584	17440	19660.771	19662.269	19753.795	19743.744	19747.655	19769.490
Chromium	108.74	100.92	122	148.6	99.134	99.142	99.609	109.318	109.334	109.460
Cobalt	23.045	18.5	26.6	29	22.282	22.283	22.388	23.167	23.170	23.194
Copper	106.85	79.5	798.4	269.4	106.160	106.165	106.714	107.467	107.450	107.711
Gallium	11.97	6.2			12.081	12.082	12.137	12.031	12.033	12.038
Gold	0.04784	0.00702			0.014	0.014	0.014	0.048	0.048	0.048
Iron	57060	45100	112620	79840	58181.66	58184.863	58461.491	57365.953	57371.012	57440.686
Lanthanum	12.93	14.96	10	5	13.382	13.383	13.445	12.998	13.001	13.015
Lead	42.685	27.292	183.6	118.4	39.992	39.994	40.195	42.923	42.920	42.997
Magnesium	29560	14500	20800	26720	29715.779	29716.790	29855.146	29714.434	29717.071	29736.477
Manganese	919.3	1068.4	1275	1632.4	916.509	916.587	920.929	924.246	924.407	925.754
Mercury	0.092	0.05	105	140.5	0.081	0.081	0.096	0.108	0.099	0.146
Molybdenum	32.33	14.04	4	5	30.996	30.997	31.139	32.496	32.500	32.512
Nickel	55.305	50.1	62.4	78	52.599	52.602	52.85	55.599	55.607	55.671
Phosphorus	2260	1358	1830	1680	2336.246	2336.343	2347.202	2271.821	2272.079	2273.730
Potassium	1640	2400	39180	4440	1651.036	1651.191	1661.357	1651.306	1650.308	1660.385



Constituent	Background (mg/kg)	Road	Ore (mg/kg)	Waste Rock (mg/kg)	Background Plus Deposition Road Between lower portal and Plant site Root Zone (mg/kg)	Background Plus Deposition Between Lower Portal and Bitter Creek Root Zone (mg/kg)	Background Plus Deposition Bitter Creek Downstream of TMF Root Zone (mg/kg)	Predicted Soil Concentration at Bitter Creek Down Stream of TMF (mg COPC/kg soil)	Predicted Soil Concentration at Road Between Lower Portal and Plant site (mg COPC/kg soil)	Predicted Soil Concentration Between Lower Portal and Bitter Creek (mg COPC/kg soil)
Scandium	6.77	7.42			6.779	6.779	6.81	6.805	6.807	6.812
Selenium	4.7	2.98	31.9	11.5	4.543	4.543	4.566	4.727	4.726	4.737
Silver	1.58	0.869	28.80	2.94	1.001	1.001	1.007	1.590	1.589	1.596
Sodium	605	832	6900	1194.00	612.861	612.918	616.196	608.658	608.568	610.726
Strontium	95.56	71.9	134.8	151.2	96.903	96.908	97.366	96.070	96.079	96.186
Sulfur	11690	5660			12081.355	12081.759	12136.83	11749.874	11751.580	11755.631
Tellurium	0.701	0.128	25	25	0.315	0.315	0.32	0.708	0.706	0.716
Thallium	0.32	0.12	2.5	2.5	0.300	0.30018	0.3019	0.322	0.322	0.323
Thorium	1.65	10.4			1.676	1.677	1.684	1.659	1.662	1.669
Tin	0.62	0.3	10	10	0.580	0.580	0.584	0.624	0.624	0.628
Titanium	2247	1680	3000.00	1650.00	2313.747	2313.868	2324.687	2258.854	2259.139	2261.253
Tungsten	20.14	1.7	10	10	4.027	4.027	4.047	20.244	20.244	20.249
Uranium	1.174	1.364	7.5	10	1.209	1.209	1.215	1.181	1.181	1.185
Vanadium	111.365	97.58	234	189	108.249	108.256	108.775	111.966	111.976	112.128
Yttrium			7.1	9	0.000	0.000	0.001	0.001	0.000	0.003
Zinc	237.205	97.6	2597	1633.6	143.758	143.763	144.677	238.687	238.565	239.437

**Table A4: Soil Screening Levels Evaluated in the Identification of Human Health COPCs**

Chemicals	USEPA RSLs (mg/kg)	BC Background (Protocol 4) (mg/kg)	CEQG Soil Quality for the Protection of Human Health (Residential/ Parkland) (mg/kg)	BC CSR Schedule 3.1 Part 2 Residential/ Parkland (mg/kg)	BC CSR Schedule 3.1 Part 1 Residential/ Parkland (mg/kg)	Screening value (mg/kg)
Aluminum <sup>1</sup>	15400	40000		40000		40000
Antimony			20	500		500
Arsenic		15	12		40	12
Barium		400	6800		15000	500
Beryllium		2	75		150	75
Bismuth						
Boron				15000		3200
Cadmium <sup>2</sup>		0.6	14		40	14
Chloride					1000	1000
Chromium		65	220		250	220
Cobalt		15	50		25	25
Copper		50	1100		75000	1100
Gallium <sup>3</sup>						
Gold <sup>4</sup>						
Iron <sup>5</sup>	11000	30000		35000		35000
Lead		15	140		120	120
Manganese					10000	10000
Mercury <sup>2</sup>		0.15	6.6		25	6.6
Molybdenum		1	10		400	400
Nickel	50	50	200		900	200
Scandium <sup>6</sup>						
Selenium <sup>2</sup>		0.25	80		400	80
Silver		1	20	400		20
Sodium <sup>7</sup>					1000	1000
Strontium		47000		20000		20000
Sulfur <sup>8</sup>						
Thallium			1			1
Thorium <sup>9</sup>						
Tin		4	50	50000		50000
Titanium <sup>10</sup>						
Tungsten	12.6			25		25
Uranium			23		250	23

Chemicals	USEPA RSLs (mg/kg)	BC Background (Protocol 4) (mg/kg)	CEQG Soil Quality for the Protection of Human Health (Residential/Parkland) (mg/kg)	BC CSR Schedule 3.1 Part 2 Residential/Parkland (mg/kg)	BC CSR Schedule 3.1 Part 1 Residential/Parkland (mg/kg)	Screening value (mg/kg)
Vanadium		100			400	400
Zinc		150	200		25000	25000

1 - Aluminum is most abundant element in the earth's crust 8.23% average =82300 mg/kg (Wedepohl, K.H. 1995. The composition of the continental crust. *Geochemica et Cosmochemica Acta* 46(4): 741-752.); 2 - Due to biomagnification potential cadmium and mercury and selenium were included as COPCs 3 - Average crustal abundance of Gallium = 19 mg/kg (Wedepohl 1995); generally considered to have low toxicity (Jewett, S.A., Makowski, M.S., Andrews, B., Manfra, M.J., and Ivanisevic, A. 2012. Gallium nitride is biocompatible and non-toxic before and after functionalization with peptides. *Acta Biomaterialia* 8(2): 728-733. 4 - Gold generally considered to be non-toxic (Tang D., Yuan R., and Chai Y. 2007. Biochemical and immunochemical characterization of the antigen-antibody reaction on a non-toxic biomimetic interface immobilized red blood cells of crucian carp and gold nanoparticles. *Biosensors and Bioelectronics* 22(6): 1116-1120.). 5 - Iron is 2nd most abundant element in the earth's crust 5.63% average = 56,300 mg/kg (Wedepohl, 1995); 6 - Average crustal abundance of Scandium = 16 mg/kg (Wedepohl 1995); 7 - essential nutrients calcium, magnesium, phosphorus, potassium, and sodium are not considered to be COPCs; 8 - The RDA for sulphur ranges from 800 to 900 mg/day if we assume that 20% of the intake comes from incidental soil ingestion that means 160 to 180 mg of sulphur can be consumed per day via the incidental soil ingestions route. However, Health Canada reports that incidental soil ingestion rates range from 20 to 80 mg per day. At that rate 100% of soil consumption could be elemental sulphur and the recommended daily contribution from soil would not be met. Therefore, sulphur was not considered to be a COPC in soil. 9 - Average crustal abundance of Thorium = 6 mg/kg (Wedepohl 1995); 10 - Titanium is 9th most abundant element in the earth's crust 0.565% average = 5,650 mg/kg (Wedepohl 1995); Additional References: BCMOE. 2017. Protocol for Contaminated Sites Establishing Background Concentrations in Soil. Version 9. Queens Printers. Victoria, British Columbia; BCMOE. 2017. BC Contaminated Sites Regulation. <https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/guidance-resources>; CCME. 2017. Environmental Quality Guidelines Summary Tables. <http://stts.cme.ca/index.html>; USEPA. 2017. Regional Screening Levels. <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017>

Table A5: Soil COPCs

Chemicals	Background (mg/kg)	Background Plus Deposition Bitter Creek Downstream of TMF (mg/kg)	Background Plus Deposition Road Between lower portal and Plant site (mg/kg)	Background Plus Deposition Between Lower Portal and Bitter Creek (mg/kg)	Screening Levels (mg/kg)	COPCs (mg/kg)
Aluminum	29300	29315.808	29459.281	29473.136	40000	No
Antimony	6.86	6.864	6.9	6.901	500	No
Arsenic	69.52	69.566	69.928	69.938	12	Yes
Barium	428.56	428.789	430.923	431.253	6800	No
Beryllium	0.6	0.600	0.603	0.604	75	No
Bismuth	0.3275	0.328	0.33	0.33	NA*	Yes
Boron	20	20.011	20.107	20.114	15000	No
Cadmium	1.097	1.098	1.104	1.105	14	Yes <sup>1</sup>
Calcium	19650	19660.379	19757.706	19772.695	NA	No <sup>2</sup>
Chromium	99.08	99.133	99.625	99.698	220	No
Cobalt	22.27	22.282	22.391	22.404	25	No
Copper	106.1	106.161	106.696	106.749	1100	No
Gallium	12.075	12.081	12.139	12.143	NA*	No <sup>4</sup>
Gold	0.014425	0.014	0.015	0.015	NA*	No
Iron	58150	58181.149	58466.598	58498.628	3500	Yes
Lanthanum	13.375	13.382	13.448	13.459	NA*	No <sup>4</sup>
Lead	39.97	39.992	40.191	40.209	120	No
Magnesium	29700	29715.515	29857.788	29867.902	NA*	No <sup>2</sup>
Manganese	916	916.493	921.09	921.869	10000	No
Mercury	0.08	0.082	0.087	0.086	6.6	Yes <sup>1</sup>
Molybdenum	30.98	30.996	31.143	31.153	400	No
Nickel	52.57	52.598	52.858	52.894	200	No
Phosphorus	2335	2336.220	2347.464	2348.427	NA*	No <sup>2</sup>
Potassium	1650	1651.136	1660.359	1661.91	NA*	No <sup>2</sup>
Scandium	6.775	6.779	6.812	6.817	NA*	No <sup>4</sup>
Selenium	4.54	4.543	4.565	4.567	80	Yes <sup>1</sup>
Silver	1	1.001	1.006	1.007	20	No
Sodium	612.5	612.870	616.106	616.683	1000	No
Strontium	96.85	96.902	97.375	97.426	20000	No
Sulfur	12075	12081.183	12138.553	12142.594	NA*	No <sup>3</sup>
Tellurium	0.315	0.315	0.318	0.318	NA*	No
Thallium	0.3	0.3002	0.302	0.30177	1	No
Thorium	1.675	1.676	1.687	1.695	NA*	No <sup>4</sup>
Tin	0.58	0.580	0.584	0.584	50000	No

Chemicals	Background (mg/kg)	Background Plus Deposition Bitter Creek Downstream of TMF (mg/kg)	Background Plus Deposition Road Between lower portal and Plant site (mg/kg)	Background Plus Deposition Between Lower Portal and Bitter Creek (mg/kg)	Screening Levels (mg/kg)	COPCs (mg/kg)
Titanium	2312.5	2313.719	2324.975	2326.178	NA*	No <sup>4</sup>
Tungsten	4.025	4.027	4.047	4.048	25	No
Uranium	1.208	1.209	1.215	1.216	23	No
Vanadium	108.19	108.248	108.785	108.855	400	No
Yttrium		0.000	0	0	NA*	No <sup>4</sup>
Zinc	143.67	143.771	144.551	144.598	25000	No

\*Screening levels were not available (NA) for bismuth, calcium gallium, gold, lanthanum, magnesium, phosphorous, potassium, scandium, sulfur, tellurium, thorium, titanium, and yttrium; 1- Cadmium, mercury and selenium were carried forward as COPCs because of their potential to biomagnify in the food chain; 2 - The essential nutrients calcium, magnesium, phosphorus, potassium, and sodium were not carried forward as COPCs, since they are generally only toxic at extremely high concentrations; 3 - Sulphur is also generally considered to have low toxicity- to humans; 4 - Because the average crustal concentration of the rare earth elements gallium (19 mg/kg) lanthanum (30 mg/kg), scandium (22 mg/kg), thorium (9.6 mg/kg), and yttrium (24 mg/kg) are considerably greater than the predicted future concentrations, they were not carried forward as COPCs. (Wedepohl, K.H. 1995. The composition of the continental crust. *Geochemica et Cosmochemica Acta* 46(4): 741-752.)

**Table A6: Surface Water Screening Levels**

<b>Parameter</b>	<b>Health Canada MAC* (mg/L)</b>	<b>BC CSR Schedule 3.2 Generic Numerical Water Standards for Drinking Water** (mg/L)</b>	<b>Regional Screening Levels*** (mg/L)</b>	<b>Screening Level (mg/L)</b>
Chloride		250		250
Fluoride		1.5		1.5
Bromide				
Sulphate (SO4)		500		500
Nitrate Nitrogen		10		10
Nitrite Nitrogen	1	1		1
Total Nitrogen				
Ammonia Nitrogen				
Cyanide	0.2	0.2		0.2
Aluminum		9.5		9.5
Antimony	0.006	0.006		0.006
Arsenic	0.01	0.01		0.01
Barium	1	1		1
Beryllium		0.08		0.08
Bismuth				
Boron	5	5		5
Cadmium	0.005	0.005		0.005
Calcium				
Chromium	0.05	0.05		0.05
Cobalt			0.006	0.006
Copper		1.5		1.5
Iron		6.5		6.5
Lead	0.01	0.01		0.01
Magnesium				
Manganese		1.5		1.5
Mercury	0.001	0.001		0.001
Molybdenum		0.25		0.25
Nickel		0.08		0.08
Selenium	0.05	0.01		0.01
Silicon				
Silver		0.02		0.02
Sodium		200		200
Strontium			2.4	2.4
Thallium			0.0002	0.0002
Tin		2.5		2.5
Titanium				
Uranium	0.02	0.02		0.02



<b>Parameter</b>	<b>Health Canada MAC* (mg/L)</b>	<b>BC CSR Schedule 3.2 Generic Numerical Water Standards for Drinking Water** (mg/L)</b>	<b>Regional Screening Levels*** (mg/L)</b>	<b>Screening Level (mg/L)</b>
Vanadium		0.02		0.02
Zinc		3		3

\*MAC = Maximum Acceptable Concentration; Health Canada. 2017. Guidelines for Canadian Drinking Water Quality – Summary Table.  
<https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table-health-canada-2012.html>; \*\* BCMOE. 2017. BC Contaminated Sites Regulation (CSR).  
<https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/guidance-resources> \*\*\*USEPA. 2017. Regional Screening Levels.  
<https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017>

**Table A7: Identification of COPCs in Surface Water (Unfiltered), Red Mountain Underground Gold Project**

Constituent	Screening Level (mg/L)	Maximum Baseline Concentration (mg/L)	Predicted Maximum 90th Percentile Concentration Operation (mg/L)	Predicted Maximum 90th Percentile Concentration Closure/ Post Closure (mg/L)	Maximum Concentration (mg/L)	COPC
Field pH		8.33	9.45	9.45	9.45	No
Hardness CaCO3		416	260.8	233.3	416	NA
Total Dissolved Solids		507	362.5	344.7	507	NA
Total Suspended Solids		2000	927.6	920.4	2000	NA
Turbidity (NTU)		2320	667.8	659.2	2320	NA
Alkalinity-Total CaCO3		135	102.6	92.24	135	NA
Acidity (as CaCO3)		32	19.23	16.91	32	NA
Chloride	250	2.5	0.9318	0.9101	2.5	No
Fluoride	1.5	0.297	0.2094	0.207	0.297	No
Bromide		0.25	0.05712	0.0536	0.25	NA
Sulphate (SO4)	500	265	294.3	176.6	294.3	No
Nitrate Nitrogen	10	0.603	2.059	0.2925	2.059	No
Nitrite Nitrogen	1	0.005	0.04745	0.001351	0.04745	No
Total Nitrogen		0.445	2.368	0.2496	2.368	NA
Ammonia Nitrogen		0.0155	0.2609	0.03455	0.2609	No
Ortho-Phosphate		0.0035	0.002709	0.002606	0.0035	NA
Phosphorus - Total		1.55	1.158	1.145	1.55	NA
Total Organic Carbon		3.96	2.663	2.642	3.96	NA
Dissolved Organic		1.11	0.8703	0.8342	1.11	NA
Aluminum	9.5	36.8	26.4	26.06	36.8	Yes
Antimony	0.006	0.2	0.02598	0.02308	0.2	Yes
Arsenic	0.01	0.0808	0.05085	0.05038	0.0808	Yes
Barium	1	0.537	0.2633	0.2613	0.537	No
Beryllium	0.08	0.001	0.001075	0.0009992	0.001075	No
Bismuth <sup>1</sup>		0.2	0.126	0.1245	0.2	Yes
Boron	5	0.1	0.1075	0.09992	0.1075	No
Cadmium	0.005	0.00293	0.006953	0.001634	0.006953	Yes
Calcium <sup>2</sup>		145	98.68	97.95	145	No
Chromium	0.05	0.058	0.03826	0.03822	0.058	Yes
Cobalt	0.006	0.0649	0.01737	0.01764	0.0649	Yes
Copper	1.5	0.175	0.09272	0.09148	0.175	No
Iron	6.5	100	65.86	65.01	100	Yes
Lead	0.01	0.0339	0.01769	0.0177	0.0339	Yes
Magnesium <sup>3</sup>		30	25.49	25.3	30	No
Manganese	1.5	1.98	1.833	1.165	1.98	Yes
Mercury <sup>4</sup>	0.001	0.000086	0.0004778	0.00005016	0.000478	Yes

Constituent	Screening Level (mg/L)	Maximum Baseline Concentration (mg/L)	Predicted Maximum 90th Percentile Concentration Operation (mg/L)	Predicted Maximum 90th Percentile Concentration Closure/ Post Closure (mg/L)	Maximum Concentration	COPC
Molybdenum	0.25	0.03	0.01418	0.01211	0.03	No
Nickel	0.08	0.21	0.1173	0.117	0.21	No
Selenium	0.01	0.0125	0.008669	0.005565	0.0125	Yes
Silicon		47.2	30.7	30.36	47.2	No
Silver	0.02	0.0016	0.001017	0.00105	0.0016	No
Sodium	200	12	6.42	4.979	12	No
Strontium	2.4	1.06	0.5337	0.5075	1.06	No
Thallium	0.0002	0.00021	0.000215	0.0001998	0.000215	Yes
Tin	2.5	0.0005	0.0005375	0.0004996	0.000538	No
Titanium <sup>5</sup>		0.466	0.4522	0.449	0.466	No
Uranium	0.02	0.00156	0.0009434	0.0009259	0.00156	No
Vanadium	0.02	0.134	0.08637	0.0854	0.134	Yes
Zinc	3	0.258	0.4318	0.1553	0.4318	No
Cyanide (Total)	0.2	NA	0.00297	0.0000932	0.00297	No
Cyanide WAD	0.2	NA	0.000127	0.00000398	0.000127	No

1-Bismuth - No drinking water guideline or toxicity value available Therefore included as a COPC; 2-There is no evidence of adverse health effects specifically attributable to Calcium in drinking water. (Government of Canada. 2017. Guidelines for Canadian Drinking Water Quality: Supporting Documents – Calcium. <https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-supporting-documents-calcium.html>); 3- There is no evidence of adverse health effects specifically attributable to magnesium in drinking water. (Government of Canada. 2017. Guidelines for Canadian Drinking Water Quality: Supporting Documents – Magnesium. <https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-supporting-documents-magnesium.html>); 4 - Mercury did not screen in; however, because of the potential for bioaccumulation it was considered to be a COPC; 5 - Titanium is relatively non-toxic. It does not accumulate in the human body (New Brunswick. 2017. Facts on Drinking Water. [http://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/HealthyEnvironments/water/GeneralChemistry\\_Metalse.pdf](http://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/HealthyEnvironments/water/GeneralChemistry_Metalse.pdf); NA – Not Available.

**Table A8: Groundwater Sample Locations**

<b>Sample ID</b>	<b>Established</b>	<b>Location Description</b>	<b>Notes</b>
RMS1	August 2014	Seep on east side of waste rock dump	Included in geochemistry evaluation
RMS2	August 2014	Seep on southwest side of waste rock dump	Included in geochemistry evaluation
RMS3	August 2014	Seep on northwest side of waste rock dump	Included in geochemistry evaluation
RMS4	June 2014	Ponded water in the underground decline	Included in baseline water quality evaluation
RMS5	July 2015	Artesian drill holes located on steep slope on the southern edge of cirque, the inclined pipe is sampled	Included in baseline water quality evaluation
RMS6	August 2014	Artesian drill hole located in cirque near GSC09 and GSC07	Included in baseline water quality evaluation
RMS7	September 2014	Artesian drill hole located on steep slope on the northern side of cirque	Included in baseline water quality evaluation
NCribs	October 2015	Two separate cribs (Ncrib N and Ncrib S) containing waste rock near portal entrance	Included in geochemistry evaluation
MW16-002	August 2016	Monitoring well near Bromley Humps west of south embankment of proposed tailings facility	Monitoring initiated in September 2016
MW16-003	August 2016	Monitoring well near Bromley Humps west of south embankment of proposed tailings facility	Monitoring initiated in September 2016
MW16-004	August 2016	Monitoring well near Bromley Humps northwest of north embankment of proposed tailings facility	Monitoring initiated in September 2016

Table A9: Groundwater COPCs

Chemical	Drinking Water Screening Level (mg/L)	Maximum Baseline Concentration (mg/L)	Maximum Predicted Future Concentration (mg/L)	COPC
Ammonia	NA	15	-	No
Nitrite	1	0.01	-	No
Nitrate	10	15	-	Yes
Chloride	250	1.5	-	No
Cyanide (SAD)	0.2	NA	-	No <sup>1</sup>
Sulphate	500	198.15	340	No
Aluminum	9.5	0.2346	0.067	No
Antimony	0.006	0.11	0.031	Yes
Arsenic	0.01	0.0178	0.01	Yes
Barium	1	0.04015	-	No
Beryllium	0.08	0.000244	-	No
Bismuth		Non-detect at <0.05	-	No <sup>1</sup>
Boron	5	0.11	-	No
Cadmium	0.005	0.0012	0.0082	Yes
Calcium		90.05	97	No <sup>2</sup>
Chromium	0.05	0.0036	0.004	No
Cobalt	0.006	0.00332	0.011	Yes
Copper	1.5	0.080925	0.018	No
Iron	6.5	0.0948	0.37	No
Lead	0.01	0.0017225	0.002	No
Magnesium		15	13	No
Manganese	1.5	0.3287	2.2	Yes
Mercury	0.001	0.0002075	0.0002	Yes <sup>3</sup>
Molybdenum	0.25	0.03	0.011	No
Nickel	0.08	0.014179955	0.065	No
Selenium	0.01	0.006	0.0099	Yes <sup>3</sup>
Silicon		4.049	-	No <sup>4</sup>
Silver	0.02	0.0001	0.00008	No
Sodium	200	8.085	-	No
Strontium	2.4	1.751	-	No
Sulfur		65.78	-	No
Thallium	0.0002	0.000011	-	No
Tin	2.5	0.00015	-	No
Titanium		0.013	-	No
Uranium	0.02	0.0011	-	No

<b>Chemical</b>	<b>Drinking Water Screening Level (mg/L)</b>	<b>Maximum Baseline Concentration (mg/L)</b>	<b>Maximum Predicted Future Concentration (mg/L)</b>	<b>COPC</b>
Vanadium	0.02	NA	-	No <sup>1</sup>
Zinc	3	0.07435	0.51	No

1 – Groundwater modelling indicates that chemical unlikely to reach groundwater; 2 - The essential nutrients calcium, magnesium, phosphorus, potassium, and sodium were not carried forward as COPCs, since they are generally only toxic at extremely high concentrations; 3 - Mercury and selenium did not screen in; however, because of the potential for bioaccumulation they were considered to be COPCs; 4 – non-toxic; NA – not available



**Table A10: Sediment COPCs**

Constituent	Sediment Screening Level (mg/kg)	95 <sup>th</sup> Percentile Baseline Concentration (mg/kg)	Maximum Future Predicted Concentration (mg/kg)	COPC
Aluminum	40000	23350	33227	No
Antimony	500	8.628	19.855	No
Arsenic	12	119.616	218.351	Yes
Barium	500	542.12	1208.13	Yes
Beryllium	75	0.704	1.122	No
Bismuth	NA	0.91	1.08	Yes
Cadmium	14	3.33	12.84	Yes <sup>1</sup>
Calcium	NA	33836	38458.52	No <sup>2</sup>
Chromium	220	55.72	95.93	No
Cobalt	25	37.01	330.79	Yes
Copper	1100	608.70	1798.15	Yes
Iron	35000	72017.00	124478.5	Yes
Lead	120	62.43	279.52	Yes
Lithium	65	25.33	-	No
Magnesium	NA	17199.40	21202.78	No <sup>2</sup>
Manganese	10000	1573.54	22123.88	Yes
Mercury	6.6	0.08	0.16	Yes <sup>1</sup>
Molybdenum	400	88.43	194.53	No
Nickel	200	70.58	121.66	No
Potassium	NA	1795.60	-	No <sup>2</sup>
Selenium	80	9.29	15.34	Yes <sup>1</sup>
Silver	20	1.27	6.64	No
Sodium	1,000	252.14	346.95	No
Strontium	20000	155.12	161.93	No
Thallium	1	0.22	0.28	No
Tin	50000	0.52	0.58	No
Titanium	NA	905.60	973.66	No <sup>2</sup>
Uranium	23	1.78	2.51	No
Vanadium	400	132.20	137.54	No
Zinc	25000	440.60	1306.70	No

COPC – Contaminant of Potential Concern; NA – Not Available; 1 – Identified as a COPC as a COPC because of the potential to bioaccumulate; 2 – The essential nutrients calcium, magnesium, and potassium were not carried forward as COPCs since they are generally only toxic at extremely high concentrations. The concentration titanium in sediment was not carried forward as COPCs as the concentration was much lower than the average concentrations in the earth's crust for 5,650 mg/kg for titanium (Wedepohl, K.H. 1995. The composition of the continental crust. *Geochemica et Cosmochemica Acta* 46(4): 741-752).

**Table A11: Country Food Screening Levels**

Chemicals	Toxicity Reference Value		Screening Level (Fish and Plants)				Source of TRV
	Total Daily Intake (TDI) (mg/kg-d)	Cancer Slope Factor (CSF) (mg/kg-d) <sup>-1</sup>	Non-carcinogenic (Adult) (mg/kg)	Non-carcinogenic (Toddler) (mg/kg)	Carcinogenic (Adult) (mg/kg)	Carcinogenic (Toddler) (mg/kg)	
Aluminum	1	NA	48.76	36.26	NA	NA	PPRTV
Antimony	0.0004	NA	0.020	0.015	NA	NA	IRIS
Arsenic	0.001	1.8	0.049	0.036	0.00135	0.00020	TDI - RIVM; SF - Health Canada
Barium	0.2	NA	9.75	7.25	NA	NA	IRIS
Beryllium	0.002	NA	0.10	0.07	NA	NA	IRIS
Bismuth	NA	NA	NA	NA	NA	NA	
Boron	0.2	NA	9.75	7.25	NA	NA	IRIS
Cadmium	0.001	NA	0.049	0.036	NA	NA	Health Canada 2010
Chromium	0.003	NA	0.15	0.11	NA	NA	Health Canada 2010
Cobalt	0.0014	NA	0.068	0.051	NA	NA	PPRTV
Copper	0.141	NA	6.87	5.11	NA	NA	Health Canada 2010
Iron	0.7	NA	34.13	25.38	NA	NA	Richardson and Wilson
Lead (Adult)	0.0015	NA	0.07	NA	NA	NA	Richardson and Wilson
Lead (Toddler)	0.0006	NA	NA	0.02	NA	NA	Health Canada 2010
Manganese (Adult)	0.156	NA	7.61	NA	NA	NA	Health Canada 2010
Manganese (Toddler)	0.136	NA	NA	4.93	NA	NA	Health Canada 2010
Mercury (Adult)	0.00047	NA	0.023	NA	NA	NA	Health Canada 2010
Mercury (Toddler)	0.0002	NA	NA	0.007	NA	NA	Health Canada 2010
Molybdenum	0.028	NA	1.37	1.02	NA	NA	Health Canada 2010
Nickel	0.02	NA	0.98	0.73	NA	NA	Health Canada 2010
Selenium	0.005	NA	0.24	0.18	NA	NA	IRIS
Silver	0.005	NA	0.24	0.18	NA	NA	IRIS
Strontium	0.6	NA	29.26	21.76	NA	NA	IRIS
Thallium	0.00001	NA	0.00049	0.00036	NA	NA	IRIS
Tin	0.6	NA	29.26	21.76	NA	NA	HEAST
Titanium	3	NA	146.28	108.79	NA	NA	NSF
Uranium	0.0006	NA	0.029	0.022	NA	NA	Health Canada 2010

Chemicals	Toxicity Reference Value		Screening Level (Fish and Plants)				Source of TRV
	Total Daily Intake (TDI) (mg/kg-d)	Cancer Slope Factor (CSF) (mg/kg-d) <sup>-1</sup>	Non-carcinogenic (Adult) (mg/kg)	Non-carcinogenic (Toddler) (mg/kg)	Carcinogenic (Adult) (mg/kg)	Carcinogenic (Toddler) (mg/kg)	
Vanadium	0.005	NA	0.24	0.18	NA	NA	RSL
Zinc	0.5	NA	24.38	18.13	NA	NA	Health Canada 2010

NA = TRV not available and screening not calculated.

$$\text{noncarcinogenic SL} = 0.2 \times \frac{(TDI \times BW)}{IR}$$

$$\text{carcinogenic SL} = \frac{\left(\frac{ARL}{CSF} \times BW\right)}{IR} \times ADAF$$

Calculation general input values not included in table:

	Adult	Toddler
Body weight (kg; BW)	70.7	16.5
Ingestion Rate (kg/day; IR)	0.29	0.091
Acceptable cancer risk level (ARL) (unitless)	1.00E-05	1.00E-05
ADAFs (unitless Health Canada 2013)	5	

Reference: Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada Part II: Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0. September 2010; Health Canada. 2013. Interim Guidance on Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites. Publications Health Canada. Ottawa Ontario. Oakridge National Laboratory Risk Assessment Information System (RAIS). 2017. Available online at: <http://rais.ornl.gov/>. Last accessed on Aug. 30, 2017. Richardson M., and Wilson R. 2012. Proposed Toxicological Reference Values and Risk-based Soil Concentrations for Protection of Human Health from Lead (Pb) at Federal Contaminated Sites. RPIC Federal Contaminated Sites National Workshop, April 30 – May 3. Toronto. United States Environmental Protection Agency Health Effects Assessment Summary Tables (HEAST). 2017. Available online at: <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=2877>. Last accessed on Aug. 30, 2017. United States Environmental Protection Agency Integrated Risk Information System (IRIS). 2017. Available online at: <http://www.epa.gov/iris/>. Last accessed on Aug. 30, 2017. United States Environmental Protection Agency Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). 2017. Available online at: <http://hhpprtv.ornl.gov/>. Last accessed on Aug. 30, 2017. United States Environmental Protection Agency Regional Screening Levels (RSLs). 2017. Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls>. Last accessed on Aug. 30, 2017.

**Table A12: Country Food – Fish and Plant COPCs**

<b>Constituent</b>	<b>Country Foods – Fish and Plants Screening Level (mg/kg)</b>	<b>Maximum Measured Fish Concentration (mg/kg)</b>	<b>Maximum Measured Plant Concentration (mg/kg)</b>	<b>COPC</b>
Aluminum	36.264	56.90	54.53	Yes
Antimony	0.015	0.127	0.029	Yes
Arsenic	0.0002	10.30	0.38	Yes
Barium	7.253	2.86	29.49	Yes
Beryllium	0.073	0.0020	0.00256	No
Bismuth	NA	0.020	0.0037	No
Boron	7.253	0.10	17.32	Yes
Cadmium	0.036	1.03	2.65	Yes
Calcium	NA	10300	8893.80	No
Chromium	0.109	0.10	0.25	Yes
Cobalt	0.05	0.51	0.48	Yes
Copper	5.11	2.47	5.46	No
Iron	25.38	314.00	139.45	Yes
Lead	0.02	1.02	0.138	Yes
Manganese	4.93	7.63	235.97	Yes
Mercury	0.007	0.0110	0.0054	Yes <sup>1</sup>
Molybdenum	1.02	0.600	0.16	No
Nickel	0.73	0.59	4.87	Yes
Phosphorus	NA	7400.00	1395.90	No
Selenium	0.18	3.44	1.28	Yes
Silver	0.18	0.040	0.0073	No
Sodium	NA	1060.00	14.27	No
Strontium	21.76	9.43	38.53	Yes
Thallium	0.00036	0.030	0.00074	Yes
Tin	21.76	0.070	0.0110	No
Titanium	108.79	2.11	1.70	No
Uranium	0.022	0.0290	0.00146	Yes
Vanadium	0.18	0.26	0.168	Yes
Zinc	18.13	40.50	129.93	Yes

1 – Identified as a COPC as a COPC because of the potential to bioaccumulate

**Table A13: Country Food – Wild Game, Fish and Plant COPCs**

<b>Constituent</b>	<b>Soil COPC</b>	<b>Surface Water COPC</b>	<b>Country Food COPC based on Fish and Plant Screening</b>	<b>Country Foods COPC based on Soil and Surface Water</b>
Aluminum		X	X	X
Antimony		X	X	X
Arsenic	X	X	X	X
Barium			X	X
Bismuth	X	X		X
Boron			X	X
Cadmium	X	X	X	X
Chromium		X	X	X
Cobalt		X	X	X
Iron	X	X	X	X
Lead		X	X	X
Manganese		X	X	X
Mercury	X	X	X	X
Nickel			X	X
Selenium	X	X	X	X
Strontium			X	X
Tellurium	X			X
Thallium		X	X	X
Vanadium		X	X	X
Uranium			X	X
Zinc			X	X

**Table A14: Baseline, Operational, and Post Closure Surface Water Concentrations**

<b>Constituent</b>	<b>Baseline Mean P90 (mg/L)</b>	<b>Operational Mean P90 (mg/L)</b>	<b>Post Closure Mean P90 (mg/L)</b>
Total Hardness	1.34E+02	1.44E+02	1.37E+02
TDS	1.82E+02	1.84E+02	1.80E+02
Turbidity	2.82E+02	2.83E+02	2.79E+02
Alkalinity	6.49E+01	6.67E+01	6.48E+01
Acidity	6.46E+00	6.83E+00	6.37E+00
Chloride	5.58E-01	5.70E-01	5.53E-01
Fluoride	6.37E-02	6.39E-02	6.30E-02
Bromide	5.04E-02	5.08E-02	4.98E-02
Sulfate	6.18E+01	7.42E+01	6.56E+01
Nitrate Nitrogen (mg/L as N)	1.30E-01	3.01E-01	1.29E-01
Nitrite Nitrogen (mg/L as N)	1.01E-03	1.97E-03	1.01E-03
Nitrogen, total	1.73E-01	1.98E-01	1.72E-01
Ammonia Nitrogen	6.97E-03	1.63E-02	1.18E-02
Phosphate	1.60E-03	1.60E-03	1.58E-03
Phosphorus, total	3.57E-01	3.58E-01	3.54E-01
Total Organic Carbon	1.04E+00	1.07E+00	1.03E+00
Dissolved Organic Carbon	6.10E-01	6.31E-01	6.04E-01
Aluminum, dissolved	8.22E-02	8.44E-02	8.21E-02
Antimony, dissolved	1.02E-03	2.18E-03	1.40E-03
Arsenic, dissolved	7.32E-04	1.09E-03	8.32E-04
Barium, dissolved	5.65E-02	5.66E-02	5.58E-02
Beryllium, dissolved	9.41E-04	9.42E-04	9.30E-04
Bismuth, dissolved	1.04E-02	1.05E-02	1.04E-02
Boron, dissolved	9.41E-02	9.47E-02	9.32E-02
Cadmium, dissolved	1.33E-04	4.30E-04	2.16E-04
Calcium, dissolved	4.50E+01	4.81E+01	4.61E+01
Chromium, dissolved	9.41E-04	1.08E-03	1.27E-03
Cobalt, dissolved	3.33E-04	7.68E-04	8.00E-04
Copper, dissolved	1.40E-03	2.07E-03	1.58E-03
Iron, dissolved	6.50E-02	7.78E-02	7.38E-02
Lead, dissolved	4.97E-04	5.69E-04	7.37E-04
Magnesium, dissolved	5.17E+00	5.58E+00	5.26E+00
Manganese, dissolved	1.88E-02	9.87E-02	3.93E-02
Mercury, dissolved	7.16E-06	1.45E-05	8.10E-06
Molybdenum, dissolved	4.64E-03	5.05E-03	4.77E-03
Nickel, dissolved	2.09E-03	4.43E-03	2.85E-03
Selenium, dissolved	1.90E-03	2.26E-03	2.10E-03
Silicon, dissolved	1.84E+00	1.85E+00	1.82E+00
Silver, dissolved	1.92E-05	2.24E-05	5.72E-05

<b>Constituent</b>	<b>Baseline Mean P90 (mg/L)</b>	<b>Operational Mean P90 (mg/L)</b>	<b>Post Closure Mean P90 (mg/L)</b>
Sodium, dissolved	2.15E+00	2.48E+00	2.13E+00
Strontium, dissolved	2.57E-01	2.57E-01	2.53E-01
Thallium, dissolved	1.88E-04	1.88E-04	1.86E-04
Tin, dissolved	4.78E-04	4.79E-04	4.72E-04
Titanium, dissolved	1.03E-02	1.03E-02	1.02E-02
Uranium, dissolved	4.11E-04	4.12E-04	4.05E-04
Vanadium, dissolved	7.08E-04	7.10E-04	7.01E-04
Zinc, dissolved	6.84E-03	2.53E-02	1.34E-02
Cyanide, total	Not Available	4.61E-04	1.52E-05
Cyanide, WAD	Not Available	1.97E-05	6.48E-07



**Table A15: Summary Statistics Fish Tissue Residue Data**

<b>Constituent</b>	<b>Minimum (mg/L)</b>	<b>Maximum (mg/L)</b>	<b>75th Percentile (mg/L)</b>	<b>90th Percentile (mg/L)</b>	<b>95th Percentile (mg/L)</b>	<b>Mean (mg/L)</b>
Moisture	72.2	77.5	76.100	76.970	77.425	75.208
Aluminum	2.1	56.9	17.850	35.350	50.100	14.921
Antimony	0.002	0.127	0.022	0.062	0.071	0.021
Arsenic	0.052	10.3	0.280	0.736	2.079	0.698
Barium	0.12	2.86	1.275	1.683	2.025	1.073
Beryllium	0.002	0.002	0.002	0.002	0.002	0.002
Bismuth	0.02	0.02	0.020	0.020	0.020	0.020
Boron	0.1	0.1	0.100	0.100	0.100	0.100
Cadmium	0.053	1.03	0.286	0.848	0.943	0.280
Calcium	1490	10300	6447.500	8730.000	10033.500	5250.417
Chromium	0.01	0.1	0.070	0.094	0.100	0.048
Cobalt	0.079	0.51	0.221	0.286	0.355	0.190
Copper	0.45	2.47	1.313	1.686	2.102	1.166
Iron	13	314	82.000	128.800	193.800	71.542
Lead	0.006	1.02	0.066	0.106	0.354	0.097
Magnesium	237	370	316.250	326.000	351.100	291.875
Manganese	0.43	7.63	4.040	5.039	6.855	3.415
Mercury	0.003	0.011	0.008	0.009	0.010	0.007
Molybdenum	0.01	0.6	0.038	0.049	0.069	0.051
Nickel	0.03	0.59	0.165	0.214	0.280	0.130
Phosphorus	2680	7400	5275.000	6099.000	6865.000	4595.000
Potassium	3310	4000	3735.000	3807.000	3835.500	3595.833
Selenium	0.97	3.44	2.365	2.906	3.122	2.045
Silver	0.01	0.04	0.025	0.034	0.037	0.020
Sodium	641	1060	888.750	999.700	1038.500	825.208
Strontium	1	9.43	5.760	7.997	8.803	4.803
Thallium	0.006	0.03	0.016	0.023	0.028	0.014
Tin	0.03	0.07	0.060	0.066	0.068	0.050
Titanium	0.18	2.11	0.640	1.035	1.603	0.609
Uranium	0.001	0.029	0.003	0.006	0.015	0.004
Vanadium	0.03	0.26	0.125	0.194	0.236	0.085
Zinc	15.9	40.5	36.650	37.770	38.905	30.071

**Table A16: Baseline Fish Tissue Residue and Predicted Fish Tissue Residue**

<b>Constituent</b>	<b>Mean Fish Tissue Concentration (mg/kg)</b>	<b>Mean Surface Water Concentration (mg/L)</b>	<b>BCF Based on Means of Water and Tissue Residue (mg/kg)</b>	<b>Fish Tissue Residue Concentration Predicted (mg/kg)</b>
Aluminum	14.92	0.097	169.99	13.94
Antimony	0.021	0.0006	28.59	0.04
Arsenic	0.66	0.0006	873.90	0.73
Barium	1.073	0.046	28.39	1.58
Bismuth	0.010	0.0083	1.21	0.013
Boron	0.10	0.073	1.37	0.13
Cadmium	0.28	0.0001	3258.33	0.71
Chromium	0.048	0.0008	78.91	0.10
Cobalt	0.19	0.0003	643.86	0.52
Iron	71.54	0.033	2210.74	163.15
Lead	0.097	0.0004	256.36	0.19
Manganese	3.42	0.0079	477.13	18.75
Mercury	0.0069	0.0000	1232.45	0.01
Nickel	0.13	0.0012	92.94	0.27
Selenium	2.045	0.0012	1539.69	3.23
Strontium	4.80	0.15	29.04	7.35
Thallium	0.014	0.0001	92.44	0.017
Uranium	0.0041	0.0002	15.34	0.0062
Vanadium	0.085	0.0007	120.27	0.084
Zinc	30.071	0.0043	6621.78	88.73

**Table A 17: Plant Tissue Residue Data**

Constituent	Sample V33 (leaf) (mg/kg)	Sample 023 (leaf) (mg/kg)	Sample V38 (leaf) (mg/kg)	Sample V36 (leaf) (mg/kg)	026 (leaf) (mg/kg)	Sample 1 (leaf) (mg/kg)	Plot 22 (leaf) (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)
Aluminum	54.534	20.9613	3.6226	6.2667	28.9168	28.0476	7.1852	21.3620	54.534
Antimony	0.02928	0.010272	0.001842	0.003564	0.014322	0.012614	0.00284	0.011	0.02928
Arsenic	0.37698	0.121659	0.01842	0.021087	0.328383	0.135044	0.050836	0.150	0.37698
Barium	16.141	6.003	22.165	29.492	2.141	6.270	6.816	12.718	29.4921
Beryllium	0.00256	0.00064	0.00031	0.00030	0.00102	0.00111	0.00028	0.0009	0.002562
Bismuth	0.00366	0.00321	0.00307	0.00297	0.00341	0.00371	0.00284	0.0033	0.00371
Boron	2.562	8.1213	11.9116	17.3151	9.5821	8.162	14.3988	10.293	17.3151
Cadmium	2.6535	1.06572	0.8903	0.7425	0.217899	1.57675	1.79204	1.277	2.6535
Calcium	8893.8	5489.1	6140	6623.1	8729.6	6195.7	6532	6943	8893.8
Chromium	0.24888	0.0963	0.05219	0.04752	0.11935	0.14469	0.0568	0.109	0.24888
Cobalt	0.48312	0.119733	0.11359	0.150282	0.42966	0.347627	0.113032	0.251	0.48312
Copper	4.2456	2.71887	5.4646	2.83041	1.01959	4.7859	3.2944	3.480	5.4646
Iron	139.446	65.805	27.63	26.433	84.227	83.846	30.672	65.437	139.446
Lead	0.138348	0.047829	0.011666	0.027027	0.065813	0.061957	0.019028	0.053	0.138348
Magnesium	1050.42	831.39	991.61	1092.96	1636.8	1291.08	661.72	1079	1636.8
Manganese	147.132	22.7268	48.506	68.31	235.972	89.04	39.76	93.064	235.972
Mercury	0.00366	0.004173	0.001842	0.002673	0.00341	0.004081	0.005396	0.004	0.005396
Molybdenum	0.0732	0.14445	0.13815	0.06534	0.04774	0.15582	0.1136	0.105	0.15582
Nickel	4.8678	1.78155	0.79206	0.18711	0.28644	3.07559	0.9514	1.706	4.8678
Phosphorus	695.4	921.27	1384.57	1395.9	941.16	1153.81	994	1069	1395.9
Potassium	4575	6741	4697.1	5643	4603.5	5713.4	6503.6	5497	6741
Selenium	0.4941	1.00152	0.04912	0.02673	0.28985	0.3339	1.28368	0.497	1.28368
Silver	0.00732	0.001605	0.001535	0.001485	0.001705	0.001855	0.00142	0.002	0.00732
Sodium	14.274	8.346	6.14	5.346	11.594	10.759	8.804	9.323	14.274
Strontium	36.966	18.618	20.5997	23.3145	38.533	20.7389	21.2432	25.716	38.533
Thallium	0.000732	0.000161	0.000154	0.000594	0.000341	0.000742	0.000568	0.00047	0.000742
Tin	0.01098	0.00642	0.00307	0.00297	0.00341	0.00371	0.00284	0.005	0.01098
Titanium	1.69824	0.72546	0.16271	0.27918	1.43902	1.04993	0.29536	0.807	1.69824
Uranium	0.001464	0.000963	0.000154	0.000149	0.001023	0.001113	0.00142	0.001	0.001464
Vanadium	0.16836	0.0642	0.01228	0.02079	0.09207	0.10759	0.02272	0.070	0.16836
Zinc	129.93	50.718	38.068	42.471	14.663	78.652	46.292	57.256	129.93

**Table A18: Soil Invertebrate Tissue Residue Data**

<b>Constituent</b>	<b>Soil Concentrations (mg/kg)</b>	<b>Soil to Soil Invertebrate BCFs</b>	<b>Soil Invertebrates (mg/kg)</b>
Aluminum	29240.00	7.50E-02	2209
Antimony	7.40	5.00E-02	0.37
Arsenic	72.92	6.60E-03	0.49
Bismuth	0.32	1.00E+00	0.33
Cadmium	1.35	1.10E+01	15.0
Chromium	108.74	1.60E-01	17.5
Cobalt	23.21	1.00E+01	232.0
Gallium	11.97	1.00E+00	12.0
Gold	0.05	1.00E+00	0.048
Iron	57060.00	1.00E+01	574661
Lead	42.69	2.13E+01	917.7
Manganese	919.30	2.00E-02	18.5
Mercury	0.09	3.40E-01	0.051
Molybdenum	32.33	1.00E+00	32.5
Selenium	4.70	7.60E-01	3.6
Tellurium	0.70	1.00E+00	0.72
Thallium	0.32	1.00E+00	0.32
Titanium	2247.00	1.00E+00	2262
Vanadium	111.37	1.30E-01	15
Zinc	237.21	1.80E+01	4312.5

Table A19: Toxicity Reference Values

COPC <sup>2</sup>	Non-carcinogenic Toxicity Reference Values (TRVs) <sup>1</sup>				Carcinogenic Toxicity Reference Values (TRVs) <sup>1</sup>				Dermal		Target
	Oral TDI or RfD (mg/kg-day)	Source	Inhalation TDI or RfC <sup>3</sup> (mg/m <sup>3</sup> )	Source	Oral SF (mg/kg-day) <sup>-1</sup>	Source	Inhalation UR (mg/m <sup>3</sup> ) <sub>1</sub> <sup>-</sup>	Source	RAF <sup>2</sup>	Source	Organ
Aluminum	1.00E+00	a	5.00E-03	a	NA	NA	NA	NA	0.01	a	Lung/ Neuro
Antimony	4.00E-04	b	1.40E-03	e	NA	NA	NA	NA	0.01	a	Blood
Arsenic	1.00E-03	d	1.00E-03	d	1.80E+00	c	2.70E+01	a	0.03	a	Skin
Barium	2.00E-01	b	1.00E-03	d	NA	NA	NA	NA	0.1	c	Kidney
Beryllium	2.00E-03	b	2.00E-05	b	NA	NA	2.40E+00	b	0.01	c	Gastro/ Resp
Bismuth	NA	NA	NA	NA	NA	NA	NA	NA	0.01	a	
Boron	2.00E-01	b	7.00E-01	b	NA	NA	NA	NA	0.01	c	Develop
Cadmium	1.00E-03	c	3.50E-03	e	NA	NA	4.20E+01	a	0.01	a	Kidney
Chromium <sup>4</sup> (Total)	1.00E-03	c	0.06	d	NA	NA	4.60E+01	a	0.10	a	Liver/ Gastro
Cobalt	1.40E-03	d	5.00E-04		NA	NA	NA	NA	0.01	a	Heart/ Liver
Copper	1.41E-01	c	1.00E-03	d	NA	NA	NA	NA	0.06	c	Liver/ Gastro
Iron	7.00E-01	a	2.45E+00	e	NA	NA	NA	NA	0.01	a	Gastro/ Heart
Lead	0.0006	j	2.10E-03	e	NA	NA	NA	NA	0.01	a	Neuro
	1.50E-03	j	4.55E-03		NA	NA	NA	NA	0.01	a	Neuro
Manganese	infant 0.136, toddler 0.136, child 0.122, teen 0.142, adult 0.156	c	5.00E-05	b	NA	NA	NA	NA	0.01	a	Neuro
Mercury (Inorganic)	3.00E-04	c	3.00E-04	b	NA	NA	NA	NA	1.00	a	Kidney
Methyl Mercury	infant 0.0002, toddler 0.0002, child 0.0002, teen 0.00047, adult 0.00047	c									Develop/ Neuro
Molybdenum	2.80E-03	c	9.80E-03	e	NA	NA	NA	NA	0.01	c	

COPC <sup>2</sup>	Non-carcinogenic Toxicity Reference Values (TRVs) <sup>1</sup>				Carcinogenic Toxicity Reference Values (TRVs) <sup>1</sup>				Dermal		Target
	Oral TDI or RfD (mg/kg-day)	Source	Inhalation TDI or RfC <sup>3</sup> (mg/m <sup>3</sup> )	Source	Oral SF (mg/kg-day) <sup>-1</sup>	Source	Inhalation UR (mg/m <sup>3</sup> ) <sup>-1</sup>	Source	RAF <sup>2</sup>	Source	Organ
Nickel (Soluble)	1.10E-02	g	3.00E-02	g	NA	NA	7.10E-01	c	0.09	c	Respro
Selenium	5.00E-03	b	1.75E-02	e	NA	NA	NA	NA	0.01	a	Skin/ Blood
Silver	5.00E-03	b	1.75E-02	e	NA	NA	NA	NA	0.01	c	Skin
Strontium	6.00E-01	b	2.10E+00	e	NA	NA	NA	NA	0.01	c	Musculo sketal
Tellurium	NA	NA	NA	NA	NA	NA	NA	NA	0.01	a	
Thallium	1.00E-05	b	3.50E-05	e	NA	NA	NA	NA	0.01	a	Neuro
Tin	6.00E-01	h	2.10E+00	e	NA	NA	NA	NA	0.01	c	
Titanium	3.00E+00	i	1.05E+01	e	NA	NA	NA	NA	0.01	c	
Uranium	6.00E-04	c	8.00E-04	f	NA	NA	NA	NA	0.1	c	
Vanadium	5.00E-03	b	7.00E-04	f	NA	NA	NA	NA	0.01	a	Skin
Zinc	5.00E-01	c	1.75E+00	e	NA	NA	NA	NA	0.10	a	Blood/ Immune

1. The selection of Toxicity reference values (TRVs) was based on a review of the recommended sources according to the heirarchy outlined in BC MOE Technical Guidance on Contaminated Sites No. 7 (November 2015). TRVs were compiled prior June 2017.
  2. Abbreviations: COPC = Chemical of Potential Concern; IARC = International Agency for Research on Cancer; US EPA = United States Environmental Protection Agency; RfD = Reference Dose; SF = Slope Factor; RfC = Reference Concentration; UR = Unit Risk; RAF = relative absorption factor; IRIS = Integrated Risk Information System; NA = not listed, not assessed, or insufficient data to assess,
  3. RfC to TDI conversion were based on the equation in Health Canada (2005) using 1.4 m<sup>3</sup>/hour inhalation rate and 70.7 kg body weight for the worker receptor (adult) evaluated in this risk assessment.
  4. Chromium (VI) TRVs used for chromium (total) for cancer endpoint
- Sources
- a - PPRTV (Regional Screening Levels for Chemical Contaminants at Superfund Sites), 2017. United States Environmental Protection Agency. Waste and Cleanup Risk Assessment. <https://hhpprtv.ornl.gov/quickview/pprtv.php>; b - IRIS (Integrated Risk Information System), 2017. Available online at: <https://www.epa.gov/iris>. Last accessed on Aug. 30, 2017; c - Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada Part II: Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0. September 2010; d - RIVM = Netherlands National Institute of Public Health and the Environment, 2001. <http://www.rivm.nl/bibliotheek/rapporten/711701025.pdf>; e - Based on Oral TRV; f - ATSDR (Agency for Toxic Substances and Disease Registry, 2017. Toxicological Profiles. <http://www.atsdr.cdc.gov/toxprofiles/index.asp>. Last accessed June 2017; g - Haber LT, Bates HK, Allen BC, Vincent MJ, Oler AR. 2017. Derivation of an oral toxicity reference value for nickel. Regulatory Toxicology and Pharmacology. 87:S1-S18; h - HEAST (Health Effects Assessment Summary Tables, US EPA). 2017. Available online at: <http://cfpub.epa.gov/ncea/cfm/recorddisplay.cfm?deid=2877>. Last accessed on Aug. 30, 2017; i = NSF (NSF International), 2017. Cited in International Toxicity Estimates for Risk Assessment (ITER). Available online at: [https://iter.ctc.com/publicURL/p\\_report\\_l2\\_non.cfm?crn=7440-32-6&type=NCO](https://iter.ctc.com/publicURL/p_report_l2_non.cfm?crn=7440-32-6&type=NCO). Last accessed on Aug. 30, 2017; j - Richardson M., and Wilson R. 2012. Proposed Toxicological Reference Values and Risk-based Soil Concentrations for Protection of Human Health from Lead (Pb) at Federal Contaminated Sites. RPIC Federal Contaminated Sites National Workshop, April 30 – May 3. Toronto.

Attachment B  
Summary Statistics Tables



**Table B1: Summary Statistics for Baseline Soils (Local Background)**

Constituent	Count	Minimum	Mean	Median	75 Percentile	90 Percentile	95 Percentile	Maximum
Aluminum	7	9700	18714.29	18200	26050	28880	29240	29600
Antimony	22	0.32	3.02	2.5	4	5.6	7.4	8.06
Arsenic	22	0.9	95.43	21.4	35.125	59.94	72.92	1573.4
Barium	22	49.1	190.56	102.5	175.45	314.4	468.76	1238.8
Beryllium	15	0.2	0.41	0.4	0.5	0.56	0.69	0.9
Bismuth	7	0.03	0.13	0.08	0.16	0.27	0.32	0.37
Boron	7	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Cadmium	22	0.03	1.08	0.44	0.67	1.10	1.35	13.97
Calcium	7	1300.00	9257.14	4800.00	15600.00	19580.00	19640.00	19700.00
Chromium	22	8.3	47.51	29.8	67.5	104.43	108.74	146.5
Cobalt	22	5.3	14.32	14.35	15.6	19.88	23.045	29
Copper	22	1.59	77.65	81.38	89.1975	103.51	106.85	194
Gallium	7	3.7	7.77	8	9.7	11.34	11.97	12.6
Gold	7	0.0003	0.01	0.0013	0.01265	0.03428	0.04784	0.0614
Iron	7	22700	36085.71	35300	39450	50520	57060	63600
Lanthanum	7	1.8	6.11	5.4	6.45	10.26	12.93	15.6
Lead	22	1.01	20.84	11.95	22.875	41.59	42.685	127.81
Magnesium	7	8300	17528.57	16100	25200	28720	29560	30400
Manganese	7	201	604.43	662	713.5	844.6	919.3	994
Mercury	22	0.005	0.04	0.05	0.0625	0.08	0.092	0.128
Molybdenum	22	0.66	13.26	4.95	11.4	26.02	32.33	122.9
Nickel	22	4.2	33.83	31.05	44.7	53.19	55.305	74.2
Phosphorus	7	440	1167.14	1110	1165	1810	2260	2710
Potassium	7	400	1028.57	1200	1350	1580	1640	1700
Scandium	7	2.1	4.97	5	6.45	6.74	6.77	6.8
Selenium	22	0.1	2.35	2.2	3	3.9	4.7	8.3
Silver	22	0.006	0.77	0.5	0.7	1.02	1.58	5.9
Sodium	7	290	397.14	350	435	560	605	650
Strontium	7	9.2	44.74	39.3	63.9	87.82	95.56	103.3
Sulfur	7	800	4742.86	2800	5900	9380	11690	14000
Tellurium	7	0.02	0.20	0.05	0.23	0.572	0.701	0.83
Thallium	22	0.02	0.13	0.1	0.2	0.3	0.32	0.4
Thorium	7	0.3	1.03	1.1	1.25	1.5	1.65	1.8
Tin	15	0.2	0.36	0.3	0.3	0.54	0.62	0.7
Titanium	7	50	1082.86	1120	1240	1854	2247	2640
Tungsten	7	0.1	4.64	0.2	2.75	13.78	20.14	26.5
Uranium	22	0.1	0.53	0.475	0.5575	1.028	1.174	1.92
Vanadium	22	11	73.60	74.85	85.35	98.67	111.365	115
Zinc	22	33.6	117.01	84.5	118.5	145.29	237.205	688.9

Units = mg/kg

Table B2: Summary Statistics for Surface Water Sampling Station AC02 in American Creek

Constituent	All										
	Mean	Std. Dev.	Min.	5th Perc.	25th Perc.	Median	75th Perc.	90th Perc.	95th Perc.	Max.	Count
Field pH	7.77	0.329	7.33	7.34	7.54	7.7	8.16	8.23	8.26	8.27	16
Conductivity	106	32.5	66.3	71.4	81.6	99.5	130	158	161	161	19
Hardness CaCO3	50	15.8	30.7	32.6	37.5	46.6	61.1	76	77.1	78.1	19
Total Dissolved Solids	72.6	19.7	47	47.9	58	68	91	96.8	102	116	19
Total Suspended Solids	25.7	28.6	3	3	7.1	14.4	37.8	59.5	72.4	112	19
Turbidity	18.9	32.8	0.15	0.177	2.2	11	l've	33	48.2	146	19
Alkalinity-Total CaCO3	40.7	11.7	25.6	27.3	31.2	39	51.3	57.5	57.9	60.8	19
Acidity (as CaCO3)	1.52	0.388	1	1.09	1.2	1.6	1.75	1.9	1.96	2.5	19
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	19
Fluoride F	0.0431	0.0111	0.029	0.0317	0.0355	0.041	0.0455	0.0604	0.0625	0.067	19
Bromide Br	0.05	1.43E-17	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	19
Sulphate SO4	12.6	4.24	7.3	7.71	9.49	11.5	15	19.4	19.8	20.5	19
Nitrate Nitrogen N	0.113	0.0919	0.0249	0.0279	0.0345	0.0722	0.167	0.23	0.271	0.33	19
Nitrite Nitrogen N	0.001	4.46E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	19
Total Nitrogen	0.102	0.102	0.03	0.0372	0.066	0.102	0.138	0.16	0.167	0.174	2
Ammonia Nitrogen N	0.005	8.91E-19	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	19
Ortho-Phosphate	0.00117	0.000481	0.001	0.001	0.001	0.001	0.00105	0.00132	0.00192	0.003	19
Phosphorus (P)-Total	0.077	0.105	0.002	0.00236	0.0153	0.0377	0.0619	0.3	0.3	0.3	19
Total Organic Carbon	0.526	0.0663	0.5	0.5	0.5	0.5	0.5	0.6	0.685	0.73	19
Dissolved Organic Carbon	0.593	0.157	0.5	0.5	0.5	0.5	0.625	0.784	0.831	1.11	19
Aluminum T-Al	1.08	1.53	0.0079	0.0107	0.122	0.571	1.3	1.9	2.86	6.67	19
Aluminum D-Al	0.0295	0.018	0.0041	0.00491	0.013	0.0302	0.0412	0.0528	0.0565	0.0622	19
Antimony T-Sb	0.000451	0.0000984	0.00027	0.000315	0.00036	0.0005	0.0005	0.0005	0.000518	0.00068	19
Antimony D-Sb	0.000413	0.000121	0.0002	0.000218	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	19
Arsenic T-As	0.000964	0.000459	0.00064	0.00064	0.0007	0.00074	0.00107	0.0014	0.00167	0.00252	19
Arsenic D-As	0.000532	0.000107	0.00033	0.000375	0.0005	0.0005	0.0006	0.000678	0.000711	0.00072	19
Barium T-Ba	0.114	0.0338	0.088	0.0889	0.0996	0.105	0.119	0.128	0.141	0.243	19
Barium D-Ba	0.0849	0.0238	0.0575	0.0578	0.068	0.075	0.0988	0.123	0.129	0.13	19
Beryllium T-Be	0.000668	0.000446	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Beryllium D-Be	0.000668	0.000446	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Bismuth T-Bi	0.000125	0.000168	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	19

Constituent	All										
	Mean	Std. Dev.	Min.	5th Perc.	25th Perc.	Median	75th Perc.	90th Perc.	95th Perc.	Max.	Count
Bismuth D-Bi	0.000121	0.000169	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	19
Boron T-B	0.0677	0.0435	0.01	0.01	0.0135	0.1	0.1	0.1	0.1	0.1	19
Boron D-B	0.0673	0.044	0.01	0.01	0.012	0.1	0.1	0.1	0.1	0.1	19
Cadmium T-Cd	0.0000245	0.0000257	0.000005	0.000005	0.0000073	0.0000135	0.0000286	0.0000506	0.0000682	0.000106	19
Cadmium D-Cd	0.0000147	0.00000363	0.000005	0.0000095	0.0000124	0.000017	0.000017	0.000017	0.000017	0.000017	19
Calcium T-Ca	18.3	5.63	11.6	12	13.8	17	22.3	26.9	27.8	28.4	19
Calcium D-Ca	18.1	5.74	11.2	11.8	13.5	16.8	22.1	27.6	28.1	28.4	19
Chromium T-Cr	0.000727	0.000378	0.0001	0.000127	0.000345	0.001	0.001	0.001	0.001	0.001	19
Chromium D-Cr	0.000668	0.000446	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Cobalt T-Co	0.000547	0.00056	0.0001	0.000127	0.0003	0.0003	0.000605	0.000888	0.00123	0.00261	19
Cobalt D-Co	0.000226	0.0000991	0.0001	0.0001	0.0001	0.0003	0.0003	0.0003	0.0003	0.0003	19
Copper T-Cu	0.00225	0.00315	0.0005	0.000608	0.001	0.00104	0.00235	0.00296	0.00458	0.0148	19
Copper D-Cu	0.000719	0.000378	0.0002	0.0002	0.00025	0.001	0.001	0.001	0.001	0.001	19
Iron T-Fe	1.1	1.48	0.01	0.028	0.161	0.525	1.32	2.09	3	6.33	19
Iron D-Fe	0.0272	0.00777	0.01	0.01	0.0285	0.03	0.03	0.0312	0.0328	0.04	19
Lead T-Pb	0.0012	0.00161	0.00005	0.00028	0.0005	0.00055	0.00135	0.00181	0.00279	0.00742	19
Lead D-Pb	0.000337	0.00022	0.00005	0.00005	0.000057	0.0005	0.0005	0.0005	0.0005	0.0005	19
Magnesium T-Mg	1.56	0.503	1.24	1.24	1.34	1.43	1.6	1.69	1.89	3.54	19
Magnesium D-Mg	1.16	0.344	0.677	0.735	0.901	1.11	1.43	1.68	1.7	1.72	19
Manganese T-Mn	0.0464	0.0624	0.00093	0.000966	0.00819	0.022	0.0558	0.0866	0.121	0.271	19
Manganese D-Mn	0.00529	0.0042	0.00068	0.000689	0.00197	0.00475	0.00687	0.0119	0.0135	0.0137	19
Mercury T-Hg	0.00000616	0.00000234	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.0000102	0.000012	19
Mercury D-Hg	0.00000579	0.00000187	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	19
Molybdenum T-Mo	0.000861	0.000199	0.000494	0.000512	0.000708	0.001	0.001	0.001	0.001	0.001	19
Molybdenum D-Mo	0.000838	0.000227	0.000426	0.000449	0.00065	0.001	0.001	0.001	0.001	0.001	19
Nickel T-Ni	0.000817	0.000246	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.001	19
Nickel D-Ni	0.000816	0.000248	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.001	19
Selenium T-Se	0.00023	0.0000773	0.000146	0.00015	0.000162	0.00021	0.000304	0.000338	0.000358	0.000376	19
Selenium D-Se	0.000209	0.0000914	0.0001	0.000114	0.000137	0.000174	0.000281	0.00034	0.000365	0.000373	19
Silicon T-Si	2.85	2.46	1.48	1.52	1.56	2.18	3.03	4.05	5.23	12.3	19
Silicon D-Si	1.06	0.33	0.615	0.68	0.778	0.973	1.36	1.49	1.56	1.59	19

Constituent	All										
	Mean	Std. Dev.	Min.	5th Perc.	25th Perc.	Median	75th Perc.	90th Perc.	95th Perc.	Max.	Count
Silver T-Ag	0.0000261	0.0000272	0.00001	0.00001	0.00002	0.00002	0.000023	0.0000306	0.0000433	0.000136	19
Silver D-Ag	0.0000163	0.00000496	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	19
Sodium T-Na	1.51	0.666	0.521	0.535	0.758	2	2	2	2	2	19
Sodium D-Na	1.48	0.712	0.35	0.39	0.702	2	2	2	2	2	19
Strontium T-Sr	0.108	0.031	0.0681	0.0684	0.0846	0.107	0.133	0.155	0.155	0.157	19
Strontium D-Sr	0.106	0.0321	0.0647	0.0652	0.0818	0.102	0.129	0.153	0.154	0.164	19
Thallium T-Tl	0.000132	0.0000912	0.00001	0.00001	0.0000205	0.0002	0.0002	0.0002	0.0002	0.0002	19
Thallium D-Tl	0.00013	0.0000942	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	19
Tin T-Sn	0.000344	0.000201	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	18
Tin D-Sn	0.000348	0.000196	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	18
Titanium T-Ti	0.0337	0.0395	0.0003	0.00719	0.01	0.019	0.041	0.0612	0.0735	0.177	19
Titanium D-Ti	0.00798	0.00401	0.0003	0.0003	0.01	0.01	0.01	0.01	0.01	0.01	19
Uranium T-U	0.000159	0.0000563	0.000072	0.0000756	0.000096	0.0002	0.0002	0.0002	0.0002	0.0002	19
Uranium D-U	0.000148	0.0000712	0.000036	0.0000369	0.000068	0.0002	0.0002	0.0002	0.0002	0.0002	19
Vanadium T-V	0.0028	0.00299	0.0005	0.0005	0.000615	0.0017	0.00358	0.00511	0.00713	0.0128	19
Vanadium D-V	0.000579	0.000187	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	19
Zinc T-Zn	0.00655	0.00466	0.003	0.003	0.005	0.005	0.00625	0.0089	0.0126	0.024	19
Zinc D-Zn	0.00357	0.00192	0.001	0.001	0.00115	0.005	0.005	0.005	0.005	0.005	19

Units = mg/L



Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth T-Bi	0.00257	0.0109	0.00005	0.00005	0.000069	0.000101	0.00041	0.0005	0.0005	0.05	21
Bismuth D-Bi	0.00251	0.0109	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.05	21
Boron T-B	0.0659	0.0446	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	21
Boron D-B	0.0658	0.0447	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	21
Cadmium T-Cd	0.000393	0.000384	0.0000354	0.0000578	0.0001	0.00028	0.0005	0.000984	0.001	0.00197	63
Cadmium D-Cd	0.0001	0.0000728	0.000005	0.000017	0.000035	0.0001	0.000105	0.0002	0.0002	0.00031	63
Calcium T-Ca	36.7	16.8	14.5	16.5	22.9	30.9	51.1	61.2	64.5	75.4	64
Calcium D-Ca	30.9	16.7	10.3	12.3	16.6	26.3	41.6	55	60.2	75.4	64
Chromium T-Cr	0.0122	0.0116	0.00013	0.001	0.0044	0.0105	0.0149	0.0239	0.0273	0.0492	21
Chromium D-Cr	0.000672	0.00043	0.0001	0.0001	0.00015	0.001	0.001	0.001	0.001	0.001	21
Cobalt T-Co	0.00386	0.00459	0.00007	0.00008	0.00053	0.00262	0.00584	0.00922	0.0111	0.0269	63
Cobalt D-Co	0.000299	0.000653	0.00003	0.000033	0.000075	0.0001	0.0003	0.000452	0.001	0.005	63
Copper T-Cu	0.022	0.0248	0.0002	0.00081	0.00315	0.017	0.0315	0.0443	0.0598	0.149	63
Copper D-Cu	0.00136	0.00347	0.00005	0.0001	0.0003	0.0006	0.001	0.00184	0.0038	0.0252	63
Iron T-Fe	7.85	10.1	0.01	0.0161	0.91	4.74	12.2	18.3	24.6	60.6	64
Iron D-Fe	0.0293	0.0231	0.005	0.0055	0.01	0.03	0.0348	0.06	0.0836	0.1	63
Lead T-Pb	0.00581	0.00653	0.00005	0.000101	0.001	0.00389	0.00747	0.0154	0.017	0.0306	63
Lead D-Pb	0.000351	0.00091	0.000025	0.000025	0.00005	0.00008	0.0005	0.0005	0.001	0.00709	63
Magnesium T-Mg	7.62	3.03	2.12	3.75	6.18	7.43	8.62	10.3	11.4	24.5	64
Magnesium D-Mg	3.8	2.32	0.809	1.17	1.82	2.76	6.12	7.28	7.81	8.14	64
Manganese T-Mn	0.237	0.296	0.00185	0.00223	0.024	0.166	0.354	0.523	0.679	1.81	64
Manganese D-Mn	0.00812	0.0315	0.00005	0.0001	0.000553	0.00153	0.00438	0.0139	0.0229	0.25	64
Mercury T-Hg	0.0000116	0.00000731	0.000005	0.000005	0.000005	0.00001	0.0000137	0.000025	0.000025	0.000025	21
Mercury D-Hg	0.00000619	0.00000218	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	21
Molybdenum T-Mo	0.00419	0.00352	0.001	0.00179	0.00292	0.00395	0.00453	0.0052	0.00657	0.03	64
Molybdenum D-Mo	0.00339	0.00361	0.00089	0.00102	0.0018	0.0032	0.00393	0.00437	0.00488	0.03	64
Nickel T-Ni	0.015	0.0258	0.00051	0.00103	0.00253	0.00872	0.0183	0.0276	0.0395	0.19	64
Nickel D-Ni	0.00115	0.00118	0.00015	0.000315	0.000523	0.001	0.0014	0.0016	0.00275	0.009	64
Selenium T-Se	0.00225	0.00104	0.00094	0.00107	0.00143	0.00191	0.0031	0.00339	0.00371	0.00482	21
Selenium D-Se	0.00156	0.00119	0.00036	0.000459	0.000649	0.00101	0.00222	0.00351	0.00358	0.00374	21
Silicon T-Si	13.5	9.92	2.47	2.53	6.97	10.8	18.5	25.1	27.4	43.6	25

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silicon D-Si	1.16	0.696	0.451	0.461	0.658	0.873	1.42	2.37	2.5	2.55	25
Silver T-Ag	0.000278	0.000311	0.00001	0.00002	0.000111	0.000199	0.000265	0.000608	0.000733	0.00134	21
Silver D-Ag	0.0000162	0.00000498	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	21
Sodium T-Na	1.86	0.826	0.8	0.849	1.34	1.9	2.1	2.59	3.06	6.2	59
Sodium D-Na	1.21	0.692	0.25	0.325	0.558	1.11	2	2	2.05	2.8	64
Strontium T-Sr	0.206	0.0974	0.0846	0.095	0.116	0.175	0.3	0.344	0.37	0.436	63
Strontium D-Sr	0.178	0.1	0.0598	0.071	0.0935	0.143	0.264	0.336	0.353	0.38	63
Thallium T-Tl	0.000144	0.0000756	0.00001	0.000036	0.000054	0.0002	0.0002	0.0002	0.0002	0.0002	21
Thallium D-Tl	0.000128	0.0000945	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	21
Tin T-Sn	0.00035	0.000196	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	21
Tin D-Sn	0.000349	0.000197	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	21
Titanium T-Ti	0.199	0.15	0.00133	0.01	0.108	0.156	0.288	0.401	0.443	0.466	21
Titanium D-Ti	0.0083	0.00385	0.0003	0.0003	0.01	0.01	0.01	0.01	0.011	0.011	21
Uranium T-U	0.000415	0.000171	0.000185	0.000252	0.0003	0.000379	0.00049	0.00051	0.00077	0.00091	21
Uranium D-U	0.000236	0.000149	0.000027	0.000044	0.0002	0.0002	0.0003	0.00048	0.000486	0.00051	21
Vanadium T-V	0.0255	0.0262	0.0005	0.0005	0.00896	0.0199	0.0306	0.0506	0.0539	0.114	21
Vanadium D-V	0.000619	0.000218	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	21
Zinc T-Zn	0.043	0.0447	0.003	0.0041	0.011	0.028	0.062	0.101	0.128	0.237	63
Zinc D-Zn	0.00355	0.00398	0.0003	0.000405	0.001	0.003	0.005	0.005	0.006	0.028	63

Units = mg/L



Table B4: Summary Statistics Surface Water Sampling Station BC04 in Bitter Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.92	0.961	1.5	7.3	7.74	8.02	8.37	8.64	8.7	8.9	59
Conductivity	189	119	69	75	90.8	128	301	380	395	424	80
Hardness CaCO3	87.8	60.2	26	29.1	43.3	61.2	122	180	204	249	82
Total Dissolved Solids	129	79.6	34	49	62	100	200	260	261	280	81
Total Suspended Solids	293	316	1	3	63.3	255	396	596	653	2000	82
Turbidity	217	278	0.3	1.24	52	150	283	470	580	2070	81
Alkalinity-Total CaCO3	60.4	29.7	16	31.1	36	49.1	87.6	108	110	134	82
Acidity (as CaCO3)	2.33	3.75	0.1	0.1	1	1.1	2.8	4.2	5	32	81
Chloride Cl	0.501	0.0064	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.53	22
Fluoride F	0.0362	0.0242	0.02	0.02	0.02	0.02	0.054	0.0698	0.0729	0.098	22
Bromide Br	0.05	1.42E-17	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	22
Sulphate SO4	38.5	34.2	1.5	6.1	11.6	21.4	62.1	95.6	100	111	82
Nitrate Nitrogen N	0.0574	0.0634	0.0102	0.0107	0.0138	0.0248	0.0809	0.138	0.168	0.236	22
Nitrite Nitrogen N	0.001	6.66E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	22
Total Nitrogen	0.238	0.15	0.107	0.113	0.139	0.2	0.299	0.387	0.416	0.445	4
Ammonia Nitrogen N	0.00601	0.00188	0.005	0.005	0.005	0.005	0.0058	0.0082	0.00925	0.0122	22
Ortho-Phosphate	0.00139	0.000343	0.001	0.001	0.00103	0.00135	0.0016	0.0017	0.0018	0.0023	22
Phosphorus (P)-Total	0.353	0.354	0.002	0.00454	0.0346	0.335	0.476	0.615	0.751	1.55	22
Total Organic Carbon	0.865	0.562	0.5	0.5	0.5	0.5	1.07	1.66	1.98	2.37	22
Dissolved Organic Carbon	0.523	0.0754	0.5	0.5	0.5	0.5	0.5	0.5	0.719	0.78	22
Aluminum T-Al	6.48	6.22	0.0025	0.0304	1.53	5.71	9.81	13.9	16.1	36.6	82
Aluminum D-Al	0.0679	0.0675	0.0005	0.0033	0.0111	0.0464	0.0991	0.168	0.189	0.342	82
Antimony T-Sb	0.00216	0.00183	0.00007	0.000592	0.000913	0.00172	0.00265	0.00379	0.00602	0.012	82
Antimony D-Sb	0.000751	0.000323	0.00007	0.000352	0.00053	0.000705	0.00088	0.00116	0.00129	0.00195	82
Arsenic T-As	0.0148	0.0162	0.00072	0.000912	0.0031	0.0119	0.0196	0.0226	0.0323	0.0756	22
Arsenic D-As	0.000653	0.000164	0.00044	0.000491	0.000545	0.00063	0.000685	0.00088	0.00104	0.00105	22
Barium T-Ba	0.127	0.0866	0.02	0.0427	0.0627	0.0975	0.17	0.221	0.279	0.536	82
Barium D-Ba	0.0327	0.0133	0.015	0.0156	0.0234	0.0287	0.0389	0.0532	0.0579	0.0788	82
Beryllium T-Be	0.000701	0.000406	0.0001	0.00014	0.000208	0.001	0.001	0.001	0.001	0.001	22
Beryllium D-Be	0.000673	0.000443	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	22
Bismuth T-Bi	0.0116	0.0434	0.00005	0.00005	0.0000755	0.000148	0.00048	0.0005	0.0475	0.2	22

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.0115	0.0434	0.00005	0.00005	0.00005	0.00005	0.000388	0.0005	0.0475	0.2	22
Boron T-B	0.0673	0.0443	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	22
Boron D-B	0.0673	0.0443	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	22
Cadmium T-Cd	0.000492	0.000441	0.0000675	0.00009	0.0001	0.000381	0.00072	0.0011	0.0012	0.0022	81
Cadmium D-Cd	0.0000942	0.0000664	0.000005	0.000017	0.00007	0.0001	0.0001	0.00012	0.00019	0.00046	81
Calcium T-Ca	36.8	21.2	7.97	15.2	19.2	28.1	56.2	69.3	77.9	87	82
Calcium D-Ca	30	20.2	8.97	10	14.8	20.9	48.4	60.8	67.4	87	82
Chromium T-Cr	0.0119	0.0119	0.00016	0.001	0.00235	0.0122	0.0149	0.0199	0.0236	0.0558	22
Chromium D-Cr	0.00069	0.000425	0.0001	0.0001	0.000133	0.001	0.001	0.001	0.001	0.001	22
Cobalt T-Co	0.00586	0.00849	0.00005	0.00011	0.0014	0.00398	0.007	0.0101	0.016	0.0649	81
Cobalt D-Co	0.000162	0.000155	0.00003	0.00004	0.00007	0.0001	0.00022	0.0003	0.0003	0.00104	81
Copper T-Cu	0.027	0.0276	0.0004	0.000604	0.00537	0.0229	0.037	0.0535	0.0647	0.166	82
Copper D-Cu	0.000595	0.000498	0.00005	0.0001	0.0003	0.000475	0.000938	0.001	0.00143	0.00237	82
Iron T-Fe	9.35	10.3	0.01	0.0373	2.03	6.42	13.3	18.3	24	63.2	82
Iron D-Fe	0.0353	0.0348	0.005	0.01	0.01	0.03	0.0438	0.0749	0.107	0.202	82
Lead T-Pb	0.00693	0.00674	0.00005	0.000153	0.0015	0.00506	0.00902	0.016	0.0187	0.0316	82
Lead D-Pb	0.000178	0.000182	0.000025	0.0000263	0.00005	0.00008	0.000198	0.0005	0.0005	0.00069	82
Magnesium T-Mg	8.23	3.66	2.53	3.61	6.32	7.68	9.95	12	13	25.1	82
Magnesium D-Mg	3.52	2.64	0.725	1	1.6	2.34	5.88	7.58	8.45	9.2	82
Manganese T-Mn	0.29	0.294	0.00266	0.00724	0.0621	0.233	0.426	0.609	0.647	1.93	82
Manganese D-Mn	0.00373	0.00604	0.0001	0.000103	0.00037	0.00141	0.00465	0.00837	0.0129	0.03	82
Mercury T-Hg	0.0000138	0.000016	0.000005	0.000005	0.00000543	0.00001	0.0000129	0.000024	0.000025	0.000081	22
Mercury D-Hg	0.00000614	0.00000214	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	22
Molybdenum T-Mo	0.00481	0.00324	0.00147	0.00201	0.00309	0.00467	0.0057	0.00658	0.007	0.03	82
Molybdenum D-Mo	0.00367	0.00343	0.00046	0.00109	0.00172	0.00356	0.00468	0.0058	0.00628	0.03	82
Nickel T-Ni	0.0171	0.0215	0.00118	0.00194	0.00498	0.0118	0.0196	0.0308	0.0487	0.163	82
Nickel D-Ni	0.00125	0.00107	0.00006	0.0003	0.0005	0.001	0.0016	0.0024	0.0027	0.0068	82
Selenium T-Se	0.00269	0.00247	0.00089	0.00107	0.00151	0.00191	0.00298	0.00433	0.00538	0.0125	22
Selenium D-Se	0.00197	0.0025	0.0004	0.000448	0.000573	0.000984	0.00253	0.00345	0.00488	0.0117	22
Silicon T-Si	13.7	10.1	2.58	2.64	4.87	14.1	18.9	20.2	22	46.8	22
Silicon D-Si	1.25	0.897	0.394	0.534	0.598	0.787	1.96	2.55	2.83	3.32	22

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.000273	0.00032	0.00001	0.00002	0.000059	0.000235	0.000325	0.000428	0.00053	0.00154	22
Silver D-Ag	0.0000166	0.00000473	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	22
Sodium T-Na	1.77	0.69	0.58	0.854	1.24	1.71	2.19	2.5	2.8	5	82
Sodium D-Na	1.12	0.744	0.216	0.273	0.469	0.774	2	2	2.2	2.6	82
Strontium T-Sr	0.211	0.122	0.0513	0.0886	0.117	0.159	0.33	0.395	0.42	0.472	81
Strontium D-Sr	0.176	0.122	0.039	0.0609	0.0837	0.12	0.264	0.371	0.394	0.452	81
Thallium T-Tl	0.000147	0.0000728	0.00001	0.0000451	0.0000708	0.0002	0.0002	0.0002	0.0002	0.0002	22
Thallium D-Tl	0.000131	0.000093	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	22
Tin T-Sn	0.000356	0.000195	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	22
Tin D-Sn	0.000364	0.000189	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	22
Titanium T-Ti	0.187	0.134	0.00096	0.01	0.0533	0.197	0.275	0.325	0.381	0.458	22
Titanium D-Ti	0.00857	0.00379	0.0003	0.000516	0.01	0.01	0.01	0.01	0.0119	0.013	22
Uranium T-U	0.000436	0.00018	0.000183	0.000249	0.00033	0.000392	0.00053	0.000632	0.000706	0.00096	22
Uranium D-U	0.000273	0.000193	0.000037	0.0000418	0.0002	0.0002	0.000453	0.000538	0.00054	0.0007	22
Vanadium T-V	0.0247	0.0271	0.0005	0.0005	0.0049	0.0243	0.0297	0.0395	0.0437	0.129	22
Vanadium D-V	0.000614	0.000214	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	22
Zinc T-Zn	0.0508	0.0443	0.001	0.00491	0.0203	0.042	0.0691	0.101	0.121	0.254	82
Zinc D-Zn	0.00412	0.00489	0.0004	0.001	0.001	0.00225	0.005	0.00793	0.016	0.022	82

Units = mg/L

Table B5: Summary Statistics for Surface Water Sampling Station BC06 in Bitter Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.62	0.73	6.25	6.6	7.67	7.76	7.82	8.15	8.3	8.46	7.62
Conductivity	165	133	77.1	79.9	84.4	106	125	377	404	430	165
Hardness CaCO3	79	67.8	34.4	35.8	42.2	50	55.8	187	200	213	79
Total Dissolved Solids	137	90.5	68	68	75	86	218	263	276	290	137
Total Suspended Solids	363	382	5.8	8.4	277	307	332	587	948	1310	363
Turbidity	418	721	3.29	4.03	219	232	250	674	1500	2320	418
Alkalinity-Total CaCO3	47.2	22.6	31.4	31.6	32.5	37.9	44.2	81.1	87.4	93.6	47.2
Acidity (as CaCO3)	1.19	0.31	1	1	1	1	1.3	1.64	1.72	1.8	1.19
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Fluoride F	0.0337	0.0275	0.02	0.02	0.02	0.02	0.02	0.0758	0.0834	0.091	0.0337
Bromide Br	0.05	7.36E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sulphate SO4	37.5	47.2	8.4	9.32	10.9	16.5	19.3	114	122	130	37.5
Nitrate Nitrogen N	0.0219	0.0185	0.0073	0.00878	0.0131	0.0135	0.0168	0.047	0.0549	0.0629	0.0219
Nitrite Nitrogen N	0.001	N/A	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total Nitrogen	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia Nitrogen N	0.00646	0.00231	0.005	0.005	0.005	0.005	0.007	0.00928	0.0104	0.0116	0.00646
Ortho-Phosphate	0.00161	0.000434	0.001	0.001	0.0013	0.0018	0.0019	0.00204	0.00212	0.0022	0.00161
Phosphorus (P)-Total	0.438	0.426	0.0055	0.0091	0.246	0.357	0.543	0.743	1.09	1.44	0.438
Total Organic Carbon	0.951	1.15	0.5	0.5	0.5	0.5	0.5	1.67	2.82	3.96	0.951
Dissolved Organic Carbon	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Aluminum T-Al	10.3	10.8	0.0901	0.195	7.64	8.32	9.74	17.4	27.1	36.8	10.3
Aluminum D-Al	0.272	0.615	0.0092	0.011	0.0758	0.0804	0.0925	0.464	1.19	1.91	0.272
Antimony T-Sb	0.00246	0.00181	0.00114	0.00118	0.00171	0.00218	0.00227	0.00345	0.00528	0.00711	0.00246
Antimony D-Sb	0.000782	0.000299	0.0005	0.0005	0.00052	0.0007	0.00104	0.00116	0.00123	0.0013	0.000782
Arsenic T-As	0.0195	0.024	0.001	0.00124	0.0102	0.0151	0.0192	0.0319	0.0564	0.0808	0.0195
Arsenic D-As	0.000894	0.00065	0.00057	0.000582	0.00061	0.00067	0.00073	0.00129	0.00194	0.0026	0.000894
Barium T-Ba	0.177	0.143	0.049	0.0506	0.133	0.155	0.176	0.251	0.394	0.537	0.177
Barium D-Ba	0.0327	0.0135	0.021	0.0214	0.022	0.028	0.044	0.0524	0.0532	0.054	0.0327
Beryllium T-Be	0.001	N/A	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Beryllium D-Be	0.001	N/A	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Bismuth T-Bi	0.0224	0.0666	0.00005	0.00005	0.000074	0.000107	0.000202	0.0404	0.12	0.2	0.0224

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.0223	0.0667	0.00005	0.00005	0.00005	0.00005	0.00005	0.04	0.12	0.2	0.0223
Boron T-B	0.1	1.47E-17	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Boron D-B	0.1	1.47E-17	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cadmium T-Cd	0.000605	0.000663	0.000118	0.000119	0.000322	0.000432	0.00061	0.00104	0.00167	0.00229	0.000605
Cadmium D-Cd	0.0000421	0.0000383	0.000017	0.000017	0.000017	0.000017	0.000077	0.0000994	0.0001	0.000101	0.0000421
Calcium T-Ca	35	22	16.4	16.8	21.8	23.8	48.7	67.9	70.5	73.1	35
Calcium D-Ca	27	22.7	12.2	12.6	14.2	17.3	19.3	63.3	67.6	71.8	27
Chromium T-Cr	0.0158	0.0169	0.001	0.001	0.011	0.0124	0.0157	0.0262	0.0421	0.058	0.0158
Chromium D-Cr	0.00112	0.000367	0.001	0.001	0.001	0.001	0.001	0.00122	0.00166	0.0021	0.00112
Cobalt T-Co	0.00774	0.0092	0.0003	0.00036	0.00445	0.00583	0.00732	0.0131	0.0221	0.0311	0.00774
Cobalt D-Co	0.000372	0.000217	0.0003	0.0003	0.0003	0.0003	0.0003	0.00043	0.00069	0.00095	0.000372
Copper T-Cu	0.0424	0.052	0.0018	0.00216	0.024	0.0298	0.0405	0.0722	0.124	0.175	0.0424
Copper D-Cu	0.00139	0.00117	0.001	0.001	0.001	0.001	0.001	0.0017	0.0031	0.0045	0.00139
Iron T-Fe	16.6	19	0.217	0.374	10.4	13.5	16.4	27.5	46	64.4	16.6
Iron D-Fe	0.0313	0.00282	0.03	0.03	0.03	0.03	0.0305	0.0338	0.0359	0.038	0.0313
Lead T-Pb	0.00889	0.00997	0.0005	0.0005	0.00536	0.00686	0.00859	0.0153	0.0246	0.0339	0.00889
Lead D-Pb	0.000611	0.000333	0.0005	0.0005	0.0005	0.0005	0.0005	0.0007	0.0011	0.0015	0.000611
Magnesium T-Mg	9.07	6.12	5.52	5.54	7.11	7.28	8.2	11.6	18.4	25.2	9.07
Magnesium D-Mg	2.85	2.71	0.96	1.04	1.34	1.72	1.87	7.1	7.69	8.29	2.85
Manganese T-Mn	0.487	0.587	0.0165	0.0195	0.274	0.369	0.486	0.799	1.39	1.98	0.487
Manganese D-Mn	0.00934	0.0208	0.00024	0.000264	0.00044	0.00072	0.00718	0.02	0.0421	0.0642	0.00934
Mercury T-Hg	0.0000191	0.0000258	0.000005	0.000005	0.0000084	0.0000096	0.0000127	0.0000372	0.0000616	0.000086	0.0000191
Mercury D-Hg	0.000005	N/A	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005
Molybdenum T-Mo	0.00431	0.00247	0.0018	0.00204	0.0025	0.0031	0.0073	0.00756	0.00768	0.0078	0.00431
Molybdenum D-Mo	0.00327	0.00243	0.0011	0.00126	0.0015	0.0023	0.0044	0.00708	0.00724	0.0074	0.00327
Nickel T-Ni	0.0198	0.021	0.0041	0.0043	0.0117	0.015	0.0182	0.0327	0.0531	0.0735	0.0198
Nickel D-Ni	0.00192	0.0014	0.001	0.001	0.001	0.001	0.0035	0.00372	0.00396	0.0042	0.00192
Selenium T-Se	0.00229	0.00146	0.00113	0.00116	0.00151	0.00171	0.00275	0.00378	0.00473	0.00569	0.00229
Selenium D-Se	0.00131	0.00108	0.000484	0.000526	0.000659	0.000834	0.00135	0.00287	0.00321	0.00355	0.00131
Silicon T-Si	16.6	12.9	2.63	2.69	14.3	15.8	16.8	24.4	35.8	47.2	16.6
Silicon D-Si	1.47	1.46	0.512	0.523	0.574	0.712	2.15	2.94	3.88	4.82	1.47

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.00037	0.000478	0.00002	0.00002	0.000195	0.000267	0.000351	0.000605	0.0011	0.0016	0.00037
Silver D-Ag	0.000022	0.000006	0.00002	0.00002	0.00002	0.00002	0.00002	0.0000236	0.0000308	0.000038	0.000022
Sodium T-Na	2.14	0.265	2	2	2	2	2.1	2.54	2.62	2.7	2.14
Sodium D-Na	2.04	0.133	2	2	2	2	2	2.08	2.24	2.4	2.04
Strontium T-Sr	0.198	0.125	0.0956	0.0994	0.126	0.139	0.231	0.393	0.412	0.431	0.198
Strontium D-Sr	0.157	0.141	0.0649	0.068	0.0813	0.0967	0.108	0.4	0.405	0.41	0.157
Thallium T-Tl	0.000201	0.00000333	0.0002	0.0002	0.0002	0.0002	0.0002	0.000202	0.000206	0.00021	0.000201
Thallium D-Tl	0.0002	2.87E-20	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Tin T-Sn	0.0005	N/A	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Tin D-Sn	0.0005	N/A	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Titanium T-Ti	0.216	0.136	0.01	0.0108	0.214	0.228	0.257	0.336	0.391	0.445	0.216
Titanium D-Ti	0.0167	0.02	0.01	0.01	0.01	0.01	0.01	0.022	0.046	0.07	0.0167
Uranium T-U	0.000479	0.000275	0.00025	0.000266	0.0003	0.00034	0.00073	0.000788	0.000904	0.00102	0.000479
Uranium D-U	0.000306	0.00021	0.0002	0.0002	0.0002	0.0002	0.0002	0.000654	0.000682	0.00071	0.000306
Vanadium T-V	0.0342	0.0396	0.0005	0.000804	0.0231	0.0269	0.0346	0.0562	0.0951	0.134	0.0342
Vanadium D-V	0.00115	0.00195	0.0005	0.0005	0.0005	0.0005	0.0005	0.00167	0.00401	0.00635	0.00115
Zinc T-Zn	0.0676	0.0748	0.0088	0.00908	0.0397	0.0516	0.0634	0.112	0.185	0.258	0.0676
Zinc D-Zn	0.00572	0.00128	0.005	0.005	0.005	0.005	0.0061	0.0071	0.0079	0.0087	0.00572

Units = mg/L

Table B6: Summary Statistics Surface Water Sampling Station BC08 in Bitter Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	8.24	0.48	7.6	7.6	7.82	8.22	8.56	8.9	8.99	9.17	23
Conductivity	161	123	49.5	56.5	70.3	93	261	330	389	478	31
Hardness CaCO3	79	63.7	20.9	21.5	32.2	52	131	170	196	257	31
Total Dissolved Solids	118	81.5	41	44	64.5	79	179	230	260	358	31
Total Suspended Solids	315	270	3	3	165	267	390	550	820	1200	31
Turbidity	219	173	0.54	1.26	120	180	286	460	560	660	31
Alkalinity-Total CaCO3	48.9	27.8	20.4	22.3	27	38	72.1	94	100	104	31
Acidity (as CaCO3)	2.53	4.47	0.1	0.545	1	1	1.45	3.53	12.5	20	30
Chloride Cl	0.534	0.152	0.5	0.5	0.5	0.5	0.5	0.5	0.534	1.18	20
Fluoride F	0.0476	0.0649	0.02	0.02	0.02	0.02	0.049	0.0735	0.14	0.297	20
Bromide Br	0.05	7.12E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	20
Sulphate SO4	40.6	41.8	5.43	6.9	9.55	17	66.9	100	116	147	31
Nitrate Nitrogen N	0.00973	0.004	0.005	0.005	0.00608	0.01	0.0121	0.014	0.0153	0.0194	20
Nitrite Nitrogen N	0.001	4.45E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	20
Total Nitrogen	0.085	0.0551	0.03	0.033	0.045	0.08	0.12	0.138	0.144	0.15	4
Ammonia Nitrogen N	0.00565	0.00236	0.005	0.005	0.005	0.005	0.005	0.00572	0.00724	0.0155	20
Ortho-Phosphate	0.00164	0.000475	0.001	0.001	0.00133	0.0016	0.00203	0.00212	0.00232	0.0026	20
Phosphorus (P)-Total	0.262	0.167	0.002	0.00238	0.181	0.3	0.324	0.426	0.533	0.584	20
Total Organic Carbon	0.766	0.347	0.5	0.5	0.5	0.54	1.08	1.2	1.35	1.54	20
Dissolved Organic Carbon	0.532	0.0957	0.5	0.5	0.5	0.5	0.5	0.545	0.691	0.9	20
Aluminum T-Al	6.85	6.78	0.0085	0.0391	2.91	5.87	7.93	11.5	14.7	36	30
Aluminum D-Al	0.0771	0.0498	0.005	0.00671	0.0355	0.0804	0.102	0.131	0.138	0.23	30
Antimony T-Sb	0.00209	0.000897	0.0005	0.000749	0.00152	0.00202	0.0025	0.00362	0.00386	0.004	30
Antimony D-Sb	0.000892	0.000514	0.00018	0.000263	0.0005	0.00076	0.00134	0.00144	0.00172	0.0023	30
Arsenic T-As	0.0104	0.00691	0.0005	0.00088	0.00555	0.0112	0.0132	0.0147	0.022	0.028	20
Arsenic D-As	0.000785	0.000177	0.00032	0.000491	0.000698	0.00079	0.000865	0.001	0.00104	0.00106	20
Barium T-Ba	0.114	0.0612	0.02	0.0386	0.0656	0.112	0.14	0.162	0.22	0.31	30
Barium D-Ba	0.0255	0.0138	0.00828	0.00888	0.0168	0.0226	0.028	0.0438	0.0565	0.0612	30
Beryllium T-Be	0.00066	0.000429	0.0001	0.0001	0.000155	0.001	0.001	0.001	0.001	0.001	20
Beryllium D-Be	0.00064	0.000452	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Bismuth T-Bi	0.0127	0.0455	0.00005	0.00005	0.0000673	0.000124	0.0005	0.00545	0.0575	0.2	20



Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.0126	0.0455	0.00005	0.00005	0.00005	0.00005	0.0005	0.00545	0.0575	0.2	20
Boron T-B	0.064	0.0452	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	20
Boron D-B	0.064	0.0452	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	20
Cadmium T-Cd	0.000362	0.000303	0.0000414	0.0000509	0.0002	0.000313	0.000472	0.000602	0.000702	0.0016	29
Cadmium D-Cd	0.0000619	0.0000633	0.000005	0.0000094	0.000017	0.000037	0.0001	0.000114	0.000188	0.000262	29
Calcium T-Ca	34	23.1	11.5	13.1	17	23.4	53.8	66.5	76.6	85.1	30
Calcium D-Ca	27.2	22	7	7.53	11.1	17	45.3	59.2	67.2	86.7	30
Chromium T-Cr	0.00823	0.00509	0.0001	0.000955	0.00419	0.00903	0.0113	0.0125	0.0165	0.0184	20
Chromium D-Cr	0.000644	0.000448	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Cobalt T-Co	0.00529	0.00482	0.0001	0.0003	0.00239	0.00437	0.0069	0.0101	0.0126	0.023	30
Cobalt D-Co	0.000206	0.000104	0.00006	0.00008	0.0001	0.00024	0.0003	0.0003	0.000317	0.00035	30
Copper T-Cu	0.0291	0.0262	0.0005	0.001	0.0139	0.024	0.034	0.0583	0.0755	0.12	30
Copper D-Cu	0.000797	0.000608	0.0002	0.0002	0.0004	0.00097	0.001	0.001	0.00107	0.0035	30
Iron T-Fe	11.9	18.1	0.044	0.114	4.13	8.91	11.9	19.5	27.3	100	30
Iron D-Fe	0.0509	0.0339	0.01	0.0136	0.03	0.0385	0.0653	0.0888	0.124	0.14	30
Lead T-Pb	0.00682	0.00534	0.0005	0.0005	0.0031	0.00539	0.01	0.0129	0.0168	0.022	29
Lead D-Pb	0.000265	0.000207	0.00005	0.00005	0.000082	0.000128	0.0005	0.0005	0.0005	0.0005	29
Magnesium T-Mg	8.13	5.87	2.6	3.63	5.38	5.92	7.96	12.4	19.9	30	30
Magnesium D-Mg	2.89	2.4	0.57	0.712	1.09	2	4.87	5.81	7.19	9.9	30
Manganese T-Mn	0.325	0.311	0.00549	0.0117	0.153	0.279	0.395	0.584	0.727	1.6	30
Manganese D-Mn	0.00819	0.0155	0.00044	0.000464	0.000853	0.00202	0.00924	0.0212	0.0263	0.0802	30
Mercury T-Hg	0.0000105	0.00000589	0.000005	0.000005	0.000005	0.00001	0.0000109	0.000017	0.000025	0.000025	20
Mercury D-Hg	0.00000625	0.00000222	0.000005	0.000005	0.000005	0.000005	0.00000625	0.00001	0.00001	0.00001	20
Molybdenum T-Mo	0.00555	0.00369	0.0016	0.00201	0.00263	0.00425	0.00873	0.0112	0.012	0.013	30
Molybdenum D-Mo	0.00454	0.00361	0.000719	0.00118	0.00163	0.0029	0.00718	0.0101	0.0109	0.0115	30
Nickel T-Ni	0.0148	0.0117	0.0016	0.0022	0.00927	0.0119	0.0191	0.0293	0.0348	0.055	30
Nickel D-Ni	0.00143	0.0013	0.0004	0.000432	0.0005	0.001	0.00165	0.00282	0.00397	0.00589	30
Selenium T-Se	0.0014	0.000349	0.00083	0.000834	0.00118	0.00136	0.00167	0.00185	0.00193	0.00204	20
Selenium D-Se	0.000959	0.000537	0.000303	0.000405	0.000535	0.000799	0.00143	0.00158	0.00182	0.00221	20
Silicon T-Si	10.6	5	1.65	1.75	8.38	11	14.8	16.1	16.7	18.2	20
Silicon D-Si	1.24	1.52	0.267	0.319	0.463	0.702	1.37	1.95	4.47	6.4	20

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.000187	0.000125	0.00001	0.0000195	0.0000878	0.000207	0.000242	0.000276	0.000434	0.000459	20
Silver D-Ag	0.000016	0.00000503	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	20
Sodium T-Na	2.1	1.25	0.73	0.799	1.26	2	2.1	3.12	4.59	6.6	30
Sodium D-Na	1.6	1.26	0.191	0.227	0.532	2	2	2.29	2.69	6.6	30
Strontium T-Sr	0.21	0.153	0.0663	0.0731	0.096	0.142	0.361	0.455	0.466	0.47	29
Strontium D-Sr	0.174	0.145	0.0395	0.0414	0.0657	0.095	0.307	0.403	0.419	0.455	29
Thallium T-Tl	0.000138	0.0000783	0.00001	0.0000281	0.000052	0.0002	0.0002	0.0002	0.0002	0.0002	20
Thallium D-Tl	0.000124	0.0000955	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	20
Tin T-Sn	0.000367	0.000194	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	18
Tin D-Sn	0.000384	0.000182	0.0001	0.0001	0.000178	0.0005	0.0005	0.0005	0.0005	0.0005	18
Titanium T-Ti	0.14	0.0831	0.0038	0.00969	0.086	0.161	0.208	0.223	0.245	0.277	20
Titanium D-Ti	0.00823	0.00392	0.0003	0.000405	0.01	0.01	0.01	0.01	0.0101	0.012	20
Uranium T-U	0.000435	0.000247	0.000194	0.000204	0.00025	0.000334	0.000578	0.000811	0.000829	0.000994	20
Uranium D-U	0.000314	0.000283	0.00002	0.0000286	0.00017	0.0002	0.000375	0.000773	0.000805	0.000891	20
Vanadium T-V	0.0173	0.0107	0.0005	0.0005	0.00972	0.0201	0.0224	0.0273	0.035	0.0361	20
Vanadium D-V	0.000625	0.000222	0.0005	0.0005	0.0005	0.0005	0.000625	0.001	0.001	0.001	20
Zinc T-Zn	0.0506	0.0404	0.003	0.00483	0.0336	0.0439	0.0675	0.0888	0.126	0.18	30
Zinc D-Zn	0.00441	0.00375	0.0007	0.000885	0.00193	0.00475	0.005	0.0055	0.0113	0.0186	30

Units = mg/L

Table B7: Summary Statistics Surface Water Sampling Station BR06 in Bear River

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.8	0.412	7	7.09	7.6	7.8	8.03	8.38	8.42	8.51	34
Conductivity	151	69.9	69.8	78.1	95.1	127	209	257	262	310	46
Hardness CaCO3	74.4	33.3	31.1	37.2	45.5	66.5	107	129	130	140	46
Total Dissolved Solids	103	43.9	46	54.3	65	91	140	168	170	200	46
Total Suspended Solids	179	198	1	1.5	13.5	100	302	470	518	730	46
Turbidity	120	133	0.26	0.505	7.8	80.9	205	301	365	520	46
Alkalinity-Total CaCO3	57	23	26.6	31.4	38.3	50.3	78	88	97.5	110	46
Acidity (as CaCO3)	2.06	1.25	1	1	1.1	1.6	2.6	3.77	5.13	5.8	42
Chloride Cl	0.501	0.00655	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.53	21
Fluoride F	0.0369	0.017	0.02	0.02	0.023	0.03	0.047	0.066	0.066	0.066	21
Bromide Br	0.05	7.11E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	21
Sulphate SO4	22.1	13.7	7.82	8.12	11.5	16.9	31.1	43.5	47.7	56	46
Nitrate Nitrogen N	0.0932	0.0863	0.0167	0.0174	0.0251	0.0496	0.142	0.212	0.227	0.31	21
Nitrite Nitrogen N	0.001	4.44E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	21
Total Nitrogen	0.189	0.0466	0.15	0.151	0.154	0.178	0.213	0.235	0.243	0.25	4
Ammonia Nitrogen N	0.00556	0.00152	0.005	0.005	0.005	0.005	0.005	0.0063	0.0066	0.0118	21
Ortho-Phosphate	0.00121	0.000261	0.001	0.001	0.001	0.0011	0.0014	0.0017	0.0017	0.0018	21
Phosphorus (P)-Total	0.26	0.222	0.002	0.0041	0.05	0.3	0.326	0.611	0.622	0.71	21
Total Organic Carbon	0.813	0.482	0.5	0.5	0.5	0.61	0.88	1.27	1.48	2.54	21
Dissolved Organic Carbon	0.561	0.138	0.5	0.5	0.5	0.5	0.5	0.67	0.95	0.95	21
Aluminum T-Al	4.23	5.28	0.001	0.0183	0.178	2.6	6.17	11.2	11.9	27	46
Aluminum D-Al	0.0557	0.0453	0.0005	0.00125	0.0073	0.0585	0.0873	0.116	0.128	0.18	46
Antimony T-Sb	0.00553	0.0293	0.00044	0.000458	0.000678	0.001	0.00165	0.00258	0.00307	0.2	46
Antimony D-Sb	0.00052	0.000169	0.00026	0.0003	0.000433	0.0005	0.000585	0.00068	0.000793	0.0012	46
Arsenic T-As	0.00837	0.00722	0.00051	0.00052	0.00256	0.00685	0.00975	0.0198	0.0207	0.0224	21
Arsenic D-As	0.000536	0.000111	0.00033	0.00037	0.0005	0.0005	0.00055	0.00068	0.00079	0.00081	21
Barium T-Ba	0.121	0.056	0.057	0.066	0.083	0.0972	0.155	0.195	0.22	0.31	46
Barium D-Ba	0.053	0.0225	0.0242	0.028	0.0335	0.047	0.0723	0.088	0.0901	0.096	46
Beryllium T-Be	0.000679	0.000424	0.0001	0.0001	0.00012	0.001	0.001	0.001	0.001	0.001	21
Beryllium D-Be	0.000657	0.000448	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	21
Bismuth T-Bi	0.00254	0.0109	0.00005	0.00005	0.00005	0.000069	0.000213	0.0005	0.0005	0.05	21

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.00251	0.0109	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.05	21
Boron T-B	0.0663	0.044	0.01	0.01	0.012	0.1	0.1	0.1	0.1	0.1	21
Boron D-B	0.0659	0.0445	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	21
Cadmium T-Cd	0.000291	0.000258	0.0000138	0.0000261	0.0000975	0.0002	0.00041	0.000677	0.000732	0.0012	44
Cadmium D-Cd	0.0000692	0.0000569	0.000005	0.000017	0.00002	0.00007	0.0000925	0.000163	0.0002	0.0002	44
Calcium T-Ca	28.6	11.7	12.8	16	19.1	24.2	38	45.6	48.5	57	46
Calcium D-Ca	24.6	10.9	10.9	13	15.8	21.7	33	43.4	44.8	47	46
Chromium T-Cr	0.007	0.00567	0.0001	0.001	0.0018	0.0056	0.0114	0.0153	0.0154	0.0168	21
Chromium D-Cr	0.00066	0.000444	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	21
Cobalt T-Co	0.00297	0.00388	0.00007	0.0001	0.0003	0.00186	0.00382	0.00803	0.00825	0.022	46
Cobalt D-Co	0.000217	0.00023	0.00005	0.0000625	0.0000925	0.0001	0.0003	0.0003	0.000828	0.001	46
Copper T-Cu	0.0161	0.0201	0.0002	0.0005	0.002	0.00967	0.0211	0.0414	0.0446	0.11	46
Copper D-Cu	0.000673	0.000399	0.0002	0.0002	0.000358	0.00057	0.001	0.001	0.001	0.0021	46
Iron T-Fe	6.86	11.8	0.01	0.036	0.263	4	8.51	16.2	18.2	75	46
Iron D-Fe	0.0311	0.0191	0.0066	0.01	0.0135	0.03	0.0385	0.0515	0.0728	0.084	46
Lead T-Pb	0.00491	0.00512	0.00005	0.000135	0.000543	0.00345	0.00669	0.0124	0.0153	0.021	46
Lead D-Pb	0.000269	0.00027	0.00004	0.00005	0.0000725	0.00012	0.0005	0.0005	0.000875	0.001	46
Magnesium T-Mg	5.29	2.94	2.3	2.85	3.57	4.66	5.73	7.46	8.23	21	46
Magnesium D-Mg	2.49	1.26	0.926	1.03	1.49	2.12	3.43	4.41	4.71	5.27	46
Manganese T-Mn	0.199	0.257	0.0052	0.00906	0.018	0.123	0.278	0.511	0.594	1.4	46
Manganese D-Mn	0.00773	0.00674	0.0003	0.000325	0.00201	0.00615	0.011	0.0174	0.0201	0.026	46
Mercury T-Hg	0.0000102	0.00000967	0.000005	0.000005	0.000005	0.00001	0.0000101	0.0000133	0.0000143	0.00005	21
Mercury D-Hg	0.0000064	0.00000224	0.000005	0.000005	0.000005	0.000005	0.0000091	0.00001	0.00001	0.00001	21
Molybdenum T-Mo	0.00246	0.000971	0.001	0.00126	0.002	0.00225	0.00278	0.0033	0.00417	0.0063	46
Molybdenum D-Mo	0.00176	0.000592	0.000719	0.000873	0.0013	0.00185	0.00211	0.00255	0.00268	0.003	46
Nickel T-Ni	0.0139	0.0276	0.0005	0.000715	0.00208	0.00515	0.0129	0.0218	0.048	0.17	46
Nickel D-Ni	0.000848	0.000469	0.0003	0.00032	0.0005	0.001	0.001	0.0012	0.00153	0.003	46
Selenium T-Se	0.00117	0.000399	0.00049	0.00054	0.000944	0.00112	0.00145	0.00157	0.0016	0.0022	21
Selenium D-Se	0.000803	0.000445	0.00027	0.00027	0.000429	0.00068	0.001	0.00144	0.00158	0.00165	21
Silicon T-Si	9.32	6.23	1.81	1.89	3.92	7.63	14	18.4	18.9	20.5	23
Silicon D-Si	1.08	0.484	0.491	0.538	0.682	0.968	1.39	1.86	1.9	1.94	23

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.000175	0.000155	0.00001	0.00002	0.000038	0.000138	0.000254	0.000431	0.000438	0.000474	21
Silver D-Ag	0.0000162	0.00000498	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	21
Sodium T-Na	1.52	0.694	0.54	0.705	1	1.4	2	2	2.54	4.1	43
Sodium D-Na	1.1	0.679	0.272	0.316	0.49	0.995	2	2	2	2.2	46
Strontium T-Sr	0.158	0.0581	0.0753	0.088	0.11	0.146	0.209	0.245	0.259	0.27	46
Strontium D-Sr	0.139	0.0617	0.0619	0.0692	0.085	0.119	0.2	0.24	0.242	0.251	46
Thallium T-Tl	0.000146	0.0000743	0.00001	0.000029	0.000067	0.0002	0.0002	0.0002	0.0002	0.0002	21
Thallium D-Tl	0.000128	0.0000945	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	21
Tin T-Sn	0.000349	0.000197	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	21
Tin D-Sn	0.000351	0.000198	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.00053	21
Titanium T-Ti	0.139	0.11	0.00042	0.01	0.05	0.124	0.235	0.275	0.309	0.332	21
Titanium D-Ti	0.00821	0.00378	0.0003	0.00032	0.01	0.01	0.01	0.01	0.01	0.01	21
Uranium T-U	0.000267	0.000102	0.000138	0.000189	0.00021	0.00023	0.00027	0.000387	0.00047	0.00055	21
Uranium D-U	0.000166	0.0000712	0.000036	0.000036	0.000141	0.0002	0.0002	0.00023	0.00024	0.000264	21
Vanadium T-V	0.0152	0.0128	0.0005	0.0005	0.00384	0.012	0.0236	0.0341	0.0349	0.0351	21
Vanadium D-V	0.000619	0.000218	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	21
Zinc T-Zn	0.0385	0.0404	0.0019	0.00278	0.0103	0.0255	0.0566	0.0776	0.118	0.2	46
Zinc D-Zn	0.00381	0.00454	0.0003	0.0004	0.00103	0.00255	0.005	0.00575	0.00663	0.029	46

Units = mg/L

Table B8: Summary Statistics Surface Water Sampling Station BR08 in Bear River

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.67	0.345	7	7.11	7.53	7.62	7.81	8.18	8.21	8.23	26
Conductivity	115	50	51	51.2	73.5	105	160	180	198	232	38
Hardness CaCO3	54.6	22.3	23.5	25.9	34.2	51.1	74.1	83.3	95.2	101	38
Total Dissolved Solids	78.3	33.7	39	41.7	54.5	73	98.5	110	115	220	38
Total Suspended Solids	29.2	33.7	1	1	3	15.5	47.8	75.3	98.4	127	38
Turbidity	25.7	30.8	0.24	0.296	1.03	13.6	40.5	77.8	92	92.1	38
Alkalinity-Total CaCO3	44.6	19	18.2	21.7	27.5	43.4	61	74	75	76	38
Acidity (as CaCO3)	2.51	2.63	1.1	1.1	1.4	1.9	2.4	3.76	4.92	16	33
Chloride Cl	0.506	0.0262	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.62	21
Fluoride F	0.043	0.0145	0.024	0.025	0.033	0.04	0.054	0.066	0.066	0.067	21
Bromide Br	0.05	7.11E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	21
Sulphate SO4	14.3	6.69	5.84	6.77	9.3	13.5	17	21.2	25.9	38.2	38
Nitrate Nitrogen N	0.103	0.0867	0.0219	0.0223	0.0313	0.0615	0.145	0.225	0.243	0.311	21
Nitrite Nitrogen N	0.001	4.44E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	21
Total Nitrogen	0.0918	0.0598	0.046	0.0478	0.055	0.0715	0.108	0.15	0.164	0.178	4
Ammonia Nitrogen N	0.005	8.89E-19	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	21
Ortho-Phosphate	0.00109	0.000162	0.001	0.001	0.001	0.001	0.0011	0.0013	0.0015	0.0015	21
Phosphorus (P)-Total	0.0917	0.113	0.002	0.002	0.0056	0.0435	0.138	0.3	0.3	0.3	21
Total Organic Carbon	0.553	0.12	0.5	0.5	0.5	0.5	0.53	0.72	0.73	0.98	21
Dissolved Organic Carbon	0.572	0.164	0.5	0.5	0.5	0.5	0.54	0.8	0.94	1.09	21
Aluminum T-Al	1.22	1.55	0.005	0.00803	0.031	0.535	1.57	3.65	4.35	5.8	38
Aluminum D-Al	0.0422	0.0355	0.0005	0.00084	0.00568	0.0451	0.062	0.09	0.1	0.15	38
Antimony T-Sb	0.000549	0.000225	0.0002	0.000277	0.000423	0.0005	0.00058	0.00079	0.0011	0.0012	38
Antimony D-Sb	0.000362	0.000159	0.00007	0.0001	0.0002	0.000415	0.0005	0.0005	0.000503	0.00062	38
Arsenic T-As	0.00186	0.00161	0.00042	0.0005	0.00077	0.00142	0.002	0.00331	0.00513	0.00671	21
Arsenic D-As	0.00044	0.0000965	0.00024	0.00025	0.00039	0.0005	0.0005	0.0005	0.0005	0.00052	21
Barium T-Ba	0.109	0.0317	0.068	0.075	0.0883	0.101	0.119	0.162	0.18	0.184	38
Barium D-Ba	0.0732	0.0202	0.046	0.0477	0.0565	0.069	0.09	0.103	0.11	0.112	38
Beryllium T-Be	0.000658	0.000447	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	21
Beryllium D-Be	0.000657	0.000448	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	21
Bismuth T-Bi	0.00251	0.0109	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.05	21

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.00251	0.0109	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.05	21
Boron T-B	0.0666	0.0437	0.01	0.01	0.013	0.1	0.1	0.1	0.1	0.1	21
Boron D-B	0.0661	0.0442	0.01	0.01	0.011	0.1	0.1	0.1	0.1	0.1	21
Cadmium T-Cd	0.000127	0.000109	0.000005	0.0000111	0.0000526	0.0001	0.00018	0.000209	0.000327	0.0005	38
Cadmium D-Cd	0.000066	0.0000625	0.0000088	0.0000164	0.0000193	0.0000289	0.0001	0.0002	0.0002	0.0002	38
Calcium T-Ca	20	8.12	8.82	9.68	13.4	18.3	25.2	33.9	34.1	37	38
Calcium D-Ca	18.7	7.48	8.36	9.11	12	17.9	22.5	28.2	33.2	35.2	38
Chromium T-Cr	0.000845	0.000306	0.0001	0.00028	0.00076	0.001	0.001	0.001	0.00107	0.0013	21
Chromium D-Cr	0.00066	0.000444	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	21
Cobalt T-Co	0.000746	0.000762	0.00006	0.000077	0.000285	0.00038	0.001	0.00203	0.00241	0.0028	38
Cobalt D-Co	0.000259	0.000276	0.00004	0.00006	0.0001	0.000115	0.0003	0.00051	0.001	0.001	38
Copper T-Cu	0.00313	0.00382	0.0004	0.0004	0.001	0.00157	0.00357	0.00703	0.0112	0.019	38
Copper D-Cu	0.000909	0.000914	0.0002	0.0002	0.000385	0.001	0.001	0.00127	0.00192	0.0056	38
Iron T-Fe	1.53	2.03	0.005	0.0299	0.0828	0.696	1.6	4.63	6.16	7.1	38
Iron D-Fe	0.0357	0.0239	0.01	0.01	0.0223	0.03	0.0448	0.0586	0.0705	0.14	38
Lead T-Pb	0.00353	0.0037	0.00005	0.000164	0.0006	0.00247	0.00478	0.00875	0.0107	0.014	37
Lead D-Pb	0.00035	0.000294	0.00004	0.0000694	0.000092	0.000273	0.0005	0.0007	0.001	0.001	37
Magnesium T-Mg	2.23	0.728	1.1	1.22	1.62	2	2.9	3.18	3.4	3.55	38
Magnesium D-Mg	1.68	0.743	0.632	0.778	1.02	1.56	2.13	2.67	3.05	3.41	38
Manganese T-Mn	0.0827	0.0991	0.00675	0.00995	0.0164	0.0365	0.0896	0.252	0.296	0.34	38
Manganese D-Mn	0.0106	0.00468	0.0034	0.00474	0.00705	0.00994	0.0131	0.0153	0.0182	0.025	38
Mercury T-Hg	0.00000746	0.00000397	0.000005	0.000005	0.000005	0.000005	0.00001	0.0000112	0.0000115	0.000021	21
Mercury D-Hg	0.00000619	0.00000218	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	21
Molybdenum T-Mo	0.000983	0.000275	0.0002	0.000522	0.001	0.001	0.0011	0.0013	0.0014	0.0015	38
Molybdenum D-Mo	0.00087	0.000294	0.0002	0.000323	0.000667	0.001	0.001	0.00113	0.00122	0.0014	38
Nickel T-Ni	0.00336	0.00886	0.00029	0.0005	0.001	0.001	0.00195	0.00477	0.00758	0.054	38
Nickel D-Ni	0.000901	0.00072	0.0002	0.0003	0.0005	0.001	0.001	0.001	0.00156	0.0042	38
Selenium T-Se	0.000264	0.000194	0.0001	0.000111	0.000165	0.000229	0.000348	0.000391	0.000409	0.001	21
Selenium D-Se	0.000248	0.000202	0.000088	0.000094	0.000113	0.000191	0.00032	0.000408	0.000409	0.001	21
Silicon T-Si	3.1	1.96	1.29	1.37	1.66	2.54	3.63	5.27	7.75	8.41	24
Silicon D-Si	1.01	0.399	0.462	0.522	0.674	0.932	1.31	1.61	1.68	1.7	24

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.00005	0.0000417	0.00001	0.00002	0.00002	0.000034	0.000054	0.000103	0.000152	0.000156	21
Silver D-Ag	0.0000162	0.00000498	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	21
Sodium T-Na	1.45	0.899	0.422	0.449	0.682	1.55	2	2	2.11	4.9	34
Sodium D-Na	1.17	0.703	0.237	0.309	0.49	1.1	2	2	2	2.2	38
Strontium T-Sr	0.125	0.0485	0.0574	0.0633	0.079	0.121	0.162	0.192	0.211	0.216	38
Strontium D-Sr	0.119	0.0479	0.05	0.0581	0.0785	0.118	0.158	0.187	0.201	0.211	38
Thallium T-Tl	0.000142	0.0000776	0.00001	0.00002	0.000058	0.0002	0.0002	0.0002	0.0002	0.0002	21
Thallium D-Tl	0.000128	0.0000942	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	21
Tin T-Sn	0.00034	0.000201	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	20
Tin D-Sn	0.00034	0.000201	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	20
Titanium T-Ti	0.0378	0.0369	0.0003	0.01	0.01	0.026	0.043	0.083	0.116	0.137	21
Titanium D-Ti	0.00822	0.00377	0.0003	0.00036	0.01	0.01	0.01	0.01	0.01	0.01	21
Uranium T-U	0.000169	0.0000458	0.000084	0.000085	0.000144	0.0002	0.0002	0.0002	0.0002	0.00021	21
Uranium D-U	0.000146	0.0000749	0.000026	0.000026	0.000068	0.0002	0.0002	0.0002	0.0002	0.0002	21
Vanadium T-V	0.00318	0.00289	0.0005	0.0005	0.00059	0.0025	0.00384	0.00727	0.00753	0.0109	21
Vanadium D-V	0.000619	0.000218	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	21
Zinc T-Zn	0.0225	0.0253	0.003	0.00478	0.0054	0.0129	0.0253	0.0549	0.0615	0.13	38
Zinc D-Zn	0.00415	0.00455	0.0003	0.0004	0.00123	0.005	0.005	0.005	0.0053	0.029	38

Units = mg/L



Table B9: Summary Statistics Surface Water Sampling Station GSC02 in Goldslide Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.42	0.448	6.26	6.65	7.19	7.43	7.63	7.89	8.04	8.73	70
Conductivity	139	36.9	71	85	119	134	160	189	194	250	88
Hardness CaCO3	57.5	16.4	24	34.4	47	58	66.5	78.6	89.3	110	88
Total Dissolved Solids	95.4	24.7	36	63.4	76	94	110	120	125	200	89
Total Suspended Solids	3.15	6.17	0.5	1	1	1	3	4.08	13.4	51	87
Turbidity	0.499	0.892	0.1	0.1	0.16	0.23	0.46	0.932	1.56	6.9	85
Alkalinity-Total CaCO3	14.3	7.12	7	8	10	12	15	22.4	28.6	56	89
Acidity (as CaCO3)	3.58	4.36	1	1.4	2	2.7	3.7	4.18	6.29	29	83
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	20
Fluoride F	0.0412	0.00753	0.031	0.032	0.0358	0.0405	0.0443	0.0522	0.0542	0.057	20
Bromide Br	0.05	7.12E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	20
Sulphate SO4	46	16.3	18	22	35.9	45.3	56.7	68	70.8	98	88
Nitrate Nitrogen N	0.0157	0.00604	0.005	0.00719	0.00983	0.0174	0.0196	0.0237	0.0241	0.0249	20
Nitrite Nitrogen N	0.001	4.45E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	20
Total Nitrogen	0.0515	0.0176	0.03	0.033	0.045	0.0515	0.058	0.067	0.07	0.073	4
Ammonia Nitrogen N	0.005	8.9E-19	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	20
Ortho-Phosphate	0.00108	0.000174	0.001	0.001	0.001	0.001	0.0011	0.0013	0.00132	0.0017	20
Phosphorus (P)-Total	0.0726	0.118	0.002	0.002	0.00215	0.005	0.05	0.3	0.3	0.3	20
Total Organic Carbon	0.518	0.0805	0.5	0.5	0.5	0.5	0.5	0.5	0.518	0.86	20
Dissolved Organic Carbon	0.519	0.0568	0.5	0.5	0.5	0.5	0.5	0.542	0.57	0.75	20
Aluminum T-Al	0.056	0.0921	0.001	0.00412	0.0148	0.0415	0.0612	0.0962	0.129	0.653	85
Aluminum D-Al	0.0159	0.0142	0.0005	0.000734	0.00692	0.014	0.022	0.0266	0.0358	0.103	87
Antimony T-Sb	0.000332	0.000268	0.00005	0.0000625	0.0001	0.000295	0.0005	0.00063	0.000758	0.0016	86
Antimony D-Sb	0.00021	0.000177	0.00001	0.00005	0.0001	0.0001	0.000338	0.0005	0.0005	0.00072	86
Arsenic T-As	0.000375	0.000201	0.0001	0.0001	0.000163	0.0005	0.0005	0.0005	0.000515	0.00079	20
Arsenic D-As	0.000349	0.000191	0.0001	0.0001	0.00013	0.0005	0.0005	0.0005	0.0005	0.0005	20
Barium T-Ba	0.0311	0.035	0.018	0.02	0.023	0.025	0.0274	0.0339	0.0391	0.314	87
Barium D-Ba	0.0237	0.00459	0.017	0.0182	0.021	0.023	0.0254	0.0287	0.0305	0.0419	87
Beryllium T-Be	0.00064	0.000452	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Beryllium D-Be	0.00064	0.000452	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Bismuth T-Bi	0.00264	0.0111	0.00005	0.00005	0.00005	0.00005	0.000163	0.0005	0.00298	0.05	20

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.00264	0.0111	0.00005	0.00005	0.00005	0.00005	0.000163	0.0005	0.00298	0.05	20
Boron T-B	0.064	0.0452	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	20
Boron D-B	0.064	0.0452	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	20
Cadmium T-Cd	0.000348	0.00032	0.00005	0.0001	0.0002	0.000268	0.0004	0.0006	0.0009	0.00223	86
Cadmium D-Cd	0.000226	0.000132	0.00007	0.00009	0.000133	0.0002	0.000286	0.00034	0.00046	0.00085	86
Calcium T-Ca	21.2	6.51	9.9	12.7	16.6	20.7	24.3	28.4	31.5	50.8	87
Calcium D-Ca	19.3	5.46	7.4	11.5	15.3	19.3	22.5	27	29.8	34.1	87
Chromium T-Cr	0.000645	0.000447	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Chromium D-Cr	0.00065	0.000442	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Cobalt T-Co	0.000676	0.00117	0.00005	0.000063	0.0003	0.00045	0.00071	0.001	0.00107	0.00914	87
Cobalt D-Co	0.000382	0.000251	0.00003	0.00006	0.00016	0.00036	0.0005	0.000682	0.000964	0.001	87
Copper T-Cu	0.0084	0.0138	0.0005	0.00173	0.00333	0.0047	0.007	0.0138	0.0265	0.0904	87
Copper D-Cu	0.00341	0.00262	0.00005	0.0005	0.00169	0.0028	0.00415	0.00652	0.00866	0.013	87
Iron T-Fe	0.0606	0.115	0.01	0.01	0.01	0.03	0.06	0.12	0.192	0.751	85
Iron D-Fe	0.0156	0.0113	0.005	0.01	0.01	0.01	0.0155	0.03	0.03	0.07	87
Lead T-Pb	0.000905	0.00232	0.00005	0.00005	0.000145	0.0005	0.000745	0.00154	0.0028	0.02	87
Lead D-Pb	0.000205	0.000306	0.00002	0.0000395	0.00005	0.00008	0.00019	0.0005	0.00085	0.002	87
Magnesium T-Mg	2.75	1.46	1.39	1.67	2.07	2.53	2.98	3.43	3.88	12.5	87
Magnesium D-Mg	2.28	0.576	0.87	1.38	1.84	2.3	2.6	2.98	3.23	4.07	87
Manganese T-Mn	0.00791	0.00704	0.00012	0.000228	0.00306	0.00669	0.011	0.0146	0.0186	0.0403	84
Manganese D-Mn	0.00713	0.00916	0.0001	0.000163	0.00288	0.00551	0.00823	0.0125	0.0156	0.0692	86
Mercury T-Hg	0.00000625	0.00000222	0.000005	0.000005	0.000005	0.000005	0.00000625	0.00001	0.00001	0.00001	20
Mercury D-Hg	0.00000625	0.00000222	0.000005	0.000005	0.000005	0.000005	0.00000625	0.00001	0.00001	0.00001	20
Molybdenum T-Mo	0.00597	0.00325	0.0027	0.00355	0.00447	0.0053	0.0066	0.00792	0.00908	0.03	87
Molybdenum D-Mo	0.00535	0.00309	0.00114	0.00315	0.0039	0.00493	0.00615	0.0072	0.00793	0.03	87
Nickel T-Ni	0.00579	0.0236	0.0003	0.000715	0.00109	0.0015	0.0028	0.00482	0.0168	0.21	87
Nickel D-Ni	0.00117	0.00062	0.00015	0.00033	0.0008	0.0011	0.0014	0.002	0.0024	0.00304	87
Selenium T-Se	0.00156	0.000375	0.001	0.00111	0.00127	0.0015	0.00172	0.00214	0.00219	0.00231	20
Selenium D-Se	0.00158	0.000387	0.001	0.00109	0.00129	0.0015	0.00183	0.00219	0.00221	0.00228	20
Silicon T-Si	2.85	0.389	2.26	2.27	2.62	2.73	3.13	3.26	3.32	3.95	24
Silicon D-Si	2.78	0.386	2.19	2.25	2.55	2.71	3.02	3.28	3.36	3.76	24

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.0000161	0.00000497	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	20
Silver D-Ag	0.000016	0.00000503	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	20
Sodium T-Na	1.57	0.541	0.79	0.955	1.22	1.47	1.98	2	2.17	4.35	82
Sodium D-Na	1.34	0.383	0.627	0.755	1.08	1.3	1.58	2	2	2	87
Strontium T-Sr	0.138	0.0548	0.047	0.0752	0.102	0.121	0.161	0.221	0.246	0.29	85
Strontium D-Sr	0.129	0.051	0.038	0.065	0.0915	0.118	0.152	0.206	0.228	0.277	85
Thallium T-Tl	0.000124	0.0000955	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	20
Thallium D-Tl	0.000124	0.0000955	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	20
Tin T-Sn	0.000343	0.000198	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	20
Tin D-Sn	0.000356	0.000199	0.0001	0.0001	0.000135	0.0005	0.0005	0.0005	0.000507	0.00064	20
Titanium T-Ti	0.00813	0.00398	0.0003	0.0003	0.01	0.01	0.01	0.01	0.0101	0.011	20
Titanium D-Ti	0.00806	0.00398	0.0003	0.0003	0.01	0.01	0.01	0.01	0.01	0.01	20
Uranium T-U	0.000125	0.0000939	0.00001	0.00001	0.0000138	0.0002	0.0002	0.0002	0.0002	0.0002	20
Uranium D-U	0.000125	0.0000937	0.00001	0.00001	0.0000148	0.0002	0.0002	0.0002	0.0002	0.0002	20
Vanadium T-V	0.00064	0.000256	0.0005	0.0005	0.0005	0.0005	0.000625	0.001	0.00102	0.0013	20
Vanadium D-V	0.000625	0.000222	0.0005	0.0005	0.0005	0.0005	0.000625	0.001	0.001	0.001	20
Zinc T-Zn	0.0231	0.0223	0.0046	0.00785	0.0126	0.0172	0.024	0.041	0.0513	0.173	86
Zinc D-Zn	0.0147	0.00757	0.001	0.00454	0.0101	0.014	0.0175	0.024	0.0303	0.045	86

Units = mg/L

Table B10: Summary Statistics Surface Water Sampling Station OC06 in Otter Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.94	0.601	7.14	7.32	7.65	7.74	8.04	8.69	9	9.45	14
Conductivity	260	213	58.3	67.2	106	167	361	634	687	715	19
Hardness CaCO3	138	127	26.7	29	47.7	79.6	191	355	411	412	19
Total Dissolved Solids	174	149	38	49.7	66.5	112	228	435	484	507	19
Total Suspended Solids	33.1	55.9	3	3	7.05	14.4	31.2	57.9	104	247	19
Turbidity	17.5	26.3	0.9	0.9	2.66	9.28	19.1	32.5	59.7	112	19
Alkalinity-Total CaCO3	62.5	38	20	25	33.4	48.1	83.9	129	134	135	19
Acidity (as CaCO3)	1.65	0.508	1	1	1.25	1.7	1.9	2.04	2.28	3	19
Chloride Cl	0.711	0.631	0.5	0.5	0.5	0.5	0.5	0.9	2.5	2.5	19
Fluoride F	0.0501	0.0484	0.02	0.02	0.02	0.023	0.0635	0.129	0.152	0.17	19
Bromide Br	0.0711	0.0631	0.05	0.05	0.05	0.05	0.05	0.09	0.25	0.25	19
Sulphate SO4	74.8	81.9	7.23	7.91	18.8	36.3	101	217	247	265	19
Nitrate Nitrogen N	0.0241	0.0163	0.005	0.005	0.0107	0.0211	0.0331	0.0486	0.0518	0.0599	19
Nitrite Nitrogen N	0.00142	0.00126	0.001	0.001	0.001	0.001	0.001	0.0018	0.005	0.005	19
Total Nitrogen	0.06	N/A	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	1
Ammonia Nitrogen N	0.005	8.91E-19	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	19
Ortho-Phosphate	0.00124	0.000344	0.001	0.001	0.001	0.001	0.00145	0.0018	0.00182	0.002	19
Phosphorus (P)-Total	0.0843	0.114	0.0022	0.00346	0.0102	0.0233	0.0991	0.3	0.3	0.3	19
Total Organic Carbon	0.539	0.112	0.5	0.5	0.5	0.5	0.5	0.592	0.777	0.93	19
Dissolved Organic Carbon	0.509	0.0286	0.5	0.5	0.5	0.5	0.5	0.524	0.548	0.62	19
Aluminum T-Al	0.75	0.947	0.0143	0.0244	0.0722	0.507	0.987	1.33	2.24	3.96	19
Aluminum D-Al	0.0288	0.022	0.005	0.005	0.0083	0.0266	0.0469	0.0549	0.0638	0.0771	19
Antimony T-Sb	0.000451	0.00018	0.00014	0.000185	0.00037	0.0005	0.0005	0.000538	0.000709	0.00088	19
Antimony D-Sb	0.000383	0.000178	0.0001	0.0001	0.000175	0.0005	0.0005	0.0005	0.0005	0.0005	19
Arsenic T-As	0.000866	0.000807	0.00021	0.000327	0.0005	0.0005	0.000705	0.00202	0.00244	0.00338	19
Arsenic D-As	0.000389	0.000167	0.00013	0.000139	0.00016	0.0005	0.0005	0.0005	0.0005	0.0005	19
Barium T-Ba	0.0812	0.0246	0.05	0.0536	0.0652	0.074	0.095	0.111	0.128	0.139	19
Barium D-Ba	0.0613	0.0169	0.039	0.0406	0.0469	0.0625	0.072	0.0792	0.089	0.098	19
Beryllium T-Be	0.000716	0.00043	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Beryllium D-Be	0.000716	0.00043	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Bismuth T-Bi	0.000125	0.000167	0.00005	0.00005	0.00005	0.00005	0.000064	0.0005	0.0005	0.0005	19

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.000121	0.000169	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	19
Boron T-B	0.0716	0.043	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	19
Boron D-B	0.0716	0.043	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	19
Cadmium T-Cd	0.00013	0.0000855	0.000035	0.0000395	0.0000771	0.000115	0.000156	0.000218	0.000256	0.000395	19
Cadmium D-Cd	0.000063	0.0000479	0.000011	0.000016	0.0000282	0.000051	0.000079	0.000109	0.000123	0.000211	19
Calcium T-Ca	43.9	37.6	9.79	12	16.1	28.4	60.6	110	119	125	19
Calcium D-Ca	43.8	38.4	9.43	10.3	16.2	26.4	60.8	109	125	125	19
Chromium T-Cr	0.00107	0.000612	0.00016	0.000394	0.001	0.001	0.001	0.0014	0.00228	0.00301	19
Chromium D-Cr	0.000716	0.00043	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Cobalt T-Co	0.000842	0.000772	0.0001	0.000235	0.000405	0.00059	0.000845	0.00218	0.00258	0.00279	19
Cobalt D-Co	0.000409	0.000524	0.0001	0.0001	0.0001	0.0003	0.00032	0.000626	0.00115	0.00238	19
Copper T-Cu	0.00268	0.00295	0.0005	0.00095	0.001	0.0015	0.00258	0.00614	0.0103	0.0107	19
Copper D-Cu	0.000771	0.000351	0.0002	0.0002	0.000385	0.001	0.001	0.001	0.001	0.001	19
Iron T-Fe	1.14	1.39	0.101	0.142	0.304	0.57	1.24	2.39	4.28	5.37	19
Iron D-Fe	0.0364	0.0217	0.01	0.0163	0.03	0.03	0.0375	0.0574	0.0747	0.108	19
Lead T-Pb	0.00141	0.00151	0.000121	0.000376	0.0005	0.00076	0.00196	0.00267	0.00504	0.00557	19
Lead D-Pb	0.000361	0.00021	0.00005	0.00005	0.000081	0.0005	0.0005	0.0005	0.0005	0.0005	19
Magnesium T-Mg	7.34	7.35	1.04	1.52	2.35	4.06	9.77	20.5	22.8	24.2	19
Magnesium D-Mg	6.99	7.59	0.772	0.811	1.86	3.7	9.42	20.2	23.9	23.9	19
Manganese T-Mn	0.0584	0.0532	0.00504	0.0187	0.0327	0.0469	0.0579	0.101	0.167	0.233	19
Manganese D-Mn	0.0188	0.0187	0.00108	0.0032	0.00561	0.0115	0.0279	0.0354	0.0443	0.0794	19
Mercury T-Hg	0.00000625	0.00000256	0.000005	0.000005	0.000005	0.000005	0.0000051	0.00001	0.0000104	0.0000135	19
Mercury D-Hg	0.00000579	0.00000187	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	19
Molybdenum T-Mo	0.0017	0.00114	0.000233	0.000313	0.000649	0.0015	0.00265	0.00316	0.00341	0.0035	19
Molybdenum D-Mo	0.00138	0.00105	0.000203	0.000208	0.000595	0.001	0.00195	0.00312	0.00323	0.0035	19
Nickel T-Ni	0.00549	0.00495	0.00082	0.000865	0.00177	0.0042	0.0077	0.0123	0.0135	0.0193	19
Nickel D-Ni	0.00425	0.00524	0.0005	0.0005	0.000605	0.0018	0.0056	0.0119	0.0135	0.0193	19
Selenium T-Se	0.0028	0.003	0.00016	0.000196	0.000563	0.002	0.00406	0.00627	0.00687	0.0116	19
Selenium D-Se	0.00273	0.00316	0.00015	0.000174	0.000523	0.00153	0.00383	0.00647	0.00748	0.012	19
Silicon T-Si	2.46	1.35	1.07	1.12	1.64	2.1	2.7	3.45	4.58	7.02	19
Silicon D-Si	1.17	0.813	0.34	0.363	0.558	0.893	1.64	2.48	2.74	2.78	19

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.0000398	0.0000444	0.00001	0.00001	0.000019	0.00002	0.0000405	0.0000896	0.000109	0.000191	19
Silver D-Ag	0.0000168	0.00000478	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	19
Sodium T-Na	1.6	0.804	0.273	0.357	0.719	2	2	2.4	2.43	2.7	19
Sodium D-Na	1.54	0.832	0.195	0.197	0.608	2	2	2.22	2.32	2.5	19
Strontium T-Sr	0.249	0.206	0.0525	0.0584	0.0935	0.16	0.365	0.618	0.645	0.654	19
Strontium D-Sr	0.242	0.199	0.0505	0.0509	0.0914	0.163	0.366	0.584	0.608	0.644	19
Thallium T-Tl	0.000141	0.0000892	0.00001	0.00001	0.0000205	0.0002	0.0002	0.0002	0.0002	0.0002	19
Thallium D-Tl	0.00014	0.0000907	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	19
Tin T-Sn	0.000374	0.000191	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	19
Tin D-Sn	0.000406	0.000184	0.0001	0.0001	0.00025	0.0005	0.0005	0.0005	0.000524	0.00074	19
Titanium T-Ti	0.0233	0.0223	0.00658	0.00966	0.01	0.014	0.0245	0.0412	0.079	0.0877	19
Titanium D-Ti	0.00923	0.00467	0.00035	0.000404	0.01	0.01	0.01	0.0106	0.0138	0.021	19
Uranium T-U	0.000459	0.00047	0.000054	0.0000792	0.000164	0.00025	0.00057	0.00132	0.00145	0.00156	19
Uranium D-U	0.000412	0.000454	0.000035	0.0000386	0.000146	0.0002	0.00053	0.00122	0.00144	0.00145	19
Vanadium T-V	0.00203	0.00205	0.0005	0.0005	0.00057	0.00114	0.00253	0.00401	0.00675	0.00785	19
Vanadium D-V	0.000579	0.000187	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	19
Zinc T-Zn	0.0156	0.00968	0.0048	0.00507	0.00715	0.0134	0.0197	0.0267	0.0372	0.0378	19
Zinc D-Zn	0.00726	0.00752	0.001	0.001	0.0026	0.005	0.0086	0.0129	0.0173	0.0332	19

Units = mg/L

Table B11: Summary Statistics Surface Water Sampling Station RBC02 in Rio Blanco Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.74	0.323	6.8	7.24	7.6	7.72	7.87	8.16	8.28	8.51	53
Conductivity	282	308	68	110	150	236	330	409	500	2690	73
Hardness CaCO3	117	64.5	34	50	67	107	150	211	224	416	73
Total Dissolved Solids	170	87.5	42	72	100	147	217	277	354	420	73
Total Suspended Solids	47.4	127	1	1	3	8	27	103	207	724	73
Turbidity	24.5	85.6	0.14	0.318	1.1	2.8	10.2	41.7	69.6	640	72
Alkalinity-Total CaCO3	47.1	22.4	21	26	30.8	41	56.2	68.8	100	124	73
Acidity (as CaCO3)	3.09	3.37	0.1	1	1.88	2.3	3.4	4	6	22	72
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	19
Fluoride F	0.0598	0.0241	0.03	0.0327	0.0425	0.05	0.084	0.0916	0.0949	0.103	19
Bromide Br	0.05	1.43E-17	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	19
Sulphate SO4	77.6	45.6	16	22.6	37.6	71	110	139	163	180	73
Nitrate Nitrogen N	0.00893	0.00506	0.005	0.005	0.005	0.0053	0.0127	0.0168	0.0174	0.0187	19
Nitrite Nitrogen N	0.001	4.46E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	19
Total Nitrogen	0.0433	0.0115	0.03	0.032	0.04	0.05	0.05	0.05	0.05	0.05	3
Ammonia Nitrogen N	0.005	8.91E-19	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	19
Ortho-Phosphate	0.00142	0.00069	0.001	0.001	0.001	0.0012	0.00135	0.00212	0.00305	0.0035	19
Phosphorus (P)-Total	0.086	0.121	0.002	0.002	0.00425	0.021	0.117	0.3	0.3	0.3	19
Total Organic Carbon	0.518	0.056	0.5	0.5	0.5	0.5	0.5	0.55	0.569	0.74	19
Dissolved Organic Carbon	0.514	0.0456	0.5	0.5	0.5	0.5	0.5	0.514	0.582	0.69	19
Aluminum T-Al	0.783	2.21	0.0005	0.00834	0.027	0.12	0.359	1.62	3.69	14	73
Aluminum D-Al	0.0144	0.0172	0.0003	0.0005	0.0026	0.00836	0.0179	0.0376	0.0521	0.0775	73
Antimony T-Sb	0.000585	0.000465	0.0001	0.0002	0.00035	0.00049	0.0006	0.000908	0.00171	0.00267	73
Antimony D-Sb	0.000329	0.000171	0.0001	0.0001	0.0002	0.00029	0.0005	0.0005	0.00058	0.00087	73
Arsenic T-As	0.00188	0.00174	0.00057	0.000597	0.000705	0.00099	0.00234	0.00517	0.00534	0.00575	19
Arsenic D-As	0.000617	0.000144	0.0005	0.0005	0.0005	0.00059	0.00067	0.000768	0.00086	0.00104	19
Barium T-Ba	0.0474	0.0373	0.02	0.023	0.03	0.038	0.0452	0.0673	0.107	0.249	73
Barium D-Ba	0.031	0.00861	0.0181	0.02	0.024	0.031	0.037	0.0427	0.0475	0.0545	73
Beryllium T-Be	0.000668	0.000446	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Beryllium D-Be	0.000668	0.000446	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Bismuth T-Bi	0.00015	0.000193	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	18

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.00015	0.000193	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	18
Boron T-B	0.0671	0.0443	0.01	0.01	0.011	0.1	0.1	0.1	0.1	0.1	19
Boron D-B	0.0668	0.0446	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	19
Cadmium T-Cd	0.00034	0.000497	0.00004	0.000086	0.0001	0.000172	0.00028	0.00101	0.0012	0.00293	73
Cadmium D-Cd	0.000141	0.0000933	0.00007	0.00008	0.0001	0.0001	0.000156	0.000222	0.0003	0.00071	73
Calcium T-Ca	44.2	25.1	16.5	19.3	24	39	53.8	72.7	90.8	145	73
Calcium D-Ca	39.8	21.3	11.7	17.6	22.8	37.3	50.1	68.4	73.7	145	73
Chromium T-Cr	0.000912	0.000368	0.00013	0.00022	0.000955	0.001	0.001	0.00119	0.00147	0.0016	19
Chromium D-Cr	0.000668	0.000446	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	19
Cobalt T-Co	0.000859	0.00158	0.00007	0.0001	0.0002	0.000305	0.00073	0.00169	0.00319	0.00993	72
Cobalt D-Co	0.000194	0.000151	0.00003	0.0000328	0.0000975	0.00015	0.0003	0.000318	0.000424	0.00099	72
Copper T-Cu	0.00919	0.0171	0.0003	0.0005	0.0014	0.0036	0.007	0.0194	0.0523	0.085	73
Copper D-Cu	0.000846	0.00091	0.00005	0.0001	0.00032	0.00066	0.001	0.00159	0.00176	0.00693	73
Iron T-Fe	1.23	3.34	0.01	0.0268	0.07	0.2	0.67	2.92	4.68	23.1	73
Iron D-Fe	0.0204	0.0201	0.005	0.01	0.01	0.01	0.03	0.03	0.0572	0.12	73
Lead T-Pb	0.00149	0.00242	0.00005	0.000088	0.000258	0.00054	0.00136	0.00331	0.00705	0.0124	73
Lead D-Pb	0.000174	0.000197	0.000025	0.000034	0.00005	0.00008	0.000195	0.0005	0.0005	0.001	73
Magnesium T-Mg	5.52	3.57	1.8	2.08	3.04	4.32	6.9	11.3	14	17.5	73
Magnesium D-Mg	4.36	2.52	1.1	1.83	2.33	3.7	5.43	7.78	9.96	13	73
Manganese T-Mn	0.0571	0.118	0.00053	0.0015	0.0052	0.0123	0.0392	0.13	0.313	0.583	73
Manganese D-Mn	0.0138	0.0282	0.00005	0.000188	0.0013	0.00458	0.00907	0.0206	0.0909	0.13	73
Mercury T-Hg	0.00000632	0.00000226	0.000005	0.000005	0.000005	0.000005	0.0000075	0.00001	0.00001	0.00001	19
Mercury D-Hg	0.00000632	0.00000226	0.000005	0.000005	0.000005	0.000005	0.0000075	0.00001	0.00001	0.00001	19
Molybdenum T-Mo	0.00302	0.00357	0.000949	0.00102	0.0016	0.0022	0.003	0.0051	0.00681	0.03	73
Molybdenum D-Mo	0.00197	0.00104	0.00039	0.000794	0.0013	0.00171	0.00256	0.00299	0.00399	0.00645	72
Nickel T-Ni	0.0083	0.0184	0.00016	0.0015	0.0021	0.0028	0.0053	0.0167	0.0285	0.13	73
Nickel D-Ni	0.00215	0.00222	0.00012	0.0003	0.0008	0.0016	0.00221	0.00389	0.00636	0.0115	73
Selenium T-Se	0.00253	0.00123	0.00102	0.00112	0.00155	0.00224	0.0036	0.00421	0.00436	0.00477	19
Selenium D-Se	0.00254	0.0013	0.00094	0.00106	0.00154	0.00215	0.00372	0.00441	0.00448	0.00466	19
Silicon T-Si	3.07	0.726	1.9	2.06	2.47	3.27	3.74	3.98	4.01	4.06	19
Silicon D-Si	2.44	0.867	1.34	1.37	1.76	2.22	3.34	3.56	3.58	3.77	19



Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.0000259	0.0000183	0.00001	0.00001	0.00002	0.00002	0.000023	0.0000428	0.0000574	0.000088	19
Silver D-Ag	0.0000163	0.00000496	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	19
Sodium T-Na	2.05	1.62	0.554	0.7	1.1	1.74	2.35	3.53	4.84	12	73
Sodium D-Na	1.71	1.34	0.305	0.612	0.8	1.6	2	2.69	3.55	10	73
Strontium T-Sr	0.208	0.157	0.0734	0.084	0.109	0.157	0.244	0.325	0.515	1.06	72
Strontium D-Sr	0.19	0.14	0.0489	0.0758	0.101	0.153	0.23	0.33	0.455	0.966	72
Thallium T-Tl	0.00013	0.0000938	0.00001	0.00001	0.0000105	0.0002	0.0002	0.0002	0.0002	0.0002	19
Thallium D-Tl	0.00013	0.0000942	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	19
Tin T-Sn	0.000353	0.000198	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	19
Tin D-Sn	0.000353	0.000198	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	19
Titanium T-Ti	0.0161	0.0148	0.0024	0.00924	0.01	0.01	0.0135	0.0308	0.0435	0.066	19
Titanium D-Ti	0.00856	0.00357	0.0003	0.000444	0.01	0.01	0.01	0.01	0.0101	0.011	19
Uranium T-U	0.000277	0.000152	0.000118	0.000131	0.000191	0.0002	0.00034	0.000522	0.000577	0.00064	19
Uranium D-U	0.000252	0.000151	0.000075	0.0000813	0.000176	0.0002	0.000305	0.000486	0.000556	0.00061	19
Vanadium T-V	0.00174	0.00206	0.0005	0.0005	0.0005	0.00057	0.00184	0.00529	0.00641	0.0065	19
Vanadium D-V	0.000632	0.000226	0.0005	0.0005	0.0005	0.0005	0.00075	0.001	0.001	0.001	19
Zinc T-Zn	0.0258	0.0355	0.0011	0.0053	0.0086	0.013	0.023	0.0566	0.09	0.216	73
Zinc D-Zn	0.00615	0.00605	0.0004	0.00088	0.0034	0.005	0.0072	0.00994	0.0134	0.048	73

Units = mg/L

Table B12: Summary Statistics Surface Water Sampling Station RC02 in Roosevelt Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.76	0.338	7.05	7.19	7.58	7.76	7.92	8.28	8.36	8.4	40
Conductivity	134	58.3	59.4	65.1	82	130	191	220	235	244	53
Hardness CaCO3	63.3	30.1	26	28.7	38.3	57	81.3	113	121	129	54
Total Dissolved Solids	79.3	33.3	32	39.3	53	67.5	111	130	134	149	54
Total Suspended Solids	17.7	29.4	1	1	3	7	19	40.7	63.9	147	54
Turbidity	14.2	22.7	0.16	0.352	1.8	5.76	17	31.8	42	128	53
Alkalinity-Total CaCO3	53.2	21.8	26	28.1	34.2	46.2	74.3	86.6	88.8	94	54
Acidity (as CaCO3)	2.27	3.1	0.8	1	1.03	1.75	2.1	2.94	3.44	23	54
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	20
Fluoride F	0.0217	0.00339	0.02	0.02	0.02	0.02	0.0218	0.0252	0.0273	0.033	20
Bromide Br	0.05	7.12E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	20
Sulphate SO4	15.9	7.85	4.7	6.36	9.9	13.8	20.3	28	31.1	33.6	54
Nitrate Nitrogen N	0.173	0.174	0.0143	0.0181	0.0301	0.102	0.304	0.387	0.434	0.603	20
Nitrite Nitrogen N	0.001	4.45E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	20
Total Nitrogen	0.147	0.149	0.041	0.0451	0.0615	0.082	0.2	0.27	0.294	0.317	3
Ammonia Nitrogen N	0.00514	0.000626	0.005	0.005	0.005	0.005	0.005	0.005	0.00514	0.0078	20
Ortho-Phosphate	0.00106	0.000119	0.001	0.001	0.001	0.001	0.00103	0.00121	0.00131	0.0014	20
Phosphorus (P)-Total	0.116	0.166	0.002	0.002	0.0071	0.0171	0.299	0.3	0.314	0.579	20
Total Organic Carbon	0.558	0.152	0.5	0.5	0.5	0.5	0.5	0.68	0.788	1.13	20
Dissolved Organic Carbon	0.531	0.0784	0.5	0.5	0.5	0.5	0.508	0.568	0.65	0.83	20
Aluminum T-Al	0.557	0.761	0.0005	0.00966	0.0697	0.218	0.756	1.54	2.16	3.3	54
Aluminum D-Al	0.0182	0.021	0.0005	0.0005	0.00188	0.00705	0.0308	0.0514	0.0573	0.0745	54
Antimony T-Sb	0.000431	0.00024	0.0001	0.000173	0.00025	0.0004	0.0005	0.000664	0.000861	0.0013	54
Antimony D-Sb	0.00026	0.000155	0.00005	0.0001	0.00014	0.00021	0.00047	0.0005	0.0005	0.0005	54
Arsenic T-As	0.000725	0.000431	0.00022	0.000268	0.0005	0.0005	0.000938	0.00132	0.00163	0.00169	20
Arsenic D-As	0.000365	0.000171	0.0001	0.000129	0.000188	0.0005	0.0005	0.0005	0.0005	0.0005	20
Barium T-Ba	0.085	0.0237	0.0344	0.058	0.069	0.0817	0.095	0.106	0.135	0.17	53
Barium D-Ba	0.0685	0.0178	0.0269	0.0466	0.057	0.0628	0.0836	0.0947	0.0954	0.11	53
Beryllium T-Be	0.00064	0.000452	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Beryllium D-Be	0.00064	0.000452	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	20
Bismuth T-Bi	0.00014	0.000185	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	20

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.00014	0.000185	0.00005	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	20
Boron T-B	0.0659	0.0431	0.01	0.01	0.017	0.1	0.1	0.1	0.1	0.1	20
Boron D-B	0.0651	0.0439	0.01	0.01	0.013	0.1	0.1	0.1	0.1	0.1	20
Cadmium T-Cd	0.000108	0.0000975	0.0000053	0.00000705	0.0000404	0.0001	0.0001	0.000224	0.000335	0.0004	54
Cadmium D-Cd	0.0000712	0.0000497	0.00001	0.0000136	0.000017	0.000095	0.0001	0.0001	0.000135	0.0002	54
Calcium T-Ca	21.5	9.82	7.7	10	13.1	19.3	26.2	36	39.4	42	53
Calcium D-Ca	20.1	9.26	7.4	8.79	12.1	19	26	34.9	37.8	39.8	53
Chromium T-Cr	0.000812	0.000314	0.00013	0.000159	0.00062	0.001	0.001	0.001	0.001	0.001	20
Chromium D-Cr	0.000646	0.000445	0.0001	0.0001	0.000115	0.001	0.001	0.001	0.001	0.001	20
Cobalt T-Co	0.000462	0.000465	0.00006	0.000066	0.00016	0.0003	0.00061	0.000996	0.00107	0.0025	53
Cobalt D-Co	0.000134	0.0000976	0.00003	0.00003	0.00006	0.0001	0.00019	0.0003	0.0003	0.0003	53
Copper T-Cu	0.0025	0.00289	0.0001	0.00026	0.0007	0.001	0.0032	0.00618	0.00908	0.014	53
Copper D-Cu	0.000528	0.00068	0.00005	0.00005	0.00013	0.00028	0.001	0.001	0.001	0.0045	53
Iron T-Fe	0.703	0.961	0.01	0.0139	0.0828	0.3	0.913	1.92	2.3	4.4	54
Iron D-Fe	0.0265	0.0195	0.005	0.01	0.01	0.0265	0.0323	0.049	0.0561	0.11	54
Lead T-Pb	0.00137	0.00178	0.00005	0.00005	0.000293	0.00057	0.00169	0.00376	0.00427	0.01	54
Lead D-Pb	0.000169	0.000184	0.000025	0.000025	0.00005	0.000069	0.00021	0.0005	0.0005	0.0005	54
Magnesium T-Mg	4.03	1.93	1.6	1.79	2.71	3.55	4.9	6.86	7.71	9.9	54
Magnesium D-Mg	3.59	1.73	1.37	1.51	2.13	3.35	4.75	6.2	6.76	7.2	54
Manganese T-Mn	0.0452	0.0805	0.0006	0.0011	0.00405	0.0133	0.0454	0.119	0.168	0.453	54
Manganese D-Mn	0.00227	0.00242	0.00005	0.000152	0.000425	0.00125	0.00362	0.00622	0.00741	0.00951	54
Mercury T-Hg	0.0000104	0.000017	0.000005	0.000005	0.000005	0.000005	0.00001	0.0000104	0.000017	0.000082	20
Mercury D-Hg	0.000006	0.00000205	0.000005	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	20
Molybdenum T-Mo	0.00137	0.00399	0.00005	0.000287	0.00045	0.0008	0.00103	0.0014	0.00157	0.03	54
Molybdenum D-Mo	0.0012	0.00401	0.00005	0.000167	0.000335	0.000635	0.001	0.00114	0.00124	0.03	54
Nickel T-Ni	0.00293	0.0108	0.00012	0.00015	0.000608	0.001	0.00118	0.00396	0.00631	0.08	54
Nickel D-Ni	0.000632	0.00044	0.00006	0.00015	0.0003	0.0005	0.001	0.001	0.00128	0.002	54
Selenium T-Se	0.000467	0.000367	0.000112	0.00012	0.00017	0.000336	0.00062	0.00112	0.00116	0.00118	20
Selenium D-Se	0.000485	0.000392	0.0001	0.000116	0.000168	0.000365	0.000689	0.00108	0.00117	0.00128	20
Silicon T-Si	2.09	0.567	1.38	1.56	1.69	1.99	2.3	2.82	3.07	3.66	20
Silicon D-Si	1.17	0.649	0.456	0.487	0.618	1.03	1.63	2.16	2.23	2.25	20

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.0000306	0.0000215	0.00001	0.00001	0.00002	0.00002	0.000044	0.0000591	0.00007	0.000088	20
Silver D-Ag	0.000016	0.00000503	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	20
Sodium T-Na	1.05	0.682	0.27	0.313	0.42	0.794	1.93	2	2	2.3	54
Sodium D-Na	0.926	0.691	0.2	0.237	0.32	0.665	1.4	2	2	2	54
Strontium T-Sr	0.128	0.0583	0.0487	0.0542	0.0805	0.117	0.181	0.217	0.219	0.23	53
Strontium D-Sr	0.122	0.0556	0.0425	0.0502	0.0739	0.11	0.17	0.199	0.216	0.236	53
Thallium T-Tl	0.000129	0.0000898	0.00001	0.00001	0.00003	0.0002	0.0002	0.0002	0.0002	0.0002	20
Thallium D-Tl	0.000124	0.0000955	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	20
Tin T-Sn	0.00034	0.000201	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0005	20
Tin D-Sn	0.00037	0.000188	0.0001	0.0001	0.00016	0.0005	0.0005	0.0005	0.000502	0.00054	20
Titanium T-Ti	0.0136	0.00843	0.0003	0.00173	0.01	0.01	0.019	0.024	0.0293	0.035	20
Titanium D-Ti	0.00812	0.00386	0.0003	0.0003	0.01	0.01	0.01	0.01	0.01	0.01	20
Uranium T-U	0.000145	0.0000698	0.000048	0.000049	0.0000618	0.0002	0.0002	0.0002	0.0002	0.0002	20
Uranium D-U	0.000138	0.00008	0.000018	0.0000237	0.0000508	0.0002	0.0002	0.0002	0.0002	0.0002	20
Vanadium T-V	0.00174	0.00143	0.0005	0.0005	0.0005	0.00109	0.00306	0.00396	0.00414	0.00449	20
Vanadium D-V	0.0006	0.000205	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	20
Zinc T-Zn	0.0129	0.0171	0.001	0.001	0.0035	0.0055	0.0118	0.0288	0.0568	0.075	54
Zinc D-Zn	0.00284	0.00217	0.0002	0.0003	0.001	0.002	0.005	0.005	0.00618	0.0091	54

Units = mg/L

Table B13: Summary Statistics Surface Water Sampling Station GSC09 in Goldslide Creek

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	6	0.722	5.2	5.28	5.48	5.64	6.66	6.9	6.91	6.91	7
Conductivity	153	15.7	134	136	144	151	157	169	177	185	8
Hardness CaCO3	60.2	8.01	50.6	51.7	55.7	59.2	62.4	67.6	72.3	77	8
Total Dissolved Solids	109	12.6	86	90.6	103	110	120	121	121	122	8
Total Suspended Solids	3.11	0.318	3	3	3	3	3	3.27	3.59	3.9	8
Turbidity	0.114	0.0207	0.1	0.1	0.1	0.1	0.125	0.143	0.147	0.15	8
Alkalinity-Total CaCO3	1.51	0.491	1	1	1.08	1.4	2	2.06	2.13	2.2	8
Acidity (as CaCO3)	2.63	0.763	1.9	1.94	2.08	2.3	3.08	3.69	3.8	3.9	8
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	8
Fluoride F	0.0225	0.00193	0.02	0.0204	0.021	0.0225	0.0233	0.0246	0.0253	0.026	8
Bromide Br	0.05	7.42E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	8
Sulphate SO4	65.1	8.25	54.4	56.2	59.8	63.9	67.9	74	77.7	81.4	8
Nitrate Nitrogen N	0.0254	0.00501	0.0208	0.0209	0.0215	0.024	0.0271	0.0328	0.0332	0.0336	8
Nitrite Nitrogen N	0.001	N/A	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	8
Total Nitrogen	0.03	N/A	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	1
Ammonia Nitrogen N	0.005	N/A	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	8
Ortho-Phosphate	0.001	N/A	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	8
Phosphorus (P)-Total	0.0945	0.129	0.002	0.002	0.00223	0.05	0.113	0.3	0.3	0.3	8
Total Organic Carbon	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	8
Dissolved Organic Carbon	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	8
Aluminum T-Al	0.111	0.0112	0.0968	0.0974	0.103	0.109	0.119	0.125	0.126	0.126	8
Aluminum D-Al	0.1	0.0145	0.0752	0.0806	0.0924	0.0976	0.115	0.115	0.116	0.116	8
Antimony T-Sb	0.00025	0.000207	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	8
Antimony D-Sb	0.00025	0.000207	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	8
Arsenic T-As	0.00025	0.000207	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	8
Arsenic D-As	0.00025	0.000207	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	8
Barium T-Ba	0.0171	0.00244	0.015	0.015	0.0152	0.0157	0.02	0.02	0.02	0.02	8
Barium D-Ba	0.017	0.0025	0.0146	0.0147	0.0152	0.0157	0.02	0.02	0.02	0.02	8
Beryllium T-Be	0.000438	0.000466	0.0001	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	8
Beryllium D-Be	0.000438	0.000466	0.0001	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	8
Bismuth T-Bi	0.000163	0.000208	0.00005	0.00005	0.00005	0.00005	0.000163	0.0005	0.0005	0.0005	8

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.000163	0.000208	0.00005	0.00005	0.00005	0.00005	0.000163	0.0005	0.0005	0.0005	8
Boron T-B	0.0475	0.0435	0.013	0.0134	0.0155	0.0185	0.1	0.1	0.1	0.1	8
Boron D-B	0.0455	0.0451	0.012	0.012	0.012	0.014	0.1	0.1	0.1	0.1	8
Cadmium T-Cd	0.000866	0.0000574	0.000761	0.000787	0.000842	0.000869	0.000893	0.000918	0.000938	0.000959	8
Cadmium D-Cd	0.000888	0.0000731	0.000802	0.000819	0.000855	0.000872	0.000893	0.000956	0.001	0.00105	8
Calcium T-Ca	20.3	2.4	16.7	17.3	19	20.1	21.2	22.6	23.7	24.8	8
Calcium D-Ca	19.7	2.62	16.7	17	18.3	19.2	20.4	22	23.7	25.3	8
Chromium T-Cr	0.000439	0.000465	0.0001	0.0001	0.0001	0.000105	0.001	0.001	0.001	0.001	8
Chromium D-Cr	0.000438	0.000466	0.0001	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	8
Cobalt T-Co	0.000491	0.0000236	0.00046	0.000464	0.000485	0.00049	0.000493	0.000512	0.000526	0.00054	8
Cobalt D-Co	0.000465	0.0000359	0.00039	0.000415	0.00046	0.00047	0.000473	0.000492	0.000506	0.00052	8
Copper T-Cu	0.0101	0.000804	0.00932	0.00933	0.00947	0.00974	0.0109	0.0111	0.0112	0.0113	8
Copper D-Cu	0.00946	0.000672	0.00887	0.00892	0.00911	0.00919	0.00955	0.0103	0.0106	0.0109	8
Iron T-Fe	0.0175	0.0104	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	8
Iron D-Fe	0.018	0.01	0.01	0.01	0.01	0.012	0.03	0.03	0.03	0.03	8
Lead T-Pb	0.000219	0.000233	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	8
Lead D-Pb	0.000219	0.000233	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	8
Magnesium T-Mg	2.77	0.39	2.21	2.29	2.5	2.79	2.98	3.17	3.31	3.44	8
Magnesium D-Mg	2.67	0.373	2.14	2.21	2.42	2.7	2.84	3.07	3.19	3.32	8
Manganese T-Mn	0.0237	0.000915	0.0223	0.0225	0.0233	0.0239	0.0241	0.0245	0.0249	0.0253	8
Manganese D-Mn	0.0227	0.00116	0.0204	0.0208	0.0226	0.023	0.0233	0.0236	0.0239	0.0241	8
Mercury T-Hg	0.00000625	0.00000231	0.000005	0.000005	0.000005	0.000005	0.00000625	0.00001	0.00001	0.00001	8
Mercury D-Hg	0.00000625	0.00000231	0.000005	0.000005	0.000005	0.000005	0.00000625	0.00001	0.00001	0.00001	8
Molybdenum T-Mo	0.000439	0.000465	0.000074	0.0000761	0.0000965	0.000127	0.001	0.001	0.001	0.001	8
Molybdenum D-Mo	0.000427	0.000475	0.000054	0.000061	0.0000823	0.000101	0.001	0.001	0.001	0.001	8
Nickel T-Ni	0.0023	0.000192	0.00206	0.00207	0.0021	0.00235	0.00245	0.00251	0.00251	0.00252	8
Nickel D-Ni	0.00218	0.000173	0.002	0.002	0.00205	0.00213	0.00236	0.0024	0.0024	0.00241	8
Selenium T-Se	0.000755	0.0000784	0.000669	0.000676	0.000704	0.000736	0.000783	0.000863	0.000879	0.000894	8
Selenium D-Se	0.000743	0.000105	0.000628	0.000645	0.000684	0.00069	0.000803	0.000887	0.000906	0.000925	8
Silicon T-Si	3.12	0.127	2.97	2.99	3.04	3.09	3.2	3.26	3.31	3.36	8
Silicon D-Si	3.03	0.119	2.92	2.92	2.95	3.02	3.06	3.14	3.21	3.29	8

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.0000138	0.00000518	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	8
Silver D-Ag	0.0000138	0.00000518	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	8
Sodium T-Na	1.6	0.359	1.21	1.23	1.28	1.52	2	2	2	2	8
Sodium D-Na	1.57	0.373	1.17	1.19	1.26	1.44	2	2	2	2	8
Strontium T-Sr	0.203	0.0196	0.17	0.177	0.194	0.202	0.212	0.221	0.229	0.237	8
Strontium D-Sr	0.197	0.0218	0.168	0.171	0.185	0.195	0.208	0.221	0.229	0.237	8
Thallium T-Tl	0.0000813	0.0000983	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	8
Thallium D-Tl	0.0000813	0.0000983	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	8
Tin T-Sn	0.00025	0.000207	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	8
Tin D-Sn	0.000306	0.000201	0.0001	0.0001	0.0001	0.000325	0.0005	0.0005	0.0005	0.0005	8
Titanium T-Ti	0.00636	0.00502	0.0003	0.0003	0.0003	0.01	0.01	0.01	0.01	0.01	8
Titanium D-Ti	0.00636	0.00502	0.0003	0.0003	0.0003	0.01	0.01	0.01	0.01	0.01	8
Uranium T-U	0.0000813	0.0000983	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	8
Uranium D-U	0.0000813	0.0000983	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	8
Vanadium T-V	0.000625	0.000231	0.0005	0.0005	0.0005	0.0005	0.000625	0.001	0.001	0.001	8
Vanadium D-V	0.000625	0.000231	0.0005	0.0005	0.0005	0.0005	0.000625	0.001	0.001	0.001	8
Zinc T-Zn	0.0567	0.0032	0.0526	0.053	0.055	0.0558	0.059	0.0602	0.0612	0.0622	8
Zinc D-Zn	0.059	0.00398	0.0534	0.0541	0.056	0.0588	0.0616	0.0642	0.0643	0.0643	8

Units = mg/L

Table B14: Summary Statistics Surface Water Sampling Station GSC07 in Goldslide Creek

Lower Bitter Creek (BC02)	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.3	0.498	6.36	6.6	7.04	7.31	7.68	7.81	7.85	7.89	8
Conductivity	149	29.5	99.9	110	132	149	164	174	192	209	11
Hardness CaCO3	63.2	16.3	41.5	45.3	52.3	61.3	70.6	75.5	88.3	101	11
Total Dissolved Solids	103	22.9	72	74.5	85.5	106	117	133	136	139	11
Total Suspended Solids	3.3	0.995	3	3	3	3	3	3	4.65	6.3	11
Turbidity	0.287	0.375	0.1	0.1	0.1	0.18	0.255	0.34	0.865	1.39	11
Alkalinity-Total CaCO3	7.8	1.62	5.9	6.05	6.65	7.5	8.85	9.7	10.3	10.9	11
Acidity (as CaCO3)	2.04	0.52	1.5	1.5	1.5	2.1	2.45	2.7	2.75	2.8	11
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	11
Fluoride F	0.0401	0.00528	0.032	0.0325	0.0375	0.039	0.044	0.046	0.0475	0.049	11
Bromide Br	0.05	7.28E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	11
Sulphate SO4	58.3	13.1	38.6	42.5	50.3	56.1	64.8	70.5	78.3	86	11
Nitrate Nitrogen N	0.028	0.0044	0.0213	0.022	0.0256	0.0283	0.0306	0.0319	0.0343	0.0366	11
Nitrite Nitrogen N	0.00109	0.000302	0.001	0.001	0.001	0.001	0.001	0.001	0.0015	0.002	11
Total Nitrogen	0.04	0.0141	0.03	0.031	0.035	0.04	0.045	0.048	0.049	0.05	2
Ammonia Nitrogen N	0.005	9.1E-19	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	11
Ortho-Phosphate	0.001	2.27E-19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	11
Phosphorus (P)-Total	0.124	0.141	0.002	0.002	0.00365	0.05	0.3	0.3	0.3	0.3	11
Total Organic Carbon	0.522	0.0724	0.5	0.5	0.5	0.5	0.5	0.5	0.62	0.74	11
Dissolved Organic Carbon	0.555	0.126	0.5	0.5	0.5	0.5	0.5	0.75	0.805	0.86	11
Aluminum T-Al	0.0218	0.0161	0.006	0.008	0.0104	0.0196	0.0276	0.0356	0.0486	0.0616	11
Aluminum D-Al	0.0138	0.00784	0.005	0.0063	0.00945	0.0104	0.015	0.0244	0.0281	0.0317	11
Antimony T-Sb	0.000251	0.000198	0.0001	0.0001	0.0001	0.00012	0.0005	0.0005	0.0005	0.0005	11
Antimony D-Sb	0.000248	0.0002	0.0001	0.0001	0.0001	0.00011	0.0005	0.0005	0.0005	0.0005	11
Arsenic T-As	0.000252	0.000197	0.0001	0.0001	0.0001	0.00011	0.0005	0.0005	0.0005	0.0005	11
Arsenic D-As	0.000247	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	11
Barium T-Ba	0.0193	0.00136	0.0168	0.0174	0.0186	0.0195	0.02	0.02	0.021	0.022	11
Barium D-Ba	0.0193	0.00164	0.0166	0.0173	0.0182	0.0197	0.02	0.02	0.0215	0.023	11
Beryllium T-Be	0.000427	0.000454	0.0001	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	11
Beryllium D-Be	0.000427	0.000454	0.0001	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	11
Bismuth T-Bi	0.000214	0.000227	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	11



Lower Bitter Creek (BC02)	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.000214	0.000227	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	11
Boron T-B	0.0427	0.0454	0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.1	11
Boron D-B	0.0427	0.0454	0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.1	11
Cadmium T-Cd	0.000319	0.0000508	0.000235	0.000251	0.000286	0.000323	0.000334	0.000372	0.000393	0.000415	10
Cadmium D-Cd	0.000322	0.0000485	0.000247	0.000256	0.000293	0.000324	0.000337	0.000373	0.000393	0.000413	10
Calcium T-Ca	21.4	5.6	14.2	15.1	17.9	21.9	23.2	24.9	29.9	34.9	11
Calcium D-Ca	21.3	5.61	14	15.3	17.5	20.7	23.6	25.6	30	34.4	11
Chromium T-Cr	0.000431	0.000451	0.0001	0.0001	0.0001	0.00011	0.001	0.001	0.001	0.001	11
Chromium D-Cr	0.000437	0.000447	0.0001	0.0001	0.0001	0.0001	0.001	0.001	0.001	0.001	11
Cobalt T-Co	0.000416	0.000136	0.00025	0.000265	0.000305	0.00039	0.000515	0.0006	0.00062	0.00064	11
Cobalt D-Co	0.000404	0.000128	0.00025	0.00026	0.0003	0.00037	0.000485	0.0006	0.000605	0.00061	11
Copper T-Cu	0.00901	0.00347	0.0032	0.00429	0.00648	0.0096	0.0115	0.0134	0.0137	0.0139	11
Copper D-Cu	0.00816	0.00308	0.003	0.00392	0.00613	0.0082	0.0101	0.0117	0.0125	0.0133	11
Iron T-Fe	0.0235	0.0254	0.01	0.01	0.01	0.01	0.03	0.03	0.0625	0.095	11
Iron D-Fe	0.0173	0.0101	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	11
Lead T-Pb	0.000214	0.000227	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	11
Lead D-Pb	0.000214	0.000227	0.00005	0.00005	0.00005	0.00005	0.0005	0.0005	0.0005	0.0005	11
Magnesium T-Mg	2.48	0.52	1.62	1.79	2.17	2.46	2.82	2.98	3.22	3.45	11
Magnesium D-Mg	2.44	0.572	1.6	1.75	2.09	2.36	2.74	3.02	3.33	3.64	11
Manganese T-Mn	0.00514	0.00307	0.00034	0.00111	0.00268	0.00563	0.00744	0.00899	0.00922	0.00944	11
Manganese D-Mn	0.00513	0.00282	0.00072	0.00132	0.00281	0.00607	0.00753	0.00826	0.00842	0.00858	11
Mercury T-Hg	0.00000682	0.00000252	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	0.00001	11
Mercury D-Hg	0.00000682	0.00000252	0.000005	0.000005	0.000005	0.000005	0.00001	0.00001	0.00001	0.00001	11
Molybdenum T-Mo	0.0027	0.000397	0.0022	0.00225	0.00246	0.00263	0.00294	0.0032	0.00332	0.00343	11
Molybdenum D-Mo	0.00255	0.000285	0.0021	0.00215	0.0024	0.00252	0.00276	0.00291	0.00294	0.00297	11
Nickel T-Ni	0.0016	0.000267	0.001	0.00122	0.00153	0.00163	0.00169	0.0018	0.00195	0.0021	11
Nickel D-Ni	0.00162	0.000213	0.0012	0.00131	0.00153	0.00163	0.00174	0.0018	0.0019	0.002	11
Selenium T-Se	0.000829	0.00016	0.00056	0.000615	0.000729	0.000817	0.000942	0.000997	0.00105	0.00111	11
Selenium D-Se	0.000848	0.000175	0.0006	0.000648	0.000719	0.000803	0.000974	0.00104	0.00111	0.00118	11
Silicon T-Si	2.34	0.211	2.01	2.06	2.23	2.32	2.45	2.5	2.64	2.78	11
Silicon D-Si	2.32	0.237	1.99	2.06	2.17	2.32	2.39	2.56	2.71	2.86	11

Lower Bitter Creek (BC02)	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.0000136	0.00000505	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	11
Silver D-Ag	0.0000136	0.00000505	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	11
Sodium T-Na	1.31	0.554	0.699	0.757	0.917	1.03	2	2	2	2	11
Sodium D-Na	1.31	0.555	0.698	0.759	0.908	1.02	2	2	2	2	11
Strontium T-Sr	0.13	0.0406	0.0866	0.0917	0.107	0.119	0.143	0.155	0.195	0.234	11
Strontium D-Sr	0.131	0.0464	0.0878	0.0908	0.102	0.127	0.138	0.149	0.203	0.257	11
Thallium T-Tl	0.0000791	0.0000959	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	11
Thallium D-Tl	0.0000791	0.0000959	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	11
Tin T-Sn	0.000245	0.000202	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	11
Tin D-Sn	0.000272	0.000189	0.0001	0.0001	0.0001	0.00016	0.0005	0.0005	0.0005	0.0005	11
Titanium T-Ti	0.00735	0.00453	0.0003	0.0003	0.00515	0.01	0.01	0.01	0.01	0.01	11
Titanium D-Ti	0.00735	0.00453	0.0003	0.0003	0.00515	0.01	0.01	0.01	0.01	0.01	11
Uranium T-U	0.0000791	0.0000959	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	11
Uranium D-U	0.0000791	0.0000959	0.00001	0.00001	0.00001	0.00001	0.0002	0.0002	0.0002	0.0002	11
Vanadium T-V	0.000682	0.000252	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	11
Vanadium D-V	0.000682	0.000252	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	11
Zinc T-Zn	0.0203	0.00377	0.0151	0.0157	0.0178	0.0204	0.0221	0.0235	0.026	0.0284	11
Zinc D-Zn	0.0209	0.00429	0.0149	0.0159	0.0179	0.021	0.0233	0.0245	0.0272	0.0299	11

Units = mg/L

Table B15: Summary Statistics Surface Water Sampling Station BR03 in Bear River

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Field pH	7.75	0.207	7.42	7.47	7.66	7.78	7.86	7.95	7.98	8.01	6
Conductivity	155	68.8	92.3	93	97.2	130	210	239	254	268	8
Hardness CaCO3	76.1	35.7	43.9	44	44.3	63.6	107	118	125	133	8
Total Dissolved Solids	106	40.1	67	68.1	79	89.5	134	165	165	165	8
Total Suspended Solids	173	214	3	3	3	77.9	289	459	510	560	8
Turbidity	110	124	0.38	0.499	1.52	66.4	196	290	290	291	8
Alkalinity-Total CaCO3	55.9	19.8	35.4	36.7	39.2	49.3	72.1	80.8	83.7	86.5	8
Acidity (as CaCO3)	1.27	0.591	1	1	1	1	1.15	1.76	2.18	2.6	7
Chloride Cl	0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	8
Fluoride F	0.0393	0.0176	0.02	0.02	0.0238	0.0365	0.0545	0.0605	0.0623	0.064	8
Bromide Br	0.05	7.42E-18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	8
Sulphate SO4	23	14.2	9.23	9.42	12.2	18	33	41.8	43.5	45.2	8
Nitrate Nitrogen N	0.107	0.0948	0.0209	0.0217	0.026	0.0868	0.151	0.221	0.252	0.283	8
Nitrite Nitrogen N	0.001	N/A	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	8
Total Nitrogen	0.128	0.0204	0.11	0.111	0.117	0.123	0.137	0.145	0.147	0.15	3
Ammonia Nitrogen N	0.00578	0.00162	0.005	0.005	0.005	0.005	0.00543	0.00754	0.00852	0.0095	8
Ortho-Phosphate	0.00109	0.00021	0.001	0.001	0.001	0.001	0.00103	0.00125	0.00143	0.0016	8
Phosphorus (P)-Total	0.278	0.314	0.0032	0.00453	0.0393	0.191	0.384	0.699	0.775	0.851	8
Total Organic Carbon	0.953	0.506	0.5	0.5	0.53	0.865	1.16	1.52	1.71	1.91	8
Dissolved Organic Carbon	0.561	0.0917	0.5	0.5	0.5	0.5	0.613	0.692	0.706	0.72	8
Aluminum T-Al	4.45	4.62	0.0157	0.0254	0.0786	3.25	8.16	10.3	10.9	11.5	8
Aluminum D-Al	0.0595	0.0533	0.0041	0.00508	0.0102	0.0606	0.0907	0.109	0.13	0.15	8
Antimony T-Sb	0.00109	0.000706	0.0005	0.0005	0.000508	0.000835	0.00142	0.00214	0.00218	0.00222	8
Antimony D-Sb	0.000466	0.0000447	0.00039	0.000397	0.00044	0.00049	0.0005	0.0005	0.0005	0.0005	8
Arsenic T-As	0.0074	0.00792	0.00069	0.000722	0.000825	0.00499	0.0106	0.0177	0.02	0.0223	8
Arsenic D-As	0.000634	0.0000578	0.00057	0.000581	0.0006	0.00062	0.00065	0.000683	0.000722	0.00076	8
Barium T-Ba	0.127	0.0559	0.072	0.0762	0.0881	0.0985	0.173	0.205	0.208	0.21	8
Barium D-Ba	0.0548	0.0213	0.035	0.0353	0.0375	0.0464	0.0733	0.0818	0.084	0.0861	8
Beryllium T-Be	0.000574	0.00046	0.0001	0.0001	0.0001	0.000645	0.001	0.001	0.001	0.001	8
Beryllium D-Be	0.00055	0.000481	0.0001	0.0001	0.0001	0.00055	0.001	0.001	0.001	0.001	8
Bismuth T-Bi	0.00637	0.0176	0.00005	0.00005	0.00005	0.000052	0.000259	0.0154	0.0327	0.05	8

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Bismuth D-Bi	0.00635	0.0176	0.00005	0.00005	0.00005	0.00005	0.000163	0.0154	0.0327	0.05	8
Boron T-B	0.0563	0.0468	0.012	0.012	0.012	0.057	0.1	0.1	0.1	0.1	8
Boron D-B	0.0554	0.0477	0.01	0.01	0.01	0.0565	0.1	0.1	0.1	0.1	8
Cadmium T-Cd	0.000222	0.000248	0.0000162	0.000017	0.0000228	0.000123	0.000348	0.00059	0.000606	0.000621	8
Cadmium D-Cd	0.0000187	0.00000658	0.0000056	0.00000959	0.000017	0.0000183	0.0000215	0.0000263	0.0000267	0.000027	8
Calcium T-Ca	28.6	12.1	17	17.1	19.2	24	37.7	43.9	46.2	48.4	8
Calcium D-Ca	26.5	12.2	15.4	15.5	15.8	22.2	37	40.7	43.3	45.9	8
Chromium T-Cr	0.00604	0.00596	0.0001	0.000415	0.001	0.00419	0.0101	0.0132	0.0149	0.0165	8
Chromium D-Cr	0.00055	0.000481	0.0001	0.0001	0.0001	0.00055	0.001	0.001	0.001	0.001	8
Cobalt T-Co	0.00294	0.00318	0.0001	0.00017	0.0003	0.00176	0.0049	0.00702	0.0078	0.00858	8
Cobalt D-Co	0.0002	0.000107	0.0001	0.0001	0.0001	0.0002	0.0003	0.0003	0.0003	0.0003	8
Copper T-Cu	0.0146	0.016	0.0005	0.000675	0.001	0.00917	0.0235	0.0352	0.0393	0.0434	8
Copper D-Cu	0.000664	0.000366	0.0002	0.000235	0.000338	0.00073	0.001	0.001	0.001	0.001	8
Iron T-Fe	6.5	7.27	0.036	0.0528	0.123	3.97	11.4	16	17.4	18.7	8
Iron D-Fe	0.0411	0.0241	0.01	0.017	0.03	0.031	0.0525	0.0666	0.0778	0.089	8
Lead T-Pb	0.00512	0.00568	0.00005	0.000208	0.0005	0.00327	0.00765	0.0132	0.014	0.0149	8
Lead D-Pb	0.000285	0.00023	0.00005	0.0000532	0.000077	0.000294	0.0005	0.0005	0.0005	0.0005	8
Magnesium T-Mg	4.85	1.67	3.18	3.24	3.72	4.32	5.6	7.21	7.43	7.65	8
Magnesium D-Mg	2.42	1.31	1.12	1.15	1.36	1.99	3.43	3.96	4.26	4.56	8
Manganese T-Mn	0.206	0.222	0.0125	0.0133	0.0163	0.121	0.357	0.526	0.535	0.544	8
Manganese D-Mn	0.0119	0.0078	0.00099	0.00118	0.00796	0.0128	0.0164	0.0189	0.0214	0.0238	8
Mercury T-Hg	0.0000109	0.00000749	0.000005	0.000005	0.000005	0.00000755	0.0000161	0.0000189	0.000022	0.000025	8
Mercury D-Hg	0.00000625	0.00000231	0.000005	0.000005	0.000005	0.000005	0.00000625	0.00001	0.00001	0.00001	8
Molybdenum T-Mo	0.00218	0.000375	0.0016	0.00163	0.00207	0.0022	0.00236	0.00257	0.00263	0.0027	8
Molybdenum D-Mo	0.0016	0.000533	0.001	0.00104	0.00112	0.0016	0.00209	0.00213	0.00217	0.0022	8
Nickel T-Ni	0.00689	0.0071	0.0005	0.000675	0.001	0.00437	0.011	0.016	0.0178	0.0197	8
Nickel D-Ni	0.00075	0.000267	0.0005	0.0005	0.0005	0.00075	0.001	0.001	0.001	0.001	8
Selenium T-Se	0.0012	0.000359	0.00063	0.000701	0.000939	0.00132	0.00139	0.0015	0.00161	0.00173	8
Selenium D-Se	0.00095	0.000496	0.000412	0.000424	0.000494	0.000903	0.00129	0.00156	0.00164	0.00172	8
Silicon T-Si	8.46	6.94	1.81	1.85	1.94	6.45	14.6	16.9	18	19	8
Silicon D-Si	1.25	0.486	0.697	0.728	0.819	1.22	1.69	1.8	1.81	1.81	8

Constituent	All										
	Mean	Std. Dev.	Minimum	5th Perc	25th Perc	Median	75th Perc	90th Perc	95th Perc	Maximum	Count
Silver T-Ag	0.000145	0.000158	0.00001	0.0000135	0.00002	0.0000845	0.000218	0.000372	0.000393	0.000414	8
Silver D-Ag	0.000015	0.00000535	0.00001	0.00001	0.00001	0.000015	0.00002	0.00002	0.00002	0.00002	8
Sodium T-Na	1.64	0.442	0.83	0.97	1.44	1.77	2	2	2	2	8
Sodium D-Na	1.4	0.722	0.386	0.409	0.774	1.75	2	2	2	2	8
Strontium T-Sr	0.159	0.0598	0.102	0.102	0.111	0.14	0.203	0.235	0.246	0.257	8
Strontium D-Sr	0.144	0.0676	0.0799	0.0808	0.0871	0.12	0.204	0.231	0.236	0.241	8
Thallium T-Tl	0.000123	0.0000861	0.00001	0.0000188	0.0000365	0.000153	0.0002	0.0002	0.0002	0.0002	8
Thallium D-Tl	0.000105	0.000102	0.00001	0.00001	0.00001	0.000105	0.0002	0.0002	0.0002	0.0002	8
Tin T-Sn	0.000301	0.000212	0.0001	0.0001	0.0001	0.000305	0.0005	0.0005	0.0005	0.0005	8
Tin D-Sn	0.000303	0.000211	0.0001	0.0001	0.0001	0.00031	0.0005	0.0005	0.0005	0.0005	8
Titanium T-Ti	0.117	0.119	0.00041	0.00377	0.0108	0.0739	0.23	0.256	0.277	0.297	8
Titanium D-Ti	0.00661	0.00469	0.0003	0.000577	0.0014	0.01	0.01	0.01	0.01	0.01	8
Uranium T-U	0.000244	0.000083	0.00015	0.000168	0.0002	0.000205	0.000279	0.000367	0.000374	0.00038	8
Uranium D-U	0.000163	0.0000651	0.000065	0.0000654	0.000124	0.0002	0.0002	0.00021	0.000221	0.000232	8
Vanadium T-V	0.013	0.0134	0.0005	0.0005	0.0005	0.00909	0.0232	0.0306	0.0322	0.0338	8
Vanadium D-V	0.000625	0.000231	0.0005	0.0005	0.0005	0.0005	0.000625	0.001	0.001	0.001	8
Zinc T-Zn	0.0292	0.0292	0.003	0.0037	0.005	0.0186	0.0465	0.0719	0.0733	0.0748	8
Zinc D-Zn	0.00301	0.00212	0.001	0.001	0.001	0.00305	0.005	0.005	0.005	0.005	8

Units = mg/L

Table B16: Summary Statistics for Surface Water Baseline Conditions

Constituent	Mean	Minimum	25th Perc	75th Perc	90th Perc	Max
pH	N/A	N/A	N/A	N/A	N/A	N/A
Total Hardness	134	52	67	195	197	197
TDS	182	84	122	240	252	264
Turbidity	282	10.9	47	405	582	603
Alkalinity	65	28.8	37.8	92	92.8	92.8
Acidity	6.5	1.05	2.5575	7	16.7	16.7
Chloride	0.56	0.467	0.5	0.546	0.831	0.913
Fluoride	0.06	0.0195	0.0306	0.06675	0.069	0.208
Bromide	0.05	0.0467	0.05	0.05	0.0546	0.0546
Sulfate	61.8	14.4	21.7	88.6	114	114
Nitrate Nitrogen (mg/L as N)	0.13	0.00945	0.015325	0.277	0.296	0.296
Nitrite Nitrogen (mg/L as N)	0.0010	0.000933	0.001	0.001	0.00109	0.00109
Nitrogen, total	0.17	0.133	0.133	0.21	0.25	0.25
Ammonia Nitrogen	0.0070	0.00467	0.005	0.0083975	0.0106	0.0128
Phosphate	0.00160	0.001	0.00112	0.00219	0.002195	0.00231
Phosphorus, total	0.3568	0.0346	0.0354	0.618	0.93	1.15
Total Organic Carbon	1.04	0.467	0.5	1.4	2.055	2.65
Dissolved Organic Carbon	0.61	0.467	0.5	0.62525	0.838	0.838
Aluminum, dissolved	0.0822	0.00982	0.021	0.126	0.138	0.164
Antimony, dissolved	0.0010	0.000582	0.0006795	0.001185	0.00195	0.00195
Arsenic, dissolved	0.0007	0.000518	0.0005987	0.00094225	0.000949	0.000976
Barium, dissolved	0.057	0.024	0.03735	0.0686	0.0938	0.0938
Beryllium, dissolved	0.0009	0.00073	0.000933	0.001	0.001	0.001
Bismuth, dissolved	0.0104	0.0000467	0.00005	0.004125	0.0154	0.125
Boron, dissolved	0.094	0.073	0.0933	0.1	0.1	0.1
Cadmium, dissolved	0.0001	0.0000591	0.0000973	0.000197	0.000209	0.00025
Calcium, dissolved	45	15.6	21.3	65.6	66	66
Chromium, dissolved	0.00094	0.00073	0.000933	0.001	0.001	0.001
Cobalt, dissolved	0.00033	0.00018	0.0003	0.000336	0.00037	0.001
Copper, dissolved	0.00140	0.000862	0.000933	0.0020325	0.00211	0.004
Iron, dissolved	0.0650	0.03	0.04755	0.0788	0.103	0.109

Constituent	Mean	Minimum	25th Perc	75th Perc	90th Perc	Max
Lead, dissolved	0.00050	0.000274	0.000467	0.0005	0.00055	0.001
Magnesium, dissolved	5.17	1.82	2.43	7.42	8.09	8.09
Manganese, dissolved	0.02	0.00355	0.01335	0.024375	0.027	0.0459
Mercury, dissolved	0.0000072	0.00000467	0.000005	0.00001	0.00001	0.00001
Molybdenum, dissolved	0.0046	0.00174	0.00254	0.00493	0.0102	0.0102
Nickel, dissolved	0.0021	0.001	0.0014325	0.00327	0.0038	0.0038
Selenium, dissolved	0.0019	0.000601	0.00115	0.00238	0.00368	0.00368
Silicon, dissolved	1.84	0.609	0.914	2.0725	2.53	5.04
Silver, dissolved	0.0000192	0.000017	0.0000187	0.00002	0.00002	0.00002
Sodium, dissolved	2.15	0.791	2	2.215	2.56	4.13
Strontium, dissolved	0.26	0.0846	0.124	0.363	0.401	0.401
Thallium, dissolved	0.00019	0.000143	0.000187	0.0002	0.0002	0.0002
Tin, dissolved	0.00048	0.00038	0.000467	0.0005	0.000518	0.000518
Titanium, dissolved	0.010	0.00933	0.01	0.011	0.0112	0.0112
Uranium, dissolved	0.00041	0.000162	0.0002	0.000512	0.000838	0.000838
Vanadium, dissolved	0.00071	0.000467	0.0005	0.001	0.001	0.001
Zinc, dissolved	0.00684	0.0035	0.005	0.007055	0.0105	0.0127
Cyanide, total	N/A	N/A	N/A	N/A	N/A	N/A
Cyanide, WAD	N/A	N/A	N/A	N/A	N/A	N/A

Units = mg/L

Table B17: Summary Statistics for Surface Water Operations Phase

Constituent	Mean	Minimum	25th Perc	75th Perc	90th Perc	Max
pH	N/A	N/A	N/A	N/A	N/A	N/A
Total Hardness	145	56	67	210.25	355	416
TDS	193	86	103	228	218	225
Turbidity	294	3.29	219	286	674	2320
Alkalinity	68	35.4	43.4	94.7	129	135
Acidity	6.89	1.9	2.08	3.7	5.72	32
Chloride	0.61	0.5	0.5	0.5	0.9	2.5
Fluoride	0.067	0.032	0.0425	0.084	0.129	0.297
Bromide	0.053	0.05	0.05	0.05	0.09	0.25
Sulfate	76.7	54.4	59.8	110	217	265
Nitrate Nitrogen (mg/L as N)	0.51	0.0249	0.0345	0.304	0.387	0.603
Nitrite Nitrogen (mg/L as N)	0.0029	0.001	0.001	0.001	0.0018	0.005
Nitrogen, total	0.22	0.15	0.16	0.299	0.387	0.445
Ammonia Nitrogen	0.034	0.005	0.005	0.0071	0.0109	0.0155
Phosphate	0.0017	0.001	0.00133	0.00203	0.00212	0.0035
Phosphorus, total	0.37	0.0055	0.246	0.543	0.919	1.55
Total Organic Carbon	1.14	0.5	0.53	1.48	2.36	3.96
Dissolved Organic Carbon	0.68	0.5	0.5	0.625	0.8	1.11
Aluminum, dissolved	0.087	0.0092	0.0758	0.0991	0.464	1.91
Antimony, dissolved	0.0025	0.0005	0.00053	0.00104	0.00116	0.00195
Arsenic, dissolved	0.0011	0.00057	0.00061	0.00073	0.00129	0.0026
Barium, dissolved	0.058	0.046	0.057	0.09	0.103	0.112
Beryllium, dissolved	0.00098	0.001	0.001	0.001	0.001	0.001
Bismuth, dissolved	0.011	0.00005	0.00005	0.000388	0.04	0.2
Boron, dissolved	0.098	0.1	0.1	0.1	0.1	0.1
Cadmium, dissolved	0.00046	0.000017	0.00007	0.000105	0.0002	0.00046
Calcium, dissolved	48.4	12.2	16.6	48.4	63.3	87
Chromium, dissolved	0.0011	0.001	0.001	0.001	0.00122	0.0021
Cobalt, dissolved	0.00088	0.0003	0.0003	0.0003	0.00051	0.005
Copper, dissolved	0.0022	0.001	0.001	0.001	0.00184	0.0252



Constituent	Mean	Minimum	25th Perc	75th Perc	90th Perc	Max
Iron, dissolved	0.080	0.03	0.03	0.0448	0.0749	0.202
Lead, dissolved	0.00059	0.0005	0.0005	0.0005	0.0007	0.00709
Magnesium, dissolved	5.62	1.37	2.13	6.12	7.58	9.2
Manganese, dissolved	0.11	0.0034	0.00705	0.0131	0.02	0.25
Mercury, dissolved	0.000015	0.000005	0.000005	0.0000091	0.00001	0.00001
Molybdenum, dissolved	0.0052	0.0011	0.0018	0.00468	0.00708	0.03
Nickel, dissolved	0.0047	0.001	0.001	0.0035	0.00372	0.009
Selenium, dissolved	0.0023	0.000484	0.000659	0.00253	0.00351	0.0117
Silicon, dissolved	1.92	0.512	0.682	2.15	2.94	4.82
Silver, dissolved	0.000024	0.00002	0.00002	0.00002	0.0000236	0.000038
Sodium, dissolved	3.0	2	2	2	2.08	2.8
Strontium, dissolved	0.268	0.0649	0.0935	0.264	0.4	0.452
Thallium, dissolved	0.00020	0.0002	0.0002	0.0002	0.0002	0.0002
Tin, dissolved	0.00050	0.0005	0.0005	0.0005	0.0005	0.00054
Titanium, dissolved	0.011	0.01	0.01	0.01	0.022	0.07
Uranium, dissolved	0.00043	0.0002	0.0002	0.000453	0.000654	0.00071
Vanadium, dissolved	0.00073	0.0005	0.0005	0.0005	0.00167	0.00635
Zinc, dissolved	0.027	0.005	0.005	0.0061	0.00793	0.029
Cyanide, total	0.00043	0.00000731	0.0000653	0.00062525	0.002935	0.013
Cyanide, WAD	0.0000182	0.000000313	0.0000027	0.000026775	0.0001255	0.000554

Units = mg/L

Table B18: Summary Statistics for Surface Water Predicted Reclamation and Closure/Post Closure Phases

Constituent	Mean	Minimum	25th Perc	75th Perc	90th Perc	Max
pH	N/A	N/A	N/A	N/A	N/A	N/A
Total Hardness	143	59	72.975	207	209	210
TDS	187	84.3	126.5	245.25	259.5	279
Turbidity	290	11	47.95	420	598.5	630
Alkalinity	67.3	29.4	39.55	94.85	96.8	97.5
Acidity	6.62	1.11	2.5975	7.155	17.1	17.3
Chloride	0.57	0.485	0.50775	0.56	0.8665	0.964
Fluoride	0.066	0.0203	0.030975	0.069	0.07075	0.219
Bromide	0.052	0.0482	0.0504	0.05155	0.056	0.0567
Sulfate	68	15.8	28.3	97.275	125.5	127
Nitrate Nitrogen (mg/L as N)	0.135	0.0128	0.019075	0.28	0.3045	0.306
Nitrite Nitrogen (mg/L as N)	0.0011	0.00103	0.00103	0.0010925	0.00122	0.00125
Nitrogen, total	0.180	0.141	0.143	0.213	0.2595	0.261
Ammonia Nitrogen	0.0075	0.00514	0.005375	0.0091175	0.01155	0.0135
Phosphate	0.0016	0.00102	0.00113	0.00224	0.002285	0.00243
Phosphorus, total	0.367	0.0351	0.035675	0.63875	0.9565	1.18
Total Organic Carbon	1.07	0.477	0.5105	1.4225	2.115	2.74
Dissolved Organic Carbon	0.624	0.486	0.51725	0.64825	0.843	0.846
Aluminum, dissolved	0.085	0.00997	0.0217	0.1315	0.142	0.172
Antimony, dissolved	0.00155	0.000782	0.000895	0.00183	0.002785	0.00307
Arsenic, dissolved	0.000850	0.000559	0.0006727	0.0010775	0.001155	0.0012
Barium, dissolved	0.0576	0.0248	0.037825	0.07015	0.0944	0.0947
Beryllium, dissolved	0.000964	0.000737	0.0009615	0.00102	0.00103	0.00104
Bismuth, dissolved	0.0109	0.0000477	0.0000503	0.00418625	0.0158	0.132
Boron, dissolved	0.0965	0.0737	0.0966	0.102	0.103	0.104
Cadmium, dissolved	0.000291	0.000138	0.000224	0.0003555	0.0003915	0.00047
Calcium, dissolved	47.8	18.8	23.425	68.825	70.7	71.2
Chromium, dissolved	0.00129	0.000867	0.0011375	0.00143	0.001505	0.00166
Cobalt, dissolved	0.00101	0.00045	0.0005957	0.0013525	0.00153	0.00179
Copper, dissolved	0.00154	0.00091	0.00111	0.00221	0.00229	0.00421
Iron, dissolved	0.0672	0.0304	0.04945	0.081725	0.107	0.115

Constituent	Mean	Minimum	25th Perc	75th Perc	90th Perc	Max
Lead, dissolved	0.000764	0.000373	0.0006325	0.000866	0.0009195	0.00125
Magnesium, dissolved	5.47	1.9	2.6525	7.9525	8.435	8.46
Manganese, dissolved	0.0350	0.0191	0.0221	0.045225	0.0592	0.0734
Mercury, dissolved	1.67E-05	0.00000838	0.0000129	0.000020525	0.00002365	0.0000275
Molybdenum, dissolved	0.0051	0.00187	0.00279	0.005365	0.011	0.0111
Nickel, dissolved	0.00301	0.00121	0.001815	0.0045875	0.00526	0.00574
Selenium, dissolved	0.00226	0.000816	0.001355	0.003005	0.00409	0.00419
Silicon, dissolved	1.89	0.633	0.923	2.0975	2.59	5.3
Silver, dissolved	0.000071	0.0000317	0.0000415	0.000093325	0.0001065	0.000129
Sodium, dissolved	2.20	0.812	2.01	2.2675	2.66	4.37
Strontium, dissolved	0.263	0.088	0.12775	0.37125	0.411	0.416
Thallium, dissolved	0.000193	0.000144	0.000193	0.000204	0.000205	0.000207
Tin, dissolved	0.000489	0.000384	0.0004812	0.00051525	0.000521	0.000523
Titanium, dissolved	0.0106	0.00964	0.0101	0.011225	0.0115	0.0117
Uranium, dissolved	0.000423	0.000164	0.0002037	0.00053125	0.00086	0.00087
Vanadium, dissolved	0.000725	0.000477	0.0005037	0.00101	0.001025	0.00103
Zinc, dissolved	0.0170	0.00736	0.0108	0.0216	0.02785	0.0325
Cyanide, total	N/A	N/A	N/A	N/A	N/A	N/A
Cyanide, WAD	N/A	N/A	N/A	N/A	N/A	N/A

Units = mg/L

Table B19: Summary Statistics for Surface Water Total Baseline Conditions

Constituent	Mean	Minimum	25th Perc	50th Perc	75th Perc	90th Perc	Max
pH	7.35	6.47	6.98	7.38	7.61	8.03	8.33
Conductivity	275.3678	91.84	188.70	282.05	374.55	388.42	503.40
Hardness	156.3089	52.11	95.56	156.20	217.15	233.65	260.80
TDS	191.7063	83.83	126.93	176.00	252.30	264.86	362.50
TSS	296.9984	3.01	19.80	223.10	526.03	689.76	927.60
Turbidity	223.3857	0.31	12.32	149.95	405.15	584.33	667.80
Alkalinity	53.5725	14.05	28.9275	51.00	72.6375	94.943	102.60
Acidity	7.43206	1.088	3.287	5.996	10.55	17.607	19.23
Chloride	0.54450	0.47730	0.50125	0.504	0.53750	0.64044	0.93180
Fluoride	0.06778	0.01980	0.04571	0.06580	0.06901	0.10164	0.20940
Bromide	0.05071	0.047	0.05000	0.05018	0.05059	0.05375	0.05712
Sulphate	105.81278	14.69	55.63750	99.60	144.95	186.83	294.30
Nitrate_N	0.31705	0.00997	0.02833	0.12810	0.35188	0.98737	2.05900
Nitrite_N	0.00511	0.00100	0.00109	0.00158	0.00331	0.01229	0.04745
Total_Nitrogen	0.30862	0.03851	0.12603	0.17175	0.25015	0.61184	2.36800
Ammonia_N	0.03086	0.00500	0.00793	0.01286	0.02610	0.06716	0.26090
Phosphate	0.00175	0.00100	0.00112	0.00169	0.00219	0.00258	0.00271
Total_Phosphorus	0.26794	0.00438	0.03541	0.05014	0.51390	0.64896	1.15800
TOC	0.86211	0.46640	0.50135	0.62110	1.04750	1.50830	2.66300
DOC	0.59297	0.48330	0.50805	0.58000	0.62598	0.76611	0.87030
Aluminum_T	6.14862	0.12680	0.39745	4.95850	10.72500	13.57100	26.40000
Antimony_T	0.00574	0.00069	0.00216	0.00368	0.00665	0.01338	0.02598
Arsenic_T	0.00979	0.00070	0.00189	0.00482	0.01319	0.02317	0.05085
Barium_T	0.11870	0.02921	0.06084	0.11650	0.15755	0.22055	0.26330
Beryllium_T	0.00096	0.00073	0.00093	0.00100	0.00100	0.00101	0.00108
Bismuth_T	0.00844	0.00005	0.00005	0.00008	0.00069	0.01546	0.12600
Boron_T	0.09567	0.07327	0.09404	0.10000	0.10040	0.10154	0.10750
Cadmium_T	0.00133	0.00026	0.00058	0.00076	0.00140	0.00251	0.00695
Calcium_T	58.36667	23.04000	37.33250	54.50500	77.94000	91.79600	98.68000
Chromium_T	0.00713	0.00100	0.00125	0.00300	0.01080	0.01692	0.03826

Constituent	Mean	Minimum	25th Perc	50th Perc	75th Perc	90th Perc	Max
Cobalt_T	0.00612	0.00058	0.00168	0.00627	0.01012	0.01119	0.01737
Copper_T	0.03356	0.00246	0.01351	0.03182	0.05096	0.05969	0.09272
Iron_T	9.65581	0.26150	1.08500	5.82050	15.83000	20.91000	65.86000
Lead_T	0.00739	0.00074	0.00228	0.00673	0.01262	0.01513	0.01769
Magnesium_T	11.22004	3.69000	5.98975	9.76900	14.00000	23.66000	25.49000
Manganese_T	0.53762	0.03983	0.21178	0.50365	0.70678	1.04660	1.83300
Mercury_T	0.00007	0.00001	0.00001	0.00003	0.00007	0.00015	0.00048
Molybdenum_T	0.00666	0.00234	0.00345	0.00590	0.00963	0.01268	0.01418
Nickel_T	0.02724	0.00531	0.01012	0.02247	0.03661	0.05283	0.11730
Selenium_T	0.00326	0.00107	0.00184	0.00302	0.00417	0.00484	0.00867
Silicon_T	8.12282	1.95000	3.20425	4.17250	11.34000	19.23100	30.70000
Silver_T	0.00017	0.00002	0.00003	0.00005	0.00024	0.00045	0.00102
Sodium_T	3.12618	1.44800	2.01200	2.54400	4.26900	5.20000	6.42000
Strontium_T	0.29599	0.11610	0.16730	0.27795	0.43203	0.47049	0.53370
Thallium_T	0.00019	0.00014	0.00019	0.00020	0.00020	0.00020	0.00022
Tin_T	0.00048	0.00038	0.00047	0.00050	0.00050	0.00050	0.00054
Titanium_T	0.10053	0.01000	0.01075	0.05575	0.16465	0.31617	0.45220
Uranium_T	0.00051	0.00015	0.00026	0.00050	0.00072	0.00093	0.00094
Vanadium_T	0.01373	0.00050	0.00059	0.00466	0.02270	0.03534	0.08637
Zinc_T	0.11312	0.02774	0.06119	0.08656	0.13575	0.20284	0.43180
CN_Total	0.0002306	0.0000000	0.0000000	0.0000024	0.00017	0.00073	0.00297
CN_WAD	0.0000099	0.0000000	0.0000000	0.0000001	0.00001	0.00003	0.00013

Table B20: Summary Statistics for Surface Water Total Operation Phase

Constituent	Mean	Minimum	25th Perc	50th Perc	75th Perc	90th Perc	Max
pH	7.35	6.47	6.98	7.38	7.61	8.03	8.33
Conductivity	275.3678	91.84	188.70	282.05	374.55	388.42	503.40
Hardness	156.3089	52.11	95.56	156.20	217.15	233.65	260.80
TDS	191.7063	83.83	126.93	176.00	252.30	264.86	362.50
TSS	296.9984	3.01	19.80	223.10	526.03	689.76	927.60
Turbidity	223.3857	0.31	12.32	149.95	405.15	584.33	667.80
Alkalinity	53.57250	14.05000	28.92750	51.00000	72.63750	94.94300	102.60000
Acidity	7.43206	1.08800	3.28700	5.99600	10.55000	17.60700	19.23000
Chloride	0.54450	0.47730	0.50125	0.50400	0.53750	0.64044	0.93180
Fluoride	0.06778	0.01980	0.04571	0.06580	0.06901	0.10164	0.20940
Bromide	0.05071	0.04700	0.05000	0.05018	0.05059	0.05375	0.05712
Sulphate	105.81278	14.69000	55.63750	99.60000	144.95000	186.83000	294.30000
Nitrate_N	0.31705	0.00997	0.02833	0.12810	0.35188	0.98737	2.05900
Nitrite_N	0.00511	0.00100	0.00109	0.00158	0.00331	0.01229	0.04745
Total_Nitrogen	0.30862	0.03851	0.12603	0.17175	0.25015	0.61184	2.36800
Ammonia_N	0.03086	0.00500	0.00793	0.01286	0.02610	0.06716	0.26090
Phosphate	0.00175	0.00100	0.00112	0.00169	0.00219	0.00258	0.00271
Total_Phosphorus	0.26794	0.00438	0.03541	0.05014	0.51390	0.64896	1.15800
TOC	0.86211	0.46640	0.50135	0.62110	1.04750	1.50830	2.66300
DOC	0.59297	0.48330	0.50805	0.58000	0.62598	0.76611	0.87030
Aluminum_T	6.14862	0.12680	0.39745	4.95850	10.72500	13.57100	26.40000
Antimony_T	0.00574	0.00069	0.00216	0.00368	0.00665	0.01338	0.02598
Arsenic_T	0.00979	0.00070	0.00189	0.00482	0.01319	0.02317	0.05085
Barium_T	0.11870	0.02921	0.06084	0.11650	0.15755	0.22055	0.26330
Beryllium_T	0.00096	0.00073	0.00093	0.00100	0.00100	0.00101	0.00108
Bismuth_T	0.00844	0.00005	0.00005	0.00008	0.00069	0.01546	0.12600
Boron_T	0.09567	0.07327	0.09404	0.10000	0.10040	0.10154	0.10750
Cadmium_T	0.00133	0.00026	0.00058	0.00076	0.00140	0.00251	0.00695

Constituent	Mean	Minimum	25th Perc	50th Perc	75th Perc	90th Perc	Max
Calcium_T	58.36667	23.04000	37.33250	54.50500	77.94000	91.79600	98.68000
Chromium_T	0.00713	0.00100	0.00125	0.00300	0.01080	0.01692	0.03826
Cobalt_T	0.00612	0.00058	0.00168	0.00627	0.01012	0.01119	0.01737
Copper_T	0.03356	0.00246	0.01351	0.03182	0.05096	0.05969	0.09272
Iron_T	9.65581	0.26150	1.08500	5.82050	15.83000	20.91000	65.86000
Lead_T	0.00739	0.00074	0.00228	0.00673	0.01262	0.01513	0.01769
Magnesium_T	11.22004	3.69000	5.98975	9.76900	14.00000	23.66000	25.49000
Manganese_T	0.53762	0.03983	0.21178	0.50365	0.70678	1.04660	1.83300
Mercury_T	0.00007	0.00001	0.00001	0.00003	0.00007	0.00015	0.00048
Molybdenum_T	0.00666	0.00234	0.00345	0.00590	0.00963	0.01268	0.01418
Nickel_T	0.02724	0.00531	0.01012	0.02247	0.03661	0.05283	0.11730
Selenium_T	0.00326	0.00107	0.00184	0.00302	0.00417	0.00484	0.00867
Silicon_T	8.12282	1.95000	3.20425	4.17250	11.34000	19.23100	30.70000
Silver_T	0.00017	0.00002	0.00003	0.00005	0.00024	0.00045	0.00102
Sodium_T	3.12618	1.44800	2.01200	2.54400	4.26900	5.20000	6.42000
Strontium_T	0.29599	0.11610	0.16730	0.27795	0.43203	0.47049	0.53370
Thallium_T	0.00019	0.00014	0.00019	0.00020	0.00020	0.00020	0.00022
Tin_T	0.00048	0.00038	0.00047	0.00050	0.00050	0.00050	0.00054
Titanium_T	0.10053	0.01000	0.01075	0.05575	0.16465	0.31617	0.45220
Uranium_T	0.00051	0.00015	0.00026	0.00050	0.00072	0.00093	0.00094
Vanadium_T	0.01373	0.00050	0.00059	0.00466	0.02270	0.03534	0.08637
Zinc_T	0.11312	0.02774	0.06119	0.08656	0.13575	0.20284	0.43180
CN_Total	0.0002306	0.0000000	0.0000000	0.0000024	0.00017	0.00073	0.00297
CN_WAD	0.0000099	0.0000000	0.0000000	0.0000001	0.00001	0.00003	0.00013

Table B21: Summary Statistics for Surface Water Total Reclamation and Closure/Post Closure Phases

Constituent	Mean	Minimum	25th Perc	50th Perc	75th Perc	90th Perc	Max
pH	7.35	6.47	6.98	7.38	7.61	8.03	8.33
Conductivity	266.9565	90.29	181.50	279.20	363.55	381.04	478.70
Hardness	139.9299	57.94	94.01	132.30	197.73	199.85	233.30
TDS	185.2678	83.27	120.88	174.60	244.55	260.48	344.70
TSS	292.0013	2.91	18.74	219.05	516.25	676.98	920.40
Turbidity	219.6858	0.28	12.12	146.90	396.98	577.76	659.20
Alkalinity	48.70583	10.51000	27.17750	38.97500	70.73500	91.51700	92.24000
Acidity	6.47165	1.01700	3.17550	5.30950	6.93175	16.37800	16.91000
Chloride	0.52429	0.46240	0.47863	0.49365	0.51425	0.63064	0.91010
Fluoride	0.06579	0.01935	0.04498	0.06390	0.06762	0.09647	0.20700
Bromide	0.04904	0.04591	0.04775	0.04911	0.04977	0.05115	0.05360
Sulphate	84.27542	15.56000	50.20000	89.60000	113.15000	123.22000	176.60000
Nitrate_N	0.07411	0.00750	0.01110	0.02366	0.06051	0.27580	0.29250
Nitrite_N	0.00103	0.00092	0.00098	0.00100	0.00105	0.00123	0.00135
Total_Nitrogen	0.11448	0.02811	0.05587	0.13025	0.15460	0.23967	0.24960
Ammonia_N	0.00881	0.00468	0.00506	0.00750	0.00987	0.01392	0.03455
Phosphate	0.00170	0.00097	0.00111	0.00167	0.00213	0.00244	0.00261
Total_Phosphorus	0.26345	0.00406	0.03478	0.04917	0.50703	0.64744	1.14500
TOC	0.83228	0.45140	0.47920	0.55360	1.03175	1.48690	2.64200
DOC	0.56687	0.46360	0.49620	0.53705	0.59405	0.74448	0.83420
Aluminum_T	6.03101	0.04320	0.38150	4.86700	10.66750	13.34700	26.06000
Antimony_T	0.00330	0.00102	0.00254	0.00325	0.00376	0.00435	0.02308
Arsenic_T	0.00881	0.00075	0.00117	0.00325	0.01308	0.02299	0.05038
Barium_T	0.11639	0.02773	0.05756	0.11275	0.15488	0.21841	0.26130
Beryllium_T	0.00093	0.00069	0.00092	0.00096	0.00099	0.00100	0.00100
Bismuth_T	0.00829	0.00005	0.00005	0.00006	0.00050	0.01535	0.12450
Boron_T	0.09274	0.06957	0.09179	0.09632	0.09886	0.09960	0.09992
Cadmium_T	0.00071	0.00021	0.00041	0.00070	0.00103	0.00116	0.00163
Calcium_T	53.31931	23.48000	33.35000	51.78000	71.44000	75.69700	97.95000



Constituent	Mean	Minimum	25th Perc	50th Perc	75th Perc	90th Perc	Max
Chromium_T	0.00762	0.00112	0.00261	0.00327	0.01102	0.01713	0.03822
Cobalt_T	0.00644	0.00058	0.00380	0.00627	0.00973	0.01043	0.01764
Copper_T	0.03241	0.00212	0.01174	0.02880	0.04988	0.05783	0.09148
Iron_T	9.42236	0.04509	0.70570	5.68200	15.44250	20.84000	65.01000
Lead_T	0.00778	0.00079	0.00296	0.00679	0.01273	0.01516	0.01770
Magnesium_T	10.37133	3.40300	5.44100	9.08600	13.23500	22.89500	25.30000
Manganese_T	0.35267	0.03030	0.11573	0.33000	0.55653	0.62512	1.16500
Mercury_T	0.00001	0.00001	0.00001	0.00001	0.00002	0.00003	0.00005
Molybdenum_T	0.00643	0.00240	0.00379	0.00544	0.00946	0.01157	0.01211
Nickel_T	0.02303	0.00489	0.00957	0.02025	0.02673	0.04068	0.11700
Selenium_T	0.00291	0.00136	0.00191	0.00260	0.00381	0.00442	0.00557
Silicon_T	7.97322	1.93100	3.10000	4.01550	11.21750	19.16200	30.36000
Silver_T	0.00027	0.00003	0.00010	0.00026	0.00032	0.00049	0.00105
Sodium_T	2.87206	1.39800	1.99050	2.50800	4.13750	4.33080	4.97900
Strontium_T	0.28649	0.11410	0.16370	0.25890	0.41830	0.46155	0.50750
Thallium_T	0.00019	0.00014	0.00018	0.00019	0.00020	0.00020	0.00020
Tin_T	0.00047	0.00036	0.00046	0.00048	0.00049	0.00050	0.00050
Titanium_T	0.09921	0.00937	0.01011	0.05365	0.16368	0.31540	0.44900
Uranium_T	0.00049	0.00014	0.00026	0.00049	0.00071	0.00091	0.00093
Vanadium_T	0.01356	0.00046	0.00056	0.00455	0.02255	0.03497	0.08540
Zinc_T	0.07378	0.02435	0.05266	0.07157	0.09249	0.11187	0.15530
CN_Total	0.0000076	0.0000000	0.0000000	0.0000001	0.000001	0.000003	0.000009
CN_WAD	0.0000003	0.0000000	0.0000000	0.0000000	0.000000	0.000000	0.000000

Table B22: Summary Statistics for Baseline Groundwater

Constituent	Mean	Minimum	5th Perc	25th Perc	75th Perc	90th Perc	Max
Field pH	7.57	4.55	6.44	7.39	7.90	8.08	9.00
Conductivity	341	81	105	248	439	542	660
Specific Conductivity	404	321	346	406	424	429	431
Dissolved Oxygen	3.04	0.87	1.10	1.69	4.65	4.92	5.41
Dissolved Oxygen	26	7	10	16	35	45	52
ORP	181	106	114	146	219	239	253
Turbidity	1.7	0.0	0.0	0.4	2.0	4.6	4.9
TDS	0.28	0.27	0.27	0.27	0.28	0.28	0.28
Temperature	2.85	1.20	1.29	2.18	3.58	3.81	3.90
pH	7.1	4.1	5.1	7.0	7.8	7.9	8.0
Specific Conductance	347	46	73	210	482	536	620
Hardness CaCO3	177	29	40	140	220	245	540
Total Dissolved Solids	228	0.024	0.061	112	328	368	470
Total Suspended Solids	279	0.0010	0.0020	2	118	790	6400
Turbidity	124	0.100	0.151	0.35	30	260	4700
Alkalinity-Total CaCO3	70	1.0	3.5	50	69	120	880
Alkalinity to pH 4.5	17	1.0	1.1	2	14	54	65
Alkalinity, Bicarbonate (as CaCO3)	63	47	48	58	68	72	73
Alkalinity, Carbonate (as CaCO3)	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Alkalinity, Hydroxide (as CaCO3)	ND <2						
Alkalinity, Phenolphthalein (as CaCO3)	NA						
Acidity (as CaCO3)	4.6	1.0	1.6	2.4	5.3	7.0	56.0
Chloride Cl	0.55	0.00	0.00	0.15	0.70	1.50	2.50
Fluoride F	0.10	0.00	0.00	0.04	0.10	0.20	0.50
Bromide Br	ND <0.05						
Sulphate SO4	110	0.012	0.019	52	160	189	249
Nitrate Nitrogen N	1.86	0.01	0.01	0.02	0.89	9.75	17.00
Nitrite Nitrogen N	10	0.0010	0.0015	0.0065	2.15	58	94
Total Nitrogen	ND <0.05						
Ammonia Nitrogen N	0.0090	0.0060	0.0066	0.0090	0.0100	0.0100	0.0100

Constituent	Mean	Minimum	5th Perc	25th Perc	75th Perc	90th Perc	Max
Free Ammonia	2.3	0.0050	0.0068	0.012	0.56	14.5	15.0
Ortho-Phosphate	0.011	0.001	0.002	0.002	0.008	0.020	0.100
Phosphorus (P)-Total	0.19	0.00	0.00	0.01	0.21	0.40	2.70
Total Organic Carbon	ND <0.5						
Dissolved Organic Carbon	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Cyanide, total	ND <0.005						
Cyanide, WAD	ND <0.005						
Thiocyanate	0.067	0.050	0.050	0.050	0.075	0.090	0.100
Aluminum	0.043	0.001	0.002	0.006	0.032	0.091	0.651
Antimony	0.019	0.000	0.000	0.003	0.015	0.055	0.130
Arsenic	0.0075	0.0007	0.0013	0.0039	0.0080	0.0124	0.0580
Barium	0.023	0.010	0.012	0.016	0.027	0.037	0.053
Beryllium	0.00011	0.00003	0.00004	0.00006	0.00011	0.00018	0.00034
Bismuth	ND <0.05						
Boron	0.033	0.001	0.002	0.008	0.044	0.071	0.130
Cadmium	0.00043	0.00001	0.00003	0.00018	0.00054	0.00092	0.00190
Calcium	52	5	9	26	72	82	190
Cesium	NA						
Chromium	0.0018	0.0001	0.0004	0.0008	0.0025	0.0034	0.0150
Chromium VI	ND<0.001						
Cobalt	0.00076	0.00003	0.00010	0.00019	0.00070	0.00210	0.00800
Copper	0.012	0.000	0.000	0.001	0.005	0.039	0.095
Iron	0.051	0.010	0.011	0.025	0.066	0.082	0.330
Lead	0.00035	0.00003	0.00003	0.00009	0.00029	0.00068	0.00250
Magnesium	7.0	0.9	1.3	4.0	9.4	11.3	18.0
Manganese	0.088	0.000	0.001	0.016	0.105	0.244	0.550
Mercury	0.00010	0.00003	0.00003	0.00004	0.00012	0.00019	0.00023
Molybdenum	0.0071	0.0003	0.0007	0.0017	0.0062	0.0263	0.0470
Nickel	0.0039	0.0001	0.0005	0.0012	0.0051	0.0089	0.0180
Potassium	0.79	0.01	0.05	0.14	0.59	1.91	8.00
Selenium	0.0024	0.0002	0.0007	0.0013	0.0029	0.0050	0.0060

Constituent	Mean	Minimum	5th Perc	25th Perc	75th Perc	90th Perc	Max
Silicon	3.62	3.09	3.13	3.36	3.83	3.98	4.07
Silver	0.000040	0.000010	0.000010	0.000020	0.000050	0.000090	0.000110
Sodium	3.62	0.48	0.80	2.05	3.62	6.92	38.00
Strontium	0.83	0.02	0.03	0.20	1.19	1.57	2.94
Sulfur	57	44	46	55	65	65	66
Thallium	0.000011	0.000011	0.000011	0.000011	0.000011	0.000011	0.000011
Tin	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015
Titanium	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Uranium	0.00035	0.00002	0.00005	0.00013	0.00038	0.00084	0.00180
Vanadium	ND <0.03						
Zinc	0.020	0.000	0.002	0.005	0.026	0.048	0.098

Units = mg/L

Table B23: Summary Statistics for Baseline Sediment

Constituent	Mean	Minimum	75 Perc	90 Perc	Max
Aluminum	17,175	13,233	18,060	20,140	32,350
Antimony	4.89	1.62	6.5	7.804	9.26
Arsenic	65	9.9	92	112.432	145.28
Barium	226	78.7	180	347.52	1205.8
Beryllium	0.46	0.3	0.43	0.588	1.12
Bismuth	0.59	0.11	0.72	0.834	1.07
Cadmium	1.8	0.83	1.8	2.472	4.51
Calcium	18,939	1,550	24,800	32,242	34,460
Chromium	29.0	4.2	34.33	50.64	56.6
Cobalt	23	13.63	25.7	28.24	69.43
Copper	179	46.2	136.6	275.398	1215.5
Iron	50765	36100	53583	63426.8	99017
Lead	36.6	14.6	41.77	54.464	80.72
Lithium	19	15.2	23.3	25.264	25.4
Magnesium	13885	10200	14567	16496	18717
Manganese	1077	746.5	1135.6	1349.58	2011.7
Mercury	0.053	0.02	0.05	0.074	0.1
Molybdenum	18	1.38	5.78	30.04	181.33
Nickel	39	6.46	52.2	65.236	73.52
Potassium	1088	498	1,282	1,719	1,938
Selenium	5.1	0.87	7.1	8.062	12.2
Silver	0.92	0	1	1	1
Sodium	152	99.7	176	225.72	257.5
Strontium	86	14.8	108.67	152.442	161.2
Thallium	0.12	0.05	0.1475	0.2	0.28
Tin	0.30	0.12	0.37	0.458	0.58
Titanium	591	305	731.3	875.8	970.8
Uranium	0.95	0.48	1.1	1.33	2.5
Vanadium	75	44.5	83.8	104.36	137
Zinc	193	107.7	192.2	320.24	443
Zirconium	2.7	1.35	3.91	4.334	4.39

Units = µg/g

Attachment C  
Derivation of Predicted Future Air and Soil Quality

# 1 PREDICTED FUTURE METALS IN AIR PARTICULATE AND SOIL

Project related activities are anticipated to cause the release of fugitive dust and processing plant emissions to air, some of which will have elevated concentrations of metals when compared to baseline soil concentrations. This dust (air particulate), will settle out of the air onto soil, plants, and surface water, and therefore has the potential to elevate the concentrations of chemicals of potential concern in those media.

Air particulate concentrations estimated by air modelling (Volume 8, Appendix 7-A) was combined with source material concentrations to estimate COPCs concentrations in air particulate (Table C1 and C2). Most air particulate falls out of the air and settles on the ground, and is referred to as dustfall. Dustfall rate contour maps were developed for the LSA, and dustfall rates were identified at 10 specified locations (Table C3) (Figure C1). The air particulate concentrations and subsequently dust deposition rates were predicted to be greatest during the Operation phase of the project. Figure C1 also illustrates the total deposition contours predicted to occur because of Project activities during the Operation Phase, and indicates the degree to which the LSA is affected by dust.

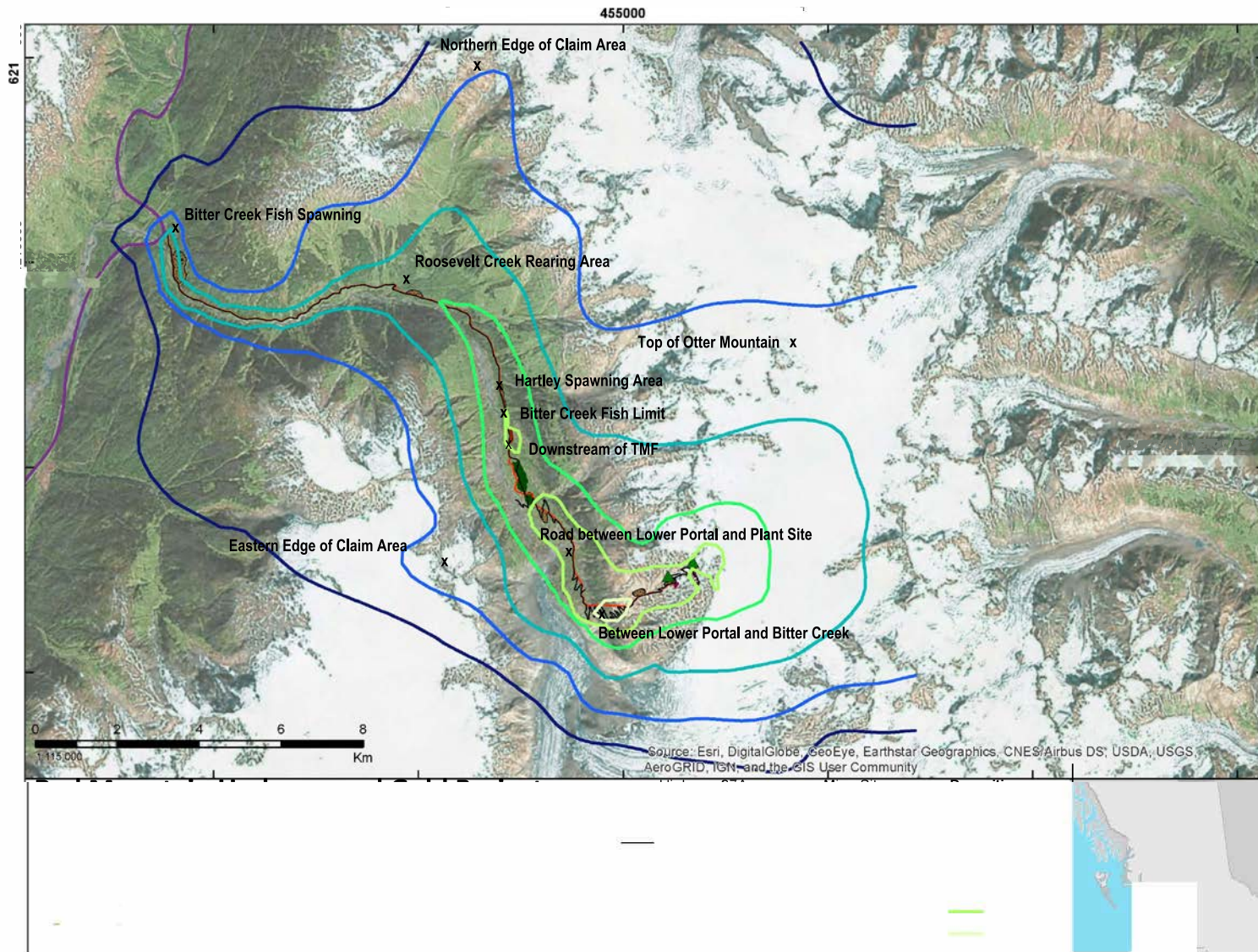
## 1.1 Methodology for Predicting the Yearly Deposition Rate of COPCs

Air particulate-causing activities that will occur at the proposed Project include: driving on unpaved roads, handling ore material and waste rock, and plant site emissions mainly associated with the crushing of ore material prior to refining. However, modelling indicates that the majority of the air particulate will be unrelated to Project activities, but rather a result of wind erosion from undisturbed areas of the LSA (Appendix 7-A of Red Mountain Gold Project EA Report).

The CALPUFF model was used to estimate mass fraction of each dust source in air particulate/dustfall at three locations, 1) Bitter Creek Down Stream of the TMF, 2) the Haul Road between the Lower Portal and Plant site, and 3) Between Lower Portal and Bitter Creek (Figure C1). Three dust sources were considered in the CALPUFF modelling, background soil, road, and non-road. Non-road sourced dust was assumed to be comprised of 50% waste rock and 50% ore material (Table C3). Summary statistics for baseline soil, waste rock, ore material, and road material is reported in Tables C5 to C7.

The constituent concentrations in the air particulate ( $\mu\text{g}/\text{m}^3$ )/dustfall ( $\text{mg}/\text{m}^2/\text{year}$ ) was calculated by multiplying the sum of the mass fraction of dust from each source by the constituent concentrations associated with each respective source type. The CALPUFF model results for maximum daily deposition rates in  $\text{mg}/\text{dm}^2/\text{day}$  were multiplied by 36.5 to convert to an annual deposition rates in units of  $\text{g}/\text{m}^2/\text{year}$ .

The air particulate COPC concentration (PM<sub>2.5</sub> and PM<sub>10</sub>) was estimated based on the mass fraction of source at the three locations (Table C9). The highest air particulate was estimate using the mass fractions for location 2.



FigureC1: Contour Plot for Annual Maximum Predicted Total Dustfall



## 1.2 Methodology for Predicting COPC Concentrations in Surface Soil

The predicted future concentrations of metals in surface soil were calculated by adding the predicted future concentrations of metals associated with particulate deposition, to the baseline soil concentrations. The concentration of metals in the dust was predicted using the following formula (USEPA 2005):

$$C_s = (100 \times D) / (Z_s \times BD) \times tD$$

where:

- C<sub>s</sub> = Soil concentration over exposure duration (mg COPC/kg soil)
- 100 = Unit conversion factor (from mg-m<sup>2</sup> to kg-cm<sup>2</sup>)
- D = Yearly dry deposition rate of metals (g COPC/m<sup>2</sup>-year)
- tD = Time period over which deposition occurs (years)
- Z<sub>s</sub> = Soil mixing zone depth (cm)
- BD = Soil bulk density (g/cm<sup>3</sup>)

The time period over which particulate deposition was modelled was 7.5 years, 1.5 years for the Construction Phase and 6 years for the Operations Phase. Metals deposited with particulate were assumed to mix with the top 2 cm of soil. The bulk density for soil was set to 1.5 g soil/cm<sup>3</sup> soil (USEPA 2005). A soil loss constant was not included in the modelling as it was assumed that none of the metals deposited from particulate were lost to weathering or degradation. This is a conservative assumption. Predicted COPC soil concentrations are provided in Table C10.

## 1.3 Example Calculations for Calculating Air and Soil COPC Concentrations

Data used to calculate the air COPC concentrations and soil concentrations are provided in Tables C1 to C10 at the end of the document. Examples of the calculations are provided below for aluminum to support the review.

### **EXAMPLE CALCULATION 1:**

#### **Predicted Aluminum Soil Concentration at Bitter Creek Downstream of Tailings Management Facility During Mining Operations Based on 24-hour PM<sub>10</sub>**

The predicted future concentrations of metals in surface soil were calculated by adding the predicted future concentrations of metals associated with particulate deposition (dustfall), to the baseline soil concentrations. This was calculated using the following formula:

$$\text{COPC concentration in deposited material (mg/kg)} = [\text{Deposition Rate (mg/dm}^2\text{/day)} \times \text{COPC Background Concentration (mg/kg)} \times \text{Fraction from background}] + [\text{Deposition Rate (mg/dm}^2\text{/day)} \times \text{COPC Road Concentration (mg/kg)} \times \text{Fraction from road}] + [\text{Deposition Rate (mg/dm}^2\text{/day)} \times \text{COPC (Ore Concentration (mg/kg) + Waste Rock Concentration (mg/kg))/2} \times \text{Fraction from Ore material and waste rock}]$$

The concentration of metals in soil after deposition was predicted using the following formula (USEPA 2005):

$$C_s = (100 \times D) / (Z_s \times BD) \times tD$$

where:

- C<sub>s</sub> = Soil concentration over exposure duration (mg COPC/kg soil)
- 100 = Unit conversion factor (from mg-m<sup>2</sup> to kg-cm<sup>2</sup>)
- D = Yearly dry deposition rate of metals (g COPC/m<sup>2</sup>-year)
- tD = Time period over which deposition occurs (years)
- Z<sub>s</sub> = Soil mixing zone depth (cm)
- BD = Soil bulk density (g/cm<sup>3</sup>)

The time period over which particulate deposition was modelled was 7.5 years, 1.5 years for the Construction Phase and 6 years for the Operations Phase. Metals deposited with particulate were assumed to mix with the top 2 cm of soil. The bulk density for soil was set to 1.5 g soil/cm<sup>3</sup> soil (USEPA 2005). A soil loss constant was not included in the modelling as it was assumed that none of the metals deposited from particulate were lost to weathering or degradation.

The particulate deposition rate (dustfall) of 0.58 mg/dm<sup>2</sup>/day (Table 3) was used to calculate the amount of aluminum deposited on soil from particulate each year. The relative particulate contributions from background (96%), roads (1.6%), and ore/waste rock (2.4%) were obtained using modelling and provided by WSP (Volume 8, Appendix 7-A, Table 6-1).

#### **Particulate Contribution from Background**

$(0.58 \text{ mg/dm}^2/\text{day}) \times [\text{Background Concentration of Aluminum} = 29240 \text{ mg/kg (Table 4)}] \times (0.96) / 1000000 \text{ mg/kg} = 0.01628 \text{ mg/dm}^2/\text{day}$

#### **Particulate Contribution from Road**

$(0.58 \text{ mg/dm}^2/\text{day}) \times [\text{Concentration of Aluminum on Road} = 19900 \text{ mg/kg (Table 4)}] \times 0.016 / 1000000 \text{ mg/kg} = 0.000185 \text{ mg/dm}^2/\text{day}$

#### **Particulate Contribution from Ore/Waste Rock**

$(0.58 \text{ mg/dm}^2/\text{day}) \times [\text{Mean Concentration of Aluminum of Ore (85800 mg/kg) \& Waste Rock (32800 mg/kg)} = 59300 \text{ mg/kg}] \times 0.024 / 1000000 \text{ mg/kg} = 0.000825 \text{ mg/dm}^2/\text{day}$

#### **Amount of aluminum particulate deposited on soil each day from background, road and ore/waste rock**

$(0.01628 \text{ mg/dm}^2/\text{day}) + (0.000185 \text{ mg/dm}^2/\text{day}) + (0.000825 \text{ mg/dm}^2/\text{day}) = 0.0173 \text{ mg/dm}^2/\text{day}$

#### **Amount of aluminum particulate deposited on soil each year from background, road and ore/waste rock**

$(0.0173 \text{ mg/dm}^2/\text{day}) \times (36.5 \text{ g/m}^2/\text{year}) / (\text{mg/dm}^2/\text{day}) = 0.631 \text{ g/m}^2/\text{year}$

#### **Concentration of aluminum particulate deposited on soil from background, road and ore/waste rock**

$(0.631 \text{ g/m}^2/\text{year}) \times (100 \text{ mg-m}^2/\text{kg/cm}^2) \times (7.5 \text{ years}) / ((2 \text{ cm}) \times (1.5 \text{ g/cm}^3)) = 157.77 \text{ mg/kg}$

#### **Predicted future soil concentration of aluminum based on background plus particulate deposits**

$(157.77 \text{ mg/kg}) + (29240 \text{ mg/kg}) = 29397.77 \text{ mg/kg}$

#### **EXAMPLE CALCULATION 2:**

##### **Maximum Aluminum Particulate Concentration During Mining Operation Based on Max 24-hour PM<sub>2.5</sub>**

The site-wide maximum 24-hour PM<sub>2.5</sub> of 18.6 µg/m<sup>3</sup> (Table 1) was used to calculate the maximum aluminum particulate concentration. The relative particulate contributions from background (96%), roads (1.6%), and ore/waste rock (2.4%) were obtained using modelling and provided by WSP (Volume 8, Appendix 7-A, Table 6-1).

**Particulate Contribution from Background**

$$(18.6 \mu\text{g}/\text{m}^3 \times [\text{Background Concentration of Aluminum} = 29240 \text{ mg}/\text{kg}] \times 0.96) / 1000000 \text{ mg}/\text{kg} = 0.5221 \mu\text{g}/\text{m}^3$$

**Particulate Contribution from Road**

$$(18.6 \mu\text{g}/\text{m}^3 \times [\text{Concentration of Aluminum on Road} = 19900 \text{ mg}/\text{kg}] \times 0.016) / 1000000 \text{ mg}/\text{kg} = 0.005922 \mu\text{g}/\text{m}^3$$

**Particulate Contribution from Ore/Waste Rock**

$$(18.6 \mu\text{g}/\text{m}^3 \times [\text{Mean Concentration of Aluminum of Ore (85800 mg}/\text{kg}) \& \text{ Waste Rock (32800 mg}/\text{kg}) = 59300 \text{ mg}/\text{kg}] \times 0.024) / 1000000 \text{ mg}/\text{kg} = 0.02647 \mu\text{g}/\text{m}^3$$

**Maximum particulate concentration of aluminum in dust from background, road and ore/waste rock**

$$(0.52 \mu\text{g}/\text{m}^3) + (0.0059 \mu\text{g}/\text{m}^3) + (0.026 \mu\text{g}/\text{m}^3) = 0.555 \mu\text{g}/\text{m}^3$$

The maximum particulate concentration based on annual PM<sub>2.5</sub> would require the same calculation as shown above except that a PM<sub>2.5</sub> (annual) value of 4.4  $\mu\text{g}/\text{m}^3$  would be used instead of PM<sub>2.5</sub> (24-hour) value of 18.6  $\mu\text{g}/\text{m}^3$ .

**EXAMPLE CALCULATION 3:****Aluminum Particulate Concentration at Bitter Creek Downstream of Tailings Management Facility During Mining Operations Based on annual PM<sub>10</sub>**

The annual PM<sub>10</sub> of 17.79  $\mu\text{g}/\text{m}^3$  (Table 1) was used to calculate the maximum aluminum particulate concentration. The relative particulate contributions from background (96%), roads (1.6%), and ore/waste rock (2.4%) were obtained using modelling and provided by WSP (Volume 8, Appendix 7-A, Table 6-1).

**Particulate Contribution from Background**

$$(17.79 \mu\text{g}/\text{m}^3 \times [\text{Background Concentration of Aluminum} = 29240 \text{ mg}/\text{kg}] \times 0.96) / 1000000 \text{ mg}/\text{kg} = 0.4994 \mu\text{g}/\text{m}^3$$

**Particulate Contribution from Road**

$$(17.79 \mu\text{g}/\text{m}^3 \times [\text{Concentration of Aluminum on Road} = 19900 \text{ mg}/\text{kg}] \times 0.016) / 1000000 \text{ mg}/\text{kg} = 0.005664 \mu\text{g}/\text{m}^3$$

**Particulate Contribution from Ore and Waste Rock**

$$(17.79 \mu\text{g}/\text{m}^3 \times [\text{Mean Concentration of Aluminum of Ore (85800 mg}/\text{kg}) \& \text{ Waste Rock (32800 mg}/\text{kg}) = 59300 \text{ mg}/\text{kg}] \times 0.024) / 1000000 \text{ mg}/\text{kg} = 0.02532 \mu\text{g}/\text{m}^3$$

**Maximum particulate concentration of aluminum in dust from background, road and ore/waste rock**

$$(0.52 \mu\text{g}/\text{m}^3) + (0.0059 \mu\text{g}/\text{m}^3) + (0.026 \mu\text{g}/\text{m}^3) = 0.530 \mu\text{g}/\text{m}^3$$

**Table C1: Background and Predicted Particulate Matter**

Parameter	Background				Predicted				
	PM2.5 ug/m3	PM10 ug/m3	PMtotal ug/m3	24-hour PM2.5 ug/m3	Annual PM2.5 ug/m3	24-hour PM10 ug/m3	Annual PM10 ug/m3	24-hour PM Total ug/m3	Annual PM Total ug/m3
MAX				18.6	4.4	42.7			
Bitter Creek Down Stream of Tailings Management Facility	1.3	3.4	10	6.17	1.98	17.79	4.95	47.39	1.45E+01
Road Between lower portal and Plant site	1.3	3.4	10	5.95	1.74	24.3	4.35	73.57	1.55E+01
Between Lower Portal and Bitter Creek	1.3	3.4	10	3.35	1.6	9.7	4	29.87	1.36E+01

**Table C2: Source Contribution of Particulate Matter**

Location	Background	Road	Other (Waste Rock and Ore Material)
Bitter Creek Down Stream of Tailings Management Facility	0.96	0.016	0.024
Road Between lower portal and Plant site	0.936	0.054	0.01
Between Lower Portal and Bitter Creek	0.822	0.171	0.007

Table C3: Dustfall at 10 Locations

Receptor Description	Deposition Results							
	Maximum Dry Deposition (mg/dm <sup>2</sup> /day)	Maximum Wet Deposition (mg/dm <sup>2</sup> /day)	Maximum Total Dust Fall (mg/dm <sup>2</sup> /day)	Background Dustfall (mg/dm <sup>2</sup> /day)	Final Maximum Dry Deposition (mg/dm <sup>2</sup> /day)	Final Maximum Wet Deposition (mg/dm <sup>2</sup> /day)	Final Maximum Total Dust Fall (mg/dm <sup>2</sup> /day)	AAQO (mg/dm <sup>2</sup> /day)
Downstream of Tailings Management Facility	2.35E-02	1.56E-02	2.35E-02	0.56	0.58	0.58	0.58	1.7
Bitter Creek Fish limit	1.08E-02	1.29E-02	1.08E-02	0.56	0.57	0.57	0.57	1.7
Bitter Creek Fish Spawning	1.04E-03	7.56E-04	1.04E-03	0.56	0.56	0.56	0.56	1.7
Roosevelt Creek - Rearing	1.06E-02	6.09E-03	1.06E-02	0.56	0.57	0.57	0.57	1.7
Top of Otter Mountain Highest point in area	1.82E-03	1.71E-03	1.82E-03	0.56	0.56	0.56	0.56	1.7
Hartley Spawning Area	1.17E-02	1.22E-02	1.17E-02	0.56	0.57	0.57	0.57	1.7
Eastern edge of claim Area	3.60E-03	9.90E-04	3.60E-03	0.56	0.56	0.56	0.56	1.7
Northern Edge of Claim Area	3.78E-04	2.07E-03	3.78E-04	0.56	0.56	0.56	0.56	1.7
Road Between lower portal and Plant site	4.75E-02	1.93E-02	4.75E-02	0.56	0.61	0.58	0.61	1.7
Between Lower Portal and Bitter Creek	1.56E-01	1.60E-02	1.56E-01	0.56	0.72	0.58	0.72	1.7
Max:	1.56E-01	2.23E-02	1.56E-01		0.72	0.58	0.72	

**Table C4: Modelled Dust Deposition**

Road Dust								
Modelling Receptor ID	Receptor Description	Modelled maximum total dust fall (mg/dm <sup>2</sup> /day)	Percentage of modelled source contribution	Percentage of overall contribution with background	Background dustfall (mg/dm <sup>2</sup> /day)	Percentage of total predicted dustfall coming from the background assumption	Final maximum total dust fall (mg/dm <sup>2</sup> /day)	AAQO (mg/dm <sup>2</sup> /day)
24304	Bitter Creek Down Stream of Tailings Management Facility	9.28E-03	40.2%	1.6%	0.56	96.0%	0.57	1.7
24312	Road Between lower portal and Plant site	3.25E-02	84.3%	5.4%	0.56	93.6%	0.59	1.7
24313	Between Lower Portal and Bitter Creek	1.17E-01	96.1%	17.1%	0.56	82.2%	0.68	1.7

All Other Sources Except Road Dust								
Modelling Receptor ID	Receptor Description	Modelled maximum total dust fall (mg/dm <sup>2</sup> /day)	Percentage of modelled source contribution	Percentage of overall contribution with background	Background dustfall (mg/dm <sup>2</sup> /day)	Percentage of total predicted dustfall coming from the background assumption	Final maximum total dust fall (mg/dm <sup>2</sup> /day)	AAQO (mg/dm <sup>2</sup> /day)
24304	Bitter Cree. Down Stream of Tailings Management Facility	1.38E-02	59.8%	2.4%	0.56	96.0%	0.57	1.7
24312	Road Between lower portal and Plant site	6.03E-03	15.7%	1.0%	0.56	93.6%	0.57	1.7
24313	Between Lower Portal and Bitter Creek	4.72E-03	3.9%	0.7%	0.56	82.2%	0.56	1.7

Total								
Modelling Receptor ID	Receptor Description	Modelled maximum total dust fall (mg/dm <sup>2</sup> /day)	Percentage of modelled source contribution	Percentage of overall contribution with background	Background dustfall (mg/dm <sup>2</sup> /day)	Percentage of total predicted dustfall coming from the background assumption	Final maximum total dust fall (mg/dm <sup>2</sup> /day)	AAQO (mg/dm <sup>2</sup> /day)
24304	Bitter Creek Down Stream of Tailings Management Facility	2.31E-02	100.0%	4.0%	0.56	96.0%	<b>0.58</b>	1.7
24312	Road Between lower portal and Plant site	3.85E-02	100.0%	6.4%	0.56	93.6%	<b>0.60</b>	1.7
24313	Between Lower Portal and Bitter Creek	1.21E-01	100.0%	17.8%	0.56	82.2%	<b>0.68</b>	1.7

**Table C5: Summary Statistics for Baseline Soils**

Constituent	Count	Minimum	Mean	Median	75 Percentile	90 Percentile	95 Percentile	Maximum
Aluminum	6	9700	20133.33	20950	27225	29000	29300	29600
Antimony	27	0.32	2.90	2.5	3.6	5.06	6.86	8.06
Arsenic	27	0.9	28.19	21.5	31.1	59.64	69.52	124
Barium	27	49.1	181.43	107	178.5	306.4	428.56	1238.8
Beryllium	21	0.2	0.41	0.4	0.5	0.6	0.6	0.9
Bismuth	6	0.03	0.14	0.095	0.18	0.285	0.3275	0.37
Boron	6	20	20.00	20	20	20	20	20
Cadmium	27	0.03	0.51	0.45	0.73	0.924	1.097	1.36
Calcium	6	1300	10266.67	8250	17550	19600	19650	19700
Chromium	27	8.3	43.34	29	62.7	77.22	99.08	146.5
Cobalt	27	5.3	14.37	14.1	15.6	19.14	22.27	29
Copper	27	1.59	75.23	72	86.395	101.06	106.1	194
Gallium	6	3.7	8.15	8.45	10.1	11.55	12.075	12.6
Gold	6	0.0003	0.00	0.00095	0.00715	0.01265	0.014425	0.0162
Iron	6	22700	37416.67	36200	40625	52700	58150	63600
Lanthanum	6	3	6.83	5.8	6.575	11.15	13.375	15.6
Lead	27	1.01	16.10	12.8	22.25	30.82	39.97	42.7
Magnesium	6	8700	19066.67	19450	26400	29000	29700	30400
Manganese	6	201	581.00	608.5	677	838	916	994
Mercury	27	0	0.04	0.05	0.06	0.072	0.08	0.08
Molybdenum	27	0.66	11.37	4.7	9.55	20.12	30.98	122.9
Nickel	27	4.2	32.43	30.3	44.4	50.22	52.57	55.4
Phosphorus	6	440	1263.33	1115	1187.5	1960	2335	2710
Potassium	6	400	1000.00	950	1425	1600	1650	1700
Scandium	6	2.1	5.12	5.6	6.575	6.75	6.775	6.8
Selenium	27	0.1	2.20	1.8	3	3.62	4.54	8.3
Silver	27	0.006	0.51	0.5	0.625	0.94	1	1.1
Sodium	6	310	415.00	360	467.5	575	612.5	650
Strontium	6	16.3	50.67	44.8	70.7	90.4	96.85	103.3
Sulfur	6	800	4616.67	2800	5425	10150	12075	14000
Tellurium	6	0.02	0.10	0.045	0.0575	0.23	0.315	0.4
Thallium	27	0.02	0.13	0.1	0.2	0.3	0.3	0.4
Thorium	6	0.6	1.15	1.15	1.275	1.55	1.675	1.8
Tin	21	0.2	0.32	0.3	0.3	0.46	0.58	0.7
Titanium	6	50	1093.33	1135	1285	1985	2312.5	2640
Tungsten	6	0.1	1.00	0.15	0.2	2.75	4.025	5.3
Uranium	27	0.1	0.57	0.5	0.58	1.108	1.208	1.92
Vanadium	27	11	71.82	70	82.6	97.26	108.19	115
Zinc	27	33.6	89.68	85	100	134.4	143.67	242

Units = mg/kg



**Table C6: Summary Statistics for Waste Rock**

Constituent	Count	Minimum	Mean	Median	75 Percentile	90 Percentile	95 Percentile	Maximum
Aluminum	367	4.80E+03	2.50E+04	1.91E+04	2.32E+04	3.28E+04	8.37E+04	9.27E+04
Antimony	296	2.50E+00	2.48E+01	2.00E+01	3.00E+01	3.50E+01	4.13E+01	8.85E+02
Arsenic	367	1.00E+00	3.25E+02	2.00E+02	4.13E+02	7.88E+02	9.91E+02	3.55E+03
Barium	367	1.00E+01	1.55E+02	6.50E+01	8.50E+01	2.26E+02	8.37E+02	4.20E+03
Beryllium	71	1.00E-01	5.77E-01	5.00E-01	8.00E-01	1.50E+00	1.50E+00	2.00E+00
Bismuth	365	1.00E+00	4.38E+00	2.50E+00	5.00E+00	1.00E+01	1.00E+01	2.00E+01
Boron	296	2.00E+00	3.61E+01	1.40E+01	2.60E+01	5.90E+01	1.07E+02	7.52E+02
Cadmium	367	1.00E-01	1.04E+01	4.00E+00	9.70E+00	2.64E+01	4.54E+01	2.53E+02
Calcium	367	7.10E+02	8.49E+03	7.30E+03	1.14E+04	1.74E+04	2.14E+04	5.47E+04
Chromium	367	1.00E+00	6.90E+01	4.90E+01	8.95E+01	1.49E+02	1.86E+02	4.25E+02
Cobalt	364	8.00E+00	2.14E+01	2.00E+01	2.40E+01	2.90E+01	3.20E+01	5.10E+01
Copper	367	5.00E+00	1.71E+02	1.47E+02	2.00E+02	2.69E+02	3.19E+02	1.83E+03
Iron	367	2.19E+04	6.61E+04	6.36E+04	7.26E+04	7.98E+04	8.67E+04	5.98E+05
Lanthanum	296	5.00E+00	5.49E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01	1.00E+01
Lead	367	1.00E+00	6.01E+01	3.40E+01	6.20E+01	1.18E+02	1.64E+02	1.76E+03
Magnesium	367	3.00E+03	2.00E+04	1.94E+04	2.32E+04	2.67E+04	2.88E+04	1.55E+05
Manganese	367	1.40E+02	8.69E+02	7.29E+02	1.15E+03	1.63E+03	1.80E+03	2.48E+03
Mercury	40	1.00E+00	6.59E+01	4.00E+01	6.10E+01	1.41E+02	2.15E+02	4.20E+02
Molybdenum	367	5.00E-01	2.44E+00	2.00E+00	3.00E+00	5.00E+00	5.70E+00	4.00E+01
Nickel	361	5.00E-01	2.66E+01	1.10E+01	3.40E+01	7.80E+01	9.20E+01	1.26E+02
Phosphorus	367	5.70E+02	1.32E+03	1.32E+03	1.51E+03	1.68E+03	1.75E+03	2.01E+03
Potassium	367	2.00E+02	4.63E+03	1.40E+03	2.10E+03	4.44E+03	3.57E+04	4.62E+04
Selenium	6	4.00E+00	7.35E+00	6.10E+00	8.50E+00	1.15E+01	1.28E+01	1.40E+01
Silver	367	1.00E-01	1.58E+00	2.00E-01	8.00E-01	2.94E+00	6.14E+00	1.00E+02
Sodium	367	5.00E+01	2.11E+03	3.00E+02	4.65E+02	1.19E+03	1.80E+04	5.03E+04
Strontium	367	8.00E+00	7.12E+01	4.40E+01	7.75E+01	1.51E+02	2.68E+02	5.88E+02
Tellurium	296	2.50E+01	2.50E+01	2.50E+01	2.50E+01	2.50E+01	2.50E+01	2.50E+01
Thallium	296	0.00E+00	1.35E+00	2.50E+00	2.50E+00	2.50E+00	2.50E+00	2.50E+00
Tin	296	1.00E+01	1.32E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01	2.60E+02
Titanium	336	5.00E+01	7.94E+02	6.00E+02	1.00E+03	1.65E+03	2.80E+03	3.40E+03
Tungsten	365	1.00E+00	8.53E+00	5.00E+00	5.00E+00	1.00E+01	2.00E+01	4.50E+02
Uranium	296	5.00E+00	6.57E+00	5.00E+00	5.00E+00	1.00E+01	1.25E+01	6.00E+01
Vanadium	367	1.10E+01	1.29E+02	1.31E+02	1.60E+02	1.89E+02	2.16E+02	2.80E+02
Yttrium	296	5.00E-01	4.79E+00	5.00E+00	7.00E+00	9.00E+00	1.00E+01	1.30E+01
Zinc	367	5.00E-01	5.19E+02	9.20E+01	2.41E+02	1.63E+03	2.95E+03	8.49E+03

Units = mg/kg

**Table C7: Summary Statistics for Ore Material**

Constituent	Count	Minimum	Mean	Median	75 Percentile	90 Percentile	95 Percentile	Maximum
Aluminum	52	4600	31126	15060	63800	85800	87700	93600
Antimony	10	20.000	72	55.000	91	117	148.5	180
Arsenic	52	1.000	357	262.000	510	793	906.5	1998
Barium	36	2.500	368	127.000	655	984	1436.0	1460
Beryllium	26	0.100	0.6	0.500	0.8	1.4	1.5	1.5
Bismuth	33	1.000	5.8	2.250	5.8	19.2	22.3	30
Boron	10	6.000	9	9.000	10.0	10.2	11.1	12
Cadmium	36	0.100	12.7	5.000	10.3	22.8	42.6	153
Calcium	36	4400	10490	7400	11030	17584	27500.0	40700
Chromium	52	1.000	54	43.000	77	122	166.0	204
Cobalt	34	9.000	19	19.000	21	27	28.8	33
Copper	36	51.000	439	233.000	346	798	2085.1	2540
Iron	36	50.000	70190	65400	82000	112620	143060.0	155000
Lanthanum	10	5.000	6	5.000	5	10	10.0	10
Lead	36	12.000	91	58.000	94	184	260.5	536
Magnesium	52	50.000	10816	8690.0	17300	20800	24040.0	27700
Manganese	52	31.000	605	462.0	865	1275	1474.0	2267
Mercury	42	1.000	25	1.0	10	105	150.0	210
Molybdenum	36	0.500	2.2	1.0	3.0	4.0	5.6	13
Nickel	34	1.000	25	12.0	34	62	79.8	84
Phosphorus	52	917.000	1484	1530.0	1660	1830	1840.0	2010
Potassium	48	300.000	13626	3610.0	31750	39180	40180.0	45000
Selenium	6	7.000	17	11.1	26	32	33.0	34
Silver	52	0.100	16	7.0	18	29	50.4	184
Sodium	52	50.000	1960	250.0	1390	6900	9650.0	18000
Strontium	51	8.000	54	26.0	67	135	158.4	285
Tellurium	10	25.000	25	25.0	25	25	25.0	25
Thallium	10	2.500	2.5	2.5	2.5	2.5	2.5	2.5
Tin	10	10.000	10	10.0	10	10	10.0	10
Titanium	24	50.000	1623	2100.0	2750	3000	3085.0	3300
Tungsten	49	1.000	3.8	2.0	5.0	10.0	10.0	20
Uranium	10	5.000	7.5	5.0	5.0	7.5	18.8	30
Vanadium	52	6.000	101	78.2	168	234	246.5	251
Yttrium	10	0.500	1.9	0.5	0.5	7.1	7.6	8
Zinc	52	30.000	987	236.0	718	2597	4729.0	10000

Units = mg/kg

**Table C8: Summary Statistics for Future Road**

Constituent	Count	Minimum	Mean	Median	75 Percentile	90 Percentile	95 Percentile	Maximum
Aluminum	19	3000.00	14415.79	15800.00	18250	19900	20750	28400.00
Antimony	33	0.55	2.34	1.88	2.4	2.6	5.717	12.17
Arsenic	33	0.90	65.95	17.10	20.8	27.6	76.9	1573.40
Barium	33	55.00	255.67	157.00	251.2	453.3	866.4	1238.80
Beryllium	14	0.20	0.39	0.35	0.475	0.57	0.6	0.60
Bismuth	19	0.03	0.71	0.16	0.185	0.546	2.193	9.60
Boron	19	20.00	20.00	20.00	20	20	20	20.00
Cadmium	33	0.03	0.91	0.50	0.78	0.82	0.924	13.97
Calcium	19	1300.00	8389.47	5100.00	11100	20460	24300	24300.00
Chromium	33	13.60	60.55	60.90	74.4	100.92	108.08	126.20
Cobalt	33	2.60	12.68	13.00	15.4	18.5	19.1	29.00
Copper	33	1.59	59.34	61.97	72	79.5	90.642	107.00
Gallium	19	0.90	5.18	5.50	5.75	6.2	6.84	12.60
Gold	19	0.00	0.01	0.00	0.0026	0.00702	0.01433	0.06
Iron	19	10700.00	30268.42	29500.00	35950	45100	46950	63600.00
Lanthanum	19	1.80	10.64	12.00	14	14.96	16.29	22.50
Lead	33	1.01	17.11	12.50	17.4	27.292	31.114	127.81
Magnesium	19	1300.00	10563.16	10000.00	14000	14500	17250	27600.00
Manganese	19	137.00	701.42	753.00	979	1068.4	1366	1366.00
Mercury	33	0.00	0.03	0.02	0.04	0.05	0.064	0.13
Molybdenum	33	0.87	9.26	2.89	4.5	14.04	34.88	122.90
Nickel	33	2.80	28.55	28.10	36	50.1	54.26	74.20
Phosphorus	19	390.00	1050.00	1010.00	1190	1358	1594	2710.00
Potassium	19	400.00	1842.11	1800.00	1900	2400	2600	4400.00
Scandium	19	1.30	4.75	4.80	6.2	7.42	9.9	9.90
Selenium	33	0.10	3.19	1.20	1.8	2.98	3.42	67.30
Silver	33	0.01	0.70	0.50	0.621	0.869	1.8084	5.90
Sodium	19	20.00	413.16	290.00	520	832	899	1070.00
Strontium	19	9.20	38.82	26.30	57.45	71.9	80.08	103.30
Sulfur	19	200.00	1763.16	800.00	1700	5660	6580	9100.00
Tellurium	19	0.02	0.10	0.04	0.08	0.128	0.335	0.83
Thallium	33	0.02	0.11	0.10	0.1	0.12	0.272	0.40
Thorium	19	0.30	3.40	1.30	2	10.4	13.39	15.10
Tin	14	0.20	0.24	0.20	0.3	0.3	0.3	0.30
Titanium	19	40.00	794.74	730.00	1085	1680	2172	2640.00
Tungsten	19	0.10	1.88	0.10	0.3	1.7	7.42	26.50
Uranium	33	0.10	0.84	0.50	0.6	1.364	3	5.50
Vanadium	33	11.00	66.92	68.70	80	97.58	99	115.00
Zinc	33	30.00	97.15	84.00	90.4	97.6	119.64	688.90

**Table C9: PM<sub>2.5</sub> and PM<sub>10</sub> Background and Predicted Air Particulate Chemical Concentrations**

Parameters	Background	Road	Ore	Waste Rock	Background PM2.5	Background PM10	Annual PM2.5 Bitter Creek Down Stream of Tailings Management Facility	Annual PM10 Bitter Creek Down Stream of Tailings Management Facility
	mg/kg	mg/kg	mg/kg	mg/kg	ug/m3	ug/m3	ug/m3	ug/m3
Aluminum	29300	19900	85800	32800	3.81E-02	9.96E-02	5.91E-02	1.48E-01
Antimony	6.86	2.6	117	35	8.92E-06	2.33E-05	1.67E-05	4.18E-05
Arsenic	69.52	27.6	793	788.4	9.04E-05	2.36E-04	1.71E-04	4.26E-04
Barium	428.56	453.3	984	226.4	5.57E-04	1.46E-03	8.58E-04	2.14E-03
Beryllium	0.6	0.57	1.38	1.5	7.80E-07	2.04E-06	1.23E-06	3.07E-06
Bismuth	0.3275	0.546	19.2	10	4.26E-07	1.11E-06	1.33E-06	3.33E-06
Boron	20	10	10.2	59	2.60E-05	6.80E-05	4.00E-05	9.99E-05
Cadmium	1.097	0.82	22.78	26.4	1.43E-06	3.73E-06	3.28E-06	8.20E-06
Calcium	19650	20460	17584	17440	2.55E-02	6.68E-02	3.88E-02	9.71E-02
Chromium	99.08	100.92	122	148.6	1.29E-04	3.37E-04	1.98E-04	4.95E-04
Cobalt	22.27	18.5	26.6	29	2.90E-05	7.57E-05	4.42E-05	1.11E-04
Copper	106.1	79.5	798.4	269.4	1.38E-04	3.61E-04	2.30E-04	5.74E-04
Gallium	12.075	6.2			1.57E-05	4.11E-05	2.31E-05	5.79E-05
Gold	0.014425	0.00702			1.88E-08	4.90E-08	2.76E-08	6.91E-08
Iron	58150	45100	112620	79840	7.56E-02	1.98E-01	1.17E-01	2.91E-01
Lanthanum	13.375	14.96	10	5	1.74E-05	4.55E-05	2.63E-05	6.56E-05
Lead	39.97	27.292	183.6	118.4	5.20E-05	1.36E-04	8.40E-05	2.10E-04
Magnesium	29700	14500	20799.999	26720	3.86E-02	1.01E-01	5.80E-02	1.45E-01
Manganese	916	1068.4	1275	1632.4	1.19E-03	3.11E-03	1.84E-03	4.61E-03
Mercury	0.08	0.05	105	140.5	1.04E-07	2.72E-07	5.99E-06	1.50E-05
Molybdenum	30.98	14.04	4	5	4.03E-05	1.05E-04	5.95E-05	1.49E-04
Nickel	52.57	50.1	62.4	78	6.83E-05	1.79E-04	1.05E-04	2.62E-04
Phosphorus	2335	1358	1830	1680	3.04E-03	7.94E-03	4.56E-03	1.14E-02
Potassium	1650	2400	39180	4440	2.15E-03	5.61E-03	4.25E-03	1.06E-02
Scandium	6.775	7.42			8.81E-06	2.30E-05	1.31E-05	3.28E-05
Selenium	4.54	2.98	31.9	11.5	5.90E-06	1.54E-05	9.76E-06	2.44E-05
Silver	1	0.869	28.799999	2.94	1.30E-06	3.40E-06	2.68E-06	6.71E-06
Sodium	612.5	832	6900	1194	7.96E-04	2.08E-03	1.38E-03	3.46E-03
Strontium	96.85	71.9	134.8	151.2	1.26E-04	3.29E-04	1.93E-04	4.83E-04
Sulfur	12075	5660			1.57E-02	4.11E-02	2.31E-02	5.78E-02
Tellurium	0.315	0.128	25	25	4.10E-07	1.07E-06	1.79E-06	4.48E-06

Parameters	Background	Road	Ore	Waste Rock	Background PM2.5	Background PM10	Annual PM2.5 Bitter Creek Down Stream of Tailings Management Facility	Annual PM10 Bitter Creek Down Stream of Tailings Management Facility
	mg/kg	mg/kg	mg/kg	mg/kg	ug/m3	ug/m3	ug/m3	ug/m3
Thallium	0.3	0.12	2.5	2.5	3.90E-07	1.02E-06	6.93E-07	1.73E-06
Thorium	1.675	10.4			2.18E-06	5.70E-06	3.51E-06	8.78E-06
Tin	0.58	0.3	10	10	7.54E-07	1.97E-06	1.59E-06	3.97E-06
Titanium	2312.5	1680	3000.0001	1650	3.01E-03	7.86E-03	4.56E-03	1.14E-02
Tungsten	4.025	1.7	10	10	5.23E-06	1.37E-05	8.18E-06	2.04E-05
Uranium	1.208	1.364	7.5	10	1.57E-06	4.11E-06	2.76E-06	6.89E-06
Vanadium	108.19	97.58	234	189	1.41E-04	3.68E-04	2.19E-04	5.47E-04
Yttrium			7.1	9	0.00E+00	0.00E+00	3.83E-07	9.56E-07
Zinc	143.67	97.6	2597	1633.6	1.87E-04	4.88E-04	3.77E-04	9.42E-04

**Table C10: Background and Predicted Soil Chemical Concentrations**

Parameter	Background	Road	Ore	Waste Rock	Bitter Creek Down Stream of TMF	Road Between Lower Portal and Plant site	Between Lower Portal and Bitter Creek	Background Plus Deposition Bitter Creek Down Stream of TMF	Background Plus Deposition Road Between lower portal and Plant site	Background Plus Deposition Between Lower Portal and Bitter Creek
	mg/kg	mg/kg	mg/kg	mg/kg	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)
Aluminum	29300	19900	85800	32800	1.58E+02	159.28	173.14	29458.09	29459.28	29473.14
Antimony	6.86	2.6	117	35	4.47E-02	4.01E-02	4.10E-02	6.905	6.900	6.901
Arsenic	69.52	27.6	793	788.4	4.56E-01	4.08E-01	4.18E-01	69.976	69.928	69.938
Barium	428.56	453.3	984	226.4	2.29E+00	2.36E+00	2.69E+00	430.853	430.923	431.253
Beryllium	0.6	0.57	1.38	1.5	3.28E-03	3.32E-03	3.73E-03	0.603	0.603	0.604
Bismuth	0.3275	0.546	19.2	10	3.56E-03	2.64E-03	2.88E-03	0.331	0.330	0.330
Boron	20	10	10.2	59	1.07E-01	1.07E-01	1.14E-01	20.107	20.107	20.114
Cadmium	1.097	0.82	22.78	26.4	8.77E-03	7.21E-03	7.53E-03	1.106	1.104	1.105
Calcium	19650	20460	17584	17440	1.04E+02	1.08E+02	1.23E+02	19753.795	19757.706	19772.695
Chromium	99.08	100.92	122	148.6	5.29E-01	5.45E-01	6.18E-01	99.609	99.625	99.698
Cobalt	22.27	18.5	26.6	29	1.18E-01	1.21E-01	1.34E-01	22.388	22.391	22.404
Copper	106.1	79.5	798.4	269.4	6.14E-01	5.96E-01	6.49E-01	106.714	106.696	106.749
Gallium	12.075	6.2			6.19E-02	6.37E-02	6.82E-02	12.137	12.139	12.143
Gold	0.0144	0.007			7.39E-05	7.60E-05	8.10E-05	0.014	0.015	0.015
Iron	58150	45100	112620	79840	3.11E+02	3.17E+02	3.49E+02	58461.491	58466.598	58498.628
Lanthanum	13.375	14.96	10	5	7.02E-02	7.34E-02	8.44E-02	13.445	13.448	13.459
Lead	39.97	27.292	183.6	118.4	2.25E-01	2.21E-01	2.39E-01	40.195	40.191	40.209
Magnesium	29700	14500	20800	26720	1.55E+02	1.58E+02	1.68E+02	29855.146	29857.788	29867.902
Manganese	916	1068.4	1275	1632.4	4.93E+00	5.09E+00	5.87E+00	920.929	921.090	921.869
Mercury	0.08	0.05	105	140.5	1.60E-02	7.15E-03	5.79E-03	0.096	0.087	0.086
Molybdenum	30.98	14.04	4	5	1.59E-01	1.63E-01	1.73E-01	31.139	31.143	31.153
Nickel	52.57	50.1	62.4	78	2.80E-01	2.88E-01	3.24E-01	52.850	52.858	52.894
Phosphorus	2335	1358	1830	1680	1.22E+01	1.25E+01	1.34E+01	2347.202	2347.464	2348.427
Potassium	1650	2400	39180	4440	1.14E+01	1.04E+01	1.19E+01	1661.357	1660.359	1661.910
Scandium	6.775	7.42			3.51E-02	3.69E-02	4.24E-02	6.810	6.812	6.817
Selenium	4.54	2.98	31.9	11.5	2.61E-02	2.53E-02	2.73E-02	4.566	4.565	4.567
Silver	1	0.869	28.8	2.94	7.17E-03	6.25E-03	6.71E-03	1.007	1.006	1.007
Sodium	612.5	832	6900	1194	3.70E+00	3.61E+00	4.18E+00	616.196	616.106	616.683
Strontium	96.85	71.9	134.8	151.2	5.16E-01	5.25E-01	5.76E-01	97.366	97.375	97.426

Parameter	Background	Road	Ore	Waste Rock	Bitter Creek Down Stream of TMF	Road Between Lower Portal and Plant site	Between Lower Portal and Bitter Creek	Background Plus Deposition Bitter Creek Down Stream of TMF	Background Plus Deposition Road Between lower portal and Plant site	Background Plus Deposition Between Lower Portal and Bitter Creek
	mg/kg	mg/kg	mg/kg	mg/kg	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)	(mg COPC/ kg-soil)
Sulfur	12075	5660			6.18E+01	6.36E+01	6.76E+01	12136.830	12138.553	12142.594
Tellurium	0.315	0.128	25	25	4.79E-03	3.02E-03	2.83E-03	0.320	0.318	0.318
Thallium	0.3	0.12	2.5	2.5	1.85E-03	1.71E-03	1.77E-03	0.3019	0.302	0.30177
Thorium	1.675	10.4			9.39E-03	1.17E-02	1.96E-02	1.684	1.687	1.695
Tin	0.58	0.3	10	10	4.24E-03	3.61E-03	3.71E-03	0.584	0.584	0.584
Titanium	2312.5	1680	3000	1650	1.22E+01	1.25E+01	1.37E+01	2324.687	2324.975	2326.178
Tungsten	4.025	1.7	10	10	2.19E-02	2.17E-02	2.28E-02	4.047	4.047	4.048
Uranium	1.208	1.364	7.5	10	7.36E-03	7.07E-03	7.99E-03	1.215	1.215	1.216
Vanadium	108.19	97.58	234	189	5.85E-01	5.95E-01	6.65E-01	108.775	108.785	108.855
Yttrium			7.1	9	1.02E-03	4.41E-04	3.50E-04	0.001	0.000	0.000
Zinc	143.67	97.6	2597	1633.6	1.01E+00	8.81E-01	9.28E-01	144.677	144.551	144.598

Attachment D - Update  
Detailed Country Food Concentration Calculations



Table D1. Exposure Media Concentrations Used to Estimate Tissue Concentrations in Country Foods – Baseline

<b>COPCs</b>	<b>Soil 90th Baseline  (mg/kg)</b>	<b>Surface Water (unfiltered) 90th Percentile Baseline  (mg/L)</b>	<b>Terrestrial Plants (Wet Weight)  (mg/kg)</b>	<b>Terrestrial Plants (Dry Weight)  (mg/kg)</b>	<b>Invertebrates   (mg/kg)</b>	<b>Fish   (mg/kg)</b>
Aluminum	29300	5.89E+00	21.362	61.84	2198	35.35
Antimony	6.86	2.05E-03	0.011	0.031	0.34	0.062
Arsenic	69.52	8.45E-03	0.150	0.44	0.46	0.7358
Barium	428.56	1.13E-01	13	40.21	3	1.68
Bismuth	0.33	8.36E-03	0.0033	0.010	0.33	0.02
Boron	20.00	9.19E-02	10.2933	32.89	20.00	0.10
Cadmium	1.10	4.83E-04	1.277	3.88	12.1	0.85
Chromium	19650.00	6.68E-03	0.109	0.32	3144.0	0.094
Cobalt	99.08	5.03E-03	0.251	0.74	990.8	0.29
Iron	58150.00	9.17E+00	65.437	192.29	581500	128.80
Lead	39.97	6.83E-03	0.053	0.15	838.3	0.11
Manganese	916.00	2.94E-01	93.064	276.11	18.3	5.04
Mercury	0.08	1.21E-05	0.0036	0.011	0.027	0.0087
Nickel	52.57	2.06E-02	1.71	4.93	10.5	0.21
Selenium	4.54	2.30E-03	0.50	1.57	3.5	2.91
Tellurium	0.32	-	-	-	-	-
Thallium	0.30	1.84E-04	0.00047	0.0014	0.30	0.023
Titanium	2312.50	9.82E-02	0.807	2.35	2313	1.04
Uranium	1.21	5.00E-04	0.00146	0.0027	0.3624	0.0064
Vanadium	108.19	1.35E-02	0.070	0.20	14	0.19
Zinc	143.67	5.81E-02	57.256	171.14	2586.1	37.77

Tissue concentrations are expressed in wet weight unless otherwise specified.

Table D2. Exposure Media Concentrations Used to Estimate Tissue Concentrations in Country Foods – Predicted Future

<b>COPCs</b>	<b>Soil 90th Percentile  (mg/kg)</b>	<b>Surface Water 90th Percentile Predicted  (mg/L)</b>	<b>Terrestrial Plants Total (Wet Weight)  (mg/kg)</b>	<b>Terrestrial Plants Total (Dry Weight)  (mg/kg)</b>	<b>Terrestrial Plants from Deposition (Dry Weight)  (mg/kg)</b>	<b>Terrestrial Plants from Root Uptake (Dry Weight)  (mg/kg)</b>	<b>Invertebrates  (mg/kg)</b>	<b>Fish  (mg/kg)</b>
Aluminum	29473.14	6.1486	20.416	62.487	6.08E-01	61.88	2210	13.94
Antimony	6.90	0.0057	0.011	0.03	1.83E-04	0.032	0.35	0.040
Arsenic	69.94	0.0098	0.127	0.39	1.82E-03	0.39	0.46	0.73
Barium	431.25	0.1187	13.920	43	9.62E-03	42.60	3.2	1.58
Bismuth	0.33	0.0084	0.003	0.01	1.36E-05	0.010	0.33	0.013
Boron	20.11	0.0957	10.751	32.91	2.16E-04	32.91	20.11	0.13
Cadmium	1.10	0.0013	1.1575	3.54	3.87E-05	3.54	12.1	0.70
Chromium	99.70	0.0076	0.109	0.33	2.23E-03	0.33	16.0	0.10
Cobalt	22.40	0.0064	0.240	0.73	4.71E-04	0.73	224.0	0.52
Iron	58498.63	9.6558	63.243	193.6	1.18E+00	192.40	584986	163.15
Lead	40.21	0.0078	0.050	0.15	9.19E-04	0.15	844.1	0.19
Manganese	921.87	0.5376	90.271	276.3	1.91E-02	276.29	18.4	18.75
Mercury	0.086	0.0001	0.004	0.011	6.19E-05	0.011	0.029	0.010
Nickel	52.89	0.0272	1.588	4.9	1.13E-03	4.86	10.6	0.26
Selenium	4.57	0.0033	0.532	1.63	1.04E-04	1.63	3.5	3.23
Strontium	97.43	0.2960	25.606	78	1.96E-03	78.38	57	7.35
Tellurium	0.32	NA	-	-	2.60E-05	-	0.32	
Thallium	0.30	0.000192	0.000	0.0015	7.53E-06	0.0015	0.30	0.02
Titanium	2326.18	0.1005	0.784	2.4	4.57E-02	2.35	2326	0.59
Uranium	1.22	0.0005	0.001	0.0027	2.77E-05	0.0026	0.365	0.006
Vanadium	108.85	0.0137	0.068	0.21	2.32E-03	0.20	14	0.08
Zinc	144.60	0.1131	56.013	171.45	5.71E-03	171.44	2602.8	88.73

Tissue concentrations are expressed in wet weight unless otherwise specified.

Table D3. Bioconcentration and Biotransfer Factors Used to Estimate Tissue Concentrations in Country Foods – Baseline

COPCs	Soil Concentrations (mg/kg)	Soil to Soil Invertebrate BCFs	Soil to Plant BCFs (Modelled from Baseline)	Soil to Rabbit BAFs	Soil to Moose BAFs	Soil to Grouse BAFs	Diet to Rabbit BAFs	Diet to Moose BAFs	Diet to Grouse BAFs
Aluminum	29300.00	7.50E-02	3.30E-03	3.87E-07	3.97E-05	2.24E-07	1.17E-04	1.20E-02	6.79E-05
Antimony	6.86	5.00E-02	1.02E-02	7.97E-07	8.17E-05	4.63E-07	7.80E-05	8.00E-03	4.53E-05
Arsenic	69.52	6.60E-03	4.56E-03	7.11E-07	7.30E-05	4.13E-07	1.56E-04	1.60E-02	9.06E-05
Barium	428.56	7.50E-03	2.11E-01	3.17E-05	3.17E-05	3.17E-05	1.50E-04	1.50E-04	1.50E-04
Bismuth	0.33	1.00E+00	7.69E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Boron	20.00	1.00E+00	1.64E+00	1.64E+00	5.15E-01	5.15E-01	1.00E+00	1.00E+00	1.00E+00
Cadmium	1.10	1.10E+01	3.61E+00	1.55E-04	1.59E-02	8.99E-05	4.29E-05	4.40E-03	2.49E-05
Chromium	19650.00	1.60E-01	6.77E-03	2.90E-06	2.98E-04	1.68E-06	4.29E-04	4.40E-02	2.49E-04
Cobalt	99.08	1.00E+01	5.15E-02	8.04E-05	8.24E-03	4.67E-05	1.56E-03	1.60E-01	9.06E-04
Iron	58150.00	1.00E+01	5.33E-03	8.31E-06	8.53E-04	4.83E-06	1.56E-03	1.60E-01	9.06E-04
Lead	39.97	2.10E+01	7.42E-03	2.32E-07	2.38E-05	1.34E-07	3.12E-05	3.20E-03	1.81E-05
Manganese	916.00	2.00E-02	4.57E-01	1.43E-05	1.46E-03	8.27E-06	3.12E-05	3.20E-03	1.81E-05
Mercury	0.08	3.40E-01	2.57E-01	5.02E-03	5.15E-01	2.91E-03	1.95E-02	2.00E+00	1.13E-02
Nickel	52.57	2.00E-01	1.46E-01	6.83E-05	7.00E-03	3.96E-05	4.68E-04	4.80E-02	2.72E-04
Selenium	4.54	7.60E-01	6.67E-01	7.81E-04	8.01E-02	4.53E-04	1.17E-03	1.20E-01	6.79E-04
Strontium	95.56	5.80E-01	1.75E+00	1.74E-04	1.74E-04	1.74E-04	3.00E-04	3.00E-04	3.00E-04
Tellurium	0.32	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Thallium	0.30	1.00E+00	1.13E-02	3.52E-05	3.61E-03	2.05E-05	3.12E-03	3.20E-01	1.81E-03
Titanium	2312.50	1.00E+00	2.17E-03	5.08E-06	5.21E-04	2.95E-06	2.34E-03	2.40E-01	1.36E-03
Uranium	1.21	3.00E-01	5.09E-03	7.93E-08	8.14E-06	4.61E-08	1.56E-05	1.60E-03	9.06E-06
Vanadium	108.19	1.30E-01	2.74E-03	5.34E-07	5.47E-05	3.10E-07	1.95E-04	2.00E-02	1.13E-04
Zinc	143.67	1.80E+01	1.46E+00	1.14E-02	1.17E+00	6.62E-03	7.80E-03	8.00E-01	4.53E-03

Note: BCF = 1, when no literature values for dietary biotransfer factors were available.

BAF for soil to receptor = (BAF soil to plant) x (BAF plant to mammal) (USEPA 2007)

BAF for diet to receptor = Biotransfer Factor (cattle) x Receptor Ingestion Rate (USEPA 1998, 1999, 2005, 2007)

USEPA. 1998. *Guidelines for Ecological Risk Assessment*. Federal Register 63(93):26846-26942.

USEPA. 1999. *Ecological Risk Assessment and Risk Management Principles for Superfund Sites*. OSWER Directive 9285.7-28.P.

USEPA 2005. *Guidance for Developing Ecological Soil Screening Levels*. OSWER Directive 9285.7-55.

USEPA. 2007. *Attachment 4-1 Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs*.

Table D4. Bioconcentration and Biotransfer Factors Used to Estimate Tissue Concentrations in Country Foods - Predicted Future

COPCs	Soil Concentrations (mg/kg)	Soil to Soil Invertebrate BCFs	Soil to Plant BCFs (dry) (Modelled from Baseline)	Soil to Rabbit BAFs	Soil to Moose BAFs	Soil to Grouse BAFs	Diet to Rabbit BAFs	Diet to Moose BAFs	Diet to Grouse BAFs
Aluminum	29473.14	7.50E-02	3.30E-03	3.87E-07	3.97E-05	2.24E-07	1.17E-04	1.20E-02	6.79E-05
Antimony	6.90	5.00E-02	1.02E-02	7.97E-07	8.17E-05	4.63E-07	7.80E-05	8.00E-03	4.53E-05
Arsenic	69.94	6.60E-03	4.56E-03	7.11E-07	7.30E-05	4.13E-07	1.56E-04	1.60E-02	9.06E-05
Barium	431.25	7.50E-03	2.11E-01	3.17E-05	3.17E-05	3.17E-05	1.50E-04	1.50E-04	1.50E-04
Bismuth	0.33	1.00E+00	7.69E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Boron	20.00	1.00E+00	1.64E+00	1.64E+00	1.64E+00	1.64E+00	1.00E+00	1.00E+00	1.00E+00
Cadmium	1.10	1.10E+01	3.61E+00	1.55E-04	1.59E-02	8.99E-05	4.29E-05	4.40E-03	2.49E-05
Chromium	99.70	1.60E-01	6.77E-03	2.90E-06	2.98E-04	1.68E-06	4.29E-04	4.40E-02	2.49E-04
Cobalt	22.40	1.00E+01	5.15E-02	8.04E-05	8.24E-03	4.67E-05	1.56E-03	1.60E-01	9.06E-04
Iron	58498.63	1.00E+01	5.33E-03	8.31E-06	8.53E-04	4.83E-06	1.56E-03	1.60E-01	9.06E-04
Lead	40.21	2.10E+01	7.42E-03	2.32E-07	2.38E-05	1.34E-07	3.12E-05	3.20E-03	1.81E-05
Manganese	921.87	2.00E-02	4.57E-01	1.43E-05	1.46E-03	8.27E-06	3.12E-05	3.20E-03	1.81E-05
Mercury	0.09	3.40E-01	2.57E-01	5.02E-03	5.15E-01	2.91E-03	1.95E-02	2.00E+00	1.13E-02
Nickel	52.89	2.00E-01	1.46E-01	6.83E-05	7.00E-03	3.96E-05	4.68E-04	4.80E-02	2.72E-04
Selenium	4.57	7.60E-01	6.67E-01	7.81E-04	8.01E-02	4.53E-04	1.17E-03	1.20E-01	6.79E-04
Strontium	97.43	5.80E-01	1.75E+00	5.25E-04	5.25E-04	5.25E-04	3.00E-04	3.00E-04	3.00E-04
Tellurium	0.32	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Thallium	0.30	1.00E+00	1.13E-02	3.52E-05	3.61E-03	2.05E-05	3.12E-03	3.20E-01	1.81E-03
Titanium	2326.18	1.00E+00	2.17E-03	5.08E-06	5.21E-04	2.95E-06	2.34E-03	2.40E-01	1.36E-03
Uranium	1.22	3.00E-01	5.09E-03	7.93E-08	8.14E-06	4.61E-08	1.56E-05	1.60E-03	9.06E-06
Vanadium	108.85	1.30E-01	2.74E-03	5.34E-07	5.47E-05	3.10E-07	1.95E-04	2.00E-02	1.13E-04
Zinc	144.60	1.80E+01	1.46E+00	1.14E-02	1.17E+00	6.62E-03	7.80E-03	8.00E-01	4.53E-03

Note: BCF = 1, when no literature values for dietary biotransfer factors were available.

BAF for soil to receptor = (BAF soil to plant) x (BAF plant to mammal) (USEPA 2007)

BAF for diet to receptor = Biotransfer Factor (cattle) x Receptor Ingestion Rate (USEPA 1998, 1999, 2005, 2007)

USEPA. 1998. *Guidelines for Ecological Risk Assessment*. Federal Register 63(93):26846-26942.

USEPA. 1999. *Ecological Risk Assessment and Risk Management Principles for Superfund Sites*. OSWER Directive 9285.7-28.P.

USEPA 2005. *Guidance for Developing Ecological Soil Screening Levels*. OSWER Directive 9285.7-55.

USEPA. 2007. *Attachment 4-1 Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs*

Table D5. Rabbit Receptor Characteristics Used for Estimating Tissue Concentrations

Receptor Characteristics <sup>a</sup>	Snowshoe Hare	
Body weight (kg)	1.3	b
Food consumption rate (kg/day)	0.078	c
Water consumption rate (L/day)	0.13	d
Home range (hectares)	1.6	
Dietary Composition	Percentages <sup>e</sup>	
Soil ingestion (direct)	6%	a
Grasses, forbs, berries	38%	d
Shrubs	56%	d

a = Receptor characteristics for snowshoe hare (*Lepus americanus*) are from EC (2012).

b = Value selected is average of male and female.

c = food consumption rate based on 0.06 kg dry food / kg wet BW / day.

d = Percentages for diet composition for snowshoe hare foraging in western Canada, Ontario, and Alaska.

e = Diet percentages were normalized to 100% to include 6.3% soil ingestion.

EC (Environment Canada). 2012. *Federal Contaminated Sites Action Plan (FCSAP), Ecological Risk Assessment Guidance, Module 3: Standardization of Wildlife Receptor Characteristics*.

Table D6. Moose Receptor Characteristics Used for Estimating Tissue Concentrations

Receptor Characteristics <sup>a</sup>	Moose	
Body weight (kg)	400	b
Food consumption rate (kg/day)	8.0	c
Water consumption rate (L/day)	20.0	d
Home range (hectares)	460	
Dietary Composition	Percentages <sup>g</sup>	
Soil ingestion (direct)	2%	e
Aquatic plants	20%	f
Ferns, shrubs, trees, other	78%	f

a = Receptor characteristics for moose (*Alces alces*) (EC 2012).

b = Value selected is average of male and female reported literature values for moose.

c = Food consumption rate based on 0.02 kg dry food / kg wet BW / day.

d = Water consumption rate based on 0.05 L / kg wet BW / day.

e = BCMELP recommended percentage of soil ingestion for wildlife (BCMELP 2000)

f = Percentages for diet were taken from literature (EC 2012) values for two free-ranging moose foraging at Ministik Wildlife Research Station located 48 km southeast of Edmonton. The observations were made during continuous 24-hour period every 6-8 weeks for one year. Concentrations of substances in aquatic vegetation was assumed to be equal to concentrations in terrestrial vegetation.

g = Diet percentages were normalized to 100% to include 2% soil ingestion.

EC (Environment Canada). 2012. *Federal Contaminated Sites Action Plan (FCSAP), Ecological Risk Assessment Guidance, Module 3: Standardization of Wildlife Receptor Characteristics*.

BCMELP (British Columbia Ministry of Environment, Lands, and Parks). 2000. *Tier I Ecological Risk Assessment Policy Decision Summary*.

Table D7. Grouse Receptor Characteristics Used for Estimating Tissue Concentrations

Receptor Characteristics <sup>a</sup>	Ruffed Grouse	
Body weight (kg)	0.680	b
Food consumption rate (kg/day)	0.0453	c
Water consumption rate (L/day)	0.0456	d
Home range (hectares)	12	e
Dietary Composition <sup>f</sup>	Percentages <sup>j</sup>	
Soil (direct ingestion)	2%	h
Insects	1.4%	g
Grasses & Forbs	39%	
Shrubs & Trees (seeds)	58%	

a = General receptor characteristics and dietary consumption for *Bonassa umbellus* are from Connecticut Department of Environmental Protection.

b = Value selected is average of males and females for BWs reported for adults.

c = Based on USEPA (1993) - Allometric Equation 3-3.

d = Based on USEPA (1993) - Allometric Equation 3-16.

e = Home range based on average of hectares/bird reported values.

f = Dietary information from Missouri Department of Conservation (2002)

g = For modeling purposes, EECs in insects were based on soil invertebrates.

h = Direct ingestion of 2% soil is based on BCMOE recommended level (BCMELP 2000).

j = Diet percentages were normalized to 100% to include 2% soil ingestion.

USEPA. 1993. *Wildlife Exposure Factors Handbook*. EPA/600/R-93/187.

Missouri Department of Conservation. 2002. Ruffed Grouse (*Bonassa umbellus*). Online Resource.

BCMELP (British Columbia Ministry of Environment, Lands, and Parks). 2000. *Tier I Ecological Risk Assessment Policy Decision Summary*.

Table D8. Calculation of Rabbit Tissue Concentrations by Dietary Source – Baseline

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Body Burden or Tissue (mg/kg)
Aluminum	Soil ingestion (direct)	6%	2.93E+04	7.14E-04
	Grasses, forbs, berries	38%	6.18E+01	2.72E-03
	Shrubs	56%	6.18E+01	4.08E-03
	Water ingestion (direct)	NA	5.89E+00	6.89E-04
	<b>Total</b>	<b>100%</b>		<b>8.21E-03</b>
Antimony	Soil ingestion (direct)	6%	6.86E+00	3.44E-07
	Grasses, forbs, berries	38%	3.09E-02	9.06E-07
	Shrubs	56%	3.09E-02	1.36E-06
	Water ingestion (direct)	NA	2.05E-03	1.60E-07
	<b>Total</b>	<b>100%</b>		<b>2.77E-06</b>
Arsenic	Soil ingestion (direct)	6%	6.95E+01	3.12E-06
	Grasses, forbs, berries	38%	4.35E-01	2.55E-05
	Shrubs	56%	4.35E-01	3.83E-05
	Water ingestion (direct)	NA	8.45E-03	1.32E-06
	<b>Total</b>	<b>100%</b>		<b>6.83E-05</b>
Barium	Soil ingestion (direct)	6%	4.29E+02	8.55E-04
	Grasses, forbs, berries	38%	4.02E+01	2.27E-03
	Shrubs	56%	4.02E+01	3.40E-03
	Water ingestion (direct)	NA	1.13E-01	1.69E-05
	<b>Total</b>	<b>100%</b>		<b>6.55E-03</b>
Bismuth	Soil ingestion (direct)	6%	3.28E-01	2.06E-02
	Grasses, forbs, berries	38%	1.00E-02	3.76E-03
	Shrubs	56%	1.00E-02	5.64E-03
	Water ingestion (direct)	NA	8.36E-03	8.36E-03
	<b>Total</b>	<b>100%</b>		<b>3.84E-02</b>
Boron	Soil ingestion (direct)	6%	2.00E+01	2.07E+00
	Grasses, forbs, berries	38%	3.29E+01	1.24E+01
	Shrubs	56%	3.29E+01	1.86E+01
	Water ingestion (direct)	NA	9.19E-02	9.19E-02
	<b>Total</b>			<b>3.31E+01</b>



Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Body Burden or Tissue (mg/kg)
Cadmium	Soil ingestion (direct)	6%	1.10E+00	1.07E-05
	Grasses, forbs, berries	38%	3.88E+00	6.27E-05
	Shrubs	56%	3.88E+00	9.40E-05
	Water ingestion (direct)	NA	4.83E-04	2.07E-08
	<b>Total</b>	<b>100%</b>		<b>1.67E-04</b>
Chromium	Soil ingestion (direct)	6%	1.97E+04	3.59E-03
	Grasses, forbs, berries	38%	3.21E-01	5.19E-05
	Shrubs	56%	3.21E-01	7.78E-05
	Water ingestion (direct)	NA	6.68E-03	2.87E-06
	<b>Total</b>	<b>100%</b>		<b>3.73E-03</b>
Cobalt	Soil ingestion (direct)	6%	9.91E+01	5.02E-04
	Grasses, forbs, berries	38%	7.38E-01	4.33E-04
	Shrubs	56%	7.38E-01	6.50E-04
	Water ingestion (direct)	NA	5.03E-03	7.85E-06
	<b>Total</b>	<b>100%</b>		<b>1.59E-03</b>
Iron	Soil ingestion (direct)	6%	5.82E+04	3.05E-02
	Grasses, forbs, berries	38%	1.92E+02	1.13E-01
	Shrubs	56%	1.92E+02	1.69E-01
	Water ingestion (direct)	NA	9.17E+00	1.43E-02
	<b>Total</b>	<b>100%</b>		<b>3.27E-01</b>
Lead	Soil ingestion (direct)	6%	4.00E+01	5.83E-07
	Grasses, forbs, berries	38%	1.55E-01	1.82E-06
	Shrubs	56%	1.55E-01	2.72E-06
	Water ingestion (direct)	NA	6.83E-03	2.13E-07
	<b>Total</b>	<b>100%</b>		<b>5.34E-06</b>
Manganese	Soil ingestion (direct)	6%	9.16E+02	8.22E-04
	Grasses, forbs, berries	38%	2.76E+02	3.24E-03
	Shrubs	56%	2.76E+02	4.86E-03
	Water ingestion (direct)	NA	2.94E-01	9.18E-06
	<b>Total</b>	<b>100%</b>		<b>8.94E-03</b>
Mercury	Soil ingestion (direct)	6%	8.00E-02	2.53E-05
	Grasses, forbs, berries	38%	1.11E-02	8.18E-05

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Body Burden or Tissue (mg/kg)
	Shrubs	56%	1.11E-02	1.23E-04
	Water ingestion (direct)	NA	1.21E-05	2.37E-07
	<b>Total</b>	<b>100%</b>		<b>2.30E-04</b>
Nickel	Soil ingestion (direct)	6%	5.26E+01	2.26E-04
	Grasses, forbs, berries	38%	4.93E+00	8.69E-04
	Shrubs	56%	4.93E+00	1.30E-03
	Water ingestion (direct)	NA	2.06E-02	9.63E-06
	<b>Total</b>	<b>100%</b>		<b>2.41E-03</b>
Selenium	Soil ingestion (direct)	6%	4.54E+00	2.23E-04
	Grasses, forbs, berries	38%	1.57E+00	6.91E-04
	Shrubs	56%	1.57E+00	1.04E-03
	Water ingestion (direct)	NA	2.30E-03	2.69E-06
	<b>Total</b>	<b>100%</b>		<b>1.95E-03</b>
Strontium	Soil ingestion (direct)	6%	9.56E+01	1.05E-03
	Grasses, forbs, berries	38%	7.83E+01	8.84E-03
	Shrubs	56%	7.83E+01	1.33E-02
	Water ingestion (direct)	Na	2.69E-01	8.07E-05
	<b>Total</b>	<b>100%</b>		<b>2.32E-02</b>
Tellurium	Soil ingestion (direct)	6%	3.15E-01	1.98E-02
	Grasses, forbs, berries	38%	-	-
	Shrubs	56%	-	-
	Water ingestion (direct)	NA	-	-
	<b>Total</b>	<b>100%</b>		<b>1.98E-02</b>
Thallium	Soil ingestion (direct)	6%	3.00E-01	6.66E-07
	Grasses, forbs, berries	38%	1.43E-03	1.68E-06
	Shrubs	56%	1.43E-03	2.52E-06
	Water ingestion (direct)	NA	1.84E-04	5.75E-07
	<b>Total</b>	<b>100%</b>		<b>5.43E-06</b>
Titanium	Soil ingestion (direct)	6%	2.31E+03	7.40E-04
	Grasses, forbs, berries	38%	2.35E+00	2.07E-03
	Shrubs	56%	2.35E+00	3.11E-03
	Water ingestion (direct)	NA	9.82E-02	2.30E-04

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Body Burden or Tissue (mg/kg)
	<b>Total</b>	<b>100%</b>		<b>6.15E-03</b>
Uranium	Soil ingestion (direct)	6%	1.21E+00	6.04E-09
	Grasses, forbs, berries	38%	2.71E-03	1.59E-08
	Shrubs	56%	2.71E-03	2.39E-08
	Water ingestion (direct)	NA	5.00E-04	7.80E-09
	<b>Total</b>	<b>100%</b>		<b>5.37E-08</b>
Vanadium	Soil ingestion (direct)	6%	1.08E+02	3.64E-06
	Grasses, forbs, berries	38%	2.01E-01	1.48E-05
	Shrubs	56%	2.01E-01	2.22E-05
	Water ingestion (direct)	NA	1.35E-02	2.62E-06
	<b>Total</b>	<b>100%</b>		<b>4.32E-05</b>
Zinc	Soil ingestion (direct)	6%	1.44E+02	1.03E-01
	Grasses, forbs, berries	38%	1.71E+02	5.02E-01
	Shrubs	56%	1.71E+02	7.53E-01
	Water ingestion (direct)	NA	5.81E-02	4.53E-04
	<b>Total</b>	<b>100%</b>		<b>1.36E+00</b>

Table D9. Calculation of Moose Tissue Concentrations by Dietary Source – Baseline

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mf/L)	Body Burden or Tissue (mg/kg)
Aluminum	Soil ingestion (direct)	2%	2.93E+04	2.32E-02
	Aquatic plants	20%	6.18E+01	1.46E-01
	Ferns, shrubs, trees, other	78%	6.18E+01	5.82E-01
	Water ingestion (direct)	NA	5.89E+00	7.07E-02
	<b>Total</b>	<b>100%</b>		<b>8.21E-01</b>
Antimony	Soil ingestion (direct)	2%	6.86E+00	1.12E-05
	Aquatic plants	20%	3.09E-02	4.84E-05
	Ferns, shrubs, trees, other	78%	3.09E-02	1.94E-04
	Water ingestion (direct)	NA	2.05E-03	1.64E-05
	<b>Total</b>	<b>100%</b>		<b>2.70E-04</b>
Arsenic	Soil ingestion (direct)	2%	6.95E+01	1.01E-04
	Aquatic plants	20%	4.35E-01	1.37E-03
	Ferns, shrubs, trees, other	78%	4.35E-01	5.46E-03
	Water ingestion (direct)	NA	8.45E-03	1.35E-04
	<b>Total</b>	<b>100%</b>		<b>9.16E-03</b>
Barium	Soil ingestion (direct)	2%	4.29E+02	2.71E-04
	Aquatic plants	20%	4.02E+01	1.18E-03
	Ferns, shrubs, trees, other	78%	4.02E+01	4.73E-03
	Water ingestion (direct)	NA	1.13E-01	1.69E-05
	<b>Total</b>	<b>100%</b>		<b>6.20E-03</b>
Bismuth	Soil ingestion (direct)	2%	3.28E-01	6.55E-03
	Aquatic plants	20%	1.00E-02	1.96E-03
	Ferns, shrubs, trees, other	78%	1.00E-02	7.84E-03
	Water ingestion (direct)	NA	8.36E-03	8.36E-03
	<b>Total</b>	<b>100%</b>		<b>2.47E-02</b>
Boron	Soil ingestion (direct)	2%	2.00E+01	2.06E-01
	Aquatic plants	20%	3.29E+01	6.45E+00
	Ferns, shrubs, trees, other	78%	3.29E+01	2.58E+01
	Water ingestion (direct)	NA	9.19E-02	9.19E-02
	<b>Total</b>			<b>3.26E+01</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mf/L)	Body Burden or Tissue (mg/kg)
Cadmium	Soil ingestion (direct)	2%	1.10E+00	3.48E-04
	Aquatic plants	20%	3.88E+00	3.35E-03
	Ferns, shrubs, trees, other	78%	3.88E+00	1.34E-02
	Water ingestion (direct)	NA	4.83E-04	2.12E-06
	<b>Total</b>	<b>100%</b>		<b>5.28E-01</b>
Chromium	Soil ingestion (direct)	2%	1.97E+04	1.17E-01
	Aquatic plants	20%	3.21E-01	2.77E-03
	Ferns, shrubs, trees, other	78%	3.21E-01	1.11E-02
	Water ingestion (direct)	NA	6.68E-03	2.94E-04
	<b>Total</b>	<b>100%</b>		<b>1.31E-01</b>
Cobalt	Soil ingestion (direct)	2%	9.91E+01	1.63E-02
	Aquatic plants	20%	7.38E-01	2.31E-02
	Ferns, shrubs, trees, other	78%	7.38E-01	9.26E-02
	Water ingestion (direct)	NA	5.03E-03	8.05E-04
	<b>Total</b>	<b>100%</b>		<b>1.33E-01</b>
Iron	Soil ingestion (direct)	2%	5.82E+04	9.92E-01
	Aquatic plants	20%	1.92E+02	6.03E+00
	Ferns, shrubs, trees, other	78%	1.92E+02	2.41E+01
	Water ingestion (direct)	NA	9.17E+00	1.47E+00
	<b>Total</b>	<b>100%</b>		<b>3.26E+01</b>
Lead	Soil ingestion (direct)	2%	4.00E+01	1.90E-05
	Aquatic plants	20%	1.55E-01	9.71E-05
	Ferns, shrubs, trees, other	78%	1.55E-01	3.88E-04
	Water ingestion (direct)	NA	6.83E-03	2.19E-05
	<b>Total</b>	<b>100%</b>		<b>5.57E-04</b>
Manganese	Soil ingestion (direct)	2%	9.16E+02	2.68E-02
	Aquatic plants	20%	2.76E+02	1.73E-01
	Ferns, shrubs, trees, other	78%	2.76E+02	6.93E-01
	Water ingestion (direct)	NA	2.94E-01	9.41E-04
	<b>Total</b>	<b>100%</b>		<b>8.94E-01</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mf/L)	Body Burden or Tissue (mg/kg)
Mercury	Soil ingestion (direct)	2%	8.00E-02	8.23E-04
	Aquatic plants	20%	1.11E-02	4.37E-03
	Ferns, shrubs, trees, other	78%	1.11E-02	1.75E-02
	Water ingestion (direct)	NA	1.21E-05	2.43E-05
	<b>Total</b>	<b>100%</b>		<b>2.68E-02</b>
Nickel	Soil ingestion (direct)	2%	5.26E+01	7.36E-03
	Aquatic plants	20%	4.93E+00	4.64E-02
	Ferns, shrubs, trees, other	78%	4.93E+00	1.86E-01
	Water ingestion (direct)	NA	2.06E-02	9.88E-04
	<b>Total</b>	<b>100%</b>		<b>2.41E-01</b>
Selenium	Soil ingestion (direct)	2%	4.54E+00	7.27E-03
	Aquatic plants	20%	1.57E+00	3.69E-02
	Ferns, shrubs, trees, other	78%	1.57E+00	1.48E-01
	Water ingestion (direct)	NA	2.30E-03	2.76E-04
	<b>Total</b>	<b>100%</b>		<b>2.32E-02</b>
Strontium	Soil ingestion (direct)	2%	9.56E+01	3.33E-04
	Aquatic plants	20%	7.83E+01	4.61E-03
	Ferns, shrubs, trees, other	78%	7.83E+01	1.84E-02
	Water ingestion (direct)	NA	2.69E-01	8.07E-05
	<b>Total</b>	<b>100%</b>		<b>2.35E-02</b>
Tellurium	Soil ingestion (direct)	2%	3.15E-01	6.30E-03
	Aquatic plants	20%	-	-
	Ferns, shrubs, trees, other	78%	-	-
	Water ingestion (direct)	NA	NA	-
	<b>Total</b>	<b>100%</b>		<b>6.30E-03</b>
Thallium	Soil ingestion (direct)	2%	3.00E-01	2.17E-05
	Aquatic plants	20%	1.43E-03	8.96E-05
	Ferns, shrubs, trees, other	78%	1.43E-03	3.59E-04
	Water ingestion (direct)	NA	1.84E-04	5.89E-05
	<b>Total</b>	<b>100%</b>		<b>5.29E-04</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mf/L)	Body Burden or Tissue (mg/kg)
Titanium	Soil ingestion (direct)	2%	2.31E+03	2.41E-02
	Aquatic plants	20%	2.35E+00	1.11E-01
	Ferns, shrubs, trees, other	78%	2.35E+00	4.43E-01
	Water ingestion (direct)	NA	9.82E-02	2.36E-02
	<b>Total</b>	<b>100%</b>		<b>6.01E-01</b>
Uranium	Soil ingestion (direct)	2%	1.21E+00	1.97E-07
	Aquatic plants	20%	2.71E-03	8.52E-07
	Ferns, shrubs, trees, other	78%	2.71E-03	3.41E-06
	Water ingestion (direct)	NA	5.00E-04	8.00E-07
	<b>Total</b>	<b>100%</b>		<b>5.25E-06</b>
Vanadium	Soil ingestion (direct)	2%	1.08E+02	1.18E-04
	Aquatic plants	20%	2.01E-01	7.90E-04
	Ferns, shrubs, trees, other	78%	2.01E-01	3.16E-03
	Water ingestion (direct)	NA	1.35E-02	2.69E-04
	<b>Total</b>	<b>100%</b>		<b>4.34E-03</b>
Zinc	Soil ingestion (direct)	2%	1.44E+02	3.36E+00
	Aquatic plants	20%	1.71E+02	2.68E+01
	Ferns, shrubs, trees, other	78%	1.71E+02	1.07E+02
	Water ingestion (direct)	NA	5.81E-02	4.65E-02
	<b>Total</b>	<b>100%</b>		<b>1.38E+02</b>

Table D10. Calculation of Grouse Tissue Concentrations by Dietary Source – Baseline

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Diet (mg/kg)
Aluminum	Soil (direct ingestion)	2%	2.93E+04	1.32E-04
	Insects	1%	2.20E+03	2.09E-03
	Grasses & Forbs	39%	6.18E+01	1.62E-03
	Shrubs & Trees (seeds)	58%	6.18E+01	2.43E-03
	Water ingestion (direct)	NA	2.05E-03	1.39E-07
	<b>Total</b>	<b>100%</b>		<b>6.28E-03</b>
Antimony	Soil (direct ingestion)	2%	6.86E+00	6.35E-08
	Insects	1%	3.43E-01	2.17E-07
	Grasses & Forbs	39%	3.09E-02	5.40E-07
	Shrubs & Trees (seeds)	58%	3.09E-02	8.10E-07
	Water ingestion (direct)	NA	2.05E-03	9.30E-08
	<b>Total</b>	<b>100%</b>		<b>1.72E-06</b>
Arsenic	Soil (direct ingestion)	2%	6.95E+01	5.74E-07
	Insects	1%	4.59E-01	5.82E-07
	Grasses & Forbs	39%	4.35E-01	1.52E-05
	Shrubs & Trees (seeds)	58%	4.35E-01	2.28E-05
	Water ingestion (direct)	NA	8.45E-03	7.65E-07
	<b>Total</b>	<b>100%</b>		<b>4.00E-05</b>
Barium	Soil (direct ingestion)	2%	4.29E+02	2.71E-04
	Insects	1%	3.21E+00	6.75E-06
	Grasses & Forbs	39%	4.02E+01	2.33E-03
	Shrubs & Trees (seeds)	58%	4.02E+01	3.50E-03
	Water ingestion (direct)	NA	1.13E-01	1.69E-05
	<b>Total</b>	<b>100%</b>		<b>6.12E-03</b>
Bismuth	Soil (direct ingestion)	2%	3.28E-01	6.55E-03
	Insects	1%	3.28E-01	4.59E-03
	Grasses & Forbs	39%	1.00E-02	3.86E-03
	Shrubs & Trees (seeds)	58%	1.00E-02	5.80E-03
	Water ingestion (direct)	NA	8.36E-03	8.36E-03
	<b>Total</b>	<b>100%</b>		<b>2.92E-02</b>



Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Diet (mg/kg)
Boron	Soil (direct ingestion)	2%	2.00E+01	2.06E-01
	Insects	1%	2.00E+01	2.80E-01
	Grasses & Forbs	39%	3.29E+01	1.27E+01
	Shrubs & Trees (seeds)	58%	3.29E+01	1.91E+01
	Water ingestion (direct)	NA	9.19E-02	9.19E-02
	<b>Total</b>			<b>3.24E+01</b>
Cadmium	Soil (direct ingestion)	2%	1.10E+00	1.97E-06
	Insects	1%	1.21E+01	4.21E-06
	Grasses & Forbs	39%	3.88E+00	3.73E-05
	Shrubs & Trees (seeds)	58%	3.88E+00	5.60E-05
	Water ingestion (direct)	NA	4.83E-04	1.20E-08
	<b>Total</b>		<b>100%</b>	<b>9.96E-05</b>
Chromium	Soil (direct ingestion)	2%	1.97E+04	6.62E-04
	Insects	1%	3.14E+03	1.10E-02
	Grasses & Forbs	39%	3.21E-01	3.09E-05
	Shrubs & Trees (seeds)	58%	3.21E-01	4.64E-05
	Water ingestion (direct)	NA	6.68E-03	1.66E-06
	<b>Total</b>		<b>100%</b>	<b>1.17E-02</b>
Cobalt	Soil (direct ingestion)	2%	9.91E+01	9.25E-05
	Insects	1%	9.91E+02	1.26E-02
	Grasses & Forbs	39%	7.38E-01	2.58E-04
	Shrubs & Trees (seeds)	58%	7.38E-01	3.87E-04
	Water ingestion (direct)	NA	5.03E-03	4.55E-06
	<b>Total</b>		<b>100%</b>	<b>1.33E-02</b>
Iron	Soil (direct ingestion)	2%	5.82E+04	5.61E-03
	Insects	1%	5.82E+05	7.37E+00
	Grasses & Forbs	39%	1.92E+02	6.73E-02
	Shrubs & Trees (seeds)	58%	1.92E+02	1.01E-01
	Water ingestion (direct)	NA	9.17E+00	8.30E-03
	<b>Total</b>		<b>100%</b>	<b>7.55E+00</b>
Lead	Soil (direct ingestion)	2%	4.00E+01	1.07E-07
	Insects	1%	8.38E+02	2.13E-04

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Diet (mg/kg)
	Grasses & Forbs	39%	1.55E-01	1.08E-06
	Shrubs & Trees (seeds)	58%	1.55E-01	1.62E-06
	Water ingestion (direct)	NA	6.83E-03	1.24E-07
	<b>Total</b>	<b>100%</b>		<b>2.16E-04</b>
Manganese	Soil (direct ingestion)	2%	9.16E+02	1.52E-04
	Insects	1%	1.83E+01	4.65E-06
	Grasses & Forbs	39%	2.76E+02	1.93E-03
	Shrubs & Trees (seeds)	58%	2.76E+02	2.90E-03
	Water ingestion (direct)	NA	2.94E-01	5.33E-06
	<b>Total</b>	<b>100%</b>		<b>4.99E-03</b>
Mercury	Soil (direct ingestion)	2%	8.00E-02	4.66E-06
	Insects	1%	2.72E-02	4.31E-06
	Grasses & Forbs	39%	1.11E-02	4.87E-05
	Shrubs & Trees (seeds)	58%	1.11E-02	7.31E-05
	Water ingestion (direct)	NA	1.21E-05	1.38E-07
	<b>Total</b>	<b>100%</b>		<b>1.31E-04</b>
Nickel	Soil (direct ingestion)	2%	5.26E+01	4.17E-05
	Insects	1%	1.05E+01	4.00E-05
	Grasses & Forbs	39%	4.93E+00	5.18E-04
	Shrubs & Trees (seeds)	58%	4.93E+00	7.77E-04
	Water ingestion (direct)	NA	2.06E-02	5.59E-06
	<b>Total</b>	<b>100%</b>		<b>1.38E-03</b>
Selenium	Soil (direct ingestion)	2%	4.54E+00	4.12E-05
	Insects	1%	3.45E+00	3.28E-05
	Grasses & Forbs	39%	1.57E+00	4.12E-04
	Shrubs & Trees (seeds)	58%	1.57E+00	6.18E-04
	Water ingestion (direct)	NA	2.30E-03	1.56E-06
	<b>Total</b>	<b>100%</b>		<b>1.11E-03</b>
Strontium	Soil (direct ingestion)	2%	9.56E+01	3.33E-04
	Insects	1%	5.54E+01	2.33E-04
	Grasses & Forbs	39%	7.83E+01	9.08E-03
	Shrubs & Trees (seeds)	58%	7.83E+01	1.36E-02

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Diet (mg/kg)
	Water ingestion (direct)	NA	2.69E-01	8.07E-05
	<b>Total</b>	<b>100%</b>		<b>2.33E-02</b>
Tellurium	Soil (direct ingestion)	2%	3.15E-01	6.30E-03
	Insects	1%	-	#VALUE!
	Grasses & Forbs	39%	-	-
	Shrubs & Trees (seeds)	58%	-	-
	Water ingestion (direct)	NA	-	-
	<b>Total</b>	<b>100%</b>		<b>#VALUE!</b>
Thallium	Soil (direct ingestion)	2%	3.00E-01	1.23E-07
	Insects	1%	3.00E-01	7.61E-06
	Grasses & Forbs	39%	1.43E-03	1.00E-06
	Shrubs & Trees (seeds)	58%	1.43E-03	1.50E-06
	Water ingestion (direct)	NA	1.84E-04	3.34E-07
	<b>Total</b>	<b>100%</b>		<b>1.06E-05</b>
Titanium	Soil (direct ingestion)	2%	2.31E+03	1.36E-04
	Insects	1%	2.31E+03	4.40E-02
	Grasses & Forbs	39%	2.35E+00	1.23E-03
	Shrubs & Trees (seeds)	58%	2.35E+00	1.85E-03
	Water ingestion (direct)	NA	9.82E-02	1.33E-04
	<b>Total</b>	<b>100%</b>		<b>4.73E-02</b>
Uranium	Soil (direct ingestion)	2%	1.21E+00	1.11E-09
	Insects	1%	3.62E-01	4.59E-08
	Grasses & Forbs	39%	2.71E-03	9.50E-09
	Shrubs & Trees (seeds)	58%	2.71E-03	1.42E-08
	Water ingestion (direct)	NA	5.00E-04	4.53E-09
	<b>Total</b>	<b>100%</b>		<b>7.53E-08</b>
Vanadium	Soil (direct ingestion)	2%	1.08E+02	6.70E-07
	Insects	1%	1.41E+01	2.23E-05
	Grasses & Forbs	39%	2.01E-01	8.81E-06
	Shrubs & Trees (seeds)	58%	2.01E-01	1.32E-05
	Water ingestion (direct)	NA	1.35E-02	1.52E-06
	<b>Total</b>	<b>100%</b>		<b>4.65E-05</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg or mg/L)	Diet (mg/kg)
Zinc	Soil (direct ingestion)	2%	1.44E+02	1.90E-02
	Insects	1%	2.59E+03	1.64E-01
	Grasses & Forbs	39%	1.71E+02	2.99E-01
	Shrubs & Trees (seeds)	58%	1.71E+02	4.49E-01
	Water ingestion (direct)	NA	5.81E-02	2.63E-04
	<b>Total</b>		<b>100%</b>	

Table D11. Arsenic, Cadmium, Mercury Moose Tissue Exposure Concentrations that Reflect Higher Uptake by the Kidney and Liver

Parameter	Total Country foods	Moose Kidney	Moose Liver	Moose Muscle (meat)	Modelled Concentration Baseline	Modelled Concentration Predicted	Total Moose	Weighted Concentration
Ingestion Rate (95 percentile) g/person/day	413.22	6.1	5.13	138.61	–	–	–	–
Ingestion Rate normalized to 290 g/person/day	290	4.281	3.600	97.277	–	–	105.159	–
Arsenic (ug/g)	–	0.03	0.04	0.004	0.007	0.0064		
Arsenic Organ: Muscle Ratio	–	7.5	10	1	–	–	–	–
Arsenic Mass (ug)	–	0.1284	0.1440	0.3891	–	–	0.6615	0.0063
Cadmium (mg/kg)	–	11.85	3.51	0.02	0.017	0.0156	–	–
Cadmium Organ: Muscle	–	592.5	175.5	1	–	–	–	–
Weighted Cadmium (mg/kg)	–	50.730	12.637	1.946	–	–	–	0.6211
Lead (mg/kg)	–	0.17	0.02	0.06	0.00053	0.00052	65.313	–
Adjusted Lead (mg/kg)	–	0.00150	0.00018	0.00053	–	–	–	–
Lead Organ: Muscle Ratio	–	2.833	0.3333	1	–	–	–	–
Weighted Lead (mg/kg)	–	0.0064	0.0006	0.0516	–	–	–	0.0006
Mercury (mg/kg)	–	0.01	0.003	0.002	0.023	0.025	0.0586	–
Adjusted Mercury (mg/kg)	–	0.115	0.0345	0.023	–	–	–	–
Mercury Organ: Muscle Ratio	–	5	1.5	1	–	–	–	–
Weighted Mercury (mg/kg)	–	0.4923	0.1242	2.2374	–	–	–	0.0271

Information taken from Chan et. al. (2011) and modelled and measured plant concentrations.

Chan, L., O. Receveur, D. Sharp, H. Schwartz, A. Ing, and C. Tikhonov. 2011. First Nations Food, Nutrition & Environment Study (FNFNES): Results from British Columbia (2008/2009). University of Northern British Columbia: Prince George, BC.

Table D12. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Plants – Baseline

Parameter	Plant EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	2.14E+01	1.00E+00	1.2E-01	8.7E-02	6.7E-02	8.8E-02
Antimony	1.10E-02	6.00E-03	1.0E-02	7.5E-03	5.8E-03	7.5E-03
Arsenic	4.35E-02	1.00E-03	2.4E-01	1.8E-01	1.4E-01	1.8E-01
Barium	1.27E+01	2.00E-01	3.5E-01	2.6E-01	2.0E-01	2.6E-01
Bismuth	3.27E-03	NA	-	-	-	-
Boron	1.03E+01	2.00E-01	2.9E-01	2.1E-01	1.6E-01	2.1E-01
Cadmium	1.277E+00	1.00E-03	7.1E+00	5.2E+00	4.0E+00	5.2E+00
Chromium	1.09E-01	3.00E-03	2.0E-01	1.5E-01	1.1E-01	1.5E-01
Cobalt	2.51E-01	1.40E-03	9.9E-01	7.3E-01	5.7E-01	7.4E-01
Iron	6.54E+01	7.00E-01	5.2E-01	3.8E-01	2.9E-01	3.8E-01
Lead	5.31E-02	1.50E-03	4.9E-01	3.6E-01	1.1E-01	1.5E-01
Manganese	9.31E+01	1.56E-01	3.3E+00	2.4E+00	1.9E+00	2.4E+00
Mercury	3.61E-03	3.00E-04	6.7E-02	4.9E-02	3.8E-02	4.9E-02
Nickel	1.71E+00	1.10E-02	8.6E-01	6.3E-01	4.9E-01	6.4E-01
Selenium	4.97E-01	5.50E-03	5.0E-01	3.7E-01	2.8E-01	3.7E-01
Strontium	2.69E-01	6.00E-01	2.5E-03	1.8E-03	1.4E-03	1.8E-03
Tellurium	-	NA	-	-	-	-
Thallium	4.70E-04	7.0E-05	3.7E-02	2.7E-02	2.1E-02	2.8E-02
Titanium	8.07E-01	3.00E+00	1.5E-03	1.1E-03	8.5E-04	1.1E-03
Uranium	1.46E-03	6.00E-04	1.4E-02	1.0E-02	7.7E-03	1.0E-02
Vanadium	6.97E-02	5.00E-03	7.7E-02	5.7E-02	4.4E-02	5.7E-02
Zinc	5.73E+01	5.00E-01	6.3E-01	4.7E-01	3.6E-01	4.7E-01
<b>Max Hazard</b>			<b>7.1E+00</b>	<b>5.2E+00</b>	<b>4.0E+00</b>	<b>5.2E+00</b>

Parameter	Plant EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	4.35E-02	1.80E+00	1E-04	8E-05	5E-05	9E-05

Table D13. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Fish – Baseline

Parameter	Fish EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	3.54E+01	1.00E+00	2.0E-01	1.4E-01	1.1E-01	1.5E-01
Antimony	6.17E-02	6.00E-03	5.7E-02	4.2E-02	3.2E-02	4.2E-02
Arsenic	3.68E-02	1.00E-03	2.0E-01	1.5E-01	1.2E-01	1.5E-01
Barium	1.68E+00	2.00E-01	4.7E-02	3.4E-02	2.7E-02	3.5E-02
Bismuth	2.00E-02	NA	-	-	-	-
Boron	1.00E-01	2.00E-01	2.8E-03	2.0E-03	1.6E-03	2.1E-03
Cadmium	8.48E-01	1.00E-03	4.7E+00	3.5E+00	2.7E+00	3.5E+00
Chromium	9.40E-02	3.00E-03	1.7E-01	1.3E-01	9.9E-02	1.3E-01
Cobalt	2.86E-01	1.40E-03	1.1E+00	8.3E-01	6.4E-01	8.4E-01
Iron	1.29E+02	7.00E-01	1.0E+00	7.5E-01	5.8E-01	7.6E-01
Lead	1.06E-01	1.50E-03	9.8E-01	7.2E-01	2.2E-01	2.9E-01
Manganese	5.04E+00	1.56E-01	1.8E-01	1.3E-01	1.0E-01	1.3E-01
Mercury (Methyl)	8.70E-03	4.70E-04	2.4E-01	1.8E-01	5.8E-02	7.6E-02
Nickel	2.14E-01	1.10E-02	1.1E-01	7.9E-02	6.1E-02	8.0E-02
Selenium	2.91E+00	5.50E-03	2.9E+00	2.2E+00	1.7E+00	2.2E+00
Strontium	8.00E+00	6.00E-01	7.4E-02	5.4E-02	4.2E-02	5.5E-02
Tellurium	-	NA	-	-	-	-
Thallium	2.34E-02	7.0E-05	1.9E+00	1.4E+00	1.1E+00	1.4E+00
Titanium	1.04E+00	3.00E+00	1.9E-03	1.4E-03	1.1E-03	1.4E-03
Uranium	6.40E-03	6.00E-04	5.9E-02	4.4E-02	3.4E-02	4.4E-02
Vanadium	1.94E-01	5.00E-03	2.1E-01	1.6E-01	1.2E-01	1.6E-01
Zinc	3.78E+01	5.00E-01	4.2E-01	3.1E-01	2.4E-01	3.1E-01
<b>Max Hazard</b>			<b>4.7E+00</b>	<b>3.5E+00</b>	<b>2.7E+00</b>	<b>3.5E+00</b>

Parameter	Fish EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	3.68E-02	1.80E+00	1.03E-04	7E-05	4E-05	7E-05

Table D14. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Rabbit – Baseline

Parameter	Snowshoe Hare EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	8.21E-03	1.00E+00	4.5E-05	3.4E-05	2.6E-05	3.4E-05
Antimony	2.77E-06	6.00E-03	2.6E-06	1.9E-06	1.5E-06	1.9E-06
Arsenic	6.83E-05	1.00E-03	3.8E-04	2.8E-04	2.2E-04	2.8E-04
Barium	8.55E-04	2.00E-01	2.4E-05	1.7E-05	1.3E-05	1.8E-05
Bismuth	3.84E-02	NA	-	-	-	-
Boron	3.31E+01	2.00E-01	9.2E-01	6.8E-01	5.2E-01	6.8E-01
Cadmium	1.67E-04	1.00E-03	9.3E-04	6.8E-04	5.3E-04	6.9E-04
Chromium	3.73E-03	3.00E-03	6.9E-03	5.1E-03	3.9E-03	5.1E-03
Cobalt	1.59E-03	1.40E-03	6.3E-03	4.6E-03	3.6E-03	4.7E-03
Iron	3.27E-01	7.00E-01	2.6E-03	1.9E-03	1.5E-03	1.9E-03
Lead	5.34E-06	1.50E-03	4.9E-05	3.6E-05	1.1E-05	1.5E-05
Manganese	8.94E-03	1.56E-01	3.2E-04	2.3E-04	1.8E-04	2.4E-04
Mercury	2.30E-04	3.00E-04	4.2E-03	3.1E-03	2.4E-03	3.1E-03
Nickel	2.26E-04	1.10E-02	1.1E-04	8.4E-05	6.5E-05	8.4E-05
Selenium	1.95E-03	5.50E-03	2.0E-03	1.5E-03	1.1E-03	1.5E-03
Strontium	2.32E-02	6.00E-01	2.1E-04	1.6E-04	1.2E-04	1.6E-04
Tellurium	1.98E-02	NA	-	-	-	-
Thallium	5.43E-06	7.0E-05	4.3E-04	3.2E-04	2.4E-04	3.2E-04
Titanium	6.15E-03	3.00E+00	1.1E-05	8.4E-06	6.5E-06	8.4E-06
Uranium	5.37E-08	6.00E-04	5.0E-07	3.7E-07	2.8E-07	3.7E-07
Vanadium	4.32E-05	5.00E-03	4.8E-05	3.5E-05	2.7E-05	3.5E-05
Zinc	1.36E+00	5.00E-01	1.5E-02	1.1E-02	8.6E-03	1.1E-02
<b>Max Hazard</b>			<b>9.2E-01</b>	<b>6.8E-01</b>	<b>5.2E-01</b>	<b>6.8E-01</b>

Parameter	Snowshoe Hare EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	6.83E-05	1.80E+00	2E-07	1E-07	8E-08	1E-07



Table D15. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Moose – Baseline

Parameter	Moose EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	8.21E-01	1.00E+00	4.6E-03	3.4E-03	2.6E-03	3.4E-03
Antimony	2.70E-04	6.00E-03	2.5E-04	1.8E-04	1.4E-04	1.8E-04
Arsenic	9.16E-03	1.00E-03	5.1E-02	3.7E-02	2.9E-02	3.8E-02
Barium	2.71E-04	2.00E-01	7.5E-06	5.5E-06	4.3E-06	5.6E-06
Bismuth	2.47E-02	NA	-	-	-	-
Boron	3.26E+01	2.00E-01	9.0E-01	6.7E-01	5.1E-01	6.7E-01
Cadmium	5.28E-01	1.00E-03	2.9E+00	2.2E+00	1.7E+00	2.2E+00
Chromium	1.31E-01	3.00E-03	2.4E-01	1.8E-01	1.4E-01	1.8E-01
Cobalt	1.33E-01	1.40E-03	5.3E-01	3.9E-01	3.0E-01	3.9E-01
Iron	3.26E+01	7.00E-01	2.6E-01	1.9E-01	1.5E-01	1.9E-01
Lead	5.57E-04	1.50E-03	5.1E-03	3.8E-03	1.2E-03	1.5E-03
Manganese	8.94E-01	1.56E-01	3.2E-02	2.3E-02	1.8E-02	2.4E-02
Mercury	2.68E-02	3.00E-04	4.9E-01	3.6E-01	2.8E-01	3.7E-01
Nickel	7.36E-03	1.10E-02	3.7E-03	2.7E-03	2.1E-03	2.7E-03
Selenium	2.32E-02	5.50E-03	2.3E-02	1.7E-02	1.3E-02	1.7E-02
Strontium	2.35E-02	6.00E-01	2.2E-04	1.6E-04	1.2E-04	1.6E-04
Tellurium	6.30E-03	NA	-	-	-	-
Thallium	5.29E-04	7.0E-05	4.2E-02	3.1E-02	2.4E-02	3.1E-02
Titanium	6.01E-01	3.00E+00	1.1E-03	8.2E-04	6.3E-04	8.2E-04
Uranium	5.25E-06	6.00E-04	4.9E-05	3.6E-05	2.8E-05	3.6E-05
Vanadium	4.34E-03	5.00E-03	4.8E-03	3.5E-03	2.7E-03	3.6E-03
Zinc	1.38E+02	5.00E-01	1.5E+00	1.1E+00	8.7E-01	1.1E+00
<b>Max Hazard</b>			<b>2.9E+00</b>	<b>2.2E+00</b>	<b>1.7E+00</b>	<b>2.2E+00</b>

Parameter	Moose EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	9.16E-03	1.80E+00	3E-05	2E-05	1E-05	2E-05

Table D16. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Grouse – Baseline

Parameter	Grouse EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	6.28E-03	1.00E+00	3.5E-05	2.6E-05	2.0E-05	2.6E-05
Antimony	1.72E-06	6.00E-03	1.6E-06	1.2E-06	9.1E-07	1.2E-06
Arsenic	4.00E-05	1.00E-03	2.2E-04	1.6E-04	1.3E-04	1.6E-04
Barium	2.71E-04	2.00E-01	7.5E-06	5.5E-06	4.3E-06	5.6E-06
Bismuth	2.92E-02	NA	-	-	-	-
Boron	3.24E+01	2.00E-01	9.0E-01	6.6E-01	5.1E-01	6.6E-01
Cadmium	9.96E-05	1.00E-03	5.5E-04	4.1E-04	3.1E-04	4.1E-04
Chromium	1.17E-02	3.00E-03	2.2E-02	1.6E-02	1.2E-02	1.6E-02
Cobalt	1.33E-02	1.40E-03	5.3E-02	3.9E-02	3.0E-02	3.9E-02
Iron	7.55E+00	7.00E-01	6.0E-02	4.4E-02	3.4E-02	4.4E-02
Lead	2.16E-04	1.50E-03	2.0E-03	1.5E-03	4.5E-04	5.9E-04
Manganese	4.99E-03	1.56E-01	1.8E-04	1.3E-04	1.0E-04	1.3E-04
Mercury	1.31E-04	3.00E-04	2.4E-03	1.8E-03	1.4E-03	1.8E-03
Nickel	4.17E-05	1.10E-02	2.1E-05	1.5E-05	1.2E-05	1.6E-05
Selenium	1.11E-03	5.50E-03	1.1E-03	8.2E-04	6.3E-04	8.3E-04
Strontium	2.33E-02	6.00E-01	2.2E-04	1.6E-04	1.2E-04	1.6E-04
Tellurium	6.30E-03	NA	-	-	-	-
Thallium	1.06E-05	7.0E-05	8.4E-04	6.2E-04	4.8E-04	6.2E-04
Titanium	4.73E-02	3.00E+00	8.7E-05	6.4E-05	5.0E-05	6.5E-05
Uranium	7.53E-08	6.00E-04	7.0E-07	5.1E-07	4.0E-07	5.2E-07
Vanadium	4.65E-05	5.00E-03	5.2E-05	3.8E-05	2.9E-05	3.8E-05
Zinc	9.32E-01	5.00E-01	1.0E-02	7.6E-03	5.9E-03	7.7E-03
<b>Max Hazard</b>			<b>9.0E-01</b>	<b>6.6E-01</b>	<b>5.1E-01</b>	<b>6.6E-01</b>

Parameter	Grouse EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	4.00E-05	1.80E+00	1E-07	8E-08	5E-08	8E-08

Table D17. Calculation of Rabbit Tissue Concentrations by Dietary Source – Predicted Future

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg Soil) or (mg/L Water)	Body Burden or Tissue (mg/kg)
Aluminum	Soil ingestion (direct)	6%	2.95E+04	7.18E-04
	Grasses, forbs, berries	38%	6.25E+01	2.75E-03
	Shrubs	56%	6.25E+01	4.13E-03
	Water ingestion (direct)	NA	6.15E+00	7.19E-04
	<b>Total</b>	<b>100%</b>		<b>8.32E-03</b>
Antimony	Soil ingestion (direct)	6%	6.90E+00	3.46E-07
	Grasses, forbs, berries	38%	3.24E-02	9.50E-07
	Shrubs	56%	3.24E-02	1.43E-06
	Water ingestion (direct)	NA	5.74E-03	4.48E-07
	<b>Total</b>	<b>100%</b>		<b>3.17E-06</b>
Arsenic	Soil ingestion (direct)	6%	6.99E+01	3.13E-06
	Grasses, forbs, berries	38%	3.89E-01	2.28E-05
	Shrubs	56%	3.89E-01	3.42E-05
	Water ingestion (direct)	NA	9.79E-03	1.53E-06
	<b>Total</b>	<b>100%</b>		<b>6.17E-05</b>
Barium	Soil ingestion (direct)	6%	4.31E+02	8.60E-04
	Grasses, forbs, berries	38%	4.26E+01	2.41E-03
	Shrubs	56%	4.26E+01	3.61E-03
	Water ingestion (direct)	NA	1.19E-01	1.78E-05
	<b>Total</b>	<b>100%</b>		<b>6.89E-03</b>
Bismuth	Soil ingestion (direct)	6%	3.30E-01	2.08E-02
	Grasses, forbs, berries	38%	1.00E-02	3.77E-03
	Shrubs	56%	1.00E-02	5.66E-03
	Water ingestion (direct)	NA	8.44E-03	8.44E-03
	<b>Total</b>	<b>100%</b>		<b>3.87E-02</b>
Boron	Soil ingestion (direct)	6%	2.01E+01	2.08E+00
	Grasses, forbs, berries	38%	3.29E+01	1.24E+01
	Shrubs	56%	3.29E+01	1.86E+01
	Water ingestion (direct)	NA	9.57E-02	9.57E-02
	<b>Total</b>	<b>100%</b>		<b>3.31E+01</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg Soil) or (mg/L Water)	Body Burden or Tissue (mg/kg)
Cadmium	Soil ingestion (direct)	6%	1.10E+00	1.08E-05
	Grasses, forbs, berries	38%	3.54E+00	5.72E-05
	Shrubs	56%	3.54E+00	8.58E-05
	Water ingestion (direct)	NA	1.33E-03	5.72E-08
	<b>Total</b>	<b>100%</b>		<b>1.54E-04</b>
Chromium	Soil ingestion (direct)	6%	9.97E+01	1.82E-05
	Grasses, forbs, berries	38%	3.33E-01	5.38E-05
	Shrubs	56%	3.33E-01	8.07E-05
	Water ingestion (direct)	NA	7.62E-03	3.27E-06
	<b>Total</b>	<b>100%</b>		<b>1.56E-04</b>
Cobalt	Soil ingestion (direct)	6%	2.24E+01	1.13E-04
	Grasses, forbs, berries	38%	7.35E-01	4.31E-04
	Shrubs	56%	7.35E-01	6.47E-04
	Water ingestion (direct)	NA	6.44E-03	1.00E-05
	<b>Total</b>	<b>100%</b>		<b>1.20E-03</b>
Iron	Soil ingestion (direct)	6%	5.85E+04	3.06E-02
	Grasses, forbs, berries	38%	1.94E+02	1.14E-01
	Shrubs	56%	1.94E+02	1.70E-01
	Water ingestion (direct)	NA	9.66E+00	1.51E-02
	<b>Total</b>	<b>100%</b>		<b>3.30E-01</b>
Lead	Soil ingestion (direct)	6%	4.02E+01	5.87E-07
	Grasses, forbs, berries	38%	1.52E-01	1.79E-06
	Shrubs	56%	1.52E-01	2.68E-06
	Water ingestion (direct)	NA	7.78E-03	2.43E-07
	<b>Total</b>	<b>100%</b>		<b>5.30E-06</b>
Manganese	Soil ingestion (direct)	6%	9.22E+02	8.28E-04
	Grasses, forbs, berries	38%	2.76E+02	3.24E-03
	Shrubs	56%	2.76E+02	4.87E-03
	Water ingestion (direct)	NA	5.38E-01	1.68E-05
	<b>Total</b>	<b>100%</b>		<b>8.95E-03</b>
Mercury	Soil ingestion (direct)	6%	8.58E-02	2.71E-05
	Grasses, forbs, berries	38%	1.10E-02	8.05E-05

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg Soil) or (mg/L Water)	Body Burden or Tissue (mg/kg)
	Shrubs	56%	1.10E-02	1.21E-04
	Water ingestion (direct)	NA	6.91E-05	1.35E-06
	<b>Total</b>	<b>100%</b>		<b>2.30E-04</b>
Nickel	Soil ingestion (direct)	6%	5.29E+01	2.27E-04
	Grasses, forbs, berries	38%	4.86E+00	8.56E-04
	Shrubs	56%	4.86E+00	1.28E-03
	Water ingestion (direct)	NA	2.72E-02	1.27E-05
	<b>Total</b>	<b>100%</b>		<b>2.38E-03</b>
Selenium	Soil ingestion (direct)	6%	4.57E+00	2.25E-04
	Grasses, forbs, berries	38%	1.63E+00	7.17E-04
	Shrubs	56%	1.63E+00	1.07E-03
	Water ingestion (direct)	NA	3.26E-03	3.81E-06
	<b>Total</b>	<b>100%</b>		<b>2.02E-03</b>
Strontium	Soil ingestion (direct)	6%	9.74E+01	3.22E-03
	Grasses, forbs, berries	38%	7.84E+01	8.85E-03
	Shrubs	56%	7.84E+01	1.33E-02
	Water ingestion (direct)		9.57E-02	2.87E-05
	<b>Total</b>	<b>100%</b>		<b>2.54E-02</b>
Tellurium	Soil ingestion (direct)	6%	3.18E-01	2.00E-02
	Grasses, forbs, berries	38%		
	Shrubs	56%	-	-
	Water ingestion (direct)	NA	-	-
	<b>Total</b>	<b>100%</b>		<b>2.00E-02</b>
Thallium	Soil ingestion (direct)	6%	3.02E-01	6.70E-07
	Grasses, forbs, berries	38%	1.47E-03	1.72E-06
	Shrubs	56%	1.47E-03	2.58E-06
	Water ingestion (direct)	NA	1.92E-04	5.98E-07
	<b>Total</b>	<b>100%</b>		<b>5.57E-06</b>
Titanium	Soil ingestion (direct)	6%	2.33E+03	7.45E-04
	Grasses, forbs, berries	38%	2.40E+00	2.11E-03
	Shrubs	56%	2.40E+00	3.17E-03
	Water ingestion (direct)	NA	1.01E-01	2.35E-04

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg Soil) or (mg/L Water)	Body Burden or Tissue (mg/kg)
	<b>Total</b>	<b>100%</b>		<b>6.26E-03</b>
Uranium	Soil ingestion (direct)	6%	1.22E+00	6.08E-09
	Grasses, forbs, berries	38%	2.66E-03	1.56E-08
	Shrubs	56%	2.66E-03	2.34E-08
		NA	5.00E-04	7.80E-09
	<b>Total</b>	<b>100%</b>		<b>5.29E-08</b>
Vanadium	Soil ingestion (direct)	6%	1.09E+02	3.66E-06
	Grasses, forbs, berries	38%	2.07E-01	1.52E-05
	Shrubs	56%	2.07E-01	2.28E-05
	Water ingestion (direct)	NA	1.37E-02	2.68E-06
	<b>Total</b>	<b>100%</b>		<b>4.43E-05</b>
Zinc	Soil ingestion (direct)	6%	1.45E+02	1.04E-01
	Grasses, forbs, berries	38%	1.71E+02	5.03E-01
	Shrubs	56%	1.71E+02	7.55E-01
	Water ingestion (direct)	NA	1.13E-01	8.82E-04
	<b>Total</b>	<b>100%</b>		<b>1.36E+00</b>

Table D18. Calculation of Moose Tissue Concentrations by Dietary Source – Predicted Future

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
Aluminum	Soil ingestion (direct)	2%	2.95E+04	2.34E-02
	Aquatic plants	20%	6.25E+01	1.47E-01
	Ferns, shrubs, trees, other	78%	6.25E+01	5.88E-01
	Water ingestion (direct)	NA	6.15E+00	7.38E-02
	<b>Total</b>	<b>100%</b>		<b>8.32E-01</b>
Antimony	Soil ingestion (direct)	2%	6.90E+00	1.13E-05
	Aquatic plants	20%	3.24E-02	5.08E-05
	Ferns, shrubs, trees, other	78%	3.24E-02	2.03E-04
	Water ingestion (direct)	NA	5.74E-03	4.59E-05
	<b>Total</b>	<b>100%</b>		<b>3.11E-04</b>
Arsenic	Soil ingestion (direct)	2%	6.99E+01	1.02E-04
	Aquatic plants	20%	3.89E-01	1.22E-03
	Ferns, shrubs, trees, other	78%	3.89E-01	4.88E-03
	Water ingestion (direct)	NA	9.79E-03	1.57E-04
	<b>Total</b>	<b>100%</b>		<b>9.16E-03</b>
Barium	Soil ingestion (direct)	2%	4.31E+02	2.73E-04
	Aquatic plants	20%	4.26E+01	1.25E-03
	Ferns, shrubs, trees, other	78%	4.26E+01	5.01E-03
	Water ingestion (direct)	NA	1.19E-04	1.78E-08
	<b>Total</b>	<b>100%</b>		<b>6.54E-03</b>
Bismuth	Soil ingestion (direct)	2%	3.30E-01	6.61E-03
	Aquatic plants	20%	1.00E-02	1.97E-03
	Ferns, shrubs, trees, other	78%	1.00E-02	7.86E-03
	Water ingestion (direct)	NA	8.44E-03	8.44E-03
	<b>Total</b>	<b>100%</b>		<b>2.49E-02</b>
Boron	Soil ingestion (direct)	2%	2.01E+01	6.61E-01
	Aquatic plants	20%	3.29E+01	6.45E+00
	Ferns, shrubs, trees, other	78%	3.29E+01	2.58E+01
	Water ingestion (direct)	NA	9.57E-02	9.57E-02
	<b>Total</b>			<b>3.30E+01</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
Cadmium	Soil ingestion (direct)	2%	1.10E+00	3.51E-04
	Aquatic plants	20%	3.54E+00	3.06E-03
	Ferns, shrubs, trees, other	78%	3.54E+00	1.22E-02
	Water ingestion (direct)	NA	1.33E-03	5.87E-06
	<b>Total</b>	<b>100%</b>		<b>5.28E-01</b>
Chromium	Soil ingestion (direct)	2%	9.97E+01	5.94E-04
	Aquatic plants	20%	3.33E-01	2.87E-03
	Ferns, shrubs, trees, other	78%	3.33E-01	1.15E-02
	Water ingestion (direct)	NA	7.62E-03	3.35E-04
	<b>Total</b>	<b>100%</b>		<b>1.53E-02</b>
Cobalt	Soil ingestion (direct)	2%	2.24E+01	3.69E-03
	Aquatic plants	20%	7.35E-01	2.31E-02
	Ferns, shrubs, trees, other	78%	7.35E-01	9.22E-02
	Water ingestion (direct)	NA	6.44E-03	1.03E-03
	<b>Total</b>	<b>100%</b>		<b>1.20E-01</b>
Iron	Soil ingestion (direct)	2%	5.85E+04	9.97E-01
	Aquatic plants	20%	1.94E+02	6.07E+00
	Ferns, shrubs, trees, other	78%	1.94E+02	2.43E+01
	Water ingestion (direct)	NA	9.66E+00	1.54E+00
	<b>Total</b>	<b>100%</b>		<b>3.29E+01</b>
Lead	Soil ingestion (direct)	2%	4.02E+01	1.91E-05
	Aquatic plants	20%	1.52E-01	9.56E-05
	Ferns, shrubs, trees, other	78%	1.52E-01	3.82E-04
	Water ingestion (direct)	NA	7.78E-03	2.49E-05
	<b>Total</b>	<b>100%</b>		<b>5.56E-04</b>
Manganese	Soil ingestion (direct)	2%	9.22E+02	2.70E-02
	Aquatic plants	20%	2.76E+02	1.73E-01
	Ferns, shrubs, trees, other	78%	2.76E+02	6.93E-01
	Water ingestion (direct)	NA	5.38E-01	1.72E-03
	<b>Total</b>	<b>100%</b>		<b>8.96E-01</b>
Mercury	Soil ingestion (direct)	2%	8.58E-02	8.83E-04
	Aquatic plants	20%	1.10E-02	4.30E-03



Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
	Ferns, shrubs, trees, other	78%	1.10E-02	1.72E-02
	Water ingestion (direct)	NA	6.91E-05	1.38E-04
	<b>Total</b>	<b>100%</b>		<b>2.95E-02</b>
Nickel	Soil ingestion (direct)	2%	5.29E+01	7.41E-03
	Aquatic plants	20%	4.86E+00	4.57E-02
	Ferns, shrubs, trees, other	78%	4.86E+00	1.83E-01
	Water ingestion (direct)	NA	2.72E-02	1.31E-03
	<b>Total</b>	<b>100%</b>		<b>2.37E-01</b>
Selenium	Soil ingestion (direct)	2%	4.57E+00	7.32E-03
	Aquatic plants	20%	1.63E+00	3.83E-02
	Ferns, shrubs, trees, other	78%	1.63E+00	1.53E-01
	Water ingestion (direct)	NA	3.26E-03	3.91E-04
	<b>Total</b>	<b>100%</b>		<b>2.41E-02</b>
Strontium	Soil ingestion (direct)	2%	9.74E+01	1.02E-03
	Aquatic plants	20%	7.84E+01	4.61E-03
	Ferns, shrubs, trees, other	78%	7.84E+01	1.84E-02
	Water ingestion (direct)		2.96E-01	8.88E-05
	<b>Total</b>	<b>100%</b>		<b>2.42E-02</b>
Tellurium	Soil ingestion (direct)	2%	3.18E-01	6.36E-03
	Aquatic plants	20%	-	-
	Ferns, shrubs, trees, other	78%	-	-
	Water ingestion (direct)	NA	NA	-
	<b>Total</b>	<b>100%</b>		<b>6.36E-03</b>
Thallium	Soil ingestion (direct)	2%	3.02E-01	2.18E-05
	Aquatic plants	20%	1.47E-03	9.19E-05
	Ferns, shrubs, trees, other	78%	1.47E-03	3.68E-04
	Water ingestion (direct)	NA	1.92E-04	6.14E-05
	<b>Total</b>	<b>100%</b>		<b>5.43E-04</b>
Titanium	Soil ingestion (direct)	2%	2.33E+03	2.42E-02
	Aquatic plants	20%	2.40E+00	1.13E-01
	Ferns, shrubs, trees, other	78%	2.40E+00	4.51E-01
	Water ingestion (direct)	NA	1.01E-01	2.41E-02

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
	<b>Total</b>	<b>100%</b>		<b>6.13E-01</b>
Uranium	Soil ingestion (direct)	2%	1.22E+00	1.98E-07
	Aquatic plants	20%	2.66E-03	8.34E-07
	Ferns, shrubs, trees, other	78%	2.66E-03	3.33E-06
	Water ingestion (direct)		5.00E-04	8.00E-07
	<b>Total</b>	<b>100%</b>		<b>5.17E-06</b>
Vanadium	Soil ingestion (direct)	2%	1.09E+02	1.19E-04
	Aquatic plants	20%	2.07E-01	8.13E-04
	Ferns, shrubs, trees, other	78%	2.07E-01	3.25E-03
	Water ingestion (direct)	NA	1.37E-02	2.75E-04
	<b>Total</b>	<b>100%</b>		<b>4.46E-03</b>
Zinc	Soil ingestion (direct)	2%	1.446E+02	3.38E+00
	Aquatic plants	20%	1.71E+02	2.69E+01
	Ferns, shrubs, trees, other	78%	1.71E+02	1.08E+02
	Water ingestion (direct)	NA	1.13E-01	9.05E-02
	<b>Total</b>	<b>100%</b>		<b>1.38E+02</b>

Table D19. Calculation of Grouse Tissue Concentrations by Dietary Source - Predicted Future

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
Aluminum	Soil (direct ingestion)	2%	2.95E+04	1.32E-04
	Insects	1%	2.21E+03	2.10E-03
	Grasses & Forbs	39%	6.25E+01	1.64E-03
	Shrubs & Trees (seeds)	58%	6.25E+01	2.46E-03
	Water ingestion (direct)	NA	5.74E-03	3.90E-07
	<b>Total</b>	<b>100%</b>		<b>6.33E-03</b>
Antimony	Soil (direct ingestion)	2%	6.90E+00	6.39E-08
	Insects	1%	3.45E-01	2.19E-07
	Grasses & Forbs	39%	3.24E-02	5.66E-07
	Shrubs & Trees (seeds)	58%	3.24E-02	8.50E-07
	Water ingestion (direct)	NA	5.74E-03	2.60E-07
	<b>Total</b>	<b>100%</b>		<b>1.96E-06</b>
Arsenic	Soil (direct ingestion)	2%	6.99E+01	5.78E-07
	Insects	1%	4.62E-01	5.85E-07
	Grasses & Forbs	39%	3.89E-01	1.36E-05
	Shrubs & Trees (seeds)	58%	3.89E-01	2.04E-05
	Water ingestion (direct)	NA	9.79E-03	8.86E-07
	<b>Total</b>	<b>100%</b>		<b>3.61E-05</b>
Barium	Soil (direct ingestion)	2%	4.31E+02	2.73E-04
	Insects	1%	3.23E+00	6.79E-06
	Grasses & Forbs	39%	4.26E+01	2.47E-03
	Shrubs & Trees (seeds)	58%	4.26E+01	3.70E-03
	Water ingestion (direct)	NA	1.19E-01	1.78E-05
	<b>Total</b>	<b>100%</b>		<b>6.47E-03</b>
Bismuth	Soil (direct ingestion)	2%	3.30E-01	6.61E-03
	Insects	1%	3.30E-01	4.63E-03
	Grasses & Forbs	39%	1.00E-02	3.87E-03
	Shrubs & Trees (seeds)	58%	1.00E-02	5.81E-03
	Water ingestion (direct)	NA	8.44E-03	8.44E-03
	<b>Total</b>	<b>100%</b>		<b>2.94E-02</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
Boron	Soil (direct ingestion)	2%	2.01E+01	6.61E-01
	Insects	1%	0.00E+00	0.00E+00
	Grasses & Forbs	39%	3.29E+01	1.27E+01
	Shrubs & Trees (seeds)	58%	3.29E+01	1.91E+01
	Water ingestion (direct)	NA	9.57E-02	9.57E-02
	<b>Total</b>		<b>100%</b>	
Cadmium	Soil (direct ingestion)	2%	1.10E+00	1.99E-06
	Insects	1%	1.21E+01	4.24E-06
	Grasses & Forbs	39%	3.54E+00	3.41E-05
	Shrubs & Trees (seeds)	58%	3.54E+00	5.11E-05
	Water ingestion (direct)	NA	1.33E-03	3.32E-08
	<b>Total</b>		<b>100%</b>	
Chromium	Soil (direct ingestion)	2%	9.97E+01	3.36E-06
	Insects	1%	1.60E+01	5.56E-05
	Grasses & Forbs	39%	3.33E-01	3.21E-05
	Shrubs & Trees (seeds)	58%	3.33E-01	4.81E-05
	Water ingestion (direct)	NA	7.62E-03	1.90E-06
	<b>Total</b>		<b>100%</b>	
Cobalt	Soil (direct ingestion)	2%	2.24E+01	2.09E-05
	Insects	1%	2.24E+02	2.84E-03
	Grasses & Forbs	39%	7.35E-01	2.57E-04
	Shrubs & Trees (seeds)	58%	7.35E-01	3.86E-04
	Water ingestion (direct)	NA	6.44E-03	5.83E-06
	<b>Total</b>		<b>100%</b>	
Iron	Soil (direct ingestion)	2%	5.85E+04	5.65E-03
	Insects	1%	5.85E+05	7.42E+00
	Grasses & Forbs	39%	1.94E+02	6.77E-02
	Shrubs & Trees (seeds)	58%	1.94E+02	1.02E-01
	Water ingestion (direct)	NA	9.66E+00	8.74E-03
	<b>Total</b>		<b>100%</b>	
Lead	Soil (direct ingestion)	2%	4.02E+01	1.08E-07
	Insects	1%	8.44E+02	2.14E-04

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
	Grasses & Forbs Shrubs & Trees (seeds) Water ingestion (direct) <b>Total</b>	39% 58% NA <b>100%</b>	1.52E-01 1.52E-01 7.78E-03	1.07E-06 1.60E-06 1.41E-07 <b>2.17E-04</b>
Manganese	Soil (direct ingestion) Insects Grasses & Forbs Shrubs & Trees (seeds) Water ingestion (direct) <b>Total</b>	2% 1% 39% 58% NA <b>100%</b>	9.22E+02 1.84E+01 2.76E+02 2.76E+02 5.38E-01	1.53E-04 4.67E-06 1.93E-03 2.90E-03 9.74E-06 <b>5.00E-03</b>
Mercury	Soil (direct ingestion) Insects Grasses & Forbs Shrubs & Trees (seeds) Water ingestion (direct) <b>Total</b>	2% 1% 39% 58% NA <b>100%</b>	8.58E-02 2.92E-02 1.10E-02 1.10E-02 6.91E-05	5.00E-06 4.62E-06 4.80E-05 7.20E-05 7.82E-07 <b>1.30E-04</b>
Nickel	Soil (direct ingestion) Insects Grasses & Forbs Shrubs & Trees (seeds) Water ingestion (direct) <b>Total</b>	2% 1% 39% 58% NA <b>100%</b>	5.29E+01 1.06E+01 4.86E+00 4.86E+00 2.72E-02	4.19E-05 4.02E-05 5.10E-04 7.65E-04 7.40E-06 <b>1.36E-03</b>
Selenium	Soil (direct ingestion) Insects Grasses & Forbs Shrubs & Trees (seeds) Water ingestion (direct) <b>Total</b>	2% 1% 39% 58% NA <b>100%</b>	4.57E+00 3.47E+00 1.63E+00 1.63E+00 3.26E-03	4.14E-05 3.30E-05 4.27E-04 6.41E-04 2.21E-06 <b>1.14E-03</b>
Strontium	Soil (direct ingestion) Insects Grasses & Forbs Shrubs & Trees (seeds)	2% 1% 39% 58%	9.74E+01 5.65E+01 7.84E+01 7.84E+01	1.02E-03 2.37E-04 9.09E-03 1.36E-02

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
	<b>Total</b>	<b>100%</b>	2.96E-01	8.88E-05 <b>2.41E-02</b>
Tellurium	Soil (direct ingestion)	2%	3.18E-01	6.36E-03
	Insects	1%	-	-
	Grasses & Forbs	39%	-	-
	Shrubs & Trees (seeds)	58%	-	-
	Water ingestion (direct)	NA	-	-
	<b>Total</b>	<b>100%</b>		<b>6.36E-03</b>
Thallium	Soil (direct ingestion)	2%	3.02E-01	1.23E-07
	Insects	1%	3.02E-01	7.65E-06
	Grasses & Forbs	39%	1.47E-03	1.03E-06
	Shrubs & Trees (seeds)	58%	1.47E-03	1.54E-06
	Water ingestion (direct)	NA	1.92E-04	3.47E-07
	<b>Total</b>	<b>100%</b>		<b>1.07E-05</b>
Titanium	Soil (direct ingestion)	2%	2.33E+03	1.37E-04
	Insects	1%	2.33E+03	4.42E-02
	Grasses & Forbs	39%	2.40E+00	1.26E-03
	Shrubs & Trees (seeds)	58%	2.40E+00	1.89E-03
	Water ingestion (direct)	NA	1.01E-01	1.37E-04
	<b>Total</b>	<b>100%</b>		<b>4.77E-02</b>
Uranium	Soil (direct ingestion)	2%	1.22E+00	1.12E-09
	Insects	1%	3.65E-01	4.62E-08
	Grasses & Forbs	39%	2.66E-03	9.30E-09
	Shrubs & Trees (seeds)	58%	2.66E-03	1.39E-08
	<b>Total</b>	<b>100%</b>	5.00E-04	4.53E-09 <b>7.51E-08</b>
Vanadium	Soil (direct ingestion)	2%	1.09E+02	6.74E-07
	Insects	1%	1.42E+01	2.24E-05
	Grasses & Forbs	39%	2.07E-01	9.06E-06
	Shrubs & Trees (seeds)	58%	2.07E-01	1.36E-05
	Water ingestion (direct)	NA	1.37E-02	1.55E-06
	<b>Total</b>	<b>100%</b>		<b>4.73E-05</b>

Constituent	Media/Diet Consumed	Proportion of Medium Consumed (%)	Source (mg/kg)	Body Burden or Tissue (mg/kg)
Zinc	Soil (direct ingestion)	2%	1.45E+02	1.92E-02
	Insects	1%	2.60E+03	1.65E-01
	Grasses & Forbs	39%	1.71E+02	3.00E-01
	Shrubs & Trees (seeds)	58%	1.71E+02	4.50E-01
	Water ingestion (direct)	NA	1.13E-01	5.12E-04
	<b>Total</b>		<b>100%</b>	

Table D20. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Plants – Predicted Future

Constituent	Plant EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	2.04E+01	1.00E+00	1.1E-01	8.3E-02	6.4E-02	8.4E-02
Antimony	1.06E-02	6.00E-03	9.8E-03	7.2E-03	5.6E-03	7.2E-03
Arsenic	3.68E-02	1.00E-03	2.0E-01	1.5E-01	1.2E-01	1.5E-01
Barium	1.39E+01	2.00E-01	3.9E-01	2.8E-01	2.2E-01	2.9E-01
Bismuth	3.28E-03	NA	-	-	-	-
Boron	1.08E+01	2.00E-01	3.0E-01	2.2E-01	1.7E-01	2.2E-01
Cadmium	1.16E+00	1.00E-03	6.4E+00	4.7E+00	3.6E+00	4.8E+00
Chromium	1.09E-01	3.00E-03	2.0E-01	1.5E-01	1.1E-01	1.5E-01
Cobalt	2.40E-01	1.40E-03	9.5E-01	7.0E-01	5.4E-01	7.0E-01
Iron	6.32E+01	7.00E-01	5.0E-01	3.7E-01	2.8E-01	3.7E-01
Lead	4.98E-02	1.50E-03	4.6E-01	3.4E-01	1.0E-01	1.4E-01
Manganese	9.03E+01	1.56E-01	3.2E+00	2.4E+00	1.8E+00	2.4E+00
Mercury	3.59E-03	3.00E-04	6.6E-02	4.9E-02	3.8E-02	4.9E-02
Nickel	1.59E+00	1.10E-02	8.0E-01	5.9E-01	4.5E-01	5.9E-01
Selenium	5.32E-01	5.50E-03	5.4E-01	3.9E-01	3.0E-01	4.0E-01
Strontium	2.56E+01	6.00E-01	2.4E-01	1.7E-01	1.3E-01	1.8E-01
Tellurium	-	NA	-	-	-	-
Thallium	4.79E-04	7.00E-05	3.8E-02	2.8E-02	2.2E-02	2.8E-02
Titanium	7.84E-01	3.00E+00	1.4E-03	1.1E-03	8.2E-04	1.1E-03
Uranium	8.68E-04	6.00E-04	8.0E-03	5.9E-03	4.6E-03	5.9E-03
Vanadium	6.77E-02	5.00E-03	7.5E-02	5.5E-02	4.3E-02	5.6E-02
Zinc	5.60E+01	5.00E-01	6.2E-01	4.6E-01	3.5E-01	4.6E-01
<b>Max Hazard</b>			<b>6.4E+00</b>	<b>4.7E+00</b>	<b>3.6E+00</b>	<b>4.8E+00</b>

Constituent	Plant EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	3.68E-02	1.80E+00	1.0E-04	7.1E-05	4.2E-05	7.5E-05



Table D21. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Fish – Predicted Future

Constituent	Fish EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	1.39E+01	1.00E+00	7.7E-02	5.7E-02	4.4E-02	5.7E-02
Antimony	4.00E-02	6.00E-03	3.7E-02	2.7E-02	2.1E-02	2.7E-02
Arsenic	3.64E-02	1.00E-03	2.0E-01	1.5E-01	1.1E-01	1.5E-01
Barium	1.58E+00	2.00E-01	4.4E-02	3.2E-02	2.5E-02	3.3E-02
Bismuth	1.26E-02	NA	-	-	-	-
Boron	1.28E-01	2.00E-01	3.5E-03	2.6E-03	2.0E-03	2.6E-03
Cadmium	7.04E-01	1.00E-03	3.9E+00	2.9E+00	2.2E+00	2.9E+00
Chromium	1.00E-01	3.00E-03	1.9E-01	1.4E-01	1.1E-01	1.4E-01
Cobalt	5.15E-01	1.40E-03	2.0E+00	1.5E+00	1.2E+00	1.5E+00
Iron	1.63E+02	7.00E-01	1.3E+00	9.5E-01	7.3E-01	9.6E-01
Lead	1.89E-01	1.50E-03	1.7E+00	1.3E+00	4.0E-01	5.2E-01
Manganese	1.88E+01	1.56E-01	6.7E-01	4.9E-01	3.8E-01	4.9E-01
Mercury	9.98E-03	3.00E-04	1.8E-01	1.4E-01	1.0E-01	1.4E-01
Nickel	2.65E-01	1.10E-02	1.3E-01	9.8E-02	7.6E-02	9.9E-02
Selenium	3.23E+00	5.50E-03	3.3E+00	2.4E+00	1.9E+00	2.4E+00
Strontium	7.35E+00	6.00E-01	6.8E-02	5.0E-02	3.9E-02	5.0E-02
Tellurium	0.00E+00	NA	-	-	-	-
Thallium	1.72E-02	7.00E-05	1.4E+00	1.0E+00	7.7E-01	1.0E+00
Titanium	5.90E-01	3.00E+00	1.1E-03	8.0E-04	6.2E-04	8.1E-04
Uranium	6.21E-03	6.00E-04	5.7E-02	4.2E-02	3.3E-02	4.3E-02
Vanadium	8.43E-02	5.00E-03	9.3E-02	6.9E-02	5.3E-02	6.9E-02
Zinc	8.87E+01	5.00E-01	9.8E-01	7.2E-01	5.6E-01	7.3E-01
<b>Max Hazard</b>			<b>3.9E+00</b>	<b>2.9E+00</b>	<b>2.2E+00</b>	<b>2.9E+00</b>

Constituent	Fish EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	3.64E-02	1.80E+00	1.0E-04	7.0E-05	4.1E-05	7.4E-05

Table D22. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Rabbit – Predicted Future

Constituent	Snowshoe Hare EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	8.32E-03	1.00E+00	4.6E-05	3.4E-05	2.6E-05	3.4E-05
Antimony	3.17E-06	6.00E-03	2.9E-06	2.2E-06	1.7E-06	2.2E-06
Arsenic	6.17E-05	1.00E-03	3.4E-04	2.5E-04	1.9E-04	2.5E-04
Barium	8.60E-04	2.00E-01	2.4E-05	1.8E-05	1.4E-05	1.8E-05
Bismuth	3.87E-02	NA	-	-	-	-
Boron	3.31E+01	2.00E-01	<b>9.2E-01</b>	<b>6.8E-01</b>	<b>5.2E-01</b>	<b>6.8E-01</b>
Cadmium	1.54E-04	1.00E-03	8.5E-04	6.3E-04	4.8E-04	6.3E-04
Chromium	1.56E-04	3.00E-03	2.9E-04	2.1E-04	1.6E-04	2.1E-04
Cobalt	1.20E-03	1.40E-03	4.8E-03	3.5E-03	2.7E-03	3.5E-03
Iron	3.30E-01	7.00E-01	2.6E-03	1.9E-03	1.5E-03	1.9E-03
Lead	5.30E-06	1.50E-03	4.9E-05	3.6E-05	1.1E-05	1.5E-05
Manganese	8.95E-03	1.56E-01	3.2E-04	2.3E-04	1.8E-04	2.4E-04
Mercury	2.30E-04	3.00E-04	4.2E-03	3.1E-03	2.4E-03	3.1E-03
Nickel	2.27E-04	1.10E-02	1.1E-04	8.4E-05	6.5E-05	8.5E-05
Selenium	2.02E-03	5.50E-03	2.0E-03	1.5E-03	1.2E-03	1.5E-03
Strontium	2.54E-02	6.00E-01	2.3E-04	1.7E-04	1.3E-04	1.7E-04
Tellurium	2.00E-02	NA	-	-	-	-
Thallium	5.57E-06	7.00E-05	4.4E-04	3.3E-04	2.5E-04	3.3E-04
Titanium	6.26E-03	3.00E+00	1.2E-05	8.5E-06	6.6E-06	8.6E-06
Uranium	5.29E-08	6.00E-04	4.9E-07	3.6E-07	2.8E-07	3.6E-07
Vanadium	4.43E-05	5.00E-03	4.9E-05	3.6E-05	2.8E-05	3.6E-05
Zinc	1.36E+00	5.00E-01	1.5E-02	1.1E-02	8.6E-03	1.1E-02
<b>Max Hazard</b>			<b>9.2E-01</b>	<b>6.8E-01</b>	<b>5.2E-01</b>	<b>6.8E-01</b>

Constituent	Snowshoe Hare EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	6.17E-05	1.80E+00	1.7E-07	1.2E-07	7.0E-08	1.3E-07

Table D23. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Moose – Predicted Future

Constituent	Moose EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	8.32E-01	1.00E+00	4.6E-03	3.4E-03	2.6E-03	3.4E-03
Antimony	3.11E-04	6.00E-03	2.9E-04	2.1E-04	1.6E-04	2.1E-04
Arsenic	9.16E-03	1.00E-03	5.1E-02	3.7E-02	2.9E-02	3.8E-02
Barium	2.73E-04	2.00E-01	7.6E-06	5.6E-06	4.3E-06	5.6E-06
Bismuth	2.49E-02	NA	-	-	-	-
Boron	3.30E+01	2.00E-01	9.2E-01	6.7E-01	5.2E-01	6.8E-01
Cadmium	5.28E-01	1.00E-03	2.9E+00	2.2E+00	1.7E+00	2.2E+00
Chromium	1.53E-02	3.00E-03	2.8E-02	2.1E-02	1.6E-02	2.1E-02
Cobalt	1.20E-01	1.40E-03	4.7E-01	3.5E-01	2.7E-01	3.5E-01
Iron	3.29E+01	7.00E-01	2.6E-01	1.9E-01	1.5E-01	1.9E-01
Lead	5.56E-04	1.50E-03	5.1E-03	3.8E-03	1.2E-03	1.5E-03
Manganese	8.96E-01	1.56E-01	3.2E-02	2.3E-02	1.8E-02	2.4E-02
Mercury	2.95E-02	3.00E-04	5.4E-01	4.0E-01	3.1E-01	4.0E-01
Nickel	7.41E-03	1.10E-02	3.7E-03	2.8E-03	2.1E-03	2.8E-03
Selenium	2.41E-02	5.50E-03	2.4E-02	1.8E-02	1.4E-02	1.8E-02
Strontium	2.42E-02	6.00E-01	2.2E-04	1.6E-04	1.3E-04	1.7E-04
Tellurium	6.36E-03	NA	-	-	-	-
Thallium	5.43E-04	7.00E-05	4.3E-02	3.2E-02	2.4E-02	3.2E-02
Titanium	6.13E-01	3.00E+00	1.1E-03	8.3E-04	6.4E-04	8.4E-04
Uranium	5.17E-06	6.00E-04	4.8E-05	3.5E-05	2.7E-05	3.5E-05
Vanadium	4.46E-03	5.00E-03	4.9E-03	3.6E-03	2.8E-03	3.7E-03
Zinc	1.38E+02	5.00E-01	1.5E+00	1.1E+00	8.7E-01	1.1E+00
<b>Max Hazard</b>			<b>2.9E+00</b>	<b>2.2E+00</b>	<b>1.7E+00</b>	<b>2.2E+00</b>

Constituent	Moose EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	9.16E-03	1.80E+00	2.6E-05	1.8E-05	1.0E-05	1.9E-05

Table D24. Calculation of Non-Carcinogenic and Carcinogenic Hazards from Ingestion of Grouse – Predicted Future

Constituent	Grouse EEC (mg/kg)	RfD (mg/kg-day)	Hazard Quotient			
			Toddler	Child	Teen	Adult
Aluminum	6.33E-03	1.00E+00	3.5E-05	2.6E-05	2.0E-05	2.6E-05
Antimony	1.96E-06	6.00E-03	1.8E-06	1.3E-06	1.0E-06	1.3E-06
Arsenic	3.61E-05	1.00E-03	2.0E-04	1.5E-04	1.1E-04	1.5E-04
Barium	2.73E-04	2.00E-01	7.6E-06	5.6E-06	4.3E-06	5.6E-06
Bismuth	2.94E-02	NA	-	-	-	-
Boron	3.25E+01	2.00E-01	9.0E-01	6.6E-01	5.1E-01	6.7E-01
Cadmium	9.15E-05	1.00E-03	5.1E-04	3.7E-04	2.9E-04	3.8E-04
Chromium	1.41E-04	3.00E-03	2.6E-04	1.9E-04	1.5E-04	1.9E-04
Cobalt	3.51E-03	1.40E-03	1.4E-02	1.0E-02	7.9E-03	1.0E-02
Iron	7.60E+00	7.00E-01	6.0E-02	4.4E-02	3.4E-02	4.5E-02
Lead	2.17E-04	1.50E-03	2.0E-03	1.5E-03	4.6E-04	5.9E-04
Manganese	5.00E-03	1.56E-01	1.8E-04	1.3E-04	1.0E-04	1.3E-04
Mercury	1.30E-04	3.00E-04	2.4E-03	1.8E-03	1.4E-03	1.8E-03
Nickel	4.19E-05	1.10E-02	2.1E-05	1.6E-05	1.2E-05	1.6E-05
Selenium	1.14E-03	5.50E-03	1.2E-03	8.5E-04	6.6E-04	8.5E-04
Strontium	2.41E-02	6.00E-01	2.2E-04	1.6E-04	1.3E-04	1.6E-04
Tellurium	6.36E-03	NA	-	-	-	-
Thallium	1.07E-05	7.00E-05	8.5E-04	6.2E-04	4.8E-04	6.3E-04
Titanium	4.77E-02	3.00E+00	8.8E-05	6.5E-05	5.0E-05	6.5E-05
Uranium	7.51E-08	6.00E-04	6.9E-07	5.1E-07	3.9E-07	5.1E-07
Vanadium	4.73E-05	5.00E-03	5.2E-05	3.9E-05	3.0E-05	3.9E-05
Zinc	9.35E-01	5.00E-01	1.0E-02	7.6E-03	5.9E-03	7.7E-03
<b>Max Hazard</b>			<b>9.0E-01</b>	<b>6.6E-01</b>	<b>5.1E-01</b>	<b>6.7E-01</b>

Constituent	Grouse EEC (mg/kg)	Slope Factor (mg/kg-day) <sup>-1</sup>	Incremental Lifetime Cancer Risk			
			Toddler	Child	Teen	Adult
Arsenic	3.61E-05	1.80E+00	1.0E-07	7.0E-08	4.1E-08	7.3E-08

Attachment E  
Toxicity Profile Summaries

# 1 TOXICITY PROFILE SUMMARIES

## 1.1 Aluminum

Aluminum (Al) is a silvery-white, malleable and ductile metal and the most abundant metal in the earth's crust (ATSDR 2008). It has a molecular weight of 26.98 g/mol and a density of 2.70 g/cm<sup>3</sup> (ATSDR 2008). Aluminum only occurs in one oxidation state: +3. Aluminum is highly reactive with water and is typically found in the environment as a constituent of inorganic and organic compounds. Human exposure to aluminum can occur through inhalation of air particles, ingestion of contaminated food, sediment or soil, and dermal contact with water, soil or sediment. The primary source of exposure to aluminum is typically from inhalation of dust in contaminated workplace and ingestion of food. The absorption of ingested aluminum in humans depends upon the solubility of the compound and is generally low (0.1 to 0.4%) (ATSDR 2008). Ingestion of more bioavailable forms such as organic aluminum compounds (i.e., aluminum citrate) have slightly higher absorption (0.5 to 5%), but are still considered to have low absorption (ATSDR 2008). The extent of absorption of inhaled aluminum depends on solubility of the compound and particle size. Dermal absorption of aluminum is considered to be negligible (ATSDR 2008). Exposure to excess aluminum has been shown to elicit a variety of toxic effects including neurotoxicity, bone disease, and lung disease (ATSDR 2008). Due to important role kidneys play in removing aluminum from the body, people with kidneys that are not functioning properly can accumulate toxic concentrations of aluminum in the body resulting in bone disease and neurotoxicity (ATSDR 2008).

Aluminum has been shown to accumulate in plants and some animals; however, it does not appear to biomagnify in food chains (ATSDR 2008; BCMOE 1988).

## 1.2 Antimony

Antimony is a silvery-white metalloid with a molecular weight (MW) of 121.75 g/mol and a density of 6.684 g/cm<sup>3</sup>. Antimony in the environment typically exists in the +3 and +5 of its four oxidation states (-3, 0, +3, and +5). Antimony (elemental) is considered insoluble in water and does not have a reported value for octanol-water partition coefficient; however, some antimony compounds are soluble in water (i.e., antimony trichloride) (ATSDR 1992). Human exposure to antimony can occur through inhalation of air particles, ingestion of contaminated food, water, sediment or soil, and dermal contact with water, soil or sediment. The primary source of exposure to antimony is typically from food, water, and contaminated workplace (ATSDR 1992). The absorption of ingested antimony in humans depends upon the solubility of the compound. The absorption of inhaled antimony depends on particle size and solubility. Absorption rates for antimony have been estimated between 1% and 10% (ATSDR 1992). Once absorbed, antimony is distributed widely throughout the body via blood and eliminated from the body in urine and feces (ATSDR 1992).

Antimony has been shown to accumulate in plants and some animals; however, it does not appear to biomagnify in food chains (ATSDR 1992; HSDB 2017a).

## 1.3 Arsenic

Arsenic is a metalloid element with properties of both metallic and non-metallic elements. It has a molecular weight of 74.92 g/mol and a density of 5.73 g/cm<sup>3</sup>. Arsenic typically exists in one of three oxidation states: -3, +3, and +5. Arsenic is considered insoluble in water and does not have a reported value for octanol–water partition coefficient (ATSDR 2007a). Arsenic is typically found in the environment combined with oxygen, chlorine and/or sulphur to form inorganic compounds. Arsenic can also combine with carbon and hydrogen to form organic compounds.

Numerous epidemiologic studies investigating occupational exposures to various forms of inorganic arsenic compounds have established a strong correlation between exposure and the incidence of cancer, including cancer in the bladder, kidneys, lungs, skin, and liver (CEPA 1993a). Consequently, arsenic is classified as a Group I carcinogen by Health Canada, Group 1 carcinogen by the International Agency for Research on Cancer (IARC), and Group A carcinogen by the United States Environmental Protection Agency (USEPA).

In addition to carcinogenic effects, exposure to arsenic may also result in a wide-range of non-carcinogenic effects, including death. Regardless of the intake pathway, the most common symptoms of chronic arsenic exposure are non-cancerous dermal lesions, hyperkeratosis, and hyperpigmentation. Consequently, similar respiratory effects (i.e., inflammation and pulmonary edema) have been observed following inhalation of arsenic. Epidemiological studies have reported that arsenic exposure may result in gastrointestinal effects, neurological effects, and various cardiovascular effects such as blackfoot disease, which is characterized by the progressive loss of circulation in hands and feet (ATSDR 2007a).

Arsenic has been shown to accumulate in plants and some animals; however, it does not appear to biomagnify in food chains (ATSDR 2007a; CCME 2001a; CCME 2001b).

## 1.4 Barium

Barium (Ba) is a highly reactive alkaline earth metal that has one stable oxidation state (+2) and only occurs in a combined state in nature (ATSDR 2007b). It has a molecular weight of 137.327 g/mol and a density of 3.62 g/cm<sup>3</sup>. Barium is highly reactive with water and is therefore considered insoluble in water. Due to its reactivity, barium is found in the environment combined with carbon, chlorine, oxygen, and/or sulphur to form inorganic and organic compounds.

Human exposure to barium can occur through inhalation of soil particles in air, ingestion of contaminated food, sediment or soil, and dermal contact with water, soil or sediment. The primary source of exposure for the general population is typically from drinking water and food; however, soil particles in air are an important exposure route in mining operations and in the processing industry (ATSDR 2007b). The absorption of ingested inorganic arsenic in humans depends upon the solubility of the compound. Studies report barium absorption ranges from approximately 1 to 60% (ATSDR 2007b). Acid soluble barium compounds may be absorbed more readily than other forms. The absorption of inhaled barium depends upon the solubility and particle size. Animal studies indicate that 50 to 75% of barium chloride and barium sulphate is absorbed in the respiratory tract (ATSDR 2007b). Barium is not expected to be absorbed through the skin (ATSDR 2007b).

Exposure to barium may result in a wide-range of non-carcinogenic effects in a variety of organ systems, including cardiovascular, respiratory, developmental, gastrointestinal, hematological, hepatic, and musculoskeletal (ATSDR 2007b). The primary target organs for barium are the cardiovascular (heart and vessels), gastrointestinal and reproductive systems (ATSDR 2007b).

Barium has been shown to accumulate in plants and some aquatic organisms; however, it is not expected to biomagnify in food chains (ATSDR 2007b; CCME 2013).

## 1.5 Bismuth

Bismuth (Bi) is a greyish-white, brittle, lustrous metal with a molecular weight of 208.98 g/mol and a density of 9.78 g/cm<sup>3</sup> (Fowler et al. 2015; HSDB 2017b). Bismuth occurs in two main oxidation states (+3 and +5) (Fowler et al. 2015; Salminen 2005). Elemental bismuth is reactive with and insoluble in water; however, in the presence of oxygen and water, bismuth is readily oxidized and generally exists as inorganic and organic compounds with a wide-range of water solubility (Fowler et al. 2015; HSDB 2017b; Salminen 2005).

The primary sources of exposure to bismuth is typically from cosmetics, pharmaceuticals and dust at workplaces where bismuth is processed or handled. The absorption of ingested bismuth in humans is considered to be poor (NRC 2005; HSDB 2017b). The extent of absorption of inhaled bismuth depends on solubility and particle size.

Bismuth compounds are poorly soluble and poorly absorbed with limited bioavailability, toxicity is likely to occur via the intake of pharmaceuticals containing bismuth (Fowler et al. 2005; NRC 2005). Exposure to elevated concentrations of bismuth may result in a neurological and renal toxicity (HSDB 2017b). The primary target organ for bismuth toxicity is the nervous system. Exposure to high doses of bismuth may result in death, encephalopathy, and kidney failure; whereas, chronic exposure to low doses may result in memory loss, depression, mucosal lesions, nausea, vomiting, diarrhea, and discoloration of skin (HSDB 2017b). People with kidney or liver disease may be susceptible to bismuth toxicity (HSDB 2017b).

Bismuth concentrations are low in the environment and in animal tissues and has been shown to not accumulate in laboratory studies; therefore, it is not considered to biomagnify in food chains (NRC 2005).

## 1.6 Cadmium

Cadmium is a soft, silver-white lustrous metal with a molecular weight of 112.41 g/mol and a density of 8.65 g/cm<sup>3</sup>. Cadmium typically exists in one of two oxidation states: 0 and +2. Cadmium is typically found in the environment combined with oxygen, chlorine and/or sulphur to form inorganic compounds. Cadmium (elemental) is considered insoluble in water and does not have a reported value for octanol–water partition coefficient; however, some cadmium salts are soluble with water solubility ranging from 0.00013 to 140 g/mL (CCME 2014).

Numerous rat laboratory studies on cadmium compounds have established shown a correlation between exposure and the incidence of cancer, including cancer in the prostate, testes, and lungs (CEPA 1994). Limited evidence from epidemiologic studies investigating occupational exposures has



established a correlation between inhalation exposure and the incidence of lung cancer (ATSDR 2012a). Consequently, cadmium is classified as a Group II carcinogen by Health Canada, Group 1 carcinogen by the International Agency for Research on Cancer, and Group B1 probable carcinogen by the United States Environmental Protection Agency (USEPA).

In addition to carcinogenic effects, exposure to cadmium may also result in a wide-range of non-carcinogenic effects, including death. Regardless of the intake pathway, chronic cadmium exposure may lead to kidney disease and fragile bones. Respiratory effects (i.e., inflammation and pulmonary edema) have been observed following inhalation of cadmium. Epidemiological studies have reported that cadmium exposure may result in adverse effects to the reproductive, skeletal, hepatic, hematological, and immune systems (ATSDR 2012a; CEPA 1994).

## 1.7 Chromium

Chromium (Cr) is a grey lustrous metal with a MW of 52.0 g/mol and a density of 7.14 g/cm<sup>3</sup>. Chromium occurs in nine different oxidation states of which +3 and +6 are the most common (CCME 1999a). Chromium is typically found in the environment combined with oxygen, iron or chromium, such as chromite (FeOCr<sub>2</sub>O<sub>3</sub>), chromitite (Fe<sub>2</sub>O<sub>3</sub>•2Cr<sub>2</sub>O<sub>3</sub>), and crocitate (PbCrO<sub>4</sub>). Chromium can also combine carbon and hydrogen to form organic compounds. Trivalent chromium (Cr[III]) and hexavalent chromium (Cr[VI]) are the most common of nine oxidation (valence) states that chromium may have (ATSDR 2012b). Trivalent chromium is ubiquitous in the environment and the most dominant form of chromium, since it's the most thermodynamically stable form in ambient conditions (CCME 1999a). Hexavalent chromium is a strong oxidizing agent and primarily originates from anthropogenic sources (ATSDR 2012b; CEPA 1993b). Hexavalent chromium is rare in nature because it's highly reactive with organic matter and other reducing substances (CCME 1999a). Chromium compounds may be highly soluble (i.e., chromic acid) or insoluble (i.e., chromium oxide) in water and generally do not have octanol–water partition coefficients (ATSDR 2012b).

The general population is predominantly exposed to chromium via inhalation pathway; whereas, occupational populations are predominantly exposed to chromium via ingestion of food. Chromium [III] is an essential nutrient and plays a role in various body functions such as enhancing absorption and metabolism of sugars, protein and fat (CEPA 1993). The absorption of ingested chromium [VI] compounds is generally more efficient (2 to 10% of dose) than chromium [III] compounds (0.5 to 3%). Absorption in the lungs appears to be more efficient than in the digestive tract, with the absorption of 12% of inhaled chromium [III] and 30% of inhaled chromium [VI] by lung tissues (ATSDR 2012b; CCME 1999a).

No association has been identified between exposure to chromium (+3) compounds and increased incidence of cancer. However, numerous epidemiologic studies investigating occupational exposures to chromium (+6) compounds have established a strong correlation between exposure and the incidence of stomach, intestinal tract and lung cancer (ATSDR 2012b). Consequently, chromium (+6) compounds are classified as a Group I carcinogen by Health Canada and Group A carcinogen (inhalation route only) by the United States Environmental Protection Agency (USEPA). Exposure to chromium may result in a wide-range of non-carcinogenic effects in a variety of organ systems. The primary target systems for chromium are the immune, renal, and respiratory (ATSDR 2012b).

Chromium has been shown to accumulate in some plants and animals; however, it does not biomagnify in food chains (BCMOE 2015; HSDB 2017c).

## 1.8 Cobalt

Cobalt (Co) is a silvery grey, hard metal and occurs naturally in the earth's crust (ATSDR 2004). It has a molecular weight of 58.93 g/mol and a density of 8.9 g/cm<sup>3</sup> (ATSDR 2004). Cobalt commonly occurs in three oxidation states: 0, +2 and +3. Cobalt occurs in a variety of inorganic and organic compounds with a wide-range of water solubility (ATSDR 2004).

Cobalt is ubiquitous in the environment at low concentrations and thus people may come into contact with it as dust in air, in drinking water, and in food. The primary source of exposure to cobalt for most people is in food (ATSDR 2004). The absorption of ingested cobalt is about 18 to 97% depending on the bioavailability of the ingested cobalt compound and body burden (ATSDR 2004). The extent of absorption of inhaled cobalt depends on bioavailability and particle size. Dermal absorption of cobalt compounds is considered to be very small (less than 1 %) (ATSDR 2004). The most bioavailable forms of cobalt are soluble compounds (ATSDR 2004).

Cobalt is an essential nutrient as it is part of vitamin B<sub>12</sub> which is necessary to maintain human health (ATSDR 2004). Exposure to elevated concentrations of cobalt may result in a cardiovascular, developmental, hematological and respiratory toxicity (ATSDR 2004). The primary target organ for cobalt toxicity is the cardiovascular system. Exposure to high doses of cobalt may result in death, lung damage, liver damage, and kidney impairment and failure; whereas, chronic exposure to low doses may result in impaired vision, asthma, nausea, and vomiting (ATSDR 2004).

Cobalt has been shown to accumulate in plants and animals; however, it is not known to biomagnify in food chains (ATSDR 2004).

## 1.9 Iron

Iron (Fe) is a white or grey, soft, malleable and ductile metal and the fourth most abundant element in the earth's crust (HSDB 2017d). It has a molecular weight of 55.85 g/mol and a density of 7.86 g/cm<sup>3</sup> (BCMOE 2008a; HSDB 2017d). Iron occurs in three oxidation states: 0, +2 and +3; however, pure iron is highly reactive with water and generally occurs in a variety of inorganic and organic compounds with a wide-range of water solubility (BCMOE 2008a).

The primary source of exposure to iron is typically from food. Iron is an essential nutrient and thus, its uptake, storage, and excretion are highly regulated (HSDB 2017d). The absorption of ingested iron is about 2 to 15% depending on the bioavailability of the ingested iron compound and body burden (HSDB 2017d). The extent of absorption of inhaled iron depends on bioavailability and particle size. No information was available regarding dermal absorption of iron compounds. The most bioavailable forms of iron are soluble compounds such as ferrous sulfate (HSDB 2017d). Once absorbed, iron is distributed throughout the body, stored in the blood, macrophage (reticuloendothelial) system, liver and muscle, and primarily excreted in urine and feces (HSDB 2017d).

Iron is an essential nutrient that plays a vital role in the function of numerous proteins and enzymes such as hemoglobin in red blood cells (HSDB 2017d). Nutrient deficiency may also exhibit toxic effects, such as anemia in which the iron content in red blood cells is low resulting in reduced oxygen uptake and numerous symptoms including fatigue, weakness, shortness of breath, confusion, thirst, impaired immune system, and loss of consciousness (HSDB 2017d).

Exposure to elevated concentrations of iron may a wide-range of non-carcinogenic effects to various organ systems, including gastrointestinal, cardiovascular, nervous, hepatic, and reproductive systems (HSDB 2017d). The primary target organs for iron toxicity include the lungs, gastrointestinal tract and reproductive system (specifically with respect to fetal development) (HSDB 2017d).

As iron is an essential nutrient to plants and animals, it is highly regulated and will accumulate in tissues; however, excess iron is readily excreted in healthy organisms and thus, it does not appear to biomagnify in food chains (BCMOE 2008a; HSDB 2017d; USEPA 2003).

## 1.10 Lead

Lead (Pb) is a soft, dense, lustrous bluish-grey metal that occurs naturally in earth's crust. It is rarely found in its elemental form in nature. The molecular weight of lead is 207.20 and the density is 11.34 g/cm<sup>3</sup> (ATSDR 2007c). Lead has three oxidation states (0, +2, and +4) with the divalent (+2) form being the most common. Lead rarely exists in its elemental form and is to be considered insoluble in water; however, most lead compounds are soluble in water (i.e., lead nitrate). Lead and its compounds have no reported octanol-water partition coefficients in ATSDR (2007c). Lead has been shown to bioaccumulate in plants and animals; however, it has not been reported to biomagnify in food chains (ATSDR 2007c; Wixson and Davis 1993; Eisler 1988).

No association has been found between the occurrence of cancer in humans and occupational exposure to lead (ATSDR 2007c). Exposure to lead may result in a wide-range of non-carcinogenic effects in a variety of organ systems, including cardiovascular, developmental, gastrointestinal, hematological, musculoskeletal, neurological, ocular, urinary, and reproduction (ATSDR 2007c). The primary target organ for lead is the nervous system. Children are particularly sensitive to lead toxicity. Exposure to high doses of lead may result in death and severe brain and kidney damage; whereas, chronic exposure to low doses may result in decreased cognitive and musculoskeletal performance (ATSDR 2007c).

Lead has been shown to bioaccumulate in plants and animals; however, it has not been reported to biomagnify in food chains (ATSDR 2007c; Wixson and Davis 1993; Eisler 1988). The primary uptake route for lead in plants is through roots where it generally remains bound, as the translocation of lead in plants is limited. The highest lead concentrations in aquatic organisms are usually observed in lower trophic level benthic organisms and algae; whereas, the lowest lead concentrations are observed in the upper trophic level organisms such as carnivorous fishes (Eisler 1988). Lead tends to concentrate in bone tissue rather than soft tissue, which minimizes the movement to higher trophic levels in the food chain and thus, lead is not considered to biomagnify (ATSDR 2007c; Stansley and Roscoe 1996).

## 1.11 Mercury

Mercury (Hg) is a metal with silver-white colour as a liquid (at room temperature). It has a molecular weight of 200.59 g/mol and a density of 13.534 g/cm<sup>3</sup>. Mercury exists in one of three stable oxidation states: 0, +1 and +2. Mercury has a low water solubility (0.28 μmoles/L) and a log octanol–water partition coefficient of 5.95 (ATSDR 1999). Mercury is typically found in the environment combined with oxygen, chlorine and/or sulphur to form inorganic compounds.

Exposure to elemental mercury has not been shown to result in cancer (ATSDR 1999; USEPA 2017). Numerous epidemiologic studies investigating occupational exposures to various forms of inorganic and organic mercury compounds have established a correlation between exposure and the incidence of cancer in laboratory studies; however, insufficient evidence is available for humans (ATSDR 1999; USEPA 2017). Consequently, inorganic and organic mercury compounds are classified as Group 3 (inorganic mercury) or Group 2B (methylmercury) carcinogen by the International Agency for Research on Cancer (IARC), and Group C, a possible human carcinogen, by the United States Environmental Protection Agency (USEPA). Health Canada has no classified mercury as to its potential carcinogenicity.

Exposure to mercury may result in a wide-range of non-carcinogenic effects on the nervous system, kidneys, stomach, intestines, development, immune system, reproductive system, cardiovascular system and death (ATSDR 1999).

Mercury has been shown to accumulate in plants and animals, and biomagnify in food chains (BCMOE 1989; CCME 1999).

## 1.12 Nickel

Nickel (Ni) is a hard, silvery white, lustrous metal that occurs naturally in earth's crust. It has a molecular weight of 58.69 g/mol and a density of 8.91 g/cm<sup>3</sup>. Nickel has six oxidation states (-1, 0, +1, +2, +3, and +4); however, the most relevant oxidation state in the environment is +2 (CCME 2015). Nickel compounds have a wide-range of water solubility, including insoluble compounds such as nickel cyanide, and highly soluble compounds such as nickel chloride (CCME 2015).

The primary source of exposure to nickel is typically from food (ATSDR 2005a). The absorption of ingested nickel in humans ranges from 3% to 40% depending on the form and solubility of the compound. The absorption of inhaled nickel ranges from 20% to 35%, varying with particle size and solubility.

Numerous epidemiologic studies investigating occupational exposures to nickel refinery dust has established a strong correlation between exposure and the incidence of lung cancer and nasal tumours (IRIS 2015). Consequently, nickel refinery dust is classified as a Group I carcinogen by Health Canada (HC), Group 1 carcinogen by the International Agency for Research on Cancer (IARC), and Group A carcinogen by the United States Environmental Protection Agency (US EPA).

Non-carcinogenic effects resulting from exposure to nickel vary with the uptake route, since nickel and its compounds often elicit contact dermatitis (allergic reaction which is thought to affect 10% to 20% of the general public); moreover, lung inflammation may follow inhalation of nickel and its compounds

(ATSDR 2005a). A wide-range of non-carcinogenic adverse effects have been documented in association with human oral ingestion of nickel compounds, including gastrointestinal upset and neurological symptoms. Animal studies have shown that nickel oral exposure may result in adverse effects to development, growth, reproduction and survival (ATSDR 2005a).

Nickel has been shown to accumulate in plants and some animals; however, it does not appear to biomagnify in food chains (ATSDR 2005a; CCME 2015).

### 1.13 Selenium

Selenium (Se) is a black, grey or red non-metal solid element with chemical properties similar to sulphur (ATSDR 2003). It has a molecular weight of 72.96 g/mol and a density of 4.39 g/cm<sup>3</sup> (red), 4.81 g/cm<sup>3</sup> (grey), or 4.28 g/cm<sup>3</sup> (black) g/cm<sup>3</sup>. Selenium typically exists in one of four oxidation states: -2, 0, +4 and +6.

Selenium is an essential nutrient and is incorporated in enzymes responsible for antioxidant defense (ATSDR 2003; BCMOE 2014). The margin between toxicity and essentiality of selenium is very narrow (BCMOE 2014). Selenium deficiencies can result in cardiovascular disease (i.e., enlarged heart, congestive heart failure), muscle pain, Kashin-Beck disease (atrophy, degeneration and necrosis of cartilage), loss of immunocompetence, and risk of miscarriage (ATSDR 2003; BCMOE 2014). No association has been found between the occurrence of cancer in humans and exposure to most forms of selenium; moreover, studies have shown that exposure to selenium may reduce the risk of cancer (ATSDR 2003). One selenium compound, selenium sulphide, has been shown to cause cancer in animals and is considered to be a probable human carcinogen by the US EPA; however, selenium is not considered to be a carcinogen by Health Canada (ATSDR 2003; CCME 2009). Selenium sulphide does not occur in food, does not dissolve in water and is considered to be safe for dermal exposure (i.e., commonly used in anti-dandruff shampoo) (ATSDR 2003). Exposure to excess selenium may result in non-carcinogenic effects to the respiratory and reproduction systems (ATSDR 2003).

Selenium has been shown to accumulate in plants and animals, and biomagnify in food chains (ATSDR 2003; BCMOE 2014).

### 1.14 Tellurium

Tellurium (Te) is a lustrous greyish-white metalloid that occurs naturally in earth's crust. The molecular weight of tellurium is 127.60 and the density is 6.11 to 6.27 g/cm<sup>3</sup> (HSDB 2017f; Salminen 2005). Tellurium has four main oxidation states (-2, +2, +4 and +6). Elemental tellurium does not occur in nature and is insoluble in water; however, some tellurium compounds are soluble in water (i.e., telluric acids).

No association has been found between the occurrence of cancer in humans and occupational exposure to tellurium (HSDB 2017f). Exposure to tellurium may result in a wide-range of non-carcinogenic effects in a variety of organ systems, including skin, gastrointestinal, hematological, musculoskeletal, neurological, urinary, and respiratory systems (HSDB 2017f). The primary target organs for tellurium are the organ with first contact (i.e., lungs, gastrointestinal tract, skin) and the nervous system (HSDB 2017f). Exposure to high doses of tellurium may result in blue-black skin discolouration, headache,

gastritis, somnolence, dizziness, fatigue, and lung irritation upon inhalation; whereas, chronic exposure to low doses may result in garlic breath, metallic taste, decreased sweating, dry mouth, fatigue, anorexia, and nausea (HSDB 2017f).

Tellurium is a rare earth metal and its concentration is low in the environment (HSDB 2017f). Tellurium has not been shown to not accumulate or biomagnify in food chains; however, limited studies are available investigating the fate of tellurium in food chains (HSDB 2017f).

## 1.15 Thallium

Thallium (Tl) is a greyish-white, soft, malleable heavy metal with a molecular weight of 204.38 g/mol and a density of 11.85 g/cm<sup>3</sup> (ATSDR 1992b; CCME 1999a). Thallium occurs in three main oxidation states (+1, +2 and +3) with the monovalent (+1) and trivalent (+3) being the most common (CCME 1999a). Thallium occurs naturally as inorganic and organic compounds with a wide-range of water solubility (ATSDR 1992b; CCME 1999a).

No association has been found between the occurrence of cancer in humans and occupational exposure to thallium (ATSDR 1992b). Exposure to elevated concentrations of thallium may a wide-range of non-carcinogenic effects to fetal development and various organ systems, including nervous, cardiovascular, gastrointestinal, hepatic, respiratory, ocular, and renal systems (ATSDR 1992b). The primary target organs for thallium toxicity were the nervous and cardiovascular systems, and fetal development (ATSDR 1992b). Exposure to high doses (e.g., over one gram) of thallium may result in death, blindness, vomiting, diarrhea, hair loss, muscle fiber necrosis, bradycardia, and myocardial necrosis; whereas, chronic exposure to low doses may result in birth defects, failing eye sight, neural degeneration, and myelin sheath delamination (ATSDR 1992b).

Thallium has been shown to accumulate in plants and some animals; however, it does not appear to biomagnify in food chains (ATSDR 1992b; HSDB 2017i).

## 1.16 Titanium

Titanium (Ti) is a dark grey lustrous metal with a molecular weight of 47.90 g/mol and a density of 4.506 g/cm<sup>3</sup> (HSDB 2017g). Titanium exist in four main oxidation states (0, +2, +3, and +4); however, the tetravalent (+4) form is the principal form in the environment (HSDB 2017g; Salminen 2005). Elemental titanium does not occur in nature (HSDB 2017g). Elemental titanium is considered insoluble in water and does not have a reported value for octanol–water partition coefficient; however, some titanium compounds are soluble in water (i.e., titanium oxides and hydroxides) (HSDB 2017g; Salminen 2005).

Numerous animal studies investigating exposures to titanium dioxide have provided sufficient evidence for a correlation between exposure and the incidence of cancer; however, there is insufficient evidence in humans for carcinogenicity (CCOHS 2013; IARC 2010). Consequently, titanium dioxide is classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC) and Class D2A (carcinogenic) by the Canadian Centre for Occupational Health and Safety in the Workplace Hazardous Materials Information System (CCOHS 2013; CCOHS 2017; IARC 2010). The United States Environmental Protection Agency and National Institute for Occupational Safety and Health (NIOSH) do not classify titanium dioxide as a carcinogen (USEPA 2010; NIOSH 2011). No

association has been found between the occurrence of cancer in humans and occupational exposure to titanium compounds, including titanium dioxide (HSDB 2017g; IARC 2010; NIOSH 2011).

Exposure to elevated concentrations of naturally occurring titanium may result a wide-range of non-carcinogenic effects to various organ systems, including gastrointestinal, nervous, hepatic, reproductive, renal, and cardiovascular (HSDB 2017g). The primary target organ for naturally occurring titanium compounds is the lung (HSDB 2017g). Limited human data is available; however, animal studies indicate that exposure to high doses of naturally occurring titanium may result in strong immune response, pulmonary inflammation, enhanced proliferation of pulmonary cells, atherosclerosis, disturbances in energy and amino acid metabolism, and liver and heart damage (HSDB 2017g; HSDB 2017h; Shi et al. 2013). Chronic exposure to low doses may result in irritation of respiratory tract, defects in macrophage function, enhanced proliferation of pulmonary cells, metaplasia, pulmonary inflammation, pneumonia, and lesions in the kidney, lungs and spleen (HSDB 2017g; HSDB 2017h; Shi et al. 2013).

Limited studies have investigated bioaccumulation of titanium compounds; however, they are not expected to accumulate in plants or animals and thus, they are not considered to biomagnify in food chains (Doyle et al., 2015; HSDB 2017g; Oliver et al., 2015).

## 1.17 Vanadium

Vanadium (V) is a grey metal with a molecular weight of 50.9415 g/mol and a density of 6.11 g/cm<sup>3</sup> (ATSDR 2012c). Vanadium may exist in six oxidation states (-2, -1, +2, +3, +4, +5); however, it is commonly found as +3, +4 and +5 (ATSDR 2012c). Elemental vanadium does not occur in nature. Elemental vanadium is considered insoluble in water and does not have a reported value for octanol-water partition coefficient; however, some vanadium compounds are soluble in water (i.e., vanadium pentoxide) (ATSDR 2012c).

There is an insufficient amount of evidence to determine if exposure to vanadium may result in an increased incidence of cancer (ATSDR 2012c). Exposure to excess vanadium has been shown to elicit a variety of toxic effects including dermal irritation on contact, stomach irritation upon ingestion, and haematological effects (ATSDR 2012c).

Vanadium has been shown to accumulate in plants and some animals; however, there is no evidence of biomagnification in food chains (ATSDR 2012c). Human studies suggest that biomagnification is unlikely due to the rapid and complete excretion of absorbed vanadium, with no evidence of long-term accumulation (ATSDR 2012c).

## 1.18 Zinc

Zinc (Zn) is a bluish-white, shiny metal and one of the most common elements in the earth's crust. It has a molecular weight of 65.38 g/mol and a density of 7.14 g/cm<sup>3</sup> (ATSDR 2005b). Zinc exists in one of three oxidation states: +2, +1, and 0. Pure zinc is highly reactive with water and may spontaneously combust in damp areas. Consequently, zinc predominantly exists in a variety of inorganic and organic compounds. Zinc compounds have a wide-range of water solubility; however, pure zinc is considered to be insoluble in water (ASTDR 2005b).

Exposure to excess zinc has been shown to elicit a variety of toxic effects including infertility, decreased birth weight, pancreatic damage, anaemia, nausea, vomiting and skin irritation. Zinc deficiency can result in a wide range of adverse effects including decreased immune response, birth defects, slow wound healing, and slow growth (CCME 1999).

Zinc has been shown to accumulate in some plants and animals; however, it does biomagnify in food chains (ATSDR 2005b).

## 1.19 Nitrogen Dioxide

### 1.19.1 Inhalation Exposure Limits

#### 1.19.1.1 Acute Inhalation

Table E1 presents the acute inhalation exposure limits for nitrogen dioxide.

**Table E1. Acute Inhalation Exposure Limits for Nitrogen Dioxide**

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
ATSDR	-	-	-	-	-	ATSDR 2013
B.C. MOE	1-hour	188	-	-	-	B.C. MOE 2014
CCME	1-hour 24-hour NAAQO	400 200	-	-	-	CCME 1999g
METRO VANCOUVER	1-hour AAQO	200	-	-	Adopted NAAQO	MV 2011
OEHHA	1-hour REL	470	Respiratory system	Human	CARB, 1992	OEHHA 2008; 2014
TCEQ	-	-	-	-	-	TCEQ 2014
US EPA	1-hour NAAQS	188	Respiratory system	Human	Various	US EPA 2008; 2012
WHO	1-hour	200	Respiratory system	Human	Various	WHO 2006

Clinical studies of controlled human exposure have reported increased airway responsiveness to inhaled allergens in sensitive individuals as a result of acute exposure to nitrogen dioxide while



epidemiological studies have correlated ambient nitrogen dioxide exposure with increased respiratory symptoms, emergency department visits and hospital admissions (e.g., US EPA 2008).

The desirable Canadian NAAQOs for NO<sub>2</sub> are 400 µg/m<sup>3</sup> for a 1-hour averaging time and 200 µg/m<sup>3</sup> over 24 hours (CCME 1999). The Metro Vancouver (2011) 1-hour AAQO reflects the Canadian 1-hour desirable NAAQO for nitrogen dioxide. Supporting health-based documentation is not available for the nitrogen dioxide NAAQO values. Canada Ambient Air Quality Standards (CAAQS), defined by Environment Canada (2013) as *health-based air quality objectives for pollutant concentrations in outdoor air*, are being developed for Canada under the current Air Quality Management System. There are currently no CAAQS for nitrogen dioxide, although work has been initiated by federal, provincial and territorial governments (CCME 2013; Environment Canada 2013).

The OEHHA (2008; 2014) recommends a 1-hour REL of 470 µg/m<sup>3</sup>. This REL was equivalent to a NOAEL for increased airway reactivity in asthmatics exposed to nitrogen dioxide for 1 hour (CARB, 1992).

The US EPA (2008, 2012) has implemented a 1-hour NAAQS of 188 µg/m<sup>3</sup> to protect against the respiratory effects of nitrogen dioxide. This standard considers the 3-year average of the 98<sup>th</sup> percentile of the yearly distribution of 1-hour daily maximum nitrogen dioxide concentrations. B.C. MOE (2014) recommends the same objective (188 µg/m<sup>3</sup>) for 1-hour exposure to nitrogen dioxide, with achievement based on the annual 98th percentile of daily 1- hour maximum values, over one year.

In controlled exposure studies, acute effects on the pulmonary function of asthmatics were observed at nitrogen dioxide concentrations levels greater than 500 µg/m<sup>3</sup>, with one meta-analysis suggesting an increase in bronchial responsiveness in asthmatics exposed to air concentrations above 200 µg/m<sup>3</sup> (Folinsbee 1992 cited in WHO 2006). The WHO (2006) has therefore set a 1-hour exposure limit of 200 µg/m<sup>3</sup> for short-term exposure to nitrogen dioxide.

Considering the weight of available evidence for airway reactivity of susceptible individuals (e.g., asthmatics) exposed to nitrogen dioxide, the lowest reported exposure limit, US EPA NAAQS of 188 µg/m<sup>3</sup>, was selected for use in the acute effects assessment of nitrogen dioxide. Nitrogen dioxide was included in the chemical group for respiratory irritation following acute inhalation exposures.

### 1.19.1.2 Chronic Inhalation

Table E2 presents the chronic inhalation exposure limits for nitrogen dioxide.

**Table E2 Chronic Inhalation Exposure Limits for Nitrogen Dioxide**

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
ATSDR	-	-	-	-	-	ATSDR 2013
B.C. MOE	Annual AAQO	60				B.C. MOE 2014
CCME	Annual Average NAAQO	60	-	-	-	CCME 1999g
METRO VANCOUVER	Annual AAQO	40	-	-	-	MV 2011
OEHHA	-	-	-	-	-	OEHHA 2014
RIVM	-	-	-	-	-	RIVM, 2001
TCEQ	-	-	-	-	-	TCEQ 2014
US EPA	Annual Average NAAQS	100	Respiratory system	Human	Various	US EPA 2008; 2012
WHO	Annual Average	40	Respiratory system	Human	Various	WHO 2006; 2000

The desirable annual average NAAQO for  $\text{NO}_2$  is  $60 \mu\text{g}/\text{m}^3$  (CCME 1999) which is the same as the B.C. MOE annual air quality objective for  $\text{NO}_2$  (B.C. MOE 2014). No supporting documentation was available for these objectives. The WHO (2000, 2006) established an annual average guideline value of  $40 \mu\text{g}/\text{m}^3$  for  $\text{NO}_2$ . In the absence of a particular study or set of studies that clearly support an annual average guideline, the WHO considered background ambient levels of  $15 \mu\text{g}/\text{m}^3$  and evidence of a 20% increase in respiratory illness in primary children with an increase of  $28 \mu\text{g}/\text{m}^3$  nitrogen dioxide indoors (averaged over 1 year) (WHO 1997). The annual AAQO recommended for nitrogen dioxide by Metro Vancouver (2011) reflects the WHO (2000, 2006) guideline.

The US EPA (2012) annual standard for  $\text{NO}_2$  is  $100 \mu\text{g}/\text{m}^3$ . This exposure limit is based on limited evidence to support a link between long-term exposure to nitrogen dioxide and adverse respiratory

effects, particularly for persons with pre-existing pulmonary dysfunction (US EPA 2008).

Considering the available evidence for respiratory illness in children and individuals with pre-existing pulmonary dysfunction following long-term exposure to NO<sub>2</sub>, the lowest WHO guideline of 40 µg/m<sup>3</sup> was selected for the assessment of chronic inhalation exposure to NO<sub>2</sub>.

## 1.20 Particulate Matter

### 1.20.1 Inhalation Exposure Limits

#### 1.20.1.1 Acute Inhalation

Tables E3 and E4 present the acute inhalation exposure limits for fine PM (≤2.5 µm in diameter; PM<sub>2.5</sub>) and coarse PM (≤10 µm in diameter; PM<sub>10</sub>) respectively.

**Table E3 Acute Inhalation Exposure Limits for Fine PM ( ≤2.5 µm inDiameter)**

Agency	Exposure Limit Type	Exposure Limit Value (µg/m <sup>3</sup> )	Critical Organ or Effect	Species	Study	Source
ATSDR	-	-	-	-	-	ATSDR 2013
B.C. MOE	24 hour AAQO	25	-	-	-	B.C. MOE 2013
CCME	24-hour CWS/CAA QS	27-30	Population mortality and morbidity	Human	Various	CCME 2012; 2000
CARB	24 hour AAQS	-	-	-	-	CARB 2009
METRO VANCOUVER	24 hour AAQO	25	-	-	-	MV 2011
TCEQ	-	-	-	-	-	TCEQ 2014
US EPA	24-hour	35	Population mortality and morbidity	Human	Various	US EPA 2012; 2009
WHO	24-hour	25	Population mortality and morbidity	Human	Various	WHO 2006

**Table E4 Acute Inhalation Exposure Limits for Coarse PM ( $\leq 10 \mu\text{m}$  in Diameter)**

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
ATSDR	-	-	-	-	-	ATSDR 2013
B.C. MOE	24 hour AAQO	50	-	-	-	B.C. MOE 2013
CCME	-	-	-	-	-	CCME 2012; 2000
CARB	24 hour AAQS	50	Population mortality and morbidity	Human	Various	CARB 2009
METRO VANCOUVER	24 hour AAQO	50	-	-	-	MV 2011
TCEQ	-	-	-	-	-	TCEQ 2014
US EPA	24-hour	150	Population mortality and morbidity	Human	Various	US EPA 2012; 2009
WHO	24-hour	50	Based on PM <sub>2.5</sub>	Human	Based on PM <sub>2.5</sub>	WHO 2006

The CCME (2000) developed a 24-hour Canada Wide Standard (CWS) of  $30 \mu\text{g}/\text{m}^3$  for fine particulate matter (PM<sub>2.5</sub>). The CWS is based on the 3-year average of the annual 98<sup>th</sup> percentile of the 24-hour average concentrations. The PM<sub>2.5</sub> CWS was based on the weight of available evidence for an association between acute exposure to ambient fine particulate matter and increased population mortality and morbidity, particularly related to the cardiovascular and respiratory systems, reported in numerous epidemiological studies from the US, Canada, Britain and Europe (WGAQOG 1998; Health Canada 2000; US EPA 2009).

The available data (e.g., epidemiological studies of large populations) have not identified a threshold concentration below which adverse effects do not occur; therefore, actions to reduce ambient PM<sub>2.5</sub> concentrations are considered an improvement in air quality that will be beneficial to human health (CCME, 2000; WHO 2006). In addition to the CWS for fine particulate matter, the CCEM (2000) provides guidance for i) continuous improvement and ii) keeping clean areas. This guidance is intended to reinforce the health benefits of lowering ambient PM<sub>2.5</sub> air concentrations and dissuade actions that could result in "polluting up" to the CWS in areas where ambient PM<sub>2.5</sub> concentrations are low.

In May 2013, the Canadian Ambient Air Quality Standards (CAAQS) for PM<sub>2.5</sub> were published in the

Canada Gazette (Vol 147, No. 21). The CAAQS replaced the existing CWS for fine particulate matter, based on amendments to the Canadian Environmental Protection Act in 2013. In keeping with the intent for continuous improvement of air quality, the 24-hour  $PM_{2.5}$  standard to be achieved by 2015 was  $28 \mu\text{g}/\text{m}^3$  with a slightly more stringent standard of  $27 \mu\text{g}/\text{m}^3$  recommended for 2020 (CCME 2012). The CAAQS is based on the 3-year average of the annual 98<sup>th</sup> percentile of the 24-hour average concentrations. The CCME (2000, 2012) have not established standards specific to coarse particulate matter ( $PM_{10}$ ) as the management of  $PM_{2.5}$  was considered to result in the greatest health benefits and reductions in fine particulate matter are expected to reduce concentrations of coarse particulate matter (CCME 2000).

The California Air Resources Board (CARB 2009) have established an acute ambient air quality standard of  $50 \mu\text{g}/\text{m}^3$  (24-hour average) for  $PM_{10}$ . The acute health effects noted for coarse particulate matter exposure include worsening symptoms of asthma and acute bronchitis, particularly in the elderly and very young, as well as increased mortality or risk of hospitalization due to respiratory illness and lung disease (CARB 2009).

The US EPA (2012) implemented a 24-hour primary standard (NAAQS) of  $35 \mu\text{g}/\text{m}^3$  for  $PM_{2.5}$  based on the 3-year average of 98<sup>th</sup> percentile concentrations. This standard is intended to increase protection against adverse health effects associated with acute exposure to respirable particles, including cardiovascular and respiratory effects and premature mortality (US EPA 2009). The US EPA (2012) also recommend an acute NAAQS of  $150 \mu\text{g}/\text{m}^3$  for  $PM_{10}$  which is not to be exceeded more than once per year over a 3-year average. Similar to  $PM_{2.5}$ , this standard is based on evidence of a causal relationship between acute exposure to coarse particulate matter ( $PM_{10-2.5}$ ) and cardiovascular effects, respiratory effects and mortality. The evidence for these associations was limited in comparison to the evidence for  $PM_{2.5}$  and these associations were only apparent for short-term (not long-term) exposures to  $PM_{10-2.5}$  (US EPA 2009).

The WHO (2006) recommends a 24-hour guideline of  $25 \mu\text{g}/\text{m}^3$  for  $PM_{2.5}$  and a 24-hour guideline of  $50 \mu\text{g}/\text{m}^3$  for  $PM_{10}$ . The 24-hour guidelines refer to the 99th percentile of the distribution of daily values (i.e. the fourth next highest value of the year). The acute PM guidelines are intended to protect against peaks of pollution that could result in excess morbidity or mortality. The acute  $PM_{2.5}$  guideline was established based on relationships between the distributions of 24-hour means and annual average PM concentrations. The acute guideline for  $PM_{10}$  was developed using  $PM_{2.5}$  as an indicator of potential health effects and applying a  $PM_{2.5}/PM_{10}$  ratio of 0.5, which represents the approximate ratio of  $PM_{2.5}/PM_{10}$  observed in urban areas. It is noted that the WHO (2006) prefers the use of the  $PM_{2.5}$  guideline for the evaluation of PM exposure. Similar to the WHO (2006), the B.C. MOE (2013; 2009) also recommend 24-hour guidelines of  $25 \mu\text{g}/\text{m}^3$  for  $PM_{2.5}$  and  $50 \mu\text{g}/\text{m}^3$  for  $PM_{10}$ , which have been adopted by Metro Vancouver (2011).

The WHO (2006) also recommend three interim 24-hour target levels as a stepped approach for

countries as they develop abatement measures to move towards eventual compliance with the guidelines. The highest interim targets are 75 and 150  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$ , respectively. These targets are associated with an approximate 5% increase in short-term mortality risk, relative to the short-term mortality risk at the recommended air quality guidelines. The next interim targets of 50  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$  and 100  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{10}$  are associated with  $\sim 2.5\%$  increase in short-term mortality risk compared to the guidelines. The lowest interim targets of 37.5 and 75  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$ , respectively, are associated with  $\sim 1.2\%$  increase in short-term mortality. These risk estimates were determined using published risk coefficients from multi-centre epidemiological studies and meta-analyses (WHO 2006).

The lowest recommended 24-hour guidelines of 25  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$  and 50  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{10}$  (WHO 2006) were selected for the assessment of potential health risks following acute inhalation exposure to fine and coarse particulate matter, recognizing the health benefits of maintaining ambient  $\text{PM}_{2.5}$  air concentrations as low as possible.

$\text{PM}_{2.5}$  and  $\text{PM}_{10}$  were included in the population mortality/morbidity group for acute (24-hour) inhalation exposures.

#### 1.20.1.2 Chronic Inhalation

Tables E5 and E6 presents the chronic inhalation exposure limits for  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$  respectively.

**Table E5 Chronic Inhalation Exposure Limits for  $\text{PM}_{2.5}$**

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
ATSDR	-	-	-	-	-	ATSDR 2013
B.C. MOE	Annual Average AAQO	8 (objective) 6 (goal)	-	-	-	B.C. MOE 2013
CCME	Annual Average CAAQS	8.8-10	Premature mortality	Human	Various	CCME 2012; 2000
CARB	Annual Average	12	Population mortality /morbidity	Human	Various	CARB 2009

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
METRO VANCOUVER	Annual Average AAQO	8 (objective) 6 (goal)	-	-	-	MV 2011
RIVM	-	-	-	-	-	RIVM, 2001
TCEQ	-	-	-	-	-	TCEQ 2014
US EPA	Annual Average NAAQS	12	Population mortality/morbidity	Human	Various	US EPA 2012; 2009
WHO	Annual Average	10	Population mortality/morbidity	Human	Pope et al., 2002, others	WHO 2006; 2000

**Table E6 Chronic Inhalation Exposure Limits for PM<sub>10</sub>**

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
ATSDR	-	-	-	-	-	ATSDR 2013
B.C. MOE	Annual Average AAQO		-	-	-	B.C. MOE 2013
CCME	-	-	-	-	-	CCME 2012; 2000
CARB	Annual Average	20	Population mortality/morbidity	Human	Various	CARB 2009
METRO VANCOUVER	Annual Average AAQO	20	-	-	-	MV 2011
RIVM	-	-	-	-	-	RIVM, 2001
TCEQ	-	-	-	-	-	TCEQ 2014

Agency	Exposure Limit Type	Exposure Limit Value ( $\mu\text{g}/\text{m}^3$ )	Critical Organ or Effect	Species	Study	Source
US EPA	-	-	-	-	-	US EPA 2012; 2009
WHO	Annual Average	20	Based on PM <sub>2.5</sub>		Based on PM <sub>2.5</sub>	WHO 2006; 2000

Annual average CAAQS for PM<sub>2.5</sub> were published in the Canada Gazette in May 2013. The annual average standard to be achieved by 2015 will be 10  $\mu\text{g}/\text{m}^3$  with a slightly more stringent standard of 8.8  $\mu\text{g}/\text{m}^3$  recommended for 2020. The CAAQS is based on the 3-year average of the annual average concentrations (CCME 2012).

The CARB (2009) established annual ambient air quality standards of 12 and 20  $\mu\text{g}/\text{m}^3$  (arithmetic means) for PM<sub>2.5</sub> and PM<sub>10</sub>, respectively. These standards are intended to protect against increased risk of hospitalization for lung and heart-related illness, premature death of the elderly and individuals with compromised pulmonary function, and reduced lung function or increased respiratory symptoms/illness in children.

The US EPA (2012) has implemented a primary annual standard (NAAQS) of 12  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub> based on the 3-year average of 98<sup>th</sup> percentile concentrations. The annual standard is intended to continue protection against adverse health effects associated with chronic exposure to respirable particles, including cardiovascular effects, respiratory effects, and premature mortality (US EPA 2009).

The WHO (2006) established an annual mean guideline of 10  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub>. This guideline represents the lower end of the air concentration range in the American Cancer Society (ACS) epidemiological study at which robust associations were reported between mortality and long-term exposure to PM<sub>2.5</sub> (Pope et al., 2002). Although threshold levels were not identified, the long-term epidemiological studies reported robust associations between PM<sub>2.5</sub> exposure and mortality and annual average target concentrations for PM<sub>2.5</sub> should take precedence over 24-hour average concentrations (WHO 2006). An annual mean guideline of 20  $\mu\text{g}/\text{m}^3$  is recommended for PM<sub>10</sub> assuming a PM<sub>2.5</sub>/PM<sub>10</sub> ratio of 0.5 and using PM<sub>2.5</sub> as an indicator of potential health effects.

Three interim target levels were developed for the annual mean guidelines for PM as a stepped approach for countries as they develop successive and sustained abatement measures to move towards eventual compliance with the recommended air quality guidelines (WHO 2006). The highest interim targets (35 and 70  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub> and PM<sub>10</sub>, respectively) are associated with a 15% higher long-term mortality risk relative to the mortality risk at the lowest recommended air quality guideline. Attainment of intermediate interim targets (25 and 50  $\mu\text{g}/\text{m}^3$  for PM<sub>2.5</sub> and PM<sub>10</sub>, respectively) is



expected to lower the mortality risks by 6% when compared to the highest interim targets. The lowest interim targets (15 and 30  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$ , respectively) would reduce by the mortality risks by a further 6%, compared to the intermediate targets (WHO 2006).

The B.C. MOE (2009, 2013) have established an annual air quality objective of 8  $\mu\text{g}/\text{m}^3$  and, in the absence of a safe threshold for human health effects, a planning goal of 6  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$ . The intent of the planning goal being *to guide airshed planning efforts and encourage communities to maintain good air quality in the face of economic growth and development* (B.C. MOE 2009). The annual objectives recommended for  $\text{PM}_{2.5}$  by B.C. MOE (2013) have been adopted by Metro Vancouver (2011).

In the absence of an identified threshold for mortality risks associated with long-term exposure to  $\text{PM}_{2.5}$  (WHO 2006), the lowest recommended guideline of 6  $\mu\text{g}/\text{m}^3$  (B.C. MOE 2013) was adopted for the current assessment of risks associated with chronic inhalation exposure to  $\text{PM}_{2.5}$ . The chronic guideline of 20  $\mu\text{g}/\text{m}^3$ , supported by WHO (2006), CARB (2009); B.C. MOE (2013) and Metro Vancouver (MV 2011), was selected for the assessment of long-term exposure to  $\text{PM}_{10}$ .

$\text{PM}_{2.5}$  and  $\text{PM}_{10}$  were included in the population mortality/morbidity group for chronic inhalation exposures.

## 1.21 References

- Agency for Toxic Substances and Diseases Registry (ATSDR). 1992a. Toxicological Profile for Antimony. United States Department of Health and Human Services. August 1992. Available online at:  
<http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=58>
- ATSDR. 1992b. Toxicological Profile for Thallium. United States Department of Health and Human Services. July 1992. Available online at:  
<https://www.atsdr.cdc.gov/toxprofiles/tp54.pdf>
- ATSDR. 1999. Toxicological Profile for Mercury. United States Department of Health and Human Services. March 1999.
- ATSDR. 2003. Toxicological Profile for Selenium. United States Department of Health and Human Services. September 2003. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp92.pdf>

- ATSDR. 2004. Toxicological Profile for Cobalt. United States Department of Health and Human Services. April 2004. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp33.pdf>
- ATSDR. 2005a. Toxicological Profile for Nickel. United States Department of Health and Human Services. August 2005. Available online at:  
<http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=245&tid=44>
- ATSDR. 2005b. Toxicological Profile for Zinc. United States Department of Health and Human Services. August 2005. Available online at:  
<http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=206&tid=37>
- ATSDR. 2007a. Toxicological Profile for Arsenic. United States Department of Health and Human Services. August 2007. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=22&tid=3>
- ATSDR. 2007b. Toxicological Profile for Barium. United States Department of Health and Human Services. August 2007. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=327&tid=57>
- ATSDR. 2007c. Toxicological Profile for Lead (Update). United States Department of Health and Human Services. August 2007. Available online at:  
<http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=96&tid=22>
- ATSDR. 2008. Toxicological Profile for Aluminum. United States Department of Health and Human Services. August 2008. Available online at:  
<https://www.atsdr.cdc.gov/toxprofiles/tp22.pdf>
- ATSDR. 2012a. Toxicological Profile for Cadmium. United States Department of Health and Human Services. September 2012. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=48&tid=15>
- ATSDR. 2012b. Toxicological Profile for Chromium. United States Department of Health and Human Services. September 2012. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=62&tid=17>
- ATSDR. 2012c. Toxicological Profile for Vanadium. United States Department of Health and Human Services. September 2012. Available online at:  
<http://www.atsdr.cdc.gov/toxprofiles/tp58.pdf>
- ATSDR. 2013. Minimal Risk Levels (MRLs) for Hazardous Substances. July 2013. US Department of Health and Human Services, Public Health Service. Atlanta, GA. Available at <http://www.atsdr.cdc.gov/mrls/mrllist.asp>. Accessed May 2014.
- British Columbia Ministry of Environment (BCMOE). 1987. Water Quality Criteria for Lead. Technical Appendix. November 1987.

- BCMOE. 1989. Ambient Water Quality Criteria for Mercury. Technical Appendix. July 1989.
- BCMOE. 2008a. Ambient Water Quality Guidelines for Iron. February 28, 2008.
- BCMOE. 2008b. Detailed Ecological Risk Assessment (DERA) in British Columbia. Technical Guidance. Science Advisory Board for Contaminated Sites in British Columbia. September 2008.
- BCMOE. 2009. Guidance on Application of Provincial Air Quality Criteria for PM<sub>2.5</sub>. Ministry of Healthy Living and Sport. Available at <http://www.bcairquality.ca/reports/pdfs/pm25-implement-guide.pdf>.
- BCMOE. 2013. Provincial Air Quality Objective Information Sheet. British Columbia Ambient Air Quality Objectives. Available at <http://www.env.gov.bc.ca/epd/bcairquality/reports/pdfs/aqotable.pdf>.
- BCMOE. 2014. Ambient Water Quality Guidelines for Selenium. Technical Report. August 2014.
- CCME (Canadian Council of Ministers of the Environment). 1999a. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Chromium.
- Canadian Council of Ministers of the Environment (CCME). 1999b. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Chromium.
- CCME. 1999c. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Lead (1999).
- CCME. 1999d. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Mercury.
- CCME. 1999e. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Thallium.
- CCME. 1999f. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Zinc.
- CCME. 1999g. Canadian National Ambient Air Quality Objectives: Process and Status. Canadian Environmental Quality Guidelines. CCME. Available at <http://ceqg-rcqe.ccme.ca/>.
- CCME. 2000. Canada-Wide Standards for Particulate Matter (PM) and Ozone. Endorsed by CCME Council of Ministers, Quebec City. Available at [http://www.ccme.ca/assets/pdf/pmozone\\_standard\\_e.pdf](http://www.ccme.ca/assets/pdf/pmozone_standard_e.pdf). 4.
- CCME. 2001a. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Arsenic (Inorganic) (1997).

- CCME. 2001b. Canadian Soil Quality Guidelines for the Protection of Aquatic Life: Arsenic.
- CCME. 2009. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Selenium (2009).
- CCME. 2012. Air Quality Management System. Canadian Ambient Air Quality Standards (CAAQS) for Fine Particulate Matter (PM<sub>2.5</sub>) and Ozone. Available at [http://www.ccme.ca/ourwork/air.html?category\\_id=146#490](http://www.ccme.ca/ourwork/air.html?category_id=146#490).
- CCME. 2013. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Barium.
- CCME. 2014. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Cadmium.
- CCME. 2015. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Nickel.
- Canadian Centre for Occupational Health and Safety (CCOHS). 2013. Titanium Dioxide Classified as Possibly Carcinogenic to Humans. Available online at: <https://www.ccohs.ca/headlines/text186.html>. Last accessed on May 27, 2017.
- CCOHS. 2017. WHMIS 1998 Classifications from CHEMINFO. Titanium Dioxide. Available online at: <http://ccinfoweb2.ccohs.ca/whmis/records/321E.html>. Last accessed on May 27, 2017.
- Canadian Environmental Protection Act (CEPA). 1993a. Arsenic and its Compounds – Priority Substance List 1. Available online at: <http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=D4CB7B42-1>
- CEPA. 1993b. Chromium and its Compounds – Priority Substance List 1. Available online at: <http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=6752A187-1>
- CEPA. 1994. Cadmium and its Compounds – Priority Substance List 1. Available online at: [http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/cadmium\\_comp/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/cadmium_comp/index-eng.php)
- California Air Resources Board (CARB). 1992. Review of the one-hour ambient air quality standard for nitrogen dioxide technical support document. Sacramento: State of California Air Resources Board Technical Support Division. Cited In: OEHHA 2012.
- CARB. 2009. Ambient Air Quality Standards (AAQS) for Particulate Matter. Available at <http://www.arb.ca.gov/research/aaqs/pm/pm.htm>.
- Doyle JJ, Ward JE, Mason R. 2015. An examination of the ingestion, bioaccumulation, and depuration of titanium dioxide nanoparticles by the blue mussel (*Mytilus edulis*) and

- the eastern oyster (*Crassostrea virginica*). *Marine Environmental Research*. 110: 45-52.
- Eisler R. 1988. Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. United States Fish and Wildlife Service Biological Report 85(1.14), Contaminant Hazard Reviews Report No. 14. 134 pp.
- Environment Canada. 2013. Background: Canadian Ambient Air Quality Standards. Available at <http://ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=A4B2C28A-2DFB-4BF4-8777-ADF29B4360BD>.
- Fowler BA, Sullivan DW, Sexton MJ. 2015. Handbook on the Toxicology of Metals. Fourth Edition.
- Hazardous Substance Data Bank (HSDB). 2017a. Antimony Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~HeSxxM:2>. Last accessed on May 31, 2017.
- HSDB. 2017b. Bismuth Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~0g5fkz:4>. Last accessed on: May 25, 2017.
- HSDB. 2017c. Chromium Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~HfbnJi:2>. Last accessed on May 31, 2017.
- HSDB. 2017d. Iron Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~RG1P5a:1>. Last accessed on: May 24, 2017.
- HSDB. 2017e. Lead Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+7407>. Last accessed on May 20, 2017.
- HSDB. 2017f. Tellurium Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~R3USIx:2>. Last accessed on May 25, 2017.
- HSDB. 2017g. Titanium Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~H3wAEy:3>. Last accessed on May 25, 2017.
- HSDB. 2017h. Titanium Oxide Nanoparticles. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~YfsGa4:5>. Last accessed on May 27, 2017.
- HSDB. 2017i. Thallium Compounds. Available online at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~yMkp5A:2>. Last accessed on May 31, 2017.
- Health Canada. 2000. Priority Substances List Assessment Report. Respirable Particulate Matter Less Than or Equal to 10 Microns. ISBN 0-662-28531-X. Cat. no. En40-215/47E. Environment Canada, Health Canada, Canadian Environmental Protection

Act, 1999. Available at [http://www.hc-sc.gc.ca/ewh-semt/alt\\_formats/hecs-sesc/pdf/pubs/contaminants/psl2-lsp2/pm10/pm10-eng.pdf](http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/psl2-lsp2/pm10/pm10-eng.pdf).

International Agency for Research on Cancer (IARC). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 93: Carbon Black, Titanium Dioxide and Talc. 2010.

Keen CL, Leach RM. In: Handbook on toxicity of inorganic compounds. Seiler HG, Sigel H, Sigel A, editors. New York: Marcel Dekker; 1987. pp. 405–415.

Kondakis XG, Makris N, Leotsinidis M, Prinou M, Papapetropoulos T. 1989. Possible health effects of high manganese concentration in drinking water. Arch. Environ. Health, 44(3): 175–178.

Metro Vancouver (MV). 2011. Metro Vancouver Integrated Air Quality and Greenhouse Gas Management Plan. Available at <http://www.metrovancouver.org/services/air/ReviewProcess/Pages/default.aspx>.

National Academy of Sciences (NAS). 1980. Mineral Tolerance of Domestic Animals. National Research Council, Committee on Animal Nutrition, Board on Agriculture and Renewable Resources, Commission on Natural Resources. Washington, D.C.

National Institute for Occupational Safety and Health (NIOSH). 2011. Occupational Exposure to Titanium Dioxide. April 2011.

National Institute of Public Health and the Environment (RIVM). 2001. Re-evaluation of human toxicological maximum permissible risk levels. RIVM Report 711701 025.

National Research Council (NRC). 1989. Recommended dietary allowances. National Research Council (ed.). 10th edition. National Academies Press, Washington, D.C.

NRC. 2005. Mineral Tolerance of Animals. Second Revised Edition.

Office of Environmental Health Hazard Assessment (OEHHA). 2008. Technical Support Document for Noncancer RELs. Appendix D.2. Acute RELs and toxicity summaries using the previous version of the Hot Spots Risk Assessment Guidelines. Acute Toxicity Summary: Nitrogen Dioxide. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Air Toxicology and Epidemiology. Available at [http://www.oehha.ca.gov/air/hot\\_spots/2008/AppendixD2\\_final.pdf#page=209](http://www.oehha.ca.gov/air/hot_spots/2008/AppendixD2_final.pdf#page=209).

OEHHA. 2014. Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary Table as of January 2014. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Air Toxicology and Epidemiology. Available at <http://www.oehha.ca.gov/air/allrels.html>.

- Oliver AL, Munoz R, Landaluze J, Rainieri S, Camara C. 2015. Bioaccumulation of Ionic Titanium and Titanium Dioxide Nanoparticles in Zebrafish Eleutheroembryos. *Nanotoxicology*. 9:835-42.
- Pope CA et al. 2002. Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution. *Journal of the American Medical Association*, 287:1132– 1141. Cited In: WHO 2006.
- Salminen (chief editor). 2005. *Geochemical Atlas of Europe, Part 1 – Background Information, Methodology and Maps*. Geological Survey of Finland.
- Shi H, Magaye R, Castranova V, Zhao J. 2013. Titanium Dioxide Nanoparticles: A Review of Current Toxicological Data. *Particle and Fibre Toxicology* 10:15.
- Schroeder HA, Balassa JJ, Tipton IH. 1966. Essential trace metals in man: manganese. A study in homeostasis. *J. Chronic Dis.*, 19:545.
- Stansley W, Roscoe DE. 1996. The Uptake and Effects of Lead in Small Mammals and Frogs at a Trap and Skeet Range. *Arch Environ Contam Toxicol*. 30(2):220-6.
- Texas Commission on Environmental Quality (TCEQ). 2014. Effects Screening Levels List. Available at [http://www.tceq.texas.gov/toxicology/esl/list\\_main.html](http://www.tceq.texas.gov/toxicology/esl/list_main.html).
- United States Environmental Protection Agency (USEPA). 1984. Health assessment document for manganese. Cincinnati, OH, US Environmental Protection Agency, Environmental Criteria and Assessment Office.
- USEPA. 2003. Ecological Soil Screening Levels for Iron. Revised November 2003.
- USEPA. 2008. Integrated Science Assessment for Oxides of Nitrogen - Health Criteria. National Center for Environmental Assessment. EPA/600/R-08/071. <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=194645>.
- USEPA. 2009. Integrated Science Assessment for Particulate Matter. National Center for Environmental Assessment-RTP Division, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA/600/R-08/139F. Available at <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546>.
- USEPA. 2010. Nanomaterial Case Studies: Nanoscale Titanium Dioxide in Water Treatment and in Topical Sunscreen. November 2010.
- USEPA. 2012. National Ambient Air Quality Standards (NAAQS). Washington, DC: U.S. Environmental Protection Agency, Office of Air and Radiation. Available at <http://www.epa.gov/air/criteria.html>.
- USEPA. 2017. Intergrated Risk Information System. Available online at: <https://www.epa.gov/iris>.

- Working Group on Air Quality Objectives and Guidelines (WGAQOG). 1998. National Ambient Air Quality Objectives for Particulate Matter. 1: Science Assessment Document. A report prepared by the Federal–Provincial Working Group on Air Quality Objectives and Guidelines for the Canadian Environmental Protection Act Federal–Provincial Advisory Committee. Available at [http://www.hc-sc.gc.ca/ewh-semt/pubs/air/naaqo-onqaa/particulate\\_matter\\_matiere\\_particulaires/summary-sommaire/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/air/naaqo-onqaa/particulate_matter_matiere_particulaires/summary-sommaire/index-eng.php).
- World Health Organization (WHO). 1973. Trace elements in human nutrition: Manganese. Report of a WHO expert committee. Geneva, World Health Organization, pp. 34–36 (Technical Report Series No. 532).
- WHO. 1997. United Nations Environment Programme, International Labour Organisation, World Health Organization, International Programme on Chemical Safety. Environmental Health Criteria 188. Nitrogen Oxides (Second Edition). World Health Organization, Geneva.  
<http://www.inchem.org/documents/ehc/ehc/ehc188.htm#PartNumber:9>.
- WHO. 2000. Air Quality Guidelines for Europe, Second Edition. World Health Organization, Regional Office for Europe, Copenhagen. WHO Regional Publications, European Series, No. 91. ISBN 92 890 1358 3 ISSN 0378-2255
- WHO. 2006. Air Quality Guidelines. Global Update 2005. Particulate Matter, Ozone, Nitrogen Dioxide, and Sulfur Dioxide. ISBN 92 890 2192 6. Available at [http://apps.who.int/iris/bitstream/10665/69477/1/WHO\\_SDE\\_PHE\\_OEH\\_06.02\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdf).
- Wixson BG and BE Davis, 1993. Lead in Soil. Lead in Soil Task Force, Science Reviews. Northwood. 132 pp.



Attachment F  
Detailed Risk Estimates for Soil, Air, and Surface Water

Table F1: Constituent Concentrations Used in the HHRA

Constituent	Soil Baseline mg/kg	Soil Predicted mg/kg	Surface Water Baseline mg/L	Predicted Surface Water mg/L	Air Baseline (PM10) mg/m <sup>3</sup>	Predicted Air (PM10) mg/m <sup>3</sup>
Aluminum	2.93E+04	2.95E+04	5.89E+00	6.15E+00	9.96E-05	1.48E-04
Antimony	6.86E+00	6.90E+00	2.05E-03	5.74E-03	2.33E-08	4.18E-08
Arsenic	6.95E+01	6.99E+01	8.45E-03	9.79E-03	2.36E-07	4.26E-07
Barium	4.29E+02	4.31E+02	1.13E-01	1.19E-01	1.46E-06	2.14E-06
Bismuth	3.28E-01	3.30E-01	8.36E-03	8.44E-03	1.11E-09	3.33E-09
Boron	2.00E+01	2.01E+01	9.19E-02	9.57E-02	6.80E-08	9.99E-08
Cadmium	1.10E+00	1.10E+00	4.83E-04	1.33E-03	3.73E-09	8.20E-09
Calcium	1.97E+04	1.98E+04	4.75E+01	5.84E+01	6.68E-05	9.71E-05
Chromium	9.91E+01	9.97E+01	6.68E-03	7.62E-03	3.37E-07	4.95E-07
Cobalt	2.23E+01	2.24E+01	5.03E-03	6.44E-03	7.57E-08	1.11E-07
Gallium	1.21E+01	1.21E+01	NA	NA	4.11E-08	5.79E-08
Gold	1.44E-02	1.45E-02	NA	NA	4.90E-11	6.91E-11
Iron	5.82E+04	5.85E+04	9.17E+00	9.66E+00	1.98E-04	2.91E-04
Lead	4.00E+01	4.02E+01	6.83E-03	7.78E-03	1.36E-07	2.10E-07
Manganese	2.97E+04	2.99E+04	2.94E-01	5.38E-01	3.11E-06	4.61E-06
Mercury, inorganic	8.00E-02	8.58E-02	1.21E-05	6.91E-05	2.72E-10	1.50E-08
Molybdenum	3.10E+01	3.12E+01	5.84E-03	6.66E-03	1.05E-07	1.49E-07
Nickel	5.26E+01	5.29E+01	2.06E-02	2.72E-02	1.79E-07	2.62E-07
Selenium	4.54E+00	4.57E+00	2.30E-03	3.26E-03	1.54E-08	2.44E-08
Silicon			NA	NA	0.00E+00	0.00E+00
Strontium	9.69E+01	9.74E+01	2.69E-01	2.96E-01	3.29E-07	4.83E-07
Tellurium	3.15E-01	3.18E-01	NA	NA	1.07E-09	4.48E-09
Thallium	3.00E-01	3.02E-01	1.84E-04	1.92E-04	1.02E-09	1.73E-09

<b>Constituent</b>	<b>Soil Baseline mg/kg</b>	<b>Soil Predicted mg/kg</b>	<b>Surface Water Baseline mg/L</b>	<b>Predicted Surface Water mg/L</b>	<b>Air Baseline (PM10) mg/m<sup>3</sup></b>	<b>Predicted Air (PM10) mg/m<sup>3</sup></b>
Titanium	2.31E+03	2.33E+03	9.82E-02	1.01E-01	7.86E-06	1.14E-05
Uranium	1.21E+00	1.22E+00	5.00E-04	5.00E-04	4.11E-09	6.89E-09
Vanadium	1.08E+02	1.09E+02	1.35E-02	1.37E-02	3.68E-07	5.47E-07
Zinc	1.44E+02	1.45E+02	5.81E-02	1.13E-01	4.88E-07	9.42E-07

Table F2. Calculation of Non-Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Hunter/Trapper/Fisher – Baseline

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Incidental Soil Ingestion</b>					
Aluminum	2.93E+04	1.0E+00	N/A	6.5E-03	5.5E-03
Antimony	6.86E+00	6.0E-03	N/A	2.6E-04	2.2E-04
Arsenic	2.29E+01	1.0E-03	N/A	5.1E-03	4.3E-03
Barium	4.29E+02	2.0E-01	N/A	4.8E-04	4.0E-04
Bismuth	3.28E-01	N/A	N/A	N/A	N/A
Boron	2.00E+01	2.0E-01	0.0919	2.2E-05	1.9E-05
Cadmium	1.10E+00	1.0E-03	N/A	2.5E-04	2.1E-04
Chromium	9.91E+01	3.0E-03	N/A	7.4E-03	6.2E-03
Cobalt	2.23E+01	1.4E-03	N/A	3.6E-03	3.0E-03
Iron	5.82E+04	7.0E-01	N/A	1.9E-02	1.6E-02
Lead	4.00E+01	1.5E-03	N/A	6.0E-03	5.0E-03
Manganese	2.97E+04	1.56E-01	N/A	4.3E-02	3.6E-02
Mercury	8.00E-02	3.0E-04	N/A	6.0E-05	5.0E-05
Nickel	5.26E+01	1.10E-02	N/A	1.1E-03	9.0E-04
Selenium	4.54E+00	5.5E-03	N/A	1.8E-04	1.6E-04
Strontium	9.56E+01	0.6	2.69E-01	3.6E-05	3.0E-05
Tellurium	3.15E-01	N/A	N/A	N/A	N/A
Thallium	3.00E-01	7.0E-05	N/A	9.6E-04	8.1E-04
Titanium	2.31E+03	3.0E+00	N/A	1.7E-04	1.5E-04
Uranium	1.21E+00	6.0E-04	5.00E-04	4.5E-04	3.8E-04
Vanadium	1.44E+02	5.0E-03	N/A	6.4E-03	5.4E-03
Zinc	1.44E+02	5.0E-01	N/A	6.4E-05	5.4E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Dermal Contact with Soil</b>					
Aluminum	2.93E+04	1.0E+00	1.0E-02	5.0E-04	4.7E-04
Antimony	6.86E+00	6.0E-03	1.0E-02	1.9E-05	1.8E-05
Arsenic	6.95E+01	1.0E-03	3.0E-02	3.5E-03	3.4E-03
Barium	4.29E+02	2.0E-01	1.0E-01	3.6E-04	3.5E-04
Bismuth	3.28E-01	N/A	N/A	N/A	N/A
Boron	2.00E+01	0.2	1.0E-02	1.7E-06	1.6E-06
Cadmium	1.10E+00	1.0E-03	1.0E-02	1.9E-05	1.8E-05
Chromium	9.91E+01	1.0E-03	1.0E-02	1.7E-03	1.6E-03
Cobalt	2.23E+01	1.4E-03	1.0E-02	2.7E-04	2.6E-04
Iron	5.82E+04	7.0E-01	1.0E-02	1.4E-03	1.3E-03
Lead	4.00E+01	1.5E-03	1.0E-02	4.5E-04	4.3E-04
Manganese	2.97E+04	1.56E-01	1.0E-02	3.2E-03	3.1E-03
Mercury	8.00E-02	3.0E-04	1.0E+00	4.5E-04	4.3E-04
Nickel	5.26E+01	1.10E-02	9.0E-02	7.3E-04	6.9E-04
Selenium	4.54E+00	5.5E-03	1.0E-02	1.4E-05	1.3E-05
Strontium	9.56E+00	6.0E-01	1.0E-02	2.7E-07	2.6E-07
Tellurium	3.15E-01	N/A	N/A	N/A	N/A
Thallium	3.00E-01	7.0E-05	1.0E-02	7.3E-05	6.9E-05
Titanium	2.31E+03	3.0E+00	1.0E-02	1.3E-05	1.2E-05
Uranium	1.21E+00	6.0E-04	1.0E-02	3.4E-05	3.3E-05
Vanadium	1.08E+02	5.0E-03	1.0E-02	3.7E-04	3.5E-04
Zinc	1.44E+02	5.0E-01	1.0E-01	4.9E-05	4.6E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Inhalation of Particulate</b>					
	<b>Air Concentration (mg/m<sup>3</sup>)</b>				
Aluminum	9.96E-05	5.0E-03	N/A	3.5E-03	3.1E-03
Antimony	2.33E-08	2.1E-02	N/A	1.9E-07	1.7E-07
Arsenic	2.36E-07	1.0E-03	N/A	4.1E-05	3.7E-05
Barium	1.46E-06	1.0E-03	N/A	2.5E-04	2.3E-04
Bismuth	1.11E-09	N/A	N/A	N/A	N/A
Boron	6.80E-08	7.0E-01	N/A	1.7E-08	1.5E-08
Cadmium	3.73E-09	3.5E-03	N/A	1.9E-07	1.7E-07
Chromium	3.37E-07	6.0E-02	N/A	9.8E-07	8.8E-07
Cobalt	7.57E-08	4.9E-03	N/A	2.7E-06	2.4E-06
Iron	1.98E-04	2.5E+00	N/A	1.4E-05	1.3E-05
Lead	1.36E-07	5.3E-03	N/A	4.5E-06	4.1E-06
Manganese	3.11E-06	5.46E-01	N/A	9.9E-07	8.9E-07
Mercury	2.72E-10	1.1E-03	N/A	4.5E-08	4.1E-08
Nickel	1.79E-07	3.00E-02	N/A	1.0E-06	9.3E-07
Selenium	1.54E-08	1.9E-02	N/A	1.4E-07	1.3E-07
Strontium	3.29E-07	2.1E+00	N/A	2.7E-08	2.5E-08
Tellurium	1.07E-09	N/A	N/A	N/A	N/A
Thallium	1.02E-09	3.5E-05	N/A	5.1E-06	4.6E-06
Titanium	7.86E-06	2.1E+00	N/A	6.5E-07	5.9E-07
Uranium	4.11E-09	8.0E-04	N/A	8.9E-07	8.0E-07
Vanadium	3.68E-07	8.0E-04	N/A	8.0E-05	7.2E-05
Zinc	4.88E-07	7.0E-04	N/A	1.2E-04	1.1E-04

Table F3. Calculation of Non-Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Hunter/Trapper/Fisher – Predicted

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Incidental Soil Ingestion</b>					
Aluminum	2.95E+04	1.0E+00	N/A	6.6E-03	5.6E-03
Antimony	6.90E+00	6.0E-03	N/A	2.6E-04	2.2E-04
Arsenic	2.31E+01	1.0E-03	N/A	5.2E-03	4.4E-03
Barium	4.31E+02	2.0E-01	N/A	4.8E-04	4.1E-04
Bismuth	3.30E-01	N/A	N/A	N/A	N/A
Boron	2.01E+01	2.0E-01	0.0919	2.2E-05	1.9E-05
Cadmium	1.10E+00	1.0E-03	N/A	2.5E-04	2.1E-04
Chromium	9.97E+01	1.0E-03	N/A	2.2E-02	1.9E-02
Cobalt	2.24E+01	1.4E-03	N/A	3.6E-03	3.0E-03
Iron	5.85E+04	7.0E-01	N/A	1.9E-02	1.6E-02
Lead	4.02E+01	1.5E-03	N/A	6.0E-03	5.1E-03
Manganese	2.99E+04	0.156	N/A	4.3E-02	3.6E-02
Mercury	8.58E-02	3.0E-04	N/A	6.4E-05	5.4E-05
Nickel	5.29E+01	1.10E-02	N/A	1.1E-03	9.1E-04
Selenium	4.57E+00	5.5E-03	N/A	1.9E-04	1.6E-04
Strontium	9.56E+01	0.6	2.69E-01	3.6E-05	3.0E-05
Tellurium	3.18E-01	N/A	N/A	N/A	N/A
Thallium	3.02E-01	7.0E-05	N/A	9.6E-04	8.1E-04
Titanium	2.33E+03	3.0E+00	N/A	1.7E-04	1.5E-04
Uranium	1.22E+00	6.0E-04	5.00E-04	4.5E-04	3.8E-04
Vanadium	1.09E+02	5.0E-03	N/A	4.9E-03	4.1E-03
Zinc	1.45E+02	5.0E-01	N/A	6.5E-05	5.5E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Dermal Contact with Soil</b>					
Aluminum	2.95E+04	1.0E+00	1.0E-02	5.0E-04	4.8E-04
Antimony	6.90E+00	6.0E-03	1.0E-02	2.0E-05	1.9E-05
Arsenic	6.99E+01	1.0E-03	3.0E-02	3.6E-03	3.4E-03
Barium	4.31E+02	2.0E-01	1.0E-01	3.7E-04	3.5E-04
Bismuth	3.30E-01	N/A	N/A	N/A	N/A
Boron	2.01E+01	0.2	1.0E-02	1.7E-06	1.6E-06
Cadmium	1.10E+00	1.0E-03	1.0E-02	1.9E-05	1.8E-05
Chromium	9.97E+01	1.0E-03	1.0E-02	1.7E-03	1.6E-03
Cobalt	2.24E+01	1.4E-03	1.0E-02	2.7E-04	2.6E-04
Iron	5.85E+04	7.0E-01	1.0E-02	1.4E-03	1.3E-03
Lead	4.02E+01	1.5E-03	1.0E-02	4.6E-04	4.3E-04
Manganese	2.99E+04	0.156	1.0E-02	3.2E-03	3.1E-03
Mercury	8.58E-02	3.0E-04	1.0E+00	4.9E-04	4.6E-04
Nickel	5.29E+01	1.10E-02	9.0E-02	7.3E-04	7.0E-04
Selenium	4.57E+00	5.5E-03	1.0E-02	1.4E-05	1.3E-05
Strontium	9.56E+00	6.0E-01	1.0E-02	2.7E-07	2.6E-07
Tellurium	3.18E-01	N/A	N/A	N/A	N/A
Thallium	3.02E-01	7.0E-05	1.0E-02	7.3E-05	7.0E-05
Titanium	2.33E+03	3.0E+00	1.0E-02	1.3E-05	1.3E-05
Uranium	1.22E+00	6.0E-04	1.0E-02	3.4E-05	3.3E-05
Vanadium	1.09E+02	5.0E-03	1.0E-02	3.7E-04	3.5E-04
Zinc	1.45E+02	5.0E-01	1.0E-01	4.9E-05	4.7E-05



Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Inhalation of Particulate</b>					
	Air Concentration (mg/m <sup>3</sup> )				
Aluminum	1.48E-04	5.0E-03	N/A	5.2E-03	4.6E-03
Aluminum	4.18E-08	2.1E-02	N/A	3.5E-07	3.1E-07
Antimony	4.26E-07	1.0E-03	N/A	7.4E-05	6.7E-05
Arsenic	2.14E-06	1.0E-03	N/A	3.7E-04	3.4E-04
Barium	3.33E-09	N/A	N/A	N/A	N/A
Bismuth	9.99E-08	7.0E-01	N/A	2.5E-08	2.2E-08
Boron	8.20E-09	3.5E-03	N/A	4.1E-07	3.7E-07
Cadmium	4.95E-07	6.0E-02	N/A	1.4E-06	1.3E-06
Chromium	1.11E-07	4.9E-03	N/A	3.9E-06	3.5E-06
Cobalt	2.91E-04	2.5E+00	N/A	2.1E-05	1.9E-05
Iron	2.10E-07	5.3E-03	N/A	7.0E-06	6.3E-06
Lead	4.61E-06	0.546	N/A	1.5E-06	1.3E-06
Manganese	1.50E-08	1.1E-03	N/A	2.5E-06	2.2E-06
Mercury	2.62E-07	3.00E-02	N/A	1.5E-06	1.4E-06
Nickel	2.44E-08	1.9E-02	N/A	2.2E-07	2.0E-07
Selenium	4.83E-07	2.1E+00	N/A	4.0E-08	3.6E-08
Strontium	4.48E-09	N/A	N/A	N/A	N/A
Tellurium	1.73E-09	3.5E-05	N/A	8.6E-06	7.7E-06
Thallium	1.14E-05	2.1E+00	N/A	9.5E-07	8.5E-07
Titanium	6.89E-09	8.0E-04	N/A	1.5E-06	1.3E-06
Uranium	5.47E-07	8.0E-04	N/A	1.2E-04	1.1E-04
Vanadium	9.42E-07	7.0E-04	N/A	2.3E-04	2.1E-04
Zinc	1.48E-04	5.0E-03	N/A	5.2E-03	4.6E-03

Table F4. Calculation of Carcinogenic Risk from Direct Contact with Soil and Inhalation of Air Particulate by the Hunter/Trapper/Fisher – Baseline

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Incidental Soil Ingestion</b>					
Arsenic	2.29E+01	1.8E+00	N/A	4.3E-07	4.942E-07
<b>Hunter/Trapper/Fisher - Dermal Contact with Soil</b>					
Arsenic	6.95E+01	1.8E+00	3.0E-02	2.9E-07	3.846E-07
<b>Hunter/Trapper/Fisher - Inhalation of Particulate</b>					
	<b>Air Concentration (mg/m<sup>3</sup>)</b>				
Arsenic	2.36E-07	2.7E+01	N/A	5.1E-08	6.3E-08
Cadmium	3.73E-09	4.2E+01	N/A	1.3E-09	1.6E-09
Chromium	3.37E-07	4.6E+01	N/A	1.2E-07	1.5E-07
Nickel	1.79E-07	7.1E-01	N/A	1.0E-09	1.3E-09

Table F5 Calculation of Carcinogenic Risk from Direct Contact with Soil and Inhalation of Air Particulate by the Hunter/Trapper/Fisher – Predicted

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Incidental Soil Ingestion</b>					
Arsenic	2.31E+01	1.8E+00	N/A	4.28E-07	4.972E-07
<b>Hunter/Trapper/Fisher - Dermal Contact with Soil</b>					
Arsenic	6.99E+01	1.8E+00	3.0E-02	3.0E-07	3.8691E-07
<b>Hunter/Trapper/Fisher - Inhalation of Particulate</b>					
	<b>Air Concentration (mg/m<sup>3</sup>)</b>				
Arsenic	4.26E-07	2.7E+01	N/A	9.3E-08	1.144E-07
Cadmium	8.20E-09	4.2E+01	N/A	2.8E-09	3.4E-09
Chromium	4.95E-07	4.6E+01	N/A	1.8E-07	2.3E-07
Nickel	2.62E-07	7.1E-01	N/A	1.5E-09	1.8E-09

Table F6. Calculation of Non-Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Recreational User – Baseline

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational User - Incidental Soil Ingestion</b>								
Aluminum	2.93E+04	1.0E+00	N/A	1.8E-02	3.6E-02	4.5E-03	2.5E-03	2.1E-03
Antimony	6.86E+00	6.0E-03	N/A	7.0E-04	1.4E-03	1.7E-04	9.6E-05	8.1E-05
Arsenic	2.29E+01	1.0E-03	N/A	1.4E-02	2.8E-02	3.5E-03	1.9E-03	1.6E-03
Barium	4.29E+02	2.0E-01	N/A	1.3E-03	2.6E-03	3.3E-04	1.8E-04	1.5E-04
Bismuth	3.28E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	2.00E+01	2.0E-01	0.0919	6.1E-05	1.2E-04	1.5E-05	8.4E-06	7.1E-06
Cadmium	1.10E+00	1.0E-03	N/A	6.7E-04	1.3E-03	1.7E-04	9.2E-05	7.8E-05
Chromium	9.91E+01	3.0E-03	N/A	2.0E-02	4.0E-02	5.0E-03	2.8E-03	2.3E-03
Cobalt	2.23E+01	1.4E-03	N/A	9.7E-03	1.9E-02	2.4E-03	1.3E-03	1.1E-03
Iron	5.82E+04	7.0E-01	N/A	5.1E-02	1.0E-01	1.3E-02	7.0E-03	5.9E-03
Lead	4.00E+01	1.5E-03	N/A	4.1E-02	8.1E-02	1.0E-02	2.2E-03	1.9E-03
Manganese	2.97E+04	0.156	N/A	1.2E-01	2E-01	2.9E-02	1.6E-02	1.3E-02
Mercury	8.00E-02	3.0E-04	N/A	1.6E-04	3.2E-04	4.1E-05	2.2E-05	1.9E-05
Nickel	5.26E+01	1.10E-02	N/A	2.9E-03	5.8E-03	7.3E-04	4.0E-04	3.4E-04
Selenium	4.54E+00	5.5E-03	N/A	5.0E-04	1.0E-03	1.3E-04	6.9E-05	5.8E-05
Strontium	9.69E+01	0.6	2.69E-01	9.8E-05	2.0E-04	2.5E-05	1.4E-05	1.1E-05
Tellurium	3.15E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.00E-01	7.0E-05	N/A	2.6E-03	5.2E-03	6.5E-04	3.6E-04	3.0E-04
Titanium	2.31E+03	3.0E+00	N/A	4.7E-04	9.3E-04	1.2E-04	6.5E-05	5.5E-05
Uranium	1.21E+00	6.0E-04	5.00E-04	1.2E-03	2.4E-03	3.1E-04	1.7E-04	1.4E-04
Vanadium	1.08E+02	5.0E-03	N/A	1.3E-02	2.6E-02	3.3E-03	1.8E-03	1.5E-03
Zinc	1.44E+02	5.0E-01	N/A	1.8E-04	3.5E-04	4.4E-05	2.4E-05	2.0E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational User - Dermal Contact with Soil</b>								
Aluminum	2.93E+04	1.0E+00	1.0E-02	4.2E-04	2.7E-04	2.3E-04	1.9E-04	1.8E-04
Antimony	6.86E+00	6.0E-03	1.0E-02	1.6E-05	1.0E-05	9.1E-06	7.3E-06	6.9E-06
Arsenic	6.95E+01	1.0E-03	3.0E-02	3.0E-03	1.9E-03	1.7E-03	1.3E-03	1.3E-03
Barium	4.29E+02	2.0E-01	1.0E-01	3.0E-04	1.9E-04	1.7E-04	1.4E-04	1.3E-04
Bismuth	3.28E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	1.00E+01	0.2	1.0E-02	7.1E-07	4.5E-07	4.0E-07	3.2E-07	3.0E-07
Cadmium	1.10E+00	1.0E-03	1.0E-02	1.6E-05	9.9E-06	8.7E-06	7.0E-06	6.6E-06
Chromium	9.91E+01	1.0E-03	1.0E-02	1.4E-03	9.0E-04	7.9E-04	6.3E-04	6.0E-04
Cobalt	2.23E+01	1.4E-03	1.0E-02	2.3E-04	1.4E-04	1.3E-04	1.0E-04	9.6E-05
Iron	5.82E+04	7.0E-01	1.0E-02	1.2E-03	7.5E-04	6.6E-04	5.3E-04	5.0E-04
Lead	4.00E+01	1.5E-03	1.0E-02	9.5E-04	6.0E-04	6.0E-04	1.7E-04	1.6E-04
Manganese	2.97E+04	0.156	1.0E-02	2.7E-03	1.7E-03	1.5E-03	1.2E-03	1.2E-03
Mercury	8.00E-02	3.0E-04	1.0E+00	3.8E-04	2.4E-04	2.1E-04	1.7E-04	1.6E-04
Nickel	5.26E+01	1.10E-02	9.0E-02	6.1E-04	3.9E-04	3.4E-04	2.7E-04	2.6E-04
Selenium	4.54E+00	5.5E-03	1.0E-02	1.2E-05	7.5E-06	6.6E-06	5.3E-06	5.0E-06
Strontium	9.69E+01	6.0E-01	1.0E-02	2.3E-06	1.5E-06	1.3E-06	1.0E-06	9.8E-07
Tellurium	3.15E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.00E-01	7.0E-05	1.0E-02	6.1E-05	3.9E-05	3.4E-05	2.7E-05	2.6E-05
Titanium	2.31E+03	3.0E+00	1.0E-02	1.1E-05	7.0E-06	6.1E-06	4.9E-06	4.7E-06
Uranium	1.21E+00	6.0E-04	1.0E-02	2.9E-05	1.8E-05	1.6E-05	1.3E-05	1.2E-05
Vanadium	1.08E+02	5.0E-03	1.0E-02	3.1E-04	2.0E-04	1.7E-04	1.4E-04	1.3E-04
Zinc	1.44E+02	5.0E-01	1.0E-01	4.1E-05	2.6E-05	2.3E-05	1.8E-05	1.7E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational User - Inhalation of Particulate</b>								
	Air Concentration (mg/m <sup>3</sup> )							
Aluminum	9.96E-05	5.0E-03	N/A	1.3E-03	2.5E-03	2.2E-03	1.3E-03	1.2E-03
Antimony	2.33E-08	2.1E-02	N/A	7.1E-08	1.4E-07	1.2E-07	7.3E-08	6.5E-08
Arsenic	2.36E-07	1.0E-03	N/A	1.5E-05	3.0E-05	2.6E-05	1.5E-05	1.4E-05
Barium	1.46E-06	2.0E-01	N/A	4.7E-07	9.2E-07	8.0E-07	4.8E-07	4.3E-07
Bismuth	1.11E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	6.80E-08	7.0E-01	N/A	6.2E-09	1.2E-08	1.1E-08	6.3E-09	5.7E-09
Cadmium	3.73E-09	3.5E-03	N/A	6.8E-08	1.3E-07	1.2E-07	7.0E-08	6.3E-08
Chromium	3.37E-07	6.0E-02	N/A	3.6E-07	7.1E-07	6.2E-07	3.7E-07	3.3E-07
Cobalt	7.57E-08	4.9E-03	N/A	9.9E-07	1.9E-06	1.7E-06	1.0E-06	9.1E-07
Iron	1.98E-04	2.5E+00	N/A	5.2E-06	1.0E-05	8.9E-06	5.3E-06	4.7E-06
Lead	1.36E-07	5.3E-03	N/A	4.1E-06	8.1E-06	7.1E-06	1.7E-06	1.5E-06
Manganese	3.11E-06	0.546	N/A	3.7E-07	7.2E-07	6.3E-07	3.7E-07	3.3E-07
Mercury	2.72E-10	1.1E-03	N/A	1.7E-08	3.3E-08	2.9E-08	1.7E-08	1.5E-08
Nickel	1.79E-07	3.00E-02	N/A	3.8E-07	7.5E-07	6.6E-07	3.9E-07	3.5E-07
Selenium	1.54E-08	1.9E-02	N/A	5.1E-08	1.0E-07	8.8E-08	5.2E-08	4.7E-08
Strontium	3.29E-07	2.1E+00	N/A	1.0E-08	2.0E-08	1.7E-08	1.0E-08	9.2E-09
Tellurium	1.07E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.02E-09	3.5E-05	N/A	1.9E-06	3.7E-06	3.2E-06	1.9E-06	1.7E-06
Titanium	7.86E-06	2.1E+00	N/A	2.4E-07	4.7E-07	4.1E-07	2.4E-07	2.2E-07
Uranium	4.11E-09	8.0E-04	N/A	3.3E-07	6.5E-07	5.7E-07	3.4E-07	3.0E-07
Vanadium	3.68E-07	8.0E-04	N/A	2.9E-05	5.8E-05	5.1E-05	3.0E-05	2.7E-05
Zinc	4.88E-07	7.0E-04	N/A	4.5E-05	8.8E-05	7.7E-05	4.6E-05	4.1E-05

Table F7. Calculation of Non-Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Recreational User – Predicted

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational User - Incidental Soil Ingestion</b>								
Aluminum	2.95E+04	1.0E+00	N/A	1.8E-02	3.6E-02	4.5E-03	2.5E-03	2.1E-03
Antimony	6.90E+00	6.0E-03	N/A	7.0E-04	1.4E-03	1.7E-04	9.6E-05	8.1E-05
Arsenic	2.31E+01	1.0E-03	N/A	1.4E-02	2.8E-02	3.5E-03	1.9E-03	1.6E-03
Barium	4.31E+02	2.0E-01	N/A	1.3E-03	2.6E-03	3.3E-04	1.8E-04	1.5E-04
Bismuth	3.30E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	2.01E+01	2.0E-01	0.0919	6.1E-05	1.2E-04	1.5E-05	8.4E-06	7.1E-06
Cadmium	1.10E+00	1.0E-03	N/A	6.7E-04	1.3E-03	1.7E-04	9.3E-05	7.8E-05
Chromium	9.97E+01	3.0E-03	N/A	2.0E-02	4.0E-02	5.1E-03	2.8E-03	2.4E-03
Cobalt	2.24E+01	1.4E-03	N/A	9.8E-03	1.9E-02	2.4E-03	1.3E-03	1.1E-03
Iron	5.85E+04	7.0E-01	N/A	5.1E-02	1.0E-01	1.3E-02	7.0E-03	5.9E-03
Lead	4.02E+01	1.5E-03	N/A	4.1E-02	8.1E-02	1.0E-02	2.2E-03	1.9E-03
Manganese	2.99E+04	0.156	N/A	1.2E-01	2E-01	2.9E-02	1.6E-02	1.4E-02
Mercury	8.58E-02	3.0E-04	N/A	1.7E-04	3.5E-04	4.3E-05	2.4E-05	2.0E-05
Nickel	5.29E+01	1.10E-02	N/A	2.9E-03	5.8E-03	7.3E-04	4.0E-04	3.4E-04
Selenium	4.57E+00	5.5E-03	N/A	5.1E-04	1.0E-03	1.3E-04	7.0E-05	5.9E-05
Strontium	9.74E+01	0.6	2.69E-01	9.9E-05	2.0E-04	2.5E-05	1.4E-05	1.1E-05
Tellurium	3.18E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.02E-01	7.0E-05	N/A	2.6E-03	5.2E-03	6.6E-04	3.6E-04	3.0E-04
Titanium	2.33E+03	3.0E+00	N/A	4.7E-04	9.4E-04	1.2E-04	6.5E-05	5.5E-05
Uranium	1.22E+00	6.0E-04	5.00E-04	1.2E-03	2.5E-03	3.1E-04	1.7E-04	1.4E-04
Vanadium	1.09E+02	5.0E-03	N/A	1.3E-02	2.6E-02	3.3E-03	1.8E-03	1.5E-03
Zinc	1.45E+02	5.0E-01	N/A	1.8E-04	3.5E-04	4.4E-05	2.4E-05	2.0E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational User - Dermal Contact with Soil</b>								
Aluminum	2.95E+04	1.0E+00	1E-02	4E-04	3E-04	2E-04	2E-04	2E-04
Antimony	6.90E+00	6.0E-03	1E-02	2E-05	1E-05	9E-06	7E-06	7E-06
Arsenic	6.99E+01	1.0E-03	3E-02	3E-03	2E-03	2E-03	1E-03	1E-03
Barium	4.31E+02	2.0E-01	1E-01	3E-04	2E-04	2E-04	1E-04	1E-04
Bismuth	3.30E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	1.00E+01	0.2	1E-02	7E-07	5E-07	4E-07	3E-07	3E-07
Calcium	1.98E+04	NA						
Chromium	9.97E+01	1.0E-03	1E-02	1E-03	9E-04	8E-04	6E-04	6E-04
Gold	1.45E-02	NA						
Iron	5.85E+04	7.0E-01	1E-02	1E-03	8E-04	7E-04	5E-04	5E-04
Lead	4.02E+01	1.5E-03	1E-02	4E-04	6E-04	2E-04	2E-04	2E-04
Manganese	2.99E+04	0.156	1E-02	3E-03	2E-03	2E-03	1E-03	1E-03
Molybdenum	3.12E+01	2.00E+03		0E+00	0E+00	0E+00	0E+00	0E+00
Nickel	5.29E+01	1.10E-02	9E-02	6E-04	4E-04	3E-04	3E-04	3E-04
Silicon	4.57E+00	5.5E-03	1E-02	1E-05	8E-06	7E-06	5E-06	5E-06
Strontium	9.56E+00	6.0E-01	1E-02	2E-07	1E-07	1E-07	1E-07	1E-07
Tellurium	3.18E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.02E-01	7.0E-05	1E-02	6E-05	4E-05	3E-05	3E-05	3E-05
Titanium	2.33E+03	3.0E+00	1E-02	1E-05	7E-06	6E-06	5E-06	5E-06
Uranium	1.22E+00	6.0E-04	1E-02	3E-05	2E-05	2E-05	1E-05	1E-05
Vanadium	1.09E+02	5.0E-03	1E-02	3E-04	2E-04	2E-04	1E-04	1E-04
Zinc	1.45E+02	5.0E-01	1E-01	4E-05	3E-05	2E-05	2E-05	2E-05



Recreational User - Inhalation of Particulate								
	Air Concentration (mg/m <sup>3</sup> )							
Aluminum	1.48E-04	5.0E-03	N/A	2E-03	4E-03	3E-03	2E-03	2E-03
Antimony	4.18E-08	2.1E-02	N/A	1E-07	3E-07	2E-07	1E-07	1E-07
Arsenic	4.26E-07	1.0E-03	N/A	3E-05	5E-05	5E-05	3E-05	3E-05
Barium	2.14E-06	2.0E-01	N/A	7E-07	1E-06	1E-06	7E-07	6E-07
Bismuth	3.33E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.99E-08	7.0E-01	N/A	9E-09	2E-08	2E-08	9E-09	8E-09
Calcium	9.71E-05	NA	N/A					
Chromium	4.95E-07	6.0E-02	N/A	5E-07	1E-06	9E-07	5E-07	5E-07
Gold	6.91E-11	NA	N/A					
Iron	2.91E-04	2.5E+00	N/A	8E-06	1E-05	1E-05	8E-06	7E-06
Lead	2.10E-07	5.3E-03	N/A	6E-06	1E-05	1E-05	3E-06	2E-06
Manganese	4.61E-06	0.546	N/A	5E-07	1E-06	9E-07	6E-07	5E-07
Molybdenum*	1.49E-07	7.00E+03	N/A	1E-12	3E-12	2E-12	1E-12	1E-12
Nickel	2.62E-07	3.00E-02	N/A	6E-07	1E-06	1E-06	6E-07	5E-07
Selenium	2.44E-08	1.9E-02	N/A	8E-08	2E-07	1E-07	8E-08	7E-08
Strontium	4.83E-07	2.1E+00	N/A	1E-08	3E-08	3E-08	2E-08	1E-08
Tellurium	4.48E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.73E-09	3.5E-05	N/A	3E-06	6E-06	5E-06	3E-06	3E-06
Titanium	1.14E-05	2.1E+00	N/A	3E-07	7E-07	6E-07	4E-07	3E-07
Uranium	6.89E-09	8.0E-04	N/A	6E-07	1E-06	9E-07	6E-07	5E-07
Vanadium	5.47E-07	8.0E-04	N/A	4E-05	9E-05	8E-05	4E-05	4E-05
Zinc	9.42E-07	7.0E-04	N/A	9E-05	2E-04	1E-04	9E-05	8E-05

Table F8. Calculation of Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Recreational User – Baseline

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
Arsenic								
Arsenic	2.29E+01	1.8E+00		3.63E-07	3.25E-06	3.80E-07	1.60E-07	1.85E-07
<b>Recreational User - Dermal Contact with Soil</b>								
Arsenic	6.95E+01	1.8E+00	3.0E-02	7.7E-08	2.2E-07	1.8E-07	1.1E-07	1.44E-07
<b>Recreational User - Inhalation of Particulate</b>								
	Air Concentration (mg/m <sup>3</sup> )							
Arsenic	2.36E-07	2.7E+01	N/A	5.9E-09	5.2E-08	4.3E-08	1.9E-08	2.4E-08
Cadmium	3.73E-09	4.2E+01	N/A	1.4E-10	1.3E-09	1.0E-09	4.7E-10	5.8E-10
Chromium	3.37E-07	4.6E+01	N/A	1.4E-08	1.3E-07	1.0E-07	4.7E-08	5.8E-08
Nickel	1.79E-07	7.1E-01	N/A	1.2E-10	1.0E-09	8.5E-10	3.8E-10	4.7E-10

Table F9. Calculation of Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Recreational User – Predicted

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Incidental Soil Ingestion</b>								
Arsenic	2.31E+01	1.8E+00	N/A	3.65E-07	3.27E-06	3.82E-07	1.61E-07	1.86E-07
<b>Recreational - Dermal Contact with Soil</b>								
Arsenic	6.99E+01	1.8E+00	3.0E-02	7.7E-08	2.2E-07	1.8E-07	1.1E-07	1.45E-07
<b>Recreational - Inhalation of Particulate</b>								
	Air Concentration (mg/m <sup>3</sup> )							
Arsenic	4.26E-07	2.7E+01	N/A	1.1E-08	9.4E-08	7.7E-08	3.5E-08	4.3E-08
Cadmium	8.20E-09	4.2E+01	N/A	3.2E-10	2.8E-09	2.3E-09	1.0E-09	1.3E-09
Chromium	4.95E-07	4.6E+01	N/A	2.1E-08	1.9E-07	1.5E-07	6.9E-08	8.5E-08
Nickel	2.62E-07	7.1E-01	N/A	1.7E-10	1.5E-09	1.2E-09	5.6E-10	6.9E-10

Table F10. Calculation of Non-Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Summer Resident – Baseline

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Incidental Soil Ingestion</b>								
Aluminum	2.93E+04	1.0E+00	N/A	3.6E-02	7.1E-02	8.9E-03	4.9E-03	4.1E-03
Antimony	6.86E+00	6.0E-03	N/A	1.4E-03	2.8E-03	3.5E-04	1.9E-04	1.6E-04
Arsenic	2.29E+01	1.0E-03	N/A	2.8E-02	5.6E-02	7.0E-03	3.8E-03	3.2E-03
Barium	4.29E+02	2.0E-01	N/A	2.6E-03	5.2E-03	6.5E-04	3.6E-04	3.0E-04
Bismuth	3.28E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	2.00E+01	2.0E-01	N/A	1.2E-04	2.4E-04	3.0E-05	1.7E-05	1.4E-05
Cadmium	1.10E+00	1.0E-03	N/A	1.3E-03	2.7E-03	3.3E-04	1.8E-04	1.6E-04
Chromium	9.91E+01	3.0E-03	N/A	4.0E-02	8.0E-02	1.0E-02	5.5E-03	4.7E-03
Cobalt	2.23E+01	1.4E-03	N/A	1.9E-02	3.9E-02	4.8E-03	2.7E-03	2.2E-03
Iron	5.82E+04	7.0E-01	N/A	1.0E-01	2.0E-01	2.5E-02	1.4E-02	1.2E-02
Lead	4.00E+01	1.5E-03	N/A	8.1E-02	1.6E-01	2.0E-02	4.5E-03	3.8E-03
Manganese	2.97E+04	0.156	N/A	2E-01	4.6E-01	5.8E-02	3.2E-02	2.7E-02
Mercury	8.00E-02	3.0E-04	N/A	3.3E-04	6.5E-04	8.1E-05	4.5E-05	3.8E-05
Nickel	5.26E+01	1.10E-02	N/A	5.8E-03	1.2E-02	1.5E-03	8.0E-04	6.8E-04
Selenium	4.54E+00	5.5E-03	N/A	1.0E-03	2.0E-03	2.5E-04	1.4E-04	1.2E-04
Strontium	9.69E+01	0.6	N/A	2.0E-04	3.9E-04	4.9E-05	2.7E-05	2.3E-05
Tellurium	3.15E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.00E-01	7.0E-05	N/A	5.2E-03	1.0E-02	1.3E-03	7.2E-04	6.1E-04
Titanium	2.31E+03	3.0E+00	N/A	9.4E-04	1.9E-03	2.3E-04	1.3E-04	1.1E-04
Uranium	1.21E+00	6.0E-04	N/A	2.5E-03	4.9E-03	6.1E-04	3.4E-04	2.8E-04
Vanadium	1.08E+02	5.0E-03	N/A	2.6E-02	5.2E-02	6.6E-03	3.6E-03	3.1E-03
Zinc	1.44E+02	5.0E-01	N/A	3.5E-04	7.0E-04	8.7E-05	4.8E-05	4.1E-05

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Dermal Contact with Soil</b>								
Aluminum	1.08E+02	1.0E+00	1.0E-02	3.1E-06	2.0E-06	1.7E-06	1.4E-06	1.3E-06
Antimony	6.86E+00	6.0E-03	1.0E-02	3.2E-05	2.1E-05	1.8E-05	1.5E-05	1.4E-05
Arsenic	6.95E+01	1.0E-03	3.0E-02	5.9E-03	3.8E-03	3.3E-03	2.7E-03	2.5E-03
Barium	4.29E+02	2.0E-01	1.0E-01	6.1E-04	3.9E-04	3.4E-04	2.7E-04	2.6E-04
Bismuth	3.28E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	2.00E+01	2.0E-01	1.0E-02	2.8E-06	1.8E-06	1.6E-06	1.3E-06	1.2E-06
Cadmium	1.10E+00	1.0E-03	1.0E-02	3.1E-05	2.0E-05	1.7E-05	1.4E-05	1.3E-05
Chromium	9.91E+01	3.0E-03	1.0E-02	9.4E-04	6.0E-04	5.2E-04	4.2E-04	4.0E-04
Cobalt	2.23E+01	1.4E-03	1.0E-02	4.5E-04	2.9E-04	2.5E-04	2.0E-04	1.9E-04
Iron	5.82E+04	7.0E-01	1.0E-02	2.4E-03	1.5E-03	1.3E-03	1.1E-03	1.0E-03
Lead	4.00E+01	1.5E-03	1.0E-02	1.9E-03	1.2E-03	1.1E-03	3.4E-04	3.2E-04
Manganese	2.97E+04	0.156	1.0E-02	5.4E-03	3.5E-03	3.0E-03	2.4E-03	2.3E-03
Mercury	8.00E-02	3.0E-04	1.0E+00	7.6E-04	4.8E-04	4.2E-04	3.4E-04	3.2E-04
Nickel	5.26E+01	1.10E-02	9.0E-02	1.2E-03	7.8E-04	6.8E-04	5.5E-04	5.2E-04
Selenium	4.54E+00	5.5E-03	1.0E-02	2.3E-05	1.5E-05	1.3E-05	1.1E-05	1.0E-05
Strontium	9.69E+01	0.6	1.0E-02	4.6E-06	2.9E-06	2.6E-06	2.1E-06	2.0E-06
Tellurium	3.15E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.00E-01	7.0E-05	1.0E-02	1.2E-04	7.8E-05	6.8E-05	5.5E-05	5.2E-05
Titanium	2.31E+03	3.0E+00	1.0E-02	2.2E-05	1.4E-05	1.2E-05	9.8E-06	9.3E-06
Uranium	1.21E+00	6.0E-04	1.0E-02	5.7E-05	3.6E-05	3.2E-05	2.6E-05	2.4E-05
Vanadium	1.08E+02	5.0E-03	1.0E-02	6.1E-04	3.9E-04	3.4E-04	2.8E-04	2.6E-04
Zinc	1.44E+02	5.0E-01	1.0E-01	8.2E-05	5.2E-05	4.6E-05	3.7E-05	3.5E-05

Summer Resident - Inhalation of Particulate								
	Air Concentration (mg/m <sup>3</sup> )							
Aluminum	9.96E-05	5.0E-03	N/A	2.6E-03	5.0E-03	4.4E-03	2.6E-03	2.3E-03
Antimony	2.33E-08	2.1E-02	N/A	1.4E-07	2.8E-07	2.4E-07	1.5E-07	1.3E-07
Arsenic	2.36E-07	1.0E-03	N/A	3.0E-05	5.9E-05	5.2E-05	3.1E-05	2.8E-05
Barium	1.46E-06	2.0E-01	N/A	9.3E-07	1.8E-06	1.6E-06	9.5E-07	8.6E-07
Bismuth	1.11E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	6.80E-08	7.0E-01	N/A	1.2E-08	2.4E-08	2.1E-08	1.3E-08	1.1E-08
Cadmium	3.73E-09	3.5E-03	N/A	1.4E-07	2.7E-07	2.3E-07	1.4E-07	1.3E-07
Chromium	3.37E-07	6.0E-02	N/A	7.2E-07	1.4E-06	1.2E-06	7.3E-07	6.6E-07
Cobalt	7.57E-08	4.9E-03	N/A	2.0E-06	3.9E-06	3.4E-06	2.0E-06	1.8E-06
Iron	1.98E-04	2.5E+00	N/A	1.0E-05	2.0E-05	1.8E-05	1.1E-05	9.5E-06
Lead	1.36E-07	5.3E-03	N/A	8.3E-06	1.6E-05	1.4E-05	3.4E-06	3.0E-06
Manganese	3.11E-06	0.546	N/A	7.3E-07	1.4E-06	1.3E-06	7.5E-07	6.7E-07
Mercury	2.72E-10	1.1E-03	N/A	3.3E-08	6.5E-08	5.7E-08	3.4E-08	3.0E-08
Nickel	1.79E-07	3.00E-02	N/A	7.6E-07	1.5E-06	1.3E-06	7.8E-07	7.0E-07
Selenium	1.54E-08	1.9E-02	N/A	1.0E-07	2.0E-07	1.8E-07	1.0E-07	9.4E-08
Strontium	3.29E-07	2.1E+00	N/A	2.0E-08	3.9E-08	3.5E-08	2.0E-08	1.8E-08
Tellurium	1.07E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.02E-09	3.5E-05	N/A	3.7E-06	7.3E-06	6.4E-06	3.8E-06	3.4E-06
Titanium	7.86E-06	2.1E+00	N/A	4.8E-07	9.4E-07	8.3E-07	4.9E-07	4.4E-07
Uranium	4.11E-09	8.0E-04	N/A	6.6E-07	1.3E-06	1.1E-06	6.7E-07	6.0E-07
Vanadium	3.68E-07	8.0E-04	N/A	5.9E-05	1.2E-04	1.0E-04	6.0E-05	5.4E-05
Zinc	4.88E-07	7.0E-04	N/A	8.9E-05	1.8E-04	1.5E-04	9.1E-05	8.2E-05

Table F11. Calculation of Non-Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Summer Resident – Predicted

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Incidental Soil Ingestion</b>								
Aluminum	2.95E+04	1.0E+00	N/A	3.6E-02	7.1E-02	9.0E-03	4.9E-03	4.2E-03
Antimony	6.90E+00	6.0E-03	N/A	1.4E-03	2.8E-03	3.5E-04	1.9E-04	1.6E-04
Arsenic	2.31E+01	1.0E-03	N/A	2.8E-02	5.6E-02	7.0E-03	3.9E-03	3.3E-03
Barium	4.31E+02	2.0E-01	N/A	2.6E-03	5.2E-03	6.6E-04	3.6E-04	3.0E-04
Bismuth	3.30E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	2.01E+01	2.0E-01	N/A	1.2E-04	2.4E-04	3.1E-05	1.7E-05	1.4E-05
Cadmium	1.10E+00	1.0E-03	N/A	1.3E-03	2.7E-03	3.4E-04	1.9E-04	1.6E-04
Chromium	9.97E+01	3.0E-03	N/A	4.1E-02	8.1E-02	1.0E-02	5.6E-03	4.7E-03
Cobalt	2.24E+01	1.4E-03	N/A	2.0E-02	3.9E-02	4.9E-03	2.7E-03	2.3E-03
Iron	5.85E+04	7.0E-01	N/A	1.0E-01	2.0E-01	2.5E-02	1.4E-02	1.2E-02
Lead	4.02E+01	1.5E-03	N/A	8.2E-02	1.6E-01	2.0E-02	4.5E-03	3.8E-03
Manganese	2.99E+04	0.156	N/A	2E-01	4.6E-01	5.8E-02	3.2E-02	2.7E-02
Mercury	8.58E-02	3.0E-04	N/A	3.5E-04	6.9E-04	8.7E-05	4.8E-05	4.0E-05
Nickel	5.29E+01	1.10E-02	N/A	5.9E-03	1.2E-02	1.5E-03	8.1E-04	6.8E-04
Selenium	4.57E+00	5.5E-03	N/A	1.0E-03	2.0E-03	2.5E-04	1.4E-04	1.2E-04
Strontium	9.74E+01	0.6	N/A	2.0E-04	3.9E-04	4.9E-05	2.7E-05	2.3E-05
Tellurium	3.18E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.02E-01	7.0E-05	N/A	5.3E-03	1.0E-02	1.3E-03	7.2E-04	6.1E-04
Titanium	2.33E+03	3.0E+00	N/A	9.5E-04	1.9E-03	2.4E-04	1.3E-04	1.1E-04
Uranium	1.22E+00	6.0E-04	N/A	2.5E-03	4.9E-03	6.2E-04	3.4E-04	2.9E-04
Vanadium	1.09E+02	5.0E-03	N/A	2.7E-02	5.3E-02	6.6E-03	3.6E-03	3.1E-03

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
Zinc	1.45E+02	5.0E-01	N/A	3.5E-04	7.0E-04	8.8E-05	4.8E-05	4.1E-05
<b>Summer Resident - Dermal Contact with Soil</b>								
Aluminum	2.95E+04	1.0E+00	1.0E-02	8.4E-04	5.3E-04	4.7E-04	3.8E-04	3.6E-04
Antimony	6.90E+00	6.0E-03	1.0E-02	3.3E-05	2.1E-05	1.8E-05	1.5E-05	1.4E-05
Arsenic	6.99E+01	1.0E-03	3.0E-02	6.0E-03	3.8E-03	3.3E-03	2.7E-03	2.5E-03
Barium	4.31E+02	2.0E-01	1.0E-01	6.1E-04	3.9E-04	3.4E-04	2.7E-04	2.6E-04
Bismuth	3.30E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	2.01E+01	2.0E-01	1.0E-02	2.9E-06	1.8E-06	1.6E-06	1.3E-06	1.2E-06
Cadmium	1.10E+00	1.0E-03	1.0E-02	3.1E-05	2.0E-05	1.8E-05	1.4E-05	1.3E-05
Chromium	9.97E+01	3.0E-03	1.0E-02	9.4E-04	6.0E-04	5.3E-04	4.2E-04	4.0E-04
Cobalt	2.24E+01	1.4E-03	1.0E-02	4.5E-04	2.9E-04	2.5E-04	2.0E-04	1.9E-04
Iron	5.85E+04	7.0E-01	1.0E-02	2.4E-03	1.5E-03	1.3E-03	1.1E-03	1.0E-03
Lead	4.02E+01	1.5E-03	1.0E-02	1.9E-03	1.2E-03	1.1E-03	3.4E-04	3.2E-04
Manganese	2.99E+04	0.156	1.0E-02	5.4E-03	3.5E-03	3.0E-03	2.4E-03	2.3E-03
Mercury	8.58E-02	3.0E-04	1.0E+00	8.1E-04	5.2E-04	4.5E-04	3.6E-04	3.5E-04
Nickel	5.29E+01	1.10E-02	9.0E-02	1.2E-03	7.8E-04	6.9E-04	5.5E-04	5.2E-04
Selenium	4.57E+00	5.5E-03	1.0E-02	2.4E-05	1.5E-05	1.3E-05	1.1E-05	1.0E-05
Strontium	9.74E+01	0.6	1.0E-02	4.6E-06	2.9E-06	2.6E-06	2.1E-06	2.0E-06
Tellurium	3.18E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	3.02E-01	7.0E-05	1.0E-02	1.2E-04	7.8E-05	6.8E-05	5.5E-05	5.2E-05
Titanium	2.33E+03	3.0E+00	1.0E-02	2.2E-05	1.4E-05	1.2E-05	9.9E-06	9.4E-06
Uranium	1.22E+00	6.0E-04	1.0E-02	5.8E-05	3.7E-05	3.2E-05	2.6E-05	2.5E-05
Vanadium	1.09E+02	5.0E-03	1.0E-02	6.2E-04	3.9E-04	3.5E-04	2.8E-04	2.6E-04
Zinc	1.45E+02	5.0E-01	1.0E-01	8.2E-05	5.2E-05	4.6E-05	3.7E-05	3.5E-05



Summer Resident - Inhalation of Particulate								
	Air Concentration (mg/m <sup>3</sup> )							
Aluminum	1.48E-04	5.0E-03	N/A	3.8E-03	7.4E-03	6.5E-03	3.9E-03	3.5E-03
Antimony	4.18E-08	2.1E-02	N/A	2.6E-07	5.0E-07	4.4E-07	2.6E-07	2.3E-07
Arsenic	4.26E-07	1.0E-03	N/A	5.5E-05	1.1E-04	9.4E-05	5.6E-05	5.0E-05
Barium	2.14E-06	2.0E-01	N/A	1.4E-06	2.7E-06	2.4E-06	1.4E-06	1.3E-06
Bismuth	3.33E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.99E-08	7.0E-01	N/A	1.8E-08	3.6E-08	3.1E-08	1.9E-08	1.7E-08
Cadmium	8.20E-09	3.5E-03	N/A	3.0E-07	5.9E-07	5.2E-07	3.1E-07	2.8E-07
Chromium	4.95E-07	6.0E-02	N/A	1.1E-06	2.1E-06	1.8E-06	1.1E-06	9.7E-07
Cobalt	1.11E-07	4.9E-03	N/A	2.9E-06	5.7E-06	5.0E-06	2.9E-06	2.6E-06
Iron	2.91E-04	2.5E+00	N/A	1.5E-05	3.0E-05	2.6E-05	1.6E-05	1.4E-05
Lead	2.10E-07	5.3E-03	N/A	1.3E-05	2.5E-05	2.2E-05	5.2E-06	4.7E-06
Manganese	4.61E-06	0.546	N/A	1.1E-06	2.1E-06	1.9E-06	1.1E-06	9.9E-07
Mercury	1.50E-08	1.1E-03	N/A	1.8E-06	3.6E-06	3.1E-06	1.9E-06	1.7E-06
Nickel	2.62E-07	3.00E-02	N/A	1.1E-06	2.2E-06	1.9E-06	1.1E-06	1.0E-06
Selenium	2.44E-08	1.9E-02	N/A	1.6E-07	3.2E-07	2.8E-07	1.7E-07	1.5E-07
Strontium	4.83E-07	2.1E+00	N/A	2.9E-08	5.8E-08	5.1E-08	3.0E-08	2.7E-08
Tellurium	4.48E-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.73E-09	3.5E-05	N/A	6.3E-06	1.2E-05	1.1E-05	6.5E-06	5.8E-06
Titanium	1.14E-05	2.1E+00	N/A	7.0E-07	1.4E-06	1.2E-06	7.1E-07	6.4E-07
Uranium	6.89E-09	8.0E-04	N/A	1.1E-06	2.2E-06	1.9E-06	1.1E-06	1.0E-06
Vanadium	5.47E-07	8.0E-04	N/A	8.8E-05	1.7E-04	1.5E-04	8.9E-05	8.0E-05
Zinc	9.42E-07	7.0E-04	N/A	1.7E-04	3.4E-04	3.0E-04	1.8E-04	1.6E-04

Table F12. Calculation of Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Summer Resident – Baseline

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Incidental Soil Ingestion</b>								
Arsenic	2.29E+01	1.8E+00	N/A	1.57E-06	1E-05	1.65E-06	6.92E-07	8.03E-07
<b>Summer Resident - Dermal Contact with Soil</b>								
Arsenic	6.95E+01	1.8E+00	3.0E-02	3.3E-07	9.6E-07	7.8E-07	4.8E-07	6.25E-07
<b>Summer Resident - Inhalation of Particulate</b>								
	Air Concentration (mg/m <sup>3</sup> )							
Arsenic	2.36E-07	2.7E+01	N/A	2.6E-08	2.3E-07	1.8E-07	8.3E-08	1.0E-07
Cadmium	3.73E-09	4.2E+01	N/A	6.3E-10	5.5E-09	4.5E-09	2.0E-09	2.5E-09
Chromium	3.37E-07	4.6E+01	N/A	6.2E-08	5.5E-07	4.5E-07	2.0E-07	2.5E-07
Nickel	1.79E-07	7.1E-01	N/A	5.1E-10	4.5E-09	3.7E-09	1.7E-09	2.0E-09

Table F13. Calculation of Carcinogenic Hazard from Direct Contact with Soil and Inhalation of Air Particulate by the Summer Resident – Predicted

Constituent	Soil Concentration (mg/kg)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Incidental Soil Ingestion</b>								
Arsenic	2.31E+01	1.8E+00	N/A	1.58E-06	1.42E-05	1.66E-06	6.96E-07	8.08E-07
<b>Summer Resident - Dermal Contact with Soil</b>								
Arsenic	6.99E+01	1.8E+00	3.0E-02	3.4E-07	9.6E-07	7.9E-07	4.8E-07	6.29E-07
<b>Summer Resident - Inhalation of Particulate</b>								
	Air Concentration (mg/m <sup>3</sup> )							
Arsenic	4.26E-07	2.7E+01	N/A	4.6E-08	4.1E-07	3.3E-07	1.5E-07	1.9E-07
Cadmium	8.20E-09	4.2E+01	N/A	1.4E-09	1.2E-08	1.0E-08	4.5E-09	5.6E-09
Chromium	4.95E-07	4.6E+01	N/A	9.1E-08	8.1E-07	6.6E-07	3.0E-07	3.7E-07
Nickel	2.62E-07	7.1E-01	N/A	7.4E-10	6.6E-09	5.4E-09	2.4E-09	3.0E-09

Table F14. Calculation of Non-Carcinogenic Hazard from Direct Contact with Surface Water by the Hunter/Trapper/Fisher – Baseline

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Ingestion Surface Water</b>					
Aluminum	5.89E+00	1.0E+00	N/A	6.6E-02	8.3E-02
Antimony	2.05E-03	6.0E-03	N/A	3.8E-03	4.8E-03
Arsenic	8.45E-03	1.0E-03	N/A	9.4E-02	1.2E-01
Barium	1.13E-01	2.0E-01	N/A	6.3E-03	8.0E-03
Bismuth	8.36E-03	N/A	N/A	N/A	N/A
Boron	9.19E-02	2.0E-01	N/A	5.1E-03	6.5E-03
Cadmium	4.83E-04	1.0E-03	N/A	5.4E-03	6.8E-03
Chromium	6.68E-03	3.0E-03	N/A	2.5E-02	3.2E-02
Cobalt	5.03E-03	1.4E-03	N/A	4.0E-02	5.1E-02
Iron	9.17E+00	7.0E-01	N/A	1.5E-01	1.9E-01
Lead	6.83E-03	1.5E-03	N/A	5.1E-02	6.4E-02
Manganese	2.94E-01	0.156	N/A	2.1E-02	2.7E-02
Mercury	1.21E-05	3.0E-04	N/A	4.5E-04	5.7E-04
Nickel	2.06E-02	1.10E-02	N/A	2.1E-02	2.6E-02
Selenium	2.30E-03	5.5E-03	N/A	4.7E-03	5.9E-03
Strontium	2.69E-01	6.0E-01	N/A	5.0E-03	6.3E-03
Tellurium	N/A	N/A	N/A	N/A	N/A
Thallium	1.84E-04	7.0E-05	N/A	2.9E-02	3.7E-02
Titanium	9.82E-02	3.0E+00	N/A	3.7E-04	4.6E-04
Uranium	5.00E-04	6.0E-04	N/A	9.3E-03	1.2E-02
Vanadium	1.35E-02	5.0E-03	N/A	3.0E-02	3.8E-02
Zinc	5.81E-02	5.0E-01	N/A	1.3E-03	1.6E-03

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Dermal Contact with Surface Water</b>					
Aluminum	5.89E+00	1.0E+00	1.0E-03	2.0E-04	1.9E-04
Antimony	2.05E-03	6.0E-03	1.0E-03	1.2E-05	1.1E-05
Arsenic	8.45E-03	1.0E-03	1.0E-03	2.9E-04	2.7E-04
Barium	1.13E-01	2.0E-01	1.0E-03	1.9E-05	1.8E-05
Bismuth	8.36E-03	N/A	N/A	N/A	N/A
Boron	9.19E-02	2.0E-01	1.0E-03	1.6E-05	1.5E-05
Cadmium	4.83E-04	1.0E-03	1.0E-03	1.6E-05	1.5E-05
Chromium	6.68E-03	3.0E-03	2.0E-03	1.5E-04	1.4E-04
Cobalt	5.03E-03	1.4E-03	1.0E-03	1.2E-04	1.1E-04
Iron	9.17E+00	7.0E-01	1.0E-03	4.4E-04	4.2E-04
Lead	6.83E-03	1.5E-03	1.0E-04	1.5E-05	1.5E-05
Manganese	2.94E-01	0.156	1.0E-03	6.4E-05	6.0E-05
Mercury	1.21E-05	3.0E-04	2.5E-03	3.4E-06	3.2E-06
Nickel	2.06E-02	1.10E-02	2.0E-04	1.3E-05	1.2E-05
Selenium	2.30E-03	5.5E-03	1.0E-03	1.4E-05	1.3E-05
Strontium	2.69E-01	6.0E-01	1.0E-03	1.5E-05	1.4E-05
Tellurium	N/A	N/A	N/A	N/A	N/A
Thallium	1.84E-04	7.0E-05	1.0E-03	8.9E-05	8.4E-05
Titanium	9.82E-02	3.0E+00	1.0E-03	1.1E-06	1.0E-06
Uranium	5.00E-04	6.0E-04	1.0E-03	2.8E-05	2.7E-05
Vanadium	1.35E-02	5.0E-03	1.0E-03	9.1E-05	8.6E-05
Zinc	5.81E-02	5.0E-01	6.0E-04	2.4E-06	2.2E-06

Table F15. Calculation of Non-Carcinogenic Hazard from Direct Contact with Surface Water by the Hunter/Trapper/Fisher - Predicted Future

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Ingestion Surface Water</b>					
Aluminum	6.15E+00	1.0E+00	N/A	6.9E-02	8.7E-02
Antimony	5.74E-03	6.0E-03	N/A	1.1E-02	1.4E-02
Arsenic	9.79E-03	1.0E-03	N/A	1.1E-01	1.38E-01
Barium	1.19E-01	2.0E-01	N/A	6.6E-03	8.4E-03
Bismuth	8.44E-03	N/A	N/A	N/A	N/A
Boron	9.57E-02	2.0E-01	N/A	5.3E-03	6.8E-03
Cadmium	1.33E-03	1.0E-03	N/A	1.5E-02	1.9E-02
Chromium	7.62E-03	3.0E-03	N/A	2.8E-02	3.6E-02
Cobalt	6.44E-03	1.4E-03	N/A	5.1E-02	6.5E-02
Iron	9.66E+00	7.0E-01	N/A	1.5E-01	2.0E-01
Lead	7.78E-03	1.5E-03	N/A	5.8E-02	7.3E-02
Manganese	5.38E-01	0.156	N/A	3.8E-02	4.9E-02
Mercury	6.91E-05	3.0E-04	N/A	2.6E-03	3.3E-03
Nickel	2.72E-02	1.10E-02	N/A	2.8E-02	3.5E-02
Selenium	3.26E-03	5.5E-03	N/A	6.6E-03	8.4E-03
Strontium	2.96E-01	6.0E-01	N/A	5.5E-03	7.0E-03
Tellurium	N/A	N/A	N/A	N/A	N/A
Thallium	1.92E-04	7.0E-05	N/A	3.1E-02	3.9E-02
Titanium	1.01E-01	3.0E+00	N/A	3.7E-04	4.7E-04
Uranium	5.00E-04	6.0E-04	N/A	9.3E-03	1.2E-02
Vanadium	1.37E-02	5.0E-03	N/A	3.1E-02	3.9E-02
Zinc	1.13E-01	5.0E-01	N/A	2.5E-03	3.2E-03

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Dermal Contact with Surface Water</b>					
Aluminum	6.15E+00	1.0E+00	1.0E-03	2.1E-04	2.0E-04
Antimony	5.74E-03	6.0E-03	1.0E-03	3.2E-05	3.1E-05
Arsenic	9.79E-03	1.0E-03	1.0E-03	3.3E-04	3.1E-04
Barium	1.19E-01	2.0E-01	1.0E-03	2.0E-05	1.9E-05
Bismuth	8.44E-03	N/A	N/A	N/A	N/A
Boron	9.57E-02	2.0E-01	1.0E-03	1.6E-05	1.5E-05
Cadmium	1.33E-03	1.0E-03	1.0E-03	4.5E-05	4.3E-05
Chromium	7.62E-03	3.0E-03	2.0E-03	1.7E-04	1.6E-04
Cobalt	6.44E-03	1.4E-03	1.0E-03	1.6E-04	1.5E-04
Iron	9.66E+00	7.0E-01	1.0E-03	4.7E-04	4.4E-04
Lead	7.78E-03	1.5E-03	1.0E-04	1.8E-05	1.7E-05
Manganese	5.38E-01	0.156	1.0E-03	1.2E-04	1.1E-04
Mercury	6.91E-05	3.0E-04	2.5E-03	1.9E-05	1.8E-05
Nickel	2.72E-02	1.10E-02	2.0E-04	1.7E-05	1.6E-05
Selenium	3.26E-03	5.5E-03	1.0E-03	2.0E-05	1.9E-05
Strontium	2.96E-01	6.0E-01	1.0E-03	1.7E-05	1.6E-05
Tellurium	N/A	N/A	N/A	N/A	N/A
Thallium	1.92E-04	7.0E-05	1.0E-03	9.3E-05	8.8E-05
Titanium	1.01E-01	3.0E+00	1.0E-03	1.1E-06	1.1E-06
Uranium	5.00E-04	6.0E-04	1.0E-03	2.8E-05	2.7E-05
Vanadium	1.37E-02	5.0E-03	1.0E-03	9.3E-05	8.8E-05
Zinc	1.13E-01	5.0E-01	6.0E-04	4.6E-06	4.3E-06

Table F16. Calculation of Carcinogenic Hazard from Direct Contact with Surface Water by the Hunter/Trapper/Fisher – Baseline

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Ingestion Surface Water</b>					
Arsenic	8.45E-03	1.8E+00	N/A	7.3E-06	4.7E-06
<b>Hunter/Trapper/Fisher - Dermal Contact with Surface Water</b>					
Arsenic	8.45E-03	1.8E+00	1.0E-03	2.2E-08	1.1E-08



Table F17. Calculation of Carcinogenic Hazard from Direct Contact with Surface Water by the Hunter/Trapper/Fisher - Predicted Future

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk	
				Teen	Adult
<b>Hunter/Trapper/Fisher - Ingestion Surface Water</b>					
Arsenic	9.79E-03	1.8E+00	N/A	8.5E-06	5.4E-06
<b>Hunter/Trapper/Fisher - Dermal Contact with Surface Water</b>					
Arsenic	9.79E-03	1.8E+00	1.0E-03	2.6E-08	1.2E-08

Table F18. Calculation of Non-Carcinogenic Hazard from Direct Contact with Surface Water by the Recreational User – Baseline

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Ingestion Surface Water</b>								
Aluminum	5.89E+00	1.0E+00	N/A	5.4E-02	5.4E-02	3.6E-02	2.5E-02	3.1E-02
Antimony	2.05E-03	6.0E-03	N/A	3.1E-03	3.1E-03	2.1E-03	1.4E-03	1.8E-03
Arsenic	8.45E-03	1.0E-03	N/A	7.7E-02	7.7E-02	5.1E-02	3.5E-02	4.5E-02
Barium	1.13E-01	2.0E-01	N/A	5.2E-03	5.1E-03	3.4E-03	2.4E-03	3.0E-03
Bismuth	8.36E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.19E-02	2.0E-01	N/A	4.2E-03	4.2E-03	2.8E-03	1.9E-03	2.4E-03
Cadmium	4.83E-04	1.0E-03	N/A	4.4E-03	4.4E-03	2.9E-03	2.0E-03	2.6E-03
Chromium	6.68E-03	3.0E-03	N/A	2.0E-02	2.0E-02	1.4E-02	9.3E-03	1.2E-02
Cobalt	5.03E-03	1.4E-03	N/A	3.3E-02	3.3E-02	2.2E-02	1.5E-02	1.9E-02
Iron	9.17E+00	7.0E-01	N/A	1.2E-01	1.2E-01	8.0E-02	5.5E-02	6.9E-02
Lead	6.83E-03	1.5E-03	N/A	1.0E-01	1.0E-01	6.9E-02	1.9E-02	2.4E-02
Manganese	2.94E-01	0.156	N/A	1.7E-02	1.7E-02	1.1E-02	7.9E-03	1.0E-02
Mercury	1.21E-05	3.0E-04	N/A	3.7E-04	3.7E-04	2.5E-04	1.7E-04	2.1E-04
Nickel	2.06E-02	1.10E-02	N/A	1.7E-02	1.7E-02	1.1E-02	7.8E-03	9.9E-03
Selenium	2.30E-03	5.5E-03	N/A	3.8E-03	3.8E-03	2.5E-03	1.7E-03	2.2E-03
Strontium	2.69E-01	6.0E-01	N/A	4.1E-03	4.1E-03	2.7E-03	1.9E-03	2.4E-03
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.84E-04	7.0E-05	N/A	2.4E-02	2.4E-02	1.6E-02	1.1E-02	1.4E-02
Titanium	9.82E-02	3.0E+00	N/A	3.0E-04	3.0E-04	2.0E-04	1.4E-04	1.7E-04
Uranium	5.00E-04	6.0E-04	N/A	7.6E-03	7.6E-03	5.1E-03	3.5E-03	4.4E-03
Vanadium	1.35E-02	5.0E-03	N/A	2.5E-02	2.4E-02	1.6E-02	1.1E-02	1.4E-02
Zinc	5.81E-02	5.0E-01	N/A	1.1E-03	1.1E-03	7.1E-04	4.9E-04	6.2E-04

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Dermal Contact with Surface Water</b>								
Aluminum	5.89E+00	1.0E+00	1.0E-03	1.7E-04	1.3E-04	1.2E-04	9.9E-05	9.5E-05
Antimony	2.05E-03	6.0E-03	1.0E-03	1.0E-05	7.8E-06	6.7E-06	5.7E-06	5.5E-06
Arsenic	8.45E-03	1.0E-03	1.0E-03	2.5E-04	1.9E-04	1.7E-04	1.4E-04	1.4E-04
Barium	1.13E-01	2.0E-01	1.0E-03	1.7E-05	1.3E-05	1.1E-05	9.5E-06	9.1E-06
Bismuth	8.36E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.19E-02	2.0E-01	1.0E-03	1.4E-05	1.0E-05	9.0E-06	7.7E-06	7.4E-06
Cadmium	4.83E-04	1.0E-03	1.0E-03	1.4E-05	1.1E-05	9.4E-06	8.1E-06	7.8E-06
Chromium	6.68E-03	1.0E-03	2.0E-03	4.0E-04	3.0E-04	2.6E-04	2.2E-04	2.2E-04
Cobalt	5.03E-03	1.4E-03	1.0E-03	1.1E-04	8.2E-05	7.0E-05	6.0E-05	5.8E-05
Iron	9.17E+00	7.0E-01	1.0E-03	3.9E-04	3.0E-04	2.6E-04	2.2E-04	2.1E-04
Lead	6.83E-03	1.5E-03	1.0E-04	3.4E-05	1.0E-05	2.2E-05	7.6E-06	7.3E-06
Manganese	2.94E-01	0.156	1.0E-03	5.6E-05	4.3E-05	3.7E-05	3.2E-05	3.0E-05
Mercury	1.21E-05	3.0E-04	2.5E-03	3.0E-06	2.3E-06	1.9E-06	1.7E-06	1.6E-06
Nickel	2.06E-02	1.10E-02	2.0E-04	1.1E-05	8.5E-06	7.3E-06	6.3E-06	6.0E-06
Selenium	2.30E-03	5.5E-03	1.0E-03	1.2E-05	9.5E-06	8.2E-06	7.0E-06	6.7E-06
Strontium	2.69E-01	6.0E-01	1.0E-03	1.3E-05	1.0E-05	8.8E-06	7.5E-06	7.2E-06
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.84E-04	7.0E-05	1.0E-03	7.8E-05	6.0E-05	5.1E-05	4.4E-05	4.2E-05
Titanium	9.82E-02	3.0E+00	1.0E-03	9.7E-07	7.5E-07	6.4E-07	5.5E-07	5.3E-07
Uranium	5.00E-04	6.0E-04	1.0E-03	2.5E-05	1.9E-05	1.6E-05	1.4E-05	1.3E-05
Vanadium	1.35E-02	5.0E-03	1.0E-03	8.0E-05	6.1E-05	5.3E-05	4.5E-05	4.3E-05
Zinc	5.81E-02	5.0E-01	6.0E-04	2.1E-06	1.6E-06	1.4E-06	1.2E-06	1.1E-06

Table F19. Calculation of Non-Carcinogenic Hazard from Direct Contact with Surface Water by the Recreational User - Predicted Future

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Ingestion Surface Water</b>								
Aluminum	6.15E+00	1.0E+00	N/A	5.6E-02	5.6E-02	3.7E-02	2.6E-02	3.3E-02
Antimony	5.74E-03	6.0E-03	N/A	8.8E-03	8.7E-03	5.8E-03	4.0E-03	5.1E-03
Arsenic	9.79E-03	1.0E-03	N/A	9.0E-02	8.9E-02	6.0E-02	4.1E-02	5.2E-02
Barium	1.19E-01	2.0E-01	N/A	5.4E-03	5.4E-03	3.6E-03	2.5E-03	3.1E-03
Bismuth	8.44E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.57E-02	2.0E-01	N/A	4.4E-03	4.4E-03	2.9E-03	2.0E-03	2.5E-03
Cadmium	1.33E-03	1.0E-03	N/A	1.2E-02	1.2E-02	8.1E-03	5.6E-03	7.1E-03
Chromium	7.62E-03	3.0E-03	N/A	2.3E-02	2.3E-02	1.5E-02	1.1E-02	1.3E-02
Cobalt	6.44E-03	1.4E-03	N/A	4.2E-02	4.2E-02	2.8E-02	1.9E-02	2.4E-02
Iron	9.66E+00	7.0E-01	N/A	1.3E-01	1.3E-01	8.4E-02	5.8E-02	7.3E-02
Lead	7.78E-03	1.5E-03	N/A	1.2E-01	1.2E-01	7.9E-02	2.2E-02	2.8E-02
Manganese	5.38E-01	0.156	N/A	3.2E-02	3.1E-02	2.1E-02	1.4E-02	1.8E-02
Mercury	6.91E-05	3.0E-04	N/A	2.1E-03	2.1E-03	1.4E-03	9.6E-04	1.2E-03
Nickel	2.72E-02	1.10E-02	N/A	2.3E-02	2.3E-02	1.5E-02	1.0E-02	1.3E-02
Selenium	3.26E-03	5.5E-03	N/A	5.4E-03	5.4E-03	3.6E-03	2.5E-03	3.1E-03
Strontium	2.96E-01	6.0E-01	N/A	4.5E-03	4.5E-03	3.0E-03	2.1E-03	2.6E-03
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.92E-04	7.0E-05	N/A	2.5E-02	2.5E-02	1.7E-02	1.1E-02	1.5E-02
Titanium	1.01E-01	3.0E+00	N/A	3.1E-04	3.0E-04	2.0E-04	1.4E-04	1.8E-04
Uranium	5.00E-04	6.0E-04	N/A	7.6E-03	7.6E-03	5.1E-03	3.5E-03	4.4E-03
Vanadium	1.37E-02	5.0E-03	N/A	2.5E-02	2.5E-02	1.7E-02	1.1E-02	1.5E-02
Zinc	1.13E-01	5.0E-01	N/A	2.1E-03	2.1E-03	1.4E-03	9.5E-04	1.2E-03

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Dermal Contact with Surface Water</b>								
Aluminum	6.15E+00	1.0E+00	1.0E-03	1.8E-04	1.4E-04	1.2E-04	1.0E-04	9.9E-05
Antimony	5.74E-03	6.0E-03	1.0E-03	2.8E-05	2.2E-05	1.9E-05	1.6E-05	1.5E-05
Arsenic	9.79E-03	1.0E-03	1.0E-03	2.9E-04	2.2E-04	1.9E-04	1.6E-04	1.6E-04
Barium	1.19E-01	2.0E-01	1.0E-03	1.8E-05	1.4E-05	1.2E-05	9.9E-06	9.6E-06
Bismuth	8.44E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.57E-02	2.0E-01	1.0E-03	1.4E-05	1.1E-05	9.3E-06	8.0E-06	7.7E-06
Cadmium	1.33E-03	1.0E-03	1.0E-03	4.0E-05	3.0E-05	2.6E-05	2.2E-05	2.1E-05
Chromium	7.62E-03	1.0E-03	2.0E-03	4.5E-04	3.5E-04	3.0E-04	2.6E-04	2.5E-04
Cobalt	6.44E-03	1.4E-03	1.0E-03	1.4E-04	1.0E-04	9.0E-05	7.7E-05	7.4E-05
Iron	9.66E+00	7.0E-01	1.0E-03	4.1E-04	3.1E-04	2.7E-04	2.3E-04	2.2E-04
Lead	7.78E-03	1.5E-03	1.0E-04	3.8E-05	3.0E-05	2.5E-05	8.7E-06	8.4E-06
Manganese	5.38E-01	0.156	1.0E-03	1.0E-04	7.9E-05	6.7E-05	5.8E-05	5.6E-05
Mercury	6.91E-05	3.0E-04	2.5E-03	1.7E-05	1.3E-05	1.1E-05	9.5E-06	9.1E-06
Nickel	2.72E-02	1.10E-02	2.0E-04	1.5E-05	1.1E-05	9.7E-06	8.3E-06	8.0E-06
Selenium	3.26E-03	5.5E-03	1.0E-03	1.8E-05	1.4E-05	1.2E-05	9.9E-06	9.5E-06
Strontium	2.96E-01	6.0E-01	1.0E-03	1.5E-05	1.1E-05	9.6E-06	8.3E-06	7.9E-06
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.92E-04	7.0E-05	1.0E-03	8.1E-05	6.2E-05	5.4E-05	4.6E-05	4.4E-05
Titanium	1.01E-01	3.0E+00	1.0E-03	9.9E-07	7.6E-07	6.5E-07	5.6E-07	5.4E-07
Uranium	5.00E-04	6.0E-04	1.0E-03	2.5E-05	1.9E-05	1.6E-05	1.4E-05	1.3E-05
Vanadium	1.37E-02	5.0E-03	1.0E-03	8.1E-05	6.3E-05	5.4E-05	4.6E-05	4.4E-05
Zinc	1.13E-01	5.0E-01	6.0E-04	4.0E-06	3.1E-06	2.7E-06	2.3E-06	2.2E-06

Table F20. Calculation of Carcinogenic Hazard from Direct Contact with Surface Water by the Recreational User – Baseline

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Ingestion Surface Water</b>								
Arsenic	8.45E-03	1.8E+00	N/A	2.0E-06	9.0E-06	5.6E-06	2.8E-06	1.7E-06
<b>Recreational - Dermal Contact with Surface Water</b>								
Arsenic	8.45E-03	1.8E+00	1.0E-03	6.5E-09	2.3E-08	1.8E-08	1.1E-08	5.3E-09

Table F21. Calculation of Carcinogenic Hazard from Direct Contact with Surface Water by the Recreational User - Predicted Future

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Recreational - Ingestion Surface Water</b>								
Arsenic	9.79E-03	1.8E+00	N/A	2.3E-06	1.0E-05	6.5E-06	3.2E-06	2.0E-06
<b>Recreational - Dermal Contact with Surface Water</b>								
Arsenic	9.79E-03	1.8E+00	1.0E-03	7.5E-09	2.6E-08	2.1E-08	1.3E-08	6.1E-09

Table F22. Calculation of Non-Carcinogenic Hazard from Direct Contact with Surface Water by the Summer Resident – Baseline

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Ingestion Surface Water</b>								
Aluminum	5.89E+00	1.0E+00	N/A	1.1E-01	1.1E-01	7.2E-02	4.9E-02	6.2E-02
Antimony	2.05E-03	4.0E-04	N/A	9.4E-02	9.3E-02	6.2E-02	4.3E-02	5.4E-02
Arsenic	8.45E-03	1.0E-03	N/A	1.5E-01	1.5E-01	1.0E-01	7.1E-02	9.0E-02
Barium	1.13E-01	2.0E-01	N/A	1.0E-02	1.0E-02	6.9E-03	4.7E-03	6.0E-03
Bismuth	8.36E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.19E-02	2.0E-01	N/A	8.4E-03	8.4E-03	5.6E-03	3.8E-03	4.9E-03
Cadmium	4.83E-04	1.0E-03	N/A	8.8E-03	8.8E-03	5.9E-03	4.0E-03	5.1E-03
Chromium	6.68E-03	3.0E-03	N/A	4.1E-02	4.1E-02	2.7E-02	1.9E-02	2.4E-02
Cobalt	5.03E-03	1.4E-03	N/A	6.6E-02	6.5E-02	4.4E-02	3.0E-02	3.8E-02
Iron	9.17E+00	7.0E-01	N/A	2.4E-01	2.4E-01	1.6E-01	1.1E-01	1.4E-01
Lead	6.83E-03	1.5E-03	N/A	2.1E-01	2.1E-01	1.4E-01	3.8E-02	4.8E-02
Manganese	2.94E-01	0.156	N/A	3.4E-02	3.4E-02	2.3E-02	1.6E-02	2.0E-02
Mercury	1.21E-05	3.0E-04	N/A	7.4E-04	7.4E-04	4.9E-04	3.4E-04	4.3E-04
Nickel	2.06E-02	1.10E-02	N/A	3.4E-02	3.4E-02	2.3E-02	1.6E-02	2.0E-02
Selenium	2.30E-03	5.5E-03	N/A	7.6E-03	7.6E-03	5.1E-03	3.5E-03	4.4E-03
Strontium	2.69E-01	6.0E-01	N/A	8.2E-03	8.2E-03	5.5E-03	3.8E-03	4.8E-03
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.84E-04	7.0E-05	N/A	4.8E-02	4.8E-02	3.2E-02	2.2E-02	2.8E-02
Titanium	9.82E-02	3.0E+00	N/A	6.0E-04	6.0E-04	4.0E-04	2.7E-04	3.5E-04
Uranium	5.00E-04	6.0E-04	N/A	1.5E-02	1.5E-02	1.0E-02	7.0E-03	8.8E-03
Vanadium	1.35E-02	5.0E-03	N/A	4.9E-02	4.9E-02	3.3E-02	2.3E-02	2.9E-02
Zinc	5.81E-02	5.0E-01	N/A	2.1E-03	2.1E-03	1.4E-03	9.7E-04	1.2E-03



Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Dermal Contact with Surface Water</b>								
Aluminum	5.89E+00	1.0E+00	1.0E-03	3.1E-04	2.4E-04	1.9E-04	1.5E-04	1.4E-04
Antimony	2.05E-03	4.0E-04	1.0E-03	2.7E-04	2.1E-04	1.6E-04	1.3E-04	1.2E-04
Arsenic	8.45E-03	1.0E-03	1.0E-03	4.5E-04	3.4E-04	2.7E-04	2.1E-04	2.0E-04
Barium	1.13E-01	2.0E-01	1.0E-03	3.0E-05	2.3E-05	1.8E-05	1.4E-05	1.4E-05
Bismuth	8.36E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.19E-02	2.0E-01	1.0E-03	2.4E-05	1.8E-05	1.4E-05	1.2E-05	1.1E-05
Cadmium	4.83E-04	1.0E-03	1.0E-03	2.6E-05	1.9E-05	1.5E-05	1.2E-05	1.2E-05
Chromium	6.68E-03	3.0E-03	2.0E-03	2.4E-04	1.8E-04	1.4E-04	1.1E-04	1.1E-04
Cobalt	5.03E-03	1.4E-03	1.0E-03	1.9E-04	1.4E-04	1.1E-04	9.1E-05	8.6E-05
Iron	9.17E+00	7.0E-01	1.0E-03	6.9E-04	5.2E-04	4.1E-04	3.3E-04	3.1E-04
Lead	6.83E-03	1.5E-03	1.0E-04	6.0E-05	4.6E-05	3.6E-05	1.2E-05	1.1E-05
Manganese	2.94E-01	0.156	1.0E-03	2.6E-02	7.5E-05	5.9E-05	4.8E-05	4.5E-05
Mercury	1.21E-05	3.0E-04	2.5E-03	5.3E-06	4.0E-06	3.1E-06	2.5E-06	2.4E-06
Nickel	2.06E-02	1.10E-02	2.0E-04	2.0E-05	1.5E-05	1.2E-05	9.5E-06	9.0E-06
Selenium	2.30E-03	5.5E-03	1.0E-03	2.2E-05	1.7E-05	1.3E-05	1.1E-05	1.0E-05
Strontium	2.69E-01	6.0E-01	1.0E-03	2.4E-05	1.8E-05	1.4E-05	1.1E-05	1.1E-05
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.84E-04	7.0E-05	1.0E-03	1.4E-04	1.1E-04	8.3E-05	6.7E-05	6.3E-05
Titanium	9.82E-02	3.0E+00	1.0E-03	1.7E-06	1.3E-06	1.0E-06	8.3E-07	7.8E-07
Uranium	5.00E-04	6.0E-04	1.0E-03	4.4E-05	3.3E-05	2.6E-05	2.1E-05	2.0E-05
Vanadium	1.35E-02	5.0E-03	1.0E-03	1.4E-04	1.1E-04	8.5E-05	6.8E-05	6.5E-05
Zinc	5.81E-02	5.0E-01	6.0E-04	3.7E-06	2.8E-06	2.2E-06	1.8E-06	1.7E-06

Table F23. Calculation of Non-Carcinogenic Hazard from Direct Contact with Surface Water by the Summer Resident - Predicted Future

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Ingestion Surface Water</b>								
Aluminum	6.15E+00	1.0E+00	N/A	1.1E-01	1.1E-01	7.5E-02	5.1E-02	6.5E-02
Antimony	5.74E-03	6.0E-03	N/A	1.8E-02	1.7E-02	1.2E-02	8.0E-03	1.0E-02
Arsenic	9.79E-03	1.0E-03	N/A	1.8E-01	1.8E-01	1.2E-01	8.2E-02	1.0E-01
Barium	1.19E-01	2.0E-01	N/A	1.1E-02	1.1E-02	7.2E-03	5.0E-03	6.3E-03
Bismuth	8.44E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.57E-02	2.0E-01	N/A	8.8E-03	8.7E-03	5.8E-03	4.0E-03	5.1E-03
Cadmium	1.33E-03	1.0E-03	N/A	2.4E-02	2.4E-02	1.6E-02	1.1E-02	1.4E-02
Chromium	7.62E-03	3.0E-03	N/A	4.6E-02	4.6E-02	3.1E-02	2.1E-02	2.7E-02
Cobalt	6.44E-03	1.4E-03	N/A	8.4E-02	8.4E-02	5.6E-02	3.9E-02	4.9E-02
Iron	9.66E+00	7.0E-01	N/A	2.5E-01	2.5E-01	1.7E-01	1.2E-01	1.5E-01
Lead	7.78E-03	1.5E-03	N/A	2.4E-01	2.4E-01	1.6E-01	4.3E-02	5.5E-02
Manganese	5.38E-01	0.156	N/A	6.3E-02	6.3E-02	4.2E-02	2.9E-02	3.7E-02
Mercury	6.91E-05	3.0E-04	N/A	4.2E-03	4.2E-03	2.8E-03	1.9E-03	2.4E-03
Nickel	2.72E-02	1.10E-02	N/A	4.5E-02	4.5E-02	3.0E-02	2.1E-02	2.6E-02
Selenium	3.26E-03	5.5E-03	N/A	1.1E-02	1.1E-02	7.2E-03	5.0E-03	6.3E-03
Strontium	2.96E-01	6.0E-01	N/A	9.0E-03	9.0E-03	6.0E-03	4.1E-03	5.2E-03
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.92E-04	7.0E-05	N/A	5.0E-02	5.0E-02	3.3E-02	2.3E-02	2.9E-02
Titanium	1.01E-01	3.0E+00	N/A	6.1E-04	6.1E-04	4.1E-04	2.8E-04	3.6E-04
Uranium	5.00E-04	6.0E-04	N/A	1.5E-02	1.5E-02	1.0E-02	7.0E-03	8.8E-03
Vanadium	1.37E-02	5.0E-03	N/A	5.0E-02	5.0E-02	3.3E-02	2.3E-02	2.9E-02
Zinc	1.13E-01	5.0E-01	N/A	4.1E-03	4.1E-03	2.8E-03	1.9E-03	2.4E-03

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Hazard Quotient				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Dermal Contact with Surface Water</b>								
Aluminum	6.15E+00	1.0E+00	1.0E-03	3.3E-04	2.5E-04	1.9E-04	1.6E-04	1.5E-04
Antimony	5.74E-03	6.0E-03	1.0E-03	5.1E-05	3.8E-05	3.0E-05	2.4E-05	2.3E-05
Arsenic	9.79E-03	1.0E-03	1.0E-03	5.2E-04	3.9E-04	3.1E-04	2.5E-04	2.3E-04
Barium	1.19E-01	2.0E-01	1.0E-03	3.1E-05	2.4E-05	1.9E-05	1.5E-05	1.4E-05
Bismuth	8.44E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.57E-02	2.0E-01	1.0E-03	2.5E-05	1.9E-05	1.5E-05	1.2E-05	1.1E-05
Cadmium	1.33E-03	1.0E-03	1.0E-03	7.1E-05	5.3E-05	4.2E-05	3.4E-05	3.2E-05
Chromium	7.62E-03	3.0E-03	2.0E-03	2.7E-04	2.0E-04	1.6E-04	1.3E-04	1.2E-04
Cobalt	6.44E-03	1.4E-03	1.0E-03	2.4E-04	1.8E-04	1.4E-04	1.2E-04	1.1E-04
Iron	9.66E+00	7.0E-01	1.0E-03	7.3E-04	5.5E-04	4.3E-04	3.5E-04	3.3E-04
Lead	7.78E-03	1.5E-03	1.0E-04	6.9E-05	5.2E-05	4.1E-05	1.3E-05	1.2E-05
Manganese	5.38E-01	0.156	1.0E-03	1.8E-04	1.4E-04	1.1E-04	8.7E-05	8.3E-05
Mercury	6.91E-05	3.0E-04	2.5E-03	3.0E-05	2.3E-05	1.8E-05	1.4E-05	1.4E-05
Nickel	2.72E-02	1.10E-02	2.0E-04	2.6E-05	2.0E-05	1.6E-05	1.3E-05	1.2E-05
Selenium	3.26E-03	5.5E-03	1.0E-03	3.1E-05	2.4E-05	1.9E-05	1.5E-05	1.4E-05
Strontium	2.96E-01	6.0E-01	1.0E-03	2.6E-05	2.0E-05	1.6E-05	1.3E-05	1.2E-05
Tellurium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.92E-04	7.0E-05	1.0E-03	1.5E-04	1.1E-04	8.6E-05	7.0E-05	6.6E-05
Titanium	1.01E-01	3.0E+00	1.0E-03	1.8E-06	1.3E-06	1.1E-06	8.5E-07	8.0E-07
Uranium	5.00E-04	6.0E-04	1.0E-03	4.4E-05	3.3E-05	2.6E-05	2.1E-05	2.0E-05
Vanadium	1.37E-02	5.0E-03	1.0E-03	1.5E-04	1.1E-04	8.6E-05	7.0E-05	6.6E-05
Zinc	1.13E-01	5.0E-01	6.0E-04	7.2E-06	5.4E-06	4.3E-06	3.4E-06	3.3E-06

Table F24. Calculation of Carcinogenic Hazard from Direct Contact with Surface Water by the Summer Resident - Baseline

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Ingestion Surface Water</b>								
Arsenic	8.45E-03	1.8E+00	N/A	8.7E-06	3.9E-05	2.4E-05	1.3E-05	2.2E-05
<b>Summer Resident - Dermal Contact with Surface Water</b>								
Arsenic	8.45E-03	1.8E+00	1.0E-03	9.5E-08	3.2E-07	2.4E-07	1.5E-07	5.0E-08

Table F25. Calculation of Carcinogenic Hazard from Direct Contact with Surface Water by the Summer Resident - Predicted Future

Constituent	Surface Water (mg/L)	Toxicity Reference Value	Dermal Absorption Factor	Cancer Risk				
				Infant	Toddler	Child	Teen	Adult
<b>Summer Resident - Ingestion Surface Water</b>								
Arsenic	9.79E-03	1.8E+00	N/A	1.0E-05	4.5E-05	2.8E-05	1.5E-05	2.6E-05
<b>Summer Resident - Dermal Contact with Surface Water</b>								
Arsenic	9.79E-03	1.8E+00	1.0E-03	1.1E-07	3.7E-07	2.7E-07	1.7E-07	5.8E-08

Attachment G  
Detailed Risk Estimates for Sum of All Exposure Pathways

Table G1: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Hunter/Trapper/Fisher Teen

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.2	0.2	0.0	LUNG/ NEURO	NEURO
Antimony	0.3	0.3	0.0	BLOOD	
Arsenic	0.2	0.2	0.0	SKIN	LUNG
Barium	0.1	0.2	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.4	0.4	0.0	FETAL DEVELOPMENT	
Cadmium	2.7	2.7	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.5	0.5	0.0	HEART/ LIVER	
Iron	0.6	0.6	0.0	GASTRO/ HEART	
Lead	0.2	0.2	0.0	NEURO	
Manganese	1.3	1.3	0.0	NEURO	
Mercury	0.2	0.2	0.0	KIDNEY	
Nickel	0.3	0.4	0.0	SKIN/GASTRO	LUNG
Selenium	1.2	1.2	0.0	SKIN	
Strontium	0.0	0.1	0.1	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.7	0.7	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.6	0.6	0.0	BLOOD	

Table G2: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Hunter/Trapper/Fisher Teen

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	1.7	1.7	0.0
BLOOD	0.3	0.3	0.0
SKIN	1.9	1.9	0.0
CARDIO	1.0	1.0	0.0
KIDNEY	3.0	3.0	0.0
LIVER	0.6	0.6	0.0
GASTRO	0.7	0.7	0.0
FETAL DEVELOPMENT	0.4	0.4	0.0
MUSCULOSKELETAL	0.0	0.1	0.1
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0



Table G3: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Hunter/Trapper/Fisher Teen

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	1.6E-05	1.8E-05	1.2E-06
Cadmium	1.3E-09	2.8E-09	1.5E-09
Chromium	1.2E-07	1.8E-07	5.8E-08
Nickel	1.0E-09	1.5E-09	4.8E-10

Table G4: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Hunter/Trapper/Fisher Adult

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.2	0.2	0.0	LUNG/ NEURO	NEURO
Antimony	0.4	0.4	0.0	BLOOD	
Arsenic	0.2	0.3	0.0	SKIN	LUNG
Barium	0.2	0.2	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.5	0.5	0.0	FETAL DEVELOPMENT	
Cadmium	3.5	3.5	0.0	KIDNEY	
Chromium	0.2	0.2	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.6	0.6	0.0	HEART/ LIVER	
Iron	0.7	0.7	0.0	GASTRO/ HEART	
Lead	0.3	0.3	0.0	NEURO	
Manganese	1.7	1.7	0.0	NEURO	
Mercury	0.2	0.3	0.0	KIDNEY	
Nickel	0.5	0.5	0.0	SKIN/GASTRO	LUNG
Selenium	1.6	1.6	0.0	SKIN	
Strontium	0.0	0.1	0.1	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	1.0	1.0	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.8	0.8	0.0	BLOOD	

Table G5: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Hunter/Trapper/Fisher Adult

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	2.1	2.2	0.0
BLOOD	0.4	0.4	0.0
SKIN	2.4	2.5	0.0
CARDIO	1.3	1.3	0.0
KIDNEY	3.9	3.9	0.0
LIVER	0.8	0.8	0.0
GASTRO	0.9	0.9	0.0
FETAL DEVELOPMENT	0.5	0.5	0.0
MUSCULOSKELETAL	0.0	0.1	0.1
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G6: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Hunter/Trapper/Fisher Adult

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	2.0E-05	2.1E-05	7.9E-07
Cadmium	1.6E-09	3.4E-09	1.9E-09
Chromium	1.5E-07	2.3E-07	7.2E-08
Nickel	1.3E-09	1.8E-09	5.9E-10

Table G7: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Recreational User Infant

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.0	0.0	0.0	BLOOD	
Arsenic	0.1	0.1	0.0	SKIN	LUNG
Barium	0.0	0.0	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.0	0.0	0.0	FETAL DEVELOPMENT	
Cadmium	0.0	0.0	0.0	KIDNEY	
Chromium	0.0	0.0	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.0	0.1	0.0	HEART/ LIVER	
Iron	0.2	0.2	0.0	GASTRO/ HEART	
Lead	0.1	0.2	0.0	NEURO	
Manganese	0.1	0.2	0.0	NEURO	
Mercury	0.0	0.0	0.0	KIDNEY	
Nickel	0.0	0.0	0.0	SKIN/GASTRO	LUNG
Selenium	0.0	0.0	0.0	SKIN	
Strontium	0.0	0.0	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.0	0.0	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.0	0.0	0.0	SKIN	
Zinc	0.0	0.0	0.0	BLOOD	

Table G8: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Recreational User Infant

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.4	0.4	0.0
BLOOD	0.0	0.0	0.0
SKIN	0.1	0.2	0.0
CARDIO	0.2	0.2	0.0
KIDNEY	0.0	0.1	0.0
LIVER	0.1	0.1	0.0
GASTRO	0.2	0.2	0.0
FETAL DEVELOPMENT	0.0	0.0	0.0
MUSCULOSKELETAL	0.0	0.0	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G9: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Recreational User Infant

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	2.5E-06	2.8E-06	3.3E-07
Cadmium	1.4E-10	3.2E-10	1.7E-10
Chromium	1.4E-08	2.1E-08	6.7E-09
Nickel	1.2E-10	1.7E-10	5.5E-11

Table G10: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Recreational User Toddler

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.2	0.2	0.0	BLOOD	
Arsenic	0.2	0.2	0.0	SKIN	LUNG
Barium	0.1	0.1	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.2	0.2	0.0	FETAL DEVELOPMENT	
Cadmium	1.6	1.5	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.3	0.3	0.0	HEART/ LIVER	
Iron	0.5	0.5	0.0	GASTRO/ HEART	
Lead	0.4	0.4	0.0	NEURO	
Manganese	1.0	1.0	0.0	NEURO	
Mercury	0.1	0.1	0.0	KIDNEY	
Nickel	0.2	0.2	0.0	SKIN/GASTRO	LUNG
Selenium	0.7	0.7	0.0	SKIN	
Strontium	0.0	0.1	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.5	0.5	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.4	0.4	0.0	BLOOD	



Table G11: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Recreational User Toddler

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	1.6	1.6	0.0
BLOOD	0.2	0.2	0.0
SKIN	1.2	1.2	0.0
CARDIO	0.8	0.8	0.0
KIDNEY	1.9	1.7	0.0
LIVER	0.4	0.4	0.0
GASTRO	0.6	0.6	0.0
FETAL DEVELOPMENT	0.2	0.2	0.0
MUSCULOSKELETAL	0.0	0.1	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G12: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Recreational User Toddler

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	2.0E-05	2.1E-05	1.5E-06
Cadmium	1.3E-09	2.8E-09	1.5E-09
Chromium	1.3E-07	1.9E-07	5.9E-08
Nickel	1.0E-09	1.5E-09	4.8E-10

Table G13: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Recreational User Child

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.1	0.2	0.0	BLOOD	
Arsenic	0.1	0.1	0.0	SKIN	LUNG
Barium	0.1	0.1	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.2	0.2	0.0	FETAL DEVELOPMENT	
Cadmium	1.2	1.1	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	<b>0.2</b>	<b>0.2</b>	0.0	HEART/ LIVER	
Iron	<b>0.3</b>	<b>0.3</b>	0.0	GASTRO/ HEART	
Lead	0.2	0.3	0.0	NEURO	
Manganese	<b>0.6</b>	<b>0.6</b>	0.0	NEURO	
Mercury	0.1	0.1	0.0	KIDNEY	
Nickel	0.2	0.2	0.0	SKIN/GASTRO	LUNG
Selenium	0.6	0.6	0.0	SKIN	
Strontium	0.0	0.0	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.3	0.3	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.3	0.3	0.0	BLOOD	

Table G14: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Recreational User Child

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	<b>0.9</b>	<b>0.9</b>	0.0
BLOOD	<b>0.1</b>	<b>0.2</b>	0.0
SKIN	0.9	0.9	0.0
CARDIO	<b>0.5</b>	<b>0.5</b>	0.0
KIDNEY	1.4	1.2	0.0
LIVER	<b>0.3</b>	<b>0.3</b>	0.0
GASTRO	<b>0.3</b>	<b>0.3</b>	0.0
FETAL DEVELOPMENT	0.2	0.2	0.0
MUSCULOSKELETAL	0.0	0.0	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G15: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Recreational User Child

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	1.1E-05	1.2E-05	9.3E-07
Cadmium	1.0E-09	2.3E-09	1.3E-09
Chromium	1.0E-07	1.5E-07	4.9E-08
Nickel	8.5E-10	1.2E-09	4.0E-10

Table G16: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Recreational User Teen

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.1	0.1	0.0	BLOOD	
Arsenic	0.1	0.1	0.0	SKIN	LUNG
Barium	0.0	0.1	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.1	0.1	0.0	FETAL DEVELOPMENT	
Cadmium	0.9	0.8	0.0	KIDNEY	
Chromium	0.0	0.0	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.2	0.2	0.0	HEART/ LIVER	
Iron	0.2	0.2	0.0	GASTRO/ HEART	
Lead	0.1	0.1	0.0	NEURO	
Manganese	0.5	0.5	0.0	NEURO	
Mercury	0.1	0.1	0.0	KIDNEY	
Nickel	0.1	0.1	0.0	SKIN/GASTRO	LUNG
Selenium	<b>0.4</b>	0.4	0.0	SKIN	
Strontium	0.0	0.0	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	<b>0.3</b>	0.3	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.0	0.0	0.0	SKIN	
Zinc	0.2	0.2	0.0	BLOOD	

Table G17: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Recreational User Teen

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.6	0.6	0.0
BLOOD	0.1	0.1	0.0
SKIN	0.7	0.7	0.0
CARDIO	0.4	0.4	0.0
KIDNEY	1.0	1.0	0.0
LIVER	0.2	0.2	0.0
GASTRO	0.2	0.2	0.0
FETAL DEVELOPMENT	0.1	0.1	0.0
MUSCULOSKELETAL	0.0	0.0	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G18: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Recreational User Teen

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	5.9E-06	6.4E-06	4.6E-07
Cadmium	4.7E-10	1.0E-09	5.7E-10
Chromium	4.7E-08	6.9E-08	2.2E-08
Nickel	3.8E-10	5.6E-10	1.8E-10



Table G19: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Recreational User Adult

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.1	0.2	0.0	BLOOD	
Arsenic	0.1	0.1	0.0	SKIN	LUNG
Barium	0.1	0.1	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.2	0.2	0.0	FETAL DEVELOPMENT	
Cadmium	1.2	1.2	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.2	0.2	0.0	HEART/ LIVER	
Iron	0.3	0.3	0.0	GASTRO/ HEART	
Lead	0.1	0.1	0.0	NEURO	
Manganese	0.6	0.6	0.0	NEURO	
Mercury	0.1	0.1	0.0	KIDNEY	
Nickel	0.2	0.2	0.0	SKIN/GASTRO	LUNG
Selenium	0.6	0.6	0.0	SKIN	
Strontium	0.0	0.0	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.3	0.3	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.3	0.3	0.0	BLOOD	

Table G20: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Recreational User Adult

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.8	0.8	0.0
BLOOD	0.1	0.2	0.0
SKIN	0.9	0.9	0.0
CARDIO	0.5	0.5	0.0
KIDNEY	1.4	1.4	0.0
LIVER	0.3	0.3	0.0
GASTRO	0.3	0.3	0.0
FETAL DEVELOPMENT	0.2	0.2	0.0
MUSCULOSKELETAL	0.0	0.0	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G21: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Recreational User Adult

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	7.2E-06	7.5E-06	3.0E-07
Cadmium	5.8E-10	1.3E-09	7.0E-10
Chromium	5.8E-08	8.5E-08	2.7E-08
Nickel	4.7E-10	6.9E-10	2.2E-10

Table G22: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Summer Resident Infant

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.2	0.0	LUNG/ NEURO	NEURO
Antimony	0.1	<b>0.0</b>	-0.1	BLOOD	
Arsenic	<b>0.2</b>	<b>0.2</b>	0.0	SKIN	LUNG
Barium	0.0	0.0	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.0	<b>0.0</b>	0.0	FETAL DEVELOPMENT	
Cadmium	0.0	0.0	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.1	0.1	0.0	HEART/ LIVER	
Iron	<b>0.3</b>	<b>0.4</b>	0.0	GASTRO/ HEART	
Lead	0.3	0.3	0.0	NEURO	
Manganese	0.3	0.3	0.0	NEURO	
Mercury	0.0	0.0	0.0	KIDNEY	
Nickel	0.0	0.1	0.0	SKIN/GASTRO	LUNG
Selenium	0.0	<b>0.0</b>	0.0	SKIN	
Strontium	0.0	<b>0.0</b>	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.1	0.1	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	<b>0.0</b>	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.0	0.0	0.0	BLOOD	

Table G23: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Summer Resident Infant

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.7	0.8	0.1
BLOOD	0.1	0.02	0.0
SKIN	0.3	0.4	0.0
CARDIO	0.4	0.5	0.0
KIDNEY	0.1	0.1	0.0
LIVER	0.2	0.2	0.0
GASTRO	0.4	0.4	0.0
FETAL DEVELOPMENT	0.0	0.0	0.0
MUSCULOSKELETAL	0.0	0.0	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G24: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Summer Resident Infant

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	1.1E-05	1.2E-05	1.4E-06
Cadmium	6.3E-10	1.4E-09	7.5E-10
Chromium	6.2E-08	9.1E-08	2.9E-08
Nickel	5.1E-10	7.4E-10	2.4E-10

Table G25: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Summer Resident Toddler

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.3	0.3	0.0	LUNG/ NEURO	NEURO
Antimony	0.5	0.4	0.0	BLOOD	
Arsenic	0.3	0.4	0.0	SKIN	LUNG
Barium	0.2	0.2	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.5	0.5	0.0	FETAL DEVELOPMENT	
Cadmium	3.5	3.2	0.0	KIDNEY	
Chromium	0.2	0.2	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.7	0.7	0.0	HEART/ LIVER	
Iron	1.0	1.0	0.0	GASTRO/ HEART	
Lead	0.9	0.9	0.0	NEURO	
Manganese	2.2	2.1	0.0	NEURO	
Mercury	0.2	0.3	0.0	KIDNEY	
Nickel	0.4	0.4	0.0	SKIN/GASTRO	LUNG
Selenium	1.6	1.8	0.2	SKIN	
Strontium	0.0	0.1	0.1	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	1.0	1.0	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.1	0.0	KIDNEY	
Vanadium	0.2	0.2	0.0	SKIN	
Zinc	0.8	0.8	0.0	BLOOD	

Table G26: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Summer Resident Toddler

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	3.0	3.0	0.0
BLOOD	0.5	0.4	0.0
SKIN	2.6	2.8	0.2
CARDIO	1.6	1.7	0.0
KIDNEY	4.0	3.7	0.0
LIVER	0.9	0.9	0.0
GASTRO	1.2	1.2	0.0
FETAL DEVELOPMENT	0.5	0.5	0.0
MUSCULOSKELETAL	0.0	0.1	0.1
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0



Table G27: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Summer Resident Toddler

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	1.8E-04	1.8E-04	6.5E-06
Cadmium	5.5E-09	1.2E-08	6.6E-09
Chromium	5.5E-07	8.1E-07	2.6E-07
Nickel	4.5E-09	6.6E-09	2.1E-09

Table G28: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Summer Resident Child

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.2	0.2	0.0	LUNG/ NEURO	NEURO
Antimony	0.4	0.3	0.0	BLOOD	
Arsenic	0.2	0.2	0.0	SKIN	LUNG
Barium	0.1	0.2	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.3	0.3	0.0	FETAL DEVELOPMENT	
Cadmium	2.6	2.4	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.5	0.5	0.0	HEART/ LIVER	
Iron	0.6	0.6	0.0	GASTRO/ HEART	
Lead	0.5	0.5	0.0	NEURO	
Manganese	1.3	1.3	0.0	NEURO	
Mercury	0.2	0.2	0.0	KIDNEY	
Nickel	0.3	0.3	0.0	SKIN/GASTRO	LUNG
Selenium	1.2	1.2	0.0	SKIN	
Strontium	0.0	0.1	0.1	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.7	0.7	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.6	0.6	0.0	BLOOD	

Table G29: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Summer Resident Child

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	2.0	2.0	0.0
BLOOD	0.4	0.3	0.0
SKIN	1.8	1.8	0.0
CARDIO	1.0	1.0	0.0
KIDNEY	2.9	2.7	0.0
LIVER	0.6	0.6	0.0
GASTRO	0.7	0.7	0.0
FETAL DEVELOPMENT	0.3	0.3	0.0
MUSCULOSKELETAL	0.0	0.1	0.1
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G30: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Summer Resident Child

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	4.8E-05	5.2E-05	4.0E-06
Cadmium	4.5E-09	1.0E-08	5.4E-09
Chromium	4.5E-07	6.6E-07	2.1E-07
Nickel	3.7E-09	5.4E-09	1.7E-09

Table G31: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Summer Resident Teen

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.3	0.3	0.0	BLOOD	
Arsenic	0.1	0.2	0.0	SKIN	LUNG
Barium	0.1	0.1	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.3	0.3	0.0	FETAL DEVELOPMENT	
Cadmium	2.0	1.8	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.4	0.4	0.0	HEART/ LIVER	
Iron	0.4	0.4	0.0	GASTRO/ HEART	
Lead	0.2	0.2	0.0	NEURO	
Manganese	1.0	1.0	0.0	NEURO	
Mercury	0.1	0.2	0.0	KIDNEY	
Nickel	0.3	0.3	0.0	SKIN/GASTRO	LUNG
Selenium	0.9	0.9	0.0	SKIN	
Strontium	0.0	0.1	0.0	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.5	0.6	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.4	0.4	0.0	BLOOD	

Table G32: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Summer Resident Teen

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	1.3	1.3	0.0
BLOOD	0.3	0.3	0.0
SKIN	1.4	1.4	0.0
CARDIO	0.8	0.8	0.0
KIDNEY	2.3	2.1	0.0
LIVER	0.4	0.4	0.0
GASTRO	0.5	0.5	0.0
FETAL DEVELOPMENT	0.3	0.3	0.0
MUSCULOSKELETAL	0.0	0.1	0.0
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G33: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Summer Resident Teen

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	2.6E-05	2.9E-05	2.1E-06
Cadmium	2.0E-09	4.5E-09	2.5E-09
Chromium	2.0E-07	3.0E-07	9.5E-08
Nickel	1.7E-09	2.4E-09	7.7E-10

Table G34: Calculation of Non-Carcinogenic Hazard Index and Project Hazard for the Summer Resident Adult

Constituent	Baseline HI	Predicted Future HI	Project Hazard	Target Organ (Ingestion)	Target Organ (Inhalation)
Aluminum	0.1	0.1	0.0	LUNG/ NEURO	NEURO
Antimony	0.4	0.3	0.0	BLOOD	
Arsenic	0.2	0.2	0.0	SKIN	LUNG
Barium	0.1	0.1	0.0	KIDNEY	CARDIO
Bismuth	N/A	N/A	N/A		
Boron	0.3	0.3	0.0	FETAL DEVELOPMENT	
Cadmium	2.6	2.6	0.0	KIDNEY	
Chromium	0.1	0.1	0.0	LIVER/ GASTRO	KIDNEY
Cobalt	0.5	0.5	0.0	HEART/ LIVER	
Iron	0.5	0.5	0.0	GASTRO/ HEART	
Lead	0.2	0.2	0.0	NEURO	
Manganese	1.3	1.3	0.0	NEURO	
Mercury	0.2	0.2	0.0	KIDNEY	
Nickel	0.3	0.3	0.0	SKIN/GASTRO	LUNG
Selenium	1.2	1.2	0.0	SKIN	
Strontium	0.0	0.1	0.1	MUSCULOSKELETAL	
Tellurium	N/A	N/A	N/A		
Thallium	0.7	0.7	0.0	NEURO	
Titanium	0.0	0.0	0.0	GASTRO	
Uranium	0.0	0.0	0.0	KIDNEY	
Vanadium	0.1	0.1	0.0	SKIN	
Zinc	0.6	0.6	0.0	BLOOD	



Table G35: Calculation of Non-Carcinogenic Target Organ Hazard Index for the Summer Resident Adult

<b>Target Organ (Ingestion)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	1.6	1.6	0.0
BLOOD	0.4	0.3	0.0
SKIN	1.8	1.9	0.0
CARDIO	1.0	1.0	0.0
KIDNEY	2.9	2.9	0.0
LIVER	0.6	0.6	0.0
GASTRO	0.6	0.6	0.0
FETAL DEVELOPMENT	0.3	0.3	0.0
MUSCULOSKELETAL	0.0	0.1	0.1
<b>Target Organ (Inhalation)</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G36: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Project Hazard for the Summer Resident Adult

<b>Constituent</b>	<b>Baseline ILCR</b>	<b>Predicted Future ILCR</b>	<b>Project ILCR</b>
Arsenic	4.6E-05	4.6E-05	2.2E-07
Cadmium	2.5E-09	5.6E-09	3.0E-09
Chromium	2.5E-07	3.7E-07	1.2E-07
Nickel	2.0E-09	3.0E-09	9.6E-10

Table G37: Calculation of Non-Carcinogenic Hazard Index for the Year Round Resident Toddler

<b>Constituent</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
Aluminum	0.6	0.6	0.0
Antimony	1.0	0.9	0.0
Arsenic	0.7	0.7	0.0
Barium	0.4	0.4	0.0
Bismuth			
Boron	0.9	0.9	0.0
Cadmium	7.1	6.5	0.0
Chromium	0.5	0.5	0.0
Cobalt	1.3	1.4	0.0
Iron	1.9	1.9	0.0
Lead	1.7	1.8	0.1
Manganese	4.3	4.3	0.0
Mercury	0.5	0.6	0.06
Nickel	0.9	0.9	0.0
Selenium	3.2	3.6	0.4
Strontium	0.1	0.3	0.2
Tellurium			
Thallium	2.0	2.0	0.0
Titanium	0.0	0.0	0.0
Uranium	0.1	0.1	0.0
Vanadium	0.4	0.4	0.0
Zinc	1.5	1.5	0.0

Table G38: Non-Carcinogenic Target Organ Hazard Index for the Year Round Resident Toddler

Target Organ (Ingestion)	Baseline HI	Predicted Future HI	Project Hazard
NEURO	6.0	6.0	0.0
BLOOD	1.0	0.9	-0.2
SKIN	5.2	5.6	0.4
CARDIO	3.2	3.3	0.1
KIDNEY	8.1	7.5	0.0
LIVER	1.8	1.8	0.0
GASTRO	2.4	2.4	0.0
FETAL DEVELOPMENT			0.0
MUSCULOSKELETAL	0.1	0.3	0.2
Target Organ (Inhalation)	Baseline HI	Predicted Future HI	Project Hazard
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G39: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Hazard for the Year Round Resident Toddler

Constituent	Baseline ILCR	Predicted Future ILCR	Project ILCR
Arsenic	0.000706	0.000732	0.000026
Cadmium	0.000000	0.000000	0.000000
Chromium	0.000002	0.000003	0.000001
Nickel	0.000000	0.000000	0.000000

Table G40: Calculation of Non-Carcinogenic Hazard Index for the Year Round Resident Adult

<b>Constituent</b>	<b>Baseline HI</b>	<b>Predicted Future HI</b>	<b>Project Hazard</b>
Aluminum	0.3	0.3	0.0
Antimony	0.7	0.7	0.0
Arsenic	0.4	0.4	0.0
Barium	0.3	0.3	0.0
Bismuth			
Boron	0.7	0.7	0.0
Cadmium	5.3	5.3	0.0
Chromium	0.2	0.2	0.0
Cobalt	0.9	0.9	0.0
Iron	1.1	1.1	0.0
Lead	0.4	0.4	0.0
Manganese	2.5	2.6	0.0
Mercury	0.4	0.4	0.0
Nickel	0.7	0.7	0.0
Selenium	2.4	2.4	0.0
Strontium	0.1	0.2	0.1
Tellurium			
Thallium	1.4	1.4	0.0
Titanium	0.0	0.0	0.0
Uranium	0.1	0.1	0.0
Vanadium	0.2	0.2	0.0
Zinc	1.1	1.1	0.0

Table G41: Non-Carcinogenic Target Organ Hazard Index for the Year Round Resident Adult

Target Organ (Ingestion)	Baseline HI	Predicted Future HI	Project Hazard
NEURO	3.2	3.3	0.1
BLOOD	0.7	0.7	-0.1
SKIN	3.7	3.7	0.0
CARDIO	2.0	2.0	0.0
KIDNEY	5.9	5.9	0.0
LIVER	1.2	1.2	0.0
GASTRO	1.3	1.3	0.0
FETAL DEVELOPMENT	0.7	0.7	0.0
MUSCULOSKELETAL	0.1	0.2	0.1
Target Organ (Inhalation)	Baseline HI	Predicted Future HI	Project Hazard
NEURO	0.0	0.0	0.0
LUNG	0.0	0.0	0.0
CARDIO	0.0	0.0	0.0
KIDNEY	0.0	0.0	0.0

Table G42: Calculation of Carcinogenic Incremental Lifetime Cancer Risk and Hazard for the Year Round Resident Adult

Constituent	Baseline ILCR	Predicted Future ILCR	Project ILCR
Arsenic	0.000183	0.000184	0.000001
Cadmium	0.000000	0.000000	0.000000
Chromium	0.000001	0.000001	0.000000
Nickel	0.000000	0.000000	0.000000

Attachment H:  
Example Calculations

## DOSE

This section provides worked calculations for each of the models used to estimate arsenic exposure from soil and country food for the adult hunter, trapper, fisher receptor during construction and operation.

### *Ingestion of Soil*

The predicted intake of each constituent via ingestion of soil was calculated as:

$$\text{Dose (mg/kg - day)} = \frac{C_s \times IR_s \times RAF_{\text{Oral}} \times D_2 \times D_3 (\times D_4)}{BW (\times LE)}$$

Where:

Dose	= predicted chronic daily intake (mg/kg-day)
$C_s$	= concentration of contaminant in soil (arsenic 95 <sup>th</sup> percentile = 72.9 mg/kg)
$IR_s$	= receptor ingestion rate for soil (0.00002 kg/d)
$RAF_{\text{Oral}}$	= relative absorption factor from the gastrointestinal tract (0.33) (unit-less)
$D_2$	= days per week exposed (7 days/7-day week)
$D_3$	= weeks per year exposed (8 weeks per 12-week for assessment of non-carcinogens)
$D_3$	= weeks per year exposed (8 weeks per 52-week for assessment of carcinogens)
$D_4$	= total years exposed to site (60 years) (for assessment of carcinogens only)
BW	= body weight (70.7 kg)
LE	= life expectancy (80 years) (for assessment of carcinogens only)

$$Dose_{\text{non-carcinogen}} = \frac{(72.9 \text{ mg/kg} \times 0.00002 \text{ kg/d} \times 0.33 \times \frac{7 \text{ d}}{7 \text{ d}} \times \frac{8 \text{ w}}{12 \text{ w}})}{(70.7 \text{ kg})}$$

$$Dose_{\text{non-carcinogen}} = 4.5369 \times 10^{-6} \text{ mg/kg - day}$$

$$Dose_{\text{carcinogen}} = \frac{(72.9 \text{ mg/kg} \times 0.00002 \text{ kg/d} \times 0.33 \times \frac{7 \text{ d}}{7 \text{ d}} \times \frac{8 \text{ w}}{52 \text{ w}} \times \frac{22}{80 \text{ y}})}{(70.7 \text{ kg})}$$

$$Dose_{\text{carcinogen}} = 2.879 \times 10^{-7} \text{ mg/kg - day}$$



### Inhalation of Particulates

The predicted intake of each constituent via inhalation of soil particulate was calculated as:

$$\text{Dose (mg/kg-day)} = \frac{C_{\text{Air}} \times IR_A \times D_1 \times D_2 \times D_3 (\times D_4)}{BW(\times LE)}$$

Where:

- Dose = predicted chronic daily intake (mg/kg-day)
- $C_{\text{Air}}$  = PM10 concentration of air particulate (dust) (arsenic =  $2.48 \times 10^{-7}$  mg/m<sup>3</sup>).
- $IR_A$  = receptor inhalation rate for fugitive dust (0.69 m<sup>3</sup>/hour = 16.6 m<sup>3</sup>/day)
- $RAF_{\text{Inh}}$  = relative absorption factor from the respiratory tract (1.0)(unit-less)
- $D_1$  = hours per day exposed (24 hours/24-hour day)
- $D_2$  = days per week exposed (7 days/7-day week)
- $D_3$  = weeks per year exposed (8 weeks per 12-week for assessment of non-carcinogens)
- $D_3$  = weeks per year exposed (8 weeks per 52-week for assessment of carcinogens)
- $D_4$  = total years exposed to Site (60 years) (for assessment of carcinogens only)
- BW = body weight (70.7 kg)
- LE = life expectancy (80 years) (for assessment of carcinogens only)

$$Dose_{\text{non-carcinogen}} = \frac{(2.48 \times 10^{-7} \text{ mg/m}^3 \times 16.6 \text{ m}^3/\text{day} \times 1.0 \times \frac{24\text{h}}{24\text{h}} \times \frac{7\text{d}}{7\text{d}} \times \frac{8\text{w}}{12\text{w}})}{(70.7\text{kg})}$$

$$Dose_{\text{non-carcinogen}} = 3.882 \times 10^{-8} \text{ mg/kg} - \text{day}$$

$$Dose_{\text{carcinogen}} = \frac{(2.48 \times 10^{-7} \text{ mg/m}^3 \times 16.6 \text{ m}^3/\text{day} \times 1.0 \times \frac{24\text{h}}{24\text{h}} \times \frac{7\text{d}}{7\text{d}} \times \frac{8\text{w}}{52\text{w}} \times \frac{22}{80\text{y}})}{(70.7\text{kg})}$$

$$Dose_{\text{carcinogen}} = 2.4635 \times 10^{-9} \text{ mg/kg} - \text{day}$$

*Dermal Contact with Soil*

The predicted intake of each constituent via dermal contact with soil was calculate as:

$$\text{Dose (mg/kg-day)} = \frac{((C_s \times SA_H \times SL_H) + (C_s \times SA_o \times SL_o)) \times \text{RAF}_{\text{Derm}} \times D_2 \times D_3 (\times D_4)}{\text{BW} (\times \text{LE})}$$

Where:

- Dose = predicted chronic daily intake (mg/kg-day)
- CS = concentration of contaminant in soil (arsenic 95<sup>th</sup> percentile = 72.9 mg/kg)
- SA<sub>H</sub> = surface area of hands exposed for soil loading (890 cm<sup>2</sup>)
- SL<sub>H</sub> = soil loading rate to exposed skin of hands (1x10<sup>-7</sup> kg/cm<sup>2</sup>-event)
- SA<sub>O</sub> = surface area exposed other than hands for soil loading (8220 cm<sup>2</sup>)
- SL<sub>O</sub> = soil loading rate to exposed skin other than hands (1x10<sup>-8</sup> kg/cm<sup>2</sup>-event)
- RAF<sub>Derm</sub> = relative absorption factor from the gastrointestinal tract (0.03)(unit-less)
- D<sub>2</sub> = days per week exposed (7 days/7-day week)
- D<sub>3</sub> = weeks per year exposed (8 weeks per 12-week for assessment of non-carcinogens)
- D<sub>3</sub> = weeks per year exposed (8 weeks per 52-week for assessment of carcinogens)
- D<sub>4</sub> = total years exposed to Site (60 years) (for assessment of carcinogens only)
- BW = body weight (70.7 kg)
- LE = life expectancy (80 years) (for assessment of carcinogens only)

*Dose<sub>non-carcinogen</sub>*

$$= \frac{(72.9\text{mg/kg} \times (890\text{cm}^2 \times 1 \times 10^{-7} \frac{\text{kg}}{\text{cm}^2} - \text{event} + 8220\text{cm}^2 \times 1 \times 10^{-8} \frac{\text{kg}}{\text{cm}^2} - \text{event}) \times 0.03 \times \frac{7\text{d}}{7\text{d}} \times \frac{8\text{w}}{12\text{w}})}{(70.7\text{kg})}$$

$$\text{Dose}_{\text{non-carcinogen}} = 3.53 \times 10^{-6} \text{ mg/kg} - \text{day}$$

*Dose<sub>carcinogen</sub>*

$$= \frac{(72.9\text{mg/kg} \times (890\text{cm}^2 \times 1 \times 10^{-7} \frac{\text{kg}}{\text{cm}^2} - \text{event} + 8220\text{cm}^2 \times 1 \times 10^{-8} \frac{\text{kg}}{\text{cm}^2} - \text{event}) \times 0.03 \times \frac{7\text{d}}{7\text{d}} \times \frac{8\text{w}}{52\text{w}} \times \frac{22\text{y}}{80\text{y}})}{(70.7\text{kg})}$$

$$\text{Dose}_{\text{carcinogen}} = 2.24054 \times 10^{-8} \text{ mg/kg} - \text{day}$$

### Ingestion of Country Foods

The baseline and predicted intake of each constituent via ingestion of fish was calculated as:

$$\text{Dose (mg/kg – day)} = \frac{C_F \times IR_F \times \text{RAF}_{\text{Oral}} \times \text{BAF} \times D_2 \times D_3 (\times D_4)}{\text{BW} (\times \text{LE})}$$

This is the dose formula for all country foods.

Where:

Dose	= predicted chronic daily intake (mg/kg-day)
$C_F$	= concentration of contaminant in country food such as fish (inorganic arsenic in fish (baseline = 0.0736 mg/kg; predicted = 0.0982 mg/kg))
$IR_F$	= receptor ingestion rate for country food type such as fish (e.g., 0.29 kg/d)
$\text{RAF}_{\text{Oral}}$	= relative absorption factor from the gastrointestinal tract (1.0) (unit-less)
BAF	= Bioaccessibility Factor (0.5)
$D_i$	= days per year exposed (365 days/365-day year)
$D_4$	= total years exposed to site (60 years) (for assessment of carcinogens only)
BW	= body weight (70.7 kg)
LE	= life expectancy (80 years) (for assessment of carcinogens only)

#### Baseline

$$\text{Dose}_{\text{non-carcinogen}} = \frac{(0.0736 \text{ mg/kg} \times 0.29 \text{ kg/d} \times 1.0 \times 0.5 \times \frac{8 \text{ weeks}}{12 \text{ weeks}})}{(70.7 \text{ kg})}$$

$$\text{Dose}_{\text{non-carcinogen}} = 1.5095 \times 10^{-4} \text{ mg/kg – day} \times \frac{8 \text{ weeks}}{12 \text{ weeks}}$$

$$\text{Dose}_{\text{non-carcinogen}} = 1.0063 \times 10^{-4} \text{ mg/kg – day} =$$

$$\text{Dose}_{\text{carcinogen}} = \frac{(0.0736 \text{ mg/kg} \times 0.29 \text{ kg/d} \times 1.0 \times 0.5 \times \frac{8 \text{ weeks}}{52 \text{ weeks}} \times \frac{7.5 \text{ y}}{80 \text{ y}})}{(70.7 \text{ kg})}$$

$$\text{Dose}_{\text{carcinogen}} = (1.41515 \times 10^{-5} \text{ mg/kg – day} \times \frac{8 \text{ weeks}}{52 \text{ weeks}})$$

$$\text{Dose}_{\text{carcinogen}} = 2.1771 \times 10^{-6} \text{ mg/kg – day} =$$

Predicted

$$Dose_{non-carcinogen} = \frac{(0.0728 \text{ mg/kg} \times 0.29 \text{ kg/d} \times 1.0 \times 0.5 \times \frac{8 \text{ weeks}}{12 \text{ weeks}})}{(70.7 \text{ kg})}$$

$$Dose_{non-carcinogen} = 1.5095 \times 10^{-4} \text{ mg/kg} - \text{day} \frac{8 \text{ weeks}}{12 \text{ weeks}}$$

$$Dose_{non-carcinogen} = 9.9538 \times 10^{-5} \text{ mg/kg} - \text{day}$$

$$Dose_{carcinogen} = (1.3998 \times 10^{-5} \text{ mg/kg} - \text{day} \times \frac{8 \text{ weeks}}{52 \text{ weeks}})$$

$$Dose_{carcinogen} = 2.5196 \times 10^{-5} \text{ mg/kg} - \text{day} = 5 \times 10^{-5} \text{ mg/kg} - \text{day}$$

## HQ/ILCR

### *Soil Air and Water*

#### *Non-Carcinogenic Constituents*

Non-carcinogens are considered to be threshold chemicals where a specific dose must be exceeded before a health effects is observed. The likelihood of a potential adverse health effect is represented by a Hazard Quotient (HQ), which is calculated as the ratio of a given chemical dose to the chemical's corresponding non-carcinogenic TRV:

$$HQ = \frac{Dose}{TRV}$$

Where:

- HQ = non-carcinogenic hazard quotient
- Dose = dose for each constituent (mg/kg-day)
- TRV = non-carcinogenic toxicity reference value (mg/kg-day)

The following calculation was used to estimate the baseline HQ for the adult hunter, trapper, fisher receptor group as a result of exposure to arsenic in soil:

Inadvertent soil ingestion

$$HQ_1 = \frac{4.5369 \times 10^{-6} \text{ mg/kg} - \text{day}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 0.004537$$

Inhalation of soil particulate

$$HQ_2 = \frac{3.882 \times 10^{-8} \text{ mg/kg} - \text{day}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 3.882 \times 10^{-5}$$

Dermal Contact with soil

$$HQ_3 = \frac{3.532 \times 10^{-6} \text{ mg/kg} - \text{day}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 0.003532$$

Total (one significant figure)

$$HQ = HI = HQ_1 + HQ_3 = 0.017282 = 0.008067 = 0.008$$

The following calculation was used to estimate the predicted HQ for the adult hunter, trapper, fisher receptor group as a result of exposure to arsenic in soil:

Inadvertent soil ingestion Hazard

$$HQ_1 = \frac{4.5676 \times 10^{-5} \text{ mg/kg} - \text{day}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 0.0045676 = 0.005$$

Inhalation of soil particulate Hazard

$$HQ_2 = \frac{6.930 \times 10^{-8} \text{ mg/kg} - \text{day}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 6.930 \times 10^{-5}$$

Dermal Contact with soil Hazard

$$HQ_3 = \frac{3.554 \times 10^{-6} \text{ mg/kg} - \text{day}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 0.003554$$

Total Hazard (one significant figure)

$$HQ = HI = HQ_1 + HQ_3 = 0.008122 = 0.008$$

Project Hazard (one significant figure soil, water, air)

$$HQ_{\text{project}} = HI_{\text{Predicted}} - HI_{\text{Baseline}} = 0.008112 - 0.008067 = 0.00005495 = 0.00005$$

### *Carcinogenic Constituents*

For carcinogens, the risk of cancer is assumed to be proportional to dose and exposure results in a given probability of risk. Carcinogenic risk probabilities for the ingestion pathway were calculated by multiplying the EEC in soil by the cancer unit risk factor for each carcinogen.

The following formula was used to calculate risk estimates for carcinogenic adverse health effects (i.e., incremental lifetime cancer risk or ILCR) for arsenic:

$$ILCR_{\text{Lifestage } i} = \text{Dose}_i (\text{mg/kg} - \text{day}) \times \text{Slope Factor} (\text{mg/kg} - \text{day})^{-1} \times \text{ADAF}_i$$

Where:

- Dose<sub>i</sub> = carcinogenic dose received during lifestage i averaged over a lifetime
- Slope Factor = Route- and chemical-specific cancer slope factor
- ADAF<sub>i</sub> = Age-dependent adjustment factor for lifestage i

The following calculation/s was used to estimate the baseline ILCR for the adult hunter, trapper, fisher receptor as a result of exposure to arsenic:

Incidental soil ingestion ILCR

$$ILCR_1 = (2.879 \times 10^{-7} \text{ mg/kg} - \text{day}) \times (1.8 \frac{\text{mg}}{\text{kg}} - \text{day})^{-1} \times 1 = 5.183 \times 10^{-7}$$

Inhalation of soil particulate ILCR

$$ILCR_2 = (2.4635 \times 10^{-9} \text{ mg/kg} - \text{day}) \times (27 \frac{\text{mg}}{\text{kg}} - \text{day})^{-1} \times 1 = 6.652 \times 10^{-8}$$

Dermal Contact with soil ILCR

$$ILCR_3 = (2.2405 \times 10^{-7} \text{ mg/kg} - \text{day}) \times (1.8 \frac{\text{mg}}{\text{kg}} - \text{day})^{-1} \times 1 = 4.033 \times 10^{-7}$$

Total ILCR

$$ILCR_{total} = ILCR_1 + ILCR_2 + ILCR_3 = 9.881 \times 10^{-7} = 1.0 \times 10^{-6}$$

Particulate ILCR not added to  $ILCR_{total}$  because the primary target organ for arsenic exposure via the ingestion and dermal contact exposure routes is skin, while the primary target organ for the inhalation exposure route are the lungs. However, as a secondary target organ of arsenic exposures via inhalation, all three exposure routes were summed.

The Predicted ILCR for the adult hunter, trapper, fisher receptor as a result of exposure to arsenic:

Incidental soil ingestion ILCR

$$ILCR_1 = 5.218 \times 10^{-7}$$

Inhalation of soil particulate ILCR

$$ILCR_2 = 1.187 \times 10^{-7}$$

Dermal Contact with soil ILCR

$$ILCR_3 = 4.060 \times 10^{-7}$$

Total ILCR

$$ILCR_{total} = ILCR_1 + ILCR_2 + ILCR_3 = 1.05 \times 10^{-6} = 1 \times 10^{-6}$$

Project ILCR

$$\begin{aligned} ILCR_{Project} &= ILCR_{Predicted} - ILCR_{Baseline} \\ &= 1.05 \times 10^{-6} - 9.881 \times 10^{-7} = 5.840 \times 10^{-8} = 6 \times 10^{-8} \end{aligned}$$

### **Country foods**

*Non-Carcinogenic Hazard (Ingestion of Arsenic in Fish – Hunter/ Trapper/ Fisher)*

Baseline Hazard

$$HQ_1 = \frac{1.5095 \times 10^{-4} \text{ mg/kg} - \text{day} \times \frac{8 \text{ weeks}}{12 \text{ weeks}}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 1.5095 \times 10^{-1} \times \frac{8 \text{ weeks}}{12 \text{ weeks}}$$

$$HQ_{\text{Baseline}} = 0.10063 = 0.1$$

Predicted Hazard

$$HQ_1 = \frac{1.4931 \times 10^{-4} \text{ mg/kg} - \text{day} \times \frac{8 \text{ weeks}}{12 \text{ weeks}}}{1 \times 10^{-3} \text{ mg/kg} - \text{day}} = 1.4931 \times 10^{-1} \times \frac{8 \text{ weeks}}{12 \text{ weeks}}$$

$$HQ_{\text{Predicted}} = 0.09538 = 0.1$$

Project Hazard

$$HQ_{\text{project}} = HQ_{\text{Predicted}} - HQ_{\text{Baseline}} = -0.00522 = -0.005 = 0$$

Carcinogenic

Baseline ILCR

$$ILCR_1 = (1.4151 \times 10^{-5} \text{ mg/kg} - \text{day} \times \frac{8 \text{ weeks}}{52 \text{ weeks}}) \times (1.8 \frac{\text{mg}}{\text{kg}} - \text{day})^{-1} \times 1$$

$$ILCR_1 = (2.5472 \times 10^{-5} \times \frac{8 \text{ weeks}}{52 \text{ weeks}}) = 3.9188 \times 10^{-6}$$

Predicted ILCR

$$ILCR_1 = (1.3998 \times 10^{-5} \text{ mg/kg} - \text{day} \times \frac{8 \text{ weeks}}{52 \text{ weeks}}) \times (1.8 \frac{\text{mg}}{\text{kg}} - \text{day})^{-1} \times 1$$

$$ILCR_1 = (2.5196 \times 10^{-5} \times \frac{8 \text{ weeks}}{52 \text{ weeks}}) = 3.8762 \times 10^{-6}$$

Project ILCR

$$ILCR_{\text{project}} = ILCR_{\text{predicted}} - ILCR_{\text{Baseline}} = 3.8762 \times 10^{-6} - 3.9188 \times 10^{-6} = -4.260 \times 10^{-8} = 0$$