Final
Remedial Investigation Report

Red Devil Mine, Alaska

November 2014

Prepared for:

U.S. DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
Anchorage Field Office
4700 BLM Road
Anchorage, Alaska 99507

Prepared by:

ecology and
environment, inc.
Global Environmental Specialists

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Executive Summary

The Bureau of Land Management (BLM) initiated a Remedial Investigation (RI) in 2009 to address contamination at the Red Devil Mine (RDM) site, Alaska. The RDM consists of an abandoned mercury mine and ore processing facility located on public lands managed by the BLM, near the village of Red Devil, located in southwestern Alaska on the Kuskokwim River. The BLM performed this work pursuant to its delegated Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) lead agency authority. This RI report is part of the overall Remedial Investigation/ Feasibility Study (RI/FS) process that will result in a remediation approach for the site.

The purpose of the RI is to characterize areas of known or potential environmental contamination at the site. The objectives of the RI/FS are to:

- Characterize the nature and extent of environmental contamination released from the site.
- Assess the magnitude of potential human health and ecological risks from site-related contaminants.
- Evaluate potential remedial alternatives to reduce or eliminate human health and ecological risks posed by site contamination. This evaluation will be presented in the Feasibility Study Report under separate cover.

For this RI/FS, the RDM encompasses the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of a response action. Based on the location of tailings and other features, RI objectives and associated data collection pertain to each of the following areas:

- The Main Processing Area.
- Red Devil Creek, extending from a reservoir upstream of the Main Processing Area to the creek’s delta at its confluence with the Kuskokwim River.
- The area west of the Main Processing Area where historical surface exploration and mining occurred, referred to as the Surface Mined Area. The Surface Mined Area is underlain by the area of underground mine workings. The “Dolly Sluice” and “Rice Sluice” and their respective deltas on the bank of the Kuskokwim River are associated with the Surface Mined Area.
- Sediments in the Kuskokwim River.

The primary field investigations at the RDM were conducted during the 2010 and 2011 field seasons. Additional fieldwork was conducted at the site during the 2012 field season to supplement findings from the previous seasons. Collectively, the field investigations included the following activities:

- Surface soil sampling to determine the nature and lateral extent of contamination from tailings and waste rock in the Main Processing Area, near the Kuskokwim River, and on roads within the site, and extending from the site toward Red Devil village.

- Subsurface soil sampling to determine the nature and lateral and vertical extent of contamination from tailings and waste rock in the Main Processing Area, near the Kuskokwim River, and in the Surface Mined Area.
- Groundwater sampling to determine the nature and extent of contamination in existing and newly installed monitoring wells in the Main Processing Area, near the Kuskokwim River, and in the Surface Mined Area.
- Surface water sampling in Red Devil Creek to determine the nature and extent of contamination that exists in the creek and is being discharged to the Kuskokwim River.
- Sediment sampling in Red Devil Creek to determine the nature and extent of contamination that exists in the creek and is being discharged to the Kuskokwim River.
- Sediment sampling in the Kuskokwim River to estimate the nature and extent of solid phase contamination that has migrated offsite into the river.
- Vegetation sampling to determine the nature of contamination in onsite plants and berries.
- Monitoring well water level measurements and Red Devil Creek discharge measurements to characterize site hydrogeology and surface water hydrology.
- Evaluation of the fate and transport of contaminants in affected site media.
- Analysis of selected soil and waste samples to determine contaminant mobility and bioavailability.
- Sampling of soil, sediment, groundwater, and surface water to assess background concentrations of inorganic elements.

The results of the RI site characterization indicate that onsite tailings and waste rock are a source of heavy metals contamination of soils, surface water, and groundwater, and sediments in Red Devil Creek and the Kuskokwim River. Antimony, arsenic, and mercury are the metals most frequently detected at levels above observed background concentrations at the site. Several organic compounds, including polycyclic aromatic hydrocarbons and petroleum hydrocarbons, were detected locally in soils above regulatory criteria.

Inorganic element concentrations that exceed background values are considered “contamination.” Many of the same inorganic elements that comprise contamination, notably including antimony, arsenic, and mercury, also occur naturally in native bedrock, soil, and sediment, and groundwater and surface water that flow through them. Such naturally occurring concentrations represent pre-mining “background” conditions. It has not been possible with available RI data to determine the extent and concentrations of naturally mineralized soil at the RDM. As a result, the background levels used in this RI likely underestimate pre-mining background concentrations of inorganic elements associated with natural mineralization in various media. Distinguishing between naturally elevated concentrations of inorganics in various media and contamination resulting from mining-related activities is complicated by the superposition of mining-related impacts on natural bedrock and native soils and the physical hydrogeologic conditions within them.

Tailings and waste rock cover an area making up most of the Main Processing Area and a corridor along Red Devil Creek that extends to the creek's delta in the Kuskokwim River. Tailings and waste rock have also been used for road ballast west of the site. The tailings and waste rock deposits are deepest within the Main Processing Area and extend to a maximum depth of approximately 24 feet. Groundwater contamination is also present in the Main Processing Area down to the mouth of Red Devil Creek.

Surface water has played a significant role in distributing tailings and waste rock. Tailings and waste rock have been disposed of, eroded into, and transported down the channel of Red Devil Creek to the Kuskokwim River, where they accumulated in a delta. In the Surface Mined Area, sluicing of overburden created the Dolly and Rice Sluices. Sluiced overburden has accumulated in deltas in the Kuskokwim River. Materials deposited in the Red Devil Creek delta and sluice deltas may be subject to further erosion and transport.

Migration of contaminants to groundwater occurs principally via leaching from tailings, waste rock, and, to a lesser extent, flotation tailings and other soils. Leaching of inorganic elements from naturally mineralized bedrock and soil and migration via groundwater and surface water also is occurring at the RDM. Leached inorganic elements enter groundwater where and when groundwater immerses these source materials and by leaching and downward transport from spring snowmelt and precipitation. Inorganic elements may also enter groundwater as a result of flow through bedrock and underground mine workings. Contaminants are migrating via groundwater pathways into Red Devil Creek surface water along gaining reaches and are being transported downstream.

A human health risk assessment (HHRA) was conducted for the RDM site in accordance with Alaska State and U.S. Environmental Protection Agency (EPA) human health risk assessment guidance. Receptors evaluated included future onsite resident, current and future recreational or subsistence user, and future mine worker. The HHRA assessed exposure to contaminants of potential concern (COPCs) from the following pathways:

- Dermal (skin) contact with surface water from Red Devil Creek.
- Dermal (skin) contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Ingestion of and dermal contact with groundwater or surface water.
- Incidental ingestion of and dermal contact with soil.

- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals from soil.
- Inhalation of volatile chemicals in groundwater.

The potential cancer risks at the site exceed both Alaska Department of Environmental Conservation and EPA criteria for all receptors assessed. In general, exposure to arsenic in soil, groundwater, and fish posed greatest risk. Likewise, the potential toxic hazards at the site exceed both Alaska Department of Environmental Conservation and EPA criteria for all receptors evaluated in the HHRA. In general, exposure to antimony, arsenic, and mercury in soil, groundwater, and fish posed the greatest hazard. Cancer risks and toxic hazards were the highest for future residents potentially exposed to COPCs.

The HHRA included several areas of uncertainty. Specifically, the following areas provided source of significant uncertainty in the HHRA:

- Modeled concentrations of COPCs in some wild food, including fish, birds, and berries.
- Estimating consumption of wild food and assuming residents harvest consumed wild food from the site.
- Characterization of true background levels in the mineralized area.

Potential human health risk-based cleanup levels (RBCLs) were proposed for the contaminants of concern (COCs) and determined in the HHRA. RBCLs were developed for arsenic, antimony, and mercury in a number of media including soil, groundwater and biota. RBCLs also were developed for other COCs at the RDM site for media of concern. Several contaminants identified as COCs occur naturally at the RDM site.

An ecological risk assessment was conducted for the RDM site in accordance with Alaska State and EPA ecological risk assessment guidance. A range of ecologically relevant assessment endpoints were evaluated, including terrestrial plants, soil invertebrates, fish, benthic macroinvertebrates and other aquatic biota, terrestrial wildlife, and aquatic-dependent wildlife. For all receptor groups, with the exception of semi-aquatic avian herbivores and avian piscivores, estimated potential risks were above Alaska Department of Environmental Conservation and EPA criteria. Antimony, arsenic, and mercury yielded the highest ecological hazard quotient values for most receptors.

This RI report presents conclusions that are based on 27 key study questions developed through the data quality objectives process. In general, the answers to these questions form the following conclusions:

- The RDM is a source of heavy metals contamination to site soils, groundwater, surface water, and sediments. Antimony, arsenic, and mercury are the heavy metals of greatest concern. The site is also a source of organic contaminants to soils and groundwater.

- Contaminants from onsite waste sources are migrating to offsite locations through groundwater and surface water transport. Transport of contaminated sediments in Red Devil Creek has affected sediments in the Kuskokwim River.
- Potential human cancer and toxic hazard risks at the site exceed regulatory criteria for all receptors assessed. Modeled risks and hazards were the highest for the future residents scenario.
- Potential risks to terrestrial plants, wildlife, and aquatic biota were identified at the site. Ecological risks are greatest in the areas where tailings and waste rock are present on the surface and in surface water.

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Abbreviations, Acronyms, and Glossary

Acronym/Abbreviation	Definition
°C	degrees centigrade
°F	degrees Fahrenheit
$(\text{mg/kg-day})^{-1}$	risk per milligram per kilogram per day
$(\mu\text{g/m}^3)^{-1}$	risk per microgram per cubic meter
µg Pb/dL	micrograms of lead per deciliter
µg/dL	micrograms per deciliter
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu\text{g/m}^3$	micrograms per cubic meter
AAC	Alaska Administrative Code
$\text{ABS}_{\text{dermal}}$	dermal absorption
ADAF	age-dependent adjustment factor
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AF	adherence factor
ANHP	Alaska National Heritage Program
As_2O_3	arsenic trioxide
As_2S_3	arsenic sulfide (orpiment)
As_4S_4	arsenic sulfide (realgar)
AST	aboveground storage tanks
AT	averaging time
ATV	all-terrain vehicle
BCF	bioconcentration factor
BEI	Burlington Environmental, Inc.
BERA	baseline ecological risk assessment
bgs	below ground surface
BLM	Bureau of Land Management
BMD	benchmark dose
BMI	body mass index
BOM	United States Bureau of Mines
BRA	Baseline Risk Assessment
BSAF	biota-soil accumulation factor
BTEX	benzene toluene, ethylbenzene, xylenes
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per seconds
CIS	Community Information Summaries
cm	centimeters
cm^2	square centimeter

Abbreviations, Acronyms, and Glossary (cont.)

C_n	chemical concentration in food item *n*
COC	contaminant of concern
COPC	contaminant of potential concern
CSIS	Community Subsistence Information System
CSM	conceptual site model
Cu_3AsS_4	enargite
DA	Red Devil Creek Downstream Alluvial Area (exposure unit)
DBH	diameter at breast height
DMA	dimethylarsinic acid
DOI	Department of the Interior
DOM	dissolved organic matter
DQO	Data Quality Objective
DRO	diesel range organics
E & E	Ecology and Environment, Inc.,
EC	exposure concentration
ED	exposure duration
EER	estimated energy requirement
$EE_{soil/sed}$	estimated exposure from incidental soil/sediment ingestion
EE_{total}	total exposure
EF	exposure frequency
EF	exposure frequency
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ERAGS	United States Environmental Protection Agency Ecological Risk Assessment Guidelines for Superfund
ERS	Alaska Energy Recovery Services, Inc.
FCM	food chain multiplier
FeAsS	arsenopyrite
FeS_2	pyrite
FI	fraction ingested
F_n	fraction of diet represented by food item *n*
FS	Feasibility Study
FSP	Field Sampling Plan
FW	fresh weight
g/m^2-s per kg/m^3	grams per square meter per second, per kilograms per cubic meter
GI	gastrointestinal
GPS	global positioning system
GRO	gasoline range organics
H_3PO_4	phosphoric acid
HA	hectare
HEAST	Health Effects Assessment Summary Tables
Hg3S2Cl2	corderoite
HgS	mercury sulfide(cinnabar)
HgSO4-H20	schuetteite
HHRA	health risk assessment

HI	hazard index
HLA	Harding Lawson Associates
HQ	hazard quotient
IDW	Investigation-Derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic
IR	ingestion rate of receptor
IR_s	soil/sediment ingestion rate of receptor
IUR	inhalation unit risk
kg	kilogram
km	kilometer
L/day	liters per day
L/min	liters per minute
LADI	lifetime average daily intake
LEL	low effect level
LOAEL	lowest observed adverse effect level
LPAH	low molecular weight polycyclic aromatic hydrocarbons
LSE	Limited Sampling Event
M	molar
m	meters
m/s	meters per second
MACTEC	MACTEC Engineering and Consulting
MCL	Maximum Contaminant Level
MDL	method detection limit
mg	milligrams
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg-wet	milligrams per kilogram wet weight
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mg^3/kg	cubic meters per kilogram
m-HgS	metacinnabar
mm	millimeters
MMA	monomethylarsonic acid
MPA	Main Processing Area (exposure unit)
NAD	North American Datum
ND	nondetected value
ng	nanograms
ng/g	nanograms per gram
NOAEL	no observed adverse effect
NTCRA	non-time critical removal action
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PEF	particulate emission factor
ppm	parts per million
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective

Abbreviations, Acronyms, and Glossary (cont.)

RAWP	Risk Assessment Work Plan
RBCL	risk-based cleanup level
RBSC	risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RDM	Red Devil Mine
redox	oxidation-reduction
RfC	reference concentration
RfD	reference dose
RI Report	Remedial Investigation Report
RI	Remedial Investigation
RME	reasonable maximum exposure
ROS-	regression on order statistics
RRO	residual range organics
RSL	Regional Screening Level
SA	skin surface area
Sb_2S_3	antimony sulfide (stibnite)
SF	slope factor
SI	site inspection
SLERA	screening level ecological risk assessment
SMA	Surface Mined Area (exposure unit)
SPLP	synthetic precipitation leaching procedure
SSE	selective sequential extraction
SUF	site use factor
SVOC	semi-volatile organic compounds
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TOC	total organic carbon
TRV	toxicity reference value
TSC	tissue screening concentration
TSS	total suspended solids
TWA	time-weighted average
UCL	upper confidence limit
UPL	upper prediction limit
USGS	U.S. Geological Survey
UST	underground storage tank
Wilder	Wilder Construction Company
WOE	weight of evidence
Work Plan	Red Devil Mine Remedial Investigation/Feasibility Study Work Plan
WQC	water quality criteria
X As	arsenides
$XAsO_3Y$	arsenites
$XAsO_4Y$	arsenates
X AsS	arsenic sulfides
XRF	x-ray fluorescence
YKHC	Yukon-Kuskokwim Health Corporation

Glossary of Selected Mining and Geological Terms Used in the Remedial Investigation Report

Adit. A horizontal opening into an underground mine.

Calcine. By heating, to expel volatile matter as carbon dioxide, water, or sulfur, with or without oxidation; to roast or burn; the waste material left by calcining.

Crosscut. A horizontal underground mine passage driven from one ore body to intersect another ore body.

Dip. The angle at which a bed, stratum, or vein is inclined from the horizontal, measured perpendicular to the strike and in the vertical plane.

Drift. A horizontal passageway driven into or along the path of a vein.

Epithermal. Of or pertaining to a hydrothermal mineral deposit formed within about 1 kilometer of the earth's surface and in the temperature range of 50 to 200 degrees Celsius, occurring mainly as veins.

Flotation. A method of mineral separation in which a froth created in water by various reagents floats some finely crushed minerals that are skimmed off, while others sink and are drained off.

Gangue. The non-metallic or low-value metallic minerals in an ore; that part of an ore that is not economically desirable but cannot be avoided by mining. It is separated from desirable ore minerals during concentration.

Hydrothermal. Of or pertaining to hot water, to the action of hot water, or to the products of this action, such as a mineral deposit precipitated from a hot aqueous solution.

Level. A main underground passage driven along a level course to provide access to stopes or workings and to provide ventilation and a haulageway for the removal of ore. Levels are commonly spaced at regular depth intervals and are either numbered from the surface or designated by their elevation below the top of the shaft.

Mineralization. The process or processes by which a mineral or minerals are introduced into a rock, resulting in a valuable or potentially valuable deposit.

Ore. The naturally occurring material from which a mineral or minerals of economic value can be extracted profitably.

Portal. The surface entrance to a drift, tunnel, adit, or entry.

Raise. A vertical or inclined mine opening driven upward a level to connect upper levels or explore areas above a level.

Retort. A vessel used for the distillation of volatile materials, as in the separation of some metals.

Rotary Kiln. A large furnace used for calcining ores.

Shaft. A vertical or downward slanting opening into an underground mine.
Ore Shoot. An elongate pipe-like, ribbon-like, or chimney-like mass of ore within a deposit (usually a vein), representing the more valuable part of the deposit.

Skip. A small rail-mounted, side- or end-tipping ore carts used for conveying ore or waste rock from a workface to the surface of a mine.

Slag. A vitreous substance formed in any one of several ways by chemical action and fusion at furnace operating temperatures.

Sluice. To mine using a hydraulic mining method consisting of excavating alluvial or other mineral deposits by means of high-pressure water jets; an opening in a structure for passing debris with the aid of flowing water.

Slusher. A mechanical dragshovel loader.

Stockwork. A mineral deposit consisting of a three-dimensional network of planar to irregular veinlets closely enough spaced that the whole mass can be mined.

Stope. An underground cavity made by the removal of ore above or below a drift or working level; to remove ore by excavating a stope.

Strike. The trace of a mineral deposit, vein, or fault on the horizontal plane, at right angles to the direction of dip.

Stull. A support or framework within a mine used to prevent cave-ins.

Tailings. The gangue and other waste material resulting from the washing, concentration, or treatment of ore, including flotation tailings; a term sometimes used to describe calcined mercury ore.

Vein. A mineral filling of a fault or other fracture in a host rock, in tabular or sheetlike form.

Waste Rock. Barren or submarginal rock or ore that has been mined, but is not of sufficient value to warrant treatment and is therefore removed ahead of the milling processes.

Winze. A mine opening sunk downward from inside to connect lower levels of explore areas beneath a level.

1

Introduction

This Remedial Investigation Report (RI Report) addresses contamination at the Red Devil Mine (RDM) site. This report documents the results of the Remedial Investigation (RI) conducted at the RDM.

The RDM consists of an abandoned mercury mine and ore processing facility located on public lands managed by the Department of the Interior (DOI) Bureau of Land Management (BLM) in southwest Alaska (see Figure 1-1). Historical mining activities at the site included both underground and surface mining. Ore processing included crushing, retorting/furnacing, milling, and flotation. Ecology and Environment, Inc., (E & E) has prepared this RI Report on behalf of the BLM under Delivery Order Number L09PD02160 and General Services Administration Contract Number GS-10F-0160J.

The BLM initiated an RI/Feasibility Study (FS) at the RDM in 2009 pursuant to its delegated Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) lead-agency authority. The RI/FS is being performed per applicable CERCLA statutes, regulations, and guidance This RI/FS is being performed per applicable CERCLA guidance. In addition, planning and implementation the RI/FS is being performed in a manner consistent with regulations for contaminated site cleanup promulgated by the State of Alaska.

1.1 Purpose and Objectives

The purpose of the RI is to characterize the RDM physical setting and areas of known or potential environmental contamination at the site. The objectives of the RI/FS are to:

- Characterize the nature and extent of environmental contamination released from the site.
- Assess the magnitude of potential human health and ecological risks from site-related contaminants.
- Evaluate potential remedial alternatives to reduce or eliminate human health and ecological risks posed by site contamination. This evaluation will be presented in the FS Report under separate cover.

The BLM performed a non-time critical removal action (NTCRA) during the summer of 2014 to address threats posed by the migration of tailings into the Kuskokwim River via Red Devil Creek. The NTCRA activities locally modified the conditions at the RDM. The site conditions documented in this report are based on data gathered prior to implementation of the NTCRA.

1.2 Definition of the Site

The RDM encompasses the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of a response action. Historical mining operations left tailings and other remnants that have affected local soil, surface water, sediment, and groundwater. Based on the location of tailings and other features, RI objectives and associated data collection pertain to each of the following areas:

- The Main Processing Area.
- Red Devil Creek, extending from a reservoir upstream of the Main Processing Area to the creek's delta at its confluence with the Kuskokwim River.
- The area west of the Main Processing Area where historical surface exploration and mining occurred, referred to as the Surface Mined Area. The Surface Mined Area is underlain by the area of underground mine workings. The "Dolly Sluice" and "Rice Sluice" and their respective deltas on the bank of the Kuskokwim River are associated with the Surface Mined Area.
- Sediments in the Kuskokwim River.

Figure 1-2 illustrates the area encompassed by the RI and the major features identified above based on aerial photographs taken in 2010 (Aero-Metric, Inc. 2010a) and 2001 (Aero-Metric, Inc. 2010b).

The Main Processing Area contains most of the former site structures and is where ore beneficiation and mineral processing were conducted. The area is split by Red Devil Creek. Underground mine openings (shafts, adits, and stopes to the surface) and ore processing and mine support facilities (housing, warehousing, and so forth) were located on the west side of Red Devil Creek until 1955. After 1955, all ore processing was conducted at structures and facilities on the east side of Red Devil Creek. The Main Processing Area includes three monofills. The monofills are essentially landfills that contain demolished mine structure debris and other material. Two monofills are unlined (Monofills #1 and #3). Monofill #2, on the east side of Red Devil Creek, is an engineered and lined containment structure for building debris and materials from the demolished Post-1955 Retort structure.

The east side of Red Devil Creek is also the former location of petroleum aboveground storage tanks (ASTs), which were used to store fuel for site operations; however, the AST area itself is not included in the RI (see Section 1.4.2.4). The AST area is the subject of a separate investigation (Marsh Creek 2010).

Figure 1-3 illustrates the main historical and current features in the Main Processing Area. Underground and surface mining operations and ore beneficiation and mineral processing are discussed further in Section 1.4.2.

1.3 Document Organization

The RI Report is organized into the following chapters:

- **Chapter 1, Introduction –** Describes the purpose and objectives of the RI/FS; defines the site; describes the project location and regional setting, the operational history of the RDM, the site's environmental setting, previous investigations of the RDM, and previous removal and cleanup actions at the site; and provides a summary of the Data Quality Objectives (DQOs) presented in the Final RI/FS Work Plan (Work Plan).
- **Chapter 2, Study Area Investigations –** Describes the timing, methods, and locations of the RI field investigations and includes summaries of environmental samples collected and their analytical requirements.
- Cha**pter 3, Physical Characteristics of the Study Area –** Summarizes the results of field investigations intended to characterize physical components of the media of interest at the site.
- **Chapter 4, Nature and Extent of Contamination –** Summarizes the results of field investigations intended to characterize the presence, nature, and extent of chemical contamination in media of interest at the site.
- **Chapter 5, Contaminant Fate and Transport –** Describes the routes and mechanisms of contaminant migration at and from the site, the environmental fate of site contaminants based on data and information obtained during the RI field investigations, and the major contaminant transport pathways.
- **Chapter 6, Baseline Risk Assessment –** Presents quantitative cancer and non-cancer human health risks, and ecological risks, posed by the site based on data collected during the RI field investigations and other investigations at the site.
- **Chapter 7, Summary and Conclusions –** Summarizes the results of the RI field investigations and risk assessment and provides preliminary recommendations for remedial action objectives for the site.
- **Chapter 8, References –** Lists the guidance documents and literature resources cited in this document.
- **Appendices**
    - **A.** 2012 Red Devil Mine Baseline Monitoring Report
    - **B.** Soil Types
    - **C.** Data Validation Reports
    - **D.** ProUCL Input and Output Data

- **E.** Summary of Surface Soil, Subsurface Soil, and Groundwater Data
- **F.** Summary of Surface Soil, Subsurface Soil, and Groundwater Data
- **G.** Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2 and Response to Agency Comments
- **H.** Human Health ProUCL Inputs and Outputs
- **I.** Sculpin Metals Data
- **J.** Human Health Risk Assessment Risk Hazard Tables
- **K.** Lead Model
- **L.** Alaska National Heritage Correspondence
- **M.** Revised Screening Level Ecological Risk Assessment for the Red Devil Mine Site
- **N.** Benthic Macroinvertebrate Data (sample description and metals results)
- **O.** Baseline Ecological Risk Assessment ProUCL Output Summary
- **P.** BLM Data Used to Calculate Benthic Biota Sediment Accumulation Factors

1.4 Site Background

1.4.1 Project Location and Regional Setting

The RDM is approximately 250 air miles west and 1,500 marine/river barge miles from Anchorage, Alaska. The mine site was established on the southwest bank of the Kuskokwim River approximately 2 miles from the village of Red Devil, and approximately 8 miles from the village of Sleetmute. The Red Devil mine is generally located on the Kuskokwim River in Township 19 North, Range 44 West, within the southwest quarter of Section 5, southeast quarter of Section 6, northeast quarter section 7 and northwest quarter of section 8, Sleetmute D-4, Seward Meridian. The RDM site's approximate coordinates are 61° 45' 38.1" north latitude and 157° 18'42.7" west longitude (North American Datum 27).

The RDM site is in a remote location with no road or rail connection to any community. The site is accessed by boat or barge on the Kuskokwim River or by means of an airstrip at the nearby village of Red Devil.

1.4.2 Operational History

This section summarizes available information on the history of the RDM. Existing historical documents do not provide complete clarity on ownership and other topics related to the mine's history. The ore minerals at the RDM consisted of cinnabar (mercury sulfide [HgS])—the primary mercury ore mineral—and stibnite (antimony sulfide [Sb_2S_3]). Some realgar (arsenic sulfide [As_4S_4]), orpiment (arsenic sulfide [As_2S_3]), and secondary antimony minerals were locally associated with these ore minerals.

1.4.2.1 Mining Operations

Cinnabar from Red Devil Mine

In 1933, Hans Halverson discovered mercury ore in Red Devil Creek and staked the original claim for the RDM. By 1939, there were four claims, Red Devil numbers 1 through 4 (Roehm 1939). Ore was obtained from creek float (sediment) and overburden (Webber et al. 1947).

In 1941 and 1942, the operators sluiced the overburden from the southeast extremity of the ore zone, as then delineated, leaving a considerable depth of bedrock rubble. Ore from this loose material yielded much of the early production. Surface exploration by the United States Bureau of Mines (BOM) in 1942 consisted of more than 2,000 feet of bulldozer and hand trenching (Wright and Rutledge 1947).

In 1941, underground mine workings consisted of two adits and a shaft. The first adit, reported to be at an elevation of 311 feet above sea level, is referred to in this document as the 311 Adit. A second adit was started approximately 70 feet north of the portal of the 311 Adit and at a reported elevation of 325 feet. This second adit is referred to as the 325 Adit in this document. The main shaft, located approximately 55 feet southeast of the 311 Adit portal, was sunk to a depth of 30 feet on a 59-degree incline (Wright and Rutledge 1947).

In 1941, Harold Schmidt and L.J. Stampe secured a lease on the claims. The New Idria Quicksilver Mining Company entered into a sublease agreement with Schmidt and Stampe. The New Idria-Alaska Quicksilver Mining Company was formed and installed new thermal processing equipment for mercury, including a 40-ton rotary kiln (Wright and Rutledge 1947). Production as of June 30, 1944, amounted to 1,096 flasks of mercury recovered from 2,652 tons of ore. Most of the ore was recovered from stopes above the 325 Adit and the 276-foot level (Wright and Rutledge 1947). Ore processing during this time and subsequent operations is discussed in Section 1.4.2.2.

The price of mercury fell in 1944 and the New Idria Quicksilver Mining Company shut down mining operations and subsequently subleased its interest in the mine to the Kuskokwim Mining Company. The Kuskokwim Mining Company operated the mine for two seasons in 1945 and 1946 (Webber et al. 1947). In 1946, the price of mercury fell again and the Kuskokwim Mining Company shut down its operation. Harold Schmidt and C. J. Stampe bought out the New Idria Quicksilver Mining Company lease, including all the mining equipment. Robert

Lyman also held a lease on the mine in 1946 and produced 491 flasks of mercury, although Mr. Lyman's relationship to the other owners at this time is unclear (MACTEC 2005).

As of 1947, the ore recovered was reported to be soft and friable and to break free from the walls. The country rock was reported to be weak and to require close spacing of stulls for support of stope walls and drifts. All ore was mined from stulled stopes. Broken ore was trammed to the shaft on the 276-foot and 236-foot levels and to the storage bin on the 375-foot level. As of 1947, power for the reduction plant and mine was generated by two Caterpillar 46-30 diesel-electric units. Water was pumped from the mine at the rate of 100 gallons per minute with a 2-inch centrifugal pump (Wright and Rutledge 1947).

Between 1947 and 1951, the mine was not in operation (MACTEC 2005). In 1952, the DeCoursey Mountain Mining Company leased the mine. Various organizational changes in the operating companies occurred subsequently. As of 1962, the operating unit was called Alaska Mines and Minerals, Inc.

In 1952, DeCoursey Mountain Mining Company dewatered the mine workings and resumed production. In October 1954, a fire destroyed a large portion of the mine surface structures and equipment. The Pre-1955 Retort and the Pre-1955 Rotary Furnace facilities were rendered unusable by the fire. Some of the mine camp buildings were also damaged by the fire, but it is unknown if they were destroyed or repaired (Malone 1962).

Following the 1954 fire, DeCoursey Mountain Mining Company rebuilt a modern plant, including an airfield, a camp with bunkhouses, a commissary, a mess hall, offices, shops, warehouses, a diesel electric power station, and a modern furnace (Malone 1962). Extensive surface exploration and mining took place at the mine sometime after 1956. The reservoir was created after 1956 by constructing an earthen dam across Red Devil Creek. Aerial images indicate that soils from the hillsides adjacent to the reservoir dam were scraped and used for dam material. The reservoir may have been constructed to provide a source of water for the hydraulic sluicing operations such as those conducted at the Dolly Sluice Area, where loose overburden was sluiced away to expose ore zones in the underlying bedrock. The waste material from the sluice operation was washed down a gully toward the Kuskokwim River. This resulted in the formation of the Dolly Sluice delta on the Kuskokwim River at the base of the gully (MacKevett and Berg 1963).

As of 1963, the underground workings consisted of approximately 9,600 feet of shafts, adits, crosscuts, drifts, raises, and winzes, with workings on five levels. As indicated above, the underground mine workings began with the 311 Adit and 325 Adit. Later, the Red Devil inclined shaft (referred to in this document as the main shaft) was sunk with stations at the 33, 73, 150, 300, and 450 levels. The Dolly shaft was connected with the main shaft on the 300 level (Malone 1962). Other mine openings documented as of 1963 are the “F” Zone shaft and a caved shaft located northwest of the main shaft.

In a description of mine operations as of 1962, ore shoots were characterized as extremely short in strike length but locally persisting along the plunge for several hundred feet. Strike lengths ranged from 6 to 30 feet and vein widths from 3 to 10 inches. The ore shoots plunge at an average of 39 degrees. The combination of short strike length, narrow width, and low-angle plunge resulted in high mining costs. After a level had been opened for mining, raises were driven on the ore shoots. Stoping proceeded from the top down; the stope width was controlled by the closest convenient hanging wall that would stand until it could be supported. Stope widths ranged from 3 to 6 feet. Stulls and headboards were used for support. Muck from the stopes would not run by gravity, and the relatively small tonnage from a stope did not warrant installing slusher setups. Hence, mucking to the level was accomplished by hand, assisted with water run in from above. Where ore could not be moved economically by raises, slusher crosscuts were used to transfer muck to shafts, winzes, or ore passes. The scraper dumped directly into skips or into ore passes to the haulage level. Drifts and crosscuts were 5 by 7 feet in the clear (Malone 1962).

A large part of the 200 level and most of the shallower workings were driven during the early period of mining, and the rest of the workings present as of 1962 were excavated after 1953. The most extensive workings were near the main shaft, the portal and headworks of which were located in the vicinity of what have been referred to in previous investigations as Shop Pad A and Shop Pad B, respectively. Five main levels connect with the main shaft. The Dolly series of ore bodies was discovered in 1957. By 1963, underground workings in the vicinity of the Dolly shaft had been extensively developed and the surface had been mined by sluicing.

As of 1962, the Rice series of ore bodies had been explored by shallow trenches and pits (MacKevett and Berg 1963) and was being explored by a shaft sunk along the plunge of the strongest surface showing of ore revealed by the surface exploration, with a shaft sunk to 84 feet deep on the plunge of the shoot (Malone 1962).

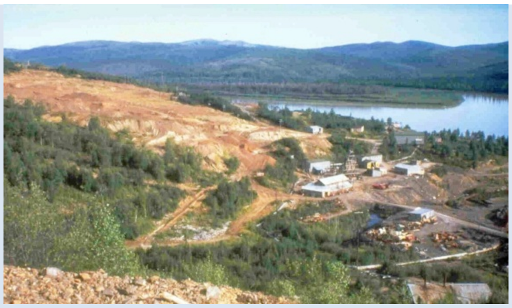
The approximate locations of underground workings and associated mine openings as of 1962 are illustrated in Figure 1-4. As of 1963, many of the older shallow workings were caved and inaccessible (MacKevett and Berg 1963). It should be noted that nomenclature of the underground workings varies depending upon the report, potentially resulting in confusion as to the identification and depth of several mine levels. For example, Wright and Rutledge (1947) and Webber et al. (1947) refer to adits driven at the 311- level and 325-foot levels and report that these adits were driven at 311 and 325 feet above sea level, respectively. These two adits are referred to in one subsequent report as the 311 Adit and 325 Adit (MacKevett and Berg 1963) and in another report as the 1311 Adit and 1325 Adit (Malone 1962). Furthermore, several levels referred to in earlier reports, such as the 236-foot level and 276-foot level, are not reported in subsequent reports (e.g., MacKevett and Berg 1963 and Malone 1962), likely because the levels were assigned different identifiers at later stages of mine development. The underground mine workings as presented in Figure 1-4 represent a combination of information presented in Malone (1962) and MacKevett and Berg (1963). Mine openings documented as of 1962 are:

- 311 Adit.
- 325 Adit.
- Main Shaft.
- “F” Zone Shaft.
- Caved shaft located southeast of the “F” Zone Shaft.
- Dolly Shaft.
- Rice Shaft.
- Two stopes that reached the surface from the 325 Adit level approximately 300 feet northwest of the 325 Adit portal.
- Two stopes that reached the surface from the 503 Crosscut (“D-3” and “D-4” Stopes) and one stope that reached the surface from the 507 Crosscut southeast of the Dolly Shaft.

In 1963, a new adit was reportedly driven on the “left limit of Red Devil Creek gulch an estimated 100 feet to mine a faulted ore-body segment in the vicinity of the mine shaft,” and 40 tons of high-grade ore were stockpiled from that effort (Jasper 1964). The specific location of this adit is not known. Production in 1963 and 1964 was minimal. The mine was subsequently shut down and allowed to flood, and equipment was removed from the site. The mine remained inactive until 1969.

In 1969, Alaska Mines and Minerals, Inc., resumed operations at the mine. Mining operations included open pit and underground mining (Buntzen and Miller 2004). Information on the location of the underground workings from this period is not available. Surface mining was conducted over a large area on the hillside west of the Main Processing Area by trenching, bulldozing, pit excavation, and, possibly, sluicing. The surface expression of these features is visible in aerial images dated 1974 and illustrated in Figure 1-5. Based on aerial photos dated 1953 and 1955 and a surficial geologic map (MacKevett and Berg 1963), most of the surface exploration and mining that had been conducted prior to 1974 lies within the footprint of the post-1969 surface mining activities.

Cinnabar and stibnite concentrates were produced after 1969 using flotation and were reportedly shipped to Japan. In addition, some mercury was also reported to be retorted at the mine. The flotation mill operated for most of 1970, and the mine closed in June 1971 due to a sharp drop in the price of both mercury and antimony. There has not been any production since that time (Buntzen and Miller 2004).



Red Devil Mine in 1971, including the Surface Mined Area on upper left.

On June 1, 1971, the mine owner, Alaska Mine and Minerals, Inc., ceased operations at the mine. Dewatering of the underground mine workings continued, with the intent that the disruption in mine operations would be temporary. In 1982, the mine was permanently closed and dewatering operations ceased (MACTEC 2005).

1.4.2.2 Ore Processing

Early production from the mine used a Johnson-McKay retort to process the ore (Webber et al. 1947). The location of early retorting operations is unknown. Two "D" retorts were used to process ore beginning in 1940 (Webber et al. 1947); these retorts are assumed to have been constructed within the Pre-1955 Retort Building.

In 1941, the New Idria Quicksilver Mining Company installed a 40-ton rotary kiln (Wright and Rutledge 1947). In 1943, the New Idria-Alaska Quicksilver Mining Co. installed modern equipment for furnacing and retorting the Red Devil ore. The reduction plant was equipped with a 50-ton fine ore bin, a 12-ton burned ore bin, a 36-inch by 40-foot rotary kiln, Sirocco dust collectors, a fan, condensers, and redwood tanks. A jaw crusher reduced the ore to less than 2 inches (Webber et.al. 1947). Wood was used for furnace fuel from 1943 to 1946. In 1947, the furnace was equipped with a burner, and diesel oil was used thereafter (Wright and Rutledge 1947). It is assumed that this rotary kiln was installed in the structures labeled "Pre-1955 Rotary Furnace Shop/Building" in Figure 1-3. The term "Pre-1955 Rotary Furnace" is retained for the purpose of this report to maintain consistency with previous reports.

The Pre-1955 Main Processing Area, showing headworks and support buildings. The post-1955 mill is in the background.

The 1954 fire destroyed several mine structures and processing facilities, including the Pre-1955 Retort and the Pre-1955 Rotary Furnace facilities. In 1956, a new processing facility and other plant facilities were built on the east side of Red Devil Creek. A modified Herreshoff furnace was installed (Malone 1962); the location of this newly installed furnace was the Post-1955 Retort building (MACTEC 2005). The thermal ore processing equipment installed in the Post-1955 Retort building is believed to consist of the Herreshoff furnace rather than a retort.

The term “Post-1955 Retort” is retained for the purpose of this report to maintain consistency with previous reports. In 1955, five diesel ASTs were installed on a road northeast of the Post-1955 Retort building.

Sometime after production resumed in 1969, a flotation mill was installed within an addition to the northern end of the Post-1955 Retort building to produce cinnabar and stibnite concentrates. A ball mill was used to mill the ore. Various materials, including pine oil and Dowfroth 250 (frothers and flotation agents), lead acetate (activator for stibnite), and other chemicals may have been used as part of the flotation process.. Tailings from the flotation unit were sluiced from the flotation mill into the three settling ponds via a wooden chute (TNH 1987).

The Main Processing Area in 1969, showing the flotation mill added to the post-1955 mill building, and the settling ponds.

Processing of mercury ores at the RDM by thermal methods (in retorts, kilns, and furnaces) was greatly complicated by the close association of stibnite (antimony sulfide) and realgar and orpiment (arsenic sulfides) with the cinnabar in the ore. The antimony content of RDM ores was locally many times that of the mercury content and averaged more than double the mercury content (particularly in the deeper mine levels). Various remedies, most of them aimed at eliminating the stibnite before thermally processing the cinnabar, had been proposed over the course of mine operations (e.g., Webber et al. 1947, Wright and Rutledge 1947), but none had been considered sufficiently promising to justify installing special equipment as of 1962. The installation of the flotation mill in 1969 was likely intended to eliminate the problems encountered over the previous decades of thermal ore processing (Webber et al. 1947; Wright and Rutledge 1947; Malone 1962).

The operational difficulties encountered as a result of furnacing mixed stibnite and cinnabar ores are summarized below based on a description by Malone (1962).

Like cinnabar, stibnite breaks down at a relatively low temperature. Its rate of reaction is similar to that of cinnabar within the operational temperature range of furnacing practices. There are, however, two differences in the way stibnite and cinnabar react during thermal treatment. First, unlike cinnabar, which transitions directly from solid to gaseous phase, stibnite passes through a liquid state. Second, the newly liberated antimony combines with oxygen to form oxides of antimony, particularly antimony trioxide, within the temperature range of mercury furnacing. These differences allowed some separation of the mercury from stibnite ore during the furnacing operations. However, in practice at the RDM, such separation was limited (Malone 1962).

Burning of stibnite in the furnaces caused problems throughout the process. Antimony oxides were transported by the furnace gas flow and rabble arms, “slagging” with the dust and adhering to the inside of the furnace. The burner blocks and drop holes required frequent cleaning to keep them from plugging with antimony glass, and periodic shutdowns were required to clean the entire inside of the furnace. A portion of the antimony oxide passed into the condensing system with the mercury-laden gases through a cyclone dust collector. A cyclone was ineffective at separating most of the antimony oxide materials due to the small particle size. For the same reason, a cyclone also was ineffective at separating arsenic trioxide, which resulted from furnacing of the arsenic sulfides that also were associated with the cinnabar ore. Within the furnace, the arsenic fumes were mostly vapor. The antimony and arsenic oxides in the cyclone and associated ducts resulted in coating of the surfaces, requiring daily blowing with compressed air and hammering with a rubber mallet to keep these components clean (Malone 1962).

When the furnace gases bearing antimony oxide and arsenic oxide reached the condensers, some of the oxides fell out as a result of the reduced gas flow velocity. Much of the oxide was so finely divided that it never settled, and it passed through the condenser and out the stack. Some of the oxides, however, settled into the launders, where the recovered mercury also accumulated, thus diluting the condenser mud, also commonly referred to as soot. This made the process of removing the mercury from the soot much more difficult than at most other mercury mines at that time. At most mines, up to 80 percent free mercury was recovered from the soot by simply settling and pouring off the mercury from under the soot, with the remainder dumped on an inclined metal hoe table and worked over by hand. At the RDM, the soot showed no visible mercury, and free metal did not separate from the mud without treatment. At the RDM, the soot was worked both wet and dry by hoeing, paddling, pushing, agitating, stirring, scraping, vibrating, rolling, pressing, raking, and jigging, with or without various additives (Malone 1962).

At times during the mine’s operations, the impoverished soot from the hoeing table was returned to the furnace. This resulted in considerable recycling of the antimony and arsenic oxides and the coating issues discussed above. Retorting the worked-over soot was found to be not only unsatisfactory but expensive and hazardous because, unless a large amount of lime was added to the soot before retorting, the charge fused into an antimonial-arsenical glass, which boiled and frothed in the retort, resulting in molten oxide glass sticking to the retort charging pans as well as condensing of the oxides in the head of the retort and in the condenser pipes, thus sealing them (Malone 1962).

The practice of hoeing the mud/soot in a mechanical hoeing machine with quicklime was used at the RDM until late 1959. In November 1959, equipment was installed to treat the condenser mud by a wet method, in which mercury was separated from the mud by (1) agitating and aerating the heated mud and (2) centrifuging with a wet cyclone. This process resulted in a residual mercury content of less than 2 percent, and treatment time was reduced to about 5 percent of that formerly needed with the hoeing machine. As of 1962, the tailings were dried and fluxed with lime for refurnacing (Malone 1962).

The processes and operational difficulties summarized above based on Malone (1962) pertain to the Herreshoff furnace. Similar operational difficulties were described for the rotary kiln (Webber et al. 1947; Wright and Rutledge 1947).

1.4.2.3 Mining and Ore Processing Wastes

Wastes generated during the mine operations consisted primarily of waste rock and tailings. These and other mining and mineral processing wastes at the RDM are discussed further below.

Dozed and Sluiced Overburden

Surface mining operations entailed dozing and sluicing of overburden soils, trenching, and open pit mining. Much of the early exploration at the mine was performed by trenching, resulting in trenches and associated spoils piles. During early mine operations, overburden on the southeast-facing slope above Red Devil Creek was sluiced downhill, with some of the sluiced overburden likely washing into Red Devil Creek and downstream to the Kuskokwim River. During the later surface mining activities, overburden was locally bulldozed into overburden dumps northwest of the Main Processing Area. Overburden also was sluiced from the Dolly and Rice ore zone areas via bermed and naturally developed gullies down to the Kuskokwim River. Sluiced overburden was deposited in fans, or deltas, along the Kuskokwim River shoreline, referred to herein as the Dolly Sluice delta and Rice Sluice delta. These features are illustrated in Figure 1-5.

Waste Rock

Waste rock included sub-ore grade material generated during underground and surface mining activities. The disposal of the all of the waste rock generated during underground mining activities is not documented, but can be inferred from historical reports and photographs. Based on a 1941 photograph (Cady 1941a), at least some waste rock generated was disposed of in dumps near the 311 Adit and 325 Adit portals. At least some of the waste rock was likely deposited in the Red Devil Creek drainage. Based on a 1941 photograph (Cady 1941b), at least some waste rock generated at that time was disposed of in a dump northeast of the 311 Adit portal. By 1943, the Main Shaft had been installed. A 1943 photograph shows a waste rock dump immediately east of the Main Shaft headworks (Cady 1943). That dump sloped down to the Red Devil Creek drainage. A 1963 geologic map (MacKevett and Berg 1963) shows a large dump, labeled “Saw dust dump” between the Main Shaft and Red Devil Creek.

As of 1962, ore processing was conducted on the Post-1955 Main Processing Area. Some segregation of ore and waste rock was likely conducted at the Post-1955 furnace area prior to thermally processing the ore. Coarse ore material was reportedly passed over a 1.5-inch screen. The ore material that passed through the screen was conveyed to the furnace. The material retained by the screen was passed over a sorting table to segregate the material to be furnaced from waste. The waste rock was conveyed via a 24-inch by 20-foot conveyor to a dump (Malone 1962). The location of the dump is not specified, but was likely in the vicinity of the Post-1955 furnace area.

Tailings

Tailings consisted of thermally processed ore, also variously referred to as calcines, burnt ore, and retorted ore. Such tailings resulted from the thermal treatment processes (retorting and furnacing) that were employed over the history of the site. Historical aerial images and historical documents indicate that over much of the history of mining and ore processing at the site, tailings were sluiced or bulldozed into the channel of Red Devil Creek from the ore processing areas and dozed into dumps. Tailings also were used for road ballast or surfacing material (Malone 1962).

A 1941 photograph illustrates the Pre-1955 Retort building and apparent tailings and/or waste rock deposited east of the retort building (Cady 1941c). This tailings/waste rock pile is evident in subsequent photographs and maps (Cady et al. 1955; MacKevett and Berg 1963).

A geologic map illustrating underground mine workings and surface features, including ore processing buildings, indicates the presence of a “Burnt Ore Disposal Tunnel” that apparently discharged calcines from the Pre-1955 Furnace building to the Red Devil Creek drainage (Cady et al. 1955).

As of 1962, disposal of calcines generated at the Post-1955 Retort building was accomplished by sluicing and bulldozing. A 7-inch by 10-inch sluicebox, at a slope of 2 inches per foot, extended from under the burned-ore bin to a waste dump 100 feet away. From there, the calcines were reportedly bulldozed away every second day. A 1963 geologic map (MacKevett and Berg 1963) shows an area labeled “Tailings” between the Post-1955 furnace and Red Devil Creek. When road surfacing material was needed, it was sometimes loaded directly into a truck spotted under the sluiceway (Malone 1962). Information on the location of placement of the calcines for road-surfacing is not available.

The tailings are likely mixed with waste rock locally in both the Pre-1955 and Post-1955 Processing Areas.

Flotation Tailings

From 1969 through 1971, a flotation mill was operated at the site to process ore into cinnabar and stibnite concentrates for shipment to Japan. The resulting flotation tailings consist of the fraction of milled ore remaining after selected ore minerals are separated from the bulk ore slurry using water and flotation agents. These flotation tailings were discharged into the settling ponds north of the Post-1955 Retort building area. Various chemicals (pine oil, Dowfroth 250, and lead acetate) may have been used as part of the flotation process (BLM 2009).

Although these materials were likely recycled to some extent, some quantities of the materials potentially were discharged to the settling ponds.

Overview of the Main Processing Area in 1969 or 1970 from the southeast.

Other Mine Wastes

Other wastes generated during mining operations include the dust and oxide glasses generated during the furnacing operations, as discussed in Section 1.4.2.2. Dust generated from the cyclone-dust bin was reportedly discharged with the aid of several water jets and discharged to the tailing sluicebox (Malone 1962).

Based on review of historical and recent aerial photographs, land-based photographs, and records of mine operations summarized above, the general locations where mining and ore processing wastes were disposed of at the site during mine operations have been approximated, as illustrated in Figure 1-6.

1.4.2.4 Petroleum-Related Wastes

As noted previously, thermal ore processing equipment, generators, and the on-site powerhouse were fueled with diesel stored in five ASTs located northeast of the Main Processing Area (see Figure 1-2).

The five ASTs had the following storage volumes:

- AST 1: 84,000 gallons
- AST 2: 52,000 gallons
- AST 3: 125,000 gallons
- AST 4: 52,000 gallons
- AST 5: 52,000 gallons

Petroleum contamination in subsurface soil was present at the AST area and was partially removed in 2006, and further remediated in 2010 (Marsh Creek 2010). The ASTs provided fuel for the Post-1955 Retort and the powerhouse, which was conveyed by a buried fuel line running along the AST access road. Petroleum contamination was encountered in subsurface soil along the pipeline route in 2006 (Wilder/URS 2007). Any residual petroleum contamination will be addressed as part of the site-wide remedial action phase of this project.

1.4.3 Environmental Setting

1.4.3.1 Climate

The RDM is located in the upper Kuskokwim River Basin and lies in a climatic transition between the continental zone of Alaska’s interior and the maritime zone of the coastal regions. Average temperatures can vary from 7 to 65 degrees Fahrenheit (˚F). Annual snowfall averages 56 inches, with a total mean annual precipitation of 18.8 inches.

1.4.3.2 Geology

The RDM site is located within the central Kuskokwim region, which contains a mobile belt of mountain building and volcanic activity. The regional geology is dominated by a thick sequence of folded sedimentary rocks of Cretaceous age known as the Kuskokwim Group (MacKevett and Berg 1963). Pre-RI information on geology of the RDM is summarized below. Additional detailed information and geological data gathered during the RI are presented in Section 3.1 and 4.1.7.

Lithologic Units

The Kuskokwim Group generally contains a very thick sequence of interbedded sedimentary rocks consisting of graywacke and argillaceous rock. The graywacke beds, which commonly are 2 or 3 feet thick, range in thickness from half a foot to about 20 feet. The graywacke is a medium- or dark-gray rock that weathers brown and is fine grained and well indurated. Its fine-grained character makes macroscopic identification of its minerals and textures difficult. Descriptions of similar graywackes from throughout the central Kuskokwim region indicate that many of them contain a variety of detrital rock fragments. Microscopic examination reveals that the graywacke is poorly sorted and composed of subrounded to angular lithic fragments and mineral grains ranging from less than 0.001 to 0.5 millimeters (mm) in average diameter. The larger and more abundant minerals consist of quartz, muscovite, pyrite, plagioclase, and calcite. These minerals and the lithic fragments, which were principally derived from slate, schist, and volcanic rocks, are surrounded by very fine-grained assemblages of quartz, calcite, plagioclase, muscovite, clay minerals, epidote, and chlorite. Calcite is the dominant cementing mineral, and it also forms veinlets (MacKevett and Berg 1963).

The very fine-grained argillaceous rocks of the Kuskokwim Group are dark gray or black and weather brown. Most of these rocks that are exposed underground are argillites, but some of their surface and near-surface counterparts are shales. Discrete argillaceous beds are commonly a few inches thick, but locally they have a cumulative thickness of 20 or 30 feet. Commonly, the argillaceous rocks are well indurated. Some of them are fissile, and many tend to fracture subconchoidally. The argillites are flecked with fine crystals of muscovite, the only megascopically visible mineral. The argillaceous rocks are similar to the graywackes in composition. A typical argillite from the RDM consists of subangular grains of quartz, epidote, muscovite, and pyrite that are less than 0.03 mm in average diameter, associated with clots and lamellar aggregates of very fine-grained clay minerals and mica (MacKevett and Berg 1963).

Kuskokwim group bedrock exposure.

The Kuskokwim Group sedimentary rocks are tightly folded and intruded by hydrothermally altered dikes composed of quartz basalt (MacKevett and Berg 1963). The dikes range from 1 foot to about 14 feet in thickness. The main dike at the RDM has a few plug-like and sill-like offshoots and a few small discontinuous branching dikes. In underground exposures, the dikes are light gray. At the surface, the dikes are masked by pervasive hydrous iron oxides and are difficult to distinguish from similarly weathered graywacke. The dikes consist entirely of fine-grained and very fine-grained masses of calcite, chalcedony, limonite, and sericite, and subordinate amounts of quartz, hematite, and clay minerals. Small relict phenocrysts are largely replaced by calcite in a very fine-grained groundmass. A few veinlets composed of calcite and minor amounts of quartz cut the dikes. As of 1963, surface exposures of bedrock at the RDM were largely confined to road cuts, stripped areas, and trenches (MacKevett and Berg 1963).

The Kuskokwim Group and dikes are locally overlain by surficial deposits of loess and alluvium that consist of fluvial deposits associated with the Kuskokwim River, Red Devil Creek, and slope wash (MacKevett and Berg 1963). The loess deposits are buff colored and friable, range from a few inches to about 30 feet in thickness, and commonly lack bedding. The fluvial deposits include gravel, sand, and silt that have been deposited on the flood plains of the Kuskokwim River. The oldest of these deposits is locally overlain by the loess, but most of the fluvial deposits postdate the loess. In some places, as much as 20 feet of the fluvial deposits are exposed. The loess commonly overlies rocky soil derived from weathering of the Kuskokwim Group bedrock. Minor quantities of recently deposited alluvium, including slope wash, are exposed on the lower slopes of some of the hills, in the valley of Red Devil Creek and along the Kuskokwim River (MacKevett and Berg 1963).

Surficial geology, as mapped by MacKevett and Berg (1963), is illustrated in Figure 1-7. It should be noted that much of the area shown in the geologic map overlay in Figure 1-7 west of the Main Processing Area has been modified by surface mining operations subsequent to the geologic mapping.

Structure

The RDM is located on the southwest limb of the Sleetmute anticline and contains multiple northeastward-trending faults that are cut by northwestward-trending faults that are exposed in some areas of the underground workings. The bedding of the Kuskokwim Group in the RDM area strikes from between N. 10° W to N. 60° W., but strikes predominantly from N. 30° W. to N. 45° W. The bedding dips toward the SW, predominantly from 45° to 60° SW. The chronological sequence of structural events is as follows (MacKevett and Berg 1963):

1. Folding of the sedimentary rocks forming the Sleetmute anticline and the probable concurrent development of steep, northeastward-striking tensional joints, which are best developed in the comparatively brittle greywacke beds.
2. Intrusion of dikes into a few of these joints.
3. Development of steep, northwestward-trending faults that offset the dikes right laterally.
4. Minor strike-slip movement of some of the northwestward-trending faults, caused by gravitational adjustments.

Ore and Mineralization

The RDM ore consists of discrete ore bodies localized along and near intersections between the northeastward-trending altered dikes and the many northwestward-trending faults. The ore bodies are crudely prismatic and range from a few inches to about 2 feet in thickness and from 1 foot to 30 feet in length along strike. Although some of the ore bodies diminish in size or pinch out with increasing depth, most of them continue to depths beyond the limits of exploration (as of 1962). The longest known ore bodies, of the Dolly series, extend from the surface at least to the 450 level (MacKevett and Berg 1963).

Some of the RDM ore is exceptionally high grade and contains as much as 30 percent mercury, but most of the ore contains between 2 and 5 percent mercury. Cinnabar, the primary mercury ore mineral, is associated with abundant stibnite; some realgar, orpiment, and secondary antimony minerals; and minor amounts of iron minerals, in a quartz, carbonate, and clay gangue. The stibnite is commonly more abundant than cinnabar (MacKevett and Berg 1963). The only sulfides found throughout the deposit at the RDM are stibnite and cinnabar; small amounts of orpiment and realgar are present locally. Rare local pyrite films on joints are probably due to migration and redeposition of authigenic pyrite during ore deposition (Malone 1962).

The dominant process of ore formation was open-space filling, although some of the rich ore bodies were probably formed partly by replacement. Cinnabar and stibnite have locally replaced parts of the altered dikes. The high-grade ore typically consists of masses of intimately associated cinnabar and stibnite. Much of the ore consists of closely spaced intricate networks of veinlets, breccia cemented by vein minerals, and cinnabar-bearing incrustations. Some of the veinlets contain numerous vugs (MacKevett and Berg 1963).

1.4.3.3 Hydrogeology

Limited existing information is available about the hydrogeology within the RDM site. The information below is augmented with site-specific data and observations collected during the RI field investigations (see Section 3.2).

A bedrock aquifer is likely hydraulically connected to a shallow aquifer within surficial deposits at the site. Seven soil borings were drilled with the intent of installing monitoring wells during the August 2000 field work for the Red Devil Mine Retort Building Demolition and Limited Site Investigation. Groundwater was encountered in five of these soil borings at depths ranging from approximately 16 to 25 feet below ground surface (bgs); monitoring wells (MW-1, MW-3, MW-4, MW-6, and MW-7) were constructed in these boreholes. The groundwater in these wells was encountered within unconsolidated materials described as tailings and mixtures of gravel, sand, and silt (HLA/Wilder 2001). Available information on groundwater levels in the existing monitoring wells at the site includes water depth measurements on the following dates: August 14, 2000 (HLA/Wilder 2001); September 5, 2007; September 18, 2008; June 19, 2009; October 6 and 7, 2009; and September 20 and 21, 2010. For these monitoring events, measured depths to groundwater in these wells ranged from approximately 18 to 28 feet bgs. Seasonally, depth to groundwater varied by as much as 3.5 feet, with the highest recorded groundwater elevations occurring in June 2009 and the lowest recorded elevations occurring in October 2009 or August 2000.

Based on the groundwater elevation from the existing monitoring wells and an assumption that Red Devil Creek is a gaining stream in the vicinity of the site, it appears that the general direction of groundwater flow is toward Red Devil Creek locally, and the Kuskokwim River on a more regional scale, generally mimicking topography. Groundwater elevations measured in September 2008 were similar to those observed in August 2000 and indicate groundwater flow in a generally north-northeast direction (Shannon and Wilson 2008).

A spring is located along the western bank of Red Devil Creek at the base of a bench comprising tailings/waste rock in the Main Processing Area. The underlying bank and stream bed is coated with “yellowboy,” an iron oxide flocculant (see Section 4.5).

Groundwater may migrate through the mine workings. It is possible that groundwater within the mine workings may discharge from former mine openings and/or interconnected bedrock fractures through overlying surface soils, alluvium, or tailings. Such groundwater could discharge to surface waters. The spring along Red Devil Creek could represent localized preferential flow of groundwater originating from underground mine workings.

There is one private drinking water well within a 1-mile radius of the site; it is located at a cabin near the mouth of McCally Creek, approximately 0.6 miles from the mouth of Red Devil Creek. Construction details of this well are unknown. Nineteen private drinking water wells were installed in Red Devil Village in 2004 by the Alaska Village Safe Water Program. These wells range in depth from 28 to 172 feet bgs. Some of the wells have been sampled for class A drinking water analyses. The analytical results for samples collected from wells in the community of Red Devil are unavailable (Wilson, personal communication, 2010).

Permafrost was not observed during mining (MacKevett and Berg 1963).

1.4.3.4 Surface Water Hydrology

Red Devil Creek is a tributary of the Kuskokwim River and has a basin of about 687 acres (HLA/Wilder 2001). Red Devil Creek feeds into the Kuskokwim River less than 1,000 feet from the main portion of the mine site. During the 1999 investigation, Red Devil Creek was reported to have a flow of 0.5 cubic feet per second (cfs) and to vary significantly seasonally (HLA/Wilder 1999). Stream discharge data collected in Red Devil Creek in 2011 and 2012 confirm this (see Chapter 3). The Kuskokwim River is generally ice-free from mid-June through October.

The Kuskokwim River drains an area of approximately 130,000 square kilometers and flows approximately 1,130 kilometers (700 miles) from interior Alaska to the Bering Sea. At the RDM site, the Kuskokwim River is more channelized than in up-river locations as it bisects the Kuskokwim Mountains. Flow in the river near the RDM site has been reported at 1,102 cubic meters per second (38,916 cfs). Sediment samples collected from the Kuskokwim River near the RDM site contained fine grained particles (<62 micrometers) ranging from 15 to 22 percent (USGS 1999).

1.4.3.5 Ecology

The vegetation around the RDM is characterized by spruce-poplar forests and upland spruce-hardwood forests. There are no known rare plants in the area of the mine site, but there is a lack of survey data for a complete evaluation. Aphragrnus eschscholtzianus, Thlaspi arcticum, and Arnica lessingii ssp. norbergi, all rare or sensitive plant species, are found in the region (HLA/Wilder 1999).

Fish found in the Kuskokwim River in the vicinity of the RDM include whitefish, grayling, sheefish, dolly varden, and Northern pike, as well as chinook, sockeye, coho, and chum salmon (HLA/Wilder 1999). Red Devil Creek was nominated for the Alaska anadromous waters catalogue by the BLM based on the observed presence of juvenile chinook and coho salmon in the creek in 2010. Moose, wolves, black bears, brown bears, lynx, martens, foxes, beavers, minks, muskrats, otters, and various small rodents are known to inhabit in the area.

The bird species that migrate through the area are olive-sided flycatcher, gray-cheeked thrush, Townsend’s warbler, blackpoll warbler, and Hudsonian godwit (HLA/Wilder 1999). A raptor survey conducted on the Kuskokwim River in July 2000 found an active peregrine falcon nest 7 miles downstream of the RDM site (BLM 2001a). Both the arctic peregrine falcon and American peregrine falcon are listed as Alaska species of special concern. However, no data could be found to indicate what kind of peregrine falcon was observed in 2000.

1.4.3.6 Demographics

The community of Red Devil is approximately 2 miles northwest of the RDM, and the community of Sleetmute is approximately 8 miles southeast of the RDM. Subsistence activities are practiced by many members of both communities. During their respective seasons, salmon, bear, moose, caribou, rabbit, and waterfowl are caught and wild berries are harvested (ADC 2010). The Kuskokwim River is used for transportation for both communities; boats are used in the summer and snow machines in the winter. The river is generally ice-free from mid-June through October. Both communities have gravel airstrips that planes can use year-round.

According to the Alaska Community Database Community Information Summaries (CIS), there were 23 housing units in the community of Red Devil, 12 of which were occupied. Its population was 43.5 percent American Indian or Alaska Native, 17.4 percent white, and 39.1 percent with multi-racial backgrounds. The per-capita income for Red Devil was $6,335 in 2010 (ADC 2012).

Sleetmute is a larger community than Red Devil and was founded by Ingalik Indians. Sleetmute remains an Ingalik Indian village, with 76.7 percent of the population identifying as Alaskan Native. According to the Alaska Community Database CIS, the population in 2008 was 70 people. The 2010 census found that 33 people in the community were employed and that 10.4 percent of the individuals in the community were below the poverty level. One school serves all students in the community (ADC 2012).

1.4.4 Previous Investigations

Regional studies, contaminant investigations, and sampling programs associated with cleanup activities have been conducted at and near the RDM over the past 40 years. The history of environmental sampling and monitoring at the RDM is described below. Table 1-1 provides a chronological summary. Refer to Figure 1-3 for the locations of features discussed in this section.

1971 EPA Study. While the flotation mill was operating, the U.S. Environmental Protection Agency (EPA) collected surface water samples for mercury and arsenic analyses. One background water sample from Red Devil Creek was collected above the mine and mill. It contained 0.3 micrograms per liter (µg/L) mercury. Arsenic and mercury concentrations in Settling Pond #1 contained 12,850 µg/L mercury and 85,000 µg/L arsenic. A water sample collected from Red Devil Creek below Settling Pond #1 contained 265 µg/L mercury and 39,000 µg/L arsenic. Two water samples were collected from the Kuskokwim River, one upstream of Red Devil Creek and one downstream, near the Red Devil Airstrip. The upstream sample contained 1.7 µg/L mercury and 56 µg/L arsenic, and the downstream sample contained 1.0 µg/L mercury and 32 µg/L arsenic (EPA 1971).

1979 EPA Study. The EPA collected five surface water samples and one sediment sample at the site. Two background sites were sampled; one water sample in Red Devil Creek from above the mine workings contained 0.21 µg/L mercury. Two water samples collected from Red Devil Creek below the settling ponds both reportedly contained 0.14 µg/L mercury. Two water samples were collected from the Kuskokwim River, one upstream of Red Devil Creek and one downstream. Mercury was detected in the upstream sample at 0.28 µg/L, and the downstream sample contained 0.14 µg/L mercury (EPA 1979).

It should be noted that for this study and the 1971 study summarized above, metadata were not available to evaluate the accuracy and precision of the laboratory data. Any comparison to more recent data sets should acknowledge the quantitative uncertainty that would result from comparing historic data of unknown quality to more recent data of known quality.

1985 Alaska Department of Environmental Conservation Well Sampling. In October 1985, the Alaska Department of Environmental Conservation (ADEC) sampled two residential wells in Red Devil Village. The identity of the well owners was confidential, so the exact locations are unknown. Neither well sample contained detectable levels of mercury or arsenic; however, one of the two wells tested “extremely high” for zinc (ADEC 1987).

Table 1-1 Summary of Previous Investigations

Year	Agency	Reference	Major Findings
1971	EPA	EPA 1971	Mercury and arsenic were detected in surface water samples collected at and near the RDM.
1979	EPA	EPA 1979	Mercury and arsenic were detected in surface water samples collected at and near the RDM.
1985	ADEC	ADEC 1987	Two residential use wells in Red Devil Village were sampled; neither well had detectable concentrations of mercury or arsenic.
1988	BLM	Unpublished	Mercury was detected in Red Devil Creek surface water and sediment and in a sample of tailings.
1989	BLM	Weston 1989	Antimony, arsenic, and mercury were detected in Red Devil Creek surface water and sediment, in the settling ponds, and in tailings samples.
1997	USGS	Bailey and Gray 1997	Elevated levels of total mercury and methylmercury in soil and vegetation samples were found at the RDM compared with background locations.
1997	USGS	USGS 1999	Water sample in Red Devil Creek contained arsenic, antimony, copper, chromium, and zinc.
1999	BLM	HLA/Wilder 1999	Antimony, arsenic, lead, and mercury were detected in soil samples collected near site sources in the Main Processing Area. Benzene was detected in soil at the Gravel Pad.
2001	BLM	HLA/Wilder 2001	Monitoring wells were installed at the site. Visible elemental mercury was observed in subsurface soils adjacent to the Post-1955 Retort slab. Groundwater samples contained antimony, arsenic, lead, and zinc at concentrations above federal MCLs.
2002	BLM	Wilder/URS 2003	Construction of Monofill #1 and Monofill #2. No environmental sampling was performed.
2002	USGS	Bailey et al. 2002	Elevated levels of total mercury and methylmercury in soil and vegetation samples were found at the RDM compared with background locations.

Table 1-1 Summary of Previous Investigations

Year	Agency	Reference	Major Findings
2004	BLM	MACTEC 2004	Construction of Monofill #3. Petroleum Release Investigation detected hydrocarbons (DRO) in subsurface soil at the AST area. Samples from existing monitoring wells contained antimony, arsenic, and mercury above ADEC groundwater cleanup levels.
2005	BLM	MACTEC 2005	Pre-1955 ore processing structures were located through research and subsurface exploration. Mercury and arsenic were detected in surface and subsurface soil samples within and around the historical structure footprints.
2005, 2006	BLM	Wilder/URS 2007	Petroleum-contaminated soil from the former AST area was excavated and stockpiled. Existing monitoring wells were sampled and contained antimony, arsenic, and mercury above ADEC groundwater cleanup standards.
2007, 2008, 2009	BLM	Shannon & Wilson, Inc. 2008	Groundwater monitoring events of the existing monitoring wells showed continued presence of antimony, arsenic, and mercury in groundwater.
2009	BLM	E & E 2010a	Groundwater monitoring event of the existing monitoring wells showed continued presence of antimony, arsenic, and mercury in groundwater. Groundwater samples collected in October 2009 showed lower concentrations of metals, likely due to the use of low-flow groundwater sampling methods.

Table 1-1 Summary of Previous Investigations

Year	Agency	Reference	Major Findings
2010	USGS and BLM	Burton and Ball 2011	A geophysical survey was conducted at the site using direct-current resistivity and electromagnetic induction surface methods. Based on the geophysical data and existing soil borings, there was not sufficient electrical or electromagnetic contrast to confidently distinguish between tailings, waste rock, and weathered bedrock. However, a water table was interpreted based on a correlation with the existing monitoring wells.
2010	BLM	E & E 2010b	Data were collected to characterize the nature and extent as well as the fate and transport of COPCs at and near the site; to provide data for human health and ecological risk assessments; and to provide data and information for use in the analysis of remedial alternatives.

Key:

ADEC	Alaska Department of Environmental Conservation
AST	aboveground storage tank
BLM	Bureau of Land Management
COPC	contaminant of potential concern
DRO	Diesel range organics
E & E	Ecology and Environment, Inc.
EPA	Environmental Protection Agency
HLA	Harding Lawson Associates
MACTEC	MACTEC Engineering and Consulting
MCL	Maximum Contaminant Level
RDM	Red Devil Mine
TCLP	toxicity characteristic leaching procedure
USGS	U.S. Geological Survey
Wilder	Wilder Construction Company

1988 BLM Sampling Event. The BLM collected six surface water and 10 sediment and soil samples from Red Devil Creek, the settling ponds, and other areas around the RDM site (Weston 1989). The results of the sampling indicated the presence of mercury in Red Devil Creek water from 0.2 to 5.5 µg/L and in Red Devil Creek sediments from 41 to 967 milligrams per kilogram (mg/kg). A tailings pile near Settling Pond #1 contained 649 mg/kg mercury. Four background soil samples were collected, which contained 0.2 to 8.0 mg/kg mercury.

1989 Site Inspection. The BLM performed a CERCLA site inspection (SI) at the RDM site during the 1988 field season. The objective of the SI was to characterize conditions for the completion of a Hazard Ranking System score for the site. The SI involved collection of samples from tailings, surface water, and sediment in Red Devil Creek and sediment in the settling ponds. Soil, sediment, and surface water samples were analyzed for a combination of analytes, including arsenic, barium, cadmium, chromium, mercury, lead, antimony, selenium, and silver. Dielectric fluid in the transformers and oil stained soil was sampled for polychlorinated biphenyls (PCBs) using field test kits. Table 1-2 presents the results of the 1989 SI samples for the applicable RI/FS contaminants of potential concern (COPCs).

Table 1-2 Summary of 1989 Site Inspection Sample Results

Matrix	Location	Antimony	Mercury	Arsenic	Chromium	Lead	Units
Sediment	Settling Pond #1	1,872	395	8,474	N/A	418.7	mg/kg
Surface Water	Above Settling Pond #1	200 U	0.4	200 U	10 U	200 U	µg/L
Surface Water	Southern border	200 U	0.3	200 U	10 U	200 U	µg/L
Surface Water	Mouth of creek	278	0.4	244	10 U	200 U	µg/L
Sediment	Above Settling Pond #1	3,450	29	2,449	25.9	480.7	mg/kg
Sediment	Southern border	0.243 U	0.6	165	17.7	261.7	mg/kg
Sediment	Below settling ponds	4,015	4,120	3,185	N/A	N/A	mg/kg
Sediment	Mouth of creek	3,113	33.3	2,194	N/A	N/A	mg/kg
Soil	Settling Pond #2	872	550	8,053	N/A	N/A	mg/kg
Soil	Settling Pond #3	664	83	6,498	N/A	N/A	mg/kg
Soil	Pile above Settling Pond #1	7,074	787	8,024	N/A	N/A	mg/kg
Soil	Pile above Settling Pond #1	22,737	498	5,851	N/A	1391.1	mg/kg

Key:

mg/kg	milligrams per kilogram.
N/A	not analyzed
U	non-detect, value listed is the method detection limit
µg/L	micrograms per liter.

It was estimated that approximately 51,600 cubic yards of tailings are located at the mine and mill area and an unknown quantity of tailings have been deposited in Red Devil Creek (Weston 1989).

Bailey and Gray 1997. The U.S. Geological Survey (USGS) analyzed samples from the RDM, Cinnabar Creek Mine, and regional background sites as part of a study to characterize the geochemistry of southwestern Alaska and to evaluate environmental conditions at abandoned mercury mines in the region. The study was conducted for research purposes and was not intended to define the full extent of heavy metals contamination from specific sites. The samples included vegetation, surface water, and soil. Results of samples collected in the RDM area are summarized in Table 1-3.

Table 1-3 Summary of Bailey and Gray 1997 Mercury and Methylmercury Data for Vegetation at Red Devil Mine Site

Matrix	Location	Total Hg Range (ppb)		MeHg Range (ppb)	
Alder	Retort area (unmined)	30	310	0.45	90
Willow	Retort area (unmined)	30	330	-	-
Black spruce	Retort area (unmined)	40	370	-	-
Blueberry	Retort area (unmined)	30	330	2.60	2.76
Paper birch	Retort area (unmined)	30	180	-	-
Alder	Mined area	<20	900	0.54	0.87
Willow	Mined area	<20	560	2.73	
White spruce	Mined area	20	140	-	-
Cottonwood	Mined area	20	280	-	-
Black spruce	Mined area	20	200	-	-
Blueberry	Mined area	<20	150	-	-
Paper birch	Mined area	<20	130	-	-
Soil	Retort area (unmined)	0.14	120	8.21	
Soil	Mined area	0.15	1,200	2.73	4.19
Water	Red Devil Creek	<0.10	0.28	-	-

Source: Bailey and Gray 1997

Key:

Hg	mercury.
MeHg	methylmercury.
ppb	parts per billion.

The study concluded that vegetation and soil samples at the mine sites contained significantly higher concentrations of total mercury and methylmercury than background locations (Baily and Gray 1997).

1997 USGS Kuskokwim River Study. As part of a regional study to assess water quality in the Kuskokwim River, suspended sediment and bed sediment samples were collected from stations located on the river between the villages of McGrath and Akiak. Three tributaries were sampled during the study, including Red Devil Creek. A dissolved surface water sample was collected in Red Devil Creek at its confluence with the Kuskokwim River. Mercury was not analyzed in the sample.

Table 1-4 summarizes the results of selected inorganic elements from this sample (USGS 1999).

Table 1-4 Summary of 1997 USGS Red Devil Creek Sample Results

Analyte (Dissolved)	Concentration (µg/L)
Arsenic	180
Antimony	281
Copper	1.4
Chromium	1.6
Zinc	<1

Source: USGS 1999

Key:

µg/L	micrograms per liter
USGS	United States Geological Survey

1999 Limited Waste Removal Action. The BLM conducted an offsite waste removal and a pre-remediation sampling investigation. This project included collection of background soil samples and sampling of known contaminant source areas in the Main Processing Area, Red Devil Creek, and the Kuskokwim River.

Contaminants were detected above Alaska soil cleanup standards (Method 2, Table B1) in samples from multiple locations around sources in the Main Processing Area (see Table 1-5). Surface water and sediment samples collected from Red Devil Creek contained concentrations of metals including arsenic, antimony, and mercury above background concentrations. Sediment samples collected from the Kuskokwim River contained concentrations of arsenic, antimony, and mercury above background concentrations (HLA/Wilder 1999).

Table 1-5 Summary of 1999 Limited Waste Removal Action Selected Soil Sample Results at Source Locations

Source/Location	Contaminants Detected Above Cleanup Levels	Detected Concentrations (mg/kg except where otherwise noted)
Battery Pile Near Shop Pad A	Lead	10,700–13,500
West Side of Post-1955 Retort Building	Antimony	529–1,520
	Arsenic	1,380–3,130
	Mercury	445–1,090
East Side of Post-1955 Retort Building	Mercury	3,330–23,800
Tailings South of Settling Pond 1	Antimony	1,780
	Arsenic	2,280
	Mercury	269
Gravel Storage Pad	Benzene	98.8 µg/kg
	Antimony	8.53
	Arsenic	1,160
	Mercury	88
Chemical Storage Sheds (near south end of Post-1955 Retort building)	Antimony	503–720
	Arsenic	183
	Chromium	255
	Mercury	185–35,300

Table 1-5 Summary of 1999 Limited Waste Removal Action Selected Soil Sample Results at Source Locations

Source/Location	Contaminants Detected Above Cleanup Levels	Detected Concentrations (mg/kg except where otherwise noted)
Settling Ponds	Antimony	162 (J)–892
	Arsenic	2,450–3,680
	Chromium	27.1
	Mercury	191 (J)–982

Key:

J	Estimated concentration.
mg/kg	milligrams per kilogram.
µg/kg	micrograms per kilogram.

2001 Source Area Removal and Investigation. The BLM conducted asbestos abatement, demolition of structures, plugging of mine shafts, offsite waste removal, and environmental sampling in the Main Processing Area and the AST area. Soil borings and monitoring wells were installed in the Main Processing Area. Nine subsurface borings were drilled and sampled; five were completed as monitoring wells. In addition, an extensive subsurface soil investigation was conducted around the slab of the Post-1955 Retort Building.

Surface and near-surface soil samples collected from soil borings contained antimony, arsenic, and mercury at concentrations exceeding background concentrations (from the 1999 Limited Waste Removal Action sampling), consistent with result of previous investigations. Concentrations of these metals decrease significantly with depth.

The soils investigation around the Post-1955 Retort Building slab indicated the presence of relatively high concentrations of arsenic and mercury in surface and subsurface soils using x-ray fluorescence (XRF) field screening and fixed laboratory methods. Elemental mercury was observed in samples from five soil borings on the west side of the slab at depths between 2 and 6 feet bgs.

Groundwater samples collected after well installation contained concentrations of antimony, arsenic, lead, and zinc above federal Maximum Contaminant Levels (MCLs) (HLA/Wilder 2001).

2002 Debris Consolidation and Disposal Project. The BLM performed further building demolition, debris segregation, and debris burial. This project involved construction of Monofill #1 and Monofill #2. No environmental sampling was performed during this project (Wilder/URS 2003).

Bailey et al. 2002. This USGS study conducted vegetation and soil sampling at three abandoned mercury mines and at regional background sites in southwestern Alaska. Total mercury and methylmercury concentrations were found to be higher in the vegetation and soil samples from the mine sites compared to the samples collected from the regional background sites. No correlation was found between total mercury in soil and total mercury in vegetation or between total mercury and methylmercury. Results of samples collected in the RDM area are summarized in Table 1-6.

Table 1-6 Summary of Bailey et al. 2002 Mercury and Methylmercury Data for Vegetation at the Red Devil Mine Site

Sample Matrix	Location	Units	Total Mercury			Methylmercury		
			Mean	Range	n	Mean	Range	n
Alder leaves and stems[a]	Tailings	ng/g	226	149–374	3	0.5	0.4–0.6	3
	Retort	ng/g	310	--	1	--	--	0
	Mined Area	ng/g	211	24–900	10	0.3	0.1–0.7	7
Willow leaves and stems[a]	Tailings	ng/g	350	346–353	2	1.6	1.4–1.8	2
	Retort	ng/g	166	74–330	19	1.8	0.4–3.4	6
	Mined Area	ng/g	136	11–560	7	5	0.3–11	6
Soil	Tailings	µg/g	970	12–1578	5	0.4	0.1–0.7	5
	Retort	µg/g	8.5	0.05–120	21	3.3	0.7–8.2	8
	Mined Area	µg/g	210	6–1200	12	2.2	0.3–7.2	10

Notes:

[a] Current year's growth.

[b] Different units are used for vegetation (ng/g) and soil (µg/g).

Key:

--	Not available or not relevant.
n	Number of samples.
ng/g	Nanograms per gram (parts per billion).
µg/g	Micrograms per gram (part per million).

2003 Historic Source Area Investigation. The BLM conducted a literature review, interviews of local persons knowledgeable about the mine history, and a sampling investigation of the Pre-1955 Retort Building, the Pre-1955 Rotary Furnace, the Pre-1955 Rotary Furnace Stack, and a "burnt ore" (tailings) disposal pile located southeast of the Pre-1955 Retort Building (MACTEC 2005).

<u>Pre-1955 Retort Building.</u> Nine surface soil samples were collected from within and around the historical structure footprint. Samples were analyzed for mercury and arsenic. Mercury speciation analysis was also performed. Arsenic was detected at concentrations from 89 to 1,250 mg/kg. Mercury was detected at concentrations from 2.9 to 32.0 mg/kg. Mercury speciation indicated methylmercury concentrations from 0.357 to 1.688 micrograms per kilogram (µg/kg).

<u>Pre-1955 Rotary Furnace</u>. Eleven soil samples were collected around the historical footprint of the structure. The samples were collected from the surface to 2.7 feet bgs. Samples were analyzed for mercury and arsenic. Mercury speciation analysis was also performed. Arsenic was detected at concentrations from 38 to 2,000 mg/kg. Mercury was detected at concentrations from 2.5 to 140 mg/kg. Mercury speciation indicated methylmercury concentrations from 0.186 to 0.563 µg/kg.

<u>Pre-1955 Rotary Furnace Stack.</u> One surface soil sample was collected and analyzed for mercury, arsenic, and mercury speciation at the site of the historical rotary furnace stack. Arsenic was detected at a concentration of 118 mg/kg.

Mercury was detected at a concentration of 3.4 mg/kg. Mercury speciation indicated a methylmercury concentration of 0.050 µg/kg.

Pre-1955 Retort "Burnt Ore" Stockpile. One surface soil sample was collected and analyzed for mercury, arsenic, and mercury speciation at the site of the "burnt ore" (tailings) disposal pile southeast of the Pre-1955 Retort Building. Arsenic was detected at 1,390 mg/kg. Mercury was detected at 940 mg/kg. Mercury speciation indicated a methylmercury concentration of 0.445 µg/kg.

2004 AST/Ore Hopper Demolition and Petroleum Release Investigation. The BLM demolished and disposed of the ASTs and ore hopper. This project involved construction of Monofill #3. Environmental sampling, including 12 soil borings, was conducted to characterize the AST area, and the existing monitoring wells were sampled.

Soils investigations at the AST area detected petroleum hydrocarbons (diesel range organics [DRO]) above ADEC cleanup levels in excavations and soil borings. Groundwater samples collected from the existing monitoring wells contained antimony, arsenic, and mercury at concentrations above ADEC cleanup levels; DRO and residual range organics (RRO) were detected in groundwater samples below ADEC cleanup levels (MACTEC 2004).

2005/2006 AST Soil Stockpiling and Debris Removal. The BLM excavated petroleum-contaminated soil in the AST area and sampled the excavated soil prior to placing the material in covered stockpiles. Environmental sampling was not conducted except for the annual sampling of the five monitoring wells. Antimony, arsenic, and mercury were detected in the groundwater samples above ADEC cleanup levels (Wilder/URS 2007).

2007, 2008, and 2009 Monitoring Events. The monitoring wells were sampled in 2000, 2003, 2005, 2006, 2007, 2008, and 2009. The 2007 and 2008 sampling events were conducted by the BLM, and are summarized in groundwater sampling reports for each year. The 2008 monitoring event also included one sample taken from a hillside seep (Shannon & Wilson, Inc. 2008)

2009 Monitoring Event. The October 2009 sampling event was conducted by E & E and included five surface water samples in addition to the monitoring well samples (E & E 2010a). The October 2009 data are presented in Chapter 4 of this report.

2010 USGS Geophysical Investigation. In August 2010, in cooperation with the BLM and in conjunction with the RI/FS, the USGS conducted a geophysical investigation at the RDM site using surface-based direct-current resistivity and electromagnetic induction methods (Burton and Ball 2011). Eight two-dimensional cross-sections and one three-dimensional grid of direct-current resistivity data, and 5.7 kilometers of electromagnetic induction data, were obtained along Red Devil Creek valley, from the Main Processing Area to Red

Devil Creek's confluence with the Kuskokwim River. Results of the geophysical investigation indicate no significant contrast in resistivity between the tailings, waste rock, and bedrock at the site. However, based on correlation with existing monitoring wells, a water table was interpreted on the direct-current resistivity cross-sections. Several anomalies were also identified in the direct-current resistivity profiles and the three-dimensional grid. Down-hole geophysical logs and analysis of soil and rock samples to determine how water content affects the bulk resistivity values were recommended (Burton and Ball 2011).

1.4.5 Previous Removal and Cleanup Actions

The BLM performed five major removal/cleanup actions at the RDM between 1999 and 2006. These actions have included offsite disposal of hazardous waste and materials and onsite consolidation of mine structure debris. To date, all mine structures have been demolished, and three debris burial areas (monofills) have been constructed.

1.4.5.1 Limited Waste Removal Action (1999)

In 1999, the BLM conducted limited waste removal and site characterization activities to address the most hazardous conditions observed at the site during the 1988 SI (HLA Wilder 1999). The following subsections summarize the waste removal activities conducted by waste type. Site features referred to within this section are depicted in Figure 1-3.

Battery Storage Areas

Five EP-2 boxes of batteries (approximately 100 batteries) were removed from the vicinity of the "Shop Building," Shop Pads A and B, the Gravel Pad, and three vehicles. The batteries were taken to Excide in Anchorage, Alaska, for recycling. Following removal, two soil samples were collected from the battery storage areas, and lead was detected at concentrations above the ADEC soil cleanup level established in 18 Alaska Administrative Code (AAC) 75, Method 2, Table B1, Under 40-Inch Zone, Most Conservative Pathway. Lead-contaminated material was addressed during the 2002 debris consolidation and disposal project (Section 1.4.5.3), but it is unknown whether contaminated soil was addressed in these areas.

Transformer Areas

Four 55-gallon drums were identified at the site. One 55-gallon drum containing used oil was recovered from the Power Plant and transported to Alaska Energy Recovery Services, Inc. (ERS), in Anchorage for recycling. Philip Services Corporation tested the oil onsite and determined that it contained less than 50 parts per million (ppm) PCBs. One soil sample was collected near the Power Plant, and no contaminants were detected at concentrations above the ADEC soil cleanup levels.

After onsite testing indicated PCBs greater than 50 ppm, two 55-gallon drums containing PCB-contaminated transformer oil were recovered from the Gravel Storage Pad and transported to the Philips Burlington Environmental, Inc. (BEI), disposal facility in Georgetown, Washington. One 55-gallon drum containing non-PCB-contaminated transformer oil (onsite testing indicated PCBs less than 50 ppm) was transported to ERS for recycling. One soil sample was collected from the Gravel Storage Pad, and benzene was detected at a concentration above the ADEC soil cleanup level. The emptied transformers were addressed during the 2002 debris consolidation and disposal project (Section 1.4.5.3).

Drum Areas

There were three main drum storage areas: an area north of the Post-1955 Retort Building containing 89 drums, an area north of the Power Plant containing 92 drums, and an area near the Former Shop Pad containing 25 drums. Drums were also found near the housing area and on the Gravel Storage Pad. Most of the drums were empty. The contents of the drums were characterized by Philip Services Corporation and bulked into a total of 23 drums for recycling or disposal:

- Seventeen 55-gallon drums of used oil were transported to ERS for recycling.
- Three 55-gallon drums of Stoddard solvent were transported to BEI for disposal.
- Three 55-gallon drums of grease were transported to BEI for disposal.

Four soil samples were collected from the drum areas. Mercury, antimony, and arsenic were detected at concentrations above the ADEC soil cleanup levels. The emptied drums were addressed during the 2002 debris consolidation and disposal project (Section 1.4.5.3), but it is unknown whether contaminated soil was addressed in these areas.

Post-1955 Retort

HLA/Wilder removed mercury-contaminated material from the Post-1955 Retort Building, including the exhaust port concrete base and ash. In addition, approximately 5 pounds of free mercury was collected from the periphery of the Post-1955 Retort Building and placed in one of the drums of mercury-contaminated material. The mercury-contaminated material transported to BEI for disposal consisted of:

- Two 55-gallon drums of mercury-contaminated ash.
- Two 55-gallon drums of mercury-contaminated concrete (broken into small pieces).
- Two Supersacks^{TM} of mercury-contaminated ash.
- Two Supersacks^{TM} of mercury-contaminated personal protective equipment and debris.

Seven soil samples were collected around the Post-1955 Retort Building. Mercury, antimony, and arsenic were detected at concentrations above the ADEC soil cleanup level. This soil was addressed during the 2002 debris consolidation and disposal project (Section 1.4.5.3).

Chemical Storage Areas

HLA/Wilder bulked chemicals from the two dilapidated chemical storage sheds located south of the Post-1955 Retort Building. The East Chemical Storage Shed contained potassium carbonate, and the West Chemical Storage Shed contained copper sulfate, sodium hydroxide, and sodium dichromate dihydrate. The bulked chemicals transported to BEI for disposal were:

- Two 55-gallon drums of sodium dichromate dihydrate.
- Seven Supersacks™ of potassium carbonate.
- Five Supersacks™ of chemical-contaminated soil and debris.
- Two Supersacks™ of sodium hydroxide.
- Two 55-gallon drums of copper sulfate.

One soil sample was collected from each of the chemical storage sheds. Mercury, antimony, arsenic, and chromium were detected at concentrations above the ADEC soil cleanup levels. This soil was further characterized in 2001 and addressed during the 2002 debris consolidation and disposal project (Section 1.4.5.3).

1.4.5.2 Post-1955 Retort Demolition (2000)

In 2000, the BLM demolished the Post-1955 Retort Building and West Chemical Storage Shed (Wilder/HLA 2001). Mercury-impacted asbestos, soil, and “slag” wastes generated during the demolition were transported offsite for disposal. Demolition debris, including wood, steel, tin sheeting, bricks, retort chamber, process piping, and miscellaneous equipment, was pressure-washed in a low area of the retort building foundation. Wash water was collected with sump pumps and discharged into a high-density polyethylene-lined holding pond. Approximately 1,067 cubic yards of washed demolition debris was staged in a pile on the concrete retort building foundation. In addition, approximately 8 cubic yards of furnace “slag” was stockpiled on a bottom liner adjacent to the concrete foundation. The “slag” stockpiled adjacent to the Post-1955 Retort Building concrete foundation was addressed during the 2002 debris consolidation and disposal project (Section 1.4.5.3).

The headworks was also demolished, resulting in a debris pile of wood and steel with a volume of approximately 175 cubic yards. The debris pile remained at the headworks location and the debris was not sampled for contaminants. Approximately 55 gallons of fuel from the fuel storage and distribution system were recovered and transported to ERS in Anchorage for recycling.

The entrances to five mine shafts and one adit were collapsed and backfilled. Large rock debris was placed in each entrance, the entrance walls were collapsed, and the material was compacted in place.

The BLM conducted source area investigations at the Post-1955 Retort Building and fuel storage and distribution system, including collection of surface soil, subsurface soil, and groundwater samples (see Section 1.4.4).

1.4.5.3 Debris Consolidation and Disposal (2002)

In 2002, the BLM demolished several onsite structures, most of which were cleared of hazardous substances in 1999 (see Section 3.2.2). Wilder also segregated and chemically treated debris and constructed Monofill #1 and Monofill #2 (Figure 1-3). In addition, some lead-contaminated material was removed from the vicinity of the houses and mess hall/bunkhouse. This material included drainpipe, sewer pipe, and lead heat trace. No sampling for lead was conducted in soils surrounding this removed debris; however, building materials tested for lead did not exceed the toxicity characteristic levels established by the Resource Conservation and Recovery Act (RCRA). One 55-gallon drum of hydraulic fluid was recovered from the drum storage areas and transported offsite for disposal. The debris consolidation and disposal work was intended to reduce arsenic and mercury mobility (Wilder/URS 2003).

Monofill #1

Approximately 4,400 cubic yards of "inert debris" (as defined by ADEC, 18 AAC 60) was placed within Monofill #1. The debris placed in Monofill #1 consisted of building debris, wood, concrete, scrap metal, 23 transformers (confirmed dry), and Category I and II non-friable asbestos-containing material (Wilder/URS 2003).

Monofill #1 was constructed below grade, ranging in depth from 8 to 15 feet bgs. Following placement of compacted inert debris, the debris was capped with at least 2 feet of soil and contoured so that it blended with the existing grade. Soil stockpiled during excavation of the monofill was used as void-filling and cap material. The cap slope was less than or equal to 3 feet horizontal to 1 foot vertical (3H:1V) (Wilder/URS 2003).

Monofill #2

Monofill #2 contains approximately 938 cubic yards of chemically treated mercury- and arsenic-contaminated debris from the Post-1955 Retort Building. A treatability study of the retort debris demonstrated that mercury and arsenic could be stabilized to RCRA toxicity characteristic leaching procedure (TCLP) criteria using chemical encapsulants. Reportedly, treatment of the debris with the chemical encapsulants rendered the debris "inert"; however, there was no confirmation sampling to determine that the treated material met the definition of "inert" as defined by ADEC (18 AAC 60). In addition to the chemical encapsulation treatments, an impermeable geomembrane liner was used in the construction of Monofill #2 as a second precautionary measure (Wilder/URS

2003). Monofill #2 was constructed above the Post-1955 Retort Building foundation where elemental mercury was previously found in the subsurface (see Section 3.1, 2001 Source Area Removal and Investigation). This mercury was not removed or otherwise remediated prior to construction of the monofill.

The debris placed within Monofill #2 consisted of retort building debris, bricks, and “slag”; tailings; and some arsenic-containing soil excavated from the vicinity of the chemical storage sheds and mess hall/bunkhouse (arsenic was detected in these areas at concentrations above RCRA TCLP criteria during sampling conducted in 2001). The Gravel Storage Pad was used as a temporary staging area for debris segregation and chemical encapsulation treatment. Prior to construction of Monofill #2 above the concrete foundation, the mercury chemical encapsulant was placed over the concrete foundation and inside the cracks, and mercury- and arsenic-contaminated soil surrounding the foundation was also treated with mercury and arsenic chemical encapsulants (Wilder/URS 2003).

Monofill #2 was constructed above-grade on top of the concrete foundation of the Post-1955 Retort Building. All debris placed within Monofill #2 was first treated with chemical encapsulants, as recommended in the treatability study. Monofill #2 was lined with an impermeable geomembrane layered with geotextile on each side for abrasion protection. The geotextile/geomembrane liner was installed above and below the monofill debris and welded to seal the liner. Liner installation and welding were supervised by qualified technicians, and Quality Assurance/Quality Control reports were provided (Wilder/URS 2003). Tailings treated with the arsenic chemical encapsulant were used as backfill material above, below, and all around the geomembrane-lined portion of Monofill #2. Treated tailings were also placed within the geomembrane-lined portion of Monofill #2 in a 1-foot layer separating the liner from the compacted retort debris to prevent protrusions from damaging the liner. Treated tailings were also used as void-filling material within the geomembrane-lined portion of Monofill #2 (Wilder/URS 2003). The report is inconsistent in stating whether or not all tailings used in the monofill construction were treated with the chemical encapsulant.

Monofill #2 is approximately 9 feet high at the center. The depth of waste in Monofill #2 is approximately 3 feet, and the treated tailings cap on top of the debris is at least 3 feet thick. The cap slope is less than or equal to 5 percent. The sidewall on the western side is approximately 50 percent. A crown was constructed at the top to promote surface water drainage (Wilder/URS 2003).

1.4.5.4 Aboveground Storage Tanks/Ore Hopper Demolition (2003–2004)

In 2003 and 2004, the BLM conducted demolition and onsite consolidation of the five fuel ASTs and the Ore Hopper and conducted an assessment of petroleum contamination at the former AST sites. The debris was consolidated in the “AST Metal Disposal Area” (MACTEC 2004). This feature is Monofill #3 (Figure 1-3).

Approximately 12,700 square feet of tank metal was placed in the onsite disposal area, which measured approximately 55 feet long, 15 feet wide, and 12 feet deep. The ASTs were reportedly inspected and emptied during previous site activities. Approximately 1,400 square feet of Ore Hopper metal, and less than 10 cubic yards of broken concrete, was also placed in the disposal area. Most of the Ore Hopper concrete structure was left in place and buried with tailings from the bench above the Ore Hopper. The disposal area was capped with more than 3 feet of soil that originated from the original excavation of the monofill pit and graded to facilitate drainage (MACTEC 2004).

1.4.5.5 Contaminated Soil Stockpiling and Debris Removal (2005–2006)

In 2005 and 2006, the BLM performed petroleum-contaminated soil excavation and stockpiling, debris removal, and inspection/repair of monofill erosion/settling problems. Approximately 3,306 cubic yards of petroleum-contaminated soil from four of the 2003 AST excavation sites, the pipeline area, and the former fuel barge area were excavated and stockpiled in two lined stockpiles. Prior to its placement in the stockpiles, the contaminated soil was screened, and material larger than 2 inches in diameter (large cobbles and boulders) were segregated and used as cap material for Monofill #3. Some AST wooden base debris was burned. The following debris was added to Monofill #3 (Wilder/URS 2007):

- A 300-foot, 6-inch-diameter steel fuel delivery pipeline that connected the AST farm to the fuel barge landing area (cut into pieces).
- Approximately 10 cubic yards of debris consisting mainly of empty drums, cans, and boxes collected from a location near the former location of AST 3.
- A collapsed mine portal iron gate.

Following placement of this miscellaneous debris in Monofill #3, the monofill was capped with the material screened from the petroleum-contaminated soil stockpiles (Wilder/URS 2007).

The BLM also performed monofill repair activities in 2005, including (Wilder/URS 2007):

- Monofill #1 – Minor settling/erosion was noted at this monofill site. In particular, the areas of concern were small surficial depressions, which were regraded to prevent pooling of rain and runoff waters.
- Monofill #2 – Precipitation runoff was observed cutting into the southwest corner of Monofill #2. This corner was regraded to stabilize erosion. A runoff ditch was also re-worked to allow runoff to leave the monofill cap in a direction that would prevent future erosion in that area.

1.5 Summary of RI/FS Data Quality Objectives

The Work Plan includes a chapter dedicated to specifying DQOs (E & E 2011). The DQO process specifies project decisions, the data quality required to support those decisions, data types needed, and data collection requirements and ensures that analytical techniques are used that will generate the specified data quality (EPA 2000). The data types that pertain to this RI report should be analyzed using the following key study questions:

Nature and Extent of Contamination

1. What COPCs, in addition to those identified in previous investigations, exist at and near the site?
2. Do COPC concentrations differ in areas where different ore processing operations were conducted?
3. Are COPC reporting limits sufficient to characterize human health and ecological risks?
4. Is mercury present in an organic form at the site?
5. What is the areal and vertical extent of tailings, flotation tailings, and waste rock?
6. Are soils in the area of former surface exploration and mining a source of COPCs, and are metals in a mobile or bioavailable form?
7. Are roads at and to the site a source of COPCs?
8. Are the Dolly Sluice and possible Rice Sluice areas sources of COPCs?
9. What is the nature and extent of contamination in native subsurface soil?
10. What is the nature and extent of contamination in groundwater?
11. What is the nature and extent of contamination in aquatic biota?
12. What are the background concentrations of COPCs in native soils and in groundwater, surface water, sediment, and biota in areas undisturbed by mining activities?
13. Are the previous locations of transformers a source of COPCs?
14. What physical and chemical characteristics can be used to define a difference between tailings, waste rock, and native soils at the site?

Fate and Transport of Contamination

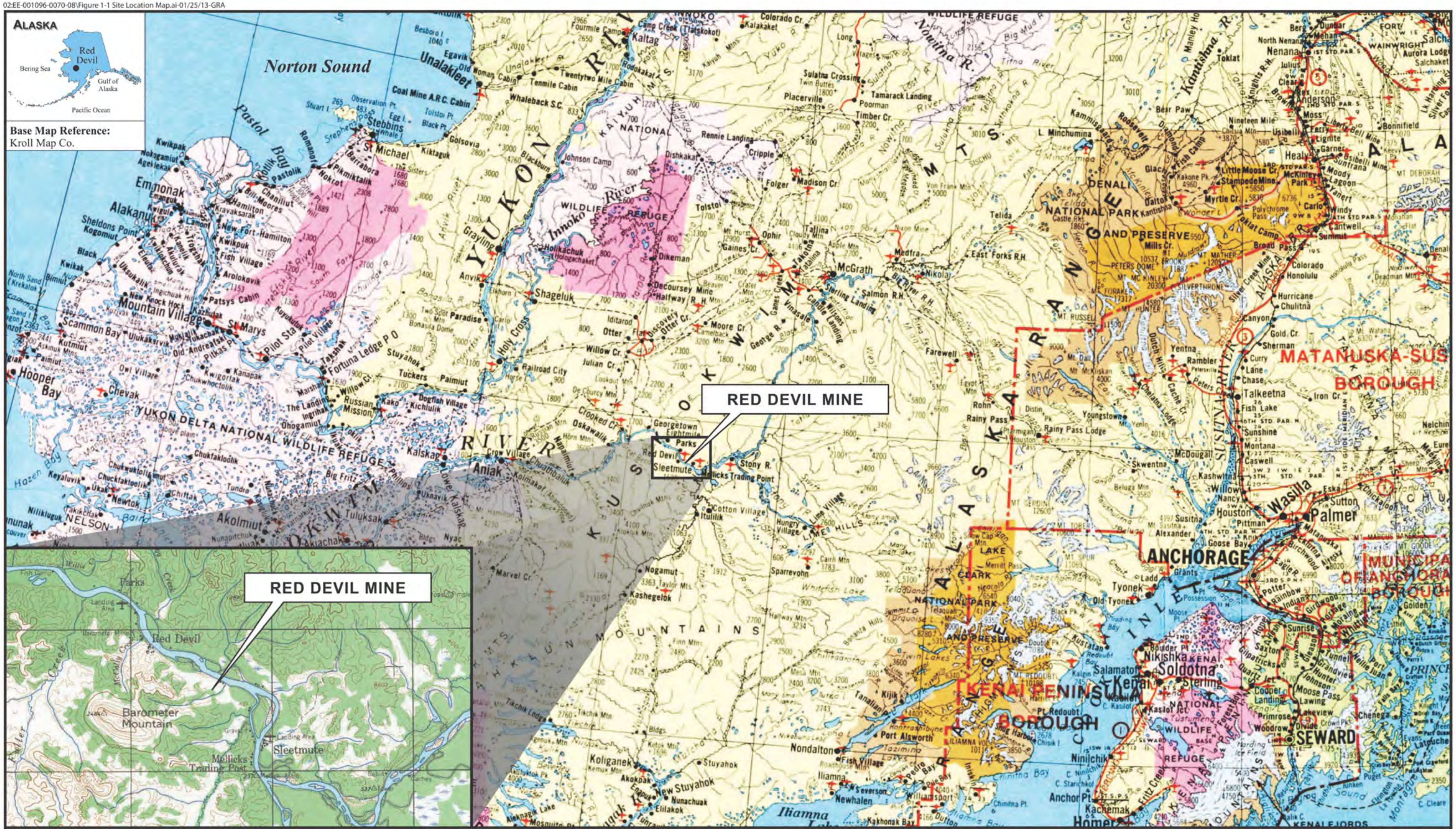
15. Is contaminated groundwater impacting Red Devil Creek or the Kuskokwim River?
16. Have tailings, flotation tailings, waste rock, and/or other site sources impacted sediments, surface water, or aquatic biota in Red Devil Creek?
17. Have tailings, flotation tailings, waste rock, and/or other site sources impacted sediments in the Kuskokwim River downriver of the mouth of Red Devil Creek?

18. Have tailings, flotation tailings, waste rock, and/or other site sources impacted native subsurface soils at the site?
19. Has elemental mercury, previously documented in subsurface soil near Monofill #2, mobilized and/or entered groundwater?
20. What is the leaching potential of COPCs in tailings and flotation tailings at the site?
21. What is the fraction of mercury in tailings, flotation tailings, waste rock, and contaminated soil that is available to chemically mobilize?
22. Are COPCs in waste rock and impacted soils leachable?
23. What is the fraction of arsenic in soil, sediment, surface water, and groundwater that is bioavailable to humans?
24. Are the underground mine workings influencing the nature, extent, and migration of COPCs in groundwater and surface water?

Human Health and Ecological Risk

25. What risks to human health under future residential, subsistence user, and industrial land use scenarios are posed by COPCs at and near the site?
26. What risks to ecological receptors at various trophic levels are posed by COPCs at and near the site?

02:EE-001096-0070-08\Figure 1-1 Site Location Map.ai-01/25/13-GRA



Base Map Reference:
Kroll Map Co.

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

N

0 40 80
Approximate Scale in Miles

RED DEVIL MINE
Red Devil, Alaska

Figure 1-1
SITE LOCATION MAP

Date: 04/18/13	JSS	02:EE-001096-0070-08

Ecology & Environment, Inc. GIS Department Project:
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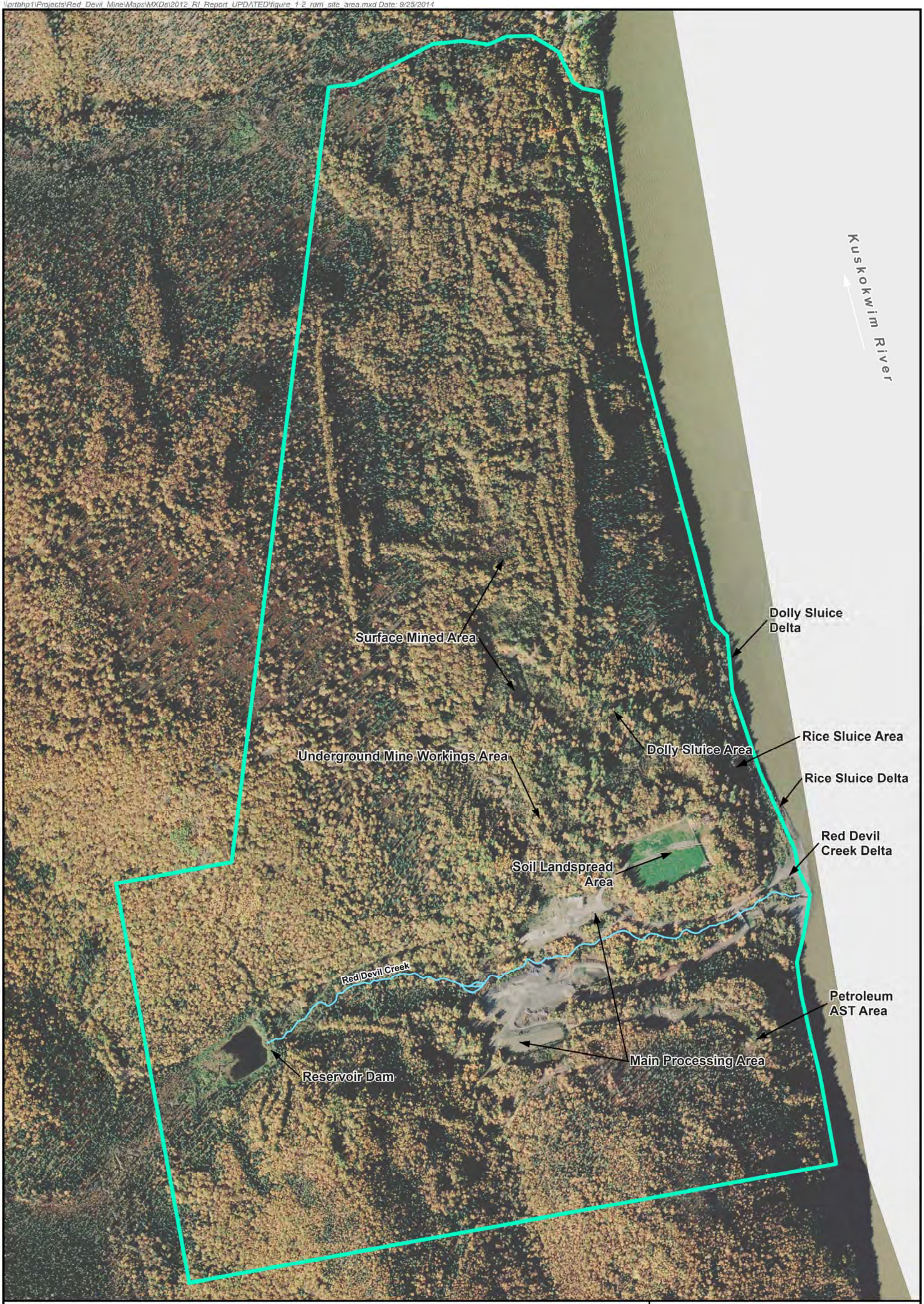

🟩 Upland Area Encompassed by Remedial Investigation

RED DEVIL MINE

Red Devil, Alaska

Figure 1-2
Upland Area Encompassed by Remedial Investigation

0 75 150 300 450 600 750
Feet
0 37.5 75 150 225
Meters
Scale 1:4,562

Image Source: Aero-Metric, Inc. 2010a

RED DEVIL MINE

Red Devil, Alaska

Figure 1-3
Main Processing Area

Image Source: Aero-Metric, Inc. 2010a

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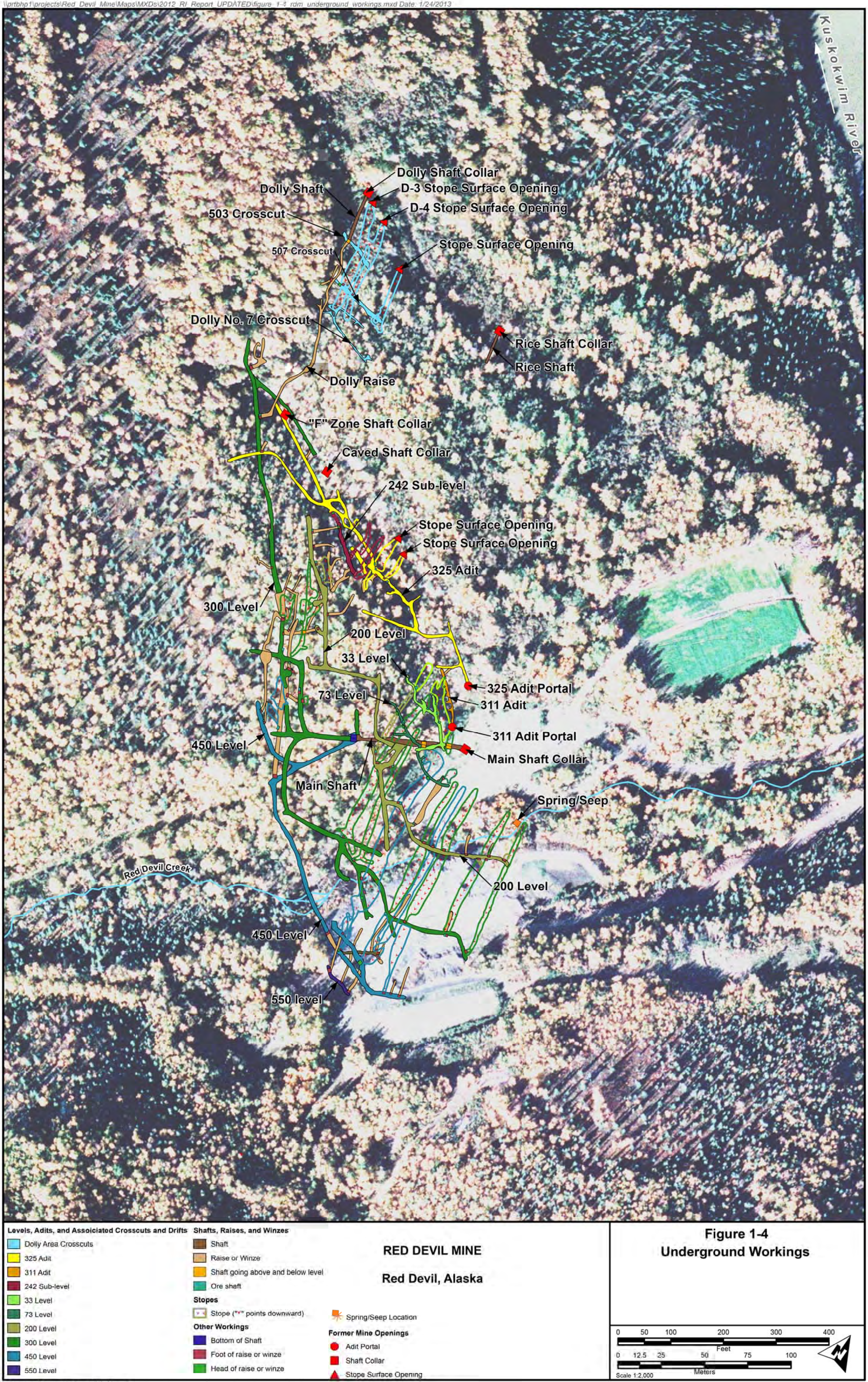

Figure 1-4
Underground Workings

Source: Malone 1962 and MacKevett and Berg 1963, Image Source: Aero-Metric, Inc. 2010a

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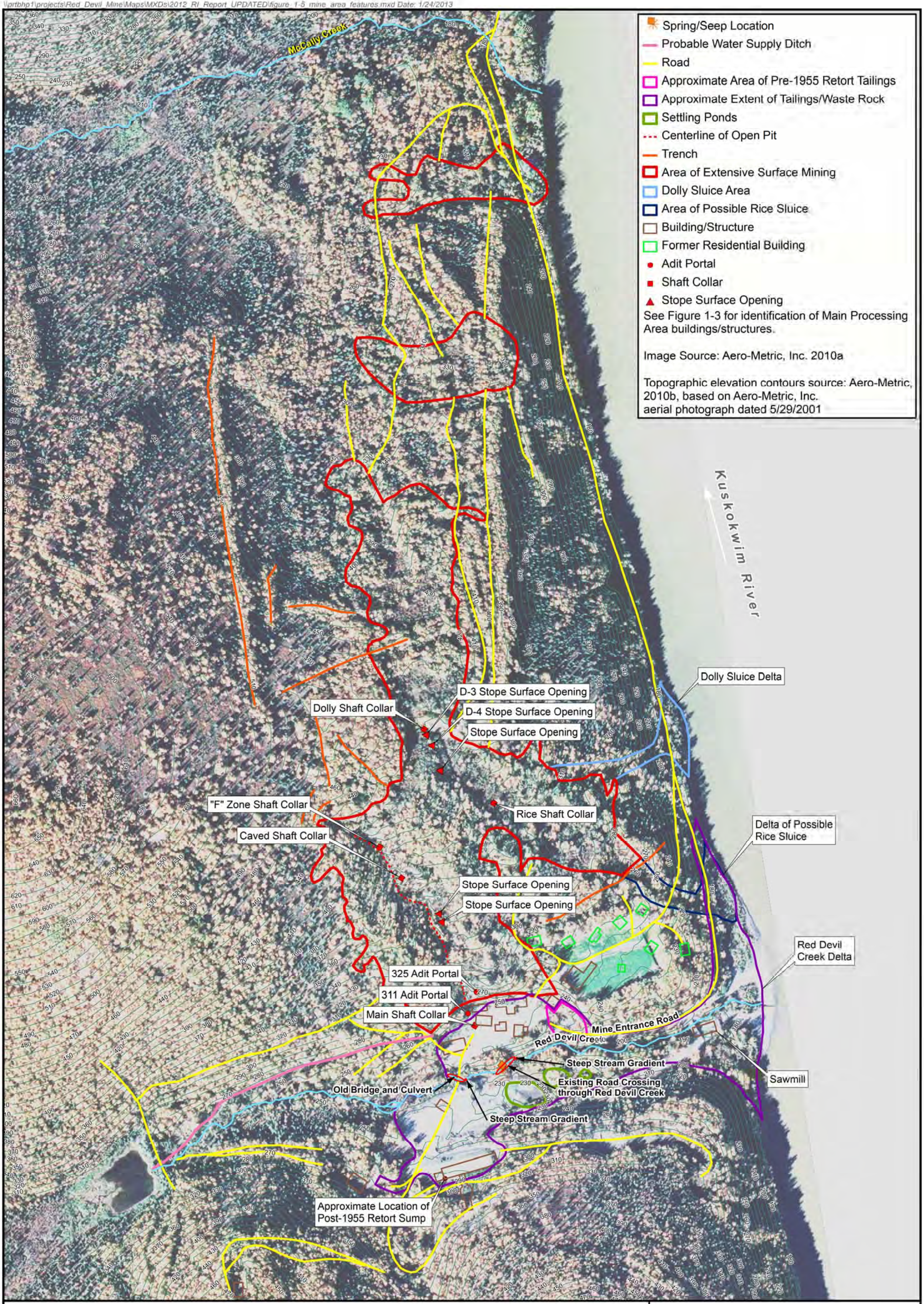

RED DEVIL MINE

Red Devil, Alaska

Figure 1-5
Mine Area Surface Features

0 100 200 400 600 800
Feet
0 25 50 100 150 200
Meters
Scale: 4,000

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\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_1-6_mining_ore_processing_wastes.mxd Date: 1/24/2013

🟥 Ore processing waste source locations
🟦 Potential areas containing tailings/waste rock
⋯ Areas where disturbed soil is present

RED DEVIL MINE

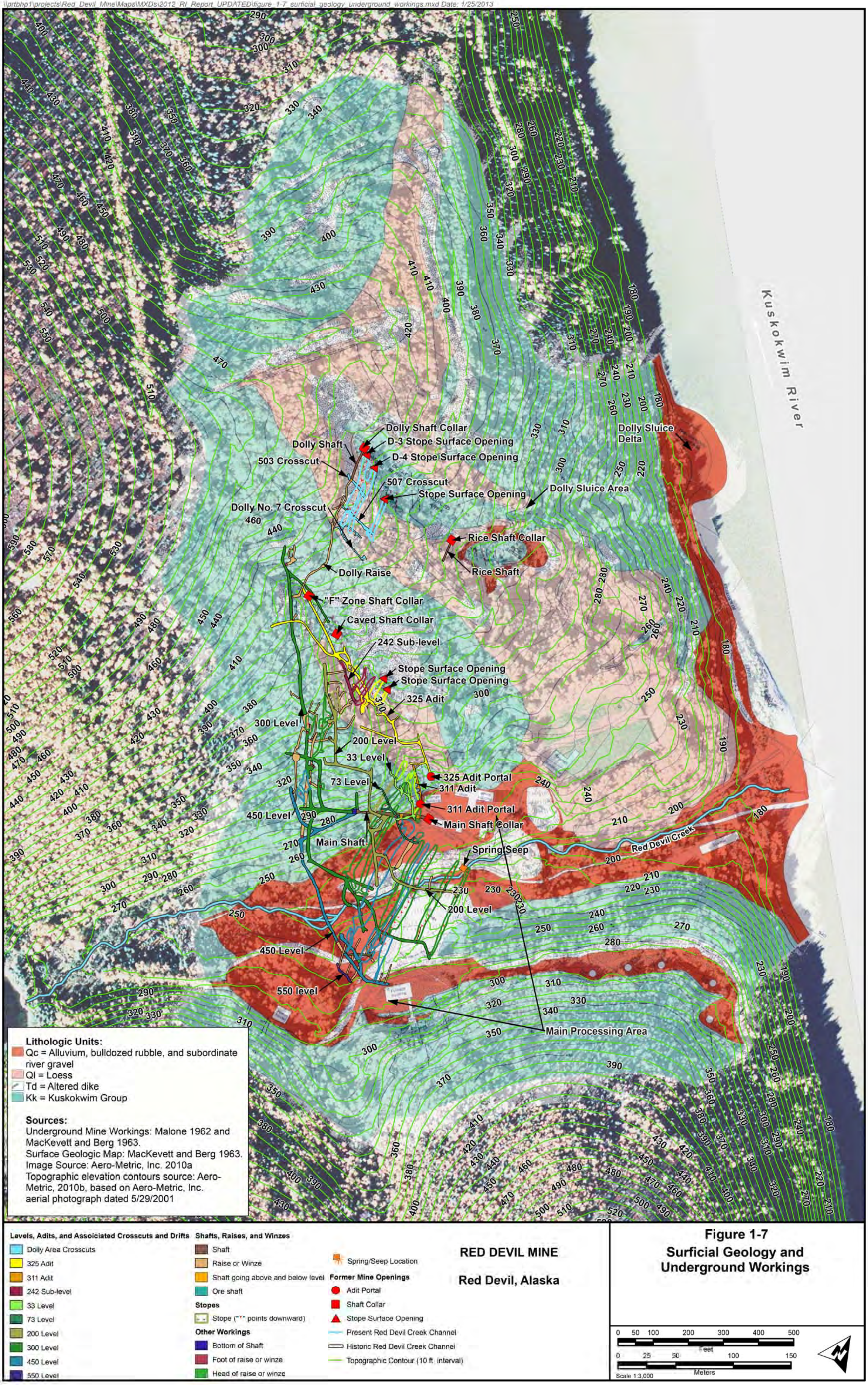
Red Devil, Alaska

Figure 1-6
Mining and Ore Processing Wastes

0 100 200 400 600
Feet
0 25 50 100 150 200
Meters
Scale 1:3,600

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project: \\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_1-7_surficial_geology_underground_workings.mxd Date: 1/25/2013



Lithologic Units:

Qc = Alluvium, bulldozed rubble, and subordinate river gravel

Ql = Loess

Td = Altered dike

Kk = Kuskokwim Group

Sources:

Underground Mine Workings: Malone 1962 and MacKevett and Berg 1963.
Surface Geologic Map: MacKevett and Berg 1963.
Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

Levels, Adits, and Assoiciated Crosscuts and Drifts

- Dolly Area Crosscuts
- 325 Adit
- 311 Adit
- 242 Sub-level
- 33 Level
- 73 Level
- 200 Level
- 300 Level
- 450 Level
- 550 Level

Shafts, Raises, and Winzes

- Shaft
- Raise or Winze
- Shaft going above and below level
- Ore shaft

Stopes

- Stope ("▼" points downward)

Other Workings

- Bottom of Shaft
- Foot of raise or winze
- Head of raise or winze

- Spring/Seep Location

Former Mine Openings

- ● Adit Portal
- ■ Shaft Collar
- ▲ Stope Surface Opening
- Present Red Devil Creek Channel
- Historic Red Devil Creek Channel
- Topographic Contour (10 ft. interval)

RED DEVIL MINE

Red Devil, Alaska

Figure 1-7
Surficial Geology and Underground Workings

2 Study Area Investigation

This chapter describes the field investigations performed at the RDM during the 2010, 2011, and 2012 field seasons. It includes descriptions of the number, type, location, and analytical requirements of samples collected; the location and methods used for soil boring and monitoring well installations; and deviations from the Work Plan. This chapter also identifies other studies that have been used to characterize the site.

The primary field investigations were conducted during the 2010 and 2011 field seasons. Additional fieldwork was conducted at the RDM during the 2012 field season. This additional fieldwork included the following:

- Collection of Red Devil Creek water samples, measurement of Red Devil Creek discharge, and collection of monitoring well groundwater samples during the period of May 25 to May 31, 2012.
- Collection of Red Devil Creek water samples, measurement of Red Devil Creek discharge, and collection of monitoring well groundwater samples during the period of September 7 to September 21, 2012.
- Collection of blueberry samples, additional soil samples in the Surface Mined Area, and additional sediment samples from the Kuskokwim River during the period of September 7 to September 21, 2012.

The 2012 surface water sampling, groundwater sampling, and discharge measurements are referred to as baseline monitoring because they establish the first year of multiple sampling/monitoring events at designated locations to characterize hydrologic conditions over time at the site. The baseline monitoring fieldwork results are documented in the 2012 Red Devil Mine Baseline Monitoring Report (E & E 2013), provided in Appendix A. Relevant interpretations of the data are integrated into this report. The results of blueberry sampling, additional soil sampling in the Surface Mined Area, and the additional sediment sampling in the Kuskokwim River conducted in 2012 are incorporated into the sections below.

2.1 Surface Soil

Surface soil samples were collected for XRF field screening and for laboratory analyses. Surface soil samples were collected between September 12, 2010, and September 24, 2010, and between July 28, 2011, and August 20, 2011.

The objective of the visual inspection and in-situ XRF field screening of surface soils was to:

- Use visual characteristics and metals concentrations in surface materials to determine the lateral surface extent of tailings/waste rock at the site

The objectives for the data resulting from the surface soil samples collected for laboratory analyses are:

- Characterization of the nature and extent of COPCs in surface soil.
- Provision of data supporting the delineation of the areal extent of tailings/waste rock on the ground surface.
- Identification and characterization of possible tailings/waste rock at the reservoir dam.
- Characterization of the soils within the Surface Mined Area.
- Characterization of soil characteristics that may affect contaminant fate, transport, bioavailability, and bioaccumulation.
- Characterization of chemical and physical characteristics of soils in background areas.
- Provision of data for the human health risk assessment (HHRA) to assess potential exposure to COPCs through direct contact, inhalation, and incidental ingestion.
- Provision of data for the ecological risk assessment (ERA) to assess potential exposure of biota to COPCs through direct contact and ingestion.
- Characterization of geotechnical properties of tailings/waste rock and soils that may be subject to excavation.
- Characterization of geotechnical properties of soils at a potential site for an onsite waste repository located within the Surface Mined Area approximately 700 feet north of the Dolly Shaft Collar.

2.1.1 XRF Field Screening Samples

In 2010, areas where tailings/waste rock could be present at the surface based on historical data, historical photographs, and aerial imagery were evaluated in the field using a combination of visual observations and in-situ field screening for total metals using a portable XRF device. In-situ XRF field screening results from the 2010 Limited Sampling Event (LSE) (E & E 2010b) indicated that further characterization during the 2011 field season was necessary to fully characterize the lateral extent of tailings/waste rock at the site. Table 2-1 summarizes the location, number, and objectives of the XRF screening locations.

Table 2-1 XRF Screening Sample Summary

General XRF Sample Location	Number of Samples XRF Screened	Objectives of Samples
Main Processing Area Grid	45	Assess the presence of tailings/waste rock and elevated concentrations of metals in surface soil
Main Processing Area Transects	106	
Surface Mined Area Grid	38	
Surface Mined Area Transects	42	
Dolly Sluice	10	Assess the distribution of metals in the sluice gullies
Rice Sluice	12	
Roads and Abandoned Roads	81	Assess whether tailings/waste rock material had been used as surface material on roads
Former Building Foundations	4	Assess the possibility that tailings/waste rock were used as foundation material

Key:

XRF	X-ray fluorescence

XRF field screening results and collocated laboratory sample results from the 2010 soil investigation were paired and a linear regression correlation coefficient was calculated for all of the sample pairs. The calculated correlation coefficient for antimony, arsenic, and mercury were $R^2 = 0.9072$, 0.9013, and 0.9209, respectively. These R^2 values indicate that there was excellent comparability between field and laboratory total metals data for these analytes.

XRF field screening was performed in-situ (on the soil surface) after removal of any surficial detritus. At each XRF field screening location, three XRF readings were taken at the corners of a one-meter (m) equilateral triangle. The lateral coordinates of each field screening location were surveyed with global positioning system (GPS) instrumentation as described in Chapter 8 of the Field Sampling Plan (FSP), which is Appendix F of the Work Plan.

Surface soil sampling for XRF field screening.

Grids were established in the Main Processing Area and other locations to characterize the nature and general extent of tailings/waste rock and to characterize COPC concentrations (Figure 2-1). A grid was established in the Surface Mined Area to characterize COPC concentrations. One location within each grid square was field screened with an XRF, and visual observations of soil characteristics were recorded. The XRF data collected at each grid node form the bulk of the data used to define the extent of tailings/waste rock and/or characterize the COPC concentrations in the Main Processing Area, along lower Red Devil Creek and the delta and in the Surface Mined Area.

To define the lateral surface extent of tailings/waste rock or areas of elevated COPCs, a series of transects located around the perimeter of the expected edge of tailings/waste rock was established (Figure 2-1). Each transect line was oriented perpendicular to the expected lateral limit of tailings/waste rock, with one end point located within the expected lateral limit (Transect Station A) and the other end point located outside of the expected lateral limit of tailings/waste rock (Transect Station B). Initially, field screening was performed at Station A and Station B along each transect. If tailings/waste rock materials were identified at the Station B location along any transect, the transect line was extended outward from Station B and the soil was re-evaluated for the presence of tailings/waste rock. Similarly, if it appeared that tailings/waste rock were not present at the Station A position along a given transect, the transect line was extended inward from Station A. This process was repeated until the lateral extent of tailings/waste rock at each transect location was identified.

Another series of transects was established around the expected edge of extensive surface mining (primarily bulldozing) in the Surface Mined Area (Figure 2-2). An approach similar to that described for delineating the extent of tailings/waste rock was followed.

XRF field screening was also performed to identify, delineate, and characterize mine waste materials and COPC concentrations at the Dolly Sluice and Rice Sluice. XRF field screening was conducted along the apparent centerline of the Dolly Sluice and Rice Sluice areas and at locations on either side of the centerline of each sluice gully (Figure 2-2).

XRF field screening was also performed to identify, delineate, and characterize mine waste materials and COPC concentrations at former and present roads. Field screening was performed at locations along the apparent centerline of the road and on either side of the road outside of the apparent road surface (Figure 2-2).

Former building foundations in the residential area were XRF field screened to assess the possibility that tailings/waste rock were used as foundation material (Figure 2-2). Review of historical information and photographs indicate that soils in this area have been disturbed as part of the building and road construction.

2.1.2 Laboratory Surface Soil Samples

Surface soil samples submitted for laboratory analysis are illustrated in Figures 2-3 and 2-4. Surface soil samples were collected from 0 to 6 inches bgs following removal of surficial detritus on the ground surface.

Surface soil sample collection.

All surface soil samples were analyzed for total target analyte list (TAL) inorganic elements. A subset of these samples was selected for analysis for mercury selective sequential extraction (SSE), arsenic speciation, arsenic bioavailability, synthetic precipitation leaching procedure (SPLP), TAL metals, RCRA metals TCLP, semi-volatile organic compounds (SVOCs), PCBs, DRO, and RRO. In addition, selected soil samples were analyzed for geotechnical parameters, including grain size/Atterburg limits, moisture content, compaction, direct shear, and permeability. Table 2-2 lists the laboratory surface soil samples and analytical parameters by general geographic area. In general, samples were selected for the additional analyses to achieve the following:

- Provide broad areal distribution of data.
- Obtain data for different tailings types (e.g., flotation tailings versus thermally processed tailings, including pre-1955 thermally processed tailings and post-1955 thermally processed tailings) that may be discernible based on chemical or physical characteristics and/or geographic position.
- Obtain data on disturbed soils within the Surface Mined Area.
- Obtain data for anticipated background locations.

Deviations from the Field Sampling Plan

The surface disturbance south of the power plant was found to be narrow, and the transects established around the perimeter of the area provided adequate data for the area; therefore, the grid point planned for the center of the area was not collected.

Some features within the Surface Mined Area and the area of surface exploration south of the Post-1955 Main Processing Area that were suspected to be roads based aerial photographic review were either not located in the field or were determined to be bulldozer paths rather than roads. The suspected roads in the Surface Mined Area that were not located appear to have been subjected to bulldozing. Planned road field screening locations that were determined in the field to not be roads were therefore not field screened.

Locations of surface soil samples 11MP80SS, 11MP81SS, 11MP82SS, 11MP86SS, and 11MP87SS were modified in the field to coincide with locations where transformers had been previously located.

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Background Areas	Red Devil Creek Alluvial Deposits Upstream of Dam	10RD14SS Duplicate 10RD31SS	9/15/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD15SS	9/15/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD16SS	9/15/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD17SS	9/15/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD18SS	9/15/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		11RD18SS Duplicate 11RD30SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
		10RD19SS	9/15/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
Dolly Sluice and Delta	Dolly Sluice Delta	10DS01SS	9/19/2010	x	-	-	-	-	x	x	x	-	x	x	-	-
		10DS02SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Gulley	10DS03SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
Pre-1955	Soil derived from bedrock (Kuskokwim Group)	10UP01SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP02SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP03SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP04SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP05SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP06SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP07SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP08SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10UP09SS Duplicate 10UP30SS	9/24/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10UP10SS	9/24/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		11UP09SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Pre-1955 (cont'd)	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	10RD10SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD11SS	9/17/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10RD12SS	9/17/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10RD13SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Along Red Devil Creek West of Gravel Pad	11MP80SS	8/20/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP81SS	8/20/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP82SS	8/20/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
	Area between mine access road and Red Devil Creek	10MP64SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP65SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Area between Pre-1955 Retort and Red Devil Creek	10MP61SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP63SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Area between Pre-1955 Retort and Red Devil Creek / Pre-1955 Rotary Furnace Burnt Ore Disposal Pile	10MP62SS	9/20/2010	x	-	x	x	x	-	-	-	-	-	-	-	-
	Area near Monofill #1 / Former Shop Pad / Tailings	10MP45SS	9/21/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
		10MP46SS	9/21/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
		10MP47SS	9/20/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
	Area near Monofill #1 / Shop Pad A / Tailings	10MP48SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP49SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		11MP83SS Duplicate 11MP92SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP84SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP85SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Pre-1955 (cont'd)	Area of Pre-1955 Furnace Building / Tailings/Waste Rock	10MP5051525354SS	9/19/2010	x	-	-	-	-	-	-	-	-	x	x	-	-
		10MP50SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP51SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP52SS	9/19/2010	x	-	-	-	-	x	x	x	-	-	-	-	-
		11MP52SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
		10MP53SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP54SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		11MP86SS	8/20/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP87SS	8/20/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
	Area of Pre-1955 Retort Building	10MP55565758SS	9/18/2010	x	-	-	-	-	-	-	-	-	x	x	-	-
		10MP55SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP56SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP57SS	9/19/2010	x	-	-	-	-	x	x	x	-	-	-	-	-
		10MP58SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	East of Pre-1955 Retort Building	10MP59SS Duplicate 10MP86SS	9/21/2010	x	-	-	-	-	x	x	x	-	x	x	-	-
		11MP59SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
	Mine Access Road / Downgradient of Pre-1955 Processing Area	10MP66SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Near spring in Red Devil Creek / Downgradient of former mine openings / Tailings	10MP60SS	9/20/2010	x	-	x	x	x	-	-	-	-	-	-	-	-

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Pre-1955 (cont'd)	Surface of Monofill #1	10MP424344SS	9/19/2010	x	-	-	-	-	-	-	-	-	x	x	-	-
		10MP42SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP43SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP44SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Area Upgradient of Monofill #2 / Post-1955 Retort Building	10MP01SS	9/24/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
Post-1955	Area of Surface Disturbance	11MP71SS	8/2/2011	x	-	-	-	-	-	x	-	-	x	-	-	-
	Berm of Settling Pond #2	10MP35SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Berm of Settling Pond #3	10MP37SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP68SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Between Settling Ponds #1 and Red Devil Creek	10MP38SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Between Settling Ponds #2 and Red Devil Creek	10MP39SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Between Settling Ponds #3 and Red Devil Creek	10MP40SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Flotation Tailings, Settling Pond #1	10MP32SS	9/20/2010	x	x	x	x	-	x	x	x	x	x	x	-	-
		11MP32SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
	Flotation Tailings, Settling Pond #2	10MP34SS	9/20/2010	x	x	x	x	-	x	x	x	x	x	x	-	-
		11MP34SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
	Flotation Tailings, Settling Pond #3	10MP36SS Duplicate 10MP84SS	9/20/2010	x	x	x	x	-	x	x	x	x	x	x	-	-
		11MP36SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Post-1955 (cont'd)	Gravel Pad	10MP23SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP24SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP25SS	9/18/2010	x	-	-	-	-	x	x	x	-	x	x	-	-
		11MP25SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
		11MP76SS (Duplicate 11MP91SS)	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP77SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP78SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP79SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
	Location where the single abandoned drum was identified during the 2010 limited sampling effort	11MP70SS	8/15/2011	x	x	-	-	-	-	-	-	x	-	-	-	-
	Monofill #3 Area/ Tailings	10MP22SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	North of Monofill #2 / Post-1955 Retort Building / Drum Storage Area	10MP10SS	9/21/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
		10MP19SS	9/23/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
	Stockpiled ore upgradient from the Ore Hopper	10MP02SS Duplicate 10MP81SS	9/18/2010	x	-	-	-	-	-	-	-	-	x	-	-	-
	Power Plant / Former Drum Storage Area	10MP20SS	9/23/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
		10MP21SS	9/23/2010	x	x	-	-	-	-	-	-	x	-	-	-	-
		11MP72SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP73SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP74SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x
		11MP75SS	8/15/2011	-	-	-	-	-	-	-	-	-	-	-	-	x

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Post-1955 (cont'd)	Red Devil Creek Alluvial Deposits and/or Soil	10RD06SS	9/17/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10RD07SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Road below Monofill #2 / Post-1955 Retort Building	10MP11SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP12SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP13SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP14SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP15SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP18SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Slope Below Perimeter of Monofill #2 / Post-1955 Retort Building	10MP06070809SS	9/17/2010	x	-	-	-	-	-	-	-	-	x	x	-	-
		10MP06SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP07SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP08SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP09SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Surface of Monofill #2	10MP030405SS	9/18/2010	x	-	-	-	-	-	-	-	-	x	x	-	-
		10MP03SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP04SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP05SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Tailings	10MP26SS	9/18/2010	x	-	-	-	-	x	x	x	-	x	x	-	-
		10MP28SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP29SS	9/20/2010	x	-	x	x	-	x	-	x	-	x	x	-	-
		10MP30SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10MP67SS	9/18/2010	x	-	-	-	-	x	x	-	-	-	-	-	-
	Tailings Borrow Area	11MP17SS Duplicate 11MP90SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
		10MP27SS	9/18/2010	x	-	-	-	-	x	x	x	-	x	x	-	-
		10OP01SS	9/18/2010	x	-	-	-	-	x	-	x	-	x	x	-	-

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Post-1955 (cont'd)	Tailings borrow area, near former chute	10MP16SS Duplicate 10MP89SS	9/18/2010	x	-	-	-	-	x	x	x	-	x	x	-	-
		10MP17SS Duplicate 10MP82SS	9/20/2010	x	-	x	x	-	x	x	x	-	x	x	-	-
	Upgradient of Settling Pond #1	10MP31SS	9/18/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Upgradient of Settling Ponds #2 and #3	10MP33SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
Red Devil Creek Delta	Red Devil Creek Alluvial Deposits Between Main Processing Area and delta	10RD05SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD20SS	9/17/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Red Devil Creek Delta	10RD01SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD02SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD03SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD04SS	9/16/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
Reservoir Dam	Dam	10RD08SS Duplicate 10RD30SS	9/15/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10RD09SS	9/15/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
Rice Sluice and Delta	Gulley	10RS03SS	9/16/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Rice Delta	10RS01SS	9/19/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10RS02SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Trenched Area West of Residential Structures	10SM30SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Surface Mined Area	Bulldozed Area Away from Known Ore Trend	10SM13SS	8/2/2011	x	-	-	-	-	x	x	x	-	x	-	-	-
		11SM13SS	9/24/2010	-	-	-	-	-	-	-	-	-	-	-	x	-
		10SM14SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM15SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM16SS	9/23/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM17SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM18SS	8/2/2011	x	-	-	-	-	x	x	x	-	x	-	-	-
		11SM18SS	9/23/2010		-	-	-	-	-	-	-	-	-	-	x	-
		10SM19SS	9/23/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
	Central Surface Mined Area	10SM20SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM21SS	9/19/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
	Dolly Ore Zone	10SM04SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM05SS	9/24/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10SM06SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Northern Surface Mined Area	10SM22SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM23SS	9/19/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
	Originally Mined Ore Zone	10SM01SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM02SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM03SS Duplicate 10SM41SS	9/24/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
	Potential Site of On-Site Repository / Bulldozed Area Away from Known Ore Trend	10SM10SS	9/21/2010	x	-	x	x	-	-	-	-	-	-	-	-	-
		10SM11SS	9/21/2010	x	-	x	x	-	-	-	-	-	-	-	-	-
		10SM12SS Duplicate 10SM40SS	9/21/2010	x	-	x	x	x	x	x	x	-	x	-	-	-

Table 2-2 Surface Soil Sample Summary

General Geographic Area	Location Description	Sample ID	Date Sampled	Total TAL Metals	Diesel Range Hydrocarbons	Moisture Content	Grain Size	Atterberg Limits Classification	Total Solids	Mercury SSE	Arsenic Speciation	SVOCs	SPLP	TCLP	Arsenic Bioavailability	PCBs
Surface Mined Area (cont'd)	Rice Ore Zone	10SM07SS	9/24/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		10SM08SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM09SS	9/24/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Trenched Area West of Bulldozed Area	10SM24SS	9/21/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM25SS	9/21/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM26SS	9/21/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
		10SM27SS	9/23/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
	Trenched Area West of Residential Structures	10SM28SS	9/19/2010	x	-	-	-	-	x	x	x	-	x	-	-	-
		11SM28SS	8/2/2011	-	-	-	-	-	-	-	-	-	-	-	x	-
		10SM29SS	9/19/2010	x	-	-	-	-	-	-	-	-	-	-	-	-
	Upslope of Pre-1955 processing facilities and Monofill #1	10MP41SS	9/19/2010	x	-	-	-	-	x	x	x	-	x	-	-	-

Key:

ID	identifier
PCBs	polychlorinated biphenyls
SPLP	synthetic precipitation leaching procedure
SSE	selective sequential extraction
SVOC	semi-volatile organic compound
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
X	A sample was collected for laboratory analysis

2.2 Subsurface Soil

Subsurface soil samples were collected between August 3, 2011, and August 27, 2011. Additional shallow subsurface soil samples were collected in the Surface Mined Area in September 2012. Results of the additional subsurface soil characterization performed in 2012 are provided in Appendix E.

Seventy-two borings were drilled within the study area. Twenty-six of the 72 borings were completed as monitoring wells. The location and identifiers of the borings and monitoring wells are shown in Figures 2-5 and 2-6, and Table 2-3. A total of 237 subsurface soil samples were collected from the borings, with sample collection guided by on-site XRF screening and geological logging, and the sample selection criteria described by the FSP. The data objectives of the soil investigation are summarized below:

- Determine the nature and extent of COPCs in subsurface soil, including tailings/waste rock and underlying native soil.
- Determine the depth of tailings/waste rock up to the total depth of the boring.
- Identify and characterize possible tailings/waste rock at the reservoir dam.
- Identify tailings/waste rock within alluvial deposits of Red Devil Creek, including its delta in the Kuskokwim River up to the total depth of the boring.
- Identify mining-related material (expected to consist of sluiced overburden) within alluvial deposits of the Dolly Sluice delta and possible Rice Sluice delta up to the total depth of the boring.
- Assess lithologic characterization of subsurface soils.
- Identify soil characteristics that may affect the fate and transport of COPCs.
- Provide data for the HHRA to assess potential exposure to COPCs through direct contact.
- Characterize the geotechnical properties of tailings/waste rock and soils that may be subject to excavation.
- Characterize the geotechnical properties of the subsurface for use in the FS.

Subsurface soil sampling was conducted with a CME 850 drill rig mounted to a Nodwell (mobile tracked vehicle) operated by Discovery Drilling, Inc. The drilling equipment/method varied depending on application and the type of subsurface material encountered. In general, direct push equipment/method was utilized for soft, shallow soils near the surface; hollow-stem auger equipment/method was utilized for overburden soils deeper than approximately 15 feet; and air rotary downhole hammer equipment/method was utilized for weathered bedrock and competent bedrock. A 2-foot-long split spoon sampler was used for all sampling occurring during direct push and hollow stem auger drilling. Downhole hammer drilling is incompatible with split spoon sampling, and therefore subsurface materials were not sampled when using this drilling method. All drill pipe, split spoon samplers, and augers were decontaminated prior to commencing drilling at a new soil boring location. Typically, a soil boring began with a direct push drilling method, using the hydraulic hammer to drive the split spoon sampler into the ground. If the boring extended beyond the depth at which the boring could be expected to stay open on its own, augers were then drilled in around the drill stem. During hollow stem auger drilling, the split spoon sampler was advanced below the auger, and then after the sample was collected, an auger-compatible tip was placed on the end of the drill string and advanced back to the position of the auger head. The combined drill string and auger assembly was then rotated downwards using a Kelly drive for 2 feet to the end of the split spoon boring. This method was utilized for most of the borings that extended beyond approximately 15 feet in depth. For locations where a monitoring well was to be placed in the bedrock aquifer, the use of the air rotary downhole hammer was necessary. The downhole hammer attaches directly to the drill string and uses compressed air to drive an impact slide hammer while the drill string is being rotated via the Kelly drive. The impact hammer has a face with buttons of tungsten carbide and channels allowing air to pass out of the hammer and into the annular space, effectively pulverizing the rock face and blasting the rock chips out of the boring. Because the use of the downhole hammer precludes the use of the split spoon sampler, efforts were made to pause the downhole hammer drilling and collect a split spoon sample within the projected screened interval of the monitoring well to be installed for lithological identification and geotechnical sample collection.

Once a split spoon sample was collected, it was opened on site and geologically logged by an E & E geologist. Particular attention was paid to the presence of minerals and lithologies that signified the presence of tailings or waste rock. After geological logging was completed the sample was collected and field screen with an XRF. Split spoon samplers were decontaminated between each use. Samples were processed and prepared for analysis in the field laboratory. Investigation-derived waste (IDW) resulting from drilling or discarded sample intervals was disposed of onsite in accordance with the Work Plan.

Subsurface soil samples were analyzed for total TAL metals, mercury SSE, arsenic speciation, SPLP TAL metals, TCLP RCRA metals, SVOCs, DRO/RRO, grain size, and a combined test of Atterberg limits and moisture content. Table 2-3 provides a summary of the analyses performed. In general, samples were selected for the various analyses to achieve the following:

- Provide broad areal distribution of data.
- Obtain data from multiple depth intervals within tailings/waste rock to assess vertical variability based on depth and/or lithologic characteristics.
- Obtain data for different tailings types (e.g., flotation tailings versus thermally processed tailings, including pre-1955 thermally processed tailings and post-1955 thermally processed tailings).

2012 Additional Subsurface Soil Characterization

In September 2012, 22 shallow subsurface soil samples were collected from the Surface Mined Area (see Figure 2-6). The intent for these samples was to characterize the extent and range of metals concentrations in naturally mineralized soils associated with ore zones at the site. Four sampling areas were selected in the Surface Mined Area. The specific sampling locations were selected based on their comparatively higher potential for possessing demonstrably undisturbed naturally mineralized soils. Stringent lithological and stratigraphic criteria were established to determine whether overburden materials and Kuskokwim Group–derived soils may be considered undisturbed. The results of the September 2012 effort did not meet the criteria specified in the work plan addendum, and therefore, are not considered representative of undisturbed mineralized soil. However, the samples provide additional site characterization data for the Surface Mined Area. Table 2-3 includes the sample collection information for these samples.

Deviations from the Field Sampling Plan

Several deviations from the FSP were made based upon field conditions and evolving data needs, discussed below.

In order to gather information on vertical groundwater gradient in the vicinity of Settling Pond #1, it was decided to install an additional soil boring MP91 and monitoring well MW17 at a location paired with planned soil boring MP30 and monitoring well MW16.

Two shallow and deep monitoring well pairs were originally planned for locations upslope of the Pre-1955 Main Processing Area at adjacent soil boring locations MP41/MP89 and SM31/SM32. However, no shallow groundwater was encountered during drilling at either of the paired locations. Therefore, only the deep soil boring (MP41 and SM31) was installed at each location.

Soil borings RD08 and RD09 were planned for installation on the dam of the reservoir. However, it was determined based on surface soil sample results, lithological observations, and aerial photographic review that the dam was constructed of locally-derived native soil rather than tailings/waste rock. Therefore, these soil borings were not installed.

In general, soil boring locations were dependent on field conditions that affected drill rig access. Actual soil boring locations are illustrated in Figures 2-5 and 2-6.

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Background Areas	Upgradient Area	MP01	2–4	11MP01SB04	3 (11MP01SB04, 11MP01SB12 (DUPLICATE: 11MP01SB18 @ 1203) , 11MP01SB16)	1 (All ND)	1 (11MP01SB16)	1 (11MP01SB16)	-	-	-	-	1 (11MP01SB10)	-
			8–10	11MP01SB10										
			10–12	11MP01SB12										
			14–16	11MP01SB16										
	Upland Area West of Surface Mined Area	UP11	2–4	11UP11SB04	3 (11UP11SB04) and 11UP11SB06, 11UP11SB08	1 (11UP11SB04)	1 (11UP11SB04)	1 (11UP11SB04)	-	-	-	1 (11UP11SB04)	-	-
			4–6	11UP11SB06										
			6–8	11UP11SB08										
Post-1955 Main Processing Area	Road below Monofill #2 / Post-1955 Retort Building	MP11	2–4	11MP11SB04	3 (11MP11SB04, 11MP11SB06, 11MP11SB08)	2 (11MP14SB04, 11MP12SB06)	1 (11MP11SB04)	2 (11MP14SB04, 11MP11SB04)	2 (11MP14SB04, 11MP11SB04)	-	-	-	-	-
			4–6	11MP11SB06										
			6–8	11MP11SB08										
		MP12	4–6	11MP12SB06	3 (11MP12SB06, 11MP12SB12, 11MP12SB16)							1 (11MP12SB08) and Moisture content	2 (11MP12SB14, 11MP12SB16)	-
			6–8	11MP12SB08										
			10–12	11MP12SB12										
			12–14	11MP12SB14										
			14–16	11MP12SB16										
		MP13	2–4	11MP13SB04	3 (11MP13SB04, 11MP13SB06)							-	-	-
			4–6	11MP13SB06										
		MP14	2–4	11MP14SB04	3 (11MP14SB04, 11MP14SB58, 11MP14SB14)							2 (11MP14SB08, 11MP14SB16) both with Moisture Content	2 (in bedrock)	-
			6–8	11MP14SB08										
			12–14	11MP14SB14										
			14–16	11MP14SB16										
			56–58	11MP14SB58										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Post-1955 Main Processing Area (cont'd)	Road below Monofill #2 / Post-1955 Retort Building (cont'd)	MP15	2–4	11MP15SB04	3 (11MP15SB04, 11MP15SB06, 11MP15SB08)	2 (11MP18SB04, 11MP17SB14)	1 (11MP18SB20)	2 (11MP18SB04, 11MP18SB20)	2 (11MP18SB04, 11MP18SB20)	-	-	-	-	-
			4–6	11MP15SB06										
			6–8	11MP15SB08										
		MP16	2–4	11MP16SB04	3 (11MP16SB04, 11MP16SB08, 11MP16SB10)							1 (11MP16SB04)	-	-
			6–8	11MP16SB08										
			8–10	11MP16SB10										
		MP17	2–4	11MP17SB04	3 (11MP17SB14, 11MP17SB04, 11MP17SB30 (DUPLICATE: 11MP17SB34 @ 1642))					11MP17SB30 Sent due to diesel odor	11MP17SB30 Sent due to diesel odor	-	2 (11MP17SB28) Dry well. Only sending one from screened interval.	-
			12–14	11MP17SB14										
			28–30	11MP17SB30										
		MP18	2–4	11MP18SB04	3 (11MP18SB20, 11MP18SB04, 11MP18SB10)					-	-	-	-	-
			8–10	11MP18SB10										
			18–20	11MP18SB20										
	North of Monofill #2 / Post-1955 Retort Building / Drum Storage Area	MP10	2–4	11MP10SB04	3 (11MP10SB04, 11MP10SB06)	2 (11MP19SB06) Detection on 1 only	1 (11MP19SB04)	2 (11MP19SB04, 11MP10SB06)	2 (11MP19SB04, 11MP10SB06)	1 (No diesel odor noted or water table encountered)	1 (No diesel odor noted or water table encountered)	-	-	-
			4–6	11MP10SB06										
		MP19	2–4	11MP19SB04	3 (11MP19SB04, 11MP19SB06)					1 (No diesel odor noted or water table encountered)	1 (No diesel odor noted or water table encountered)	1(11MP19SB06)	-	
			4–6	11MP19SB06										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Post-1955 Main Processing Area (cont'd)	Tailing Burrow Area	MP27	2-4	11MP27SB04	3 (11MP27SB04, 11MP27SB06 (DUPLICATE: 11MP27SB08 @ 1750)	3 (11MP30SB06, 11MP28SB06, 11MP28SB08)	2 (11MP28SB06, 11MP29SB16)	3 (11MP30SB06, 11MP28SB06, 11MP29SB10)	2 (11MP30SB06, 11MP28SB06)	-	-	-	-	-
			4-6	11MP27SB06								-	-	-
	Tailings / Waste Rock	MP26	2–4	11MP26SB04	3 (11MP26SB10, 11MP26SB04, 11MP26SB16)							-	-	-
			8–10	11MP26SB10										
			14–16	11MP26SB16										
		MP28	4–6	11MP28SB06	3 (11MP28SB06, 11MP28SB08, 11MP28SB10 (DUPLICATE: 11MP28SB12 @ 1022)							-	-	-
			6–8	11MP28SB08										
			8–10	11MP28SB10										
		MP29	4–6	11MP29SB06	3 (11MP29SB16, 11MP29SB06 (DUPLICATE: 11MP29SB28 @ 1448), 11MP29SB10)							1 (11MP29SB08) with Moisture Content	2 (11MP29SB18, 11MP29SB22)	-
			6–8	11MP29SB08										
			8–10	11MP29SB10										
			14–16	11MP29SB16										
			16–18	11MP29SB18										
			20–22	11MP29SB22										
		MP91	N/A	N/A (not sampled)	-							-	-	-
		MP30	4–6	11MP30SB06	3 (11MP30SB06, 11MP30SB16, 11MP30SB12)							1 (11MP30SB08) and moisture content	2 (11MP30SB14, 11MP30SB18)	-
			6–8	11MP30SB08										
			10–12	11MP30SB12										
			12–14	11MP30SB14										
			14–16	11MP30SB16										
			16–18	11MP30SB18										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Post-1955 Main Processing Area (cont'd)	Gravel Pad	MP23	8–10	11MP23SB10	3 (11MP23SB20, 11MP23SB10, 11MP23SB14)	2 (11MP23SB20, 11MP24SB12)	1 (11MP23SB20)	2 (11MP23SB20) High As and Hg in same sample	2 (11MP23SB20) High As and Hg in same sample DUPLICATE: 11MP23SB24 @ 1748)	1 (No diesel odor noted or water table encountered)	2 (No diesel odor noted or water table encountered)	-	-	-
			12–14	11MP23SB14										
			18–20	11MP23SB20										
		MP24	2–4	11MP24SB04	3 (11MP24SB12, 11MP24SB04, 11MP24SB18)					1 (No diesel odor noted or water table encountered)	1 (No diesel odor noted or water table encountered)	-	-	-
			10–12	11MP24SB12										
			16–18	11MP24SB18										
		MP25	14-18	11MP25SB14	3 (11MP25SB26, 11MP25SB20, 11MP25SB14 (DUPLICATE: 11MP25SB38 @1200)					2 (11MP28SB06, 11MP29SB16)	3 (11MP30SB06, 11MP28SB06, 11MP29SB10)	2 (11MP30SB06, 11MP28SB06)	-	-
			18–20	11MP25SB20										
			24–26	11MP25SB26										
			28–30	11MP25SB30										
			32–34	11MP25SB34										
	Monofil #3 Area / Tailings / Waste Rock	MP22	2–4	11MP22SB04	3 (11MP22SB04, 11MP22SB08, 11MP22SB12)	-	-	-	-	-	-	-	-	-
			6–8	11MP22SB08										
			10–12	11MP22SB12										
	Power Plant / Former Drum Storage Area	MP20	2–4	11MP20SB04	3 (11MP20SB04, 11MP20SB12 (DUPLICATE 11MP20SB16 @1747), 11MP20SB08)	-	-	-	-	1 (No diesel odor noted or water table encountered)	1 (No diesel odor noted or water table encountered)	-	2 (no samples below water table)	-
			10–12	11MP20SB12										
		MP21	2–4	11MP21SB04	3 (11MP21SB04, MP21SB14, 11MP21SB08)	-	-	-	-	1 (No diesel odor noted or water table encountered)	1 (No diesel odor noted or water table encountered)	-	-	-
			6–8	11MP21SB08										
			12–14	11MP21SB14										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Post–1955 Main Processing Area (cont'd)	Upgradient of Settling Pond #1	MP31	2–4	11MP31SB04	3 (11MP31SB04)	-	-	-	-	-	-	-	2 (no samples below water table)	-
	Flotation Tailings, Settling Pond #1	MP32	2–4	11MP32SB04	3 (11MP32SB04, 11MP32SB06, 11MP32SB08)	1 (11MP32SB08)	1 (11MP32SB06)	1 (11MP32SB06)	1 (11MP32SB06)	2 (11MP32SB04)	1 (11MP32SB04)	1 (11MP32SB04)	-	-
			4–6	11MP32SB06										
			6–8	11MP32SB08										
	Upgradient of Settling Ponds #2 and #3	MP33	2–4	11MP33SB04	3 (11MP33SB04) (DUPLICATE: 11MP33SB06 @ 1535)	-	-	-	-	-	-	-	2 (no samples below water table)	-
	Flotation Tailings, Settling Pond #2	MP34	2–4	11MP34SB04	3 (11MP34SB04,11MP34SB06) and 11MP34SB08 (DUPLICATE: 11MP34SB22 @ 1715) (mid-range)	1 (11MP34SB04)	1 (11MP34SB06)	1 (11MP34SB06)	1 (11MP34SB06)	2 (11MP34SB04, 11MP34SB12)	1 (11MP34SB14)	1 (11MP34SB04)	-	-
			4–6	11MP34SB06										
			6–8	11MP34SB08										
			10–12	11MP34SB12										
			12–14	11MP34SB14										
	Berm of Settling Pond #2	MP35	4–6	11MP35SB06	3 (11MP35SB12,11MP35SB16,11MP35SB06)	-	-	-	-	-	-	-	-	-
			10–12	11MP35SB12										
			14–16	11MP35SB16										
	Flotation Tailings, Settling Pond #3	MP36	2–4	11MP36SB04	3 (11MP36SB04, 11MP36SB08 and 11MP36SB16 (low-range)	1 (11MP36SB04)	1 (11MP36SB04)	1 (11MP36SB04)	1 (11MP36SB04)	2 (11MP36SB08 (DUPLICATE: 11MP36SB18 @ 1505) , No Samples Above Water Table)	1(11MP36SB08 (DUPLICATE: 11MP36SB18 @ 1505))	1 (No Samples Above water table)	-	-
			6–8	11MP36SB08										
			14–16	11MP36SB16										
	Berm of Settling Pond #3	MP37	4–6	11MP37SB06	3 (11MP37SB06 (DUPLICATE: 11MP37SB24 @ 1230),11MP37SB08,11MP37SB16)	-	-	-	-	1 (11MP37SB16) Diesel Odor	1 (11MP37SB16) Diesel Odor	-	-	-
			6–8	11MP37SB08										
			14–16	11MP37SB16										
	Between Settling Pond #1 and Red Devil Creek	MP38	8–10	11MP38SB10	3 (11MP38SB10) and 11MP38SB14, 11MP38SB16 (mid and low-range)	1 (11MP38SB10)	1 (11MP38SB10)	1 (11MP38SB10)	-	-	-	-	2 (11MP38SB12, 11MP38SB14)	-
			10–12	11MP38SB12										
			12–14	11MP38SB14										
			14–16	11MP38SB16										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Post–1955 Main Processing Area (cont'd)	Between Settling Pond #2 and Red Devil Creek	MP39	4–6	11MP39SB06	3 (11MP39SB06, 11MP39SB08) and 11MP39SB12 (low-range)	1 (11MP39SB08)	1 (11MP39SB06)	1 (11MP39SB06) (DUPLICATE 11MP39SB16 @1011)	-	-	-	-	2 (11MP39SB10, 11MP39SB14)	-
			6–8	11MP39SB08										
			8–10	11MP39SB10										
			10–12	11MP39SB12										
			12–14	11MP39SB14										
	Between Settling Pond #3 and Red Devil Creek	MP40	4–6	11MP40SB06	3 (11MP40SB08, 11MP40SB06, 11MP40SB10)	1 (11MP40SB08)	1 (11MP40SB08)	1 (11MP40SB08)	-	-	-	-	2 (11MP40SB10, 11MP40SB06)	-
			6–8	11MP40SB08										
			8–10	11MP40SB10										
Pre–1955 Main Processing Area	Near spring in Red Devil Creek / Downgradient of former mine openings / Tailings/Waste Rock	11MP60 (Shallow) (Paired with 11MP88)	2–4	11MP60SB04	3 (11MP60SB14, 11MP60SB04, 11MP60SB24)	1 (11MP60SB14)	1 (11MP60SB14)	1 (11MP60SB14)	1 (11MP60SB14)	-	-	-	2 (11MP60SB24)	-
			12–14	11MP60SB14										
			22–24	11MP60SB24										
		11MP88 (Deep) (Paired with 11MP60)	N/A	N/A (not sampled)	-	-	-	-	-	-	-	-	-	-
	Area between Pre-1955 Retort and Red Devil Creek	MP63	2–4	11MP63SB04	3 (11MP63SB04, 11MP63SB06)	-	-	-	-	-	-	-	-	-
			4–6	11MP63SB06										
	Mine Access Road / Downgradient of Pre-1955 Processing Area	MP66	4–6	11MP66SB06	3 (11MP66SB06, 11MP66SB18, 11MP66SB10 (DUPLICATE: 11MP66SB24@1050))	-	-	-	-	0 (11MP66SB16) DUPLICATE 11MP66SB26 @ 1059	0 (11MP66SB16) DUPLICATE 11MP66SB26 @ 1059	-	2 (11MP66SB20, 11MP66SB22)	-
			8–10	11MP66SB10										
			14–16	11MP66SB16										
			16–18	11MP66SB18										
			18–20	11MP66SB20										
			20–22	11MP66SB22										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Pre–1955 Main Processing Area (cont'd)	Area near Monofill #1 / Former Shop Pad / Tailings/Waste Rock	MP45	2–4	11MP45SB04	3 (11MP45SB04, 11MP45SB10, 11MP45SB12)	-	-	-	-	1 (11MP45SB04)	1 (11MP45SB04)	-	-	-
			8–10	11MP45SB10										
			10–12	11MP45SB12										
		MP46	2–4	11MP46SB04	3 (11MP46SB04, 11MP46SB12) No major variability	-	-	-	-	1 (Petroleum odor not noted)	1 (Petroleum odor not noted)	-	-	-
			10–12	11MP46SB12										
		MP47	2–4	11MP47SB04	3 (11MP47SB04, 11MP47SB22, 11MP47SB26)	-	-	-	-	1 (Petroleum odor not noted)	1 (Petroleum odor not noted)	-	-	-
			20–22	11MP47SB22										
			24–26	11MP47SB26										
	Area near Monofill #1 / Shop Pad A / Tailings/Waste Rock	MP48	2–4	11MP48SB04	3 (11MP48SB12, 11MP48SB08, 11MP48SB04)	-	-	1 (11MP48SB12 (DUPLICATE: 11MP48SB16 @1655))	1 (11MP48SB08 (DUPLICATE: 11MP48SB18 @1700))	-	-	-	-	-
			6–8	11MP48SB08										
			10–12	11MP48SB12										
		MP49	4–6	11MP49SB06	3 (11MP49SB06, 11MP49SB14(DUPLICATE: 11MP49SB16@950), 11MP49SB10)					-	-	-	-	-
			8–10	11MP49SB10										
			12–14	11MP49SB14										
	Area near Monofill #1 / Shop Pad B / Tailings/Waste Rock	MP89	4–6	11MP89SB06	3 (11MP89SB30, 11MP89SB12, 11MP89SB06)	-	-	-	-	-	-	-	2 (11MP89SB34, 11MP89SB37)	-
			10–12	11MP89SB12										
			28–30	11MP89SB30										
			32–34	11MP89SB34										
			35–37	11MP89SB37										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Pre–1955 Main Processing Area (cont'd)	Area of Pre-1955 Retort Building	MP55	2–4	11MP55SB04	3 (11MP55SB04, 11MP55SB06)	3 (11MP56SB06, 11MP56SB10, 11MP58SB08)	2 (11MP56SB06, 11MP58SB04 (DUPLICATE: 11MP58SB16@1030))	3 (11MP58SB08, 11MP56SB06)	3 (11MP58SB08, 11MP56SB06)	11MP55SB06	11MP55SB07	-	-	-
			4–6	11MP55SB06										
		MP56	2–4	11MP56SB04	3 (11MP56SB06, 11MP56SB10, 11MP56SB04)					-	-	-	-	-
			4–6	11MP56SB06										
			8–10	11MP56SB10										
		MP57	2–4	11MP57SB04	3 (11MP57SB04 (DUPLICATE: 11MP57SB12@1450), 11MP57SB08, 11MP57SB06)					11MP57SB06	11MP57SB06	-	-	-
			4–6	11MP57SB06										
			6–8	11MP57SB08										
		MP58	2–4	11MP58SB04	3 (11MP58SB04, 11MP58SB08, 11MP58SB12 (DUPLICATE: 11MP58SB16@1025))					-	-	1 (11MP58SB10)	-	-
			6–8	11MP58SB08										
			8–10	11MP58SB10										
			10–12	11MP58SB12										
	Burnt Ore near Pre-1955 Retort	MP59	2–4	11MP59SB04	3 (11MP59SB12, 11MP59SB04, 11MP59SB14 (DUPLICATE: 11MP59SB18@1920)	1 (11MP59SB12)	1 (11MP59SB04 (DUPLICATE: 11MP59SB18@1920))	1 (11MP59SB12)	1 (11MP59SB12)	-	-	1 (11MP59SB16)	-	-
			10–12	11MP59SB12										
			12–14	11MP59SB14										
			14–16	11MP59SB16										
	Area between Pre-1955 Retort and Red Devil Creek	MP61	2–4	11MP61SB04	3 (11MP61SB04 (DUPLICATE: 11MP61SB08@1525), 11MP61SB06)	-	-	-	-	-	-	-	2 (Well not indicated on figure or groundwater table)	-
			4–6	11MP61SB06										
	Area between Pre-1955 Retort and Red Devil Creek / Pre-1955 Rotary Furnace Burnt Ore Disposal Pile	MP62	2–4	11MP62SB04	3 (11MP62SB04, 11MP62SB24, 11MP62SB14)	-	-	-	-	-	-	-	2 (11MP62SB20, 11MP62SB24)	-
			12–14	11MP62SB14										
			18–20	11MP62SB20										
			22–24	11MP62SB24										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Pre-1955 Main Processing Area (cont'd)	Area of Pre-1955 Furnace Building / Tailings/Waste Rock	MP50	2–4	11MP50SB04	3 (11MP50SB04)	3 (11MP51SB04, 11MP52SB10 (DUPLICATE: 11MP52SB28@1445), 11MP52SB06)	2 (11MP52SB06, 11MP51SB06)	3 (11MP51SB06, 11MP52SB10, 11MP52SB06)	3 (11MP51SB06, 11MP52SB10, 11MP52SB06)	-	-	-	-	-
		MP51	2–4	11MP51SB04	3 (11MP51SB04, 11MP51SB06, 11MP51SB14)					11MP51SB08	11MP51SB08	-	-	-
			4–6	11MP51SB06										
			6–8	11MP51SB08										
			12–14	11MP51SB14										
		MP52	4–6	11MP52SB06	3 (11MP52SB06, 11MP52SB10, 11MP52SB26)					11MP52SB26	11MP52SB26	1 (11MP52SB08)	2 (Bedrock, No samples from screened interval)	-
			6–8	11MP52SB08										
			8–10	11MP52SB10										
			24–26	11MP52SB26										
		MP53	2–4	11MP53SB04	3 (11MP53SB04, 11MP53SB08)					-	-	-	-	-
			6–8	11MP53SB08										
		MP54	2–4	11MP54SB04	3 (11MP54SB04, 11MP54SB06)					0 (11MP54SB04)	0 (11MP54SB04)	-	-	-
			4–6	11MP54SB06										
Dolly Sluice and Delta	Dolly Sluice Delta	DS01	2–4	11DS01SB04	3 (11DS01SB06) and 11DS01SB10 (DUPLICATE: 11DS01SB18 @ 1630), 11DS01SB16 (mid and low-range)	1 (11DS01SB06)	1 (11DS01SB06)	1 (11DS01SB06 (DUPLICATE: 11DS01SB18 @ 1630))	-	-	-	1 (11DS01SB04)	-	-
			4–6	11DS01SB06										
			8–10	11DS01SB10										
			14–16	11DS01SB16										
		DS02	2–4	11DS02SB04	3 (11DS02SB04, 11DS02SB10 (Duplicate 11DS02SB16 @ 1335), 11DS02SB14)					-	-	-	-	-
			8–10	11DS02SB10										
			12–14	11DS02SB14										
Rice Sluice and Delta	Rice Sluice Delta	RS01	2–4	11RS01SB04	3 (11RS01SB12) and 11RS01SB08, 11RS01SB04	1 (11RS01SB12)	1 (11RS02SB04)	1 (11RS01SB12)	-	-	-	1 (11RS01SB06)	-	-
			4–6	11RS01SB06										
			6–8	11RS01SB08										
			10–12	11RS01SB12										
		RS02	2–4	11RS02SB04	3 (11RS02SB04) and 11RS02SB08, 11RS02SB14					-	-	-	-	-
			6–8	11RS02SB08										
			12–14	11RS02SB14										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Surface Mined Area	2012 Background Soil Study	SM51	5-6	12SM51SB06	1	-	-	-	-	-	-	-	-	1
		SM52	0-2	12SM52SB02	1	-	-	-	-	-	-	-	-	1
			8-10	12SM52SB10	1	-	-	-	-	-	-	-	-	1
			10-11	12SM52SB11	1	-	-	-	-	-	-	-	-	1
		SM53	8-10	12SM53SB10	1	-	-	-	-	-	-	-	-	1
		SM54	10-10.5	12SM54SB11	1	-	-	-	-	-	-	-	-	1
		SM55	3-4	12SM55SB04	1	-	-	-	-	-	-	-	-	1
			6-7	12SM55SB07	1	-	-	-	-	-	-	-	-	1
		SM56	4-4.5	12SM56SB05	1	-	-	-	-	-	-	-	-	1
		SM57	4-5	12SM57SB05	1	-	-	-	-	-	-	-	-	1
		SM58	0-2	12SM58SB02	1	-	-	-	-	-	-	-	-	1
		SM59	0-1	12SM59SB01	1	-	-	-	-	-	-	-	-	1
			4-5	12SM59SB05	1	-	-	-	-	-	-	-	-	1
		SM60	5-6	12SM60SB06	1	-	-	-	-	-	-	-	-	1
			6-7	12SM60SB07	1	-	-	-	-	-	-	-	-	1
		SM61	0-1	12SM61SB01	1	-	-	-	-	-	-	-	-	1
			4-5	12SM61SB05	1	-	-	-	-	-	-	-	-	1
		SM62	1.5-2	12SM62SB01	1	-	-	-	-	-	-	-	-	1
			5.5-6	12SM62SB06	1	-	-	-	-	-	-	-	-	1
			7.5-8	12SM62SB08	1	-	-	-	-	-	-	-	-	1
		SM63	0-1	12SM63SB01	1	-	-	-	-	-	-	-	-	1
			5-6	12SM63SB06	1	-	-	-	-	-	-	-	-	1
		SM64	N/A	N/A (Not Sampled)	-	-	-	-	-	-	-	-	-	-
		SM65	1-2	12SM65SB12	1	-	-	-	-	-	-	-	-	1
		SM66	N/A	N/A (Not Sampled)	-	-	-	-	-	-	-	-	-	-

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Surface Mined Area (cont'd)	Potential Site of On-Site Repository / Bulldozed Area Away from Known Ore Trend	SM10	2-4	11SM10SB04	3 (11SM10SB10) and 11SM10SB04, 11SM10SB12	1 (11SM10SB10)	1 (11SM10SB10)	1 (11SM10SB10)	-	-	-	3 (11SM10SB06, 11SM10SB08)	-	-
			4-6	11SM10SB06										
			6-8	11SM10SB08										
			8-10	11SM10SB10										
			10-12	11SM10SB12										
		SM11	2-4	11SM11SB04	3 (11SM11SB04, 11SM11SB14 (Duplicate 11SM11SB20 @ 1325), 11SM11SB16)					-	-	3 (11SM11SB10, 11SM11SB08, 11SM11SB12)	-	-
			6-8	11SM11SB08										
			8-10	11SM11SB10										
			10-12	11SM11SB12										
			12-14	11SM11SB14										
			14-16	11SM11SB16										
	Upslope of Pre-1955 processing facilities and Monofill #1	SM31	4-6	11SM31SB06	3 (11SM31SB06) Only 1 sample	1 (11SM31SB06)	1 (11SM31SB06)	1 (11SM31SB06)	-	-	-	-	2 (No Water)	-
		11SM32 (Shallow) (Paired with 11SM31)	N/A	N/A (Not Sampled)	-	-	-	-	-	-	-	-	-	-
	Upslope of Pre-1955 processing facilities and Monofill #1	MP41	2-4	11MP41SB04 (11SM41SB04)	3 (11MP41SB06) and 11MP41SB04 (Only 2 samples in borehole)	1 (11MP41SB06)	1 (11MP41SB06)	1 (11MP41SB06)	-	-	-	-	2 (No Water)	-
			4-6	11MP41SB06 (11SM41SB06)										
		11MP90 (Deep) (paired with 11MP41)	N/A	N/A (not sampled)	-	-	-	-	-	-	-	-	-	-

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Red Devil Creek	Dam	11RD08	N/A	N/A (not sampled)	-	-	-	-	-	-	-	-	-	-
		11RD09	N/A	N/A (not sampled)	-					-	-	-	-	-
	Red Devil Creek Alluvial Deposits and/or Soil	RD05	4-6	11RD05SB06	3 (11RD05SB08, 11RD05SB12, 11RD05SB16)	3 (11RD20SB20, 11RD20SB18, 11RD07SB12)	2 (11RD20SB20, 11RD05SB16 (DUPLICATE: 11RD05SB18 @ 1900)	2 (11RD20SB20, Highest As and Hg in same sample)	-	-	-	3 (11RD05SB06, 11RD05SB08, 11RD05SB14)	2 (no samples below water table)	-
			6-8	11RD05SB08										
			10-12	11RD05SB12										
			12-14	11RD05SB14										
			16-18	11RD05SB16										
		RD06	2-4	11RD06SB04	3 (11RD06SB04, 11RD06SB08, 11RD06SB12)					-	-	-	-	-
			6-8	11RD06SB08										
			10-12	11RD06SB12										
		RD07	2-4	11RD07SB04	3 (11RD07SB12) and 11RD07SB04, 11RD07SB10)					-	-	3 (11RD07SB04, 11RD07SB08, 11RD07SB12)	-	-
			6-8	11RD07SB08										
			8-10	11RD07SB10										
			10-12	11RD07SB12										
		RD20	4-6	11RD20SB06	3 (11RD20SB18, 11RD20SB20) and 11RD20SB06					-	-		2 (11RD20SB12) Not enough volume from other samples	-
			10-12	11RD20SB12										
			16-18	11RD20SB18										
			18-20	11RD20SB20										

Table 2-3 Subsurface Soil Collection Summary

General Geographic Area	Location Description	Soil Boring Location	Depth (feet)	Sample ID	Total TAL Metals	Mercury SSE	Arsenic Speciation	SPLP TAL Metals	TCLP RCRA Metals	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Total Organic Carbon
Red Devil Creek Delta Area	Red Devil Creek Delta	RD01	2-4	11RD01SB04	3 (11RD01SB04, 11RD01SB10, 11RD01SB14)	3 (11RD03SB06, 11RD03SB08, 11RS03SB10)	2 (11RD03SB06, 11RD02SB04,)	2 (11RD03SB06, Highest As and Hg in same sample)	-	-	-	-	-	-
			8-10	11RD01SB10										
			12-14	11RD01SB14										
		RD02	2-4	11RD02SB04	3 (11RD02SB04) and 11RD02SB06, 11RD02SB10)					-	-	-	-	-
			4-6	11RD02SB06										
			8-10	11RD02SB10										
		RD03	4-6	11RD03SB06	3 (11RD03SB06, 11RD03SB08, 11RS03SB10)					-	-	3 (11RD03SB12)	-	-
			6-8	11RD03SB08										
			8-10	11RD03SB10										
			10-12	11RD03SB12										
		RD04	2-4	11RD04SB04	3 (11RD04SB04, 11RD04SB08 (Duplicate: 11RD04SB16 @1545), 11RD04SB12)					-	-	-	-	-
			6-8	11RD04SB08										
			10-12	11RD04SB12										
Red Devil Creek	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	RD13	2-4	11RD13SB04	3 (11RD13SB06, 11RD13SB04, 11RD13SB14)	3 (All ND)	3 (11RD13SB06, 11RD13SB04, 11RD13SB14 (DUPLICATE 11RD13SB18 @ 1545)	3 (11RD13SB10, 11RD13SB06) Hg Non-Detect	-	-	-	-	2 (11RD13SB08, 11RD13SB12)	-
			4-6	11RD13SB06										
			6-8	11RD13SB08										
			8-10	11RD13SB10										
			10-12	11RD13SB12										
			12-14	11RD13SB14										
Totals			**-**	**237**	**217**	**36**	**33**	**35**	**20**	**14**	**13**	**27**	**26**	**22**
Additional Duplicates					**23**	**1**	**4**	**3**	**2**	**2**	**2**	**0**	**0**	**3**

Key:

DRO	diesel range organics
RCRA	Resource Conservation Recovery Act
RRO	residual range organics
SPLP	synthetic precipitation leaching procedure
SSE	selective sequential extraction
SVOCs	semivolatile organic compounds
TAL	Target Analyte List
TCLP	toxicity characteristic leaching procedure

2.3 Groundwater

In total, 31 monitoring wells have been installed at the RDM, 26 of which were installed as part of the RI in 2011. The five pre-RI monitoring wells were installed in 2000. All monitoring wells are shown in Figure 2-7. Groundwater samples were collected in 2010 and 2011. Groundwater samples also were collected as part of the Baseline Monitoring program in May and September 2012. Samples were also collected from selected wells for PCBs in 2012.

The 2011 monitoring wells were constructed with 2-inch inside diameter PVC inner casing. The screened interval in all wells was 10 feet long and consists of an inner pipe surrounded by an outer pipe. The annular space is filled with a sand pack that has been sized to match the width of the 0.010-inch slots machined into the inner and outer pipes. This prefabricated screen is generically referred to as a pre-pack and was used to ensure a consistent sand pack thickness throughout the entire screened interval. The inner diameter of the screen section is consistent with the pipe sections, and the outer diameter is 4 inches. A 1-foot-deep sump was installed at the bottom of every pre-pack screen. Once the well casing and screen were set in place, the boring was allowed to slough around the sump and pre-pack. Colorado Silica Sand was installed in the annular space above to a depth of approximately 2 feet above the top of the screen, and the upper section of the annulus was sealed using hydrated bentonite chips. A steel above-ground monument with lockable lid was installed over the inner casing and held in place by a concrete surface seal. The casing of most of the monitoring wells extends approximately 2 feet above the ground surface. Following installation, wells were developed as described in the Work Plan.

The five pre-RI monitoring wells were sampled in 2010 on September 20 and September 21.

Of the 31 monitoring wells, 26 were successfully sampled in 2011. Groundwater samples were collected between August 24, 2011, and September 1, 2011. The five wells that were not sampled were either dry or were not productive enough to allow for low-flow sampling requirements at the time of sampling. These wells included MW07, MW09, MW11, MW 13, and MW30. Monitoring wells MW09 and MW13 were subsequently sampled in 2012 as part of the baseline monitoring events.

The 2012 baseline monitoring activities and results are presented in Appendix A. Results of groundwater sampling for PCBs are presented in Chapter 4.

Results from the groundwater sampling are used to:

- Characterize the nature and extent of COPCs in groundwater.
- Determine if the monofills are a source of groundwater contamination.
- Characterize the cation-anion signature of the groundwater to assess potential sources and migration patterns of groundwater and COPCs.

- Characterize groundwater depth, flow direction, gradient, and migration patterns of COPCs.
- Assess groundwater–surface water interactions, including the potential for COPCs in groundwater to enter surface water.
- Provide data for the HHRA to assess potential exposure to COPCs through ingestion of drinking water.


Groundwater sample collection.

Samples from wells with water levels less than 25 feet deep were collected with a peristaltic pump outfitted with dedicated disposable Teflon tubing. For deeper wells, samples were collected using a decontaminated positive pressure Fultz pump and dedicated disposable Teflon tubing. A low flow purging and sampling method was used. Water quality parameters were monitored using a flow-through cell. Following stabilization of water quality parameters (see Table 2-4), the groundwater sample was collected. If, after an hour of purging, the target stabilization criteria were not met, parameter measurements were documented and a sample was collected. Samples were placed into sample containers that were pre-preserved as appropriate by the subcontracted laboratory.

Table 2-4 Water Quality Parameters Stabilization Criteria

Parameter	Stabilization Criteria
pH	+/- 0.1
Specific Conductance	+/- 3%
Oxidation Reduction Potential	+/- 10 mV
Turbidity	+/- 10% (when turbidity is > 10 NTUs)
Dissolved Oxygen	+/- 0.3 mg/L
Temperature	+/- 1° C

Key:

°C	degrees Celsius
mg/L	milligrams per liter
mV	millivolts
NTU	nephelometric turbidity unit

Teflon tubing was discarded after a single use, and the positive pressure pump was decontaminated externally and internally between uses following Chapter 7 of the Field Sampling Plan.

Samples were variously analyzed for total TAL metals, dissolved TAL metals, total low level mercury, dissolved low level mercury, methylmercury, arsenic speciation, inorganic ions, silicon, total dissolved solids (TDS), total suspended solids (TSS), nitrate and nitrite, carbonate and bicarbonate, SVOCs with tentatively identified compounds (TICs), DRO and RRO, gasoline range organics (GRO) and benzene, toluene, ethylbenzene, xylenes (BTEX), and PCBs. Table 2-5 identifies the analyses conducted for each groundwater sample.

Table 2-5 Ground Water Sample Collection Summary

General Geographic Area	Location Description	Sample Location ID (Existing Monitoring Well or RI/FS Soil Boring)	Monitoring Well Designation	Sample Date	Total TAL Metals	Dissolved TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Methylmercury	Arsenic Speciation	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate / Nitrite	Carbonate, Bicarbonate	SVOCs with TICs	DRO / RRO	GRO / BTEX	PCBs
Background Areas	Upgradient Area	11MP01	MW08	8/30/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
	Upland Area West of Surface Mined Area	11UP11	MW31	8/29/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
Post-1955 Main Processing Area	Downgradient from Monofill #2 / Post-1955 Retort Building	11MP12	MW11	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		11MP14	MW10	8/29/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		11MP17	MW09	Recharge too slow to collect sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tailings / Waste Rock	11MP29	MW15	8/30/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		11MP30	MW16	8/30/2011	X	X	X	X	X		X	X	X	X	X	-	-	-	-
		11MP91	MW17	8/30/2011	X	X	X	X	X	-	X	X	X	X	X	-	-	-	-
	Gravel Pad	11MP25 (MS/MSD)	MW14	8/31/2011	X	X	X	X	X	-	X	X	X	X	X	-	X	X	-
		11MP100 (Duplicate of 11MP25)	-	8/31/2011	X	X	X	X	X	-	X	X	X	X	X	-	X	X	-
	Gravel Pad / Downgradient from Monofill #3	MW-01 (Existing well previously referred to as MW-1)	MW01	9/20/2010 and 8/24/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	Downgradient from Power Plant / Former Drum Storage Area	11MP20	MW13	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		MW-07 (Existing well previously referred to as MW-7)	MW07	9/21/10: partial sample collected prior to well running dry. In 2011, recharge rate too low to collect sample	`	X	-	X	-	-	X	-	-	-	X	-	-	-	-

Table 2-5 Ground Water Sample Collection Summary

General Geographic Area	Location Description	Sample Location ID (Existing Monitoring Well or RI/FS Soil Boring)	Monitoring Well Designation	Sample Date	Total TAL Metals	Dissolved TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Methylmercury	Arsenic Speciation	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate / Nitrite	Carbonate, Bicarbonate	SVOCs with TICs	DRO / RRO	GRO / BTEX	PCBs
Post-1955 Main Processing Area (cont'd)	Upgradient of Settling Pond #1	11MP31 (MS/MSD)	MW18	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
	Berm of Settling Pond #1	MW-03 (Existing well previously referred to as MW-3)	MW03	9/21/2010 and 8/26/2011	X	X	X	X	X	-	X	X	X	X	X	-	-	-	-
	Upgradient of Settling Ponds #2 and #3	11MP33	MW19	9/1/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
	Berm / Downgradient of Settling Pond #3	11MP40	MW22	8/31/2011	X	X	X	X	X	-	X	X	X	X	X	X	X	-	-
	Downgradient of Settling Pond #1	11MP38	MW20	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
	Downgradient of Settling Pond #1	11MP101 (Duplicate of 11MP38)	-	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
	Downgradient of Settling Pond #2	11MP39	MW21	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-

Table 2-5 Ground Water Sample Collection Summary

General Geographic Area	Location Description	Sample Location ID (Existing Monitoring Well or RI/FS Soil Boring)	Monitoring Well Designation	Sample Date	Total TAL Metals	Dissolved TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Methylmercury	Arsenic Speciation	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate / Nitrite	Carbonate, Bicarbonate	SVOCs with TICs	DRO / RRO	GRO / BTEX	PCBs
Pre-1955 Main Processing Area	Well pair near spring in Red Devil Creek / Downgradient of former mine openings / Tailings	11MP60	MW28	8/30/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		11MP88	MW27	8/30/2011 and 9/9/2012[a]	X	X	X	X	X	X	X	X	X	X	X	-	-	-	X[a]
	Near Shop Pad B	11MP89	MW25	8/30/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
	Downgradient of Former Shop Pad	MW-04 (Existing well previously referred to as MW-4)	MW04	9/21/2010, 8/22/2011, and 9/10/2012[a]	X	X	X	X	X	-	X	X	X	X	X	X	X	-	X[a]
	Downgradient of Pre-1955 Retort Area	MW-06 (Existing well previously referred to as MW-6)	MW06	9/21/2010 and 8/24/2011	X	X	X	X	X	-	X	X	X	X	X	-	-	-	-
	Downgradient of Pre-1955 Retort Area	11MP66	MW23	8/30/2011	X	X	X	X	X	-	X	X	X	X	X	-	-	-	-
	Downgradient of Pre-1955 Retort and Pre-1955 Rotary Furnace Burnt Ore Disposal Pile	11MP62	MW24	8/30/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
	Area of Pre-1955 Furnace Building / Tailings	11MP52	MW26	8/30/2011	X	X	X	X	X	-	X	X	X	X	X	-	-	-	-

Table 2-5 Ground Water Sample Collection Summary

General Geographic Area	Location Description	Sample Location ID (Existing Monitoring Well or RI/FS Soil Boring)	Monitoring Well Designation	Sample Date	Total TAL Metals	Dissolved TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Methylmercury	Arsenic Speciation	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate / Nitrite	Carbonate, Bicarbonate	SVOCs with TICs	DRO / RRO	GRO / BTEX	PCBs
Red Devil Creek	Red Devil Creek Alluvial Deposits	11RD05	MW33	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	1	-	-
		11RD20	MW12	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
		11RD21 (Duplicate of 11RD20)	-	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	11RD10	MW32	8/31/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Surface Mined Area	Well pair upgradient from Main Processing Area	11MP41	MW29	9/1/2011	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
		11MP90	Not Installed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well pair upgradient from Main Processing Area	11SM31	MW30	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		11SM32	Not Installed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note:

[a] Samples for PCBs were collected during the fall 2012 baseline groundwater monitoring event.

Key:

BTEX	benzene toluene, ethylbenzene, xylenes
Cl	chloride
DRO	diesel range organic
F	fluoride
GRO	gasoline range organics
ID	identifier
PCBs	polychlorinated biphenyls
RI/FS	remedial investigation/feasibility study
RRO	residual range organic
SO_4	sulfate
SVOC	semi-volatile organic compound
TAL	target analyte list
TIC	tentatively identified compound
X	A sample was collected for laboratory analysis

Deviations from the Field Sampling Plan

Several deviations from the FSP were made based upon evolving data needs and the field conditions encountered, as discussed below.

In order to gather information on vertical groundwater gradient in the vicinity of Settling Pond #1, it was decided to install an additional deep monitoring well MW17 at a location paired with planned shallow monitoring well MW16.

Two shallow and deep monitoring well pairs were originally planned for locations upslope of the Pre-1955 Main Processing Area at adjacent soil boring locations MP41/MP89 and SM31/SM32. However, no shallow groundwater was encountered during drilling at either of the paired locations. Therefore, only a deep monitoring well was installed at each location. Deep well MW29 was installed at soil boring location MP41, and deep well MW30 was installed at soil boring location SM31.

In general, soil boring and monitoring well locations were dependent on field conditions that affected drill rig access. Actual monitoring well locations are illustrated in Figure 2-7.

2.4 Surface Water

Surface water samples were collected in Red Devil Creek on September 22, 2010, and on August 26 and 27, 2011. Surface water samples also were collected as part of the Baseline Monitoring program in May and September 2012 and those results are included in Appendix A.

Surface water sample collection in Red Devil Creek.

In 2010, surface water grab samples were collected from eight locations along Red Devil Creek between the creek's mouth at the Kuskokwim River and a location upstream of the reservoir, and from a seep located on the north bank of the creek. In 2011, surface water samples were collected from the same locations as in 2010 and from three additional locations to characterize the water at the location of the drum that was removed from the creek in October 2010 (RD10 and RD11) and to gather more information about surface water in the Main Processing Area (RD12). Sample locations are illustrated in Figure 2-8, and the sample locations monitored in 2010 and 2011 are identified in Table 2-6. Surface water sample locations along Red Devil Creek were co-located with surface sediment sample locations. Sample results will be used to:

- Characterize the nature and extent of COPCs in the surface water of Red Devil Creek and a seep adjacent to Red Devil Creek in the Main Processing area.

- Characterize the cation-anion signature of the surface water to assess contribution from groundwater sources.
- Characterize chemical attributes affecting contaminant fate and transport of COPCs in the surface water Red Devil Creek.
- Provide data for the HHRA to assess potential exposure to COPCs through direct contact and incidental ingestion.
- Provide data for the ERA to assess potential exposure of creek biota to COPCs through direct contact and ingestion.

Surface water samples from Red Devil Creek were collected first from near the confluence of Red Devil Creek and the Kuskokwim River. Sampling proceeded upstream to avoid disturbing sediments that could impact turbidity and contaminant concentrations in downstream locations. To the extent feasible, surface water samples were collected from mid-depth water in the creek at a single location. Samples were collected using a battery-operated peristaltic pump with single-use silicone tubing and by hand-dipping the sample container directly into the creek water. Preserved aliquots were collected using a peristaltic pump outfitted with single-use silicone tubing. Dissolved metals aliquots were collected following collection of the other aliquots using a dedicated in-line 0.45-micrometer filter.

All of the Red Devil Creek surface water samples were analyzed for total TAL inorganic elements, dissolved TAL inorganic elements, methylmercury, low-level total mercury, low-level dissolved mercury, inorganic ions, nitrate/nitrite, carbonate/bicarbonate, TDS, and TSS (Table 2-6). Selected surface water samples were also analyzed for arsenic speciation and SVOCs. Field measurements for pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity were collected at each sample station.

No deviations from the FSP were necessary during surface water sampling.

Table 2-6 Surface Water Sample Summary

Sub-Area	Location Description	Sample Location ID	Sample Date	Total TAL Metals	Dissolved TAL Metals	Methylmercury	Arsenic Speciation	Inorganic Ions (Cl, F, SO4)	Total Low-Level Hg	Dissolved Low-Level Hg	Total Dissolved Solids	Total Suspended Solids	Nitrate/ Nitrite	SVOCs with TICs	Carbonate, Bicarbonate
Upstream from Main Processing Area	50 feet upstream from reservoir	RD01	9/22/2010 and 8/27/2011	2010 and 2011	X	X	X	X	X	X	X	X	X	-	X
	50 feet downstream from reservoir dam	RD02	9/22/2010 and 8/27/2011	X	X	X	X	X	X	X	X	X	X	-	X
	Approximately 300 feet upstream from the Main Processing Area	RD03 (Duplicate 11RD21SW in 2011)	9/22/2010 and 8/27/2011	X	X	X	-	X	X	X	X	X	X	X	X
	Upstream end of the Main Processing Area	RD10	8/27/2011	X	X	X	X	X	X	X	X	X	X	X	X
	Downgradient from abandoned drum	RD11	8/27/2011	X	-	-	-	-	-	-	-	-	-	X	-
Main Processing Area	10 feet upstream from where the access road crosses Red Devil Creek	RD04	9/22/2010 and 8/27/2011	X	X	X	X	X	X	X	X	X	X	X	X
	Seep on Left Bank of Red Devil Creek	RD05	9/22/2010 and 8/27/2011	X	X	X	X	X	X	X	X	X	X	X	X
	Within Red Devil Creek, adjacent to Main Processing Area seep	RD12	8/27/2011	X	X	X	X	X	X	X	X	X	X	X	X
	Near Settling Pond #2	RD09 (Duplicate 10RD20SW in 2010)	9/22/2010 and 8/26/2011	X	X	X	-	X	X	X	X	X	X	X	X
	Near Settling Pond #3	RD06	9/22/2010 and 8/26/2011	X	X	X	X	X	X	X	X	X	X	X	X
Downstream from Main Processing Area	250 feet upstream from confluence with Kuskokwim River	RD07	9/22/2010 and 8/26/2011	X	X	X	-	X	X	X	X	X	X	X	X
	Confluence of Red Devil Creek and Kuskokwim River	RD08 (Duplicate 11RD20SW in 2011)	9/22/2010 and 8/26/2011	X	X	X	X	X	X	X	X	X	X	X	X

Key:

Cl	chlorine	SVOC	semi-volatile organic compound
F	fluoride	TAL	target analyte list
ID	identifier	TIC	tentatively identified compound
SO_4	sulfate	X	A sample was collected for laboratory analysis

2.5 Sediment

Sediment samples were collected from Red Devil Creek, from the seep adjacent to Red Devil Creek in the Main Processing Area along the shoreline of the Kuskokwim River, and in off-shore locations in the Kuskokwim River.

2.5.1 Red Devil Creek Sediment Samples

Red Devil Creek sediment sampling was performed on September 24, 2010, and on August 20, 2011.

A total of 11 sediment samples were collected from Red Devil Creek and one sediment sample was collected adjacent to the seep in the Main Processing Area. One surface sediment sample was collected upstream of the reservoir. The locations are co-located with Red Devil Creek surface water locations and are shown in Figure 2-9. Results from samples collected from Red Devil Creek are used to:

- Characterize the nature and extent of COPCs in Red Devil Creek sediment.
- Characterize chemical attributes affecting contaminant fate and transport of COPCs in surface sediment.
- Characterize grain size distribution of sediment.
- Provide data for the HHRA to assess potential exposure to COPCs through direct contact and incidental ingestion.
- Provide data for the ERA to assess potential exposure of creek biota to COPCs through direct contact and ingestion.


Sediment sample collection in Red Devil Creek.

Red Devil Creek sediment samples were collected from the top 3 inches of the sediment bed using a plastic scoop. Deeper sampling depths were deemed unnecessary because sediments in the creek, composed largely of tailings/waste rock materials, are homogenous, and deeper sampling depths would be unlikely to yield significantly different contaminant concentration ranges. Each sample was then logged by a geologist, placed into a disposable plastic mixing container, and homogenized with the plastic scoop. The disposable plastic scoop was then used to place the sample into the appropriate lab container. The aliquots for mercury SSE were placed directly into the sample container and not homogenized in order to reduce potential volatilization of any elemental mercury that could be present in the sediment material.

Samples were selectively analyzed for total TAL metals, grain size, total organic content, methylmercury, mercury SSE, and arsenic speciation. Table 2-7 identifies the analyses conducted for each sample.

Table 2-7 Summary of Red Devil Creek Sediment Samples

Location Description	Sample Location ID	Sample Date	Total TAL Metals	Methylmercury	Arsenic Speciation	Mercury SSE	Grain Size	SVOCs with TICs	Total Organic Carbon
50 feet upstream from reservoir	10RD01	9/24/2010	X	X	X	X	X	-	X
50 feet downstream from reservoir dam	10RD02	9/24/2010	X	X	X	-	X	-	X
Approximately 300 feet upstream from the Main Processing Area	10RD03	9/24/2010	X	X	X	X	X	-	X
Upstream end of the Main Processing Area	11RD10	8/20/2011	X	X	X	X	X	X	X
Downgradient from abandoned drum identified during the 2010 limited sampling effort	11RD11	8/20/2011	X	-	-	-	X	X	X
10 feet upstream from where the access road crosses Red Devil Creek	10RD04	9/24/2010	X	X	X	X	X	-	X
Seep on Left Bank of Red Devil Creek	10RD05 Duplicate 10RD21SD	9/24/2010	X	X	X	X	X	-	X
Within Red Devil Creek, in mixing zone adjacent to Main Processing Area spring	11RD12	8/20/2011	X	X	X	X	X	-	X
Near Settling Pond #2	10RD09	9/24/2010	X	X	X	-	X	-	X
Near Settling Pond #3	10RD06	9/24/2010	X	X	X	X	X	-	X

Table 2-7 Summary of Red Devil Creek Sediment Samples

Location Description	Sample Location ID	Sample Date	Total TAL Metals	Methylmercury	Arsenic Speciation	Mercury SSE	Grain Size	SVOCs with TICs	Total Organic Carbon
250 feet upstream from confluence with Kuskokwim River	10RD07	9/24/2010	X	X	X	-	X	-	X
Confluence of Red Devil Creek and Kuskokwim River	10RD08 Duplicate 10RD20SD	9/24/2010	X	X	X	X	X	-	X

Key:

ID	identifier
RRO	residual range organic
SSE	selective sequential extraction
SVOC	semi-volatile organic compound
TAL	target analyte list
TIC	tentatively identified compound
X	A sample was collected laboratory analysis

2.5.2 Kuskokwim River Shoreline Sediment Samples

Sediment sampling of the Kuskokwim River shoreline was performed on September 23, 2010, and between September 21, 2011, and September 25, 2011.

A total of 17 sediment samples were collected from the shoreline of the Kuskokwim River adjacent to the RI upland area (see Figure 1-2). Sample locations are shown in Figure 2-10. Results from samples collected from the Kuskokwim River are used to:

- Characterize the nature and extent of COPCs in river sediment.
- Characterize chemical attributes affecting fate and transport of COPCs.
- Provide data for the HHRA to assess potential exposure to COPCs through direct contact, incidental ingestion, and consumption of fish.
- Provide data for the ERA to assess potential exposure of river biota to COPCs through direct contact and ingestion.

Kuskokwim River off-shore sediment sample collection.

Shoreline samples were collected from the top 6 inches using a plastic scoop. Once acquired, a sample was then described by a geologist, placed into a disposable plastic mixing container, and homogenized with a disposable plastic stirrer. A disposable plastic scoop was then used to place the sample into the appropriate lab container. The aliquots for mercury SSE were placed directly into the sample container and not homogenized in order to reduce potential volatilization of any elemental mercury that could be present in the sediment material.

Samples were selectively analyzed for total TAL metals, grain size, total organic content, methylmercury, mercury SSE, and arsenic speciation. Table 2-8 identifies which analyses were conducted for each sample.

No deviations from the FSP occurred.

Table 2-8 Kuskokwim River Shoreline Sediment Sample Summary

Station	TAL Metals	Grain size	TOC	Methyl Hg	Hg SSE	As Spec
11KR01SD	X	X	X	X	-	X
11KR05SD	X	X	X	X	-	X
11KR06SD	X	X	X	X	-	X
11KR08SD	X	X	X	X	-	X
11KR09SD	X	X	X	X	-	X
11KR12SD	X	X	X	X	-	X
11KR14SD	X	X	X	X	-	X
11KR15SD	X	X	X	X	-	X
11KR16SD	X	X	X	X	-	X
11KR17SD	X	X	X	X	-	X
10KR02SD	X	X	X	X	X	X
10KR03SD	X	X	X	X	-	X
10KR04SD	X	X	X	X	X	X
10KR07SD	X	X	X	X	X	X
10KR10SD	X	X	X	X	-	X
10KR11SD	X	X	X	X	X	X
10KR13SD	X	X	X	X	-	X

Key:

As Spec	arsenic speciation
Hg	mercury
SSE	selective sequential extraction
TAL	target analyte list
TOC	total organic compound
X	A sample was collected laboratory analysis

2.5.3 Kuskokwim River Off-Shore Sediment Samples

Sediment sampling at off-shore locations in the Kuskokwim River was performed between September 21 and September 25, 2011. Additional off-shore sediment sampling in the Kuskokwim River was conducted between September 16 and September 19, 2012.

A total of 55 sediment samples were collected from the Kuskokwim River; their locations are shown in Figure 2-11. Results from samples collected from the Kuskokwim River are used to:

- Characterize the nature and extent of COPCs in river sediment.
- Characterize chemical attributes affecting fate and transport of COPCs.
- Provide data for the HHRA to assess potential exposure to COPCs through direct contact, incidental ingestion, and consumption of fish.
- Provide data for the ERA to assess potential exposure of river biota to COPCs through direct contact and ingestion.
- Develop estimates of the area and volume of tailings and/or contaminated sediment in the Kuskokwim River that require remediation.

- Evaluate site-specific remedial technologies on potentially contaminated sediment in the river.

The sampling vessel was a 20-foot aluminum skiff rented locally and operated by Kinetic Laboratories, Inc., under subcontract to E & E. Sediment sampling was performed using two different types of equipment/method depending on water depth and river bottom substrate encountered at a given location. Where bottom sediment was not dominated by gravel and cobbles, a Van Veen surface sediment grab sampler was used. At many locations, the Van Veen sampler was ineffective due to coarse sediment conditions. Therefore, at most locations, a hand auger was used. The off-shore sediment samples were collected from within the top 4 inches of the sediment bed.

Both the hand auger and Van Veen were decontaminated with phosphate-free detergent and a de-ionized water rinse between uses.

For both hand augering and Van Veen sampling, the vessel was anchored on the sampling if possible; however, at most locations the swift current and heavy armoring of the river bottom prevented the anchor from holding, so the boat operator held the vessel as stationary as possible under power against the river current. Recovered sample material was described by a geologist and placed into a disposable plastic mixing container and homogenized with a disposable plastic stirrer. A disposable plastic scoop was then used to place the sample into the appropriate lab container.

Samples were selectively analyzed for total TAL metals, grain size, total organic content, and methylmercury. Table 2-9 identifies which analyses were conducted for each sample.

Table 2-9 Kuskokwim River Off-Shore Sediment Sample Summary

Station	Collection Method	Total TAL Metals	Grain size	TOC	Methylmercury
11KR47SD	HA	X	X	X	-
11KR46SD	HA	X	X	X	-
11KR45SD	HA	X	X	X	X
11KR44SD	HA	X	X	X	-
11KR43SD	HA	X	X	X	-
11KR42SD	HA	X	X	X	-
11KR41SD	HA	X	X	X	-
11KR40SD	HA	X	X	X	X
11KR39SD	HA	X	X	X	-
11KR38SD	HA	X	X	X	-
11KR37SD	VV	X	X	X	X
11KR36SD	VV	X	X	X	-

Table 2-9 Kuskokwim River Off-Shore Sediment Sample Summary

Station	Collection Method	Total TAL Metals	Grain size	TOC	Methylmercury
11KR35SD	HA	X	X	X	-
11KR34SD	HA	X	X	X	X
11KR30SD	HA	X	X	X	X
11KR29SD	HA	X	X	X	-
11KR28SD	HA	X	X	X	X
11KR27SD	HA	X	X	X	-
11KR26SD	HA	X	X	X	-
11KR25SD	HA	X	X	X	-
11KR24SD	HA	X	X	X	X
11KR23SD	HA	X	X	X	-
11KR22SD	HA	X	X	X	-
11KR21SD	HA	X	X	X	-
11KR20SD	HA	X	X	X	-
11KR19SD	HA	X	X	X	-
11KR18SD	HA	X	X	X	X
0912KR81SD	HA	X	X	X	-
0912KR80SD	HA	X	X	X	-
0912KR79SD	HA	X	X	X	-
0912KR78SD	HA	X	X	X	X
0912KR77SD	HA	X	X	X	-
0912KR76SD	HA	X	X	X	-
0912KR75SD	HA	X	X	X	X
0912KR73SD	NS	-	-	-	-
0912KR72SD	HA	X	X	X	-
0912KR71SD	HA	X	X	X	-
0912KR70SD	HA	X	X	X	X
0912KR69SD	HA	X	X	X	-
0912KR68SD	HA	X	X	X	-
0912KR67SD	HA	X	X	X	-
0912KR66SD	HA	X	X	X	X
0912KR65SD	NS	-	-	-	-
0912KR64SD	HA	X	X	X	-
0912KR63SD	HA	X	X	X	-
0912KR62SD	HA	X	X	X	X
0912KR61SD	HA	X	X	X	-
0912KR60SD	HA	X	X	X	-
0912KR59SD	HA	X	X	X	-

Table 2-9 Kuskokwim River Off-Shore Sediment Sample Summary

Station	Collection Method	Total TAL Metals	Grain size	TOC	Methylmercury
0912KR58SD	HA	X	X	X	X
0912KR57SD	NS	-	-	-	-
0912KR56SD	HA	X	-	X	-
0912KR55SD	HA	X	X	X	-
0912KR54SD	HA	X	X	X	-

Key:

HA	Hand auger
NS	Not sampled
VV	Van Veen
X	A sample was collected laboratory analysis

Deviations from the Field Sampling Plan

Sediment samples planned for collection at stations KR57, KR65, and KR73 were not collected because the river bed at those locations consisted of gravel and cobbles, precluding collection of a sample with available equipment. At each of these locations, multiple attempts were made before abandoning the station. At several other planned sample stations it was necessary to revise the sample location, also due to the presence of gravelly and cobbly conditions. Actual sample locations are illustrated in Figure 2-11. Figure 2-11 also shows the locations of abandoned stations KR57, KR65, and KR73.

2.6 Vegetation

Vegetation samples were collected between August 18 and August 23, 2011. Additional vegetation sampling of blueberry fruit was conducted between September 9 and September 11, 2012.

In 2011, 50 vegetation samples were collected. Seventeen of these samples were spruce, 13 were green alder, 11 were blueberry leaves and stems, one was blueberry fruit, and eight were pond vegetation. Blueberry plant occurrence is low in the Surface Mined Area, and no blueberry plants were found in the Main Processing Area. Due to seasonal environmental conditions, blueberry fruit was very limited, and only one sample location in the upland area had enough fruit available to sample. In 2012, an additional eight blueberry fruit samples were collected. Vegetation sample locations are illustrated in Figure 2-12.

All plant tissue samples have been analyzed for total TAL metals. In addition, selected plant tissue samples were analyzed for methylmercury and arsenic speciation. Table 2-10 identifies which analyses were conducted for each sample.

The vegetation samples were co-located with the surface soil samples that were collected during the 2010 LSE except for pond vegetation samples (Figure 2-12). Target plant species were sampled within a 10-foot radius of these locations. Composite samples were collected from one to five individual plants, depending on availability, and combined into a single sample. Each sample comprised enough individual plants to achieve the required sample weight. Pond vegetation samples were collected at locations within the target areas (the reservoir on Red Devil Creek upgradient from the site and the settling ponds in the Post-1955 Main Processing Area) where sufficient vegetation was available.

Samples were collected using stainless steel scissors, placed in two re-sealable plastic bags, and placed on ice. Samples were variously analyzed for total TAL metals, percent moisture, methylmercury, and arsenic speciation. Table 2-10 identifies which analyses were conducted for each sample.

Table 2-10 Vegetation Sample Summary

Geographic Area	Target Plant	Sample Location	TAL Metals	Percent Moisture	Methylmercury	Arsenic Species
Pre-1955 Main Processing Area	GAB	11MP44GA	X	X	-	-
	WSN	11MP91WS	X	X	-	-
		11MP66WS (Duplicate of 11MP91WS)	X	X	-	-
Post-1955 Main Processing Area	GAB	11MP34GA	X	X	X	
		11MP38GA	X	X	-	-
		11MP20GA	X	X	-	-
		11MP27GA	X	X	X	-
	WSN	11MP34WS	X	X	X	-
		11MP38WS	X	X	-	-
		11MP31WS	X	X	-	-
		11MP20WS	X	X	X	-
	PVH	11MP84PV	X	X	X	-
		11MP85PV	X	X	-	-
		11MP86PV	X	X	-	-
		11MP87PV	X	X	-	-
		11MP88PV (Duplicate of 11MP87PV)	X	X	-	-
Surface Mined Area	GAB	11SM18GA	X	X	-	-
		11SM11GA	X	X	X	-
		11SM81GA (Duplicate of 11SM11GA)	X	X	X	-
		11SM07GA	X	X	X	-
	WSN	11SM18WS	X	X		-
		11SM11WS	X	X	X	-
		11SM82WS (Duplicate of 11SM11WS)	X	X	X	-
		11SM07WS	X	X	X	-

Table 2-10 Vegetation Sample Summary

Geographic Area	Target Plant	Sample Location	TAL Metals	Percent Moisture	Methylmercury	Arsenic Species
	BBF	12SM24BF	X	X	X	X
	BBL	11SM18BL	X	X	X	-
		11SM24BL	X	X	X	-
Background Area	GAB	11RD11GA	X	X	X	-
		11RD12GA	X	X	X	-
		11RD14GA	X	X	X	-
		11RD18GA	X	X	X	-
	WSN	11UP02WS	X	X	X	-
		11UP01WS	X	X	-	-
		11UP07WS	X	X	X	-
		11UP09WS	X	X	-	-
		11RD11WS	X	X	-	-
		11RD12WS	X	X	X	-
		11RD14WS	X	X	X	-
		11RD18WS	X	X	-	-
	BBF	12UP02BF	X	X	X	X
		11UP04BF	X	X	X	X
		12UP04BF	X	X	X	X
		12UP07BF	X	X	X	X
		12UP08BF	X	X	-	-
		12RD12BF	X	X	-	-
		12RD14BF	X	X	X	X
		12RD18BF	X	X	-	-
	BBL	11UP04BL	X	X	X	-
		11UP02BL	X	X	-	-
		11UP07BL	X	X	-	-
		11UP08BL	X	X	X	-
		11UP09BL	X	X	-	-
		11RD12BL	X	X	X	-
		11RD14BL	X	X	X	-
		11RD18BL	X	X	-	-
		11RD40BL (Duplicate of 11RD18BL)	X	X	-	-
	PVH	11RD81PV	X	X	X	-
		11RD82PV	X	X	-	-
		11RD83PV	X	X	-	-

Table 2-10 Vegetation Sample Summary

Geographic Area	Target Plant	Sample Location	TAL Metals	Percent Moisture	Methylmercury	Arsenic Species

Key:

BBF	blueberry fruit
BBL	blueberry leaves
GAB	green alder bark
PVH	pond vegetation, horsetail
TAL	target analyte list
WSN	white spruce needles
X	A sample was collected laboratory analysis

Results from the vegetation sampling are used to characterize the nature and extent of COPCs in the vegetation in the RDM area.

Deviations from the Field Sampling Plan

This sampling event included several deviations from the FSP, based upon evolving data needs and the field conditions encountered. White spruce sample 11MP91WS was collected at a location approximately 20 feet northeast of location soil sample location 11MP66. This vegetation sample location was adjusted to include a white spruce tree, since no white spruce trees were located within 10 feet of soil sample location 11MP66. Based on field observations, the soil at 11MP91WS is similar to that at soil sample location 11MP66.

Not all the planned blueberry plant samples were collected due to lack of blueberry plants in the Surface Mined Area, Pre-1955 Main Processing Area, and Post-1955 Main Processing Area.

Black spruce (*Picea mariana*) was sampled when white spruce (*Picea glauca*) was not available at sample locations.

2.7 Other Studies

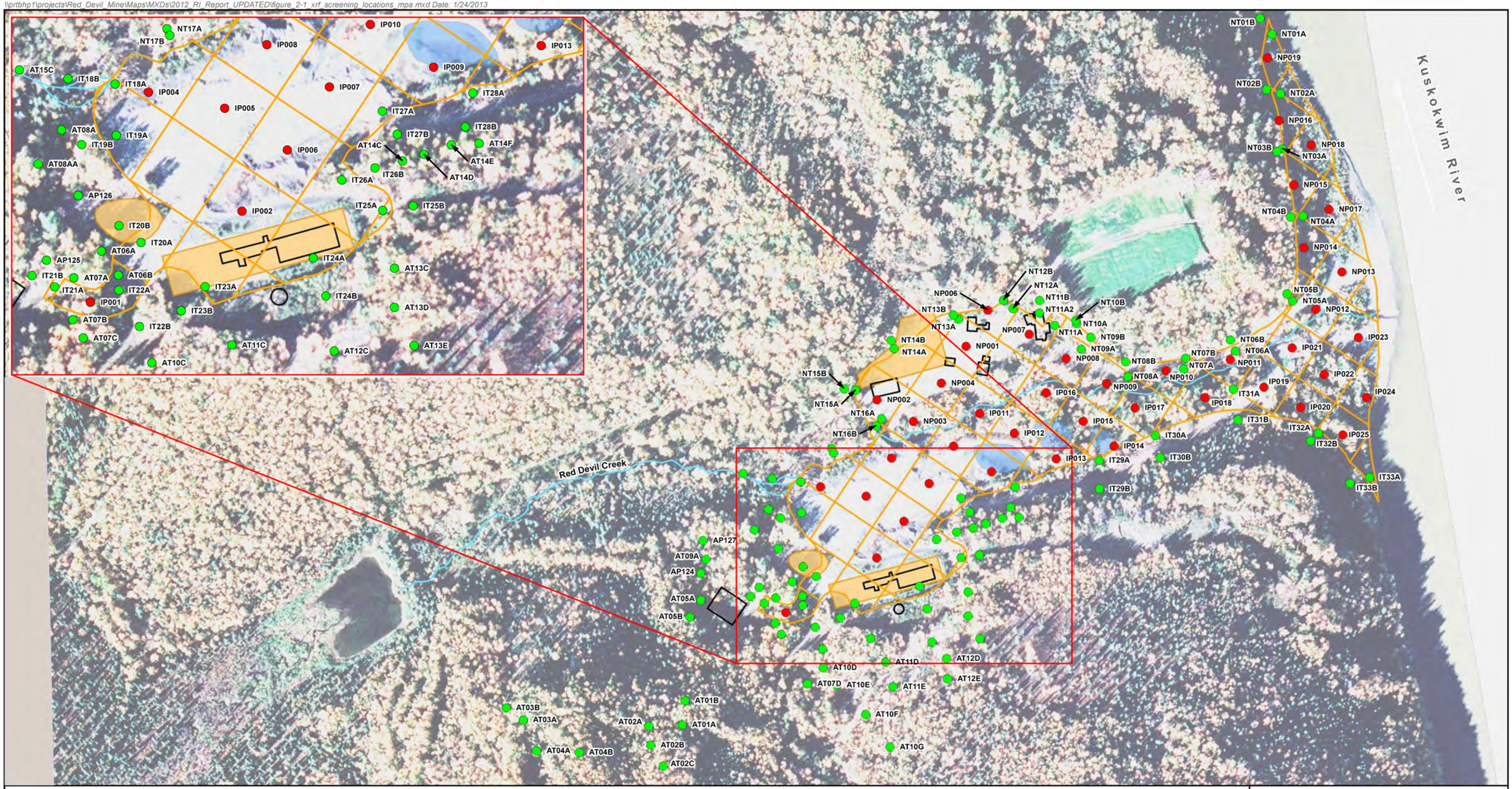
Several studies have been conducted at and near the RDM that supplement the RI field investigations discussed above. These studies have been used to supplement characterization of the site in subsequent chapters of this report, and are summarized below.

2.7.1 2010 USGS Geophysical Study

As noted in Section 1.4.4, the USGS conducted a geophysical investigation at the RDM site in 2010 using direct-current resistivity and electromagnetic induction methods (Burton and Ball 2011). Eight two-dimensional cross-sections and one three-dimensional grid of direct-current resistivity data, and 5.7 kilometers of electromagnetic induction data were obtained along the Red Devil Creek valley, from the Main Processing Area to Red Devil Creek's confluence with the Kuskokwim River. The results of the geophysical survey are used to augment the interpretation of subsurface conditions and groundwater dynamics in Chapters 4 and 5 of this report.

2.7.2 BLM Fish Tissue Sampling

In 2010 and 2011, the BLM, in coordination with the Alaska Department of Fish and Game (ADF&G), sampled forage fish and top-trophic-level fish species in the middle Kuskokwim River region and in eight tributaries, including Red Devil Creek. Fish tissue samples were analyzed for 19 inorganic elements, including total mercury and methylmercury (BLM 2012). Tissue data from forage fish samples collected in Red Devil Creek are used in the HHRA and ERA (Chapter 6) to establish exposure levels for human and ecological consumers.



● Grid Location
● Transect Location
🟦 Settling Pond
🟧 Monofill
☐ Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 2-1
XRF Screening Locations
Main Processing Area

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100 125
Meters

Image Source: Aero-Metric, Inc 2010a

Sample Location

- ● Grid Point
- ● Transect
- ● Building Foundation
- ● Dolly Sluice
- ● Rice Sluice
- ● Road

- ▨ Settling Pond
- ▨ Monofill
- □ Historical Structure

RED DEVIL MINE

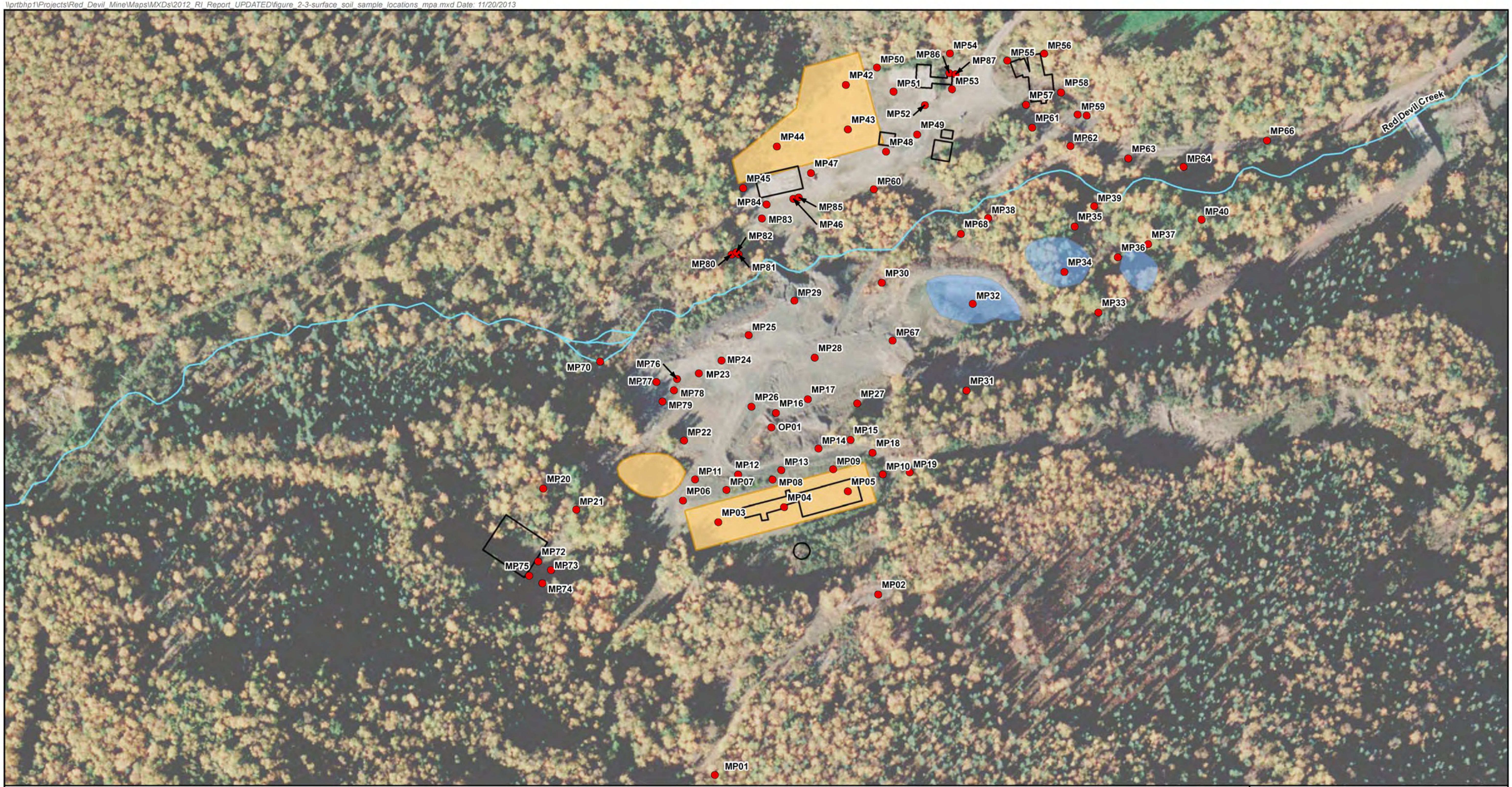
Red Devil, Alaska

Figure 2-2
XRF Screening Locations Outside Main Processing Area

0 100 200 400 600
Feet
0 25 50 100 150 200
Meters
Scale 1:3,800

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_2-3-surface_soil_sample_locations_mpa.mxd Date: 11/20/2013



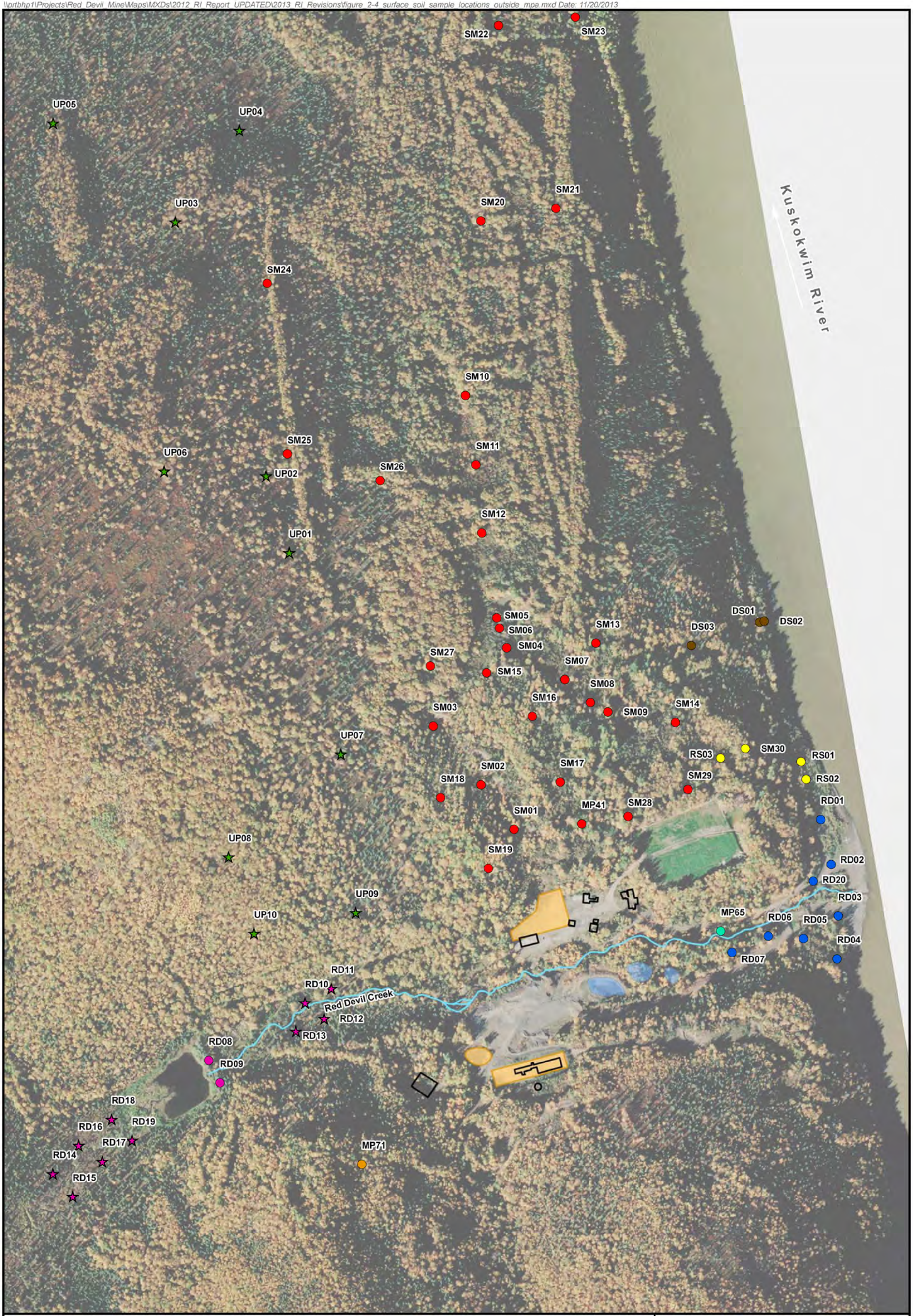
RED DEVIL MINE

Red Devil, Alaska

Figure 2-3
Surface Soil Sample Locations
Main Processing Area

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-4_surface_soil_sample_locations_outside_mpa.mxd Date: 11/20/2013



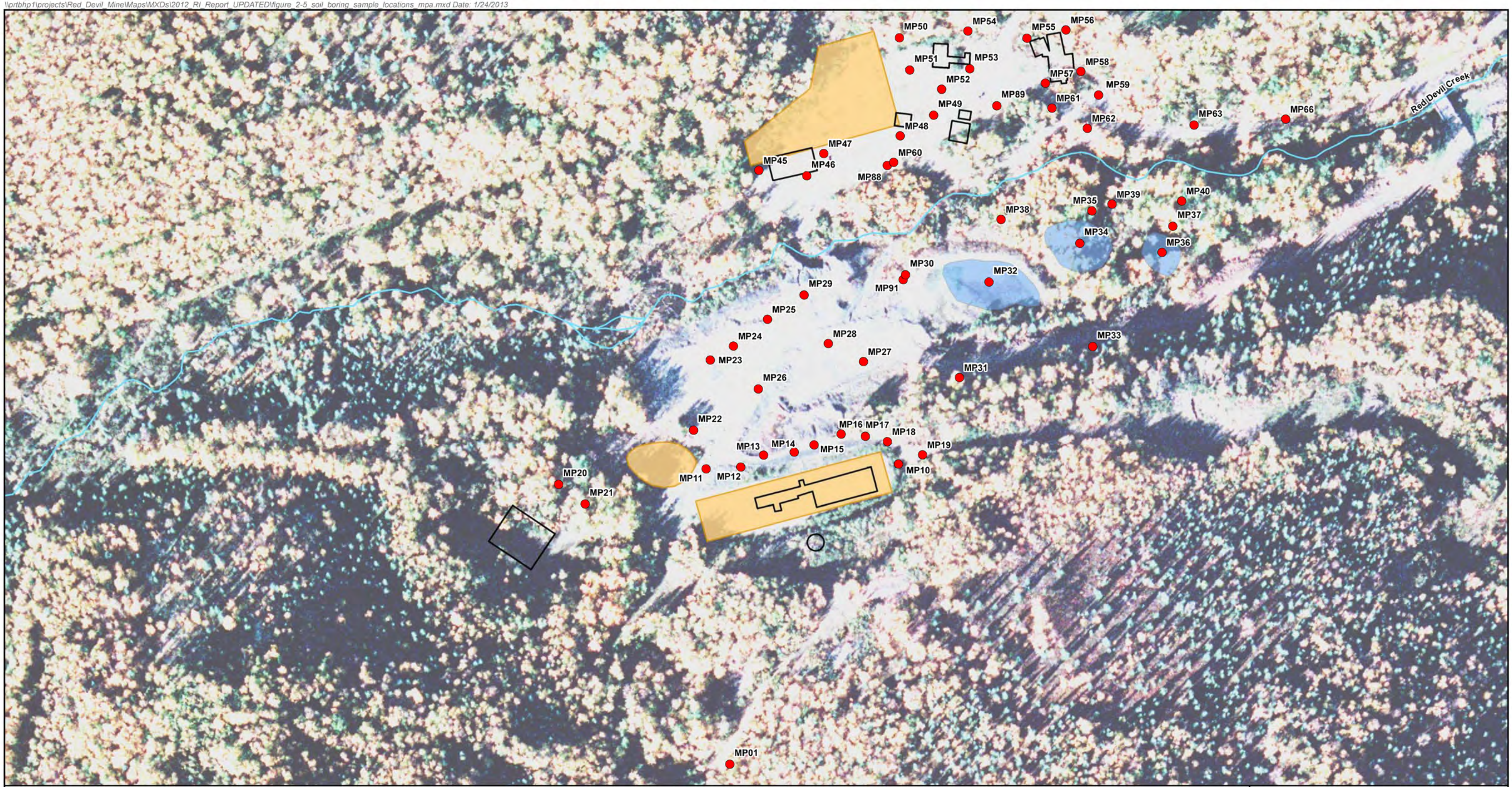
RED DEVIL MINE

Red Devil, Alaska

Figure 2-4
Surface Soil Sample Locations Outside Main Processing Area

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_2-5_soil_boring_sample_locations_mpa.mxd Date: 1/24/2013



● Soil Boring Location
🟦 Settling Pond
🟧 Monofill
☐ Historical Structure

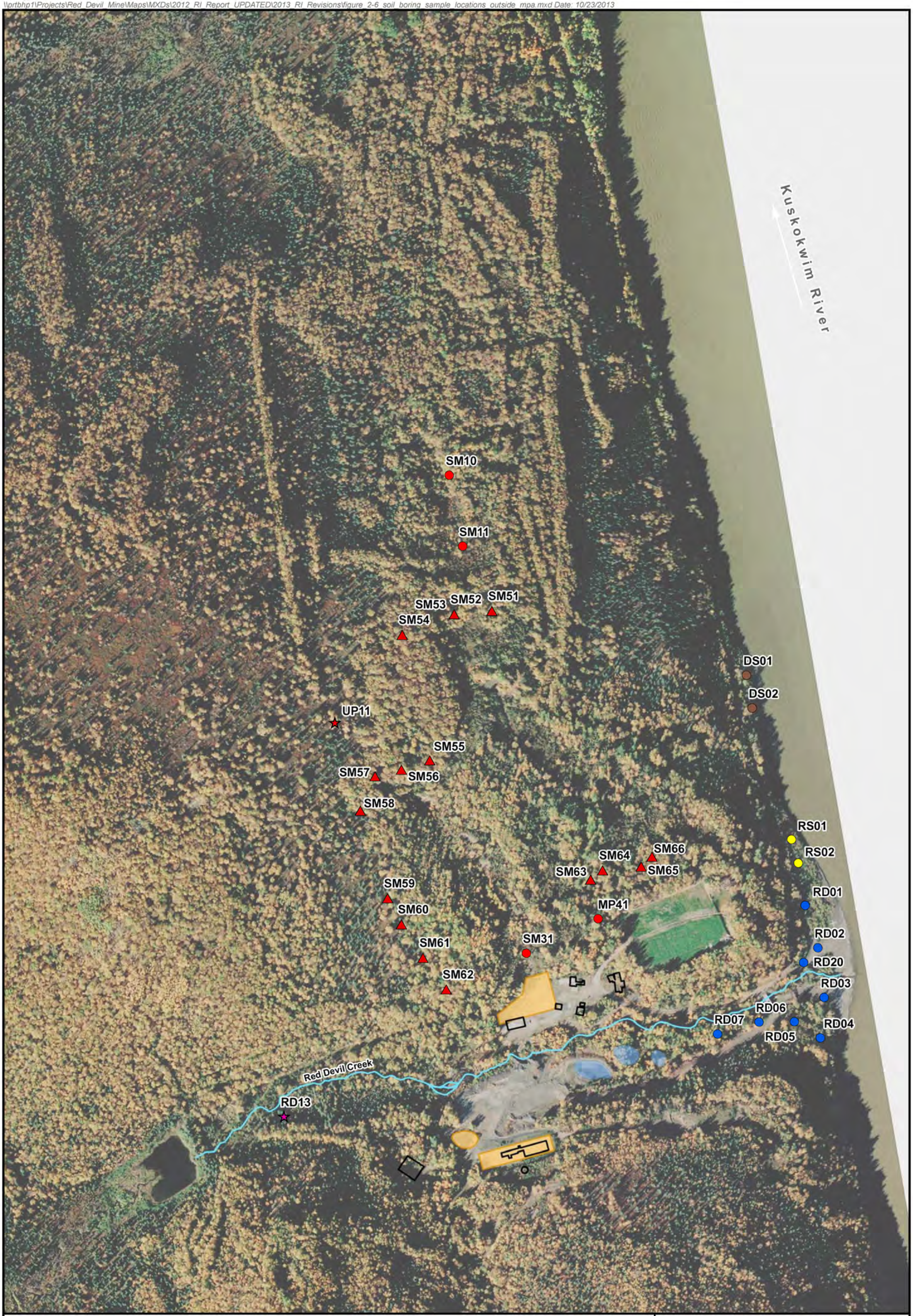
RED DEVIL MINE

Red Devil, Alaska

Figure 2-5
Soil Boring Locations
Main Processing Area

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-6_soil_boring_sample_locations_outside_mpa.mxd Date: 10/23/2013



▲ 2012 Boring Location

2011 Soil Boring Location

● Surface Mined Area

● Dolly Sluice and Delta

● Red Devil Creek Downstream Alluvial Area and Delta

● Red Devil Creek Upstream Alluvial Area

● Rice Sluice and Delta

☆ Background Location

🟦 Settling Pond

🟧 Monofill

☐ Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 2-6
Soil Boring Locations
Outside Main Processing Area

0 100 200 400 600
Feet
0 25 50 100 150 200
Meters
Scale 1:3,800

Image Source: Aero-Metric, Inc. 2010a

RED DEVIL MINE

Red Devil, Alaska

Figure 2-7
Monitoring Well Locations

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-8_surface_water_sample_locations.mxd Date: 10/23/2013

RED DEVIL MINE

Red Devil, Alaska

Figure 2-8
Surface Water Sample Locations

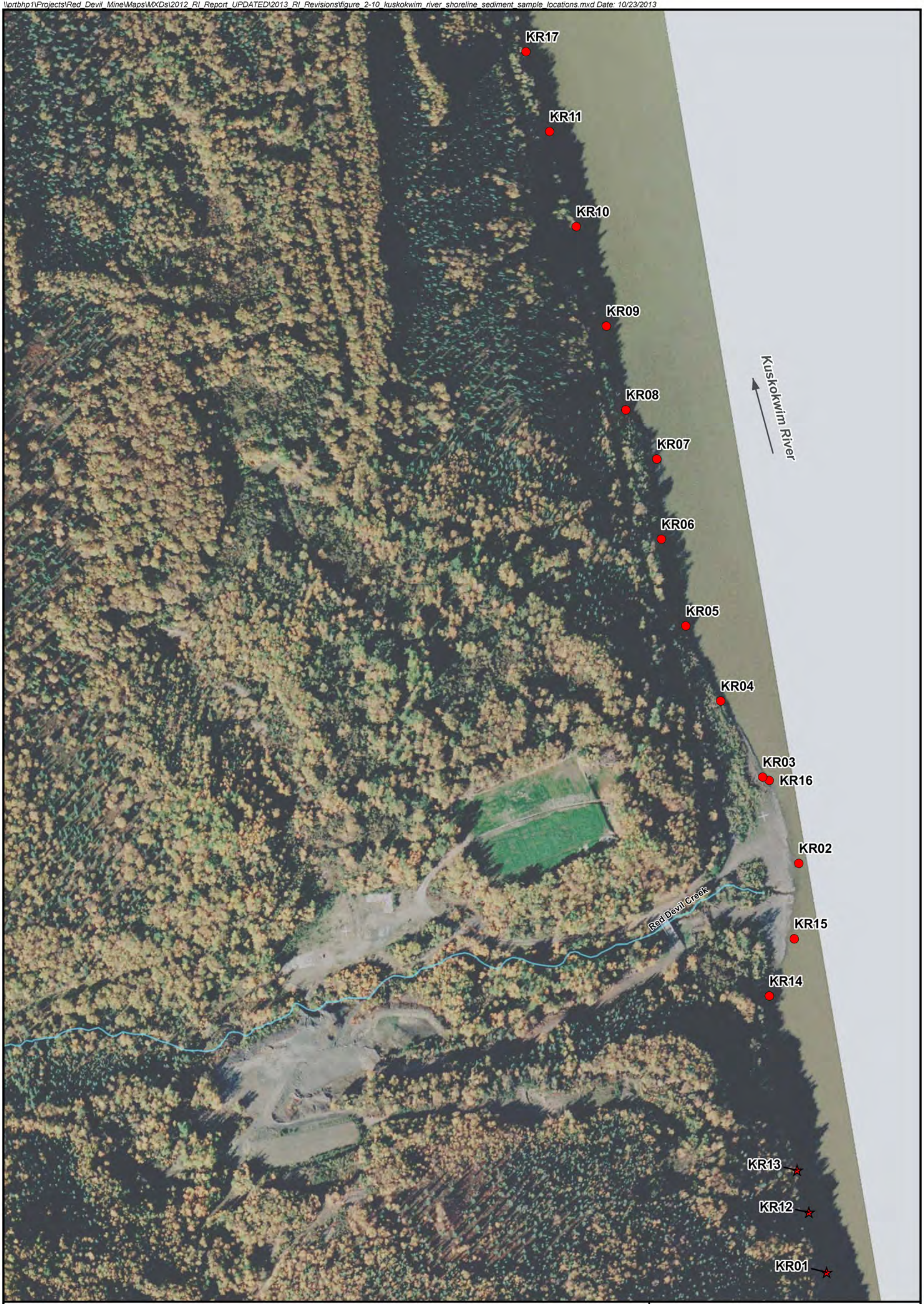
Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project: \\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_2-9_red_devil_crk_sediment_sample_locations.mxd Date: 9/25/2014

Figure 2-9
Red Devil Creek
Sediment Sample Locations

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-10_kuskokwim_river_shoreline_sediment_sample_locations.mxd Date: 10/23/2013



● Sediment Sample Location
★ Background Location

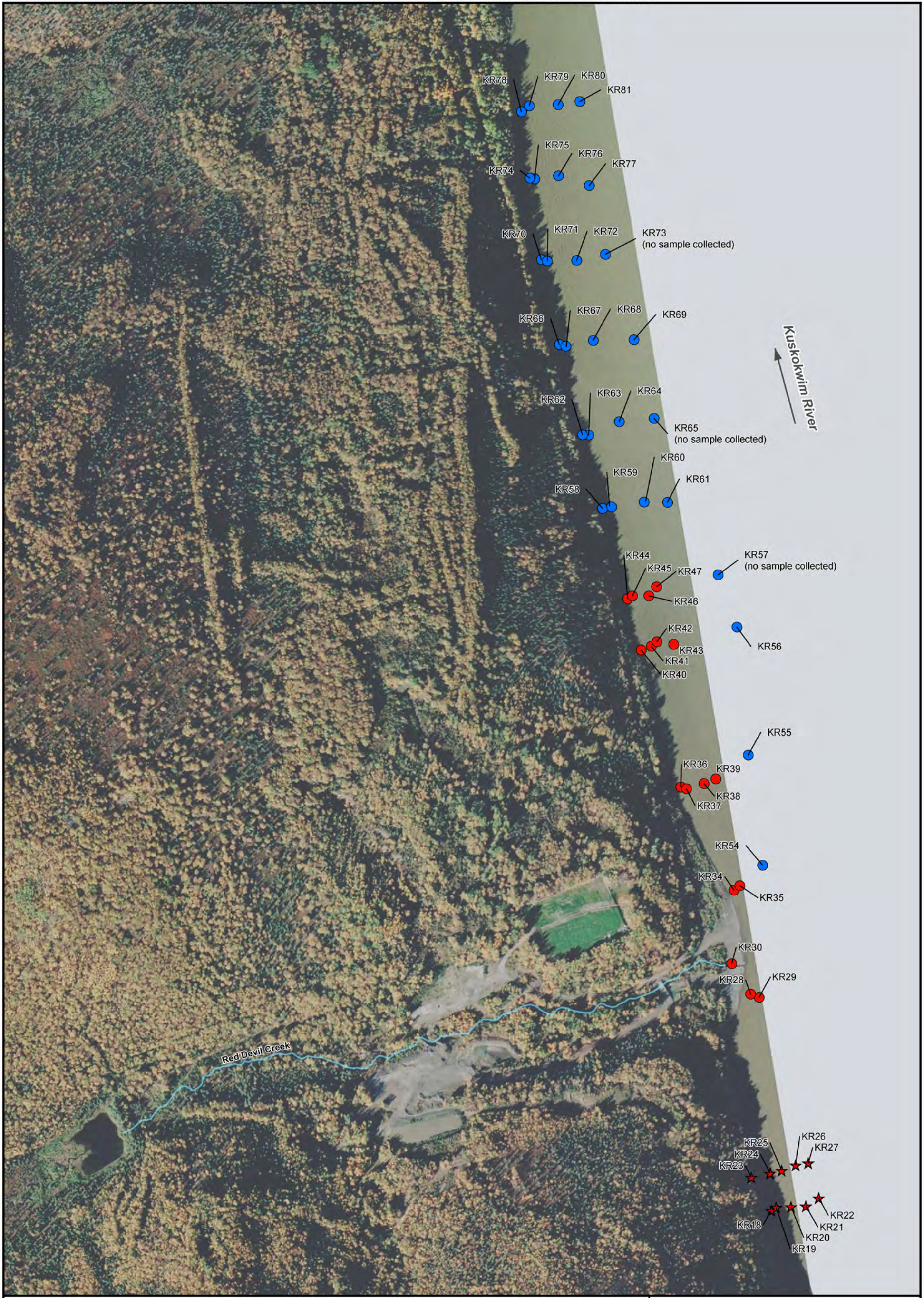
RED DEVIL MINE

Red Devil, Alaska

**Figure 2-10
Kuskokwim River Shoreline
Sediment Sample Locations**

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-11_kuskokwim_river_off-shore_sediment_sample_locations.mxd Date: 11/5/2013



● 2011 Sediment Sample Location
● 2012 Sediment Sample Locaiton
☆ Background Location

RED DEVIL MINE

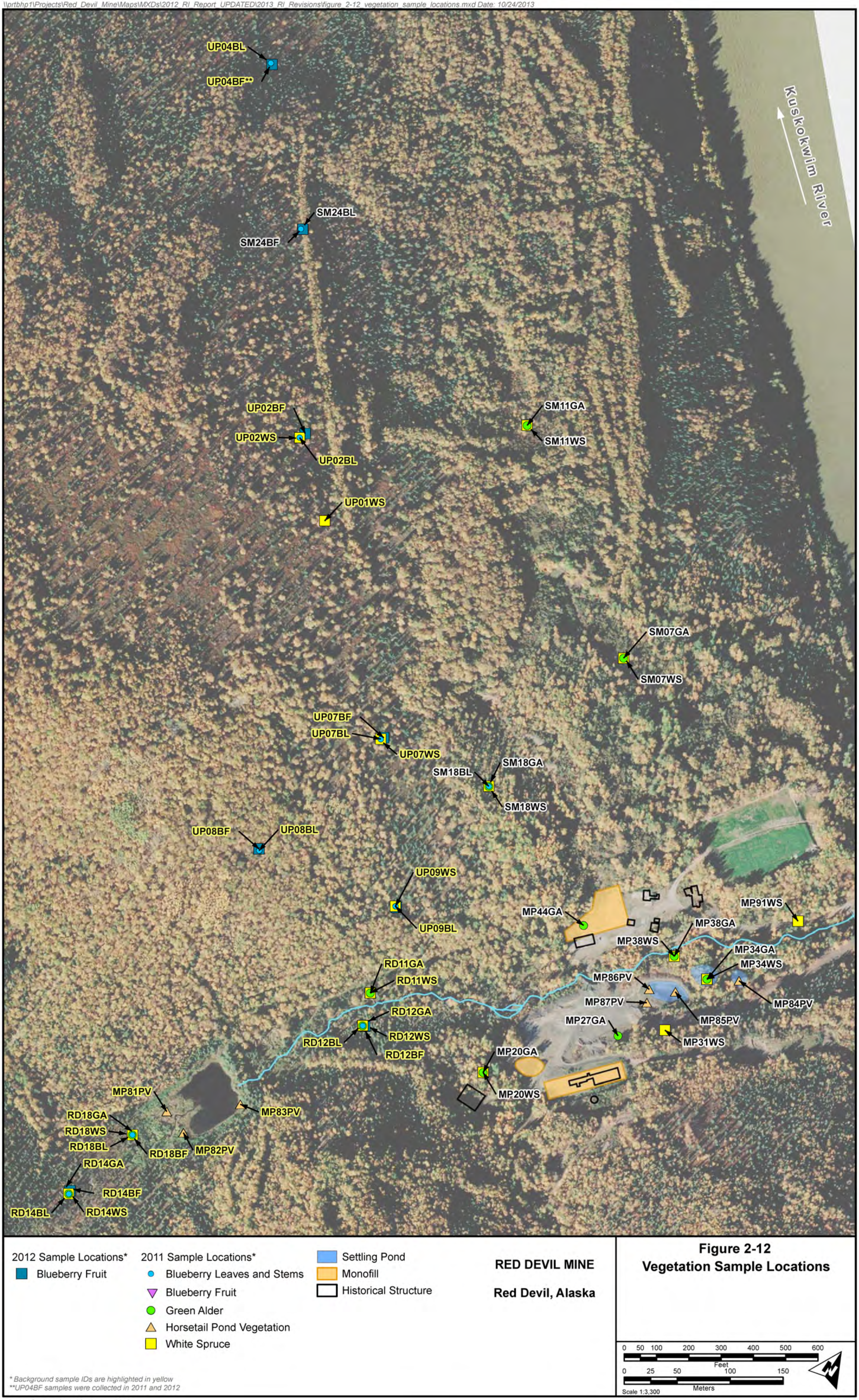
Red Devil, Alaska

Figure 2-11
Kuskokwim River Off-Shore
Sediment Sample Locations

0 87.5 175 350 525 700
Feet
0 25 50 100 150 200
Meters
Scale 1:2,000

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-12_vegetation_sample_locations.mxd Date: 10/24/2013



RED DEVIL MINE

Red Devil, Alaska

Figure 2-12
Vegetation Sample Locations

Image Source: Aero-Metric, Inc. 2010a

3

Physical Characteristics of the Study Area

This chapter presents information on the physical characteristics of the media of interest at the RDM based on field observations, measurements, and selected chemical analyses, as well as topography, historical aerial and land-based photographs, and other historical information. The information provided in this section augments the background information presented in Section 1.4.3.

3.1 Soil

Native soils at the RDM site consist of loess, soils derived from Kuskokwim Group bedrock and alluvial deposits associated with the Kuskokwim River and Red Devil Creek. Non-native materials at the site comprise various types of mining and ore processing wastes and fill. Mining waste at the site comprises waste rock and dozed and sluiced overburden. Ore processing waste primarily consists of tailings (here defined as thermally processed ore, also known as calcines, burnt ore, and retorted ore) and flotation tailings. Native materials have been removed, disturbed, relocated, covered, and/or mixed with other native soils and/or mine waste and tailings and fill locally across the site. These native soils, mine and ore processing wastes, and their distribution at the RDM are discussed further below.

3.1.1 Native Soils

Soils derived from the weathering of Kuskokwim Group bedrock contain silt, sand, and gravel derived from the underlying greywacke and argillite bedrock. Soil derived from the Kuskokwim Group is found in both disturbed and undisturbed areas of the site. Undisturbed occurrences of Kuskokwim Group–derived soils are present throughout much of the upland areas west of the Main Processing Area.

Kuskokwim Group–derived soil.

Loess commonly overlies soil derived from the Kuskokwim Group bedrock. The loess deposits are buff, light brown, or gray colored and friable. Undisturbed deposits were reported to range from a few inches to about 30 feet in thickness and commonly lack bedding.

Loess near the MainProcessing Area

Kuskokwim River alluvial deposits include gravel, sand, and silt that have been deposited on the flood plains of the Kuskokwim River. The oldest of these deposits is locally overlain by the loess, but most of the fluvial deposits postdate the loess. Kuskokwim River alluvium was also encountered in RI soil borings beneath the Red Devil Creek delta and the Dolly and Rice Sluice deltas, as discussed further below. Those soils are described in Section 3.1.3. Physical characteristics of Kuskokwim River sediment from shoreline and offshore locations are described in Section 3.3.2.

Red Devil Creek alluvium occurs within the present Red Devil Creek channel, the Red Devil Creek Delta, and floodplain upstream of the Main Processing Area, and locally beneath or mixed with other soil types. Sediment in Red Devil Creek within the Main Processing Area includes Red Devil Creek alluvium locally mixed with mine and ore processing waste materials. Red Devil Creek alluvium is composed of mixtures of silt, sand, and predominantly sub-angular to sub-rounded gravel. Fine materials in the alluvium within the present Red Devil Creek channel contain organic matter and display a medium to dark brown color. Soils interpreted as Red Devil Creek alluvium were encountered in several RI soil borings within the Main Processing Area. These soils consist of mixtures of silt, sand, and gravels with olive to brown color.

3.1.2 Mining and Ore Processing Wastes

Historical information on mine and ore processing waste types at the RDM is presented in Section 1.4.2.3. Additional information gathered on these materials is presented below.

Waste Rock

Waste rock was generated during underground mining. Much of the waste rock generated during mining was separated from ore at the surface in both the Pre-1955 and Post-1955 Main Processing Areas. Such waste rock was disposed of in the Main Processing Area. Waste rock has not undergone thermal processing and, as such, the common sulfide minerals at the RDM—cinnabar, stibnite, realgar, and orpiment—are commonly observed in waste rock material. Waste rock at the RDM typically consists predominantly of large angular gravel and sand composed of Kuskokwim Group argillite and greywacke with lesser dike material.

Dozed and Sluiced Overburden

Overburden was sluiced from the Dolly and Rice ore zone areas via bermed and naturally developed gullies down to the Kuskokwim River. Sluiced overburden was deposited in fans, or deltas, along the Kuskokwim River shoreline, referred to herein as the Dolly Sluice delta and Rice Sluice delta. Material observed in the deltas consists of mixtures of silt, sand, and gravel. Gravel consists of clasts of greywacke and argillite of the Kuskokwim Group. Early mining operations consisted of sluicing of overburden from areas west of the Pre-1955 Main Processing Area. Sluiced overburden was likely washed into the Red Devil Creek valley.

Tailings

Thermally processed mercury ore is often a rusty red color due to oxidation of iron within the rock. Review of historical photographs also suggests that not all tailings (also referred to as calcines) at the RDM may possess the rusty red color. Historical photographs of the Post-1955 furnace area show small piles of rusty red materials that are believed to be tailings. A remnant pile of rusty red rock in the Post-1955 Main Processing Area was examined during the RI. In addition to the distinctive rusty red color, some fragments of the material exhibit visible porosity. Presence of similar rusty red porous rock (hereafter referred to as red porous rock) and/or rock fragments with a distinctive red oxidation rind elsewhere at the RDM is interpreted to indicate the likely presence of tailings.

Flotation Tailings

Flotation tailings at the RDM were observed in Settling Ponds #1, #2, and #3, and consist predominantly of light to dark gray or brown silt and very fine to fine sand.

Other Mine Wastes

Other wastes generated during mining operations include the dust and oxide glass generated during the furnacing operations, as discussed Sections 1.4.2.2 and 1.4.2.3. Brown vitreous material fused to red porous rock (tailings) and other rock materials were identified during the RI. No dust materials were observed during the RI. Mercury vapor and particulates that did not accumulate in the furnaces, condensing system, or other components of the processing system may have discharged from the stack and precipitated in the vicinity of the mine. According to the 1999 Limited Waste Removal Action Report, the highest mercury concentrations were identified in the vicinity of the retort exhaust port (HLA/Wilder 1999).

3.1.3 Identification and Present Distribution of Soil Types

The distribution and arrangement of soils and mine and ore processing wastes at the site plays a significant role in determining the nature and extent of contamination, and the fate and transport of contaminants in the environment at the RDM. The identification and extent of soils and mine and ore processing waste types at the RDM are confounded by the mixing of mine and ore processing waste, and removal, disturbance, redistribution, and covering of materials of various types across much of the site. Tailings and waste rock were deposited at various locations at the site during mining and mineral processing operations and subsequently redistributed for disposal or use as construction fill and road base. For much of the mine's operational history, it appears that waste rock and tailings were generated and disposed of in close proximity at the ore processing facilities. As a result, with few exceptions, tailings and waste rock appear commonly to be mixed within the disposal areas on both the Pre-1955 and Post-1955 Main Processing Areas.

Native soils have been removed by mining; disturbed, redistributed, and mixed by dozing, trenching, and road and building construction; covered by other native soils or mine waste; and sluiced. Both native soils and mine wastes are also subject to redistribution by erosion and transport downslope and by alluvial processes in Red Devil Creek and the Kuskokwim River. In addition to the complexities introduced by the reworking of soils and mine wastes, waste rock and portions of tailings, which ultimately derive from Kuskokwim Group bedrock, share characteristics of native soils and sediments that are also derived from Kuskokwim Group bedrock.

Given the complexities outlined above, multiple lines of evidence were required in order to identify soil types and define their extent. These lines of evidence consist primarily of:

- Analysis of historical and recent aerial and land-based photographs.
- Analysis of historical and recent (2001) topography.
- Review of historical geologic and other maps.
- Review of reports of historical mining and ore processing activities.
- Lithological analysis of soil samples.
- XRF and laboratory analysis of metals concentrations.
- Results of a geophysical survey completed by the USGS (Burton and Ball 2011).

Detailed lithological analysis was performed for laboratory samples and at XRF field screening locations. In addition to typical lithological description characteristics, the presence or absence of key minerals or materials was noted. These key components include red porous rock and rock with a distinctive rust-colored oxidation rind (tailings indicator); cinnabar, stibnite, realgar, and orpiment (indicative of waste rock where it occurs in mine waste and where tailings are absent); and vitreous material (associated with tailings). As noted above, tailings and waste rock appear to be mixed at many locations within the disposal areas on both the Pre-1955 and Post-1955 Main Processing Areas.

Each surface and subsurface soil sample collected as part of the RI was assigned a site-specific soil type (hereafter, soil type). The assigned soil types for each sample are summarized in Tables B-2 through B-9 (Appendix B). The generalized distribution of soil types on the surface is illustrated in Figure 3-1. A cross-section reference map is presented in Figure 3-2. Geologic cross-sections illustrating soil type and other geologic features in the subsurface are presented in Figures 3-3 through 3-8. The soil types identified in Tables B-2 through B-9 and presented in Figure 3-1 and the geologic cross sections are described in Table B-1.

Key observations regarding the distribution of mining and ore processing wastes at the RDM are presented below:

- Accumulations of tailings/waste rock materials are present in dumps in the vicinity of both the Pre-1955 and Post-1955 Processing Areas (Figures 3-3 through 3-6), consistent with historical information regarding the locations of such dumps.
- Tailings and waste rock are largely mixed in the dumps at both the Pre-1955 and Post-1955 Processing Areas. Dump material in a portion of the Pre-1955 Processing Area appears to be waste rock with no discernible tailings (Figures 3-5 and 3-6).
- Tailings/waste rock material was identified in soil borings 11MP35SB and 11SB39SB (north of Settling Pond #2) and 11MP40SB (north of Settling Pond #3. Tailings/waste rock in these areas is likely reworked material originally deposited in the "Saw dust dump" identified in the 1963 geologic map (Figure1-7) associated with the Pre-1955 Processing Area (Figures 3-3 and 3-7.
- Material used to construct the berm of Settling Pond #1 appears to be tailings/waste rock material, flotation tailings, and fill/debris (Figure 3-3).
- Flotation tailings are largely limited to the basins of Settling Ponds #1, #2, and #3 (Figures 3-3 and 3-7). Flotation tailings were tentatively identified in a single subsurface soil interval in boring 11MP38 SB, located north of Settling Pond #1.
- Tailings/waste rock material, mixed to varying degrees with Red Devil Creek alluvium and/or soil, is locally present in the Red Devil Creek channel within and downstream of the Main Processing Area (Figures 3-4, 3-5, 3-7, and 3-8). Such materials are present in the Red Devil Creek delta (Figures 3-3 and 3-8).
- Sluiced overburden is present in fans or deltas in the Kuskokwim River at the Rice Sluice Delta and Dolly Sluice Delta (Figure 3-8).
- Dozed overburden consisting of soil derived from Kuskokwim Group bedrock and/or loess is present in the Surface Mined Area (Figures 3-4 and 3-7).

3.2 Hydrogeology

Monitoring wells were installed during the RI to assess groundwater conditions at the RDM. Monitoring wells were installed to depths ranging from 15 to 70 feet below the top of well casings. Well construction information is summarized in Table 3-1. Groundwater was observed during drilling in unconsolidated materials and bedrock at the depths indicated in Table 3-1 and in the tables presented in

Appendix F. Groundwater in bedrock occurs within fractures that include bedding-parallel fractures, the steep, northeast-striking joints, and the steep northwest-striking faults associated with the Red Devil fault. Groundwater also occurs in mine workings within the bedrock.

Following well completion and development, static water levels were measured in RI and existing monitoring wells. Static water levels were measured on two occasions for each well during the 2011 field event: once on the day of groundwater sampling immediately before sample collection, and again during a site-wide water level measurement event on September 1, 2011. With the exception of the pre-RI monitoring wells, the wells were sampled between August 29 and September 1, 2011. The pre-RI wells were sampled between August 22 and 26, 2011. Static water levels were measured in existing monitoring wells during the 2010 LSE. Baseline monitoring, including measurement of static water levels, was performed during the May and September 2012 monitoring events. Static water levels range from approximately 4 to 63 bgs across the site. Measured static water levels and elevations are summarized in Table 3-1.

Groundwater elevations during the May 2012 baseline monitoring event were higher in all monitoring wells than in September 2011 (by 0.29 to 11.29 feet), at an average of 3.9 feet higher across the site. Groundwater elevations during the May 2012 baseline monitoring event were higher in all but one well (MW15) than during the September 2012 baseline monitoring event (up to 8.55 feet), at an average of 2.2 feet higher across the site. During the September 2012 baseline monitoring event, groundwater elevations were higher in all but two monitoring wells (MW07 and MW25) than in September 2011 (up to 6.02 feet), at an average 1.8 of feet higher across the site. The largest differences in groundwater elevations between monitoring events are generally seen in the wells that are screened in bedrock. This is expected for aquifers in fractured bedrock in which the matrix materials (including argillite) have low effective porosity. Notable exceptions are wells MW16 and MW14, both of which are screened in unconsolidated materials in the Post-1955 Main Processing Area near Red Devil Creek, and in which the differences in water levels ranged as high as 8.73 and 5.61 feet (between May 2012 and September 2011).

Based on static water elevations, stream elevations, and discharge measurements along Red Devil Creek, potentiometric surface maps were developed. These maps were developed based on the assumption that groundwater within bedrock and the overlying unconsolidated materials is generally hydraulically connected. There is hydraulic segregation locally at the RDM. Information on localized hydraulic compartmentalization and preferential groundwater flow paths is discussed in Section 3.2.3. Maps for the September 2011, May 2012, and September 2012 monitoring events are presented in Figures 3-9, 3-10, and 3-11, respectively. For all three monitoring periods, groundwater at the site generally flows toward Red Devil Creek and the Kuskokwim River, with groundwater elevations generally mimicking topography.

3.2.1 Groundwater Flow

As noted above, groundwater at the site generally flows toward Red Devil Creek and the Kuskokwim River, with groundwater elevations generally mimicking topography. Groundwater in the Main Processing Area and much of the area downstream of the Main Processing Area emerges into Red Devil Creek and enters the Kuskokwim River as surface water rather than as groundwater. This pattern was exhibited during the September 2011 RI monitoring as well as the May 2012 and September 2012 baseline monitoring.

Locally, groundwater flow at the RDM is complicated due primarily to complex modification of the natural hydrogeologic environment at the site, including extensive surface and underground mining and disposal of mine waste. In order to evaluate groundwater flow at the site, the following were evaluated:

- Historical and recent aerial and land-based photographs.
- Historical and recent (2001) topography.
- Historical geologic maps.
- Historical maps and sections of underground mine workings.
- Reports of historical mining and ore processing activities.
- XRF and laboratory analysis of metals concentrations of soil materials.
- Data obtained during soil boring installation, including lithology and moisture content.
- Major ion chemistry of groundwater and surface water samples.
- Trace element chemistry of groundwater and surface water samples.
- Static water level measurements in monitoring wells.
- Red Devil Creek stream elevations.
- Red Devil Creek stream discharge measurements.
- Results of a geophysical survey completed by the USGS (Burton and Ball 2011).
- Seasonal differences in static water level measurements in monitoring wells collected during Baseline Monitoring in May and September, 2012.

Specific aspects of the groundwater flow regime at the RDM are discussed below.

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW01	N/A	29.70	19.0–29.0	254.51	257.51	17.8–TD	18.62	9/9/2012	17:05
							17.56	5/26/2012	14:32
							19.55	9/1/2011	16:03
							19.46	8/24/2011	16:38
							20.04	9/20/2010	18:18
							22.27	10/6/2009	17:30
							19.62	6/19/2009	NR
							22.16	9/18/2008	13:28
							19.87	9/5/2007	13:15
							21.72	8/14/2000	NR
MW03	N/A	27.73	14.5–25.5	228.37	230.77	19.0–TD	17.24	9/9/2012	17:10
							15.47	5/26/2012	15:17
							19.96	9/1/2011	15:41
							19.44	8/26/2011	10:18
							20.95	9/20/2010	19:50
							23.01	10/7/2009	13:20
							19.51	6/19/2009	NR
							22.57	9/18/2008	14:11
							20.68	9/5/2007	14:40
							22.28	8/14/2000	NR

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW04	N/A	32.9	20.0–30.0	239.92	242.12	25.3–TD	23.72	9/10/2012	14:15
							21.72	5/26/2012	16:47
							25.99	9/1/2011	15:00
							25.24	8/22/2011	16:02
							26.79	9/20/2010	16:09
							27.77	10/6/2009	18:55
							25.43	6/19/2009	NR
							26.82	9/18/2008	12:32
							26.78	9/5/2007	12:25
							27.77	8/14/2000	NR
MW06	N/A	26.14	13.0–23.0	214.99	217.49	20.0–TD	18.29	9/9/2012	11:45
							16.25	5/26/2012	16:02
							18.70	9/1/2011	15:09
							18.78	8/24/2011	14:56
							19.03	9/20/2010	13:22
							19.29	10/7/2009	17:25
							17.90	6/19/2009	NR
							19.08	9/18/2008	11:35
							18.63	9/5/2007	15:30
							19.29	8/14/2000	NR

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW07	N/A	23.70	11.0–21.0	278.39	280.89	14.8–TD	20.57	9/9/2012	16:45
							19.68	5/26/2012	13:36
							19.97	9/1/2011	16:14
							19.51	8/26/2011	9:12
							20.40	9/21/2010	10:20
							DRY	10/7/2009	NR
							20.10	6/19/2009	NR
							DRY	9/18/2008	NR
							20.42	9/5/2007	14:00
							DRY	8/14/2000	NR
MW08	11MP01SB	16.0	5.0–15.0	328.92	331.32	2.5–4.0, 10.5–TD	12.74	9/9/2012	16:10
							11.64	5/26/2012	13:23
							13.65	9/1/2011	16:28
							13.70	8/30/2011	9:21
MW09	11MP17SB	31.0	20.0–30.0	274.88	277.28	14.0–16.0, 31.0–TD	27.81	9/11/2012	11:20
							27.88	9/9/2012	15:30
							26.67	5/26/2012	14:04
							28.11	9/1/2011	16:43
							>31.56	8/29/2011	18:21

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW10	11MP14SB	61.0	50.0–60.0	274.31	276.21	48.0–TD	26.88	9/10/2012	11:35
							26.39	9/9/2012	15:45
							25.62	5/26/2012	14:14
							29.17	9/1/2011	16:38
							30.60	8/29/2011	16:15
MW11	11MP12SB	23.0	12.0–22.0	268.70	271.30	dry	24.24	9/9/2012	16:00
							22.60	5/26/2012	14:24
							DRY	9/1/2011	16:34
							DRY	8/29/2011	> 12:00
MW12	11RD13SB	15.0	4.0–14.0	263.22	265.62	1.0–TD	3.30	9/9/2012	16:39
							2.46	5/26/2012	11:04
							3.70	9/1/2011	16:20
							3.72	8/31/2011	13:34
MW13	11MP20SB	32.0	21.0–31.0	274.30	276.70	27.0–TD	24.06	9/9/2012	16:50
							18.41	5/26/2012	13:45
							29.70	9/1/2011	16:09
							30.05	8/30/2011	18:04

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW14	11MP25SB	36.0	25.0–35.0	246.71	249.01	25.7–TD	27.34	9/10/2012	17:35
							24.40	5/26/2012	14:45
							30.01	9/1/2011	16:00
							30.51	8/31/2011	10:05
MW15	11MP29SB	26.0	15.0–25.0	242.63	244.93	16.2–TD	18.3	9/8/2012	13:00
							18.33	5/26/2012	14:56
							19.59	9/1/2011	15:56
							19.64	8/30/2011	10:35
MW16	11MP30SB	22.0	11.0–21.0	226.09	228.09	16.0–TD	8.88	9/8/2012	14:30
							6.17	5/26/2012	15:08
							14.90	9/1/2011	15:50
							13.84	8/30/2011	11:35
MW17	11MP91SB	52.5	41.5–51.5	226.36	228.66	25.0–33.0, 33.0–TD	10.79	9/8/2012	16:20
							8.20	5/26/2012	15:03
							13.78	9/1/2011	15:52
							15.00	8/30/2011	9:20
MW18	11MP31SB	40.0	29.0–39.0	241.33	243.83	38.0–TD	24.83	9/9/2012	17:20
							21.82	5/26/2012	13:10
							29.87	9/1/2011	15:37
							29.66	8/31/2011	15:47

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW19	11MP33SB	43.0	32.0–42.0	237.70	240.00	39.0–TD	16.02	9/9/2012	17:25
							11.54	5/26/2012	12:59
							19.47	9/1/2011	15:32
							19.38	9/1/2011	9:34
MW20	11MP38SB	15.5	4.5–14.5	212.90	215.20	6.5–TD	5.53	9/9/2012	10:10
							4.82	5/26/2012	15:26
							6.97	9/1/2011	15:43
							6.89	8/31/2011	8:53
MW21	11MP39SB	17.5	6.5–16.5	208.23	210.13	7.0–TD	8.29	9/8/2012	17:35
							7.91	5/26/2012	15:36
							8.82	9/1/2011	17:10
							8.80	8/31/2011	10:16
MW22	11MP40SB	15.5	4.5–14.5	203.10	205.10	7.8–TD	7.77	9/9/2012	17:35
							5.55	5/26/2012	15:44
							8.48	9/1/2011	17:04
							8.20	8/31/2011	11:08
MW23	11MP66SB	29.0	18.0–28.0	201.96	204.16	20.0–TD	15.56	9/9/2012	17:47
							14.60	5/26/2012	15:56
							16.01	9/1/2011	15:14
							16.02	8/30/2011	16:31

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW24	11MP62SB	30.0	19.0–29.0	221.41	223.51	20.0 TD	16.45	9/9/2012	14:00
							14.59	5/26/2012	16:15
							17.61	9/1/2011	15:06
							17.70	8/30/2011	14:51
MW25	11MP89SB	42.0	31.0–41.0	237.56	239.76	32.0–TD	33.87	9/9/2012	10:30
							29.74	5/26/2012	16:22
							31.88	9/1/2011	14:50
							31.85	8/30/2011	18:02
MW26	11MP52SB	43.0	32.0–42.0	244.03	245.93	34.0–TD	34.01	9/9/2012	17:55
							32.76	5/26/2012	16:30
							36.30	9/1/2011	14:47
							36.25	8/30/2011	11:35
MW27	11MP60SB	34.0	23.0–33.0	241.04	242.94	29.0–TD	28.64	9/9/2012	12:50
							26.28	5/26/2012	16:38
							30.37	9/1/2011	14:58
							30.30	8/30/2011	16:50
MW28	11MP88SB	64.0	53.0–63.0	239.94	241.94	49.0–TD	27.01	9/10/2012	15:43
							24.19	5/26/2012	16:41
							28.61	9/1/2011	14:53
							25.50	8/30/2011	14:57

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW29	11MP41SB	70.0	59.0–69.0	280.35	282.25	61.0–TD	61.20	9/9/2012	16:22
							52.65	5/26/2012	17:09
							63.21	9/1/2011	13:20
							63.21	9/1/2011	13:28
MW30	11SM31SB	53.0	42.0–52.0	275.71	277.41	45.0–TD	nr	9/9/2012	nr
							52.63	5/26/2012	16:58
							53.53	9/1/2011	14:35
							53.44	9/1/2011	15:41
MW31	11UP11SB	44.8	33.8–43.8	495.79	497.99	34.0–TD	36.29	9/9/2012	18:10
							34.12	5/26/2012	10:10
							37.51	9/1/2011	14:05
							37.75	8/29/2011	13:51
MW32	11RD05SB	25.0	14.0–24.0	194.38	196.58	16.5–TD	17.21	9/8/2012	15:40
							16.71	5/26/2012	12:45
							18.86	9/1/2011	15:26
							18.90	8/31/2011	15:55

Table 3-1 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Total Well Depth (feet below TOC)	Screened Interval (feet bgs)	Ground Elevation (feet NAVD88)	Top of Casing Elevation (feet NAVD88)	GW Encountered During Drilling (feet bgs)	Static Water Level		
							Depth (feet below TOC)	Date	Time
MW33	11RD20SB	23.0	12.0–22.0	176.62	178.92	10.5–TD	5.97	9/8/2012	12:30
							3.98	5/26/2012	12:33
							8.19	9/1/2011	15:20
							8.14	8/31/2011	17:57
MW34	AST5 MW1	NR	NR	290.95	294.25		15.57	9/1/2011	16:49
MW35	AST5 MW2	NR	NR	285.76	289.26		41.97	9/1/2011	16:55
MW36	AST5 MW3	NR	NR	286.33	290.03		35.81	9/1/2011	16:57

Notes
Elevation datum: NAVD88 calculated using GEOID09.

Top of casing (TOC) refers to the top of PVC inner casing.

Key

GW	Groundwater
N/A	Not Applicable
NR	Not Recorded
TD	Total depth of soil boring
TOC	Top of Casing

3.2.2 Stream Gain and Loss

On a site-wide scale, Red Devil Creek exhibits predominantly gaining conditions. However, based on the groundwater elevations in monitoring wells, elevations of Red Devil Creek, and stream flow gauging (see Section 3.3), Red Devil Creek exhibits losing conditions locally.

Stream flow was measured at surface water monitoring stations on August 18, 2011, to provide additional information on groundwater-surface water interactions. Static water level measurements taken in monitoring wells (on September 1, 2011), stream elevation, and stream flow measurements (on August 18, 2011) collectively indicate that Red Devil Creek was a losing stream during that period in the reach within the Main Processing Area that extends from a point a short distance upstream of station RD04 down to a location near seep location RD05. The lowermost section of Red Devil Creek at the delta also exhibited losing conditions at that time. At the locations where Red Devil Creek is a losing stream, surface water would flow from the creek and into groundwater within the adjacent sediment and soil (which consists of tailings/waste rock in the reach within the Main Processing Area and mixed alluvium and tailings/waste rock within the Red Devil Creek delta). The water would subsequently re-emerge into surface water at downstream locations. At any given locations, groundwater would be expected to flow in a direction approximately perpendicular to the potentiometric surface contour lines shown in Figures 3-9 through 3-11

For the May 2012 baseline monitoring, stream flow and groundwater elevations were measured on May 26, 2012. For the September 2012 baseline monitoring, stream flow was measured on September 12, and groundwater elevations were measured between September 8 and 10, 2012. For both the spring and fall 2012 baseline monitoring events, the stream exhibited a pattern of gaining and losing conditions similar to that seen in late August–early September 2011 (see Figures 3-10 and 3-11).

The losing reach in the RD04-RD05 area occurs within a high gradient reach of Red Devil Creek (see Figure 3-12). Stream gradient is discussed further in Section 3.3. The banks of Red Devil Creek in that area presently consist of steep embankments of tailings/waste rock that extend approximately 15 feet above the stream bed. Based on review of a historical photograph of the mine, this area coincides with the area of a former bridge between the Pre-1955 and Post-1955 portions of the Main Processing Area during mining operations. The bridge was apparently constructed of a large culvert covered with fill and wood planks. The bridge collapsed after the mine was abandoned. This high gradient section of Red Devil Creek is likely underlain by a wedge of material consisting of tailings/waste rock that has slumped into the creek and possibly fill material that formerly covered the culvert, and which is gradually being eroded and transported downstream. This area is represented in geologic cross-section C-C’ (Figure 3-5).

Below the losing reach, the stream again exhibits gaining conditions. By surface water station RD09, the stream appears to regain the lost flow. The flow in this section appears to be regained primarily through baseflow. Some of the flow in this section could potentially be regained at the seep located on the northern bank of the creek in the central portion of the Main Processing Area, at station RD05. The seep is approximately 3 feet above the creek level and discharges from coarse gravelly material. The measured discharge at the seep was 0.18 cfs, comprising only a small fraction of flow in this section of Red Devil Creek (see discussion of stream discharge in Section 3.3). The hydrology in the vicinity of the seep is complicated, however; the seep and baseflow in this reach appear to be influenced by the underground mine workings and associated bedrock fractures (see Section 3.2.6).

The lowermost section of Red Devil Creek at the delta is likely a losing reach during most times when Kuskokwim River stage is low. The decrease in discharge between stations RD06 or RD07 and RD08 suggests that that section was losing at the time of the RI and baseline monitoring stream gauging events.

3.2.3 Hydraulic Segregation

Unconsolidated overburden and bedrock saturated zones appear to be in hydraulic communication on a large scale, although some hydrologic hydraulic segregation exists locally, as discussed below.

Thin perched groundwater zones above apparently low permeability unconsolidated zones were identified during drilling at the following locations:

- Boring MP01 / Well MW08
- Boring MP17 / Well MW09
- Boring MP29 / Well MW15
- Boring MP32
- Boring MP56

Monitoring well MW15 was screened within a zone containing aquitard(s) and associated perched saturated zone(s). For this reason, the static water level in this well is disregarded in the potentiometric surface maps (Figure 3-9 through 3-11). Wells installed in the other borings listed above were screened within deeper saturated zones that are expected to be continuous.

Weathered bedrock locally exhibits clay and silt filling fractures. Where this occurs, the top of weathered bedrock may comprise a low permeability zone locally. For example, a thin saturated zone associated with such fracture filling was observed during drilling at the contact between unconsolidated materials and underlying weathered bedrock at soil boring MP14 / well MW10. Well MW10 was screened within a deeper saturated interval in bedrock. A similar situation was observed during drilling boring MP30 / well MW16, in which the fractures within the upper four feet of weathered bedrock (23 to 27 feet bgs) were filled with silt and clay. This zone appeared to segregate the overlying saturated interval within native/disturbed native soil) from the underlying weathered bedrock interval. Well MW16 was screened at the top of the weathered bedrock surface.

In several cases, groundwater was observed in saturated zones overlying the bedrock, but drilling was not advanced deeper than these zones. As such, it is not known whether the saturated zones encountered are perched or in hydraulic communication with bedrock at such locations, listed below:

- Boring MP25 / Well MW14
- Boring MP34
- Boring MP35

3.2.4 Bedrock Fracture Flow

Groundwater within the Kuskokwim Group bedrock unit appears to occur primarily within bedrock fractures, which are known to include bedding-parallel fractures, steep, northeast-striking joints, and the steep northwest-striking faults associated with the Red Devil fault. During drilling through Kuskokwim Group bedrock, little or no groundwater was observed until a transmissive fracture was penetrated. The depth of such fractures was commonly some depth below the static water level in the completed monitoring wells. In the following soil borings/wells that were screened within bedrock, the static water level on September 1, 2011 was higher than the elevation of the groundwater encountered during drilling:

- Boring MP14 / Well MW40
- Boring MP17 / Well MW09
- Boring MP31 / Well MW18
- Boring MP33 / Well MW19
- Boring MP62 / Well MW24
- Boring MP66 / Well MW23
- Boring MP88 / Well MW28
- Boring MP89 / Well MW25
- Boring MP91 / Well MW17
- Boring RD20 / Well MW33

During drilling of other soil borings in bedrock, the first occurrence of groundwater occurred at elevations similar to the static water level in the completed monitoring well. Such was the case for the following soil borings/monitoring wells:

- Boring MP20 / Well MW13
- Boring MP41 / Well MW29
- Boring MP52 / Well MW26
- Boring RD05 / Well MW32
- Boring UP11 / Well MW31

3.2.5 Vertical Gradient

Water levels for the following paired shallow and deep wells were evaluated to assess vertical hydraulic gradient.

- MW16 (shallow, screened in native/disturbed native soil) / MW17 (deep, screened in bedrock)
- MW27 (shallow, screened in native/disturbed native soil and weathered bedrock) / MW28 (deep, screened in bedrock and suspected mine workings cavity)

During the September 2011 RI monitoring, there was an upward gradient in both the MW27/MW28 well pair and the MW16/MW17 well pair (E & E 2013). During the May 2012 and September 2012 monitoring events, there was an upward gradient in the MW27/MW28 well pair and a downward gradient in the MW16/MW17 well pair. The interpretation of vertical gradient in the MW16/MW17 well pair is complicated by possible hydraulic segregation (Section 3.2.3) and local losing conditions along Red Devil Creek (Section 3.2.2). It is likely that along the axis of the Red Devil Creek valley, the vertical gradient within bedrock is predominantly upward. Vertical groundwater flow and contaminant migration is discussed in Chapter 5.

3.2.6 Underground Mine Workings

The presence of an extensive network of underground mine workings at the site likely exerts a significant influence over groundwater flow at the RDM. The mine workings appear to provide a highly transmissive groundwater flow network that connects a large area west of and underlying the Main Processing Area.

As indicated in Figures 3-9 through 3-11, static water elevations are somewhat depressed in the area of underground mine workings. This is likely attributable to a draining effect of the mine workings. Groundwater within the mine workings likely readily drains from the mine to the highest nearby base level, which is the level of Red Devil Creek. Such groundwater migration would occur via the mine workings network and bedrock fractures. A map illustrating the configuration of the underground mine workings as of 1962 (Malone 1962 and MacKevett and Berg 1963) is presented in Figure 1-7. Information from a 1962 mine workings cross section (Alaska Mines and Minerals, Inc. and Decoursey Mountain Mining Co., Inc., 1962) is projected onto geologic cross section B-B’ (Figure 3-4). These historical mine documents indicate that overhand stopes were driven from the 200 level (see Figure 1-7), also referred to as the 150 level (see Figure 3-4), to near the surface in the vicinity of Red Devil Creek. Stoping followed the ore shoots, which are associated with fracture systems. As such, bedrock fractures associated with the stopes likely extend to the top of bedrock in this area. Groundwater from the mine workings may be expected to migrate from the stopes up the fractures to the top of bedrock. The 1962 mine workings map and cross section also indicate stoping upward from the 73 level (Figure 1-7), also referred to as the 70 level (Figure 3-4), to near the surface in the Pre-1955 Main Processing Area. These mine workings also may represent preferential groundwater flow pathways.

Results of a geophysical survey conducted by the USGS (Burton and Ball 2011) at the RDM site using surface-based, direct-current resistivity and electromagnetic induction methods, strongly support the presence of near-surface stopes described above. The resistivity results indicated the presence of several anomalies in the subsurface along Red Devil Creek in the Main Processing Area, including two anomalies that appear likely to be associated with underground mine workings. Anomaly D is interpreted to be an elongate conductive anomaly that underlies Red Devil Creek for a distance of at least approximately 200 feet. Anomaly E is interpreted to be a “discrete, nearly vertical, conductive anomaly that extends to within approximately 6 feet of the surface (anomaly E) that is closer to the creek level and has a character more indicative of a point source” (Burton and Ball 2011). Anomaly E is in close proximity to the seep on the left bank of Red Devil Creek. The approximate locations of these resistivity anomalies are shown in geologic cross sections (Figures 3-4 and 3-5).

During both the 2010 and 2011 field seasons, yellowboy was present at the seep location adjacent to Red Devil Creek. During the 2011 field season, yellowboy was also observed on the stream’s northern bank between the seep and approximately 20 feet upstream of the seep, suggesting that baseflow discharging to the creek in this area contains a similar level of dissolved iron as the focused flow at the seep. The source(s) of groundwater that emanates from the seep is not clear, but may include groundwater flowing from the mine workings. The effect of the underground mine workings on groundwater flow paths and chemical conditions is discussed further in Chapter 5.

3.3 Surface Water Hydrology and Sediment

3.3.1 Red Devil Creek

As described in Section 1.4.3.4, Red Devil Creek drains an area of approximately 687 acres and is one of the smaller tributaries of the Kuskokwim River in the region. The reach of the creek extending from the reservoir dam to the Kuskokwim River is approximately 2,500 linear feet, varying with the stage of the Kuskokwim River. A barge landing was constructed at the mouth of Red Devil Creek when the mine was first developed extending into the channel of the Kuskokwim River. The barge landing coincides with the Red Devil Creek delta. The creek channel has evidently migrated over time due to emplacement of mine waste materials into the stream bed in the Main Processing Area and other modifications. The channel has likely also migrated as a result of heavy sediment loading downstream. Figure 1-7 illustrates the positions of the stream channel as of 1963 (date of the geologic map overlay) and 2010 (date of the aerial photograph).

Stream Gradient

Red Devil Creek has an average gradient of approximately 5 percent between the reservoir dam and the Kuskokwim River. The elevation profile of Red Devil Creek is illustrated in Figure 3-12. Key features of Red Devil Creek are illustrated on Figures 1-3, 1-5, and 3-12. The creek's gradient is generally consistent between the reservoir and the confluence with the Kuskokwim River, with two noteworthy exceptions within the Main Processing Area where gradient the stream gradient flattens and then abruptly steepens to approximately 10 percent. These sections are discussed further below.

Red Devil Creek at sample station RD06.

The upper of the two higher gradient sections coincides with the losing reach in the RD04-RD05 area described in Section 3.2.2. As noted in Section 3.2.2, this section of the creek is likely underlain by a wedge of material consisting of tailings/waste rock that has slumped into the creek and possibly fill associated with the former bridge which is gradually being eroded and transported downstream.

A second, smaller section of comparatively higher gradient is located immediately downstream of the road crossing through Red Devil Creek near station RD09 (see Figure 3-12).

Stream Discharge

The Red Devil Creek delta on the Kuskokwim River.

Discharge was measured on August 18, 2011, at locations along Red Devil Creek that are collocated with sediment and surface sampling stations. Stream discharge also was measured during May 2012 and September 2012 baseline monitoring events to evaluate seasonal variation. Table 3-2 summarizes the discharge data for Red Devil Creek during the 2011 and 2012 field events.

Table 3-2 Red Devil Creek Discharge – Upstream to Downstream Locations

Monitoring Location	Estimated Discharge (cfs)		
	August 18, 2011	May 26, 2012	September 12, 2012
RD10	5.52	12.18	4.64
RD04	5.95	12.67	3.45
RD13	Station not established	10.53	3.79
RD12	8.24	Station not monitored	Station not monitored
RD09	5.98	13.36	3.40
RD06	6.81	14.47	3.80
RD08	7.19	14.20	3.09

Key:

cfs	cubic feet per second

The 2011 calculated discharge rate at station RD12SW is believed to be inaccurate. Station RD12SW is located at the road stream crossing (see Figure 3-12) where the stream is broad and shallow, making water velocity measurements difficult and subject to error.

The mouth of Red Devil Creek at the Kuskokwim River, September 2010.

Measured stream discharge rates during September 2012 were between 20 and 60 percent lower than observed in August 2011, depending on monitoring location, but generally exhibited similar trends of gain and loss along the length of Red Devil Creek (see Section 3.2.2 for discussion of stream gain and loss). In May 2012, measured discharge values were between 2 and 2.2 times those observed during August 2011, and between 2.6 and 4.6 times as high as those measured in September 2012. The May 2012 discharge was measured a short time after the beginning of breakup and thus likely approximates high flow conditions for the creek.

Review of 2012 snowpack data for the middle Kuskokwim River region indicates that May 2012 represented a period with above average snowpack depths and average snow water content. This suggests that the spring sampling event in 2012 targeted a relatively high level of runoff during the breakup season (NRCS 2012).

Stream Gain and Loss

Stream gain and loss is discussed in Section 3.2.2.

Stream Substrate

The substrate of Red Devil Creek upstream of the Main Processing Area is composed primarily of natural alluvium. From the Main Processing Area downstream to the Kuskokwim River, the creek substrate is dominated by the tailings and waste rock. Table 3-3 presents the grain size distribution of sediment samples collected from Red Devil Creek. Results are presented starting with upstream samples and moving downstream.

Seep

During the 2010, 2011, and 2012 field seasons, yellowboy was present at the seep location RD05. A sulfur odor is associated with the seep due to elevated sulfate content (see Chapters 4 and 5). During the 2011 field season, yellowboy was also observed on the stream's northern bank between the seep and approximately 20 feet upstream of the seep, suggesting a relationship between baseflow in this area and the focused flow at the seep. The source of groundwater that discharges from the seep is unclear, but appears to be associated with the underground mine workings (see Section 3.2.6 and Chapter 5).

During the spring 2012 field event, a significant accumulation of yellowboy was present above the water line of Red Devil Creek and in the bed of the creek. Flow from the seep was visually much greater than observed during previous sampling events, but could not be measured due to high water levels.

During the fall 2012 field event, yellowboy was again present at the water line of Red Devil Creek and in the creek bed. Flow from the seep was visually observed to be significantly lower than the spring field event.

Table 3-3 Red Devil Creek Grain Size Data

Sample Identification	Percent[1,2] Gravel (4.75–75 mm)	Percent Coarse Sand (2–4.75 mm)	Percent Medium Sand (0.425–2 mm)	Percent Fine Sand (0.075–0.425 mm)	Percent Fines (silt and clay >0.075 mm)	Description
10RD01SD	32.7	19.3	11.8	12	24.1	Gravelly Sand
10RD02SD	0.2	1.6	3.4	12.8	82	Sandy Silt
10RD03SD	34.7	16.1	20.4	10	18.8	Gravelly Sand
11RD11SD	0.3	0.1	3.5	63.9	30.3	Silty Sand
11RD10SD	71.6	10.9	9.83	5.68	2.12	Sandy Gravel
10RD04SD	14.8	40.8	35	2.5	6.8	Gravelly Sand
10RD05SD	4.3	2	5.4	3.8	84.8	Sandy Silt
11RD12SD	83.7	10.79	3.2	0.33	1.95	Sandy Gravel
10RD09SD	15.2	34.1	39.8	2.6	8.4	Gravelly Sand
10RD06SD	22.7	28.2	29.6	4.2	15.3	Gravelly Sand
10RD07SD	14.6	20.2	38	6.5	20.7	Silty Sand
10RD08SD	20.6	26.2	34.6	5.6	13	Gravelly Sand

Table 3-3 Red Devil Creek Grain Size Data

Sample Identification	Percent[1,2] Gravel (4.75–75 mm)	Percent Coarse Sand (2–4.75 mm)	Percent Medium Sand (0.425–2 mm)	Percent Fine Sand (0.075–0.425 mm)	Percent Fines (silt and clay >0.075 mm)	Description

Notes:

[1] Rocks and cobbles were removed from collected sample material which biases these results toward finer grain size distributions.

[2] Grain size percentages may not total to 100% due to rounding error and different measurement methodology used to determine percent fines.

Key:

mm	millimeters

3.3.2 Kuskokwim River

Discharge in the Kuskokwim River at the RDM site was not measured during the RI field investigations. However, the USGS maintains a river gauging station at Crooked Creek, located approximately 35 river miles downstream of the RDM. The discharge maximum during the 2011 summer season occurred on August 16, 2011, and was recorded at 99,200 cfs. River discharge during the Kuskokwim River off-shore sediment sampling event, conducted between September 21 and 25, 2011, ranged from 47,300 to 51,600 cfs, with river discharge levels decreasing during the sampling period (Burton and Ball 2011).

Kuskokwim River shoreline sediment.

During the 2011 Kuskokwim River off-shore sediment sampling events, river depth soundings were collected to generate a bottom profile of the river in the near shore zone adjacent to the RDM upland area. Figure 3-13 presents the near shore bathymetry of the Kuskokwim River based on these data.

Table 3-4 presents the grain size distribution of sediment samples collected from the Kuskokwim River. Results are presented starting with upstream samples moving downstream.

Table 3-4 Kuskokwim River Grain Size Data

Sample Identification	Percent[1,2] Gravel (4.75–75 mm)	Percent Coarse Sand (2–4.75 mm)	Percent Medium Sand (0.425–2 mm)	Percent Fine Sand (0.075–0.425 mm)	Percent Fines (silt and clay >0.075 mm)	Description
Shoreline Sediment Samples						
11KR01SD	73.2	11.96	6.62	6.06	1.66	Sandy Gravel
11KR12SD	63.55	8.37	6.85	5.66	17.93	Sandy Gravel
10KR13SD	17.2	6.6	4.9	28.5	42.8	Sandy Silt
11KR14SD	20.65	2.57	5.29	35.05	43.92	Sandy Silt
11KR15SD	59.77	10.61	8.34	9.32	13.29	Sandy Gravel
10KR02SD	11.2	19.7	41.7	9.3	18	Silty Sand
11KR16SD	0.01	0.08	1.06	15.9	98.32	Sandy Silt
10KR03SD	0.4	0.2	0.3	6.8	92	Sandy Silt
10KR04SD	2.6	1.4	1.2	28.1	66.6	Sandy Silt
11KR05SD	13.6	12.91	11.55	36.16	26.63	Silty Sand
11KR06SD	0	0.33	0.92	39.06	70.13	Sandy Silt
10KR07SD	6.3	21.6	32.8	17.9	21.5	Silty Sand
11KR08SD	0.07	1.58	5.96	46.19	50.71	Silty Sand
11KR09SD	2.97	4.27	4.93	44.26	52.92	Sandy Silt
10KR10SD	23.1	15.9	13.9	23.9	23.2	Silty Sand
10KR11SD	6.9	4.7	2.2	44.4	41.7	Silty Sand
11KR17SD	6.24	7.84	12.93	31.16	49.41	Sandy Silt
Off-Shore Sediment Samples						
11KR48SD	61.37	4.52	4.13	19.06	12.36	Sandy Gravel
11KR49SD	77.58	5.97	3.05	12.99	1.26	Sandy Gravel
11KR50SD	59.73	7.87	5.68	20.04	7.31	Sandy Gravel
11KR51SD	60.66	11.28	8.73	13.45	6.37	Sandy Gravel
11KR53SD	0.12	3.86	12.70	41.25	45.53	Silty Sand
11KR18SD	42.46	3.68	2.43	13.74	41.56	Silty Gravel
11KR19SD	78.8	6.2	3.1	6.04	6.04	Sandy Gravel
11KR20SD	73.0	6.1	7.8	11.87	0.97	Sandy Gravel
11KR21SD	59.9	13.9	13.8	12.4	0	Sandy Gravel
11KR22SD	74.8	2.8	3.9	11.96	6.33	Sandy Gravel
11KR23SD	59.97	10.82	5.01	11.59	14.52	Sandy Gravel
11KR24SD	72.07	9.26	3.43	11.23	7.2	Sandy Gravel
11KR25SD	32.35	5.51	8.19	28.23	25.46	Gravelly Sand
11KR26SD	2.5	2.4	7.9	48.0	45.96	Silty Sand
11KR27SD	69.2	5.5	3.3	21.7	0.19	Sandy Gravel
11KR28SD	77.3	6.2	3.9	5.58	7.39	Sandy Gravel

Table 3-4 Kuskokwim River Grain Size Data

Sample Identification	Percent[1,2] Gravel (4.75–75 mm)	Percent Coarse Sand (2–4.75 mm)	Percent Medium Sand (0.425–2 mm)	Percent Fine Sand (0.075–0.425 mm)	Percent Fines (silt and clay >0.075 mm)	Description
11KR29SD	73.2	8.10	4.2	5.52	8.8	Sandy Gravel
11KR30SD	93.84	1.97	2.38	1.18	0.63	Sandy Gravel
11KR34SD	92.37	1.71	1.92	2.81	1.97	Sandy Gravel
11KR35SD	93.26	2.59	2.21	1.43	0.42	Sandy Gravel
11KR36SD	0	0	1.1	50.2	58.1	Sandy Silt
11KR37SD	0	0	1.0	46.4	56.94	Sandy Silt
11KR38SD	58.21	11.75	12.2	15.74	1.41	Sandy Gravel
11KR39SD	62.81	8.97	4.61	2.61	20.72	Silty Gravel
11KR40SD	60.9	3.9	2.1	15.2	21.34	Silty Gravel
11KR41SD	67.8	7.1	6.6	17.12	3.09	Sandy Gravel
11KR42SD	88.4	3.8	2.0	3.87	2.47	Sandy Gravel
11KR43SD	59.06	10.35	5.24	4.25	25.82	Silty Gravel
11KR44SD	65.8	12.4	4.9	13.06	4.77	Sandy Gravel
11KR45SD	12.7	2.6	13.0	35.8	41.3	Silty Sand
11KR46SD	77.86	7.9	3.8	4.66	5.77	Sandy Gravel
11KR47SD	67.49	10.26	6.54	5.68	11.47	Sandy Gravel
0912KR54SD	49.6	13.6	18.2	16.3	2.3	Sandy Gravel
0912KR55SD	68.4	9.6	10.1	10.3	4.4	Sandy Gravel
0912KR58SD	70.5	10	8.6	11	4.1	Sandy Gravel
0912KR59SD	73.7	11	6.3	11.4	4.4	Sandy Gravel
0912KR60SD	35.1	17.6	21.2	5.6	20.5	Sandy Gravel
0912KR61SD	73	11.5	9.3	11.7	5.5	Sandy Gravel
0912KR62SD	62	9.8	7.7	13.5	7.1	Sandy Gravel
0912KR63SD	63.2	13.6	11	10.1	2.1	Sandy Gravel
0912KR64SD	63.6	16	12.3	7.1	4.4	Sandy Gravel
0912KR66SD	52.1	11	8.3	15.8	12.8	Sandy Gravel
0912KR67SD	79.6	11.3	5.6	7.1	13.0	Sandy Gravel
0912KR68SD	58.4	14.8	14.8	10.9	4.8	Sandy Gravel
0912KR69SD	73	8	12.5	11.1	4.6	Sandy Gravel
0912KR70SD	62.9	13.4	11.1	7	5.5	Sandy Gravel
0912KR71SD	67.1	15.2	7.6	9.3	0.8	Sandy Gravel
0912KR72SD	31.5	11.9	14.2	6.5	35.9	Sandy Gravel
0912KR74SD	47.7	9	12.9	19.1	11.3	Sandy Gravel
0912KR75SD	38.2	12	15.7	24.4	9.7	Sandy Gravel
0912KR76SD	40.5	19.1	10.7	5.3	24.4	Sandy Gravel

Table 3-4 Kuskokwim River Grain Size Data

Sample Identification	Percent[1,2] Gravel (4.75–75 mm)	Percent Coarse Sand (2–4.75 mm)	Percent Medium Sand (0.425–2 mm)	Percent Fine Sand (0.075–0.425 mm)	Percent Fines (silt and clay >0.075 mm)	Description
0912KR77SD	54.5	14	9.1	12.4	10	Sandy Gravel
0912KR78SD	54.9	9.3	9.1	21.8	5.0	Sandy Gravel
0912KR79SD	75.8	8.6	5.6	12.9	2.9	Sandy Gravel
0912KR80SD	58	9.4	18.1	14.3	3.5	Sandy Gravel
0912KR81SD	62.6	7	15.5	18	3.1	Sandy Gravel

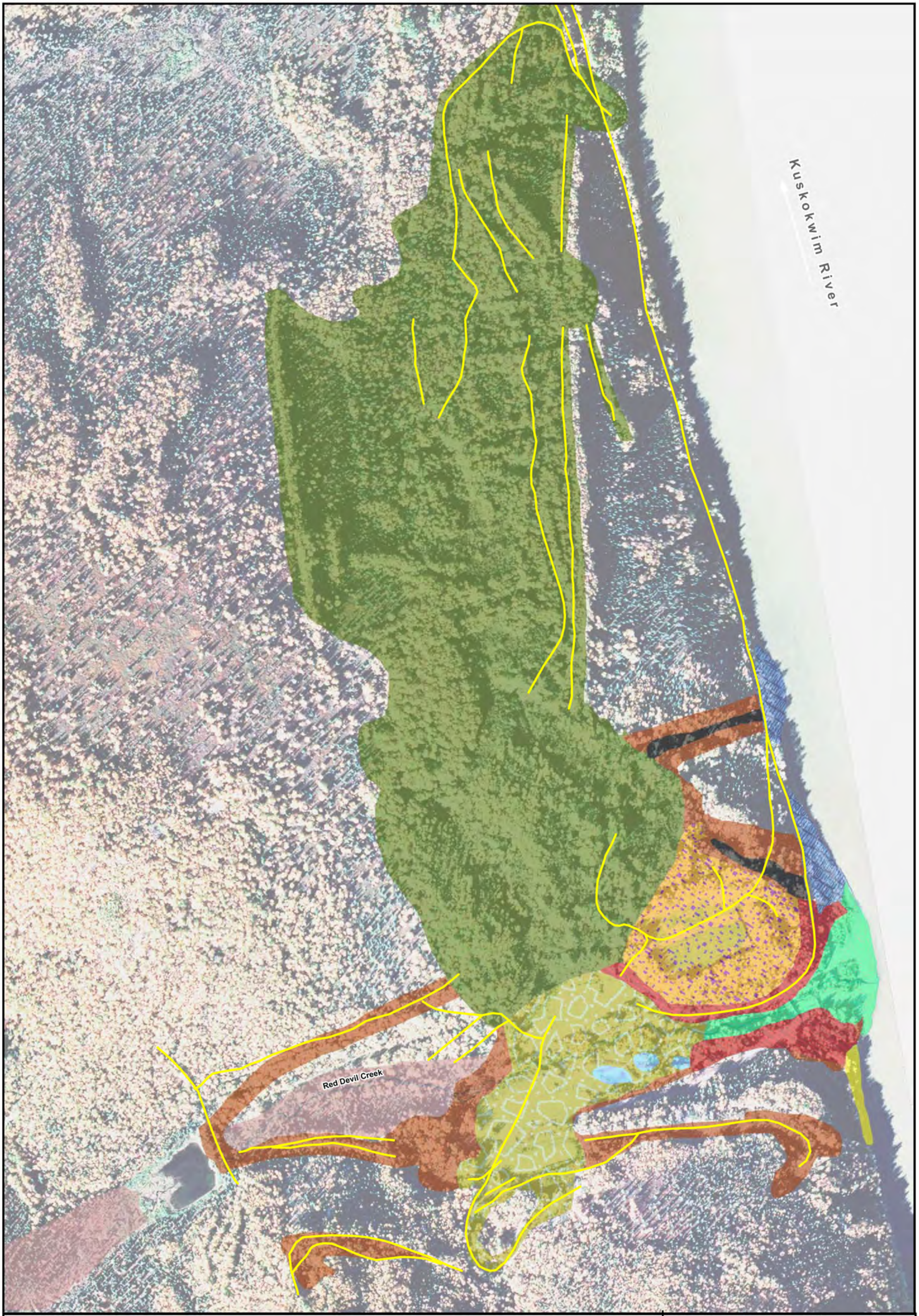
Notes:

[1] Rocks and cobbles were removed from collected sample material which biases these results toward finer grain size distributions.

[2] Grain size percentages may not total to 100% due to rounding error and different measurement methodology used to determine percent fines.

Key:

mm	millimeters



- Road
- Red Devil Creek alluvial deposits
- Kuskokwim River alluvial deposits
- Loess and/or disturbed loess mixed with soil derived from the Kuskokwim Group
- Disturbed soils in surface mined area (includes areas of undisturbed native soils)
- Mixed loess, Kuskokwim Group bedrock, and Kuskokwim Group derived soils found in the Dolly and Rice Sluices
- Disturbed native soils
- Sluiced overburden
- Tailings and/or waste rock
- Flotation tailings
- Disturbed native soil with local tailings and/or waste rock and fill along road alignments and other areas of operations
- Mixed Red Devil Creek alluvium, native soil, and tailings and/or waste rock

RED DEVIL MINE

Red Devil, Alaska

- Refer to Table 3-1 for description of soil types
- Refer to Tables 3-2 through 3-9 for detailed soil types at surface soil sample locations

Figure 3-1
Simplified Surface Soil Type Map

0 50 100 200 300 400 500 600
Feet
0 25 50 100 150
Meters
Scale 1:3,800

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_3-2_geologic_x-section_line.mxd Date: 1/25/2013

Pre-RI Monitoring Wells
Soil Boring Location
Cross-Section
Topographic Contour (2 ft. interval)
Topographic Contour (10 ft. interval)
Settling Pond
Monofill
Historical Structure

RED DEVIL MINE

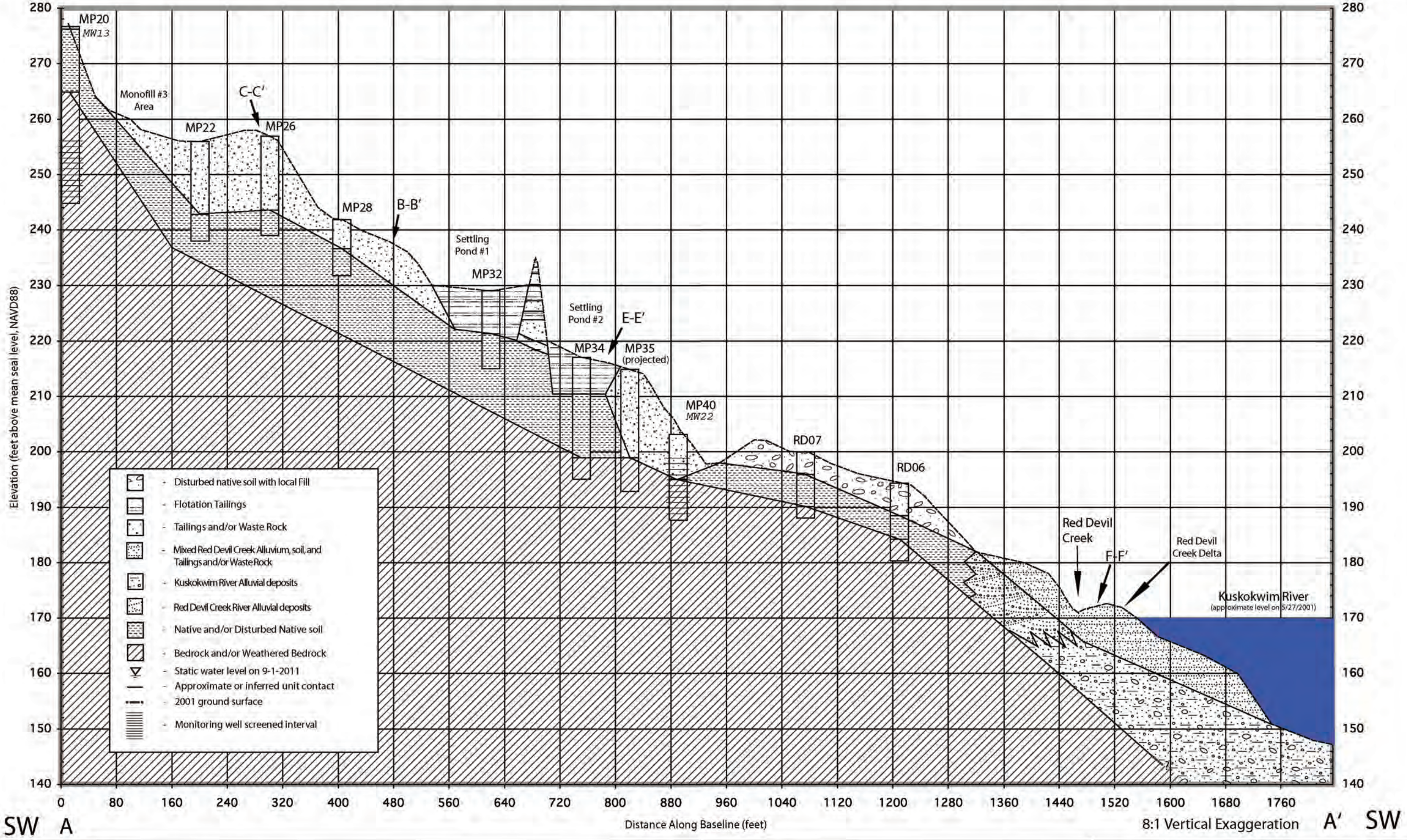
Red Devil, Alaska

Figure 3-2
Geologic Cross Section Line Map

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100
Meters

Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

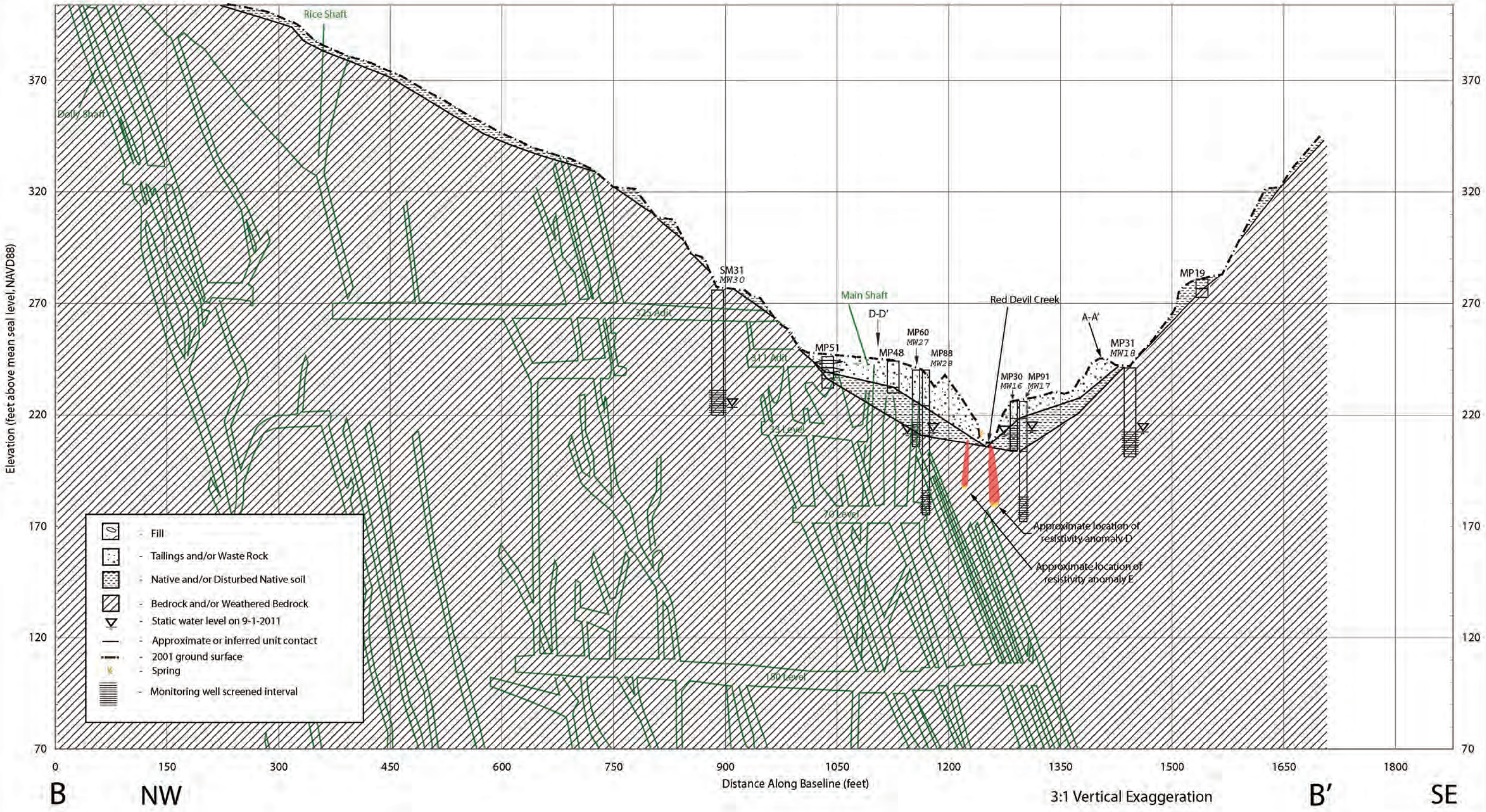
02:EE-001096-0070-08\Figure 3-3 A-A.pdf-01/28/13-GRA



Note: Surface topography and Kuskokwim River
Level based on 5/27/2001 aerial photograph
and topographic map (Aero-Metric, Inc. 2010b)

RED DEVIL MINE
Red Devil, Alaska

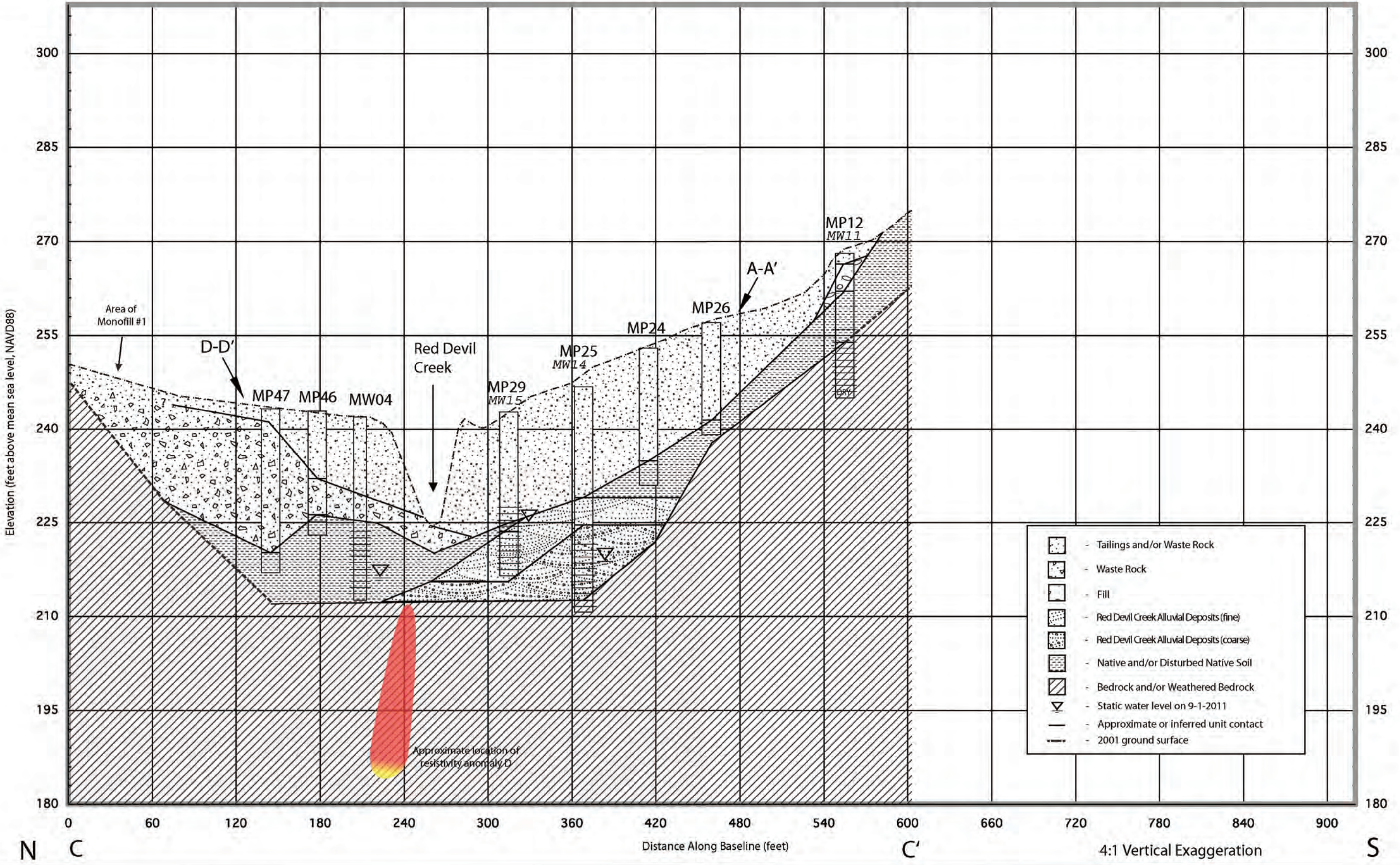
Figure 3-3
Geologic Cross Section
A-A′



Notes: 1) Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010b)
2) Mine workings projected onto geological cross section based on March 1962 longitudinal projection (Alaska Mines and Minerals, Inc. and Decoursey Mountain Mining Co., Inc., 1962)
3) Approximate resistivity anomaly locations based on USGS (2011)

RED DEVIL MINE
Red Devil, Alaska

Figure 3-4
Geologic Cross Section
B-B'

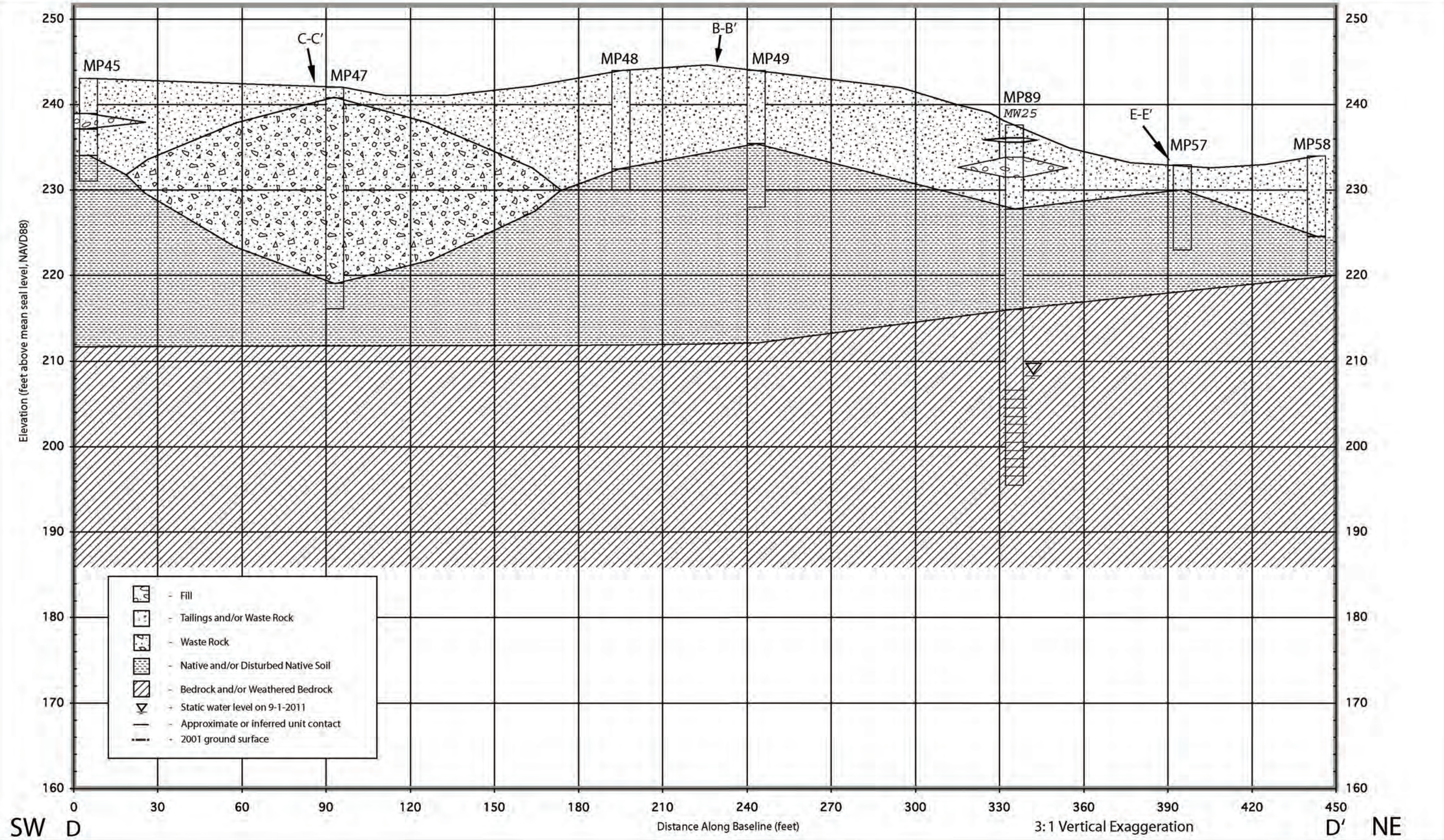


Notes: 1) Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010b)
2) Approximate resistivity anomaly locations based on USGS (2011)

RED DEVIL MINE
Red Devil, Alaska

Figure 3-5
Geologic Cross Section C-C′

02:EE-001096-0070-08\Figure 3-6 D-D.pdf-01/28/13-GRA



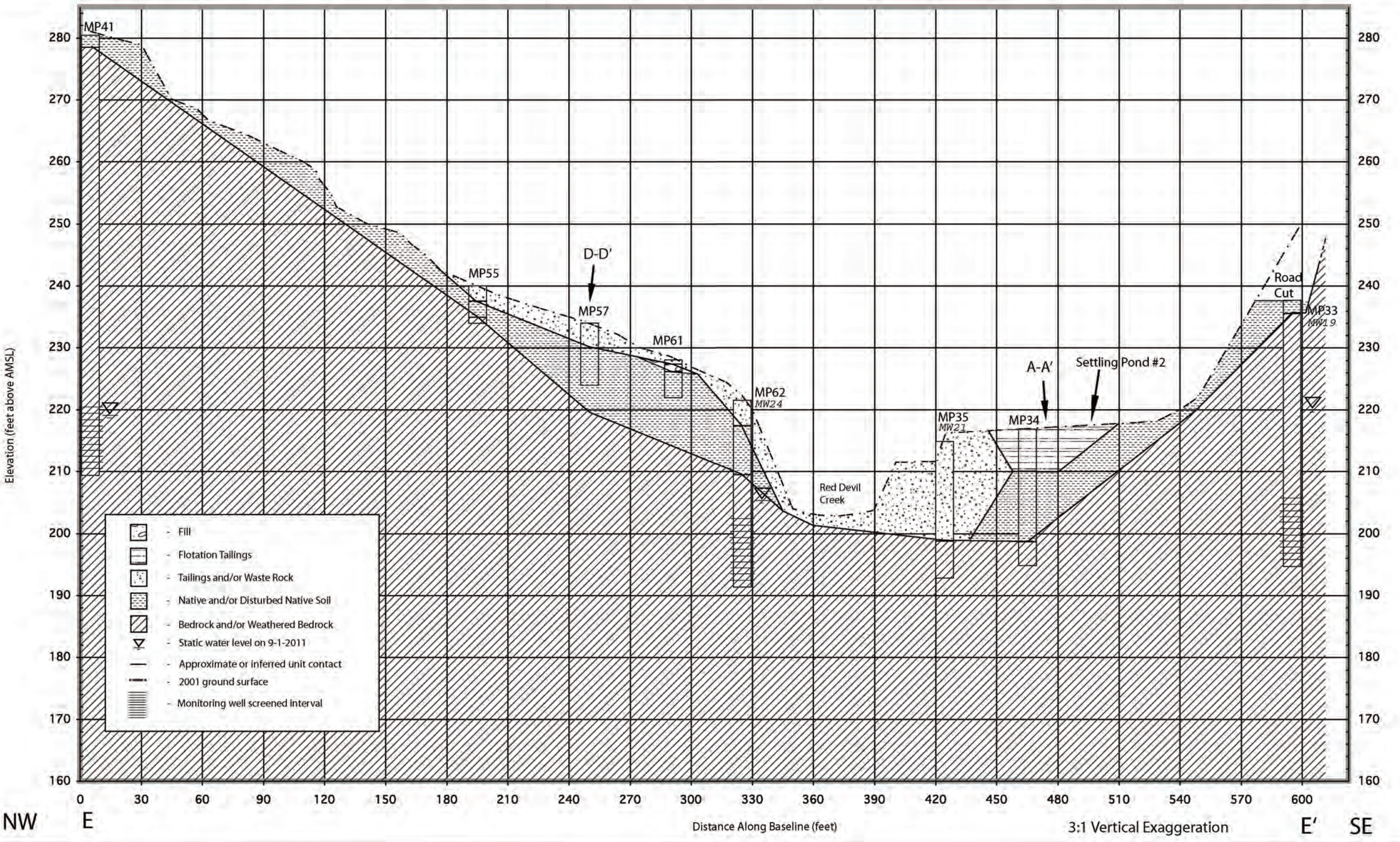
Notes: Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010b)

RED DEVIL MINE

Red Devil, Alaska

Figure 3-6
Geologic Cross Section
D-D′

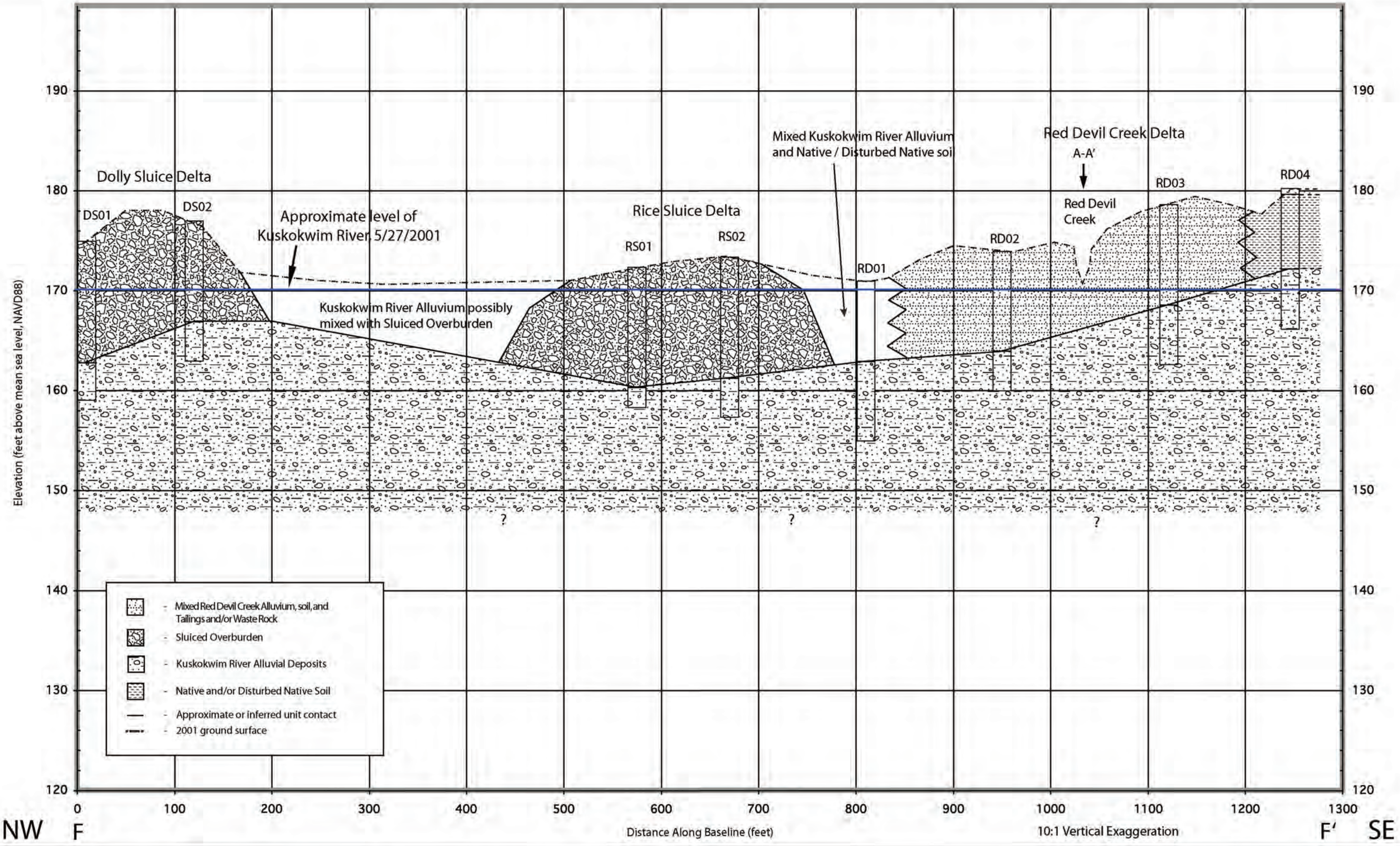
02:EE-001096-0070-08\Figure 3-7 E-E.pdf-01/28/13-GRA



Notes: 1) Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010b)

RED DEVIL MINE
Red Devil, Alaska

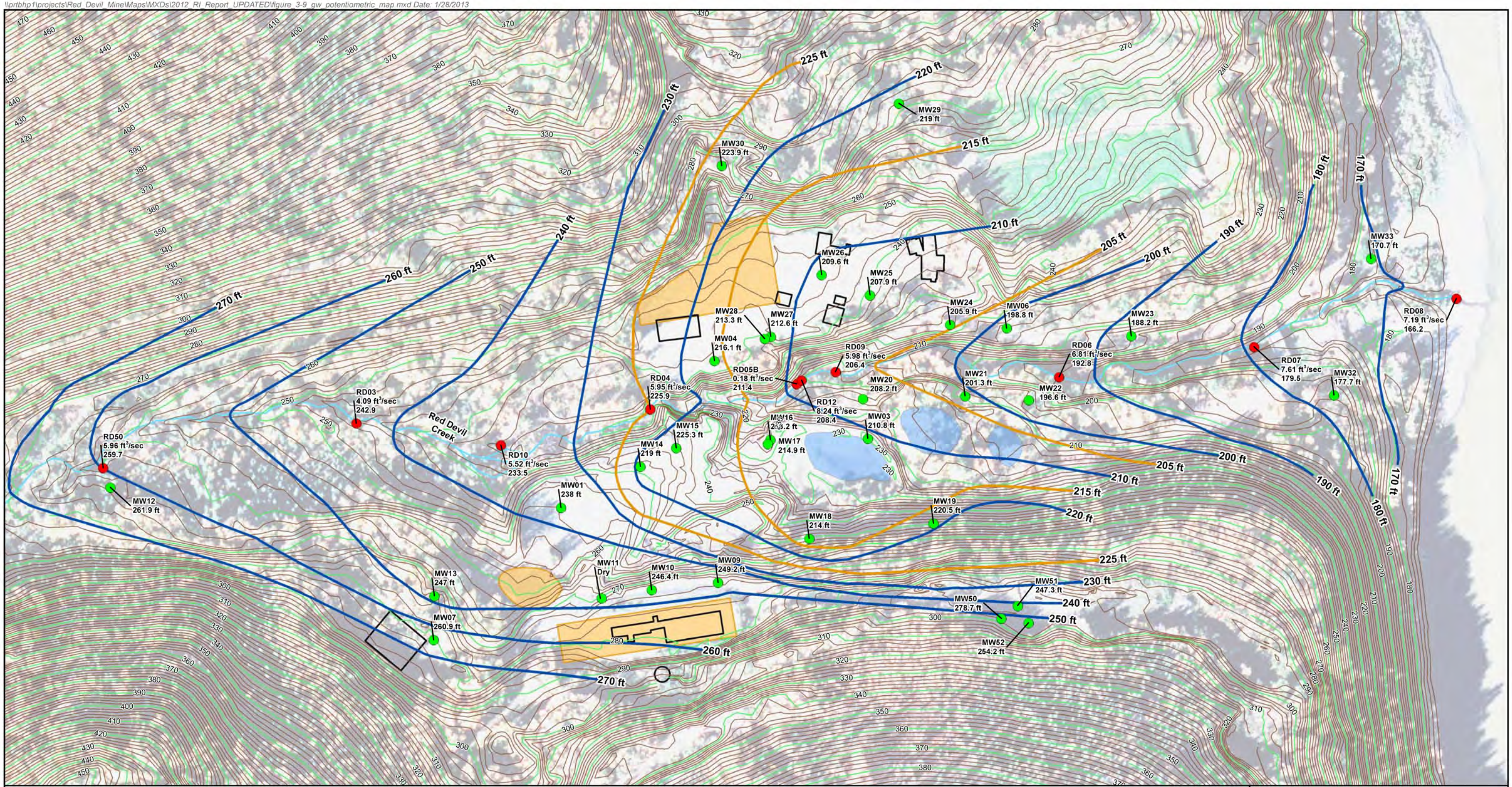
Figure 3-7
Geologic Cross Section
E-E′



Notes: Surface topography and Kuskokwim River level based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010b)

RED DEVIL MINE
Red Devil, Alaska

Figure 3-8
Geologic Cross Section
F-F'



● Red Devil Creek Estimated Flow and Elevation
● Monitoring Well Groundwater Elevation
Groundwater Contour (10 ft. interval)
Groundwater Contour (5 ft. interval)
Topographic Contour (2 ft. interval)
Topographic Contour (10 ft. interval)
▨ Settling Pond
▨ Monofill
☐ Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 3-9
Groundwater Potentiometric Surface and Surface Water

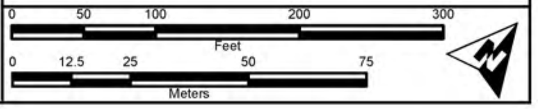
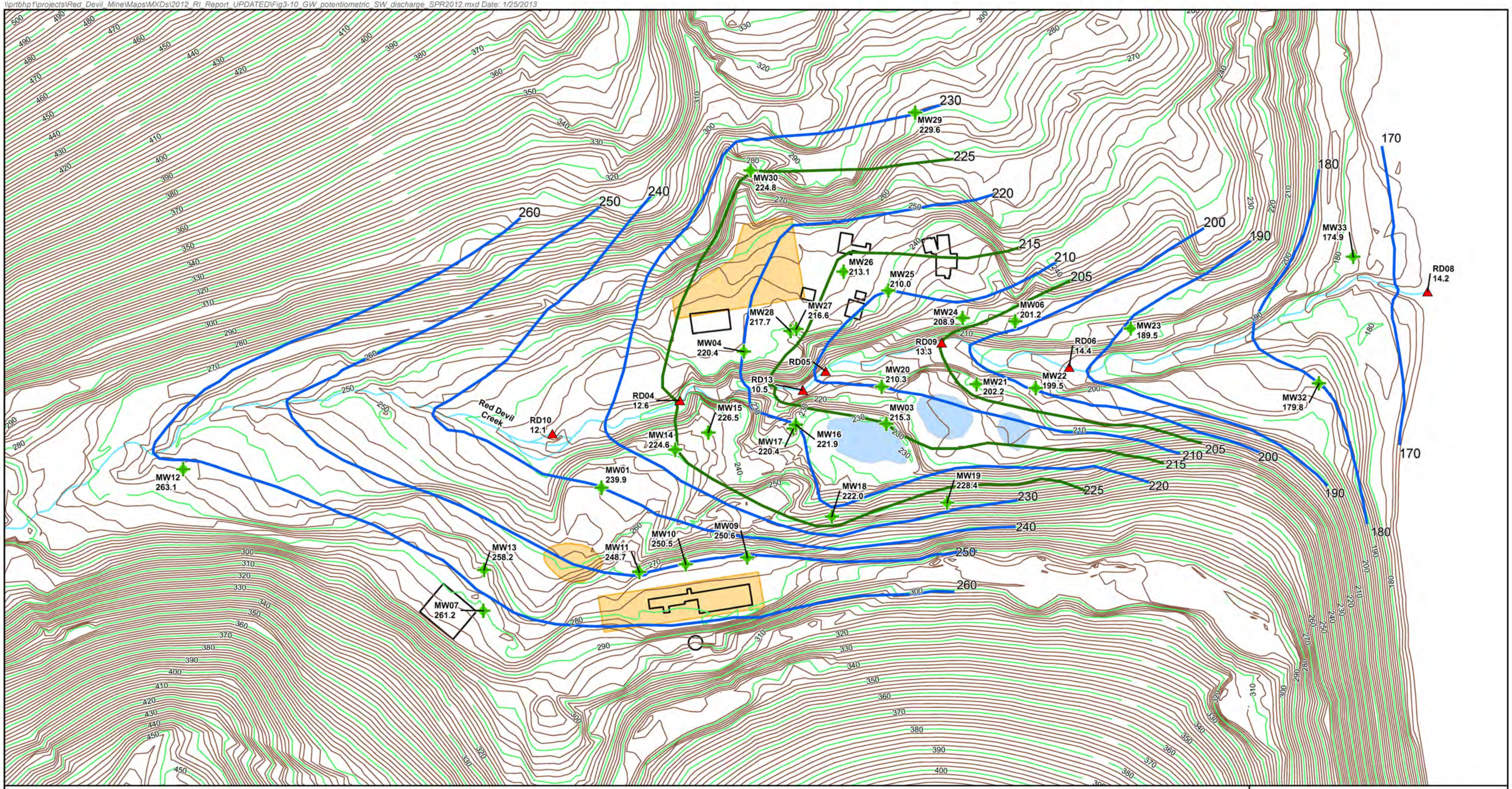


Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

Ecology & Environment, Inc. GIS Department Project: \\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\Fig3-10_GW_potentiometric_SW_discharge_SPR2012.mxd Date: 1/25/2013



- Groundwater Contour (10 ft. interval)
- Groundwater Contour (5 ft. interval)
- Topographic Contour (2 ft. interval)
- Topographic Contour (10 ft. interval)
- ✚ May 26, 2012 Groundwater Elevation
- ▲ May 26, 2012 Estimated Surface Water Discharge (cu ft/second)
- 🟦 Settling Pond
- 🟧 Monofill
- ☐ Historical Structure

RED DEVIL MINE

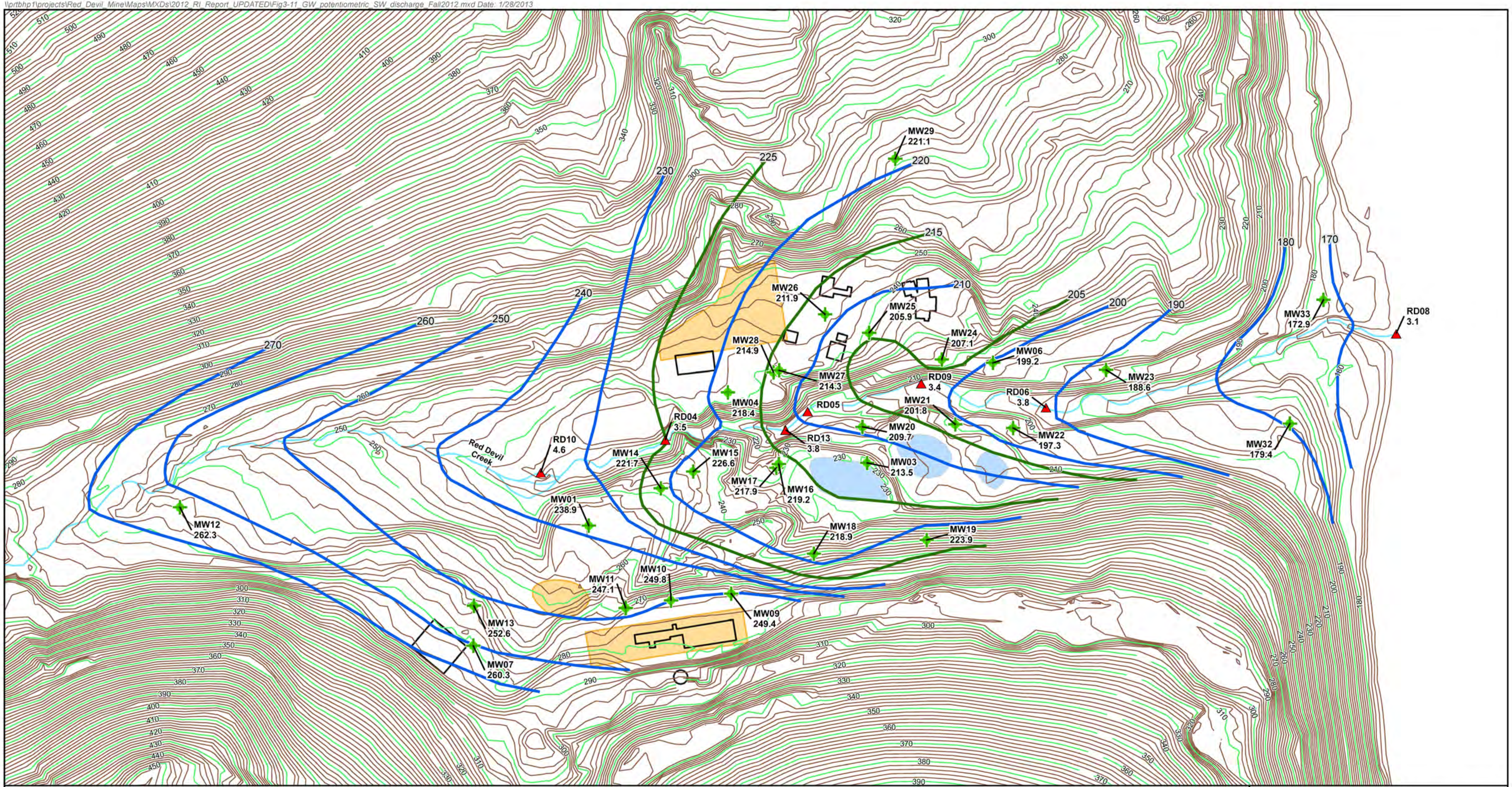
Red Devil, Alaska

Figure 3-10
Groundwater Potentiometric Surface and Surface Water Discharge Map
Spring 2012

0 50 100 200 300
Feet
0 12.5 25 50 75
Meters

Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

Ecology & Environment, Inc. GIS Department Project: \\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\Fig3-11_GW_potentiometric_SW_discharge_Fall2012.mxd Date: 1/28/2013



✔ Groundwater Contour (10ft interval)

✔ Groundwater Contour (5ft interval)

╱ Topographic Contour (2 ft. interval)

╱ Topographic Contour (10 ft. interval)

✚ September 2012 Groundwater Elevation

▲ September 2012 Estimated Surface Water Discharge (cu ft/second)

🟦 Settling Pond

🟧 Monofill

☐ Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 3-11
Groundwater Potentiometric Surface and Surface Water Discharge Map
Fall 2012

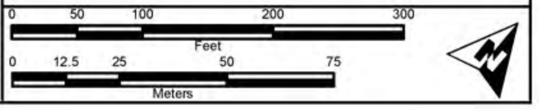
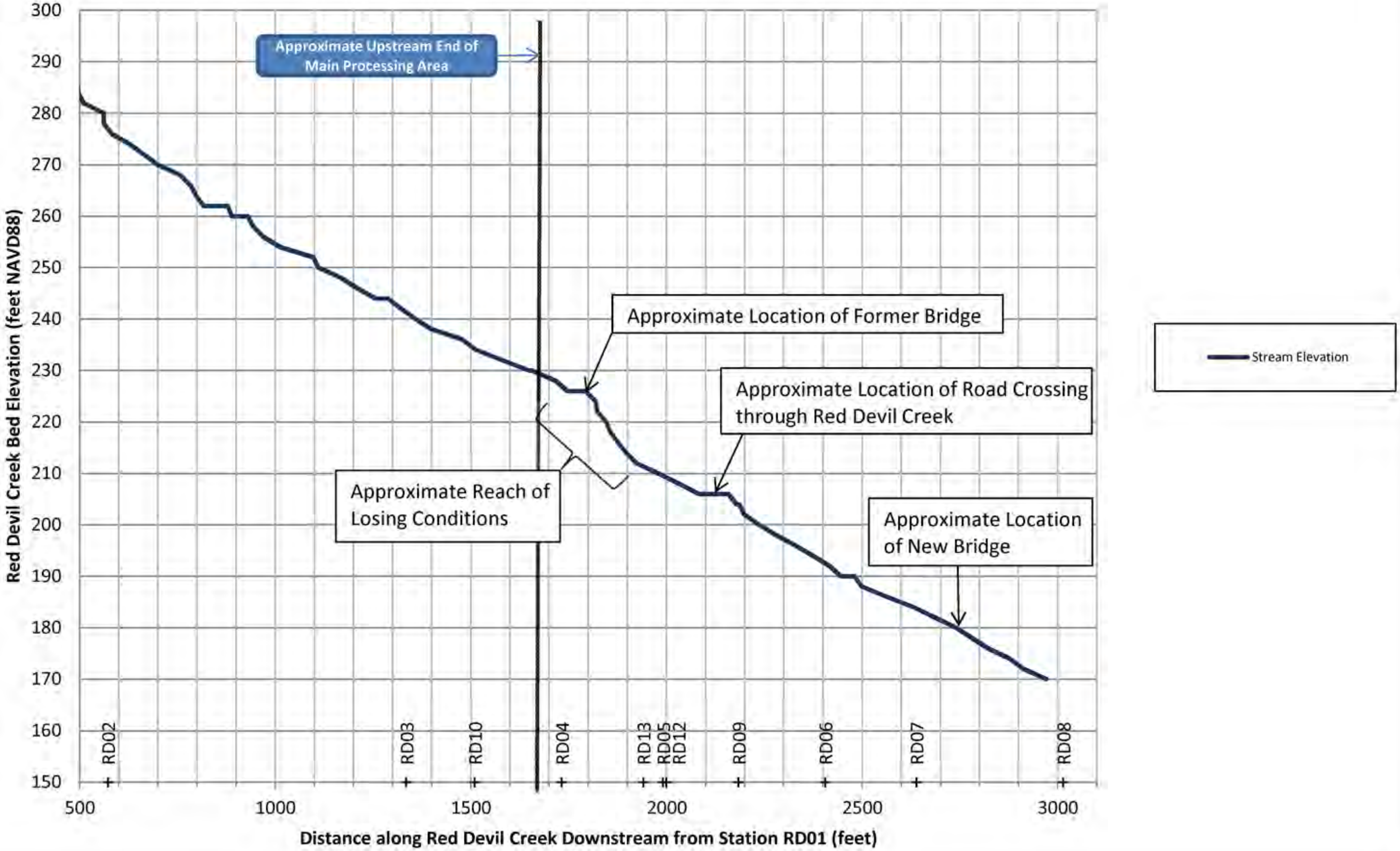


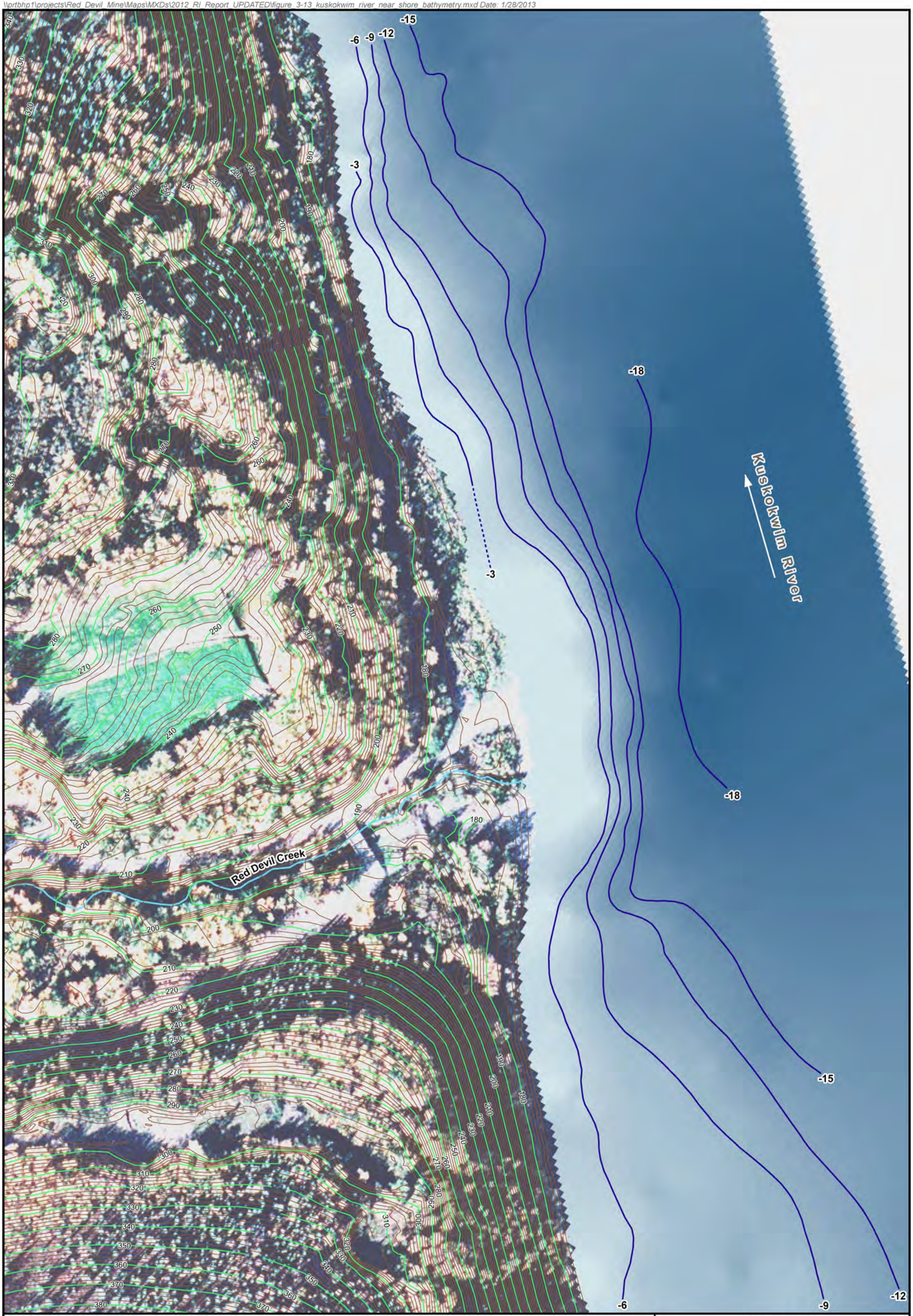
Image Source: Aero-Metric, Inc. 2010a

Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

Figure 3-12
Red Devil Creek Elevation Profile



Ecology & Environment, Inc. GIS Department Project: \\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\figure_3-13_kuskokwim_river_near_shore_bathymetry.mxd Date: 1/28/2013



— Bathymetric Contour (in feet)

— Topographic Contour (2 ft. interval)

— Topographic Contour (10 ft. interval)

Notes

Contours represent depths below river surface on September 25, 2011

RED DEVIL MINE

Red Devil, Alaska

Figure 3-13
Kuskokwim River
Near Shore Bathymetry

0 25 50 100 150 200 250
Feet
0 12.5 25 50 75
Meters
Scale 1:6,800

Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

4

Nature and Extent of Contamination

This chapter presents the nature and extent (lateral and vertical) of contamination at the RDM based on field investigation sample data collected during the 2010, 2011, and 2012 field seasons. The presentation of the nature and extent of contamination is organized by media. For surface soil, subsurface soil, and groundwater, the presentation is further organized by the general geographic areas illustrated in Figure 4-1 and listed below:

- Pre-1955 Main Processing Area
- Post-1955 Main Processing Area
- Red Devil Creek Downstream Alluvial Area and Delta
- Surface Mined Area
- Dolly Sluice and Delta
- Rice Sluice and Delta
- Kuskokwim River
- Red Devil Creek Upstream Alluvial Area
- Upland background areas
- Roads and abandoned roads

Within any given general geographic area are various site features or sub-areas that were targeted for characterization in the RI. These specific features are identified in the sample collection summary tables presented in Chapter 2. The general geographic areas and features and sub-areas targeted for characterization were defined based on knowledge of mine operational history and results of previous investigations and removal and cleanup actions. Boundaries of geographic areas are estimated based on this knowledge as well as information from historical and recent aerial and other photographs, historical geologic and topographic maps, field observations of localized topography and vegetation patterns, and soil type (see Chapter 3).

For the purposes of this chapter, background concentrations of inorganic analytes are used to determine chemical concentrations representing “contamination” and the lateral and vertical extents of contamination. Accordingly, inorganic element concentrations that exceed background values presented in Section 4.1 are considered “contamination.” In several instances, the concentrations of a given inorganic element in background samples are below detection limits; in such cases, site samples with detected concentrations of those analytes also are treated as contamination in this report. The analytes aluminum, calcium, iron, magnesium, potassium, and sodium are common earth crust elements. Based on EPA, Region 10 policy, these common earth crust elements are not discussed in this chapter; however, the sample results are presented in the data presentation tables presented at the end of this section for reference.

For organic analytes, all positive detections are considered to represent site-related “contamination” because there are no nearby offsite sources of organic contaminants that are expected to contribute to onsite contamination.

Analytical results for arsenic and mercury speciation, as well as other analyses, are included in this chapter’s data presentation tables. Interpretation of these analytical results is provided in Chapter 5, Contaminant Fate and Transport, and Chapter 6, Baseline Risk Assessment. Results of arsenic bioaccessibility testing also are included in this chapter’s data presentation tables; interpretation of these results is presented in Chapter 6.

The data used to characterize the nature and extent of contamination are presented in tabular format in this chapter. Analyte concentrations representing contamination are highlighted in the analytical data summary tables. Graphic representations are used to illustrate the distribution and trends of contamination at the site.

Analytical data generated from the RI samples collected in 2010, 2011, and 2012 were validated by E & E chemists in accordance with following:

- Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2010a).
- Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 2008a).
- Guidelines for Data Reporting, Data Reduction, and Treatment of Non-Detect Values (ADEC 2008a).
- Quality assurance guidelines in Standard Operating Procedure BR-0013 for mercury selective sequential extraction analyses (Brooks Rand 2010).
- Quality assurance guidelines in EPA Method 1632 for arsenic speciation analysis (EPA 1998a).
- Quality assurance guidelines in EPA Method 9200.1-86 for soil bioaccessibility assays (EPA 2008b).

The results of data validation are presented in Analytical Data Review Summary memoranda for each laboratory data deliverable and are contained in Appendix C. In general, all data generated for the RI are considered usable, with qualifications, for evaluation of the nature and extent of contaminants and for both human and ecological risk assessments.

4.1 Background Value Estimation

EPA's ProUCL program, Version 4.1.00 (EPA 2010b was used to calculate background values for inorganic analytes, consistent with EPA guidance (EPA 2010b, 2010c). ProUCL 4.1.00 includes goodness-of-fit tests (e.g., normal, lognormal, and gamma) for data sets with and without nondetected values (NDs). For data sets with NDs, ProUCL 4.1.00 can create additional columns to store extrapolated values for NDs obtained using regression on order statistics (ROS) methods, including normal ROS, gamma ROS, and lognormal ROS (robust ROS) methods. ProUCL 4.1.00 also has parametric (e.g., maximum likelihood estimate, t-statistic, gamma distribution), nonparametric (e.g., skewness-adjusted central limit theorem, Kaplan-Meier), and computer intensive bootstrap (e.g., percentile, bias-corrected accelerated) methods to compute background values for uncensored data sets and also for data sets with ND observations.

The background data sets consisted of results for selected background samples for each of the media for which it was possible to collect background samples. The background data sets were pre-processed with the most conservative field duplicate result retained (e.g., the lowest concentration). NDs were assigned the method detection limit and flagged with a "U." As mentioned above, ProUCL 4.1.00 was used to extrapolate values for NDs used in the calculation of the background value, consistent with ADEC (2008a) guidelines. Tables summarizing ProUCL input and output values are provided in Appendix D.

4.1.1 Surface Soil

Table 4-1[1] presents the results of the background surface soil samples selected for surface soil background value estimation. Soil samples were collected as part of the 2010 field sampling event. Historical information reviewed as part of RI work planning indicates that there are three main soil types on the mine site: Kuskokwim Group–derived soils, alluvial soils within the Red Devil Creek drainage, and loess. Kuskokwim Group–derived soils and Red Devil Creek alluvial soils are formed locally. Loess comprises wind-deposited silt and sand derived from non-local sources. Surface soil samples of Kuskokwim Group–derived soils and Red Devil Creek alluvial soils were collected. No loess soils were encountered within the selected background soil sampling area. Locations of surface soil samples selected for background value estimation are illustrated in Figure 2-4.

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[1] All tables for Chapter 4 are provided at the end of the chapter.

Ten surface soil samples plus one duplicate sample were collected from alluvium within the Red Devil Creek Upstream Alluvial Area, and 10 surface soil samples plus one duplicate sample were collected from Kuskokwim Group–derived soils within the Upland Background Area to generate the background concentrations. ProUCL was first used to determine outliers for the potential site-related chemicals, arsenic, mercury, and antimony. Antimony was not tested for outliers due to the low number of detected results. Q-Q plots were used for mercury or arsenic to determine potential outliers. Q-Q plots for mercury showed two potential outliers, 6.6 mg/kg (10RD11SS) and 6.4 mg/kg (10RD10SS). When these two data points are removed, the data set shows non-parametric distribution. The applicable ProUCL outlier test, the Dixon test for sample size less than 25, assumes normal distribution. Although the data show non-parameteric distribution, the Dixon test did support identification of these two data points as outliers. The Q-Q plot for arsenic showed a single potential outlier of 220 mg/kg (10RD10SS). With the outlier point removed, the remaining data set showed gamma distribution. Although the Dixon test assumes normal distribution, it did support identification of this point as an outlier. Based on the Q-Q plots, and since arsenic and mercury are potentially site-related chemicals, these two samples (10RD11SS and 10RD10SS) were removed from the surface soil background data set prior to determination of the background values.

ProUCL was also used to determine potential outliers for the additional chemicals by evaluating the Q-Q plots. The Q-Q plots are provided in Appendix D. Where potential outliers were identified through Q-Q plots, outlier tests were run using ProUCL. Most potential outliers were associated with samples 10RD10SS and 10RD11SS, further confirming the appropriateness of eliminating these samples from the background data set. The additional outlier not found in these two samples was 816 mg/kg for manganese. Although this sample set does not show normal distribution, the Q-Q plots, as well as results of the Dixon test, supported elimination of this single point from the manganese background data set.

ProUCL was then used to conduct a two-sample hypothesis test comparing concentrations of the two different soil types consistent with EPA guidance (EPA 2010b). Arsenic and mercury results were used as indicators for this test. Again, antimony was not investigated due to the high number of non-detected results. The data were tested for distribution with the two known outliers (10RD10SS and 10RD11SS) removed, and the Wilcoxon-Mann-Whitney test was used to determine that the means of the two populations (samples from the two soil types) were equal; therefore, the two soil type samples were combined to represent background surface soil.

Once the results from the soil types were combined and the outliers removed, ProUCL was used to determine distribution of the data and to calculate background values for all inorganic elements. When possible, the upper prediction limit (UPL) associated with the known distribution was used as the background value, consistent with the recommendations of the EPA Technical Guide (EPA 2010b). If the background and site contaminant distributions are comparable, then a typical site observation should lie below a 95-percent UPL based upon a background data set with probability 0.95. A site observation exceeding the background 95-percent UPL can be considered as providing some evidence of contamination due to site-related activities (EPA 2010a). In general, this value is slightly below the maximum detected concentration with outliers removed. For gamma distributed data, the 95-percent Kaplan Meier UPL was chosen as the background threshold value for data sets with non-detected values and the 95-percent Chebyshev UPL was chosen for data sets without non-detected values. If the UPL is greater than the maximum detected concentration, the maximum detected contract was used as the background value.

Table 4-2 presents the summary statistics and recommended background levels for inorganic analytes. The ranges in concentrations observed in the selected background soil samples are likely attributable to geologic variability. Geological factors controlling contaminant concentrations are discussed in Section 4.1.7.

4.1.2 Subsurface Soil

Table 4-3 presents the results of the subsurface soil samples used for background estimation. Seven subsurface soil samples were collected from two borings installed in background locations; one within the Red Devil Creek Upstream Alluvial Area and one within the Upland Background Area. Locations of soil borings selected for subsurface soil background value estimation are illustrated in Figure 2-6. There were an insufficient number of samples to run background statistics. EPA (2010a) suggests avoiding the use of statistical methods to estimate the background values on data sets with fewer than four to six detected values. Although there are more than six samples, they represent only two separate boring locations. Therefore, it is recommended that the maximum detected concentration as the background value be used for subsurface soils. These results for the background subsurface soil samples are presented in Table 4-4. The ranges in concentrations observed in the selected background soil samples are likely attributable to geologic variability. Geological factors controlling contaminant concentrations are discussed in Section 4.1.7.

4.1.3 Groundwater

Table 4-5 presents the results of the background groundwater samples. Two background groundwater samples were collected—11RD13GW (from MW12, located within the Red Devil Creek Upland Alluvial Area) and 11UP11GW (from MW31, located within the Upland Background Area). Locations of monitoring wells selected for groundwater background value estimation are illustrated in Figure 2-7. Table 4-6 presents the recommended background levels for inorganic analytes in groundwater.

4.1.4 Red Devil Creek Surface Water and Sediment

Table 4-7 presents the results of the Red Devil Creek background surface water and sediment samples. The background value for surface water is based on two samples collected from the same location (RD01SW), one in 2010 and one in 2011. The sediment sample was collected in 2011 from a location (RD01SD) collocated with the surface water samples. Locations of RD01SW and RD01SD are illustrated in Figure 2-8 and 2-9, respectively. Detected values only are presented in Table 4-8 in a format that is consistent with other samples to facilitate comparison.

4.1.5 Kuskokwim River Sediment

Table 4-9 presents the results of the background Kuskokwim River sediment samples. Thirteen Kuskokwim River sediments samples (one sample was collected in 2010 and 12 in 2011) plus three duplicate samples were analyzed for inorganic analytes. Locations of sediment samples selected for background value estimations are illustrated in Figures 2-10 (shoreline samples) and 2-11 (offshore samples). Samples collected near the Holitna River in 2011 were not included in the background assessment. ProUCL Q-Q plots were used to determine outliers for any mercury, arsenic, or antimony results. No results were identified as outliers for antimony. The mercury result of 0.374 mg/kg from 11KR12SD and the arsenic result of 15 mg/kg from 10KR13SD were identified as outliers in the Q-Q plots and confirmed using the Dixon test. These samples were removed from the Kuskokwim River sediment background data set prior to calculating the background values. Q-Q plots were used to identify potential outliers for the other chemicals, and the Dixon test was used to confirm the presence of outliers. Individual data points that were confirmed as outliers were removed from the data set. Once the outliers were removed, ProUCL was used to determine distribution of the data set and calculate the background value for all inorganic analytes. The recommended background value and summary statistics for the background Kuskokwim River sediment are presented in Table 4-10.

4.1.6 Vegetation

Table 4-11 presents the results of the background vegetation samples. Background vegetation samples were collected and analyzed for inorganic elements during the 2011 sampling event. In 2012, another attempt was made to collect blueberry fruit. The number of background samples collected for the following vegetation types include: blueberry fruit (n=8; one from 2011 and seven from 2012), blueberry leaves and stems (n=8 plus one duplicate), green alder bark (n=4), horsetail pond vegetation (n=3), and white spruce needles (n=8). Locations of vegetation samples selected for background value estimations are illustrated in Figure 2-12. For green alder bark and horsetail pond vegetation, sample numbers were too small to perform statistical analysis and derivation of background values using ProUCL. Although the sample number of blueberry fruit is appropriate, statistical analysis for background levels in blueberry fruit was not performed due to the high rate of non-detections. For these samples, the maximum detected concentration of inorganic elements in the vegetation is recommended for comparison to site samples. For blueberry leaves and stems and white spruce needles, ProUCL was used to determine the distribution of the data set and calculate the background value for all metals. The recommended background value and summary statistics for the background vegetation samples are presented in Tables 4-12 through 4-16.

4.1.7 Natural Mineralization

In accordance with the RI Work Plan (E & E 2011), samples used for background value estimation were collected from locations outside of and upgradient of the areas recognized as potentially impacted by mining, ore processing, waste disposal operations, and potential deposition of emissions from thermal ore processing. These background areas are located within the Upland Background Area and Red Devil Creek Upstream Alluvial Area for all media except Kuskokwim River sediment. Soil concentration trends in the RI data, combined with available geological information, indicate that the Upland Background Area and Red Devil Creek Upstream Alluvial Area lie within a zone that exhibits little natural mineralization compared to parts of the RDM. The Upland Background Area is underlain by soils derived from the clastic sedimentary rocks of the Kuskokwim Group, and the Red Devil Creek Upstream Alluvial Area is underlain by alluvium derived from the Kuskokwim Group bedrock unit. The Kuskokwim Group consists of interbedded graywacke and argillite. The argillite comprises slightly metamorphosed organic-rich marine shale. As is typical for organic-rich marine shales, the argillite of the Kuskokwim Group bedrock is enriched in mercury and other inorganic elements relative to global averages in crustal rocks. This is evident in results of area-wide sampling (e.g., Bailey and Gray 1995; Gray et al. 2000) as well as RI sampling. Mercury concentrations in RI background surface and subsurface soil samples, which were collected from areas with soil derived from Kuskokwim Group bedrock, span an order of magnitude (0.13–3.92 mg/kg). This heterogeneity in soil mercury concentrations may be attributable to the influence of one or the other primary rock types that the soil at any specific location is derived from. As such, soil materials derived from argillitic bedrock would be expected to have higher mercury concentrations than soils derived from graywacke. Mobilization, migration, and deposition (via adsorption or precipitation) of mercury originally present in soil materials also would be expected to affect the amount of mercury contained within different soil samples. These factors are discussed further in Chapter 5.

Superimposed on the area-wide enrichment of mercury and other inorganics in the Kuskokwim Group bedrock is the mineralization that gave rise to the mercury ore deposits at the RDM, as well as other mercury deposits within the southwestern Alaska mercury belt (e.g., Bailey and Gray 1995; Gray et al. 2000). The Red Devil and other regional mercury deposits are epithermal hydrothermal deposits. These deposits resulted from mobilization of mercury and other inorganics from the argillite/shale beds of Kuskokwim Group as a result of emplacement of igneous intrusions locally within the Kuskokwim Group host rock. Mercury and other inorganics were mobilized from the argillite/shale rock and migrated with the hydrothermal fluids to where they locally were deposited as sulfide minerals and possibly other species. The locations where the inorganics concentrated comprise the ore deposits and associated sub-ore grade mineralized zones of the RDM and other mineral deposits in the epithermal hydrothermal deposits in the region. The mercury concentrations in the RDM ore typically ranged from 2 to 5 percent, but ranged as high as 30 percent (MacKevett and Berg 1963).

Emplacement of ore and associated sub-ore grade mineralization is discussed further below.

Although the ore bodies mined for cinnabar ore over the course of the RDM's history are largely discrete localized ore zones, natural mineralization associated with the epithermal hydrothermal ore deposits in the RDM area extends beyond those areas that were mined. The extent of such natural mineralization is not known, but includes areas within the footprint of surface mining and exploration in the Surface Mined Area and ore processing activities that took place in the Main Processing Area. Available information on natural mineralization at the RDM is discussed further below.

Ore Geology

This subsection summarizes key information pertaining to Red Devil ore geology.

The Red Devil ore bodies are epithermal hydrothermal deposits (Gray et al. 2000). The ore minerals are cinnabar (mercury sulfide) and stibnite (antimony sulfide). Other sulfide minerals locally present are realgar and orpiment (arsenic sulfides) and pyrite (iron sulfide). The mineral-laden hydrothermal solutions were derived from dehydration of hydrous minerals in the argillite/shale and mobilization of formation waters of the Kuskokwim Group host rock by heat from igneous plutons that locally intruded the host rock. The hydrothermal solutions migrated through permeable rocks and along fractures and faults (e.g., Gray et al. 2000). Such faults include the northwest-trending Red Devil fault and associated faults that run through the RDM area. Sulfide minerals and possibly other species, along with quartz, carbonate, and clay gangue, were deposited where the chemical and physical conditions favored their formation.

As noted above, concentrations of mercury in the RDM ore were typically 2 to 5 percent (20,000 to 50,000 ppm) and ranged as high as 30 percent (300,000 ppm). The richest ore mined at the RDM consisted of numerous discrete elongate bodies (ore shoots) that are mainly localized along and near intersections of several igneous dikes (average strike and dip of North 37° East, 63° Southeast) and numerous right lateral faults associated with the Red Devil fault (average strike and dip of North 40° West, 60° Southwest), which cut the dikes into segments. The intersections of the dikes and faults, and thus the main ore shoots, plunge on average approximately 39° on a bearing of South 10° East (Malone 1962). The main ore shoots that were mined are associated with two dikes: the Dolly dike and the "F" zone dike. The right lateral slip along the numerous faults that cut these dikes result in two arrays of ore shoots that comprise the ore zones that were targeted during mining: the zone associated with the Dolly and Rice ore shoots and the zone associated with the "F" ore zone shoots (Malone 1962). Stopes were driven along these ore shoots, and locally reached the surface or were terminated a short distance below the ground surface. Stope surface openings and other mine openings generally mark the locations where the ore zones reached the top of the bedrock and illustrate the west-northwest-trending alignments of the two primary ore zones (see Figures 1-4 and 1-7). The surface expression of the "F" ore zone is approximated by the “F” Zone Shaft Collar, 325 Adit and 311 Adit Portals, the Main Shaft Collar, and intervening stope surface openings. The surface expression of the Dolly and Rice ore zone is approximated by the Dolly Shaft Collar, the Rice Shaft Collar, and intervening stope surface openings (MacKevett and Berg 1963; Malone 1962).

The extent of the ore-grade mineralization at the RDM is not clear. At a minimum, the extent of ore-grade mercury mineralization would be defined by the extent of mining; however, high concentrations of cinnabar (and associated minerals) that were not economically recoverable likely are present beyond the extent of mining. The most recent available maps of underground mine workings were based on the mine development that had taken place as of 1962 (MacKevett and Berg 1963; Malone 1962); these maps were used to develop Figures 1-4 and 1-7. However, underground mining occurred after 1962 (see Section 1.4.2.1). Therefore, the extent of ore zones illustrated in Figures 1-4 and 1-7 represents the minimum extent of the mercury ore zones.

The “F” ore zone extends to the southeast beyond the Main Shaft Collar at least as far as the center of the Main Processing Area, as evidenced by the stopes that branch off the 200 level and approach the surface beneath Red Devil Creek in the vicinity of the seep (see Figures 1-4, 1-7, and 3-4). The ore shoots that these stopes followed likely extend to the top of bedrock in this area. However, unlike some of the stopes in the Surface Mined Area, upward advancement of the stopes within the Main Processing Area was probably discontinued at a safe depth below the surface due to operational considerations that included the presence of the creek and the ore processing infrastructure, which was established prior to development of the underground workings in that part of the mine.

Mineralization Peripheral to the Ore Zones

Existing information on local geology and mine operations and RI soil data indicate the presence of mineralization associated with, but beyond the extent of, the mercury ore zones targeted by mining. The rich ore shoots exploited during mining grade along the northwest-trending faults and associated fractures into zones characterized by networks of closely spaced cinnabar-bearing veinlets, widely spaced veinlets that form protore containing less than 1 percent mercury, and more distally into a peripheral zone of “barren veinlets” and clay alteration (MacKevett and Berg 1963; Malone 1962). Sub-ore grade mineralization also extended some distance laterally (i.e., toward the northeast and southwest) from the ore zones. Such sub-ore grade mineralization is discussed further below.

For simplicity, the mercury ore zones and the associated zones of sub-ore grade mercury deposits and deposits of other sulfide minerals are collectively referred to as the “mineralized zone” in this report. The extent of the mineralized zone and the distribution of inorganic element concentrations within the zone are not well understood. Information on the extent and distribution of sub-ore grade mineralization at the RDM is limited. This is likely because during mine exploration and development little information was gathered regarding the extent of mineralization at levels below ore grade. Compounding the lack of historical information, the intensive surface mining and exploration activities that took place within the Surface Mined Area and the disposal of tailings and waste rock throughout the Main Processing Area make it difficult to characterize pre-mining conditions in these areas at the present time. Nonetheless, some information regarding the mineralized zone is available. Pertinent available information is summarized below.

Surface exploratory work performed by the United States Bureau of Mines in the 1940s includes mapping of target mineral concentrations in trenches arrayed across and roughly perpendicular to the ore zones. Sub-ore grade concentrations of mercury and antimony up to several hundred ppm were reported at locations more than 150 feet laterally away from the “F” ore zone. No information on arsenic sulfide concentrations is provided (Webber et al. 1947).

The presence of mineralization outside of the ore zones also is indicated by RI soil data. At RI soil borings 11SM10SB and 11SM11SB, located in the Surface Mined Area approximately 400 feet northwest of the Dolly Shaft (the northwestern-most known underground mine workings), subsurface soil consisting of weathered Kuskokwim Group bedrock contains arsenic concentrations up to two orders of magnitude higher than the calculated background concentrations presented in Section 4.1.2. Mercury concentrations in this weathered bedrock are higher than the calculated background concentrations by up to approximately one order of magnitude. Further information on subsurface soil at the RDM is provided in Section 4.3. Additional information on the mineralized zone is summarized below.

Characterization of the Mineralized Zone

Collectively, the historical mining information and RI data indicate that the natural mineralized zone (including the mercury ore zones and associated sub-ore grade deposits of mercury and deposits of antimony and arsenic sulfides and other minerals) lies within an elongate area that trends approximately west-northwest, perpendicular to the Red Devil Creek valley. This mineralized zone underlies part of the Main Processing Area as well as the Surface Mined Area.

Historical site information indicates that naturally mineralized Kuskokwim Group bedrock and soils derived from it occurred locally at the surface prior to mine development. As evidenced by the incised nature of the Red Devil Creek valley, Red Devil Creek has eroded into the bedrock, exposing the ore and mineralized zones in the Main Processing Area and transporting eroded ore and other mineralized rock and soil downstream. This is indicated by reports on the early mine history—the mine was discovered when cinnabar float was found in the creek bed. The cinnabar float was followed upstream to the lode, described as being located approximately 1,000 feet up Red Devil Creek from the Kuskokwim River (Webber et al. 1947). This description corresponds to the location where the “F” ore zone intercepts the creek (see Figures 1-4, 1-7, and 3-4). Cinnabar float in the Red Devil Creek alluvium and other soils in the area of the discovery, described as “detritus material in the vicinity of the lode” (interpreted here to be slope wash or other soils derived from mineralized Kuskokwim Group bedrock), were the source of cinnabar ore during the initial mining (Webber et al. 1947).

As a result of the exposure and erosion of the ore and mineralized zones, the alluvium adjacent to and downstream of the mineralized zone would contain higher natural concentrations of mineralization-related inorganic elements than alluvium found upstream of the ore and mineralized zones. Similarly, soils derived from mineralized Kuskokwim Group bedrock, including colluvium and slope wash transported downslope into Red Devil Creek valley, would contain higher natural concentrations of inorganic elements than Kuskokwim Group–derived soils from areas outside of the ore and mineralized zones.

Naturally mineralized geologic materials, including mineralized Kuskokwim Group bedrock and soils and alluvium derived from it that underlie portions of the Main Processing Area and Surface Mined Area, pre-date mining activities. As such, the natural mineralization of these materials represents pre-mining “background” conditions for those areas that are mineralized. Historical mining and ore processing activities, including disposal of the tailings and waste rock, occurred within the Main Processing Area, coinciding with part of the area where the naturally mineralized zone is expected to be present in the shallow subsurface. The presence of tailings/waste rock throughout most of the Main Processing Area makes characterization of naturally mineralized soil conditions in this part of the site difficult because of elevated concentrations of inorganic elements in these mine waste materials, which may leach from the waste materials and be deposited in the native soils. Such processes are discussed in Chapter 5.

Within the Surface Mined Area, varying degrees of disturbance by exploration and mining activities have occurred. This disturbance makes it difficult to positively identify naturally mineralized conditions because potential impacts of mining-related disturbance on underlying soils cannot be ruled out, and available information does not readily facilitate differentiation between the natural mineralization and such mining-related impacts on inorganic element concentrations. Additional subsurface soil characterization was conducted in September 2012 in an attempt to identify and characterize areas of natural mineralization in the Surface Mined Area.

The September 2012 sampling event followed the approach specified in the work plan addendum (E & E 2012b). Four general sampling areas were selected based on review of previously collected RI soil data, geological information, and understanding of mining operational history. The sampling areas were located in the general proximity of the Dolly and Rice ore zone and the “F” ore zone, either along the trend of or lateral to the trend of these ore zones. The areas targeted for sampling were selected based on their general proximity to known ore zones, but also on their locations that appeared to be undisturbed by the surface mining activities.

Stringent criteria were established in the work plan addendum for the potential use of newly gathered Kuskokwim Group soil data to characterize naturally mineralized soils. The criteria are:

- The Kuskokwim Group soils appear to be undisturbed based on information on mining operations, historical aerial photographs, topography, and lithological observations.
- The Kuskokwim Group soils do not appear to be affected by downward migration and deposition of metals leached from overlying overburden soils based on total inorganic element concentrations, such that the concentrations in overlying soils are lower than those in the undisturbed Kuskokwim Group soils.

In accordance with the work plan addendum, 16 soil borings were investigated within four general areas. Soil boring locations are illustrated in Figure E-1, Appendix E. Specific boring locations were selected in the field. Borings were advanced to depths ranging from 54 to 144 inches bgs using hand augers. Soil samples were characterized lithologically and screened by XRF for total inorganic elements in the field. Based on lithological interpretations made in the field, selected samples were submitted for laboratory analysis for total inorganic elements and total organic carbon (TOC). Based on further review of field lithological descriptions, the interpreted soil types were refined. Lithological descriptions, final interpreted soil type, and XRF field screening data are summarized in Table E-1, Appendix E. Laboratory results of total inorganic elements and TOC analyses are presented in Table E-2, Appendix E.

In general, the objectives specified in the work plan addendum were not met with the data collected during the September 2012 sampling event. The characterization results with respect to the overall project objectives are summarized below:

- Kuskokwim Group soil appears mineralized but is not demonstrably undisturbed (locations12SM51SB, 12SM52SB, 12SM55SB, and 12SM62SB).
- Kuskokwim Group soil was not encountered in the soil boring (location 12SM63SB).
- Kuskokwim Group soil appears non-mineralized and undisturbed (locations 12SM58SB, 12SM59SB, 12SM60SB, and 12SM61SB).
- Kuskokwim Group soil appears non-mineralized and is not demonstrably undisturbed (locations12SM53SB, 12SM54SB, 12SM55SB, 12SM56SB, and 12SM57SB).
- No Kuskokwim Group soil was recovered in the soil boring; however, the presence of undisturbed KG soil beneath the loess overburden is likely (locations 12SM64SB and 12SM66SB).

- Only mixed loess/ Kuskokwim Group soil was recovered in the deepest soil sample (12 feet bgs); however, the presence of undisturbed Kuskokwim Group soil beneath the loess overburden is likely, and the Kuskokwim Group soil is likely mineralized based on inorganic element concentrations in the mixed loess/ Kuskokwim Group soil sample (12SM65SB).

Only total inorganic element concentrations were evaluated as part of the September 2012 additional soil characterization. The effort did not entail collection and analysis of samples specifically for the purpose of assessing speciation of the inorganics elements (e.g., As^{3+} or As^{5+}; Hg^{2+}, Hg^{1+}, or Hg^{0}); mineralogical or chemical form in which the elements occur (e.g., sulfide mineral, iron oxide or oxyhydroxide); or location of occurrence (e.g., within sulfide mineral lattice within hydrothermal vein, sorbed to iron oxyhydroxide coating on exterior of soil grain).

Since it is has not been possible to determine naturally mineralized soil concentrations with available RI data, the data collected from the Upland Background Area and Red Devil Creek Upstream Alluvial Area were used to develop the background values for surface and subsurface soil, as well as groundwater, Red Devil Creek sediment and surface water, and vegetation. As such, the background levels presented in Section 4.1, particularly those for subsurface soil and groundwater, are considered to be conservative and likely underestimate pre-mining background concentrations of inorganic elements associated with natural mineralization that exists at part of the RDM that is likely subject to remediation. Furthermore, existing information is insufficient to determine the depth of subsurface soil contamination at parts of the RDM based on comparison to the calculated background levels.

4.2 Surface Soil

The following subsections present a summary of the nature and extent of contamination in surface soil. The distribution and arrangement of soils and mine and ore processing wastes at the site play a significant role in determining the nature and extent of contamination as well as the fate and transport of contaminants at the RDM. Results of the identification and distribution of soil and mine waste material types at the RDM are presented in Section 3.1.3. The generalized areal extent of the various soil types at the surface is illustrated in Figure 3-1 and each of the figures presented in this section.

Data for inorganic elements and organic compounds are organized by geographic area. Results are provided in Tables 4-17 through 4-23. The tables for each geographic area present the number of samples per analysis, the number of detections per analysis, the number of samples exceeding the recommended background value per analysis, and maximum and minimum concentrations per analysis. The tables also identify soil type for each sample.

Results for selected total inorganic elements for samples within the Main Processing Area are illustrated in Figures 4-2 through 4-4. TCLP and SPLP results for selected inorganic elements for samples within the Main Processing Area are illustrated in Figures 4-5 and 4-6, respectively. Results of mercury SSE and arsenic speciation analysis for samples within the Main Processing Area are illustrated in Figures 4-7 and 4-8, respectively.

Results for selected total inorganic elements for samples outside the Main Processing Area are illustrated in Figures 4-9 through 4-11. SPLP results for selected inorganic elements for samples within the Main Processing Area are illustrated in Figure 4-12. Results of mercury SSE and arsenic speciation analysis for samples outside the Main Processing Area are illustrated in Figures 4-13 and 4-14, respectively.

Locations of surface soil samples (and subsurface soil samples) with detected concentrations of organic compounds are illustrated in Figure 4-15.

Results of XRF field screening for selected total inorganic elements of the roads are illustrated in Figure 4-16.

Results are briefly summarized below.

4.2.1 Pre-1955 Main Processing Area

Laboratory analytical data for the Pre-1955 Main Processing Area surface soil are presented in Table 4-17. Additional information, including XRF field screening results for surface soil in the Pre-1955 Main Processing Area, is presented in Table F-1, Appendix F.

Soil types identified in the surface soil samples in the Pre-1955 Main Processing Area are: tailings/waste rock, waste rock, fill, and native/disturbed native soil. Tailings/waste rock lies at the surface throughout most of the Pre-1955 Main Processing Area. Waste rock was identified locally in the Pre-1955 Main Processing Area surface soil at location MP59. Fill was identified in the Pre-1955 Main Processing Area surface soil at location MP54. Native/disturbed native soil occurs in the Pre-1955 Main Processing Area surface soil at location MP56.

4.2.1.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Pre-1955 Main Processing Area surface soil are summarized below:

- Inorganic element contamination in surface soils is present throughout the Pre-1955 Main Processing Area.
- Tailings/waste rock is the dominant soil type in the Pre-1955 Main Processing Area.

- Concentrations of antimony, arsenic, and mercury are generally more elevated above the background values in tailings/waste rock than in waste rock, fill, and native/disturbed native soils.
- In native/disturbed native soil, only antimony, arsenic, and mercury were detected at concentrations above background values; their concentrations were generally lower than the concentrations in the other soil types in the Pre-1955 Main Processing Area.
- Arsenic TCLP concentrations for tailings/waste rock exceed the RCRA limit (5 milligrams per liter; mg/L) for one sample, but are below the RCRA limit for all other samples of tailings/waste rock, waste rock, and native/disturbed native soil. Mercury TCLP concentrations are below the RCRA limit for all samples.

4.2.1.2 Organic Compounds

The following organic compound groups were detected in at least one of the Pre-1955 Main Processing Area surface soil samples: SVOCs, DRO, RRO, and PCBs. Organic compounds were detected at sample locations MP45, MP46, MP47, and MP81. The extent of organic compounds in the surface soil of the Pre-1955 Main Processing Area has not been determined. None of the organic compounds detected in surface soils in the Pre-1955 Main Processing Area exceeded regulatory levels. Comparison of organic compound concentrations detected in surface soil to regulatory levels is presented in Chapter 7.

4.2.2 Post-1955 Main Processing Area

Laboratory analytical data for the Post-1955 Main Processing Area surface soil are presented in Table 4-18. Additional information, including XRF field screening results for surface soil in the Post-1955 Main Processing Area, is presented in Table F-2, Appendix F.

Soil types identified in the surface soil samples in the Post-1955 Main Processing Area are: tailings/waste rock, flotation tailings, tailings, fill, native/disturbed native soil, bedrock/weathered bedrock, and stockpiled ore. Tailings/waste rock occurs at the surface throughout most of the Post-1955 Main Processing Area. Flotation tailings were identified in Settling Ponds 1, 2, and 3 and were sampled at locations MP32, MP34, and MP36. Tailings apparently comprising entirely calcine materials (i.e., not mixed with waste rock) were identified in a small discrete pile within the Post-1955 Main Processing Area at location OP01. Fill was identified locally in surface soils of the Post-1955 Main Processing Area at locations MP20, MP21, and MP68. Native/disturbed native soil was identified in the Post-1955 Main Processing Area surface soil at locations MP01, MP10, MP19, MP20, MP21, MP33, and MP37. Bedrock/weathered bedrock was identified in the Post-1955 Main Processing Area at the ground surface at location MP31. A small pile of apparent stockpiled ore, composed of mineralized rock, was identified in the Post-1955 Main Processing Area and sampled at location MP02.

4.2.2.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Post-1955 Main Processing Area surface soil are summarized below:

- Inorganic element contamination extends throughout surface soils in the Post-1955 Main Processing Area.
- Tailings/waste rock and flotation tailings are the dominant soil types in the Post-1955 Main Processing Area.
- Concentrations of antimony, arsenic, and mercury are generally more elevated above the background values in tailings, flotation tailings, tailings/waste rock, and stockpiled ore than in fill, bedrock/weathered bedrock, and native/disturbed native soils.
- The highest total arsenic concentrations are in the flotation tailings.
- Only bedrock/weathered bedrock had concentrations of inorganic elements less than the background values.
- Arsenic TCLP concentrations for tailings/waste rock exceed the RCRA limit (5 mg/L) for most samples of tailings/waste rock and the tailings sample, but not for samples of flotation tailings or other soil types. Mercury TCLP concentrations are below the RCRA limit for all samples.

4.2.2.2 Organic Compounds

The following organic compound groups were detected in at least one of the Post-1955 Main Processing Area surface soil samples: SVOCs, DRO, and RRO. The extent of organic compounds in the surface soil of the Post-1955 Main Processing Area has not been determined. DRO was detected in one surface soil sample at a concentration greater than a regulatory level of 250 mg/kg (18 AAC 75.341 Table B2 Under 40 Inch Zone, Migration to Groundwater). Comparison of organic compound concentrations to regulatory levels is presented in Chapter 7.

4.2.3 Red Devil Creek Downstream Alluvial Area and Delta

Laboratory analytical data for the Red Devil Creek Downstream Alluvial Area and Delta surface soil are presented in Table 4-19. Additional information, including XRF field screening results for surface soil in the Red Devil Creek Downstream Area and Delta, is presented in Table F-3, Appendix F.

Soil types identified in the surface soil samples in the Red Devil Creek Downstream Alluvial Area and Delta are: mixed Red Devil Creek alluvium, soil, and tailings/waste rock, native/disturbed native soil, and fill. Mixed alluvium, soil, and tailings and/or waste rock were identified in the Red Devil Creek Downstream Alluvial Area and Delta surface soil at locations RD02 and RD03. Tailings/waste rock was identified at the surface at locations RD04 and RD20, likely due to use as road surfacing material. Native/disturbed native soil was identified in the Red Devil Creek Downstream Alluvial Area and Delta surface soil at sampling locations RD01 and RD05.

4.2.3.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Red Devil Creek Downstream Alluvial Area and Delta surface soil are summarized below:

- Mixed tailings/waste rock and Red Devil Creek alluvium are present at the surface throughout most of the Red Devil Creek Downstream Alluvial Area and Delta.
- Concentrations of antimony, arsenic, and mercury are generally more elevated above the background values in tailings/waste rock and fill than in native/disturbed native soils.

4.2.4 Red Devil Creek Upstream Alluvial Area

Laboratory analytical data for Red Devil Creek Upstream Alluvial Area surface soil are presented in Table 4-20. Additional information, including XRF field screening results for surface soil in the Red Devil Creek Upstream Area, is presented in Table F-4, Appendix F.

Soil types identified in the surface soil samples in the Red Devil Creek Upstream Alluvial Area are: native/disturbed native and native/disturbed native (Red Devil Creek Alluvium). Native/disturbed native soil was identified in surface soil at several locations, including the reservoir dam, in the Red Devil Creek Upstream Alluvial Area. Red Devil Creek Alluvium occurs at the surface throughout most of the Red Devil Creek Upstream Alluvial Area.

4.2.4.1 Inorganic Elements

Surface soil samples collected from Red Devil Creek Alluvium from the Red Devil Creek Upstream Alluvial Area are considered background surface soil locations; laboratory analytical results for those samples are presented in Section 4.1.1.

4.2.5 Dolly Sluice and Delta

Laboratory analytical data for Dolly Sluice and Delta surface soil are presented in Table 4-21. Additional information, including XRF field screening results for surface soil in the Dolly Sluice and Delta, is presented in Table F-5, Appendix F.

Soil types identified in the surface soil samples in the Dolly Sluice and Delta are: sluiced overburden and native/disturbed native. Sluiced overburden occurs in the surface soil throughout the Dolly Sluice Delta. Native/disturbed native soil occurs in the surface soil throughout the Dolly Sluice.

4.2.5.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Dolly Sluice and Delta surface soil are summarized below:

- Concentrations of antimony, arsenic, and mercury are generally more elevated above the background values in the sluiced overburden than in native/disturbed native soils. Concentrations of antimony, arsenic, and mercury above background values extend throughout surface soils in the Dolly Sluice and Delta.
- Concentrations of arsenic and mercury are higher on the downstream side of Dolly Sluice Delta.

4.2.6 Rice Sluice and Delta

Laboratory analytical data for Rice Sluice and Delta surface soil are presented in Table 4-22. Additional information, including XRF field screening results for surface soil in the Rice Sluice and Delta, is presented in Table F-6, Appendix F.

Soil types identified in the surface soil samples in the Rice Sluice and Delta are: sluiced overburden and native/disturbed native. Sluiced overburden occurs in the surface soil throughout the Rice Sluice Delta. Native/disturbed native soil occurs in the surface soil throughout the Rice Sluice. Sample 10RS03SS, collected from the Rice Sluice, was not definitively identified as either sluiced overburden or native/disturbed native soil. Because this sample has different chemical characteristics than sluiced overburden, it is included in native/disturbed native soils.

4.2.6.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Rice Sluice and Delta surface soil are summarized below:

- Concentrations of antimony, arsenic, and mercury in the sluiced overburden and native/disturbed native soils are similar.
- Inorganic element contamination extends throughout surface soils in the Rice Sluice and Delta. However, concentrations of arsenic in the surface soil on the south side of the delta are below background values.

4.2.7 Surface Mined Area

Laboratory analytical data for the Surface Mined Area surface soil are presented in Table 4-23. Additional information, including XRF field screening results for surface soil in the Surface Mined Area, is presented in Table F-7, Appendix F.

Soil types identified in the surface soil samples in the Surface Mined Area are: native/disturbed native, native/disturbed native (loess), and bedrock/weathered bedrock. Native/disturbed native soil underlies most of the Surface Mined Area. Native/disturbed native soil consisting of loess occurs locally within the Surface

Mined Area, including sample location SM11. Bedrock/weathered bedrock occurs at the surface locally within the Surface Mined Area, including sample locations SM30 and SM31.

4.2.7.1 Inorganic Elements

- Concentrations of antimony, arsenic, and mercury are generally below background values in the native/disturbed native soils consisting of loess. Other native/disturbed native soils and bedrock/weathered bedrock exhibit a wide range of concentrations ranging up to well above the calculated background levels. Locally elevated concentrations may be attributed to natural mineralization. Natural mineralization at the RDM is discussed in Section 4.1.7.
- The highest concentration of antimony, arsenic, and mercury are in the soils located along the ore zone trends.

4.2.8 Mine Roads

Results of XRF field screening for selected inorganic elements of the roads are illustrated in Figure 4-16.

Roads in the Red Devil Creek Upstream Alluvial Area have similar concentrations of antimony, arsenic, and mercury on the surface of the road and locations adjacent to the road. This indicates that the road was likely constructed from the native soils in the area.

Roads in the Post-1955 Main Processing Area, specifically near Monofill #2, have concentrations of antimony, arsenic, and mercury that are generally higher on the surface of the road than adjacent to the road. This indicates that the road may be constructed from tailings and/or waste rock.

Roads near the former AST area have similar concentrations of antimony, arsenic, and mercury on the surface of the road and locations adjacent to the road. This indicates that the road was likely constructed from the native soils in the area.

The road in the Pre-1955 Main Processing Area has elevated concentrations of antimony, arsenic, and mercury both on the surface of the road and adjacent to the road. The road likely is constructed from tailings and/or waste rock.

The road in the Red Devil Creek Downstream Alluvial Area has higher concentrations of antimony, arsenic, and mercury on the surface of the road and on the downslope side of the road than on the upslope side of the road. This suggests that such roads are constructed of, or otherwise affected by, tailings/waste rock that originated further up the valley in the Main Process Area.

Some of the locations of the roads in the Surface Mined Area have elevated concentrations of antimony and arsenic on the surface of the road relative to adjacent to the road. This could be a result of construction of some sections of the roads in the Surface Mined Area with tailings and/or waste rock, particularly near the fringe of the Main Processing Area. However, field observations indicate that tailings/waste rock are not present on the road surfaces throughout most of the Surface Mined Area. The elevated inorganic element concentrations are likely attributable to exposure of naturally mineralized Kuskokwim Group–derived soils in this area as part of road construction.

At some locations along the mine access road adjacent the Kuskokwim River, concentrations of antimony, arsenic, and mercury on the surface of the road are higher than those adjacent to the road. This indicates that some sections of this road may be constructed from tailings and/or waste rock. At other locations, concentrations of antimony, arsenic, and mercury are higher on the Kuskokwim River side (downslope) of the road than the upslope side, likely due to erosion and transport of road materials toward the river.

4.3 Subsurface Soil

The following subsections contain a summary of the nature and extent of contamination in the subsurface soils. As for surface soils, the distribution and arrangement of soils and mine and ore processing wastes at the site plays a significant role in determining the nature and extent of contamination as well as the fate and transport of contaminants at the RDM. Results of the identification and distribution of various soil and mine waste material types at the RDM are presented in Section 3.1.3. The definitions of the various soil types identified at the RDM are presented in Table B-1, Appendix B. The assigned soil types for each sample are summarized in Tables B-2 through B-9, Appendix B. Geologic cross-sections illustrating vertical distribution of soil types are presented in Figures 3-3 through 3-8. Geologic cross-sections illustrating subsurface soil laboratory results for total antimony, arsenic and mercury for cross-section soil boring are presented in Figures 4-17 through 4-22.

Data for inorganic elements and organic compounds in subsurface soil are organized by geographic area. Results are provided in Tables 4-24 through 4-29. The tables for each geographic area present the number of samples per analysis, the number of detections per analysis, the number of samples exceeding the recommended background value per analysis, and maximum and minimum concentrations per analysis. The tables also identify soil type for each sample.

As discussed in Section 4.1.7, additional soil characterization was conducted in September 2012 to attempt to better characterize the extent and ranges of inorganic element concentrations of naturally mineralized soils within selected portions of the Surface Mined Area. The results of the September 2012 effort did not meet the criteria specified in the work plan addendum for further consideration for background mineralized soil characterization. Results of the additional soil characterization are not incorporated into this chapter. Results are provided in Appendix E.

4.3.1 Pre-1955 Main Processing Area

Laboratory analytical data for Pre-1955 Main Processing Area subsurface soil are presented in Table 4-24. Additional information, including XRF field screening results for subsurface soil in the Pre-1955 Main Processing Area, is presented in Table F-8, Appendix F.

Soil types identified in the subsurface soil samples in the Pre-1955 Main Processing Area are: tailings/waste rock, native/disturbed native, fill, and bedrock/weathered bedrock. Tailings/waste rock occurs throughout much of the Pre-1955 Main Processing Area at depths ranging from the ground surface to approximately 4 to 20 feet bgs. Fill occurs locally at depths from the surface up to 8 feet bgs in several soil borings in the Pre-1955 Main Processing Area. Native/disturbed native soil occurs from approximately the ground surface to as deep as 28 feet bgs in several soil borings in the Pre-1955 Main Processing Area. The top of bedrock/weathered bedrock was encountered in several borings at depths ranging from approximately 4 to 30 feet bgs in the Pre-1955 Main Processing Area.

4.3.1.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Pre-1955 Main Processing Area subsurface soil are summarized below:

- Concentrations of antimony, arsenic, and mercury vary widely within each soil type.
- Generally, the highest concentrations of antimony, arsenic, and mercury are in the tailings/waste rock, and the lowest concentrations are in the native/disturbed native soils or bedrock/weathered bedrock.
- The depth of inorganic element contamination in subsurface soils in the Pre-1955 Main Processing Area generally extends to at least the depth of tailings and/or waste rock. Locally, native/disturbed native soils and bedrock/weathered bedrock beneath tailings/waste rock have concentrations of inorganic elements above background values. The depth of inorganic element contamination in the subsurface soils has not been determined at all soil boring locations.
- Elemental mercury was identified in a subsurface soil sample collected from 0 to 2 feet bgs at soil boring MP55, located near the western corner of the pre-1955 retort building. The sample consisted of mixed tailings/waste rock, with abundant stibnite and calcines and some cinnabar. The XRF mercury concentration for the sample was 1,787 ppm. The extent of the elemental mercury in the soil boring was limited to a part of the interval from 0 to 2 feet bgs. Elemental mercury was not observed in subsurface soil samples collected other intervals in boring MP55 or in samples from adjacent soil borings.

- Arsenic TCLP concentrations for tailings/waste rock exceed the RCRA limit (5 mg/L) for one sample (11MP58SB08), but are below the RCRA limit for the other samples. Mercury TCLP concentrations are below the RCRA limit for all samples.

4.3.1.2 Organic Compounds

The following organic compound groups were detected in at least one of the Pre-1955 Main Processing Area subsurface soil samples: SVOCs, DRO, and RRO. Organic compounds in subsurface soil are widespread throughout the Pre-1955 Main Processing Area at depths ranging up to 26 feet bgs. DRO was detected at concentrations above the regulatory level of 250 mg/kg (18 AAC 75.341 Table B2, Under 40 Inch Zone, Migration to Groundwater), at concentrations ranging up to 7300 mg/kg (estimated) in subsurface soil in the vicinity of the Former Shop Pad (sample 11MP45SB04), Pre-1955 Rotary Furnace/Shop Building (samples 11MP54SB04 and 11MP51SB08), the Pre-1955 Retort (sample 11MP57SB06) and the road along Red Devil Creek (sample 11MP66SB16). Comparison of organic compound concentrations to regulatory levels is presented in Chapter 7. The extent of organic compounds in the subsurface soil of the Pre-1955 Main Processing Area has not been determined.

4.3.2 Post-1955 Main Processing Area

Laboratory analytical data for Post-1955 Main Processing Area subsurface soil are presented in Table 4-25. Additional information, including XRF field screening results for subsurface soil in the Post-1955 Main Processing Area, is presented in Table F-9, Appendix F.

Soil types identified in the subsurface soil samples in the Post-1955 Main Processing Area are: tailings/waste rock, native/disturbed native, fill, and bedrock/weathered bedrock. Tailings/waste rock occurs throughout much of the Post-1955 Main Processing Area at depths ranging from approximately the ground surface to between 2 and 20 feet bgs. Flotation tailings occur within each of the Settling Ponds at depths from the ground surface to between approximately 8 and 10 feet bgs in the Post-1955 Main Processing Area. Fill occurs locally from the ground surface to as deep as 14 feet bgs in the Post-1955 Main Processing Area. The top of native/disturbed native soil occurs from the ground surface to as deep as 10 feet bgs. Where encountered, the bottom of native/disturbed native soil was observed at depths between approximately 2 feet bgs to the bedrock/weathered bedrock contact. The top of bedrock/weathered bedrock was encountered at depths ranging from the ground surface to approximately 30 feet bgs in Post-1955 Main Processing Area.

4.3.2.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Post-1955 Main Processing Area subsurface soil are summarized below:

- Generally, the highest concentrations of antimony, arsenic, and mercury are in the tailings/waste rock and flotation tailings, and the lowest concentrations are in the native/disturbed native soils or bedrock/weathered bedrock.
- The depth of inorganic element contamination in subsurface soils in the Post-1955 Main Processing Area generally extends to at least the depth of tailings and/or waste rock. Locally, native/disturbed native soils and bedrock/weathered bedrock beneath tailings/waste rock have concentrations of inorganic elements above background values. The depth of inorganic element contamination in the subsurface soils has not been determined at all soil boring locations.
- Elemental mercury was identified in tailings/waste rock in a subsurface soil sample collected from 2 to 4 feet bgs at soil boring MP14, located along the road below Monofill #2. The sample consisted of mixed tailings/waste rock, with some wood debris. Calcines and some cinnabar and stibnite were observed in the sample. The elemental mercury was associated with the woody debris and silt/clay matrix. The total mercury concentration for the sample was 1,410 mg/kg (estimated). The extent of the elemental mercury was limited to a part of the interval from 2 to 4 feet bgs. Elemental mercury was not observed in subsurface soil samples collected from other intervals in boring MP14 or in samples from adjacent soil borings.
- Arsenic TCLP concentrations exceed the RCRA limit (5 mg/L) for all tailings/waste rock samples but one.
- Arsenic TCLP concentrations are below the RCRA limit (5 mg/L) for all other soil types, including flotation tailings.
- Mercury TCLP concentrations are below the RCRA limit for all samples.

4.3.2.2 Organic Compounds

The following organic compound groups were detected in at least one of the Post-1955 Main Processing Area subsurface soil samples: SVOCs, DRO, and RRO. Organic compounds in subsurface soil were identified locally the Post-1955 Main Processing Area at depths ranging up to 30 feet bgs. The extent of organic compounds in the subsurface soil of the Post-1955 Main Processing Area has not been determined.

DRO was detected at concentrations above the regulatory level of 250 mg/kg (18 AAC 75.341 Table B2, Under 40 Inch Zone, Migration to Groundwater), in subsurface soil samples collected from Settling Pond #3 (11MP36SB08) and the vicinity of Monofill #2 (11MP17SB30). Comparison of organic compound concentrations to regulatory levels is presented in Chapter 7.

4.3.3 Red Devil Creek Downstream Alluvial Area and Delta

Laboratory analytical data for Red Devil Creek Downstream Alluvial Area and Delta subsurface soil are presented in Table 4-26. Additional information, including XRF field screening results for subsurface soil in the Red Devil Creek Downstream Alluvial Area and Delta, is presented in Table F-10, Appendix F.

Soil types identified in the subsurface soil samples in the Red Devil Creek Downstream Alluvial Area and Delta are: tailings/waste rock, native/disturbed native, Kuskokwim River alluvium, fill, and bedrock/weathered bedrock. Mixed Red Devil Creek alluvium, soil, and tailings/waste rock occurs locally from the ground surface to between approximately 2 and 10 feet bgs in the Red Devil Creek Downstream Alluvial Area and Delta. Kuskokwim River alluvium was encountered beneath materials comprising the Red Devil Creek Delta at depths ranging from approximately 8 to 10 feet bgs in each borehole in the Red Devil Creek Delta. Kuskokwim River alluvium was deposited prior to development of the Red Devil Creek Delta. Native/disturbed native soil was identified locally at depths ranging from the ground surface to between approximately 8 and 16 feet bgs in the Red Devil Creek Downstream Alluvial Area and Delta. Disturbed native soil with local fill was identified at locations RD06 and RD07 to depths of up to 6 feet bgs in the Red Devil Creek Downstream Alluvial Area. Fill was not identified in the Red Devil Creek Delta. The top of bedrock/weathered bedrock was encountered in several borings at depths ranging from approximately 10 to 16 feet bgs in the Red Devil Creek Downstream Alluvial Area. Bedrock/weathered bedrock was not identified in the Red Devil Creek Delta.

Observations pertaining to the nature and extent of inorganic element contamination in the Red Devil Creek Downstream Alluvial Area and Delta subsurface soil are summarized below:

- Generally, the highest concentrations of antimony, arsenic, and mercury are in the tailings/waste rock and the lowest concentrations are in the Kuskokwim River alluvium, native/disturbed native soils, or bedrock/weathered bedrock.
- The depth of inorganic element contamination in subsurface soils in the Red Devil Creek Downstream Alluvial Area and Delta generally extends to at least the depth of mixed Red Devil Creek alluvium, soil, and tailings/waste rock. Locally, Kuskokwim River Alluvium, native/disturbed native soils, disturbed native soil with fill, and bedrock/weathered bedrock have concentrations of inorganic elements above subsurface soil background values. The depth of inorganic element contamination in the subsurface soils has not been determined at all soil boring locations.
- Where tailings/waste rock is present, the depth below the base of tailings/waste rock of soil with concentrations that exceed the

recommended background level is not known at many locations. The soil boring depths at most locations were limited, in accordance with the Final RI Work Plan (E & E 2011), to approximately 3 feet below the base of tailings/waste rock, thus limiting information on soil inorganic element concentrations at depths greater than approximately 3 feet below tailings/waste rock. Concentrations of inorganic elements, including antimony, arsenic, and mercury, are commonly elevated above the recommended background level in soils below tailings/waste rock to at least the depth of the deepest sample collected from a given soil boring. As such, the depth of contamination (defined as exceeding the recommended background concentrations) below the base of tailings/waste rock is not consistently defined in those areas with tailings/waste rock. Further, existing total concentration data do not establish whether the elevated concentrations are due to leaching from tailings/waste rock or to the presence of naturally mineralized soils. The former would be considered contamination, whereas the latter would arguably not be considered contamination. As noted in Section 4.1.7, the recommended background levels are considered to be conservative and likely underestimate pre-mining background concentrations of inorganic elements associated with natural mineralization that exists at part of the RDM site. Discriminating between the impacts of leaching and vadose zone migration on natural soil and the contribution to total concentration by natural mineralization will be important in establishing appropriate remedial goals and objectives.

4.3.4 Red Devil Creek Upstream Alluvial Area

One soil boring (location RD13) was installed in the Red Devil Creek Upstream Alluvial Area and is considered a background location. Laboratory analytical results for subsurface soil collected at RD13 are presented in Section 4.1.2. Additional information, including soil type and field screening results for subsurface soil in the Red Devil Creek Upstream Alluvial Area is presented in Table F-11, Appendix F.

4.3.5 Dolly Sluice and Delta

Laboratory analytical data for the Dolly Sluice and Delta subsurface soil are presented in Table 4-27. Additional information, including XRF field screening results for subsurface soil in the Dolly Sluice and Delta is presented in Table F-12, Appendix F.

Soil types identified in the subsurface soil samples at the Dolly Sluice Delta are: sluiced overburden and Kuskokwim River alluvium. Sluiced overburden was identified in soil borings from ground surface to depths ranging from approximately 10 to 12 feet bgs in the Dolly Sluice Delta. Kuskokwim River alluvium deposited prior to formation of the Dolly Sluice Delta was encountered at depths ranging from approximately 10 to 12 feet bgs at the Dolly Sluice Delta.

4.3.5.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Dolly Sluice and Delta subsurface soil are summarized below:

- Concentrations of antimony, arsenic, and mercury are higher in the sluiced overburden than in the Kuskokwim River alluvium. No tailings/waste rock was observed in the sluiced overburden.
- The depth of inorganic element contamination in subsurface soils in the Dolly Sluice Delta generally extends to the base of sluiced overburden. However, Kuskokwim River Alluvium locally has concentrations of inorganic elements slightly above subsurface soil background values.

4.3.6 Rice Sluice and Delta

Laboratory analytical data for the Rice Sluice and Delta subsurface soil are presented in Table 4-28. Additional information, including XRF field screening results for subsurface soil in the Rice Sluice and Delta is presented in Table F-13, Appendix F.

Soil types identified in the subsurface soil samples at the Rice Sluice Delta are: sluiced overburden and Kuskokwim River alluvium. Sluiced overburden was identified in soil borings from ground surface to depths ranging from approximately 10 to 12 feet bgs in the Rice Sluice Delta. Kuskokwim River alluvium deposited prior to formation of the Rice Sluice Delta was encountered at depths of approximately 12 feet bgs at the Rice Sluice Delta.

4.3.6.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Rice Sluice and Delta subsurface soil are summarized below:

- Concentrations of antimony, arsenic, and mercury are higher in the sluiced overburden than in the Kuskokwim River alluvium. No tailings/waste rock was observed in the sluiced overburden.
- The depth of inorganic element contamination in subsurface soils in the Rice Sluice Delta generally extends to the base of sluiced overburden. However, Kuskokwim River Alluvium locally has concentrations of inorganic elements slightly above subsurface soil background values.

4.3.7 Surface Mined Area

Laboratory analytical data for the Surface Mined Area subsurface soil are presented in Table 4-29. Additional information, including XRF field screening results for subsurface soil in the Surface Mined Area, is presented in Table F-14, Appendix F.

As discussed in Section 4.1, in September 2012, additional subsurface soil characterization activities were conducted in the Surface Mined Area as part of an effort to better understand the extent and ranges of inorganic element concentrations of naturally mineralized soils within mineralized portions of the Surface Mined Area. The resulting data does not meet the conditions specified for further consideration for mineralized zone soil characterization. Results of the additional soil characterization are not incorporated into this Chapter. Results are provided in Appendix E.

Soil types identified in the subsurface soil samples in the Surface Mined Area are: native/disturbed native, native/disturbed native (loess), and bedrock/weathered bedrock. Native/disturbed native soil occurs widely to varying depths in the Surface Mined Area. Native/disturbed native soil consisting of loess was identified in soil borings to depths of approximately 12 feet bgs in the Surface Mined Area. The top of bedrock/weathered bedrock was encountered in several borings at depths ranging from approximately 5 to 12 feet bgs in the Surface Mined Area.

4.3.7.1 Inorganic Elements

Observations pertaining to the nature and extent of inorganic element contamination in the Surface Mined Area subsurface soil are summarized below:

- Generally, the highest concentrations of antimony, arsenic, and mercury are in bedrock/weathered bedrock and the lowest concentrations are in the native/disturbed native (loess).
- Elevated concentrations of inorganic elements in bedrock/weathered bedrock are attributable to natural mineralized conditions. Natural mineralization at the RDM is discussed in Section 4.1.7.

4.3.8 Petroleum-Contaminated Soil Landspread

The BLM established a soil landspread area at the RDM to address petroleum-contaminated soil associated with the former ASTs. The landspread area was constructed in 2010 near the former residential buildings west of the Red Devil Creek Downstream Alluvial Area (Weston and Marsh Creek 2011). In 2011, petroleum-contaminated soil was removed from a newly discovered historical spill and added to the landspread (Marsh Creek 2012). Soil being treated in the landspread area was monitored to track remedial performance in 2010 (Weston and Marsh Creek 2011), 2011 (Marsh Creek 2012), and 2012. The analytical results for performance monitoring samples collected in 2012 will be documented in a report scheduled for 2013.

4.4 Groundwater

The results of the RI groundwater samples collected in 2010 and 2011 are presented in Table 4-30. The table presents the number of samples per analysis, the number of detections per analysis, the number of samples exceeding the recommended background value per analysis, and maximum and minimum concentrations per analysis. Comparison of contaminant concentrations to water quality criteria is presented in Chapter 7. Results of these samples for selected inorganic elements (total and dissolved antimony, arsenic, and mercury, and methylmercury) are illustrated in Figures 4-23 through 4-35.

In 2012, groundwater samples were collected from monitoring wells MW04 and MW27 for analysis for PCBs. Results are presented in Table 4-30.

Additional groundwater sampling was conducted in 2012 as part of baseline groundwater and surface water monitoring at the RDM. Baseline monitoring entailed the collection of Red Devil Creek water samples, measurement of Red Devil Creek discharge, and collection of monitoring well groundwater samples during the spring (May 25 to May 31, 2012) and fall (September 7 to September 21, 2012). Results of the 2012 baseline monitoring are provided in Appendix A.

4.4.1 Total Inorganic Elements

The following inorganic elements were detected in at least one of the 2010 or 2011 groundwater samples at concentrations above total inorganics background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, thallium, vanadium, and zinc. Concentrations of total antimony and arsenic are highest in the Post-1955 Main Processing Area. A relatively high concentration of total mercury was detected in a sample collected from monitoring well MW24. Relatively high total mercury concentrations also were detected in samples from wells MW28, MW15, and MW17. Factors that may influence the total mercury concentrations in groundwater are discussed in Chapter 5.

4.4.2 Dissolved Inorganic Elements

The following inorganic elements were detected in at least one of the 2010 or 2011 groundwater samples at concentrations above dissolved inorganics background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. Concentrations of dissolved antimony and arsenic are highest in the Post-1955 Main Processing Area.

4.4.3 Methylmercury

Methylmercury was not detected in the background groundwater samples. Therefore, any detected concentration in site groundwater samples is treated as a background exceedance. In the 2010 samples, methylmercury was detected in monitoring wells MW01 and MW04.

In the 2011 samples, methylmercury was detected at monitoring wells MW01, MW08, MW14, MW15, MW16, MW17, MW19, MW20, MW21, MW22, MW24, MW25, MW26, MW27, and MW32. The highest concentrations were detected at monitoring wells MW01, MW16, and MW22.

4.4.4 Organic Compounds

All concentrations of organic compounds in groundwater were below regulatory levels. Comparison of contaminant concentrations to regulatory levels is presented in Chapter 7.

In 2010 groundwater samples were collected from MW01 and MW04 for analysis for SVOCs, DRO, and RRO. The sample from MW01 also was analyzed for GRO. The sample collected from MW01 contained an unknown hydrocarbon at a low concentration, and non-detect concentrations of GRO, DRO, and RRO. The sample from MW04 contained a low concentration of DRO.

In 2011 groundwater samples from 10 wells were analyzed for SVOCs, DRO, and RRO. Two of those samples also were analyzed for GRO. Toluene was detected at low concentrations in the samples from MW01 and MW14. Bis(2-ethylhexyl) phthalate was detected at a low concentration in the sample from MW04. GRO were not detected in any samples. DRO were detected in the groundwater at monitoring wells MW01, MW04, MW14, MW19, MW20, MW21, MW22, MW32, and MW33 at concentrations up to 200 µg/L. RRO were detected in the groundwater at monitoring wells MW04, MW14, MW19, and MW21 at concentrations up to 620 µg/L.

In 2012, groundwater samples were collected from monitoring wells MW04 and MW27 for analysis for PCBs. PCBs were not detected in either sample.

4.5 Red Devil Creek Surface Water

The results of the RI Red Devil Creek surface water samples collected in 2010 and 2011 are presented in Table 4-31. The table presents the number of samples per analysis, the number of detections per analysis, the number of samples exceeding the recommended background value per analysis, and maximum and minimum concentrations per analysis. Results of these samples for total and dissolved antimony, arsenic, and mercury, and methylmercury are illustrated in Figures 4-23 through 4-35. Concentration profiles along the length of Red Devil Creek for total and dissolved antimony, arsenic, and mercury and methylmercury are illustrated in Figures 4-36 through 4-39. Comparison of contaminant concentrations to water quality criteria is presented in Chapter 7.

Additional surface water sampling was conducted as part of baseline groundwater and surface water monitoring at the RDM. Baseline monitoring entailed the collection of Red Devil Creek water samples, measurement of Red Devil Creek discharge, and collection of monitoring well groundwater samples during the spring (May 25 to May 31, 2012) and fall (September 7 to September 21, 2012). Results of the 2012 baseline monitoring are provided in Appendix A.

4.5.1 Total Inorganic Elements

The following inorganic elements were detected in at least one of the 2010 or 2011 surface water samples at concentrations above total inorganics background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, thallium, and zinc.

Total antimony, arsenic, and mercury are the most highly elevated contaminants above background values in the Red Devil Creek surface water samples. Starting at the upper end of the Main Processing Area, sample results from both 2010 and 2011 indicate that total antimony, arsenic, and mercury are significantly elevated above the background levels in Red Devil Creek surface water down to the mouth of the creek.

Total barium, cobalt, manganese, and nickel were detected at concentrations above background at most sample stations within the Main Processing Area and downstream to the mouth of Red Devil Creek. The samples collected at the seep (RD05SW) contained significantly greater concentrations of these analytes than the stream samples.

Total beryllium, cadmium, chromium, copper, lead, silver, thallium, and zinc were detected at concentrations only slightly above background in a small number of samples. There is no discernible spatial trend of the concentrations of these elements in Red Devil Creek surface water.

4.5.2 Dissolved Inorganic Elements

The following inorganic elements were detected in at least one of the 2010 or 2011 surface water samples at concentrations above dissolved inorganics background values: antimony, arsenic, barium, beryllium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc.

Dissolved antimony, arsenic, and mercury were the contaminants most highly elevated above background values in the Red Devil Creek surface water samples. Starting at the upper end of the Main Processing Area, sample results from both 2010 and 2011 indicate that dissolved antimony, arsenic, and mercury are significantly elevated above the background levels in Red Devil Creek surface water down to the mouth of the creek. Dissolved concentrations of arsenic were comparable to the total concentrations of arsenic and antimony at the same stream sample locations in 2010 and 2011. For the samples collected at the seep location (RD05), the dissolved antimony concentrations were significantly lower than the total antimony concentrations. Dissolved mercury concentrations, where elevated in the Main Processing Area, were generally approximately one order of magnitude lower than the total mercury concentrations.

Dissolved barium, cobalt, manganese, and nickel were detected at concentrations above background at most sample stations within the Main Processing Area and downstream to the mouth of Red Devil Creek. The samples collected at the seep (RD05SW) contained significantly greater concentrations of these analytes than the stream samples.

Dissolved beryllium, chromium, copper, lead, selenium, silver, thallium, vanadium, and zinc were detected at concentrations only slightly above background in a small number of samples. There is no discernible spatial trend of the concentrations of these elements in Red Devil Creek surface water.

4.5.3 Methylmercury

In the 2010 samples, methylmercury was detected above the background value at all of the Red Devil Creek surface water stations. In the 2011 samples, methylmercury was detected at the background value at three stations (RD02SW, RD04SW, and RD10SW); all other samples contained concentrations of methylmercury above the background value. The highest methylmercury concentrations were detected at the seep in the Main Processing Area (RD05SW) in both 2010 and 2011.

4.5.4 Organic Compounds

Low concentrations of PAHs naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene were detected in samples collected at the seep location (RD05) in 2010 and 2011. A low concentration of unknown hydrocarbons also were detected in samples collected from stations RD03 and RD09. No organic compound concentrations in surface water samples were above regulatory levels. Comparison of contaminant concentrations to water quality criteria is presented in Chapter 7.

4.6 Red Devil Creek Sediment

The results of the Red Devil Creek sediment samples are presented in Table 4-32. The table presents the number of samples per analysis, the number of detections per analysis, the number of samples exceeding the recommended background value per analysis, and maximum and minimum concentrations per analysis. Results of these samples for selected inorganic elements (total antimony, arsenic, and mercury) are illustrated in Figure 4-40. Comparison of sediment contaminant concentrations to sediment quality criteria is presented in Chapter 7.

4.6.1 Inorganic Elements

The following inorganic elements were detected in at least one of the sediment samples at concentrations above background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc.

Total antimony, arsenic, and mercury were the contaminants most highly elevated above background values in the Red Devil Creek sediment samples. Antimony and arsenic concentrations were below background between the reservoir dam and the upper end of the Main Processing Area. Between the upper end of the Main Processing Area and the Red Devil Creek delta, antimony and arsenic concentrations are significantly above background.

Total mercury sediment concentrations were slightly above the background value at locations upstream of the Main Processing Area. Between the upper end of the

Main Processing Area and the Red Devil Creek delta, mercury concentrations are significantly above background

Barium concentrations are elevated above the background value within the Main Processing Area down to the mouth of Red Devil Creek. The samples from locations RD05SD (seep yellowboy) and RD12 (a short distance downstream from the seep) contained significantly higher barium concentrations than other locations.

Similar to barium, nickel was detected slightly above the background value in the Main Processing Area down to the mouth of Red Devil Creek. Nickel was more highly elevated in the seep yellowboy sample (10RD05SD). There is no discernible spatial trend of nickel concentrations within the Main Processing Area.

Manganese concentrations are elevated above the background value within the Main Processing Area; however, there is no discernible spatial trend of manganese concentrations in Red Devil Creek sediments.

Beryllium, cadmium, chromium, cobalt, copper, lead, selenium, thallium, vanadium, and zinc were generally detected at concentrations close to their respective background values. For these analytes, there is either no discernible spatial trend of the concentrations or a slight increase in concentration in the Main Processing Area.

4.6.2 Methylmercury

Methylmercury was detected above the background value in all but one of the Red Devil Creek sediment samples (11RD10SD). The highest concentrations were detected at the reservoir dam area (10RD02SD) and at the seep in the Main Processing Area (10RD05SD).

4.6.3 Organic Compounds

Twelve organic compounds were detected in two Red Devil Creek sediment samples submitted for SVOC analyses (10RD10SD and 11RD11SD). These samples were collected at locations adjacent to the Gravel Pad area in the Post-1955 Main Processing Area. All of the organic compounds were detected at concentrations very near the method detection limits. None of the compounds were detected at concentrations above sediment screening levels.

4.7 Kuskokwim River Sediment

The results of the Kuskokwim River sediment samples collected in 2010, 2011, and 2012 are presented in Table 4-33. The table presents the number of samples per analysis, the number of detections per analysis, the number of samples exceeding the recommended background value per analysis, and maximum and minimum concentrations per analysis. Results of 2010 and 2011 samples for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure

4-41. Results of 2012 samples for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure 4-42.

4.7.1 Inorganic Elements

The following inorganic elements were detected in at least one of the sediment samples at concentrations above background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

Of these inorganic elements, the following were generally detected at concentrations below or close to their respective background values and do not show any discernible spatial trends: barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, vanadium, and zinc.

Manganese was detected above the background value in 21 samples. The sample collected at shoreline sediment station KR15SD on the Red Devil Creek delta contained manganese at a concentration of 5,410 mg/kg, approximately seven times greater than the background value.

Thallium was detected above the background value in 17 samples. While most of these samples contained thallium concentrations close to the background value, the sample collected at off-shore sediment station KR28SD, near the mouth of Red Devil Creek, contained thallium at a concentration of 0.653 mg/kg, approximately six times greater than the background value.

Similar to Red Devil Creek sediments, antimony, arsenic, and mercury were the most highly elevated contaminants above background values in the Kuskokwim River sediment samples. Each of these inorganic elements was detected at concentrations above its respective background value in most of the samples. Concentrations generally decrease downriver from the mouth of Red Devil Creek, but not in a regular pattern. An anomalously high mercury concentration was detected in the sample collected at off-shore location KR60SD. Several sand-sized particles of cinnabar were visually observed in this sample. The samples collected from some of the most downriver and outboard sample locations exceed one or more of the background values. The extent of inorganic element contamination in river sediments has not been defined by RI sampling in either the downriver or cross-river direction.

4.7.2 Methylmercury

Methylmercury was detected above the background value in approximately half of the samples analyzed for methylmercury. Methylmercury was detected at concentrations significantly above the background value in samples collected at stations KR15, KR58, and KR66. Concentrations generally decrease downriver from the mouth of Red Devil Creek, but not in a regular pattern.

4.8 Vegetation

Analytical results for blueberry leaves and stems, green alder bark, white spruce needles, and horsetail pond vegetation are presented in this section. As noted in Chapter 2, additional blueberry fruit samples were collected during the period of September 7 to September 21, 2012. Sample results are presented in Tables 4-34 through 4-38. Results of site and background vegetation samples and co-located surface soil samples are illustrated in Figures 4-43 through 4-47. Comparison of concentrations of arsenic, antimony, and mercury in co-located vegetation and soil samples is provided in Chapter 6.

4.8.1 Blueberry Leaves and Stems

The results of the blueberry leaves and stems samples are presented in Table 4-34. Results for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure 4-43.

The following inorganic elements were detected in at least one of the blueberry leaves and stems samples at concentrations slightly above background values: barium, cadmium, chromium, manganese, and nickel.

Antimony, arsenic, mercury, and methylmercury were not detected above background values in these samples.

4.8.2 Green Alder Bark

The results of the green alder bark samples are presented in Table 4-35. Results for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure 4-44.

The following inorganic elements were detected in at least one of the green alder bark samples at concentrations above background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

The highest detected concentration of antimony in these samples was in sample 11MP27GA, located adjacent to tailings in the Pre-1955 Main Processing Area. The highest detected concentrations of arsenic and mercury were in sample 11MP34GA, located in Settling Pond #2.

Methylmercury was not detected in any of the samples.

4.8.3 White Spruce Needles

The results of the white spruce needles samples are presented in Table 4-36. Results for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure 4-45.

The following inorganic elements were detected in at least one of the white spruce needles samples at concentrations above background values: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, thallium, and vanadium.

The highest concentrations of antimony, arsenic, and mercury were in sample 11MP38WS, located near Red Devil Creek downhill from Settling Ponds #1 and #2. Concentrations of these elements were substantially higher in this sample than the other samples.

Methylmercury was not detected in any of the samples.

4.8.4 Horsetail Pond Vegetation

The results of the horsetail pond vegetation samples are presented in Table 4-37. Results for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure 4-46.

The following inorganic elements were detected in at least one of the horsetail pond vegetation samples at concentrations above background values: antimony, arsenic, cadmium, cobalt, copper, lead, mercury, nickel, selenium, thallium, and zinc.

The highest concentrations of antimony and arsenic detected in vegetation at the site were in the horsetail samples. The horsetail samples also contained the only positive detection of methylmercury in vegetation at the site. The highest concentrations of antimony and arsenic were in sample PM86PV located in Settling Pond #1. The highest concentration of mercury was in sample MP85PV, also located in Settling Pond #1.

4.8.5 Blueberry Fruit

The results of the blueberry fruit samples are presented in Table 4-38. Results for total arsenic, total antimony, total mercury, and methylmercury are illustrated in Figure 4-47.

Only one site sample of blueberry fruit was collected in 2012 at a location near a former exploration trench west of the area of intensive surface mining. No inorganic elements were detected at concentrations above background values.

Table 4-1 Background Surface Soil Results Analyte	Units	10RD10SS	10RD11SS	10RD12SS	10RD13SS	10RD14SS	10RD15SS	10RD16SS	10RD17SS	10RD18SS	10RD19SS	10UP01SS	10UP02SS	10UP03SS	10UP04SS	10UP05SS	10UP06SS	10UP07SS	10UP08SS	10UP09SS	10UP10SS	11RD18SS	11UP09SS
Total Inorganic Elements																							
Aluminum	mg/kg	9470	2.08 J	14500	14100	14300	14700	13400	14000	15600	16700	18300	14400	17400	14100	15900	17600	15300	19600	17500	19500		
Antimony	mg/kg	30 J	14 J	0.69 UJ	0.8 UJ	0.7 UJ	0.65 UJ	8 J	0.62 UJ	0.8 UJ	0.76 UJ	0.58 UJ	0.8 U	0.8 UJ	0.76 UJ	0.63 UJ	0.6 UJ	0.61 UJ	1.3 UJ	0.56 UJ	0.59 UJ		
Arsenic	mg/kg	220	41	25	20	13	8	0.47 U	0.47 U	40	12	11	10	0.6 U	0.58 U	8	11	0.46 U	20	23	16		
Barium	mg/kg	135	172	231	266	148	120	131	129	220	188	78.4	63.5	145	115	95.6	76.5	69.4	105	94.5	101		
Beryllium	mg/kg	0.5	0.4	0.5	0.5	0.4	0.3	0.3	0.3	0.5	0.5	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3		
Cadmium	mg/kg	0.7	0.4	0.4	0.041 U	0.034 U	0.032 U	0.03 U	0.3	0.4	0.037 U	0.028 U	0.039 U	0.039 U	0.037 U	0.031 U	0.029 U	0.03 U	0.063 U	0.3	0.029 U		
Calcium	mg/kg	2040	6380	6590	10100	4620	2320	3040	2560	6490	3210	972	620	4090	1150	1040	863	551	1080	796	1010		
Chromium	mg/kg	20	28.4	22.5	21	21.6	21.8	20.2	21.7	24	26.3	23.9	18	23	19.2	21.4	24	19.1	30	26.7	27.6		
Cobalt	mg/kg	16.7	8.5	11.6	8.2	7.4	6.3	6.5	6.7	10.8	8.5	5.6	3.4	5.9	5.1	6.5	5.7	5.6	11.9	7.7	6.5		
Copper	mg/kg	39.3	17.9	17.9	18.8	16.5	15.3	14.7	17.3	22.8	23.7	18.3	11.6	12.8	9.4	12.2	13.4	13.2	17	20.7	13.7		
Iron	mg/kg	31700	20600	23100	16700	17100	20300	15000	15600	26300	19300	22800	20300	18400	15500	20300	25300	17900	32400	33100	26600		
Lead	mg/kg	12	7	7	6	6	6	5	6	9	8	9	7	9	8	8	9	7	10	9	9		
Magnesium	mg/kg	2230	3720	3750	3420	3800	3610	3470	3580	3760	3870	2980	1520	3200	2140	2920	2560	2130	3570	2870	3190		
Manganese	mg/kg	570	321	816	465	276	144	135	139	251	148	157	112	118	106	142	139	182	455	268	198		
Mercury	mg/kg	6.4	6.6	0.79	0.6	0.96	0.13	0.25	0.14	1.57	1.86	0.18 J	0.23	0.19	0.2	0.19	0.23	0.15	0.32	0.25	0.22		
Nickel	mg/kg	50 J	23 J	26	24	20	19	19	20	28	25	18	9	17	14	16	16	14	24	23	19		
Potassium	mg/kg	990	790	860	790	740	680	700	740	1030	800	650	470	570	550	560	570	440	800	760	730		
Selenium	mg/kg	1.7 U	1 U	0.99 U	1.2 U	1.01 U	0.94 U	0.89 U	0.89 U	1.2 U	1.09 U	0.84 U	1.2 U	1.2 U	1.1 U	0.9 U	0.86 U	0.88 U	1.9 U	0.8 U	0.85 U		
Silver	mg/kg	0.113 U	0.068 U	0.067 U	0.082 U	0.069 U	0.064 U	0.06 U	0.06 U	0.08 U	0.074 U	0.057 U	0.078 U	0.079 U	0.074 U	0.061 U	0.059 U	0.059 U	0.127 U	0.054 U	0.058 U		
Sodium	mg/kg	42.6 U	90	25.4 U	30.8 U	90	90	90	90	100	100	70	29.5 U	100	28.1 U	80	90	22.4 U	47.8 U	20.5 U	80		
Thallium	mg/kg	0.7 U	0.43 U	0.42 U	0.5 U	0.43 U	0.4 U	0.38 U	0.38 U	0.5 U	0.46 U	0.35 U	0.5 U	0.5 U	0.47 U	0.38 U	0.37 U	0.37 U	0.8 U	0.34 U	0.36 U		
Vanadium	mg/kg	37.3	41	36.6	30.8	34.7	37.6	32.9	35.4	39.8	41.6	44.8	35.1	43.7	34	38.2	45.8	35.6	62.9	57.8	57.6		
Zinc	mg/kg	100	48	61	39	53	49	49	51	67	58	45	23	47	39	45	41	33	58	56	45		
Arsenic Speciation (mg/kg)																							
Arsenate	mg/kg		46.5 J	35.1 J						10.2 J	15.9 J									16.9 J	14.9 J		
Arsenite	mg/kg		1.68 J	0.971 J						3.91 J	0.976 J									0.506	0.408 J		
Inorganic Arsenic	mg/kg		48.2 J	36.1 J						14.1 J	16.9 J									17.4 J	15.3 J		
Arsenic Bioavailability																							
Arsenic (IVBA)	mg/L																					0.0725	0.2194 J
Arsenic, total (3050)	mg/kg																					20.8	32.2
Arsenic IVBA% (In Vitro RBA)	%																					34.9 J	68.1 J
Total Solids	%		56.44	58.17						53.21	59.53									67.95	69.47	54	51
Mercury Selective Sequencial Extraction																							
Hg(F0)	ng/g		5.68 U	5.29 U						5.84 U	4.11 U									4.15 U	4.53 U		
Hg(F1)	ng/g		10.8	2.2						1.65	2.59									1.26	0.54		
Hg(F2)	ng/g		56.9	1.25						0.63	0.85									4.11	1.62		
Hg(F3)	ng/g		4140 J	485 J						482 J	1210 J									207 J	116 J		
Hg(F4)	ng/g		259	21.1						23.7	33.3									12.9	9.66		
Hg(F5)	ng/g		2000	24.8						65	22.1									9.72 M	6.76		
Hg(F6)	ng/g		3.18 U	3.38 U						689 J	3.04 U									2.84 U	2.53 U		

Key

% = percent

Hg = mercury

IVBA = in-vitro bioaccessibility

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

ng/g = nanograms per gram

RBA = relative bioavailability

U = The analyte was analyzed for but not detected. The value provided is reporting limit.

UJ =The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-2 Background Statistics for Surface Soil

Analyte	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration	Distribution	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	18	18	13400	19600	Normal	19475	95% UPL
Antimony	18	1	8	8	NA	8	Maximum Detected Concentration
Arsenic	18	13	8	40	Gamma	28.58	95% KM UPL
Barium	18	18	63.5	266	Gamma	266	Maximum Detected Concentration
Beryllium	18	18	0.2	0.5	Non-Parametric	0.5	95% UPL
Cadmium	18	4	0.3	0.4	Gamma	0.4	Maximum Detected Concentration
Calcium	18	18	551	10100	Gamma	10,100	Maximum Detected Concentration
Chromium	18	18	18	30	Normal	28.57	95% UPL
Cobalt	18	18	3.4	11.9	Normal	11.28	95% UPL
Copper	18	18	9.4	23.7	Normal	23.02	95% UPL
Iron	18	18	15000	32400	Normal	30891	95% UPL
Lead	18	18	5	10	Normal	10	Maximum Detected Concentration
Magnesium	18	18	1520	3870	Gamma	3870	Maximum Detected Concentration
Manganese	17	17	106	465	Non-Parametric	465	Maximum Detected Concentration
Mercury	18	18	0.13	1.86	Non-Parametric	1.86	95% UPL
Nickel	18	18	9	28	Normal	28	Maximum Detected Concentration
Potassium	18	18	440	1030	Normal	954.1	95% UPL
Selenium	18	0	ND	ND		ND	Not Detected
Silver	18	0	ND	ND		ND	Not Detected
Sodium	18	11	70	100	Normal	100	Maximum Detected Concentration
Thallium	18	0	ND	ND		ND	Not Detected
Vanadium	18	18	30.8	62.9	Gamma	62.9	Maximum Detected Concentration
Zinc	18	18	23	67	Normal	66.7	95% UPL

Key:

KM	Kaplan Meier
mg/kg	milligrams per kilogram
NA	Not available
UPL	upper prediction limit
ND	Not detected

Table 4-3 Background Subsurface Soil Results

Analyte	Units	11RD13SB04	11RD13SB06	11RD13SB10	11RD13SB14	11RD13SB18	11UP11SB04	11UP11SB06	11UP11SB08
Total Inorganic Elements									
Aluminum	mg/kg	15300	4890 J	1520	12700		4980 J	14800	7880
Antimony	mg/kg	2.81 J	6.25 J	52.2 J	3.91 J		20 U	0.264 J	0.591 J
Arsenic	mg/kg	6.01	8.63	20 UJ	12.8		7.21 J	6.95 J	7.82 J
Barium	mg/kg	178	65.2 J	32.8 J	156		67.3 J	178 J	132 J
Beryllium	mg/kg	0.427	0.42	0.2 U	0.357		0.415	0.421	0.484
Cadmium	mg/kg	0.203	0.8 U	0.8 UJ	0.274		1.3 J	0.231 J	0.5 J
Calcium	mg/kg	1630 J	961 J	4640	2510 J		646 J	2010 J	1750 J
Chromium	mg/kg	23.4 J	7.1 J	3.8 J	18.9		7.4 J	23.3 J	14.6 J
Cobalt	mg/kg	9.71	2 U	6 J	7.21		9.91	6.73	19.1
Copper	mg/kg	23.9 J	7.4 J	5 U	20.1 J		6.8 J	28.2 J	59.7 J
Iron	mg/kg	31500	6100 J	1580	24300		4630	25600	39300
Lead	mg/kg	9.75 J	9.34 J	8 U	7.46 J		8.06	9.72	14.3
Magnesium	mg/kg	4880 J	718	2180	4370 J		509	4230 J	2860 J
Manganese	mg/kg	388	99	416	287		64.3	951	739
Mercury	mg/kg	0.367 J	0.4 U	0.4 U	3.92		0.4 U	0.234	0.498
Nickel	mg/kg	25.3 J	8.1 J	16.3 J	22.3		4.3 J	27.4 J	52.2 J
Potassium	mg/kg	576 J	621	536	609 J		917	939	1080
Selenium	mg/kg	0.16	30 U	30 UJ	0.37		30 U	0.09 J	0.34
Silver	mg/kg	0.123	10.5 J	9.4 J	0.138		5 U	0.167	0.319
Sodium	mg/kg	48.4	8170 J	8090 J	77.8		92.2 J	79.1 J	48.1 J
Thallium	mg/kg	0.081	30 U	30 U	0.076		30 U	0.087	0.088
Vanadium	mg/kg	37.6	36.2	5.5 J	29.7		7.3 J	30.4	26.4
Zinc	mg/kg	56.2	66.7	27.9 J	53.7		74.2 J	72.5 J	106 J
Low Level Mercury									
Mercury	ng/g						123 J		
Arsenic Speciation									
Arsenate	mg/kg	8.62	3.05 U		1.52 U	2.76 J	9.52 J		
Arsenite	mg/kg	1.75	5.69		3.8	3.84	0.19 J		
Inorganic Arsenic	mg/kg	10.4	6.8		4.84	6.6	9.7		
Mercury Selective Sequential Extraction									
Hg(F1)	ng/g						0.24 UJ		
Hg(F2)	ng/g						0.24 J		
Hg(F3)	ng/g						40.8 J		
Hg(F4)	ng/g						20 J		
Hg(F5)	ng/g						7.41 J		

Key

% = percent

Hg = mercury

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ng/g = nanograms per gram

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-4 Background Statistics for Subsurface Soil

Analyte	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	7	7	1520	15300	15300	Maximum Detected Concentration
Antimony	7	6	0.264	52.2	52.2	Maximum Detected Concentration
Arsenic	7	6	6.01	12.8	12.8	Maximum Detected Concentration
Barium	7	7	32.8	178	178	Maximum Detected Concentration
Beryllium	7	6	0.357	0.484	0.484	Maximum Detected Concentration
Cadmium	7	5	0.203	1.3	1.3	Maximum Detected Concentration
Calcium	7	7	961	4640	4640	Maximum Detected Concentration
Chromium	7	7	3.8	23.4	23.4	Maximum Detected Concentration
Cobalt	7	6	6	19.1	19.1	Maximum Detected Concentration
Copper	7	6	6.8	59.7	59.7	Maximum Detected Concentration
Iron	7	7	1580	39300	39300	Maximum Detected Concentration
Lead	7	6	7.46	14.3	14.3	Maximum Detected Concentration
Magnesium	7	7	509	4880	4880	Maximum Detected Concentration
Manganese	7	7	99	951	951	Maximum Detected Concentration
Mercury	7	4	0.234	3.92	3.92	Maximum Detected Concentration
Nickel	7	7	8.1	52.2	52.2	Maximum Detected Concentration
Potassium	7	7	536	1080	1080	Maximum Detected Concentration
Selenium	7	4	0.09	0.37	0.37	Maximum Detected Concentration
Silver	7	6	0.123	10.5	10.5	Maximum Detected Concentration
Sodium	7	7	48.1	8170	8170	Maximum Detected Concentration
Thallium	7	4	0.076	0.088	0.088	Maximum Detected Concentration
Vanadium	7	7	5.5	37.6	37.6	Maximum Detected Concentration
Zinc	7	7	27.9	106	106	Maximum Detected Concentration

Key:

mg/kg	milligrams per kilogram

Table 4-5 Background Groundwater Results **Analyte**	**Units**	**11RD13GW MW12**	**11UP11GW MW31**
Total Inorganic Elements			
Aluminum	µg/L	63.2 J	405
Antimony	µg/L	0.505 J	0.098
Arsenic	µg/L	13.5	0.1 U
Barium	µg/L	83.3	11.1
Beryllium	µg/L	0.006 U	0.018 J
Cadmium	µg/L	0.005 U	0.017 J
Calcium	µg/L	20600	7730
Chromium	µg/L	0.33	4.95
Cobalt	µg/L	1.14	0.314
Copper	µg/L	0.28	0.48
Iron	µg/L	8990	777
Lead	µg/L	0.022	0.311
Magnesium	µg/L	11300	5390
Manganese	µg/L	1120	19.2
Nickel	µg/L	1.3	2.68
Potassium	µg/L	708	417 J
Selenium	µg/L	0.2 U	0.3 U
Silver	µg/L	0.004 U	0.016 J
Sodium	µg/L	2800	1560
Thallium	µg/L	0.005 U	0.009 J
Vanadium	µg/L	0.55	0.51
Zinc	µg/L	0.7	1.3
Total Low Level Mercury			
Mercury, Total	ng/L	54.1	58.4
Dissolved Inorganic Elements			
Aluminum, Dissolved	µg/L	8.3 J	8 J
Antimony, Dissolved	µg/L	0.522 J	0.027 J
Arsenic, Dissolved	µg/L	13.9	0.1 U
Barium, Dissolved	µg/L	87.7	4.05
Beryllium, Dissolved	µg/L	0.01 J	0.006 U
Cadmium, Dissolved	µg/L	0.006 J	0.008 J
Calcium, Dissolved	µg/L	20400	7620
Chromium, Dissolved	µg/L	0.36	1.43
Cobalt, Dissolved	µg/L	1.21	0.043
Copper, Dissolved	µg/L	0.34	0.13
Iron, Dissolved	µg/L	8760	7.5 J
Lead, Dissolved	µg/L	0.244	0.005 U
Magnesium, Dissolved	µg/L	11400	5410
Manganese, Dissolved	µg/L	1190	1.78
Nickel, Dissolved	µg/L	1.56	1.84
Potassium, Dissolved	µg/L	730	162 J
Selenium, Dissolved	µg/L	0.2 U	0.3 U

Table 4-5 Background Groundwater Results		**11RD13GW**	**11UP11GW**
Analyte	**Units**	**MW12**	**MW31**
Silver, Dissolved	µg/L	0.004 J	0.004 U
Sodium, Dissolved	µg/L	2810	1500
Thallium, Dissolved	µg/L	0.005 U	0.005 U
Vanadium, Dissolved	µg/L	0.74	0.05 J
Zinc, Dissolved	µg/L	1.2	0.4 J
Dissolved Low Level Mercury			
Mercury, Dissolved	ng/L	1.14	0.7 J
Arsenic Speciation			
Arsenate	µg/L	4.56 J	0.057
Arsenite	µg/L	10.2 J	0.003 U
Inorganic Arsenic	µg/L	14.7	0.061
Methlymercury			
Methylmercury	ng/L	0.05 U	0.05 U
Gasoline, Diesel and Residual Range Organics			
Diesel Range Organics	µg/L	20 J	
Residual Range Organics	µg/L	42 J	
General Chemistry			
Bicarbonate	mg/L	108	44.1
Carbonate	mg/L	3 U	3 U
Hydroxide	mg/L		
Chloride	mg/L	0.33 J	0.51
Fluoride	mg/L	0.14 J	0.11 J
Sulfate	mg/L	0.28 J	1.27
Nitrate+Nitrite as Nitrogen	mg/L	0.009 U	0.073
Total Dissolved Solids	mg/L	82	82
Total Suspended Solids	mg/L	18.5	33.5
Silicon	µg/L	9100	6490
Silicon, Dissolved	µg/L	9160	5870

Key

µg/L	micrograms per liter
J	The analyte was detected. The associated result is estimated.
mg/L	milligrams per liter
ng/l	nanograms per liter
U	The analyte was analyzed for but not detected. The Value provided is the reporting limit.

Table 4-6 Background Evaluation for Groundwater Samples	Groundwater - Total						Groundwater - Dissolved					
Analyte	**11RD13GW (µg/L)**	**11UP11GW (µg/L)**	**Sample Size**	**Number Detections**	**Recommended Background Level (µg/L)**	**Background Rationale**	**11RD13GW (µg/L)**	**11UP11GW (µg/L)**	**Sample Size**	**Number Detections**	**Recommended Background Level (µg/L)**	**Background Rationale**
Aluminum	63.2 J	405	2	2	405	Maximum Detection	8.3 J	8 J	2	2	8.3 J	Maximum Detection
Antimony	0.505 J	0.098	2	2	0.505 J	Maximum Detection	0.522 J	0.027 J	2	2	0.522 J	Maximum Detection
Arsenic	13.5	ND	2	1	13.5	Maximum Detection	13.9	ND	2	1	13.9	Maximum Detection
Barium	83.3	11.1	2	2	83.3	Maximum Detection	87.7	4.05	2	2	87.7	Maximum Detection
Beryllium	ND	0.018 J	2	2	0.018 J	Maximum Detection	0.01 J	ND	2	0	0.01 J	Maximum Detection
Cadmium	ND	0.017 J	2	2	0.017 J	Maximum Detection	0.006 J	0.008 J	2	2	0.008 J	Maximum Detection
Calcium	20600	7730	2	2	20600	Maximum Detection	20400	7620	2	2	20400	Maximum Detection
Chromium	0.33	4.95	2	2	4.95	Maximum Detection	0.36	1.43	2	2	1.43	Maximum Detection
Cobalt	1.14	0.314	2	2	1.14	Maximum Detection	1.21	0.043	2	2	1.21	Maximum Detection
Copper	0.28	0.48	2	2	0.48	Maximum Detection	0.34	0.13	2	2	0.34	Maximum Detection
Iron	8990	777	2	2	8990	Maximum Detection	8760	7.5 J	2	1	8760	Maximum Detection
Lead	0.022	0.311	2	2	0.311	Maximum Detection	0.244	ND	2	1	0.244	Maximum Detection
Magnesium	11300	5390	2	2	11300	Maximum Detection	11400	5410	2	2	11400	Maximum Detection
Manganese	1120	19.2	2	2	1120	Maximum Detection	1190	1.78	2	2	1190	Maximum Detection
Mercury	0.0541	0.0584	2	2	0.0584	Maximum Detection	0.00114	0.0007 J	2	2	0.00114	Maximum Detection
Nickel	1.3	2.68	2	2	2.68	Maximum Detection	1.56	1.84	2	2	1.84	Maximum Detection
Potassium	708	417 J	2	2	708	Maximum Detection	730	162 J	2	2	730	Maximum Detection
Selenium	ND	ND	2	1	ND	Maximum Detection	ND	ND	2	1	ND	Maximum Detection
Silver	ND	0.016 J	2	2	0.016 J	Maximum Detection	0.004 J	ND	2	0	0.004 J	Maximum Detection
Sodium	2800	1560	2	2	2800	Maximum Detection	2810	1500	2	2	2810	Maximum Detection
Thallium	ND	0.009 J	2	1	0.009 J	Maximum Detection	ND	ND	2	0	ND	Maximum Detection
Vanadium	0.55	0.51	2	2	0.55	Maximum Detection	0.74	0.05 J	2	2	0.74	Maximum Detection
Zinc	0.7	1.3	2	2	1.3	Maximum Detection	1.2	0.4 J	2	2	1.2	Maximum Detection
Methyl Mercury	ND	ND	2	1	ND	Maximum Detection	NA	NA	0	NA	NA	NA

Key:

µg/L	micrograms per liter
J	The analyte was detected. The associated result is estimated
NA	Not available, not analyzed
ND	Not detected

Table 4-7 Background Red Devil Creek Surface Water and Sediment Results	**RD01**	**RD01**	**RD01**
Analyte	**10RD01SW**	**11RD01SW**	**10RD01SD**
Total Inorganic Elements (SW=µg/L, SD=mg/kg)			
Aluminum	80	30.5 J	10800
Antimony	1.4	1.52 J	0.54 UJ
Arsenic	0.8	1.1	65
Barium	26.4	23.8	159
Beryllium	0.027 U	0.006 U	0.5
Cadmium	0.022 U	0.005 U	0.3
Calcium	18400	17500	2380
Chromium	0.053 U	0.43	20.4
Cobalt	0.007 U	0.066	12.3
Copper	0.232 U	0.37	21.7
Iron	110	138	32100
Lead	0.2 U	0.021	8
Magnesium	9680	9460	2990
Manganese	10.2	17.5	579
Mercury			0.18
Nickel	0.081 U	0.44	32
Potassium	69.1 U	218 J	1200
Selenium	0.125 U	0.5 J	0.78 U
Silver	0.009 U	0.004 U	0.053 U
Sodium	1580	1470	19.9 U
Thallium	0.003 U	0.005 U	0.33 U
Vanadium	0.3	0.16 J	35.4
Zinc	0.81 U	0.5 J	80
Total Low Level Mercury (SW=ng/L)			
Mercury, Total	3.17	6.37	
Dissolved Inorganic Elements (SW=µg/L)			
Aluminum, Dissolved	14.8 U	11.9 J	
Antimony, Dissolved	1.3	1.4 J	
Arsenic, Dissolved	0.6	0.9	
Barium, Dissolved	24	23	
Beryllium, Dissolved	0.027 U	0.006 U	
Cadmium, Dissolved	0.022 U	0.005 U	
Calcium, Dissolved	19200	17300	
Chromium, Dissolved	0.053 U	0.23	
Cobalt, Dissolved	0.007 U	0.056	
Copper, Dissolved	0.232 U	0.27	
Iron, Dissolved	7.2 U	100	
Lead, Dissolved	0.2 U	0.005 U	
Magnesium, Dissolved	10200	9340	
Manganese, Dissolved	7.2	15.9	
Nickel, Dissolved	0.081 U	0.35	
Potassium, Dissolved	69.1 U	220 J	
Selenium, Dissolved	0.125 U	0.5 J	
Silicon, Dissolved	3.3	3680	
Silver, Dissolved	0.009 U	0.004 U	
Sodium, Dissolved	1610	1450	
Thallium, Dissolved	0.003 U	0.005 U	
Vanadium, Dissolved	0.026 U	0.13 J	
Zinc, Dissolved	0.81 U	0.2 U	
Dissolved Low Level Mercury (SW=ng/L)			
Mercury, Dissolved	1.95	2.63	
Arsenic Speciation (SW=µg/L, SD=mg/kg)			
Arsenate	0.578	0.774 J	48.7 J
Arsenite	0.102	0.089 J	4.13 J

Table 4-7 Background Red Devil Creek Surface Water and Sediment Results	**RD01**	**RD01**	**RD01**
Analyte	**10RD01SW**	**11RD01SW**	**10RD01SD**
Inorganic Arsenic	0.68	0.863 J	52.8 J
Mercury Selective Sequential Extraction (SD=ng/g)			
Hg(F0)			3.36 U
Hg(F1)			1.19 J
Hg(F2)			0.25 U
Hg(F3)			57.3 J
Hg(F4)			17.3 J
Hg(F5)			24.7
Hg(F6)			4.98 J
Methlymercury (SW=ng/L, SD=ng/g)			
Methylmercury	0.074	0.08 J	0.177
Semi-Volatile Organic Compounds (SW=ng/L)			
2-Methylnaphthalene			
Naphthalene			
1-Methylnaphthalene			
2-Methylnaphthalene			
Unknown Hydrocarbon			
Gasoline, Diesel, and Residual Range Organics (SW=mg/L)			
Gasoline Range Organics			
Diesel Range Organics			
Residual Range Organics			
Total Organic Carbon (SD=%)			
Carbon, Total Organic (TOC)		1.47	
General Chemistry (SW=mg/L)			
Bicarbonate	81	74.1	
Carbonate	1 U	3 U	
Hydroxide	1 U		
Hydroxide			
Total Dissolved Solids		74	
Total Suspended Solids		5 U	
Total Dissolved Solids	102		
Total Suspended Solids	2		
Chloride	0.4	0.35 J	
Fluoride	0.022 U	0.05 J	
Sulfate	11.2	9.58	
Nitrate+Nitrite as Nitrogen	0.166	0.208	

Key

% = percent

µg/L = micrograms per liter

Hg = mercury

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

ng/g = nanograms per gram

ng/L = nanograms per liter

SD = sediment

SW = surface water

TOC = total organic carbon

U = The analyte was analyzed for but not detected. The Value provided is the reporting limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-8 Background Evaluation for Red Devil Creek Sediment and Surface Water Samples	Sediment					Surface Water - Total						Surface Water - Dissolved					
Analyte	10RD01SD Conc.(mg/kg)	Sample Size	Number Detections	Recommended Background Level (mg/kg)	Background Rationale	10RD01SW Conc. (µg/L)	11RD01SW Conc. (µg/L)	Sample Size	Number Detections	Recommended Background Level (µg/L)	Background Rationale	10RD01SW Conc. (µg/L)	11RD01SW Conc. (µg/L)	Sample Size	Number Detections	Recommended Background Level (µg/L)	Background Rationale
Aluminum	10800	1	1	10800	Single Result	80	30.5 J	2	2	80	Maximum Detection	ND	11.9 J	2	1	11.9 J	Maximum Detection
Antimony	ND	1	0	ND	Single Result	1.4	1.52 J	2	2	1.52 J	Maximum Detection	1.3	1.4 J	2	2	1.4 J	Maximum Detection
Arsenic	65	1	1	65	Single Result	0.8	1.1	2	2	1.1	Maximum Detection	0.6	0.9	2	2	0.9	Maximum Detection
Inorganic Arsenic	NA	0	0	NA	Single Result	0.68	0.863	2	2	0.863	Maximum Detection	NA	NA	0	0	NA	Not Tested
Barium	159	1	1	159	Single Result	26.4	23.8	2	2	26.4	Maximum Detection	24	23	2	2	24	Maximum Detection
Beryllium	0.5	1	1	0.5	Single Result	ND	ND	2	0	ND	Not Detected	ND	ND	2	0	ND	Not Detected
Cadmium	0.3	1	1	0.3	Single Result	ND	ND	2	0	ND	Not Detected	ND	ND	2	0	ND	Not Detected
Calcium	2380	1	1	2380	Single Result	18400	17500	2	2	18400	Maximum Detection	19200	17300	2	2	19200	Maximum Detection
Chromium	20.4	1	1	20.4	Single Result	ND	0.43	2	1	0.43	Maximum Detection	ND	0.23	2	1	0.23	Maximum Detection
Cobalt	12.3	1	1	12.3	Single Result	ND	0.066	2	1	0.066	Maximum Detection	ND	0.056	2	1	0.056	Maximum Detection
Copper	21.7	1	1	21.7	Single Result	ND	0.37	2	1	0.37	Maximum Detection	ND	0.27	2	1	0.27	Maximum Detection
Iron	32100	1	1	32100	Single Result	110	138	2	2	138	Maximum Detection	ND	100	2	1	100	Maximum Detection
Lead	8	1	1	8	Single Result	ND	0.021	2	1	0.021	Maximum Detection	ND	ND	2	0	ND	Not Detected
Magnesium	2990	1	1	2990	Single Result	9680	9460	2	2	9680	Maximum Detection	10200	9340	2	2	10200	Maximum Detection
Manganese	579	1	1	579	Single Result	10.2	17.5	2	2	17.5	Maximum Detection	7.2	15.9	2	2	15.9	Maximum Detection
Methylmercury	0.000177	1	1	0.000177	Single Result	0.000074	0.00008 J	2	2	0.00008 J	Maximum Detection	NA	NA	0	0	NA	Not Tested
Mercury	0.18	1	1	0.18	Single Result	0.00195	0.00263	2	2	0.00263	Maximum Detection	0.00317	0.00637	2	2	0.00637	Maximum Detection
Nickel	32	1	1	32	Single Result	ND	0.44	2	1	0.44	Maximum Detection	ND	0.35	2	1	0.35	Maximum Detection
Potassium	1200	1	1	1200	Single Result	ND	218 J	2	1	218 J	Maximum Detection	ND	220 J	2	1	220 J	Maximum Detection
Selenium	ND	1	0	ND	Single Result	ND	0.5 J	2	1	0.5 J	Maximum Detection	ND	0.5 J	2	1	0.5 J	Maximum Detection
Silver	ND	1	0	ND	Single Result	ND	ND	2	0	ND	Not Detected	ND	ND	2	0	ND	Not Detected
Sodium	ND	1	0	ND	Single Result	1580	1470	2	2	1580	Maximum Detection	1610	1450	2	2	1610	Maximum Detection
Thallium	ND	1	0	ND	Single Result	ND	ND	2	0	ND	Not Detected	ND	ND	2	0	ND	Not Detected
Vanadium	35.4	1	1	35.4	Single Result	0.3	0.16 J	2	2	0.3	Maximum Detection	ND	0.13 J	2	1	0.13 J	Maximum Detection
Zinc	80	1	1	80	Single Result	ND	0.5 J	2	1	0.5 J	Maximum Detection	ND	ND	2	0	ND	Not Detected

Key:

µg/L	micrograms per liter
J	The analyte was detected. The associated result is estimated.
mg/kg	milligrams per kilogram
NA	Not available, not analyzed
ND	Not detected

Table 4-9 Background Kuskokwim River Sediment Results

Analyte	Units	10KR13SD	11KR01SD	11KR12SD	11KR18SD	11KR19SD	11KR20SD	11KR21SD	11KR22SD	11KR23SD	11KR24SD	11KR25SD	11KR26SD	11KR27SD
Total Inorganic Elements														
Aluminum	mg/kg	11600	12500 J	6340 J	10700	2160	5470	5710	10200	10300	6180	9090	11000	6400
Antimony	mg/kg	0.56 U	0.234	0.271	0.185	0.133 J	0.239 J	0.189 J	0.22 J	0.188	0.137	0.171	0.45 J	0.473 J
Arsenic	mg/kg	15	10.4 J	8.77 J	4.75	6.06 J	3.67 J	3.67 J	12.7 J	6.32	6.21	5.03	4.93 J	5.98 J
Barium	mg/kg	152	142 J	138 J	146 J	77.5	58.6	55.6	79.5	141 J	95.5 J	158 J	113	70.3
Beryllium	mg/kg	0.5	0.383	0.538	0.343	0.352	0.146	0.13	0.196	0.408	0.265	0.28	0.314	0.157
Cadmium	mg/kg	0.5	0.288 J	0.42	0.263 J	0.82	0.099	0.069	0.12	0.268 J	0.164 J	0.221 J	0.231	0.127
Calcium	mg/kg	4800	2390 J	2250 J	2960	762	1610	1700	2930	2670	1930	2220	2930	1880
Chromium	mg/kg	25.3	16.6 J	17.7 J	22.2 J	13.6 J	11.1 J	10.7 J	15.8 J	20.2 J	15.7 J	20.1 J	21.4 J	14.4 J
Cobalt	mg/kg	10.9	12.5 J	14.8 J	8.91	11.5	4.54	3.83	4.94	13.5	8.38	7.47	8.2	5.69
Copper	mg/kg	25.3 J	29.4	56.2 J	20.9 J	36.9 J	7.15 J	4.62 J	10.4 J	28 J	16.7 J	14.5 J	16.9 J	7.69 J
Iron	mg/kg	27100	33900	31200	21800	8170	13500	13400	21900	32300	18000	18100	20700	17200
Lead	mg/kg	7	11.4 J	12.3 J	7.11	13.5	2.4	1.82	3.35	10.5	4.43	5.06	5.73	2.41
Magnesium	mg/kg	4840	5040	2950	4440 J	1400	2860	3190	5900	4400 J	3270 J	4020 J	5000	3460
Manganese	mg/kg	451	740	280	395 J	465	246	197	366	536 J	385 J	253 J	261	743
Mercury	mg/kg	0.09 J	0.081 J	0.374 J	0.089 J	0.143 J	0.013 J	0.013 J	0.03 J	0.126 J	0.078 J	0.053 J	0.044 J	0.015 J
Nickel	mg/kg	32	29.2	51.7	25.3 J	37	13	10.7	14.4	36.2 J	23 J	22.2 J	23.9	14.8
Potassium	mg/kg	1280	721	853	668 J	418	637	508	614	773 J	899 J	685 J	961	718
Selenium	mg/kg	0.81 U	0.31	0.74	0.42	1.03	0.08 J	0.04 J	0.22	0.45	0.17	0.19	0.28	0.06 J
Silver	mg/kg	0.055 U	0.092	0.123	0.124	0.035	0.043	0.034	0.062	0.113	0.046	0.084	0.105	0.044
Sodium	mg/kg	170	37.9 J	57.3	79.3	35.9 J	70.3	71.4	86.5	60.9	42.5	83.1	125	89.3
Thallium	mg/kg	0.34 U	0.075	0.077	0.096	0.105	0.051	0.035	0.075	0.07	0.052	0.092	0.089	0.059
Vanadium	mg/kg	36.3	21.9 J	27.8 J	29.8	23.8	15.7	11.9	27.3	28.9	21.8	27.1	29.8	19.8
Zinc	mg/kg	84	74.3 J	116 J	69.5 J	174 J	30.9 J	21.8 J	36.2 J	78 J	52.4 J	56.4 J	62 J	35.3 J
Arsenic Speciation														
Arsenate	mg/kg	15.8 J	16.7	22.3										
Arsenite	mg/kg	1.34 J	1.1 J	1.62 J										
Inorganic Arsenic	mg/kg	17.1 J	17.8	24										
Methylmercury														
Methylmercury	ng/g	0.184	0.06 J	0.49 J	0.28 J						0.05 U			
Total Organic Carbon														
Carbon, Total Organic	%	0.794	0.324	0.522	1.43	0.663	0.276	0.266	0.735	0.724	0.518	0.676	0.795	0.173

Key

% = percent

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ng/g = nanograms per gram

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-10 Background Statistics for Kuskokwim River Sediments

Compound	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration	Distribution	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	11	11	2160	12500	Normal	12500	Maximum Detected Concentration
Antimony	11	11	0.114	0.473	Gamma	0.473	Maximum Detected Concentration
Arsenic	11	11	3.67	12.7	Gamma	12.7	Maximum Detected Concentration
Barium	11	11	55.6	146	Normal	146	Maximum Detected Concentration
Beryllium	11	11	0.13	0.408	Normal	0.408	Maximum Detected Concentration
Cadmium	10	10	0.069	0.288	Normal	0.288	95% UPL
Calcium	10	10	762	2960	Normal	2960	Maximum Detected Concentration
Chromium	11	11	10.7	22.2	Normal	22.2	Maximum Detected Concentration
Cobalt	11	11	3.83	13.5	Normal	13.5	Maximum Detected Concentration
Copper	11	11	4.62	36.9	Normal	36.9	Maximum Detected Concentration
Iron	11	11	8170	33600	Normal	33600	Maximum Detected Concentration
Lead	11	11	1.82	13.5	Normal	13.34	95% UPL
Magnesium	11	11	1400	5900	Normal	5900	Maximum Detected Concentration
Manganese	11	11	197	743	Normal	743	Maximum Detected Concentration
Methylmercury	4	4	0.00006	0.00049	NA	0.00049	Maximum (n<6)
Mercury	11	11	0.013	0.143	Normal	0.143	Maximum Detected Concentration
Nickel	11	11	10.7	37	Normal	37	Maximum Detected Concentration
Potassium	10	10	418	961	Normal	934.1	95% UPL
Selenium	11	11	0.04	1.03	Gamma	1.03	Maximum Detected Concentration
Silver	11	11	0.034	0.124	Normal	0.124	Maximum Detected Concentration
Sodium	10	10	35.9	125	Normal	121.7	95% UPL
Thallium	10	10	0.035	0.105	Normal	0.105	Maximum Detected Concentration
Vanadium	11	11	11.9	29.8	Normal	29.8	Maximum Detected Concentration
Zinc	10	10	21.8	78	Normal	78	Maximum Detected Concentration

Key:

mg/kg	milligrams per kilogram
NA	Not available, not analyzed
UPL	upper prediction limit

Table 4-11 Background Vegetation Results	Units	11MP81PV	11MP82PV	11MP83PV	11RD11GA	11RD11WS	11RD12BL	11RD12GA	11RD12WS	11RD14BL	11RD14GA	11RD14WS	11RD18BL	11RD18GA	11RD18WS	11RD40BL	11UP01WS	11UP02BL
Analyte		Horsetail Pond Veg	Horsetail Pond Veg	Horsetail Pond Veg	Green Alder Bark	White Spruce Needles	Blueberry Leaves and Stems	Green Alder Bark	White Spruce Needles	Blueberry Leaves and Stems	Green Alder Bark	White Spruce Needles	Blueberry Leaves and Stems	Green Alder Bark	White Spruce Needles	Blueberry Leaves and Stems	White Spruce Needles	Blueberry Leaves and Stems
Total Metals																		
Aluminum	mg/kg dry weight	50.7	80.7	292	8.7	3.8	11.5	4.6	0.4 U	25.4	0.4 U	0.4 U	15	3.8	0.4 U	16.1	68.8	56.7
Antimony	mg/kg dry weight	1.05 J	0.386 J	0.794 J	0.009 U	0.205 J	0.146 J	0.139 J	0.009 U	0.164 J	0.009 U	0.009 U	0.214 J	0.116 J	0.104 J	0.357 J	0.096 J	0.225 J
Arsenic	mg/kg dry weight	3.23	1.24	2.66	0.1	0.11 J	0.1 J	0.06 J	0.06 U	0.13	0.06 U	0.09	0.15	0.06	0.06 U	0.22 J	0.06 J	0.06 U
Barium	mg/kg dry weight	30.3	47.5	120	27.3	64.5	36.3	24.2	51.9	56.4	34	46.2	42.8	28.4	80.4	42.7	7.5	34.4
Beryllium	mg/kg dry weight	0.003 U	0.004 J	0.013 J	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.007 J	0.003 U
Cadmium	mg/kg dry weight	0.009 J	0.023	0.053	0.017	0.005 J	0.255	0.029	0.003 U	0.195	0.003 U	0.003 U	0.093	0.003 U	0.003 U	0.14	0.032	0.174
Calcium	mg/kg dry weight	17700	17600	20300	5030	4720	2430	4630	5320	2290	5070	6550	2870	3790	7590	2820	3210	2600
Chromium	mg/kg dry weight	0.2 U	0.2 J	0.5 J	1.1 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cobalt	mg/kg dry weight	0.307	0.592	0.77	0.049	0.023	0.017 J	0.027	0.003 U	0.034	0.079	0.024	0.021	0.051	0.003 U	0.023	0.048	0.041
Copper	mg/kg dry weight	3.39	4.27	5.02	5.51	2.34	3.93	4.61	1.54	3.7	6.4	1.9	5.75	6.19	1.61	5.08	1.31	5.32
Iron	mg/kg dry weight	185	529	618	27.9 J	18.3	19.6	12.5	19.3	37.3	0.7 U	15.8	31.1	14.9	25.2	33	16.6	30.3
Lead	mg/kg dry weight	0.042 J	0.068	0.207	0.07	0.032 J	0.056	0.061	0.019	0.041	0.058	0.021	0.021	0.034	0.015	0.027 J	0.044 J	0.032
Magnesium	mg/kg dry weight	5470	4740	6020	637	681	1060	627	847	867	637	769	1360	571	596	1600	863	1030
Manganese	mg/kg dry weight	702	1480	635	59	58.8	462	229	162	652	94.7	232	328	75.1	135	342	931	1530
Mercury	mg/kg dry weight	0.027 J	0.071 J	0.045 J	0.056	0.056 J	0.016 J	0.021 J	0.027	0.05	0.014	0.039	0.039 J	0.014	0.036	0.036 J	0.034 J	0.023
Nickel	mg/kg dry weight	0.36	0.56	1.45	0.25	0.28	0.51	0.16 J	0.29	0.96	0.25	0.58	0.58	0.32	0.03 U	0.49	1.39	1.68
Potassium	mg/kg dry weight	8960	15300	15200	2600	5930	3300	2610	4060	3390	2120	5310	5080	2760	4530	5180	3800	3550
Selenium	mg/kg dry weight	0.15 U	0.18 J	0.16 J	0.15 U	0.15 U	0.15 U	0.15 U	0.03 U	0.03 U	0.03 U	0.15 U	0.15 U	0.03 U	0.15 U	0.15 U	0.15 U	0.03 U
Silver	mg/kg dry weight	0.048	0.015 J	0.012 J	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.012
Sodium	mg/kg dry weight	766	2010	673	14.2 J	13.4 J	11.7 J	13.3 J	7.9 J	9.5 J	51.3 J	9.8 J	25.3 J	13.3 J	6.4 J	17.5 J	13.5 J	7.5 J
Thallium	mg/kg dry weight	0.006 J	0.01 J	0.018 J	0.002 U	0.002 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.015 J	0.002 U
Vanadium	mg/kg dry weight	0.13 J	0.21	0.73	0.05	0.02 J	0.04 J	0.04 J	0.03	0.05	0.05	0.04	0.04	0.04	0.03	0.02 U	0.04 J	0.03
Zinc	mg/kg dry weight	25.5 J	31.8 J	38.2 J	23.8	24.2 J	48.9 J	66.9 J	54.8	35.8	26.9	46	43.3	22.5	23.3	38.8 J	25.1 J	21.9
Total Solids																		
Total Solids	%	19	20.8	17	39.4	35.6	40.7	37.4	37.7	35.3	34.7	37.6	31.5	36.7	32.8	31.3	40.4	36.5
Methylmercury (ng/g)																		
Methylmercury	ng/g dry weight	3.9 U			3.8 U		4 U	4 U	3.8 U	3.9 U	3.8 U	3.8 U		3.9 U				
Arsenic Speciation																		
Arsenic (III)	µg/g dry weight																	
Arsenic (V)	µg/g dry weight																	
Inorganic Arsenic	µg/g dry weight																	

Table 4-11 Background Vegetation Results

Analyte	Units	11UP02WS	11UP04BF	11UP04BL	11UP07BL	11UP07WS	11UP08BL	11UP09BL	11UP09WS	12RD12BF	12RD14BF	12RD18BF	12UP02BF	12UP04BF	12UP07BF	12UP08BF
		White Spruce Needles	Blueberry Fruit	Blueberry Leaves and Stems	Blueberry Leaves and Stems	White Spruce Needles	Blueberry Leaves and Stems	Blueberry Leaves and Stems	White Spruce Needles	Blueberry Fruit	Blueberry Fruit	Blueberry Fruit	Blueberry Fruit	Blueberry Fruit	Blueberry Fruit	Blueberry Fruit
Total Metals																
Aluminum	mg/kg dry weight	53.4	0.4 U	19.5	42.2	14	28.9	51.5	9.8	440	400	350	390	840	310	370
Antimony	mg/kg dry weight	1.49 J	0.009 U	0.441 J	0.009 U	0.101 J	0.009 U	0.126 J	0.107 J	0.47 U	0.43 U	0.37 U	0.36 U	1.4	0.33 U	0.39 U
Arsenic	mg/kg dry weight	0.06 U	0.13	0.06 U	0.11	0.06 U	0.09	0.16 J	0.06 U	2 U	1.9 U	1.6 U	1.5 U	4.4	1.4 U	1.7 U
Barium	mg/kg dry weight	11.3	9.03	18.8	49.4	5.31	48.1	48.8	9.05	17	20	17	10	16	8.3	9.4
Beryllium	mg/kg dry weight	0.005 J	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.019 J	0.003 J	0.24 U	0.23 U	0.19 U	0.19 U	0.18 U	0.17 U	0.21 U
Cadmium	mg/kg dry weight	0.018 J	0.082	0.154	0.304	0.009 J	0.192	0.432	0.015 J	0.14	0.083 U	0.071 U	0.068 U	0.065 U	0.062 U	0.075 U
Calcium	mg/kg dry weight	4240	1110	1660	2030	3310	2150	3100	3840	1900	2000	2100	1200	1600	990	1100
Chromium	mg/kg dry weight	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	1.3 U	1.2 U	1 U	0.97 U	1.8	0.88 U	1.1 U
Cobalt	mg/kg dry weight	0.041	0.013	0.003 U	0.091	0.094	0.03	0.105	0.034	0.21 U	0.2 U	0.17 U	0.16 U	0.84	0.15 U	0.18 U
Copper	mg/kg dry weight	1.46	2.49	2.74	7.87	1.75	5.73	6.58	1.38	5.1	7.2	4.1	4	3.5	2.9	5.7
Iron	mg/kg dry weight	17.3	10.8	13.5	26.2	12.8	26.9	32.8	14.9	120 U	110 U	94 U	160	2100	83 U	100 U
Lead	mg/kg dry weight	0.036 J	0.032	0.022	0.078	0.022 J	0.035	0.085	0.02 J	0.14 U	0.13 U	0.11 U	0.11 U	0.32	0.1 U	0.12 U
Magnesium	mg/kg dry weight	653	582	706	770	943	1140	1060	988	810	1100	970	650	820	540	630
Manganese	mg/kg dry weight	1590	294	960	1120	1040	1250	1020	1350	310	160	200	330	270	160	260
Mercury	mg/kg dry weight	0.032 J	0.026	0.025	0.03	0.021 J	0.044	0.034 J	0.038 J	0.061 U	0.053	0.042 U	0.038 U	0.041 U	0.037 U	0.038 U
Nickel	mg/kg dry weight	1.02	0.53	0.51	1.58	1.01	1	2.01	1.11	0.79 U	0.73 U	0.63 U	0.9	2.8	0.63	0.72
Potassium	mg/kg dry weight	4280	5030	2060	2670	5370	3900	3750	3990	9300	10000	9200	7300	6000	6400	7600
Selenium	mg/kg dry weight	0.15 U	0.59 U	0.15 U	0.03 U	0.15 U	0.03 U	0.15 U	0.15 U	2.2 U	2.1 U	1.8 U	1.7 U	1.6 U	1.6 U	1.9 U
Silver	mg/kg dry weight	0.154	0.008 U	0.035	0.008 U	0.011 J	0.008 U	0.008 U	0.008 U	0.13 U	0.12 U	0.11 U	0.1 U	0.098 U	0.094 U	0.11 U
Sodium	mg/kg dry weight	7.8 J	21.8 J	5 J	7.8 J	10.5 J	7.1 J	15.8 J	7 J	440 U	410 U	350 U	340 U	320 U	310 U	370 U
Thallium	mg/kg dry weight	0.004 J	0.002 U	0.002 U	0.002 U	0.008 J	0.002 U	0.019 J	0.015 J	1.4 U	1.3 U	1.1 U	1.1 U	1.1 U	1 U	1.2 U
Vanadium	mg/kg dry weight	0.04 J	0.06	0.03	0.07	0.03 J	0.04	0.06 J	0.02 J	5.3 U	4.9 U	4.2 U	4.1 U	3.9 U	3.7 U	4.4 U
Zinc	mg/kg dry weight	50.3 J	15.7	29.6	44	28.7 J	22.4	39.5 J	29.3 J	28	37	31	22	18	13	19
Total Solids																
Total Solids	%	37.2	9.01	38.6	45	38.5	39.4	38.3	41.3							
Methylmercury (ng/g)																
Methylmercury	ng/g dry weight	3.9 U	7.9 U	3.9 U		4 U	4 U									
Arsenic Speciation																
Arsenic (III)	µg/g dry weight		0.03 J													
Arsenic (V)	µg/g dry weight		0.03 J													
Inorganic Arsenic	µg/g dry weight		0.06													

Key

µg/g = migrograms per gram

% = percent

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ng/g = nanograms per gram

U = The analyte was analyzed for but not detected. The value provided is reporting limit.

Veg = vegetation

Table 4-12 Background Statistics for Green Alder Bark

Analyte	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	4	3	3.8 J	8.7	8.7	Maximum Detected Concentration
Antimony	4	2	0.116 J	0.139	0.139	Maximum Detected Concentration
Arsenic	4	3	0.06 J	0.1	0.1	Maximum Detected Concentration
Barium	4	4	24.2	34	34	Maximum Detected Concentration
Beryllium	4	0	ND	ND	ND	Not Detected
Cadmium	4	2	0.017	0.029	0.029	Maximum Detected Concentration
Calcium	4	4	3790	5070	5070	Maximum Detected Concentration
Chromium	4	1	1.1	1.1	1.1	Maximum Detected Concentration
Cobalt	4	4	0.027	0.079	0.079	Maximum Detected Concentration
Copper	4	4	4.61	6.4	6.4	Maximum Detected Concentration
Iron	4	3	12.5	27.9	27.9	Maximum Detected Concentration
Lead	4	4	0.034	0.07	0.07	Maximum Detected Concentration
Magnesium	4	4	571	637	637	Maximum Detected Concentration
Manganese	4	4	59	229	229	Maximum Detected Concentration
Mercury	4	4	0.014	0.056	0.056	Maximum Detected Concentration
Methylmercury	4	0	ND	ND	ND	Not Detected
Nickel	4	4	0.16 J	0.32	0.32	Maximum Detected Concentration
Potassium	4	4	2120	2760	2760	Maximum Detected Concentration
Selenium	4	0	ND	ND	ND	Not Detected
Silver	4	0	ND	ND	ND	Not Detected
Sodium	4	4	13.3 J	51.3 J	51.3 J	Maximum Detected Concentration
Thallium	4	0	ND	ND	ND	Not Detected
Vanadium	4	4	0.04 J	0.05	0.05	Maximum Detected Concentration
Zinc	4	4	22.5	66.9 J	66.9 J	Maximum Detected Concentration

Key:

J	The analyte was detected. The associated result is estimated.
mg/kg	milligrams per kilogram
NA	Not available, not analyzed
ND	Not detected

Table 4-13 Background Statistics for Blueberry Leaves and Stems

Compound	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Distribution	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	8	8	11.5	56.7	Normal	56.7	Maximum Concentration; Max>95 UPL
Antimony	8	6	0.126	0.441	Normal	0.441	Maximum Concentration; Max>95 UPL
Arsenic	8	6	0.09	0.16	Normal	0.16	Maximum Concentration; Max>95 UPL
Barium	8	8	18.8	56.4	Normal	56.4	Maximum Concentration; Max>95 UPL
Beryllium	8	1	0.019	0.019	NA	0.019	Maximum; 1 Detection
Cadmium	8	8	0.093	0.432	Normal	0.432	Maximum Concentration; Max>95 UPL
Calcium	8	8	1660	3100	Normal	3100	Maximum Concentration; Max>95 UPL
Chromium	8	0	ND	ND	NA	ND	Not Detected
Cobalt	8	7	0.017	0.105	Normal	0.105	Maximum Concentration; Max>95 UPL
Copper	8	8	2.74	7.87	Normal	7.87	Maximum Concentration; Max>95 UPL
Iron	8	8	13.5	37.3	Normal	37.3	Maximum Concentration; Max>95 UPL
Lead	8	8	0.021	0.085	Normal	0.085	Maximum Concentration; Max>95 UPL
Magnesium	8	8	706	1360	Normal	1360	Maximum Concentration; Max>95 UPL
Manganese	8	8	328	1530	Normal	1530	Maximum Concentration; Max>95 UPL
Mercury	8	8	0.016	0.05	Normal	0.05	Maximum Concentration; Max>95 UPL
Methylmercury	8	0	ND	ND	NA	ND	Not Detected
Nickel	8	8	0.49	2.01	Normal	2.01	Maximum Concentration; Max>95 UPL
Potassium	8	8	2060	5080	Normal	5080	Maximum Concentration; Max>95 UPL
Selenium	8	0	ND	ND	NA	ND	Not Detected
Silver	8	2	0.012	0.035	NA	0.035	Maximum; 2 Detections
Sodium	8	8	5	17.5	Normal	17.5	Maximum Concentration; Max>95 UPL
Thallium	8	1	0.019	0.019	NA	0.019	1 Detection
Vanadium	8	7	0.03	0.07	Normal	0.07	Maximum Concentration; Max>95 UPL
Zinc	8	8	21.9	48.9	Normal	48.9	Maximum Concentration; Max>95 UPL

Key:

mg/kg	milligrams per kilogram
NA	Not available, not analyzed
ND	Not detected

Table 4-14 Background Statistics for Blueberry Fruit

Analyte	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Recommended Background Level (mg/kg)	Background Rationale
Total Metals (mg/kg dry weight)						
Aluminum	8	7	310	840	840	Maximum Detected Concentration
Antimony	8	1	1.4	1.4	1.4	Maximum Detected Concentration
Arsenic	8	2	0.13	4.4	4.4	Maximum Detected Concentration
Barium	8	8	8.3	20	20	Maximum Detected Concentration
Beryllium	8	0	ND	ND	ND	No Detections
Cadmium	8	2	0.082	0.14	0.14	Maximum Detected Concentration
Calcium	8	8	990	2100	2100	Maximum Detected Concentration
Chromium	8	1	1.8	1.8	1.8	Maximum Detected Concentration
Cobalt	8	2	0.013	0.84	0.84	Maximum Detected Concentration
Copper	8	8	2.49	7.2	7.2	Maximum Detected Concentration
Iron	8	3	10.8	2100	2100	Maximum Detected Concentration
Lead	8	2	0.32	0.32	0.32	Maximum Detected Concentration
Magnesium	8	8	582	1100	1100	Maximum Detected Concentration
Manganese	8	8	160	330	330	Maximum Detected Concentration
Mercury	8	2	0.026	0.053	0.053	Maximum Detected Concentration
Methylmercury	8	0	ND	ND	ND	No Detections
Nickel	8	5	0.53	2.8	2.8	Maximum Detected Concentration
Potassium	8	8	5030	10000	10000	Maximum Detected Concentration
Selenium	8	0	ND	ND	ND	No Detections
Silver	8	0	ND	ND	ND	No Detections
Sodium	8	1	21.8	21.8	21.8	Maximum Detected Concentration
Thallium	8	0	ND	ND	ND	No Detections
Vanadium	8	1	0.06	0.06	0.06	Maximum Detected Concentration
Zinc	8	8	13	37	37	Maximum Detected Concentration

Key:

mg/kg	milligrams per kilogram
NA	Not available, not analyzed

Table 4-15 Background Statistics for Horsetail Pond Vegetation

Compound	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	3	3	50.7	292	292	Maximum Detected Concentration
Antimony	3	3	0.386 J	1.05	1.05	Maximum Detected Concentration
Arsenic	3	3	1.24	3.23	3.23	Maximum Detected Concentration
Barium	3	3	30.3	120	120	Maximum Detected Concentration
Beryllium	3	2	0.004 J	0.013 J	0.013 J	Maximum Detected Concentration
Cadmium	3	3	0.009	0.053	0.053	Maximum Detected Concentration
Calcium	3	3	17600	20300	20300	Maximum Detected Concentration
Chromium	3	2	0.2 J	0.5 J	0.5 J	Maximum Detected Concentration
Cobalt	3	3	0.307	0.77	0.77	Maximum Detected Concentration
Copper	3	3	3.39	5.02	5.02	Maximum Detected Concentration
Iron	3	3	185	618	618	Maximum Detected Concentration
Lead	3	3	0.042 J	0.207	0.207	Maximum Detected Concentration
Magnesium	3	3	4740	6020	6020	Maximum Detected Concentration
Manganese	3	3	635	1480	1480	Maximum Detected Concentration
Mercury	3	3	0.027 J	0.071 J	0.071 J	Maximum Detected Concentration
Methylmercury	1	0	ND	ND	ND	Not Detected
Nickel	3	3	0.36	1.45	1.45	Maximum Detected Concentration
Potassium	3	3	8960	15300	15300	Maximum Detected Concentration
Selenium	3	2	0.16 J	0.18 J	0.18 J	Maximum Detected Concentration
Silver	3	3	0.012 J	0.048	0.048	Maximum Detected Concentration
Sodium	3	3	673	2010	2010	Maximum Detected Concentration
Thallium	3	3	0.006 J	0.018 J	0.018 J	Maximum Detected Concentration
Vanadium	3	3	0.13	0.73	0.73	Maximum Detected Concentration
Zinc	3	3	25.5 J	38.2 J	38.2 J	Maximum Detected Concentration

Key:

J	The analyte was detected. The associated result is estimated.
mg/kg	milligrams per kilogram
ND	Not detected

Table 4-16 Background Statistics for White Spruce Needles

Analyte	Sample Size	Number Detections	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Distribution	Recommended Background Level (mg/kg)	Background Rationale
Aluminum	8	5	3.8	68.8	NA	68.8	Detects less than n=8
Antimony	8	6	0.096	1.49	NA	1.49	Detects less than n=8
Arsenic	8	3	0.06	0.11	NA	0.11	Detects less than n=8
Barium	8	8	5.31	80.4	Normal	80.4	Maximum Concentration; Max>95 UPL
Beryllium	8	3	0.003	0.007	NA	0.007	Detects less than n=8
Cadmium	8	5	0.005	0.032	NA	0.032	Detects less than n=8
Calcium	8	8	3210	7590	Normal	7590	Maximum Concentration; Max>95 UPL
Chromium	8	0	ND	ND	NA	ND	Not Detected
Cobalt	8	6	0.023	0.094	NA	0.094	Detects less than n=8
Copper	8	8	1.31	2.34	Normal	2.335	95% UPL
Iron	8	8	12.8	25.2	Normal	24.96	95% UPL
Lead	8	8	0.015	0.044	Normal	0.044	Maximum Concentration; Max>95 UPL
Magnesium	8	8	596	988	Normal	988	Maximum Concentration; Max>95 UPL
Manganese	8	8	58.8	1590	Normal	1590	Maximum Concentration; Max>95 UPL
Mercury	8	8	0.021	0.056	Normal	0.056	Maximum Concentration; Max>95 UPL
Methylmercury	4	0	ND	ND	NA	ND	Not Detected
Nickel	8	7	0.028	1.39	NA	1.39	Detects less than n=8
Potassium	8	8	uhr	5930	Normal	5930	Maximum Concentration; Max>95 UPL
Selenium	8	0	ND	ND	NA	ND	Not Detected
Silver	8	2	0.011	0.154	NA	0.154	Detects less than n=8
Sodium	8	8	6.4	13.5	Normal	13.5	Maximum Concentration; Max>95 UPL
Thallium	8	5	0.002	0.015	NA	0.015	Detects less than n=8
Vanadium	8	8	0.02	0.05	Normal	0.05	Maximum Concentration; Max>95 UPL
Zinc	8	8	23.3	54.8	Normal	54.8	Maximum Concentration; Max>95 UPL

Key:

mg/kg	milligrams per kilogram
NA	Not available, not analyzed
ND	Not detected
UPL	upper prediction limit

Table 4-17 Pre-1955 Main Processing Area Surface Soil Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**MP424344 (Composite)**	**MP42**	**MP43**	**MP44**	**MP45**	**MP46**	**MP47**	**MP48**	**MP49**	**MP5051525354 (Composite)**	**MP50**	**MP51**	**MP52**	**MP53**	**MP54**
							Soil Type*		**T/WR**	**T/WR**	**T/WR**	**T/WR**	**T/WR**	**T/WR**	**WR**	**T/WR**	**T/WR**	**T/WR**	**T/WR**	**T/WR**	**T/WR**	**T/WR**	**F**
							Sample ID		**10MP424344SS**	**10MP42SS**	**10MP43SS**	**10MP44SS**	**10MP45SS**	**10MP46SS**	**10MP47SS**	**10MP48SS**	**10MP49SS**	**10MP5051525354SS**	**10MP50SS**	**10MP51SS**	**10MP52SS**	**10MP53SS**	**10MP54SS**
Analyte							**Method**																
Total Inorganic Elements																							
Aluminum	19475	28	28	0	12800	3370	SW6010B	mg/kg	**5280**	**5660**	**5360**	**5210**	**5630**	**12700**	**5650**	**10500**	**11900**	**9170**	**10600**	**11100**	**12800**	**6490**	**6340**
Antimony	8	28	28	28	23300	20	SW6010B	mg/kg	**880**	**560**	**720**	**340**	**220**	**13000**	**90**	**5980 J**	**10900 J**	**10100 J**	**210 J**	**23300 J**	**18500 J**	**1480 J**	**20 J**
Arsenic	28.58	28	28	28	5000	333	SW6010B	mg/kg	**1840**	**1770**	**2080**	**860**	**1800**	**4940**	**1180**	**3940**	**4130**	**3610**	**826**	**4610**	**5000**	**3000**	**1360**
Barium	266.0	28	28	12	892	119	SW6010B	mg/kg	**211**	**218**	**224**	**196**	**205**	**892**	**191**	**498**	**562**	**431**	**135**	**732**	**663**	**291**	**186**
Beryllium	0.5	28	26	21	1.1	0.3	SW6010B	mg/kg	**0.8**	**0.8**	**0.8**	**0.7**	**0.9**	**1.1**	**0.8**	**0.8**	**0.8**	**0.8**	**0.4**	0.22 U	0.21 U	**0.8**	**0.7**
Cadmium	0.4	28	0	0			SW6010B	mg/kg	0.054 U	0.053 U	0.052 U	0.056 U	0.053 U	0.11 U	0.053 U	0.051 U	0.1 U	0.1 U	0.024 U	0.22 U	0.21 U	0.053 U	0.054 U
Calcium	10100	28	28	0	9210	1760	SW6010B	mg/kg	**2640**	**2360**	**2930**	**2180**	**2020**	**5620**	**2600**	**4380**	**6410**	**3830**	**2470**	**7250**	**6260**	**2590**	**2020**
Chromium	28.57	28	28	8	42	12	SW6010B	mg/kg	**20**	**20**	**21**	**19**	**19**	**39**	**20**	**31**	**42**	**28**	**20.1**	**41**	**40**	**24**	**18**
Cobalt	11.28	28	28	25	23.7	8.1	SW6010B	mg/kg	**20.5**	**19.9**	**20.5**	**19.6**	**23.1**	**19**	**21.4**	**16.3**	**17**	**17**	**8.1**	**17**	**15**	**17.8**	**18.7**
Copper	23.02	28	28	27	109	20.8	SW6010B	mg/kg	**80.1**	**71.4**	**73.3**	**80.8**	**74.4**	**91**	**78.6**	**73**	**78**	**79**	**26.8**	**109**	**93**	**68.6**	**55.9**
Iron	30891	28	28	19	53700	17300	SW6010B	mg/kg	**50200**	**41900**	**41400**	**43500**	**53700**	**37200**	**47000**	**35500**	**32600**	**40100**	**19700**	**33600**	**29700**	**41000**	**39600**
Lead	10.00	28	24	20	3090	5	SW6010B	mg/kg	**22**	**22**	**24**	**23**	**21**	1 U	**18**	**3090**	0.9 U	**20**	**11**	1.9 U	1.9 U	**44**	**12**
Magnesium	3870	28	28	16	10800	1340	SW6010B	mg/kg	**2350**	**2290**	**2840**	**1540**	**1340**	**5400**	**2830**	**4720**	**7260**	**4280**	**3370**	**7240**	**5750**	**2260**	**1640**
Manganese	465	28	28	24	1110	267	SW6010B	mg/kg	**702**	**759**	**789**	**656**	**877**	**758**	**672**	**737**	**707**	**605**	**267**	**644**	**562**	**501**	**1110**
Mercury	1.86	28	28	28	1260	19.1	SW7471A	mg/kg	**136**	**124**	**149**	**86**	**87**	**194**	**118**	**1260**	**176**	**144**	**318**	**119**	**183**	**183**	**24.4**
Nickel	28.00	28	28	26	74	24	SW6010B	mg/kg	**64**	**59**	**60**	**58**	**61**	**69**	**72**	**48**	**60**	**54**	**24**	**60**	**60**	**48**	**48**
Potassium	954.1	28	28	26	3770	770	SW6010B	mg/kg	**1480**	**1400**	**1570**	**1590**	**1790**	**3770**	**1460**	**2610**	**3180**	**2190**	**940**	**2570**	**3300**	**1990**	**1190**
Selenium	NA	28	0	0			SW6010B	mg/kg	1.6 U	1.6 U	1.5 U	1.7 U	1.6 U	3.2 U	1.6 U	1.5 U	3.1 U	3.1 U	0.7 U	6.4 U	6.1 U	1.6 U	1.6 U
Silver	NA	28	0	0			SW6010B	mg/kg	0.108 U	0.106 U	0.104 U	0.113 U	0.107 U	0.21 U	0.105 U	0.102 U	0.21 U	0.21 U	0.047 U	0.43 U	0.41 U	0.107 U	0.107 U
Sodium	100	28	14	12	380	90	SW6010B	mg/kg	40.8 U	40 U	39.3 U	42.6 U	40.3 U	**310**	39.7 U	**230**	**330**	78.8 U	**120**	163 U	156 U	**170**	40.6 U
Thallium	NA	28	0	0			SW6010B	mg/kg	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	1.3 U	0.7 U	0.6 U	1.3 U	1.3 U	0.29 U	2.7 U	2.6 U	0.7 U	0.7 U
Vanadium	62.9	28	28	0	37.3	24.3	SW6010B	mg/kg	**32.7**	**30.9**	**31.2**	**35.5**	**37.3**	**34**	**31.9**	**32.2**	**34**	**32**	**30.6**	**28**	**30**	**29.8**	**30.9**
Zinc	66.7	28	28	27	147	48	SW6010B	mg/kg	**145**	**126**	**124**	**147**	**140**	**126**	**146**	**116**	**128**	**113**	**108**	**100**	**120**	**107**	**103**
SPLP Inorganic Elements																							
Aluminum		4	4		2.96	0.27	SW6010B SPLP	mg/L	**0.39 J**									**2.96**					
Antimony		4	4		9.14	0.11	SW6010B SPLP	mg/L	**1.58**									**9.14**					
Arsenic		4	4		2	0.37	SW6010B SPLP	mg/L	**0.59 J**									**2**					
Barium		4	4		0.112	0.009	SW6010B SPLP	mg/L	**0.009 J**									**0.112**					
Beryllium		4	0				SW6010B SPLP	mg/L	0.001 U									0.001 U					
Cadmium		4	0				SW6010B SPLP	mg/L	0.002 U									0.002 U					
Calcium		4	4		3.84	1.19	SW6010B SPLP	mg/L	**1.19**									**1.7**					
Chromium		4	2		0.008	0.007	SW6010B SPLP	mg/L	0.005 U									**0.008**					
Cobalt		4	0				SW6010B SPLP	mg/L	0.003 U									0.003 U					
Copper		4	3		0.011	0.004	SW6010B SPLP	mg/L	**0.004**									**0.011**					
Iron		4	4		4.33	0.05	SW6010B SPLP	mg/L	**0.7 J**									**4.33**					
Lead		4	0				SW6010B SPLP	mg/L	0.02 U									0.02 U					
Magnesium		4	4		4.94	0.78	SW6010B SPLP	mg/L	**0.78**									**0.98**					
Manganese		4	3		0.039	0.007	SW6010B SPLP	mg/L	**0.007 J**									**0.039**					
Mercury		4	4		0.174	0.0002	SW7470A SPLP	mg/L	**0.0039 J**									**0.174**					
Nickel		4	0				SW6010B SPLP	mg/L	0.01 U									0.01 U					
Potassium		4	2		1.1	1	SW6010B SPLP	mg/L	0.5 U									**1.1**					
Selenium		4	0				SW6010B SPLP	mg/L	0.05 U									0.05 U					
Silver		4	0				SW6010B SPLP	mg/L	0.003 U									0.003 U					
Sodium		4	4		10.1	0.6	SW6010B SPLP	mg/L	**0.6 J**									**8**					
Thallium		4	0				SW6010B SPLP	mg/L	0.05 U									0.05 U					
Vanadium		4	2		0.012	0.008	SW6010B SPLP	mg/L	0.003 U									**0.012**					
Zinc		4	1		0.02	0.02	SW6010B SPLP	mg/L	0.01 U									**0.02**					
TCLP Inorganic Elements																							
Arsenic		4	3		2.8	0.9	SW6010B TCLP	mg/L	**1**									**2.8**					
Barium		4	4		1.15	0.29	SW6010B TCLP	mg/L	**0.53**									**0.29**					
Cadmium		4	0				SW6010B TCLP	mg/L	0.01 U									0.01 U					
Chromium		4	0				SW6010B TCLP	mg/L	0.02 U									0.02 U					
Lead		4	0				SW6010B TCLP	mg/L	0.1 U									0.1 U					
Selenium		4	0				SW6010B TCLP	mg/L	0.2 U									0.2 U					
Silver		4	0				SW6010B TCLP	mg/L	0.02 U									0.02 U					
Mercury		4	4		0.0076	0.0003	SW7470A TCLP	mg/L	**0.0013**									**0.0076**					
Arsenic Speciation																							
Arsenate		3	3		2490	803	EPA 1632	mg/kg													**2490 J**		
Arsenite		3	3		90.4	12.1	EPA 1632	mg/kg													**90.4 J**		
Inorganic Arsenic		3	3		2580	815	EPA 1632	mg/kg													**2580 J**		

Table 4-17 Pre-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP424344 (Composite)	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP5051525354 (Composite)	MP50	MP51	MP52	MP53	MP54
							Soil Type*		T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	F
							Sample ID		10MP424344SS	10MP42SS	10MP43SS	10MP44SS	10MP45SS	10MP46SS	10MP47SS	10MP48SS	10MP49SS	10MP5051525354SS	10MP50SS	10MP51SS	10MP52SS	10MP53SS	10MP54SS
Analyte							Method																
Arsenic Bioavailability																							
Arsenic (IVBA)		2	2		15.3	0.695	M6020 ICP-MS	mg/L															
Arsenic, total (3050)		2	2		3910	538	M6020 ICP-MS	mg/kg															
Arsenic IVBA% (In Vitro RBA)		2	2		39.1	12.9	Calculation (EPA 920	%															
Total Solids		2	2		92.2	88	CLPSOW390, PART F, D	%															
Mercury Selective Sequential Extraction																							
Hg(F0)		3	3		11.9	3.79	EPA 1631	ng/g													**11.9**		
Hg(F1)		3	3		2970	170	BRL SOP No. BR-0013	ng/g													**2970**		
Hg(F2)		3	3		36.5	0.8	BRL SOP No. BR-0013	ng/g													**36.5**		
Hg(F3)		3	3		6250	1950	BRL SOP No. BR-0013	ng/g													**4080 J**		
Hg(F4)		3	3		32300	15600	BRL SOP No. BR-0013	ng/g													**32300**		
Hg(F5)		3	3		1110000	296000	BRL SOP No. BR-0013	ng/g													**296000**		
Hg(F6)		3	3		58200	16900	BRL SOP No. BR-0013	ng/g													**16900 J**		
Semi-Volatile Organic Compounds																							
1-Methylnaphthalene		3	2		74	27	SW8270D	µg/kg					**27**	2.6 U	**74**								
2-Methylnaphthalene		3	2		200	79	SW8270D	µg/kg					**79**	2.9 U	**200**								
bis(2-Ethylhexyl)phthalate		3	2		17	13	SW8270D	µg/kg					**17 J**	**13 J**	8.5 U								
Chrysene		3	2		17	16	SW8270D	µg/kg					**17 J**	5.7 U	**16 J**								
Dibenzofuran		3	1		10	10	SW8270D	µg/kg					3 U	3.1 U	**10 J**								
Fluorene		3	1		20	20	SW8270D	µg/kg					3.4 U	3.5 U	**20**								
Naphthalene		3	2		70	26	SW8270D	µg/kg					**26**	2.7 U	**70**								
Phenanthrene		3	1		48	48	SW8270D	µg/kg					3.5 U	3.5 U	**48**								
Sulfur		2	2		1300	230	SW8270D	µg/kg						**1300 J**	**230 J**								
Unknown Aromatic		3	2		390	260	SW8270D	µg/kg					**260 J**	0 U	**390 J**								
Unknown Hydrocarbon		3	2		950	700	SW8270D	µg/kg					**950 J**	0 U	**700 J**								
Unknown Sterol		2	2		480	360	SW8270D	µg/kg					**360 J**		**480 J**								
Polychlorinated Biphenyls																							
Aroclor 1016		8	0				SW8082	mg/kg															
Aroclor 1221		8	0				SW8082	mg/kg															
Aroclor 1232		8	0				SW8082	mg/kg															
Aroclor 1242		8	0				SW8082	mg/kg															
Aroclor 1248		8	0				SW8082	mg/kg															
Aroclor 1254		8	0				SW8082	mg/kg															
Aroclor 1260		8	1		0.021	0.021	SW8082	mg/kg															
Diesel and Residual Range Organics																							
Diesel Range Hydrocarbons		3	2		140	120	AK102/AK103 TPHD	mg/kg					**120 J**	0.77 U	**140**								
Motor Oil		3	3		510	24	AK102/AK103 TPHD	mg/kg					**180**	**24**	**510**								

Table 4-17 Pre-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP55565758 (Composite)	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP52	MP59
							Soil Type*		T/WR	T/WR	N/DN	T/WR	T/WR	WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	WR
							Sample ID		10MP55565758SS	10MP55SS	10MP56SS	10MP57SS	10MP58SS	10MP59SS	10MP60SS	10MP61SS	10MP62SS	10MP63SS	10MP64SS	10MP65SS	10MP66SS	11MP52SS	11MP59SS
Analyte							Method																
Total Inorganic Elements																							
Aluminum	19475	28	28	0	12800	3370	SW6010B	mg/kg	**9340**	**9480**	**7750**	**7730**	**8980**	**3370**	**5910**	**9710**	**8550**	**8200**	**10300**	**10400**	**5500**		
Antimony	8	28	28	28	23300	20	SW6010B	mg/kg	**764 J**	**1890 J**	**183 J**	**1630 J**	**716 J**	**170 J**	**660 J**	**1200 J**	**1590 J**	**2680 J**	**1810 J**	**589 J**	**220 J**		
Arsenic	28.58	28	28	28	5000	333	SW6010B	mg/kg	**1100**	**2150**	**333**	**2000**	**1080**	**1130**	**1800**	**1410**	**1880**	**2880**	**2520**	**1200**	**2490**		
Barium	266.0	28	28	12	892	119	SW6010B	mg/kg	**221**	**340**	**119**	**269**	**256**	**191**	**217**	**211**	**297**	**319**	**371**	**255**	**212**		
Beryllium	0.5	28	26	21	1.1	0.3	SW6010B	mg/kg	**0.5**	**0.6**	**0.3**	**0.6**	**0.5**	**0.6**	**0.8**	**0.6**	**0.8**	**0.7**	**0.7**	**0.5**	**0.9**		
Cadmium	0.4	28	0	0			SW6010B	mg/kg	0.023 U	0.058 U	0.021 U	0.055 U	0.023 U	0.051 U	0.052 U	0.023 U	0.056 U	0.055 U	0.055 U	0.023 U	0.05 U		
Calcium	10100	28	28	0	9210	1760	SW6010B	mg/kg	**2190**	**3000**	**1760**	**2580**	**2570**	**9210**	**3370**	**2350**	**2560**	**3350**	**3830**	**2660**	**8620**		
Chromium	28.57	28	28	8	42	12	SW6010B	mg/kg	**26.9**	**31**	**17**	**22**	**24.3**	**12**	**20**	**23.4**	**26**	**28**	**33**	**25.1**	**31**		
Cobalt	11.28	28	28	25	23.7	8.1	SW6010B	mg/kg	**11.9**	**16.9**	**8.2**	**14.9**	**13.7**	**23.1**	**21.7**	**15.7**	**20.3**	**18.2**	**17.3**	**11.2**	**23.7**		
Copper	23.02	28	28	27	109	20.8	SW6010B	mg/kg	**33.2**	**45.4**	**20.8**	**51.5**	**38.5**	**66.8**	**73.7**	**40.8**	**59.7**	**55.8**	**52.8**	**35.4**	**61.2**		
Iron	30891	28	28	19	53700	17300	SW6010B	mg/kg	**21800**	**29200**	**17300**	**31700**	**25500**	**38000**	**35100**	**27900**	**34400**	**33300**	**28900**	**25600**	**43400**		
Lead	10.00	28	24	20	3090	5	SW6010B	mg/kg	**9**	**13**	**5**	**18**	**14**	**14**	**19**	**12**	**13**	**11**	**10**	**10**	**12**		
Magnesium	3870	28	28	16	10800	1340	SW6010B	mg/kg	**3570**	**4100**	**3030**	**4870**	**3910**	**7730**	**4980**	**3280**	**4540**	**5480**	**4930**	**4280**	**10800**		
Manganese	465	28	28	24	1110	267	SW6010B	mg/kg	**644**	**573**	**309**	**559**	**415**	**991**	**572**	**477**	**616**	**563**	**507**	**411**	**879**		
Mercury	1.86	28	28	28	1260	19.1	SW7471A	mg/kg	**114**	**124**	**19.1**	**150**	**114**	**115**	**144**	**68**	**165**	**150**	**172**	**54**	**145**		
Nickel	28.00	28	28	26	74	24	SW6010B	mg/kg	**38**	**43 J**	**24 J**	**49 J**	**44 J**	**60 J**	**57 J**	**48 J**	**62 J**	**57 J**	**56 J**	**32**	**74**		
Potassium	954.1	28	28	26	3770	770	SW6010B	mg/kg	**1350**	**1980**	**770**	**1810**	**1230**	**1290**	**1670**	**1410**	**2060**	**2490**	**2690**	**1460**	**1640**		
Selenium	NA	28	0	0			SW6010B	mg/kg	0.67 U	1.7 U	0.61 U	1.6 U	0.68 U	1.5 U	1.5 U	0.68 U	1.6 U	1.6 U	1.6 U	0.68 U	1.5 U		
Silver	NA	28	0	0			SW6010B	mg/kg	0.045 U	0.116 U	0.041 U	0.11 U	0.046 U	0.101 U	0.104 U	0.046 U	0.112 U	0.11 U	0.109 U	0.046 U	0.101 U		
Sodium	100	28	14	12	380	90	SW6010B	mg/kg	**110**	**160**	**90**	**140**	**110**	38.2 U	39.1 U	**100**	42.1 U	**380**	**350**	**110**	38 U		
Thallium	NA	28	0	0			SW6010B	mg/kg	0.28 U	0.7 U	0.26 U	0.7 U	0.29 U	0.6 U	0.6 U	0.29 U	0.7 U	0.7 U	0.7 U	0.29 U	0.6 U		
Vanadium	62.9	28	28	0	37.3	24.3	SW6010B	mg/kg	**27.3**	**28.9**	**24.7**	**28**	**28.4**	**24.3**	**29.6**	**33.2**	**31.4**	**27.7**	**28.6**	**31.5**	**32.4**		
Zinc	66.7	28	28	27	147	48	SW6010B	mg/kg	**68**	**93**	**48**	**97**	**82**	**104**	**114**	**89**	**104**	**98**	**92**	**73**	**102**		
SPLP Inorganic Elements																							
Aluminum		4	4		2.96	0.27	SW6010B SPLP	mg/L	**2.42**					**0.27**									
Antimony		4	4		9.14	0.11	SW6010B SPLP	mg/L	**0.96**					**0.11**									
Arsenic		4	4		2	0.37	SW6010B SPLP	mg/L	**0.92**					**0.37**									
Barium		4	4		0.112	0.009	SW6010B SPLP	mg/L	**0.103**					**0.029**									
Beryllium		4	0				SW6010B SPLP	mg/L	0.001 U					0.00024 U									
Cadmium		4	0				SW6010B SPLP	mg/L	0.002 U					0.00031 U									
Calcium		4	4		3.84	1.19	SW6010B SPLP	mg/L	**2.94**					**3.84**									
Chromium		4	2		0.008	0.007	SW6010B SPLP	mg/L	**0.007**					0.00329 U									
Cobalt		4	0				SW6010B SPLP	mg/L	0.003 U					0.00051 U									
Copper		4	3		0.011	0.004	SW6010B SPLP	mg/L	**0.008**					0.00113 U									
Iron		4	4		4.33	0.05	SW6010B SPLP	mg/L	**1.45**					**0.05**									
Lead		4	0				SW6010B SPLP	mg/L	0.02 U					0.0019 U									
Magnesium		4	4		4.94	0.78	SW6010B SPLP	mg/L	**2.35**					**4.94**									
Manganese		4	3		0.039	0.007	SW6010B SPLP	mg/L	**0.018**					0.00085 U									
Mercury		4	4		0.174	0.0002	SW7470A SPLP	mg/L	**0.015**					**0.0002**									
Nickel		4	0				SW6010B SPLP	mg/L	0.01 U					0.005 U									
Potassium		4	2		1.1	1	SW6010B SPLP	mg/L	**1**					0.069 U									
Selenium		4	0				SW6010B SPLP	mg/L	0.05 U					0.0061 U									
Silver		4	0				SW6010B SPLP	mg/L	0.003 U					0.00055 U									
Sodium		4	4		10.1	0.6	SW6010B SPLP	mg/L	**10.1**					**5.9**									
Thallium		4	0				SW6010B SPLP	mg/L	0.05 U					0.0052 U									
Vanadium		4	2		0.012	0.008	SW6010B SPLP	mg/L	**0.008**					0.00061 U									
Zinc		4	1		0.02	0.02	SW6010B SPLP	mg/L	0.01 U					0.0039 U									
TCLP Inorganic Elements																							
Arsenic		4	3		2.8	0.9	SW6010B TCLP	mg/L	**0.9**					0.036 U									
Barium		4	4		1.15	0.29	SW6010B TCLP	mg/L	**0.83**					**1.15**									
Cadmium		4	0				SW6010B TCLP	mg/L	0.01 U					0.0016 U									
Chromium		4	0				SW6010B TCLP	mg/L	0.02 U					0.0164 U									
Lead		4	0				SW6010B TCLP	mg/L	0.1 U					0.01 U									
Selenium		4	0				SW6010B TCLP	mg/L	0.2 U					0.03 U									
Silver		4	0				SW6010B TCLP	mg/L	0.02 U					0.0028 U									
Mercury		4	4		0.0076	0.0003	SW7470A TCLP	mg/L	**0.004**					**0.0003 J**									
Arsenic Speciation																							
Arsenate		3	3		2490	803	EPA 1632	mg/kg				**1870 J**		**803 J**									
Arsenite		3	3		90.4	12.1	EPA 1632	mg/kg				**76.4 J**		**12.1 J**									
Inorganic Arsenic		3	3		2580	815	EPA 1632	mg/kg				**1950 J**		**815 J**									

Table 4-17 Pre-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP55565758 (Composite)	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP52	MP59
							Soil Type*		T/WR	T/WR	N/DN	T/WR	T/WR	WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	WR
							Sample ID		10MP55565758SS	10MP55SS	10MP56SS	10MP57SS	10MP58SS	10MP59SS	10MP60SS	10MP61SS	10MP62SS	10MP63SS	10MP64SS	10MP65SS	10MP66SS	11MP52SS	11MP59SS
Analyte							Method																
Arsenic Bioavailability																							
Arsenic (IVBA)		2	2		15.3	0.695	M6020 ICP-MS	mg/L														**15.3 J**	**0.695 J**
Arsenic, total (3050)		2	2		3910	538	M6020 ICP-MS	mg/kg														**3910**	**538**
Arsenic IVBA% (In Vitro RBA)		2	2		39.1	12.9	Calculation (EPA 920	%														**39.1 J**	**12.9 J**
Total Solids		2	2		92.2	88	CLPSOW390, PART F, D	%														**88**	**92.2**
Mercury Selective Sequential Extraction																							
Hg(F0)		3	3		11.9	3.79	EPA 1631	ng/g				**11.2**		**3.79**									
Hg(F1)		3	3		2970	170	BRL SOP No. BR-0013	ng/g				**2170**		**170**									
Hg(F2)		3	3		36.5	0.8	BRL SOP No. BR-0013	ng/g				**36**		**0.8**									
Hg(F3)		3	3		6250	1950	BRL SOP No. BR-0013	ng/g				**1950 J**		**6250 J**									
Hg(F4)		3	3		32300	15600	BRL SOP No. BR-0013	ng/g				**28500**		**15600**									
Hg(F5)		3	3		1110000	296000	BRL SOP No. BR-0013	ng/g				**1110000**		**436000**									
Hg(F6)		3	3		58200	16900	BRL SOP No. BR-0013	ng/g				**58200 J**		**26300 J**									
Semi-Volatile Organic Compounds																							
1-Methylnaphthalene		3	2		74	27	SW8270D	µg/kg															
2-Methylnaphthalene		3	2		200	79	SW8270D	µg/kg															
bis(2-Ethylhexyl)phthalate		3	2		17	13	SW8270D	µg/kg															
Chrysene		3	2		17	16	SW8270D	µg/kg															
Dibenzofuran		3	1		10	10	SW8270D	µg/kg															
Fluorene		3	1		20	20	SW8270D	µg/kg															
Naphthalene		3	2		70	26	SW8270D	µg/kg															
Phenanthrene		3	1		48	48	SW8270D	µg/kg															
Sulfur		2	2		1300	230	SW8270D	µg/kg															
Unknown Aromatic		3	2		390	260	SW8270D	µg/kg															
Unknown Hydrocarbon		3	2		950	700	SW8270D	µg/kg															
Unknown Sterol		2	2		480	360	SW8270D	µg/kg															
Polychlorinated Biphenyls																							
Aroclor 1016		8	0				SW8082	mg/kg															
Aroclor 1221		8	0				SW8082	mg/kg															
Aroclor 1232		8	0				SW8082	mg/kg															
Aroclor 1242		8	0				SW8082	mg/kg															
Aroclor 1248		8	0				SW8082	mg/kg															
Aroclor 1254		8	0				SW8082	mg/kg															
Aroclor 1260		8	1		0.021	0.021	SW8082	mg/kg															
Diesel and Residual Range Organics																							
Diesel Range Hydrocarbons		3	2		140	120	AK102/AK103 TPHD	mg/kg															
Motor Oil		3	3		510	24	AK102/AK103 TPHD	mg/kg															

Table 4-17 Pre-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP80	MP81	MP82	MP83	MP84	MP85	MP86	MP87
							Soil Type*		N/DN	N/DN	N/DN	T/WR	T/WR	T/WR	T/WR	T/WR
							Sample ID		11MP80SS	11MP81SS	11MP82SS	11MP83SS	11MP84SS	11MP85SS	11MP86SS	11MP87SS
Analyte							Method									
Total Inorganic Elements																
Aluminum	19475	28	28	0	12800	3370	SW6010B	mg/kg								
Antimony	8	28	28	28	23300	20	SW6010B	mg/kg								
Arsenic	28.58	28	28	28	5000	333	SW6010B	mg/kg								
Barium	266.0	28	28	12	892	119	SW6010B	mg/kg								
Beryllium	0.5	28	26	21	1.1	0.3	SW6010B	mg/kg								
Cadmium	0.4	28	0	0			SW6010B	mg/kg								
Calcium	10100	28	28	0	9210	1760	SW6010B	mg/kg								
Chromium	28.57	28	28	8	42	12	SW6010B	mg/kg								
Cobalt	11.28	28	28	25	23.7	8.1	SW6010B	mg/kg								
Copper	23.02	28	28	27	109	20.8	SW6010B	mg/kg								
Iron	30891	28	28	19	53700	17300	SW6010B	mg/kg								
Lead	10.00	28	24	20	3090	5	SW6010B	mg/kg								
Magnesium	3870	28	28	16	10800	1340	SW6010B	mg/kg								
Manganese	465	28	28	24	1110	267	SW6010B	mg/kg								
Mercury	1.86	28	28	28	1260	19.1	SW7471A	mg/kg								
Nickel	28.00	28	28	26	74	24	SW6010B	mg/kg								
Potassium	954.1	28	28	26	3770	770	SW6010B	mg/kg								
Selenium	NA	28	0	0			SW6010B	mg/kg								
Silver	NA	28	0	0			SW6010B	mg/kg								
Sodium	100	28	14	12	380	90	SW6010B	mg/kg								
Thallium	NA	28	0	0			SW6010B	mg/kg								
Vanadium	62.9	28	28	0	37.3	24.3	SW6010B	mg/kg								
Zinc	66.7	28	28	27	147	48	SW6010B	mg/kg								
SPLP Inorganic Elements																
Aluminum		4	4		2.96	0.27	SW6010B SPLP	mg/L								
Antimony		4	4		9.14	0.11	SW6010B SPLP	mg/L								
Arsenic		4	4		2	0.37	SW6010B SPLP	mg/L								
Barium		4	4		0.112	0.009	SW6010B SPLP	mg/L								
Beryllium		4	0				SW6010B SPLP	mg/L								
Cadmium		4	0				SW6010B SPLP	mg/L								
Calcium		4	4		3.84	1.19	SW6010B SPLP	mg/L								
Chromium		4	2		0.008	0.007	SW6010B SPLP	mg/L								
Cobalt		4	0				SW6010B SPLP	mg/L								
Copper		4	3		0.011	0.004	SW6010B SPLP	mg/L								
Iron		4	4		4.33	0.05	SW6010B SPLP	mg/L								
Lead		4	0				SW6010B SPLP	mg/L								
Magnesium		4	4		4.94	0.78	SW6010B SPLP	mg/L								
Manganese		4	3		0.039	0.007	SW6010B SPLP	mg/L								
Mercury		4	4		0.174	0.0002	SW7470A SPLP	mg/L								
Nickel		4	0				SW6010B SPLP	mg/L								
Potassium		4	2		1.1	1	SW6010B SPLP	mg/L								
Selenium		4	0				SW6010B SPLP	mg/L								
Silver		4	0				SW6010B SPLP	mg/L								
Sodium		4	4		10.1	0.6	SW6010B SPLP	mg/L								
Thallium		4	0				SW6010B SPLP	mg/L								
Vanadium		4	2		0.012	0.008	SW6010B SPLP	mg/L								
Zinc		4	1		0.02	0.02	SW6010B SPLP	mg/L								
TCLP Inorganic Elements																
Arsenic		4	3		2.8	0.9	SW6010B TCLP	mg/L								
Barium		4	4		1.15	0.29	SW6010B TCLP	mg/L								
Cadmium		4	0				SW6010B TCLP	mg/L								
Chromium		4	0				SW6010B TCLP	mg/L								
Lead		4	0				SW6010B TCLP	mg/L								
Selenium		4	0				SW6010B TCLP	mg/L								
Silver		4	0				SW6010B TCLP	mg/L								
Mercury		4	4		0.0076	0.0003	SW7470A TCLP	mg/L								
Arsenic Speciation																
Arsenate		3	3		2490	803	EPA 1632	mg/kg								
Arsenite		3	3		90.4	12.1	EPA 1632	mg/kg								
Inorganic Arsenic		3	3		2580	815	EPA 1632	mg/kg								

Table 4-17 Pre-1955 Main Processing Area Surface Soil Results

Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP80	MP81	MP82	MP83	MP84	MP85	MP86	MP87
							Soil Type*		N/DN	N/DN	N/DN	T/WR	T/WR	T/WR	T/WR	T/WR
							Sample ID		11MP80SS	11MP81SS	11MP82SS	11MP83SS	11MP84SS	11MP85SS	11MP86SS	11MP87SS
							Method									
Arsenic Bioavailability																
Arsenic (IVBA)		2	2		15.3	0.695	M6020 ICP-MS	mg/L								
Arsenic, total (3050)		2	2		3910	538	M6020 ICP-MS	mg/kg								
Arsenic IVBA% (In Vitro RBA)		2	2		39.1	12.9	Calculation (EPA 920	%								
Total Solids		2	2		92.2	88	CLPSOW390, PART F, D	%								
Mercury Selective Sequential Extraction																
Hg(F0)		3	3		11.9	3.79	EPA 1631	ng/g								
Hg(F1)		3	3		2970	170	BRL SOP No. BR-0013	ng/g								
Hg(F2)		3	3		36.5	0.8	BRL SOP No. BR-0013	ng/g								
Hg(F3)		3	3		6250	1950	BRL SOP No. BR-0013	ng/g								
Hg(F4)		3	3		32300	15600	BRL SOP No. BR-0013	ng/g								
Hg(F5)		3	3		1110000	296000	BRL SOP No. BR-0013	ng/g								
Hg(F6)		3	3		58200	16900	BRL SOP No. BR-0013	ng/g								
Semi-Volatile Organic Compounds																
1-Methylnaphthalene		3	2		74	27	SW8270D	µg/kg								
2-Methylnaphthalene		3	2		200	79	SW8270D	µg/kg								
bis(2-Ethylhexyl)phthalate		3	2		17	13	SW8270D	µg/kg								
Chrysene		3	2		17	16	SW8270D	µg/kg								
Dibenzofuran		3	1		10	10	SW8270D	µg/kg								
Fluorene		3	1		20	20	SW8270D	µg/kg								
Naphthalene		3	2		70	26	SW8270D	µg/kg								
Phenanthrene		3	1		48	48	SW8270D	µg/kg								
Sulfur		2	2		1300	230	SW8270D	µg/kg								
Unknown Aromatic		3	2		390	260	SW8270D	µg/kg								
Unknown Hydrocarbon		3	2		950	700	SW8270D	µg/kg								
Unknown Sterol		2	2		480	360	SW8270D	µg/kg								
Polychlorinated Biphenyls																
Aroclor 1016		8	0				SW8082	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1221		8	0				SW8082	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1232		8	0				SW8082	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1242		8	0				SW8082	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1248		8	0				SW8082	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1254		8	0				SW8082	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1260		8	1		0.021	0.021	SW8082	mg/kg	0.019 U	**0.021 J**	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Diesel and Residual Range Organics																
Diesel Range Hydrocarbons		3	2		140	120	AK102/AK103 TPHD	mg/kg								
Motor Oil		3	3		510	24	AK102/AK103 TPHD	mg/kg								

* Soil types defined in Appendix B.

Key

Bold = detection

Gray shading = exceedance of background

% = percent

Hg = mercury

ID = identifier

IVBA = In-vitro bioaccessibility

J = Analyte detected but relative percent difference was outside control limits; therefore, concentration is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

NA = not available/not analyzed

ng/g = nanograms per gram

RBA = relative bioavailability

TCLP = toxicity characteristic leaching procedure

TPHD = total petroleum hydrocarbons as diesel

U = Analyte was analyzed for but not detected. Value provided is reporting limit.

Table 4-18 Post-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP01	MP02	MP030405 (Composite)	MP03	MP04	MP05	MP06070809 (Composite)	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15
							Soil Type*		N/DN	Stockpiled Ore	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR
							Sample ID		10MP01SS	10MP02SS	10MP030405SS	10MP03SS	10MP04SS	10MP05SS	10MP06070809SS	10MP06SS	10MP07SS	10MP08SS	10MP09SS	10MP10SS	10MP11SS	10MP12SS	10MP13SS	10MP14SS	10MP15SS
Analyte							Method																		
Total Inorganic Elements																									
Aluminum	19475	47	47	1	21700	2410	SW6010B	mg/kg	**15300**	**3390**	**13900**	**15200**	**16700**	**14500**	**10400**	**11500**	**10700**	**6440**	**8210**	**6800**	**12500**	**12000**	**14600**	**9920**	**14800**
Antimony	8	47	47	44	16700	0.708	SW6010B	mg/kg	**20 J**	**210 J**	**5500 J**	**4720 J**	**5530 J**	**4460 J**	**4420 J**	**5750 J**	**8200 J**	**1220 J**	**1990 J**	**470 J**	**6980 J**	**10900 J**	**12100 J**	**3400 J**	**1180 J**
Arsenic	28.58	47	47	44	9880	10.8	SW6010B	mg/kg	**100**	**7310**	**5580**	**5200**	**6670**	**5660**	**4520**	**5640**	**4280**	**3040**	**4200**	**1540**	**5320**	**4870**	**4890**	**2320**	**4660**
Barium	266.0	47	47	30	1710	76.2	SW6010B	mg/kg	**84**	**134**	**639**	**769**	**750**	**697**	**496**	**580**	**572**	**286**	**424**	**225**	**796**	**746**	**840**	**462**	**1160**
Beryllium	0.5	47	46	38	1.3	0.3	SW6010B	mg/kg	**0.4**	**1.3**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.8**	**0.8**	**0.8**	**1**	**1**	**0.9**	**0.8**	**1.1**
Cadmium	0.4	47	8	4	1.1	0.18	SW6010B	mg/kg	0.063 U	0.1 U	0.057 U	0.055 U	0.055 U	0.052 U	0.057 U	0.055 U	0.11 U	0.055 U	0.056 U	0.054 U	0.052 U	0.11 U	0.11 U	0.055 U	0.12 U
Calcium	10100	47	47	0	8150	970	SW6010B	mg/kg	**970 J**	**1400 J**	**5900 J**	**3990 J**	**3760 J**	**4830 J**	**4150 J**	**6470 J**	**6660 J**	**3290 J**	**4840 J**	**2350 J**	**4750 J**	**7180 J**	**7480 J**	**3390 J**	**6650 J**
Chromium	28.57	47	47	25	101	8	SW6010B	mg/kg	**24**	**8**	**39**	**46**	**71**	**45**	**34**	**29**	**32**	**24**	**33**	**23**	**43**	**35**	**41**	**24**	**30**
Cobalt	11.28	47	47	44	35	5.9	SW6010B	mg/kg	**10**	**35**	**17.1**	**17.8**	**15.2**	**14.3**	**19.1**	**14.2**	**17**	**21**	**20.2**	**22.5**	**21**	**19**	**18**	**18.5**	**18**
Copper	23.02	47	47	44	139	17	SW6010B	mg/kg	**32.3**	**118**	**81.6**	**75**	**73.8**	**72.9**	**81.3**	**77.2**	**77**	**79.5**	**70**	**83.5**	**86.7**	**90**	**77**	**72.3**	**87**
Iron	30891	47	47	37	55600	16800	SW6010B	mg/kg	**30300**	**50100**	**41300**	**35800**	**39400**	**38400**	**42900**	**40700**	**35400**	**46600**	**41800**	**43700**	**40300**	**38000**	**34100**	**37800**	**33300**
Lead	10.00	47	43	32	220	6.96	SW6010B	mg/kg	**9**	**20**	**28**	**38**	**24**	**24**	**22**	**33**	**10**	**29**	**29**	**30**	**19**	1 U	1 U	**24**	**20**
Magnesium	3870	47	47	26	8640	450	SW6010B	mg/kg	**3310**	**450**	**5850**	**4930**	**4370**	**5490**	**4470**	**6010**	**5320**	**3640**	**4430**	**2040**	**5420**	**5960**	**7130**	**3180**	**5350**
Manganese	465	47	47	42	1390	158	SW6010B	mg/kg	**302**	**1190**	**737**	**527**	**502**	**523**	**616**	**596**	**692**	**688**	**650**	**813**	**785**	**801**	**676**	**874**	**694**
Mercury	1.86	47	47	43	1620	0.28	SW7471A	mg/kg	**2.6**	**88**	**680**	**710**	**860**	**900**	**750**	**750**	**790 J**	**295**	**560**	**172**	**660**	**304**	**690**	**162**	**217**
Nickel	28.00	47	47	45	97	18	SW6010B	mg/kg	**30**	**97**	**51**	**55**	**53**	**45**	**62**	**45**	**55**	**65**	**58**	**64**	**69**	**64**	**64**	**58**	**58**
Potassium	954.1	47	47	41	4720	670	SW6010B	mg/kg	**880**	**1770**	**3880**	**4030**	**3880**	**3930**	**3220**	**3270**	**2930**	**1840**	**2360**	**1790**	**3380**	**3450**	**3770**	**2650**	**4010**
Selenium	NA	47	2	0	0.42	0.24	SW6010B	mg/kg	1.9 U	3 U	1.7 U	1.6 U	1.6 U	1.5 U	1.7 U	1.6 U	3.2 U	1.6 U	1.6 U	1.6 U	1.5 U	3.2 U	3.3 U	1.6 U	3.5 U
Silver	NA	47	2	0	0.123	0.068	SW6010B	mg/kg	0.13 U	0.2 U	0.113 U	0.111 U	0.11 U	0.105 U	0.113 U	0.109 U	0.22 U	0.11 U	0.111 U	0.107 U	0.103 U	0.22 U	0.22 U	0.111 U	0.23 U
Sodium	100	47	29	22	430	42.3	SW6010B	mg/kg	47.9 U	77.3 U	**370**	**390**	**360**	**370**	**240**	**310**	82.6 U	41.6 U	**170**	40.6 U	**310**	**280**	**340**	**200**	**340**
Thallium	NA	47	2	0	0.071	0.065	SW6010B	mg/kg	0.8 U	1.3 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	1.4 U	0.7 U	0.7 U	0.7 U	0.6 U	1.4 U	1.4 U	0.7 U	1.5 U
Vanadium	62.9	47	47	0	49.5	20	SW6010B	mg/kg	**47**	**20**	**36.2**	**33.9**	**33.5**	**34.7**	**33.5**	**29**	**29**	**31.4**	**30.3**	**39**	**34.5**	**32**	**31**	**36.4**	**32**
Zinc	66.7	47	47	44	386	38	SW6010B	mg/kg	**71**	**159**	**115**	**115**	**110**	**106**	**120**	**95**	**110**	**135**	**107**	**136**	**126**	**122**	**115**	**118**	**125**
SPLP Inorganic Elements µg/L																									
Aluminum		15	14		1.25	0.09	SW6010B SPLP	mg/L	**0.36**	**0.11**	**0.21**				**0.26**										
Antimony		15	14		31.3	0.07	SW6010B SPLP	mg/L	**0.07**	**0.09**	**9.25**				**8.19**										
Arsenic		15	13		6	0.44	SW6010B SPLP	mg/L	0.05 U	**0.44**	**3.05**				**2.81**										
Barium		15	11		0.032	0.004	SW6010B SPLP	mg/L	**0.008**	**0.004**	**0.027**				**0.018**										
Beryllium		15	0				SW6010B SPLP	mg/L	0.001 U	0.001 U	0.001 U				0.001 U										
Cadmium		15	0				SW6010B SPLP	mg/L	0.002 U	0.002 U	0.002 U				0.002 U										
Calcium		15	15		2.64	0.19	SW6010B SPLP	mg/L	**0.31**	**0.19**	**2.64**				**2.42**										
Chromium		15	2		0.107	0.0035	SW6010B SPLP	mg/L	0.005 U	**0.107**	0.005 U				0.005 U										
Cobalt		15	0				SW6010B SPLP	mg/L	0.003 U	0.003 U	0.003 U				0.003 U										
Copper		15	3		0.005	0.002	SW6010B SPLP	mg/L	0.002 U	**0.003**	0.002 U				**0.002**										
Iron		15	13		2.17	0.06	SW6010B SPLP	mg/L	**0.29**	**0.52**	**0.34**				**0.48**										
Lead		15	0				SW6010B SPLP	mg/L	0.02 U	0.02 U	0.02 U				0.02 U										
Magnesium		15	15		5.3	0.11	SW6010B SPLP	mg/L	**0.11**	**0.11**	**1.54**				**1.64**										
Manganese		15	15		0.051	0.003	SW6010B SPLP	mg/L	**0.03**	**0.04**	**0.01**				**0.005**										
Mercury		15	14		0.03	0.0001	SW7470A SPLP	mg/L	**0.0001**	**0.0006**	**0.03**				**0.008**										
Nickel		15	2		0.11	0.0029	SW6010B SPLP	mg/L	0.01 U	**0.11**	0.01 U				0.01 U										
Potassium		15	13		2.4	0.352	SW6010B SPLP	mg/L	**0.8**	**0.7**	**1.2**				**1**										
Selenium		15	0				SW6010B SPLP	mg/L	0.05 U	0.05 U	0.05 U				0.05 U										
Silver		15	0				SW6010B SPLP	mg/L	0.003 U	0.003 U	0.003 U				0.003 U										
Sodium		15	7		7.02	0.5	SW6010B SPLP	mg/L	0.5 U	**0.5**	0.5 U				**0.6**										
Thallium		15	0				SW6010B SPLP	mg/L	0.05 U	0.05 U	0.05 U				0.05 U										
Vanadium		15	9		0.013	0.003	SW6010B SPLP	mg/L	0.003 U	0.003 U	**0.003**				0.003 U										
Zinc		15	2		0.1	0.0173	SW6010B SPLP	mg/L	0.01 U	**0.1**	0.01 U				0.01 U										
TCLP Inorganic Elements (mg/L)																									
Arsenic		12	12		29.1	0.7	SW6010B TCLP	mg/L			**5.7**				**5.4**										
Barium		12	9		2.92	0.42	SW6010B TCLP	mg/L			**1.29**				**0.82**										
Cadmium		12	0				SW6010B TCLP	mg/L			0.01 U				0.01 U										
Chromium		12	0				SW6010B TCLP	mg/L			0.02 U				0.02 U										
Lead		12	0				SW6010B TCLP	mg/L			0.1 U				0.1 U										
Selenium		12	0				SW6010B TCLP	mg/L			0.2 U				0.2 U										
Silver		12	0				SW6010B TCLP	mg/L			0.02 U				0.02 U										
Mercury		12	12		0.0055	0.0003	SW7470A TCLP	mg/L			**0.005**				**0.0031**										
Arsenic Speciation (mg/kg)																									
Arsenate		11	11		13100 J	113 J	EPA 1632	mg/kg	**113 J**																
Arsenite		11	11		449.00 J	2.02 J	EPA 1632	mg/kg	**2.02 J**																
Inorganic Arsenic		11	11		13300	115 J	EPA 1632	mg/kg	**115 J**																
Arsenic Bioavailability																									
Arsenic (IVBA)		5	5		30.5	2.29	M6020 ICP-MS	mg/L																	
Arsenic, total (3050)		5	5		8500	1480	M6020 ICP-MS	mg/kg																	
Arsenic IVBA% (In Vitro RBA)		5	5		47.3	2.7	Calculation (EPA 920	%																	
Total Solids		5	5		88.7	77.5	CLPSOW390, PART F, D	%																	
Mercury Selective Sequential Extraction																									
Hg(F0)		11	8		379	7.54	EPA 1631	ng/g	3.74 U																
Hg(F1)		11	11		17100	4.37	BRL SOP No. BR-0013	ng/g	**4.37 J**																
Hg(F2)		11	11		1830	1.59	BRL SOP No. BR-0013	ng/g	**7.96 J**																
Hg(F3)		11	11		33300	246	BRL SOP No. BR-0013	ng/g	**1050 J**																
Hg(F4)		11	11		55900	26.9	BRL SOP No. BR-0013	ng/g	**26.9 J**																
Hg(F5)		11	11		5060000	21.7	BRL SOP No. BR-0013	ng/g	**21.7**																
Hg(F6)		10	10		106000	10.7	BRL SOP No. BR-0013	ng/g	**10.7 J**																
Semi-Volatile Organic Compounds																									
1-Methylnaphthalene		7	2		60	15	SW8270D	µg/kg													**15 J**				
2-Methylnaphthalene		7	3		140	29	SW8270D	µg/kg													**36**				
4-Bromophenyl Phenyl Ether		1	1		1.9	1.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
4-Methylphenol		1	1		4.9	4.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Acenaphthene		1	1		2.3	2.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	

Table 4-18 Post-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP01	MP02	MP030405 (Composite)	MP03	MP04	MP05	MP06070809 (Composite)	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15
							Soil Type*		N/DN	Stockpiled Ore	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR
							Sample ID		10MP01SS	10MP02SS	10MP030405SS	10MP03SS	10MP04SS	10MP05SS	10MP06070809SS	10MP06SS	10MP07SS	10MP08SS	10MP09SS	10MP10SS	10MP11SS	10MP12SS	10MP13SS	10MP14SS	10MP15SS
Analyte							Method																		
Acenaphthylene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Anthracene		1	1		2	2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Benzoic Acid		1	1		120	120	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Benzyl Alcohol		1	1		12	12	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
bis(2-Ethylhexyl)phthalate		7	5		220	11	SW8270D	µg/kg												**12 J**					
Chrysene		1	1		2.6	2.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Chrysene		7	2		42	19	SW8270D	µg/kg												**19 J**					
Dibenzofuran		1	1		2.4	2.4	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Diethyl Phthalate		1	1		8	8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Diethylphthalate		7	1		140	140	SW8270D	µg/kg												3.6 U					
Dimethyl Phthalate		1	1		160	160	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Docosanoic acid		1	1		1300	1300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Fluorene		1	1		2.5	2.5	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Hexachlorobenzene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Naphthalene		7	1		14	14	SW8270D	µg/kg												**14 J**					
Pentachlorophenol		7	1		38	38	SW8270D	µg/kg												26 U					
Phenanthrene		1	1		4.2	4.2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Phenanthrene		7	2		38	18	SW8270D	µg/kg												**18 J**					
Phenol		1	1		4.6	4.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Pyrene		1	1		2.8	2.8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Sulfur		3	3		620	190	SW8270D	µg/kg																	
Unknown		1	1		5300	5300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Unknown		1	1		140	140	SW8270D	µg/kg																	
Unknown Alkane		1	1		4000	4000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Unknown Alkene		1	1		2000	2000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Unknown Aromatic		7	7		3100	90	SW8270D	µg/kg												**220 J**					
Unknown Branched Alkane		1	1		1500	1500	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Unknown Hydrocarbon		7	7		980	96	SW8270D	µg/kg												**420 J**					
Unknown Organic Acid		5	5		380	87	SW8270D	µg/kg												**170 J**					
Unknown Sterol		1	1		3200	3200	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																	
Unknown Sterol		7	7		5000	78	SW8270D	µg/kg												**240 J**					
Polychlorinated Biphenols																									
Aroclor 1016		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Aroclor 1221		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Aroclor 1232		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Aroclor 1242		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Aroclor 1248		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Aroclor 1254		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Aroclor 1260		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																	
Diesel and Residual Range Organics (mg/kg)																									
C10 - C25 DRO		1	1		39	39	AK102 Alaska Diesel Range for Soil	mg/kg																	
Diesel Range Hydrocarbons		7	4		680	7.1	AK102/AK103 TPHD	mg/kg												**31 J**					
Motor Oil		7	7		7800	13	AK102/AK103 TPHD	mg/kg												**94**					
C25 - C36 RRO		1	1		420	420	AK103 Alaska Residual Range for Soil	mg/kg																	

Table 4-18 Post-1955 Main Processing Area Surface Soil Results Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33
							Soil Type*		T/WR	T/WR	T/WR	N/DN	F	F	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	B/WB	FT	N/DN
							Sample ID Method		10MP16SS	10MP17SS	10MP18SS	10MP19SS	10MP20SS	10MP21SS	10MP22SS	10MP23SS	10MP24SS	10MP25SS	10MP26SS	10MP27SS	10MP28SS	10MP29SS	10MP30SS	10MP31SS	10MP32SS	10MP33SS
Total Inorganic Elements																										
Aluminum	19475	47	47	1	21700	2410	SW6010B	mg/kg	**6570**	**15700**	**11300**	**13000**	**7370**	**5330**	**6170**	**11300**	**5280**	**13700**	**14600**	**12700**	**12200**	**14200**	**8560**	**14700**	**3100**	**12000**
Antimony	8	47	47	44	16700	0.708	SW6010B	mg/kg	**1570 J**	**6180 J**	**4810 J**	**40**	**40**	**80**	**2500**	**8720**	**1180**	**14100**	**15100**	**8480**	**4780**	**16700**	**720**	**7**	**1430**	**9**
Arsenic	28.58	47	47	44	9880	10.8	SW6010B	mg/kg	**6950**	**5540**	**2570**	**170**	**230**	**360**	**1960**	**4380**	**2020**	**5400**	**6420**	**6100**	**5350**	**6170**	**2930**	**19**	**9880**	**18**
Barium	266.0	47	47	30	1710	76.2	SW6010B	mg/kg	**358**	**1020**	**462**	**90.3**	**213**	**319**	**346**	**598**	**277**	**882**	**890**	**735**	**682**	**870**	**263**	**76.2**	**126**	**112**
Beryllium	0.5	47	46	38	1.3	0.3	SW6010B	mg/kg	**0.7**	**1**	**0.8**	**0.6**	**0.7**	**0.8**	**0.8**	**0.9**	**0.7**	**1**	**1**	**1**	**0.9**	0.21 U	**0.7**	**0.4**	**0.7**	**0.3**
Cadmium	0.4	47	8	4	1.1	0.18	SW6010B	mg/kg	0.052 U	0.052 U	0.054 U	0.06 U	**1.1**	**0.8**	0.054 U	0.1 U	**1**	0.11 U	0.11 U	0.11 U	0.052 U	0.21 U	0.057 U	**0.3**	0.12 U	0.032 U
Calcium	10100	47	47	0	8150	970	SW6010B	mg/kg	**6630 J**	**5000 J**	**4340 J**	**1010**	**2410**	**1860**	**5390**	**4700**	**5960**	**6110**	**8150**	**4600**	**5140**	**7670**	**3670**	**976**	**1670**	**3900**
Chromium	28.57	47	47	25	101	8	SW6010B	mg/kg	**40**	**51**	**27**	**23**	**25**	**32**	**25**	**30**	**26**	**41**	**49**	**37**	**33**	**41**	**22**	**21.5**	**19**	**18.7**
Cobalt	11.28	47	47	44	35	5.9	SW6010B	mg/kg	**22.3**	**18.9**	**17.7**	**16.2**	**18.2**	**25.2**	**26.2**	**19**	**23**	**17**	**18**	**19**	**16.6**	**18**	**15.8**	**7.4**	**16**	**5.9**
Copper	23.02	47	47	44	139	17	SW6010B	mg/kg	**54.1**	**81.9**	**72.9**	**32.4**	**89.7**	**96.9**	**87.9**	**117**	**82.3**	**95**	**97**	**139**	**77**	**94**	**63.7**	**17.9**	**71**	**20.2**
Iron	30891	47	47	37	55600	16800	SW6010B	mg/kg	**41500**	**35900**	**34500**	**30600**	**48100**	**55600**	**45000**	**38400**	**42500**	**34000**	**35500**	**42600**	**38700**	**36700**	**31200**	**26100**	**44300**	**16800**
Lead	10.00	47	43	32	220	6.96	SW6010B	mg/kg	**16**	**57**	**16**	**9**	**40**	**24**	**28**	**10**	**30**	**80**	1 U	**220**	**43**	1.9 U	**57**	**7**	**180**	**8**
Magnesium	3870	47	47	26	8640	450	SW6010B	mg/kg	**6880**	**5230**	**3690**	**2480**	**1960**	**1190**	**5400**	**4790**	**8640**	**5710**	**6710**	**5200**	**5790**	**7450**	**4460**	**2340**	**1390**	**2640**
Manganese	465	47	47	42	1390	158	SW6010B	mg/kg	**714**	**690**	**965**	**537**	**1040**	**1390**	**991**	**892**	**768**	**604**	**829**	**708**	**617**	**739**	**539**	**258**	**708**	**158**
Mercury	1.86	47	47	43	1620	0.28	SW7471A	mg/kg	**290**	**460**	**136**	**38**	**62**	**63**	**106**	**261**	**440**	**1340**	**1620**	**250**	**820**	**440**	**400**	**0.28**	**127**	**1.46**
Nickel	28.00	47	47	45	97	18	SW6010B	mg/kg	**56**	**64**	**54**	**40**	**66**	**80**	**79**	**60**	**77**	**56**	**62**	**61**	**53**	**60**	**52**	**20**	**48**	**18**
Potassium	954.1	47	47	41	4720	670	SW6010B	mg/kg	**2160**	**4220**	**2820**	**810**	**1680**	**1570**	**1820**	**3250**	**1770**	**3760**	**3870**	**3840**	**3860**	**3980**	**1920**	**670**	**1600**	**880**
Selenium	NA	47	2	0	0.42	0.24	SW6010B	mg/kg	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U	1.6 U	1.6 U	3 U	1.6 U	3.2 U	3.1 U	3.2 U	1.5 U	6.3 U	1.7 U	0.76 U	3.5 U	0.93 U
Silver	NA	47	2	0	0.123	0.068	SW6010B	mg/kg	0.104 U	0.104 U	0.108 U	0.12 U	0.108 U	0.106 U	0.107 U	0.2 U	0.11 U	0.21 U	0.21 U	0.22 U	0.104 U	0.43 U	0.114 U	0.051 U	0.24 U	0.063 U
Sodium	100	47	29	22	430	42.3	SW6010B	mg/kg	**140**	**390**	**210**	45.2 U	40.8 U	40.1 U	40.4 U	**260**	41.7 U	**350**	**370**	**340**	**350**	161 U	42.9 U	**70**	90.4 U	**90**
Thallium	NA	47	2	0	0.071	0.065	SW6010B	mg/kg	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	1.3 U	0.7 U	1.3 U	1.3 U	1.4 U	0.7 U	2.7 U	0.7 U	0.32 U	1.5 U	0.4 U
Vanadium	62.9	47	47	0	49.5	20	SW6010B	mg/kg	**27.6**	**34.8**	**35.8**	**45.4**	**39.8**	**49.5**	**31.6**	**33**	**27.3**	**31**	**34**	**32**	**31.1**	**35**	**29.4**	**47.5**	**21**	**32.2**
Zinc	66.7	47	47	44	386	38	SW6010B	mg/kg	**93**	**123**	**112**	**83**	**386**	**209**	**160**	**117**	**152**	**113**	**122**	**108**	**108**	**120**	**94**	**51**	**112**	**38**
SPLP Inorganic Elements µg/L																										
Aluminum		15	14		1.25	0.09	SW6010B SPLP	mg/L	**0.13**	**0.18**								**0.09**	**0.13**	**0.09**		**0.1**			0.05 U	
Antimony		15	14		31.3	0.07	SW6010B SPLP	mg/L	**2.79**	**7.74**								**9.24**	**11.2**	**10.7**		**31.3**			**3.66**	
Arsenic		15	13		6	0.44	SW6010B SPLP	mg/L	**3.87**	**4.9**								**3.82**	**4.89**	**3.66**		**6**			**2.31**	
Barium		15	11		0.032	0.004	SW6010B SPLP	mg/L	**0.007**	**0.013**								**0.014 J**	**0.007 J**	**0.009 J**		0.006 U			0.003 U	
Beryllium		15	0				SW6010B SPLP	mg/L	0.001 U	0.001 U								0.001 U	0.001 U	0.001 U		0.002 U			0.001 U	
Cadmium		15	0				SW6010B SPLP	mg/L	0.002 U	0.002 U								0.002 U	0.002 U	0.002 U		0.004 U			0.002 U	
Calcium		15	15		2.64	0.19	SW6010B SPLP	mg/L	**1.63**	**2.03**								**1.77**	**1.46**	**2.41**		**1.4**			**0.45**	
Chromium		15	2		0.107	0.0035	SW6010B SPLP	mg/L	0.005 U	0.005 U								0.005 U	0.005 U	0.005 U		0.01 U			0.005 U	
Cobalt		15	0				SW6010B SPLP	mg/L	0.003 U	0.003 U								0.003 U	0.003 U	0.003 U		0.006 U			0.003 U	
Copper		15	3		0.005	0.002	SW6010B SPLP	mg/L	0.002 U	0.002 U								0.002 U	0.002 U	0.002 U		0.004 U			**0.005**	
Iron		15	13		2.17	0.06	SW6010B SPLP	mg/L	**0.11**	**0.13**								0.05 U	**0.06**	**0.07**		0.1 U			**0.12**	
Lead		15	0				SW6010B SPLP	mg/L	0.02 U	0.02 U								0.02 U	0.02 U	0.02 U		0.04 U			0.02 U	
Magnesium		15	15		5.3	0.11	SW6010B SPLP	mg/L	**1.97**	**2.22**								**2.16**	**2.4**	**1.81**		**5.3**			**0.67**	
Manganese		15	15		0.051	0.003	SW6010B SPLP	mg/L	**0.003**	**0.005**								**0.003**	**0.003**	**0.011**		**0.004**			**0.004**	
Mercury		15	14		0.03	0.0001	SW7470A SPLP	mg/L	**0.0057**	**0.0147**								**0.021 J**	**0.012 J**	**0.0015 J**		**0.007 J**			**0.0033 J**	
Nickel		15	2		0.11	0.0029	SW6010B SPLP	mg/L	0.01 U	0.01 U								0.01 U	0.01 U	0.01 U		0.02 U			0.01 U	
Potassium		15	13		2.4	0.352	SW6010B SPLP	mg/L	**0.8**	**1.2**								**1.2**	**1.2**	**1.3**		**2**			**2.4**	
Selenium		15	0				SW6010B SPLP	mg/L	0.05 U	0.05 U								0.05 U	0.05 U	0.05 U		0.1 U			0.05 U	
Silver		15	0				SW6010B SPLP	mg/L	0.003 U	0.003 U								0.003 U	0.003 U	0.003 U		0.006 U			0.003 U	
Sodium		15	7		7.02	0.5	SW6010B SPLP	mg/L	0.5 U	**0.6**								**0.5**	0.5 U	**0.5**		1 U			**0.5**	
Thallium		15	0				SW6010B SPLP	mg/L	0.05 U	0.05 U								0.05 U	0.05 U	0.05 U		0.1 U			0.05 U	
Vanadium		15	9		0.013	0.003	SW6010B SPLP	mg/L	**0.004**	**0.007**								**0.006**	**0.009**	**0.004**		**0.008**			0.003 U	
Zinc		15	2		0.1	0.0173	SW6010B SPLP	mg/L	0.01 U	0.01 U								0.01 U	0.01 U	0.01 U		0.02 U			0.01 U	
TCLP Inorganic Elements (mg/L)																										
Arsenic		12	12		29.1	0.7	SW6010B TCLP	mg/L	**3.2**	**11**								**5.7**	**9**	**7.3**		**13.8**			**2.8**	
Barium		12	9		2.92	0.42	SW6010B TCLP	mg/L	**1.19**	**1.01**								**0.64**	**0.45**	**0.72**		**0.42**			0.02 U	
Cadmium		12	0				SW6010B TCLP	mg/L	0.01 U	0.01 U								0.01 U	0.01 U	0.01 U		0.01 U			0.01 U	
Chromium		12	0				SW6010B TCLP	mg/L	0.02 U	0.02 U								0.02 U	0.02 U	0.02 U		0.02 U			0.02 U	
Lead		12	0				SW6010B TCLP	mg/L	0.1 U	0.1 U								0.1 U	0.1 U	0.1 U		0.1 U			0.1 U	
Selenium		12	0				SW6010B TCLP	mg/L	0.2 U	0.2 U								0.2 U	0.2 U	0.2 U		0.2 U			0.2 U	
Silver		12	0				SW6010B TCLP	mg/L	0.02 U	0.02 U								0.02 U	0.02 U	0.02 U		0.02 U			0.02 U	
Mercury		12	12		0.0055	0.0003	SW7470A TCLP	mg/L	**0.0047**	**0.0033**								**0.0032**	**0.0055**	**0.0028**		**0.0031**			**0.005**	
Arsenic Speciation (mg/kg)																										
Arsenate		11	11		13100 J	113 J	EPA 1632	mg/kg	**12600 J**	**5550 J**								**9520 J**	**6860 J**	**7330 J**		**7050 J**			**13100 J**	
Arsenite		11	11		449.00 J	2.02 J	EPA 1632	mg/kg	**242 J**	**336 J**								**158 J**	**222 J**	**449 J**		**373 J**			**191 J**	
Inorganic Arsenic		11	11		13300	115 J	EPA 1632	mg/kg	**12800 J**	**5890 J**								**9680 J**	**7080 J**	**7780 J**		**7420 J**			**13300 J**	
Arsenic Bioavailability																										
Arsenic (IVBA)		5	5		30.5	2.29	M6020 ICP-MS	mg/L																		
Arsenic, total (3050)		5	5		8500	1480	M6020 ICP-MS	mg/kg																		
Arsenic IVBA% (In Vitro RBA)		5	5		47.3	2.7	Calculation (EPA 920	%																		
Total Solids		5	5		88.7	77.5	CLPSOW390, PART F, D	%																		
Mercury Selective Sequential Extraction																										
Hg(F0)		11	8		379	7.54	EPA 1631	ng/g	**11**	**34.1**								**174**	**253**	**128**					**7.54**	
Hg(F1)		11	11		17100	4.37	BRL SOP No. BR-0013	ng/g	**3610 J**	**9730 J**								**17100 J**	**15600 J**	**1980 J**					**1090 J**	
Hg(F2)		11	11		1830	1.59	BRL SOP No. BR-0013	ng/g	**17 J**	**124 J**								**1830 J**	**1280 J**	**34.4 J**					**406 J**	
Hg(F3)		11	11		33300	246	BRL SOP No. BR-0013	ng/g	**12900 J**	**9780 J**								**17100 J**	**14500 J**	**33300 J**					**980 J**	
Hg(F4)		11	11		55900	26.9	BRL SOP No. BR-0013	ng/g	**55900 J**	**39100 J**								**46100 J**	**42100 J**	**26900 J**					**27000 J**	
Hg(F5)		11	11		5060000	21.7	BRL SOP No. BR-0013	ng/g	**782000**	**425000**								**1390000**	**1560000**	**5060000**					**215000**	
Hg(F6)		10	10		106000	10.7	BRL SOP No. BR-0013	ng/g	**15400 J**	**13500 J**								**45400 J**	**30700 J**	**106000 J**					**7160 J**	
Semi-Volatile Organic Compounds																										
1-Methylnaphthalene		7	2		60	15	SW8270D	µg/kg				2.6 U	**60 J**	3.5 U											2.7 U	
2-Methylnaphthalene		7	3		140	29	SW8270D	µg/kg				3 U	**140**	**29**											3 U	
4-Bromophenyl Phenyl Ether		1	1		1.9	1.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
4-Methylphenol		1	1		4.9	4.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Acenaphthene		1	1		2.3	2.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		

Table 4-18 Post-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33
							Soil Type*		T/WR	T/WR	T/WR	N/DN	F	F	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	T/WR	B/WB	FT	N/DN
							Sample ID		10MP16SS	10MP17SS	10MP18SS	10MP19SS	10MP20SS	10MP21SS	10MP22SS	10MP23SS	10MP24SS	10MP25SS	10MP26SS	10MP27SS	10MP28SS	10MP29SS	10MP30SS	10MP31SS	10MP32SS	10MP33SS
Analyte							**Method**																			
Acenaphthylene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Anthracene		1	1		2	2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Benzoic Acid		1	1		120	120	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Benzyl Alcohol		1	1		12	12	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
bis(2-Ethylhexyl)phthalate		7	5		220	11	SW8270D	µg/kg				**11 J**	38 U	11 U											**13 J**	
Chrysene		1	1		2.6	2.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Chrysene		7	2		42	19	SW8270D	µg/kg				5.7 U	25 U	**42**											5.8 U	
Dibenzofuran		1	1		2.4	2.4	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Diethyl Phthalate		1	1		8	8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Diethylphthalate		7	1		140	140	SW8270D	µg/kg				3.7 U	**140**	4.9 U											3.7 U	
Dimethyl Phthalate		1	1		160	160	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Docosanoic acid		1	1		1300	1300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Fluorene		1	1		2.5	2.5	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Hexachlorobenzene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Naphthalene		7	1		14	14	SW8270D	µg/kg				2.7 U	12 U	3.6 U											2.7 U	
Pentachlorophenol		7	1		38	38	SW8270D	µg/kg				27 U	120 U	**38 J**											27 U	
Phenanthrene		1	1		4.2	4.2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Phenanthrene		7	2		38	18	SW8270D	µg/kg				3.5 U	16 U	**38**											3.6 U	
Phenol		1	1		4.6	4.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Pyrene		1	1		2.8	2.8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Sulfur		3	3		620	190	SW8270D	µg/kg																	**190 J**	
Unknown		1	1		5300	5300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Unknown		1	1		140	140	SW8270D	µg/kg																	**140 J**	
Unknown Alkane		1	1		4000	4000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Unknown Alkene		1	1		2000	2000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Unknown Aromatic		7	7		3100	90	SW8270D	µg/kg				**890 J**	**840 J**	**3100 J**											**90**	
Unknown Branched Alkane		1	1		1500	1500	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Unknown Hydrocarbon		7	7		980	96	SW8270D	µg/kg				**980 J**	**930 J**	**600 J**											**96 J**	
Unknown Organic Acid		5	5		380	87	SW8270D	µg/kg				**380 J**													**96 J**	
Unknown Sterol		1	1		3200	3200	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																		
Unknown Sterol		7	7		5000	78	SW8270D	µg/kg				**480 J**	**5000 J**	**700 J**											**78 J**	
Polychlorinated Biphenols																										
Aroclor 1016		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Aroclor 1221		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Aroclor 1232		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Aroclor 1242		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Aroclor 1248		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Aroclor 1254		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Aroclor 1260		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		
Diesel and Residual Range Organics (mg/kg)																										
C10 - C25 DRO		1	1		39	39	AK102 Alaska Diesel Range for Soil	mg/kg																		
Diesel Range Hydrocarbons		7	4		680	7.1	AK102/AK103 TPHD	mg/kg				**7.1 J**	**680 J**	**62 J**											0.88 U	
Motor Oil		7	7		7800	13	AK102/AK103 TPHD	mg/kg				**100**	**7800**	**680**											**13**	
C25 - C36 RRO		1	1		420	420	AK103 Alaska Residual Range for Soil	mg/kg																		

Table 4-18 Post-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP34	MP35	MP36	MP37	MP38	MP39	MP40	MP67	MP68	OP01	MP17	MP25	MP32	MP34	MP36	MP70	MP71	MP72
							Soil Type*		FT	T/WR	FT	N/DN or F	T/WR	T/WR	T/WR	T/WR	??????	Tailings	T/WR	T/WR	FT	FT	FT	N/DN (RDCA)	N/DN	F
							Sample ID		10MP34SS	10MP35SS	10MP36SS	10MP37SS	10MP38SS	10MP39SS	10MP40SS	10MP67SS	10MP68SS	10OP01SS	11MP17SS	11MP25SS	11MP32SS	11MP34SS	11MP36SS	11MP70SS	11MP71SS	11MP72SS
Analyte							Method																			
Total Inorganic Elements																										
Aluminum	19475	47	47	1	21700	2410	SW6010B	mg/kg	**2410**	**11900**	**3240**	**12100**	**10900**	**10800**	**11700**	**12400**	**9470**	**21700**						**9990 J**	**10800**	
Antimony	8	47	47	44	16700	0.708	SW6010B	mg/kg	**780**	**1680**	**690**	**20**	**760**	**1910**	**267**	**9830 J**	**351 J**	**3520 J**						**4.6**	**0.708 J**	
Arsenic	28.58	47	47	44	9880	10.8	SW6010B	mg/kg	**8510**	**2390**	**7050**	**60**	**992**	**1770**	**375**	**5240**	**959**	**5340**						**33.9 J**	**10.8 J**	
Barium	266.0	47	47	30	1710	76.2	SW6010B	mg/kg	**101**	**474**	**145**	**144**	**207**	**401**	**162**	**622**	**149**	**1710**						**144**	**99.1 J**	
Beryllium	0.5	47	46	38	1.3	0.3	SW6010B	mg/kg	**0.7**	**0.6**	**0.8**	**0.5**	**0.6**	**0.6**	**0.5**	**0.9**	**0.5**	**0.8**						**0.36**	**0.381**	
Cadmium	0.4	47	8	4	1.1	0.18	SW6010B	mg/kg	0.11 U	0.059 U	0.059 U	**0.7**	0.023 U	0.056 U	**0.2**	0.11 U	0.024 U	0.053 U						**0.18**	**0.385 J**	
Calcium	10100	47	47	0	8150	970	SW6010B	mg/kg	**1520**	**3640**	**3310**	**2050**	**2170**	**3570**	**1760**	**5970**	**2050**	**3240**						**2400 J**	**1140 J**	
Chromium	28.57	47	47	25	101	8	SW6010B	mg/kg	**10**	**37**	**18**	**24**	**22.9**	**34**	**25.4**	**36**	**20.8**	**101**						**18.7**	**20.3 J**	
Cobalt	11.28	47	47	44	35	5.9	SW6010B	mg/kg	**16**	**21.3**	**16.9**	**20.3**	**20.1**	**16.2**	**13.6**	**18**	**15.3**	**20.1**						**11.4**	**12.5**	
Copper	23.02	47	47	44	139	17	SW6010B	mg/kg	**73**	**46.2**	**64.2**	**35.4**	**44.4**	**40.5**	**38.2**	**79**	**30.1**	**45**						**17**	**32.6 J**	
Iron	30891	47	47	37	55600	16800	SW6010B	mg/kg	**43300**	**29900**	**49400**	**34400**	**27400**	**31600**	**26300**	**31500**	**21600**	**19500**						**30700**	**43000**	
Lead	10.00	47	43	32	220	6.96	SW6010B	mg/kg	**160**	**43**	**198**	**9**	**17**	**12**	**9**	**10**	**11**	**15**						**6.96**	**8.91**	
Magnesium	3870	47	47	26	8640	450	SW6010B	mg/kg	**680**	**4130**	**4080**	**3800**	**3630**	**3450**	**3380**	**6090**	**3790**	**2550**						**3220 J**	**3860 J**	
Manganese	465	47	47	42	1390	158	SW6010B	mg/kg	**814**	**764**	**1090**	**480**	**540**	**486**	**310**	**673**	**346**	**711**						**738**	**703**	
Mercury	1.86	47	47	43	1620	0.28	SW7471A	mg/kg	**79**	**183**	**75**	**3.6**	**154**	**42**	**15**	**730**	**109**	**170**						**0.807 J**	**0.428**	
Nickel	28.00	47	47	45	97	18	SW6010B	mg/kg	**52**	**61**	**54**	**44**	**49**	**49**	**39**	**60 J**	**38 J**	**66**						**29.3**	**39.9 J**	
Potassium	954.1	47	47	41	4720	670	SW6010B	mg/kg	**1180**	**2190**	**1490**	**1150**	**1440**	**2110**	**1280**	**3300**	**1130**	**4720**						**685**	**772**	
Selenium	NA	47	2	0	0.42	0.24	SW6010B	mg/kg	3.2 U	1.7 U	1.7 U	1.7 U	0.67 U	1.6 U	0.7 U	3.2 U	0.7 U	1.6 U						**0.42**	**0.24**	
Silver	NA	47	2	0	0.123	0.068	SW6010B	mg/kg	0.22 U	0.118 U	0.118 U	0.117 U	0.045 U	0.111 U	0.047 U	0.22 U	0.048 U	0.106 U						**0.068**	**0.123**	
Sodium	100	47	29	22	430	42.3	SW6010B	mg/kg	81.7 U	44.5 U	44.5 U	44.1 U	**80**	41.9 U	**70**	**320**	**90**	**430**						**42.3**	**43.2 J**	
Thallium	NA	47	2	0	0.071	0.065	SW6010B	mg/kg	1.4 U	0.7 U	0.7 U	0.7 U	0.28 U	0.7 U	0.3 U	1.4 U	0.3 U	0.7 U						**0.065**	**0.071**	
Vanadium	62.9	47	47	0	49.5	20	SW6010B	mg/kg	**20**	**35.6**	**25.3**	**41.1**	**35.6**	**34.1**	**39.3**	**32**	**30.9**	**37.5**						**30.9**	**35.4**	
Zinc	66.7	47	47	44	386	38	SW6010B	mg/kg	**109**	**90**	**110**	**88**	**90**	**84**	**94**	**100**	**77**	**103**						**64.9**	**85.5 J**	
SPLP Inorganic Elements µg/L																										
Aluminum		15	14		1.25	0.09	SW6010B SPLP	mg/L	**0.13 J**		**0.1 J**							**0.2**							**1.250 J**	
Antimony		15	14		31.3	0.07	SW6010B SPLP	mg/L	**0.48**		**0.51**							**1.95**							0.020 U	
Arsenic		15	13		6	0.44	SW6010B SPLP	mg/L	**0.7 J**		**0.57 J**							**4.43**							0.020 U	
Barium		15	11		0.032	0.004	SW6010B SPLP	mg/L	0.003 U		0.003 U							**0.032**							**0.0191 J**	
Beryllium		15	0				SW6010B SPLP	mg/L	0.001 U		0.001 U							0.001 U							0.0002 U	
Cadmium		15	0				SW6010B SPLP	mg/L	0.002 U		0.002 U							0.002 U							0.0008 U	
Calcium		15	15		2.64	0.19	SW6010B SPLP	mg/L	**0.51**		**1.2**							**1.78**							**0.344 J**	
Chromium		15	2		0.107	0.0035	SW6010B SPLP	mg/L	0.005 U		0.005 U							0.005 U							**0.0035 J**	
Cobalt		15	0				SW6010B SPLP	mg/L	0.003 U		0.003 U							0.003 U							0.002 U	
Copper		15	3		0.005	0.002	SW6010B SPLP	mg/L	0.002 U		0.002 U							0.002 U							0.005 U	
Iron		15	13		2.17	0.06	SW6010B SPLP	mg/L	**0.26 J**		**0.28 J**							**0.09**							**2.17**	
Lead		15	0				SW6010B SPLP	mg/L	0.02 U		0.02 U							0.02 U							0.008 U	
Magnesium		15	15		5.3	0.11	SW6010B SPLP	mg/L	**0.43**		**0.98**							**1.21**							**0.183 J**	
Manganese		15	15		0.051	0.003	SW6010B SPLP	mg/L	**0.007 J**		**0.007 J**							**0.007**							**0.051**	
Mercury		15	14		0.03	0.0001	SW7470A SPLP	mg/L	**0.0012 J**		**0.0014 J**							**0.0048 J**							0.0004 U	
Nickel		15	2		0.11	0.0029	SW6010B SPLP	mg/L	0.01 U		0.01 U							0.01 U							**0.0029 J**	
Potassium		15	13		2.4	0.352	SW6010B SPLP	mg/L	0.5 U		0.5 U							**0.7**							**0.352 J**	
Selenium		15	0				SW6010B SPLP	mg/L	0.05 U		0.05 U							0.05 U							0.03 U	
Silver		15	0				SW6010B SPLP	mg/L	0.003 U		0.003 U							0.003 U							0.005 U	
Sodium		15	7		7.02	0.5	SW6010B SPLP	mg/L	0.5 U		0.5 U							0.5 U							**7.02 J**	
Thallium		15	0				SW6010B SPLP	mg/L	0.05 U		0.05 U							0.05 U							0.030 U	
Vanadium		15	9		0.013	0.003	SW6010B SPLP	mg/L	0.003 U		0.003 U							**0.013**							**0.0068 J**	
Zinc		15	2		0.1	0.0173	SW6010B SPLP	mg/L	0.01 U		0.01 U							0.01 U							**0.0173 J**	
TCLP Inorganic Elements (mg/L)																										
Arsenic		12	12		29.1	0.7	SW6010B TCLP	mg/L	**0.9**		**0.7**							**29.1**								
Barium		12	9		2.92	0.42	SW6010B TCLP	mg/L	0.02 U		0.02 U							**2.92**								
Cadmium		12	0				SW6010B TCLP	mg/L	0.01 U		0.01 U							0.01 U								
Chromium		12	0				SW6010B TCLP	mg/L	0.02 U		0.02 U							0.02 U								
Lead		12	0				SW6010B TCLP	mg/L	0.1 U		0.1 U							0.1 U								
Selenium		12	0				SW6010B TCLP	mg/L	0.2 U		0.2 U							0.2 U								
Silver		12	0				SW6010B TCLP	mg/L	0.02 U		0.02 U							0.02 U								
Mercury		12	12		0.0055	0.0003	SW7470A TCLP	mg/L	**0.0013**		**0.0017**							**0.0003**								
Arsenic Speciation (mg/kg)																										
Arsenate		11	11		13100 J	113 J	EPA 1632	mg/kg	**12000 J**		**8020 J**							**6610 J**								
Arsenite		11	11		449.00 J	2.02 J	EPA 1632	mg/kg	**27.5 J**		**59.5 J**							**144 J**								
Inorganic Arsenic		11	11		13300	115 J	EPA 1632	mg/kg	**12000 J**		**8080 J**							**6750 J**								
Arsenic Bioavailability																										
Arsenic (IVBA)		5	5		30.5	2.29	M6020 ICP-MS	mg/L											**6.06 J**	**30.5 J**	**12.9 J**	**2.29 J**	**7.32 J**			
Arsenic, total (3050)		5	5		8500	1480	M6020 ICP-MS	mg/kg											**1480**	**6450**	**8500**	**8270**	**3680**			
Arsenic IVBA% (In Vitro RBA)		5	5		47.3	2.7	Calculation (EPA 920	%											**40.9 J**	**47.3 J**	**15.2 J**	**2.7 J**	**19.9 J**			
Total Solids		5	5		88.7	77.5	CLPSOW390, PART F, D	%											**82.6**	**88.7**	**77.5**	**85.1**	**78.6**			
Mercury Selective Sequential Extraction																										
Hg(F0)		11	8		379	7.54	EPA 1631	ng/g	2.98 U		3.07 U					**137**									**379 J**	
Hg(F1)		11	11		17100	4.37	BRL SOP No. BR-0013	ng/g	**560 J**		**442 J**					**15000 J**									**5.48 J**	
Hg(F2)		11	11		1830	1.59	BRL SOP No. BR-0013	ng/g	**318 J**		**51.3 J**					**193 J**									**1.59 J**	
Hg(F3)		11	11		33300	246	BRL SOP No. BR-0013	ng/g	**1380 J**		**727 J**					**10600 J**									**246 J**	
Hg(F4)		11	11		55900	26.9	BRL SOP No. BR-0013	ng/g	**23800 J**		**14900 J**					**52400 J**									**31.7 J**	
Hg(F5)		11	11		5060000	21.7	BRL SOP No. BR-0013	ng/g	**195000**		**218000**					**941000**									**162 J**	
Hg(F6)		10	10		106000	10.7	BRL SOP No. BR-0013	ng/g	**7230 J**		**7600 J**					**35700 J**										
Semi-Volatile Organic Compounds																										
1-Methylnaphthalene		7	2		60	15	SW8270D	µg/kg	2.6 U		2.6 U															
2-Methylnaphthalene		7	3		140	29	SW8270D	µg/kg	2.9 U		3 U															
4-Bromophenyl Phenyl Ether		1	1		1.9	1.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**1.9 J**		
4-Methylphenol		1	1		4.9	4.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**4.9 J**		
Acenaphthene		1	1		2.3	2.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2.3 J**		

Table 4-18 Post-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP34	MP35	MP36	MP37	MP38	MP39	MP40	MP67	MP68	OP01	MP17	MP25	MP32	MP34	MP36	MP70	MP71	MP72
							Soil Type*		FT	T/WR	FT	N/DN or F	T/WR	T/WR	T/WR	T/WR	??????	Tailings	T/WR	T/WR	FT	FT	FT	N/DN (RDCA)	N/DN	F
							Sample ID		10MP34SS	10MP35SS	10MP36SS	10MP37SS	10MP38SS	10MP39SS	10MP40SS	10MP67SS	10MP68SS	10OP01SS	11MP17SS	11MP25SS	11MP32SS	11MP34SS	11MP36SS	11MP70SS	11MP71SS	11MP72SS
Analyte							Method																			
Acenaphthylene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**1.3 J**		
Anthracene		1	1		2	2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2 J**		
Benzoic Acid		1	1		120	120	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**120 J**		
Benzyl Alcohol		1	1		12	12	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**12 J**		
bis(2-Ethylhexyl)phthalate		7	5		220	11	SW8270D	µg/kg	**15 J**		**220**															
Chrysene		1	1		2.6	2.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2.6 J**		
Chrysene		7	2		42	19	SW8270D	µg/kg	5.6 U		5.8 U															
Dibenzofuran		1	1		2.4	2.4	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2.4 J**		
Diethyl Phthalate		1	1		8	8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**8**		
Diethylphthalate		7	1		140	140	SW8270D	µg/kg	3.6 U		3.7 U															
Dimethyl Phthalate		1	1		160	160	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**160**		
Docosanoic acid		1	1		1300	1300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**1300 J**		
Fluorene		1	1		2.5	2.5	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2.5 J**		
Hexachlorobenzene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**1.3 J**		
Naphthalene		7	1		14	14	SW8270D	µg/kg	2.6 U		2.7 U															
Pentachlorophenol		7	1		38	38	SW8270D	µg/kg	26 U		27 U															
Phenanthrene		1	1		4.2	4.2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**4.2 J**		
Phenanthrene		7	2		38	18	SW8270D	µg/kg	3.5 U		3.6 U															
Phenol		1	1		4.6	4.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**4.6 J**		
Pyrene		1	1		2.8	2.8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2.8 J**		
Sulfur		3	3		620	190	SW8270D	µg/kg	**620 J**		**200 J**															
Unknown		1	1		5300	5300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**5300 J**		
Unknown		1	1		140	140	SW8270D	µg/kg																		
Unknown Alkane		1	1		4000	4000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**4000 J**		
Unknown Alkene		1	1		2000	2000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**2000 J**		
Unknown Aromatic		7	7		3100	90	SW8270D	µg/kg	**990**		**480**															
Unknown Branched Alkane		1	1		1500	1500	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**1500 J**		
Unknown Hydrocarbon		7	7		980	96	SW8270D	µg/kg	**150 J**		**820 J**															
Unknown Organic Acid		5	5		380	87	SW8270D	µg/kg	**87 J**		**160 J**															
Unknown Sterol		1	1		3200	3200	SW8270C Low Level Semivolatile Organics using LVI	µg/kg																**3200 J**		
Unknown Sterol		7	7		5000	78	SW8270D	µg/kg	**130 J**		**480 J**															
Polychlorinated Biphenols																										
Aroclor 1016		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Aroclor 1221		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Aroclor 1232		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Aroclor 1242		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Aroclor 1248		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Aroclor 1254		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Aroclor 1260		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg																		0.019 U
Diesel and Residual Range Organics (mg/kg)																										
C10 - C25 DRO		1	1		39	39	AK102 Alaska Diesel Range for Soil	mg/kg																**39**		
Diesel Range Hydrocarbons		7	4		680	7.1	AK102/AK103 TPHD	mg/kg	0.83 U		0.88 U															
Motor Oil		7	7		7800	13	AK102/AK103 TPHD	mg/kg	**24**		**32**															
C25 - C36 RRO		1	1		420	420	AK103 Alaska Residual Range for Soil	mg/kg																**420**		

Table 4-18 Post-1955 Main Processing Area Surface Soil Results Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP73	MP74	MP75	MP76	MP77	MP78	MP79
							Soil Type*		F	F	F	T/WR	T/WR	T/WR	T/WR
							Sample ID		11MP73SS	11MP74SS	11MP75SS	11MP76SS	11MP77SS	11MP78SS	11MP79SS
							Method								
Total Inorganic Elements															
Aluminum	19475	47	47	1	21700	2410	SW6010B	mg/kg							
Antimony	8	47	47	44	16700	0.708	SW6010B	mg/kg							
Arsenic	28.58	47	47	44	9880	10.8	SW6010B	mg/kg							
Barium	266.0	47	47	30	1710	76.2	SW6010B	mg/kg							
Beryllium	0.5	47	46	38	1.3	0.3	SW6010B	mg/kg							
Cadmium	0.4	47	8	4	1.1	0.18	SW6010B	mg/kg							
Calcium	10100	47	47	0	8150	970	SW6010B	mg/kg							
Chromium	28.57	47	47	25	101	8	SW6010B	mg/kg							
Cobalt	11.28	47	47	44	35	5.9	SW6010B	mg/kg							
Copper	23.02	47	47	44	139	17	SW6010B	mg/kg							
Iron	30891	47	47	37	55600	16800	SW6010B	mg/kg							
Lead	10.00	47	43	32	220	6.96	SW6010B	mg/kg							
Magnesium	3870	47	47	26	8640	450	SW6010B	mg/kg							
Manganese	465	47	47	42	1390	158	SW6010B	mg/kg							
Mercury	1.86	47	47	43	1620	0.28	SW7471A	mg/kg							
Nickel	28.00	47	47	45	97	18	SW6010B	mg/kg							
Potassium	954.1	47	47	41	4720	670	SW6010B	mg/kg							
Selenium	NA	47	2	0	0.42	0.24	SW6010B	mg/kg							
Silver	NA	47	2	0	0.123	0.068	SW6010B	mg/kg							
Sodium	100	47	29	22	430	42.3	SW6010B	mg/kg							
Thallium	NA	47	2	0	0.071	0.065	SW6010B	mg/kg							
Vanadium	62.9	47	47	0	49.5	20	SW6010B	mg/kg							
Zinc	66.7	47	47	44	386	38	SW6010B	mg/kg							
SPLP Inorganic Elements µg/L															
Aluminum		15	14		1.25	0.09	SW6010B SPLP	mg/L							
Antimony		15	14		31.3	0.07	SW6010B SPLP	mg/L							
Arsenic		15	13		6	0.44	SW6010B SPLP	mg/L							
Barium		15	11		0.032	0.004	SW6010B SPLP	mg/L							
Beryllium		15	0				SW6010B SPLP	mg/L							
Cadmium		15	0				SW6010B SPLP	mg/L							
Calcium		15	15		2.64	0.19	SW6010B SPLP	mg/L							
Chromium		15	2		0.107	0.0035	SW6010B SPLP	mg/L							
Cobalt		15	0				SW6010B SPLP	mg/L							
Copper		15	3		0.005	0.002	SW6010B SPLP	mg/L							
Iron		15	13		2.17	0.06	SW6010B SPLP	mg/L							
Lead		15	0				SW6010B SPLP	mg/L							
Magnesium		15	15		5.3	0.11	SW6010B SPLP	mg/L							
Manganese		15	15		0.051	0.003	SW6010B SPLP	mg/L							
Mercury		15	14		0.03	0.0001	SW7470A SPLP	mg/L							
Nickel		15	2		0.11	0.0029	SW6010B SPLP	mg/L							
Potassium		15	13		2.4	0.352	SW6010B SPLP	mg/L							
Selenium		15	0				SW6010B SPLP	mg/L							
Silver		15	0				SW6010B SPLP	mg/L							
Sodium		15	7		7.02	0.5	SW6010B SPLP	mg/L							
Thallium		15	0				SW6010B SPLP	mg/L							
Vanadium		15	9		0.013	0.003	SW6010B SPLP	mg/L							
Zinc		15	2		0.1	0.0173	SW6010B SPLP	mg/L							
TCLP Inorganic Elements (mg/L)															
Arsenic		12	12		29.1	0.7	SW6010B TCLP	mg/L							
Barium		12	9		2.92	0.42	SW6010B TCLP	mg/L							
Cadmium		12	0				SW6010B TCLP	mg/L							
Chromium		12	0				SW6010B TCLP	mg/L							
Lead		12	0				SW6010B TCLP	mg/L							
Selenium		12	0				SW6010B TCLP	mg/L							
Silver		12	0				SW6010B TCLP	mg/L							
Mercury		12	12		0.0055	0.0003	SW7470A TCLP	mg/L							
Arsenic Speciation (mg/kg)															
Arsenate		11	11		13100 J	113 J	EPA 1632	mg/kg							
Arsenite		11	11		449.00 J	2.02 J	EPA 1632	mg/kg							
Inorganic Arsenic		11	11		13300	115 J	EPA 1632	mg/kg							
Arsenic Bioavailability															
Arsenic (IVBA)		5	5		30.5	2.29	M6020 ICP-MS	mg/L							
Arsenic, total (3050)		5	5		8500	1480	M6020 ICP-MS	mg/kg							
Arsenic IVBA% (In Vitro RBA)		5	5		47.3	2.7	Calculation (EPA 920	%							
Total Solids		5	5		88.7	77.5	CLPSOW390, PART F, D	%							
Mercury Selective Sequential Extraction															
Hg(F0)		11	8		379	7.54	EPA 1631	ng/g							
Hg(F1)		11	11		17100	4.37	BRL SOP No. BR-0013	ng/g							
Hg(F2)		11	11		1830	1.59	BRL SOP No. BR-0013	ng/g							
Hg(F3)		11	11		33300	246	BRL SOP No. BR-0013	ng/g							
Hg(F4)		11	11		55900	26.9	BRL SOP No. BR-0013	ng/g							
Hg(F5)		11	11		5060000	21.7	BRL SOP No. BR-0013	ng/g							
Hg(F6)		10	10		106000	10.7	BRL SOP No. BR-0013	ng/g							
Semi-Volatile Organic Compounds															
1-Methylnaphthalene		7	2		60	15	SW8270D	µg/kg							
2-Methylnaphthalene		7	3		140	29	SW8270D	µg/kg							
4-Bromophenyl Phenyl Ether		1	1		1.9	1.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
4-Methylphenol		1	1		4.9	4.9	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Acenaphthene		1	1		2.3	2.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							

Table 4-18 Post-1955 Main Processing Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP73	MP74	MP75	MP76	MP77	MP78	MP79
							Soil Type*		F	F	F	T/WR	T/WR	T/WR	T/WR
							Sample ID		11MP73SS	11MP74SS	11MP75SS	11MP76SS	11MP77SS	11MP78SS	11MP79SS
Analyte							Method								
Acenaphthylene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Anthracene		1	1		2	2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Benzoic Acid		1	1		120	120	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Benzyl Alcohol		1	1		12	12	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
bis(2-Ethylhexyl)phthalate		7	5		220	11	SW8270D	µg/kg							
Chrysene		1	1		2.6	2.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Chrysene		7	2		42	19	SW8270D	µg/kg							
Dibenzofuran		1	1		2.4	2.4	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Diethyl Phthalate		1	1		8	8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Diethylphthalate		7	1		140	140	SW8270D	µg/kg							
Dimethyl Phthalate		1	1		160	160	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Docosanoic acid		1	1		1300	1300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Fluorene		1	1		2.5	2.5	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Hexachlorobenzene		1	1		1.3	1.3	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Naphthalene		7	1		14	14	SW8270D	µg/kg							
Pentachlorophenol		7	1		38	38	SW8270D	µg/kg							
Phenanthrene		1	1		4.2	4.2	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Phenanthrene		7	2		38	18	SW8270D	µg/kg							
Phenol		1	1		4.6	4.6	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Pyrene		1	1		2.8	2.8	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Sulfur		3	3		620	190	SW8270D	µg/kg							
Unknown		1	1		5300	5300	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Unknown		1	1		140	140	SW8270D	µg/kg							
Unknown Alkane		1	1		4000	4000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Unknown Alkene		1	1		2000	2000	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Unknown Aromatic		7	7		3100	90	SW8270D	µg/kg							
Unknown Branched Alkane		1	1		1500	1500	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Unknown Hydrocarbon		7	7		980	96	SW8270D	µg/kg							
Unknown Organic Acid		5	5		380	87	SW8270D	µg/kg							
Unknown Sterol		1	1		3200	3200	SW8270C Low Level Semivolatile Organics using LVI	µg/kg							
Unknown Sterol		7	7		5000	78	SW8270D	µg/kg							
Polychlorinated Biphenols															
Aroclor 1016		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1221		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1232		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1242		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1248		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1254		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Aroclor 1260		8	0				SW8082 Reg level 3541 PCB Aroclors in Soil update IV	mg/kg	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
Diesel and Residual Range Organics (mg/kg)															
C10 - C25 DRO		1	1		39	39	AK102 Alaska Diesel Range for Soil	mg/kg							
Diesel Range Hydrocarbons		7	4		680	7.1	AK102/AK103 TPHD	mg/kg							
Motor Oil		7	7		7800	13	AK102/AK103 TPHD	mg/kg							
C25 - C36 RRO		1	1		420	420	AK103 Alaska Residual Range for Soil	mg/kg							

* Soil types defined in Appendix B.

Key

Bold = detection

% = percent

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

BRL SOP = Brooks Rand Labs Standard Operating Procedure

DRO = diesel range organics

EPA = United States Environmental Protection Agency

Gray shading = exceedance of background

ICP-MS = Inductively Coupled Plasma-Mass Spectrometry

ID = identifier

IVBA = In-vitro bioaccessibility

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

ng/g = nanograms per gram

PCB = polychlorinated biphenyl

RBA = relative bioavailability

RRO = residual range organics

SPLP = synthetic precipitation leaching procedure

TCLP = toxicity characteristic leaching procedure

TPHD = total petroleum hydrocarbons as diesel

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-19 Red Devil Creek Downstream Alluvial Area Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD01	RD02	RD03	RD04	RD05	RD06	RD07	RD20
							Soil Type*		N/DN	T/WR	T/WR	T/WR	N/DN	F	F	T/WR
							Sample ID		10RD01SS	10RD02SS	10RD03SS	10RD04SS	10RD05SS	10RD06SS	10RD07SS	10RD20SS
Analyte							Method									
Total Inorganic Elements																
Aluminum	19475	8	8	0	16100	9070	SW6010B	mg/kg	**16100**	**10200**	**11700**	**11800**	**11500**	**9070**	**10800**	**9440**
Antimony	8	8	7	7	974	30	SW6010B	mg/kg	0.61 U	**530 J**	**479 J**	**381 J**	**39 J**	**677 J**	**30 J**	**974 J**
Arsenic	28.58	8	8	8	1310	39	SW6010B	mg/kg	**39**	**1280**	**950**	**1210**	**67**	**1250**	**76**	**1310**
Barium	266.0	8	8	1	287	120	SW6010B	mg/kg	**204**	**287**	**265**	**248**	**165**	**215**	**120**	**218**
Beryllium	0.5	8	8	4	0.7	0.4	SW6010B	mg/kg	**0.5**	**0.6**	**0.6**	**0.6**	**0.4**	**0.5**	**0.5**	**0.7**
Cadmium	0.4	8	4	1	0.6	0.3	SW6010B	mg/kg	**0.6**	0.056 U	**0.3**	0.026 U	**0.4**	0.026 U	**0.3**	0.022 U
Calcium	10100	8	8	1	10400	1930	SW6010B	mg/kg	**6450 J**	**4540 J**	**10400 J**	**3300 J**	**3560 J**	**2300 J**	**1930 J**	**2610**
Chromium	28.57	8	8	2	31.1	21.5	SW6010B	mg/kg	**31.1**	**26**	**26**	**29.6**	**22.8**	**25.7**	**21.5**	**24**
Cobalt	11.28	8	8	5	15.5	9.6	SW6010B	mg/kg	**11.2**	**14.5**	**10.5**	**15.5**	**9.6**	**11.9**	**12.2**	**12.4**
Copper	23.02	8	8	7	81.8	22.2	SW6010B	mg/kg	**28.2**	**40.3**	**29.5**	**38.1**	**22.2**	**35.7**	**32.3**	**81.8**
Iron	30891	8	8	0	30600	18400	SW6010B	mg/kg	**29800**	**30600**	**27700**	**28600**	**18400**	**23300**	**21100**	**27100**
Lead	10.00	8	8	3	11	7	SW6010B	mg/kg	**8 J**	**11 J**	**7 J**	**10 J**	**7 J**	**11 J**	**8 J**	**11**
Magnesium	3870	8	8	5	7040	2720	SW6010B	mg/kg	**5850**	**5240**	**7040**	**4760**	**3560**	**3320**	**2720**	**4470**
Manganese	465	8	8	4	635	221	SW6010B	mg/kg	**635**	**622**	**542**	**545**	**221**	**356**	**312**	**434**
Mercury	1.86	8	8	7	186	1.74	SW7471A	mg/kg	**1.74**	**43**	**28**	**99**	**3.8**	**186**	**16**	**75**
Nickel	28.00	8	8	7	46	25	SW6010B	mg/kg	**33**	**43**	**35**	**46**	**25**	**35**	**32**	**38**
Potassium	954.1	8	8	6	1870	900	SW6010B	mg/kg	**1560**	**1710**	**1870**	**1710**	**900**	**1350**	**950**	**1560**
Selenium	NA	8	0	0			SW6010B	mg/kg	0.88 U	1.6 U	0.71 U	0.77 U	0.8 U	0.76 U	0.7 U	0.63 U
Silver	NA	8	0	0			SW6010B	mg/kg	0.059 U	0.112 U	0.048 U	0.052 U	0.055 U	0.051 U	0.048 U	0.043 U
Sodium	100	8	8	5	250	70	SW6010B	mg/kg	**250**	**170**	**220**	**140**	**90**	**80**	**70**	**120**
Thallium	NA	8	0	0			SW6010B	mg/kg	0.37 U	0.7 U	0.3 U	0.32 U	0.34 U	0.32 U	0.3 U	0.27 U
Vanadium	62.9	8	8	0	42.4	28.8	SW6010B	mg/kg	**42.4**	**30.3**	**30.7**	**34.9**	**35.7**	**29.7**	**37.8**	**28.8**
Zinc	66.7	8	8	8	110	69	SW6010B	mg/kg	**93 J**	**93 J**	**83 J**	**110 J**	**76 J**	**76 J**	**69 J**	**80**
SPLP Inorganic Elements (µg/L)																
Aluminum		2	2		1.93	1.86	SW6010B SPLP	mg/L				**1.86**		**1.93**		
Antimony		2	2		1.29	0.62	SW6010B SPLP	mg/L				**0.62**		**1.29**		
Arsenic		2	2		0.66	0.54	SW6010B SPLP	mg/L				**0.54**		**0.66**		
Barium		2	2		0.071	0.068	SW6010B SPLP	mg/L				**0.068**		**0.071**		
Beryllium		2	0				SW6010B SPLP	mg/L				0.001 U		0.001 U		
Cadmium		2	0				SW6010B SPLP	mg/L				0.002 U		0.002 U		
Calcium		2	2		1.26	1.01	SW6010B SPLP	mg/L				**1.26**		**1.01**		
Chromium		2	1		0.005	0.005	SW6010B SPLP	mg/L				**0.005**		0.005 U		
Cobalt		2	0				SW6010B SPLP	mg/L				0.003 U		0.003 U		
Copper		2	2		0.008	0.007	SW6010B SPLP	mg/L				**0.007**		**0.008**		
Iron		2	2		2.01	1.78	SW6010B SPLP	mg/L				**2.01**		**1.78**		
Lead		2	0				SW6010B SPLP	mg/L				0.02 U		0.02 U		
Magnesium		2	2		0.61	0.61	SW6010B SPLP	mg/L				**0.61**		**0.61**		
Manganese		2	2		0.041	0.025	SW6010B SPLP	mg/L				**0.041**		**0.025**		
Mercury		2	2		0.04	0.037	SW7470A SPLP	mg/L				**0.037**		**0.04**		
Nickel		2	0				SW6010B SPLP	mg/L				0.01 U		0.01 U		
Potassium		2	2		0.6	0.5	SW6010B SPLP	mg/L				**0.6**		**0.5**		
Selenium		2	0				SW6010B SPLP	mg/L				0.05 U		0.05 U		
Silver		2	0				SW6010B SPLP	mg/L				0.003 U		0.003 U		
Sodium		2	2		8.2	6.5	SW6010B SPLP	mg/L				**6.5**		**8.2**		
Thallium		2	0				SW6010B SPLP	mg/L				0.05 U		0.05 U		
Vanadium		2	2		0.006	0.006	SW6010B SPLP	mg/L				**0.006**		**0.006**		
Zinc		2	0				SW6010B SPLP	mg/L				0.01 U		0.01 U		
Arsenic Speciation (mg/kg)																
Arsenate		2	2		1380	1160	EPA 1632	mg/kg				**1160 J**		**1380 J**		
Arsenite		2	2		33.7	27.8	EPA 1632	mg/kg				**27.8 J**		**33.7 J**		
Inorganic Arsenic		2	2		1410	1190	EPA 1632	mg/kg				**1190 J**		**1410 J**		
Mercury Selective Sequential Extraction																
Hg(F0)		2	1		12.5	12.5	EPA 1631	ng/g				**12.5**		3.82 U		
Hg(F1)		2	2		1910	1550	BRL SOP No. BR-0013	ng/g				**1910**		**1550**		
Hg(F2)		2	2		206	63	BRL SOP No. BR-0013	ng/g				**206**		**63**		
Hg(F3)		2	2		5260	4510	BRL SOP No. BR-0013	ng/g				**5260 J**		**4510 J**		
Hg(F4)		2	2		64500	23900	BRL SOP No. BR-0013	ng/g				**23900**		**64500**		
Hg(F5)		2	2		597000	158000	BRL SOP No. BR-0013	ng/g				**158000**		**597000**		
Hg(F6)		2	2		28800	7040	BRL SOP No. BR-0013	ng/g				**7040 J**		**28800 J**		

* Soil types defined in Appendix B.

Key

Bold = detection

% = percent

Gray shading = exceedance of background

BRL SOP = Brooks Rand Labs Standard Operating Procedure

EPA = United States Environmental Protection Agency

Hg = mercury

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

NA = not available/not analyzed

ng/g = nanograms per gram

SPLP = synthetic precipitation leaching procedure

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

µg/L = micrograms per liter

Table 4-20 Red Devil Creek Upstream Alluvial Area Surface Soil Results

Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD08	RD09	RD30
							Soil Type*		N/DN	N/DN	N/DN
							Sample ID		10RD08SS	10RD09SS	11RD30SS
							Method				
Total Inorganic Elements											
Aluminum	19475	2	2	0	17300	13800	SW6010B	mg/kg	**13800**	**17300**	
Antimony	8	2	0	0			SW6010B	mg/kg	1.2 U	1.4 UJ	
Arsenic	28.58	2	2	1	30	20	SW6010B	mg/kg	**30**	**20**	
Barium	266.0	2	2	0	162	157	SW6010B	mg/kg	**157**	**162**	
Beryllium	0.5	2	2	0	0.5	0.5	SW6010B	mg/kg	**0.5**	**0.5**	
Cadmium	0.4	2	1	1	0.6	0.6	SW6010B	mg/kg	**0.6**	0.07 U	
Calcium	10100	2	2	0	3240	1230	SW6010B	mg/kg	**1230 J**	**3240**	
Chromium	28.57	2	2	0	28	25	SW6010B	mg/kg	**25**	**28**	
Cobalt	11.28	2	2	2	16	15.6	SW6010B	mg/kg	**15.6**	**16**	
Copper	23.02	2	2	2	35.5	23.4	SW6010B	mg/kg	**35.5**	**23.4**	
Iron	30891	2	2	2	37300	31700	SW6010B	mg/kg	**31700**	**37300**	
Lead	10.00	2	2	1	11	9	SW6010B	mg/kg	**11 J**	**9**	
Magnesium	3870	2	2	1	4660	3380	SW6010B	mg/kg	**3380**	**4660**	
Manganese	465	2	2	2	936	595	SW6010B	mg/kg	**595**	**936**	
Mercury	1.86	2	2	1	2	0.9	SW7471A	mg/kg	**0.9**	**2**	
Nickel	28.00	2	2	2	44	33	SW6010B	mg/kg	**44**	**33 J**	
Potassium	954.1	2	2	0	940	890	SW6010B	mg/kg	**940**	**890**	
Selenium	NA	2	0	0			SW6010B	mg/kg	1.7 U	2.1 U	
Silver	NA	2	0	0			SW6010B	mg/kg	0.115 U	0.14 U	
Sodium	100	2	0	0			SW6010B	mg/kg	43.4 U	52.9 U	
Thallium	NA	2	0	0			SW6010B	mg/kg	0.7 U	0.9 U	
Vanadium	62.9	2	2	0	48	42.5	SW6010B	mg/kg	**42.5**	**48**	
Zinc	66.7	2	2	2	89	73	SW6010B	mg/kg	**89 J**	**73**	
SPLP Inorganic Elements (µg/L)											
Aluminum		1	1		1.19	1.19	SW6010B SPLP	mg/L		**1.19 J**	
Antimony		1	0				SW6010B SPLP	mg/L		0.05 U	
Arsenic		1	1		0.05	0.05	SW6010B SPLP	mg/L		**0.05 J**	
Barium		1	1		0.056	0.056	SW6010B SPLP	mg/L		**0.056 J**	
Beryllium		1	0				SW6010B SPLP	mg/L		0.001 U	
Cadmium		1	0				SW6010B SPLP	mg/L		0.002 U	
Calcium		1	1		1.49	1.49	SW6010B SPLP	mg/L		**1.49**	
Chromium		1	0				SW6010B SPLP	mg/L		0.005 U	
Cobalt		1	0				SW6010B SPLP	mg/L		0.003 U	
Copper		1	1		0.003	0.003	SW6010B SPLP	mg/L		**0.003**	
Iron		1	1		2.64	2.64	SW6010B SPLP	mg/L		**2.64 J**	
Lead		1	0				SW6010B SPLP	mg/L		0.02 U	
Magnesium		1	1		0.75	0.75	SW6010B SPLP	mg/L		**0.75**	
Manganese		1	1		0.046	0.046	SW6010B SPLP	mg/L		**0.046 J**	
Mercury		1	0				SW7470A SPLP	mg/L		0.0001 UJ	
Nickel		1	0				SW6010B SPLP	mg/L		0.01 U	
Potassium		1	0				SW6010B SPLP	mg/L		0.5 U	
Selenium		1	0				SW6010B SPLP	mg/L		0.05 U	
Silver		1	0				SW6010B SPLP	mg/L		0.003 U	
Sodium		1	0				SW6010B SPLP	mg/L		0.5 UJ	
Thallium		1	0				SW6010B SPLP	mg/L		0.05 U	
Vanadium		1	1		0.004	0.004	SW6010B SPLP	mg/L		**0.004**	
Zinc		1	0				SW6010B SPLP	mg/L		0.01 U	
Arsenic Speciation (mg/kg)											
Arsenate		1	1		195	195	EPA 1632	mg/kg		**195 J**	
Arsenite		1	1		2.36	2.36	EPA 1632	mg/kg		**2.36 J**	
Inorganic Arsenic		1	1		197	197	EPA 1632	mg/kg		**197 J**	
Arsenic Bioavailability											
Arsenic (IVBA)		1	1		0.0835	0.0835	M6020 ICP-MS	mg/L			**0.0835**
Arsenic, total (3050)		1	1		23.1	23.1	M6020 ICP-MS	mg/kg			**23.1**
Arsenic IVBA% (In Vitro RBA)		1	1		36.1	36.1	Calculation (EPA 920)	%			**36.1 J**
Total Solids		1	1		45.3	45.3	CLPSOW390, PART F, D	%			**45.3**
Mercury Selective Sequential Extraction											
Hg(F0)		1	0				EPA 1631	ng/g		3.29 U	
Hg(F1)		1	1		38.3	38.3	BRL SOP No. BR-0013	ng/g		**38.3**	
Hg(F2)		1	1		4.9	4.9	BRL SOP No. BR-0013	ng/g		**4.9**	
Hg(F3)		1	1		2550	2550	BRL SOP No. BR-0013	ng/g		**2550 J**	
Hg(F4)		1	1		360	360	BRL SOP No. BR-0013	ng/g		**360**	
Hg(F5)		1	1		999	999	BRL SOP No. BR-0013	ng/g		**999**	
Hg(F6)		1	0				BRL SOP No. BR-0013	ng/g		2.2 U	

* Soil types defined in Appendix B.

Key

Bold = detection
% = percent
µg/L = micrograms per liter
Gray shading = exceedance of background
BRL SOP = Brooks Rand Labs Standard Operating Procedure
EPA = United States Environmental Protection Agency
Hg = mercury
ICP-MS = inductively coupled plasma - mass spectrometry
ID = identifier

IVBA = In-vitro bioavailability
J = The analyte was detected. The associated result is estimated.
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
N A = not available/not analyzed
ng/g = nanograms per gram
RBA = relative bioavailability
SPLP = synthetic precipitation leaching procedure
U = The analyte was analyzed for but not detected. The value provided is the reporting limit.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-21 Dolly Sluice and Delta Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	DS01	DS02	DS03
							Soil Type*		SO	SO	N/DN
							Sample ID		10DS01SS	10DS02SS	10DS03SS
Analyte							Method				
Total Inorganic Elements											
Aluminum	19475	3	3	0	8200	4770	SW6010B	mg/kg	**4770**	**7770**	**8200**
Antimony	8	3	3	3	40	21	SW6010B	mg/kg	**40 J**	**40 J**	**21 J**
Arsenic	28.58	3	3	3	1010	355	SW6010B	mg/kg	**1010**	**550**	**355**
Barium	266.0	3	3	0	174	166	SW6010B	mg/kg	**171**	**174**	**166**
Beryllium	0.5	3	3	3	0.8	0.6	SW6010B	mg/kg	**0.8**	**0.6**	**0.6**
Cadmium	0.4	3	1	1	0.5	0.5	SW6010B	mg/kg	0.055 U	0.058 U	**0.5**
Calcium	10100	3	3	0	2530	1080	SW6010B	mg/kg	**1080**	**2530**	**1760**
Chromium	28.57	3	3	0	21	18.9	SW6010B	mg/kg	**20**	**21**	**18.9**
Cobalt	11.28	3	3	3	17.5	12.6	SW6010B	mg/kg	**17**	**12.6**	**17.5**
Copper	23.02	3	3	3	57.4	37.5	SW6010B	mg/kg	**57.4**	**37.5**	**49.3**
Iron	30891	3	3	2	46400	28800	SW6010B	mg/kg	**46400**	**32100**	**28800**
Lead	10.00	3	3	1	12	9	SW6010B	mg/kg	**12**	**9**	**10**
Magnesium	3870	3	3	0	3000	880	SW6010B	mg/kg	**880**	**3000**	**2090**
Manganese	465	3	3	3	833	598	SW6010B	mg/kg	**759**	**598**	**833**
Mercury	1.86	3	3	3	71	16	SW7471A	mg/kg	**71**	**22**	**16**
Nickel	28.00	3	3	3	54	39	SW6010B	mg/kg	**54**	**42**	**39**
Potassium	954.1	3	3	3	1290	1210	SW6010B	mg/kg	**1270**	**1290**	**1210**
Selenium	NA	3	0	0			SW6010B	mg/kg	1.6 U	1.7 U	0.71 U
Silver	NA	3	0	0			SW6010B	mg/kg	0.111 U	0.115 U	0.048 U
Sodium	100	3	2	1	150	70	SW6010B	mg/kg	41.8 U	**150**	**70**
Thallium	NA	3	0	0			SW6010B	mg/kg	0.7 U	0.7 U	0.3 U
Vanadium	62.9	3	3	0	33.2	31	SW6010B	mg/kg	**33.2**	**31**	**32.2**
Zinc	66.7	3	3	3	116	93	SW6010B	mg/kg	**116**	**98**	**93**
SPLP Inorganic Elements (µg/L)											
Aluminum		1	1		0.25	0.25	SW6010B SPLP	mg/L	**0.25**		
Antimony		1	1		0.06	0.06	SW6010B SPLP	mg/L	**0.06**		
Arsenic		1	0				SW6010B SPLP	mg/L	0.05 U		
Barium		1	1		0.008	0.008	SW6010B SPLP	mg/L	**0.008**		
Beryllium		1	0				SW6010B SPLP	mg/L	0.001 U		
Cadmium		1	0				SW6010B SPLP	mg/L	0.002 U		
Calcium		1	1		0.37	0.37	SW6010B SPLP	mg/L	**0.37**		
Chromium		1	0				SW6010B SPLP	mg/L	0.005 U		
Cobalt		1	0				SW6010B SPLP	mg/L	0.003 U		
Copper		1	1		0.004	0.004	SW6010B SPLP	mg/L	**0.004**		
Iron		1	1		0.47	0.47	SW6010B SPLP	mg/L	**0.47**		
Lead		1	0				SW6010B SPLP	mg/L	0.02 U		
Magnesium		1	1		0.14	0.14	SW6010B SPLP	mg/L	**0.14**		
Manganese		1	1		0.021	0.021	SW6010B SPLP	mg/L	**0.021**		
Mercury		1	1		0.0016	0.0016	SW7470A SPLP	mg/L	**0.0016 J**		
Nickel		1	0				SW6010B SPLP	mg/L	0.01 U		
Potassium		1	1		1	1	SW6010B SPLP	mg/L	**1**		
Selenium		1	0				SW6010B SPLP	mg/L	0.05 U		
Silver		1	0				SW6010B SPLP	mg/L	0.003 U		
Sodium		1	1		0.6	0.6	SW6010B SPLP	mg/L	**0.6**		
Thallium		1	0				SW6010B SPLP	mg/L	0.05 U		
Vanadium		1	0				SW6010B SPLP	mg/L	0.003 U		
Zinc		1	0				SW6010B SPLP	mg/L	0.01 U		
Arsenic Speciation (mg/kg)											
Arsenate		1	1		1330	1330	EPA 1632	mg/kg	**1330 J**		
Arsenite		1	1		3.78	3.78	EPA 1632	mg/kg	**3.78 J**		
Inorganic Arsenic		1	1		1330	1330	EPA 1632	mg/kg	**1330 J**		
Mercury Selective Sequential Extraction											
Hg(F0)		1	0				EPA 1631	ng/g	3.82 U		
Hg(F1)		1	1		446	446	BRL SOP No. BR-0013	ng/g	**446**		
Hg(F2)		1	1		125	125	BRL SOP No. BR-0013	ng/g	**125**		
Hg(F3)		1	1		7810	7810	BRL SOP No. BR-0013	ng/g	**7810 J**		
Hg(F4)		1	1		194000	194000	BRL SOP No. BR-0013	ng/g	**194000**		
Hg(F5)		1	1		1630000	1630000	BRL SOP No. BR-0013	ng/g	**1630000**		
Hg(F6)		1	1		79600	79600	BRL SOP No. BR-0013	ng/g	**79600 J**		

* Soil types defined in Appendix B.

Key

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µg/L = micrograms per liter

BRL SOP = Brooks Rand Labs Standard Operating Procedure

Gray shading = exceedance of background

EPA = United States Environmental Protection Agency

Hg = mercury

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

NA = not available/not analyzed

ng/g = nanograms per gram

SPLP = synthetic precipitation leaching procedure

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-22 Rice Sluice and Delta Surface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RS01	RS02	RS03
							Soil Type*		SO	SO	SO or N/DN
							Sample ID		10RS01SS	10RS02SS	10RS03SS
Analyte							Method				
Total Inorganic Elements											
Aluminum	19475	3	3	0	14600	10600	SW6010B	mg/kg	**14600**	**14000**	**10600**
Antimony	8	3	2	2	34	9	SW6010B	mg/kg	**34 J**	**9 J**	0.53 UJ
Arsenic	28.58	3	3	3	110	29	SW6010B	mg/kg	**29**	**30**	**110**
Barium	266.0	3	3	0	202	154	SW6010B	mg/kg	**202 J**	**188 J**	**154 J**
Beryllium	0.5	3	3	1	0.6	0.4	SW6010B	mg/kg	**0.5**	**0.6**	**0.4**
Cadmium	0.4	3	3	2	0.6	0.4	SW6010B	mg/kg	**0.6**	**0.6**	**0.4**
Calcium	10100	3	3	0	7220	1860	SW6010B	mg/kg	**7220**	**5950**	**1860**
Chromium	28.57	3	3	2	30.5	20.6	SW6010B	mg/kg	**30.5**	**29.4**	**20.6**
Cobalt	11.28	3	3	1	13.4	10.9	SW6010B	mg/kg	**11**	**10.9**	**13.4**
Copper	23.02	3	3	3	31.4	26.9	SW6010B	mg/kg	**28**	**26.9**	**31.4**
Iron	30891	3	3	0	29900	24800	SW6010B	mg/kg	**29900**	**29300**	**24800**
Lead	10.00	3	3	0	9	8	SW6010B	mg/kg	**9**	**8**	**8**
Magnesium	3870	3	3	2	5860	2960	SW6010B	mg/kg	**5860**	**5830**	**2960**
Manganese	465	3	3	3	719	609	SW6010B	mg/kg	**655**	**609**	**719**
Mercury	1.86	3	3	1	3.57	1.15	SW7471A	mg/kg	**1.25**	**1.15**	**3.57**
Nickel	28.00	3	3	3	33	32	SW6010B	mg/kg	**33**	**32**	**32**
Potassium	954.1	3	3	2	1360	880	SW6010B	mg/kg	**1290**	**1360**	**880**
Selenium	NA	3	0	0			SW6010B	mg/kg	0.88 U	0.78 U	0.77 U
Silver	NA	3	0	0			SW6010B	mg/kg	0.06 U	0.053 U	0.052 U
Sodium	100	3	3	2	210	70	SW6010B	mg/kg	**210**	**210**	**70**
Thallium	NA	3	0	0			SW6010B	mg/kg	0.37 U	0.33 U	0.32 U
Vanadium	62.9	3	3	0	40.3	33.6	SW6010B	mg/kg	**40.3**	**39.6**	**33.6**
Zinc	66.7	3	3	3	103	72	SW6010B	mg/kg	**103**	**93**	**72**
SPLP Inorganic Elements (µg/L)											
Aluminum		1	1		0.06	0.06	SW6010B SPLP	mg/L	**0.06**		
Antimony		1	0				SW6010B SPLP	mg/L	0.05 U		
Arsenic		1	0				SW6010B SPLP	mg/L	0.05 U		
Barium		1	1		0.012	0.012	SW6010B SPLP	mg/L	**0.012**		
Beryllium		1	0				SW6010B SPLP	mg/L	0.001 U		
Cadmium		1	0				SW6010B SPLP	mg/L	0.002 U		
Calcium		1	1		7.02	7.02	SW6010B SPLP	mg/L	**7.02**		
Chromium		1	0				SW6010B SPLP	mg/L	0.005 U		
Cobalt		1	0				SW6010B SPLP	mg/L	0.003 U		
Copper		1	1		0.002	0.002	SW6010B SPLP	mg/L	**0.002**		
Iron		1	1		0.2	0.2	SW6010B SPLP	mg/L	**0.2**		
Lead		1	0				SW6010B SPLP	mg/L	0.02 U		
Magnesium		1	1		0.86	0.86	SW6010B SPLP	mg/L	**0.86**		
Manganese		1	1		0.005	0.005	SW6010B SPLP	mg/L	**0.005**		
Mercury		1	0				SW7470A SPLP	mg/L	0.0001 U		
Nickel		1	0				SW6010B SPLP	mg/L	0.01 U		
Potassium		1	0				SW6010B SPLP	mg/L	0.5 U		
Selenium		1	0				SW6010B SPLP	mg/L	0.05 U		
Silver		1	0				SW6010B SPLP	mg/L	0.003 U		
Sodium		1	0				SW6010B SPLP	mg/L	0.5 U		
Thallium		1	0				SW6010B SPLP	mg/L	0.05 U		
Vanadium		1	0				SW6010B SPLP	mg/L	0.003 U		
Zinc		1	0				SW6010B SPLP	mg/L	0.01 U		
Arsenic Speciation (mg/kg)											
Arsenate		1	1		23.3	23.3	EPA 1632	mg/kg	**23.3 J**		
Arsenite		1	1		1.82	1.82	EPA 1632	mg/kg	**1.82 J**		
Inorganic Arsenic		1	1		25.1	25.1	EPA 1632	mg/kg	**25.1 J**		
Mercury Selective Sequential Extraction											
Hg(F0)		1	0		0	0	EPA 1631	ng/g	4.94 U		
Hg(F1)		1	1		3.46	3.46	BRL SOP No. BR-0013	ng/g	**3.46**		
Hg(F2)		1	1		0.63	0.63	BRL SOP No. BR-0013	ng/g	**0.63**		
Hg(F3)		1	1		1090	1090	BRL SOP No. BR-0013	ng/g	**1090 J**		
Hg(F4)		1	1		268	268	BRL SOP No. BR-0013	ng/g	**268**		
Hg(F5)		1	1		254	254	BRL SOP No. BR-0013	ng/g	**254**		
Hg(F6)		1	0		0	0	BRL SOP No. BR-0013	ng/g	3.03 U		

* Soil types defined in Appendix B.

Key

Bold = detection

Gray shading = exceedance of background

% = percent

µg/L = micrograms per liter

BRL SOP = Brooks Rand Labs Standard Operating Procedure

EPA = United States Environmental Protection Agency

Hg = mercury

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

ng/g = nanograms per gram

NA = not available/not analyzed

SPLP = synthetic precipitation leaching procedure

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-23 Surface Mined Area Surface Soil Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP41	SM01	SM02	SM03	SM04	SM05	SM06	SM07	SM08	SM09	SM10	SM11	SM12	SM13	SM14	SM15	SM16
							Soil Type*		N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN (loess)	N/DN	N/DN	N/DN	N/DN	N/DN
							Sample ID		10MP41SS	10SM01SS	10SM02SS	10SM03SS	10SM04SS	10SM05SS	10SM06SS	10SM07SS	10SM08SS	10SM09SS	10SM10SS	10SM11SS	10SM12SS	10SM13SS	10SM14SS	10SM15SS	10SM16SS
							Method																		
Total Inorganic Elements																									
Aluminum	19475	31	31	2	20300	4130	SW6010B	mg/kg	**8450**	**4340**	**5300**	**5950**	**7530**	**4720**	**5440**	**6040**	**5330**	**4130**	**15300**	**19500**	**12600**	**9170**	**16300**	**14800**	**11000**
Antimony	8	31	13	13	508	10	SW6010B	mg/kg	**39**	**40 J**	**80 J**	**90 J**	**20 J**	**140 J**	**30 J**	2.3 UJ	**10 J**	1.1 UJ	0.45 UJ	0.49 UJ	1.2 UJ	**40 J**	0.48 UJ	0.48 UJ	1.2 UJ
Arsenic	28.58	31	30	21	8510	9	SW6010B	mg/kg	**516**	**1710**	**3620**	**2290**	**1470**	**5120**	**890**	**8510**	**230**	**190**	**12**	**11**	**90**	**670**	**10**	**21**	**350**
Barium	266.0	31	31	5	339	97	SW6010B	mg/kg	**102**	**173 J**	**212 J**	**193 J**	**339 J**	**306 J**	**317 J**	**332 J**	**241 J**	**287 J**	**174**	**97**	**176**	**215**	**165**	**165**	**248**
Beryllium	0.5	31	31	16	1.3	0.4	SW6010B	mg/kg	**0.4**	**1.2**	**1**	**0.9**	**0.8**	**0.9**	**1.3**	**0.6**	**1.1**	**0.8**	**0.4**	**0.4**	**0.6**	**0.8**	**0.4**	**0.5**	**0.8**
Cadmium	0.4	31	18	7	1	0.2	SW6010B	mg/kg	0.022 U	0.053 U	0.056 U	0.056 U	0.056 U	0.055 U	**0.8**	0.11 U	**0.9**	**1**	**0.3**	**0.4**	0.058 U	0.057 U	**0.3**	**0.4**	0.058 U
Calcium	10100	31	31	0	2580	600	SW6010B	mg/kg	**2420**	**2280**	**1490**	**1650**	**1350**	**1750**	**1050**	**1010**	**1980**	**2280**	**2560**	**2010**	**2440**	**1310**	**2510**	**2320**	**1630**
Chromium	28.57	31	31	2	32	11	SW6010B	mg/kg	**18.9**	**16**	**17**	**32**	**23**	**19**	**11**	**21**	**15**	**14**	**25.6**	**26.9**	**27**	**21**	**26.1**	**24.6**	**21**
Cobalt	11.28	31	31	20	38.8	5.9	SW6010B	mg/kg	**9.5**	**31.8**	**26**	**19**	**24.3**	**38.8**	**35.3**	**11**	**22**	**26.9**	**9.4**	**10.8**	**13.4**	**34.8**	**9.5**	**15.7**	**18.6**
Copper	23.02	31	31	28	100	17.8	SW6010B	mg/kg	**24.5**	**89**	**60**	**66.5**	**56.5**	**87.1**	**79.3**	**44**	**100**	**72.3**	**24.7**	**17.8**	**34.2**	**56.1**	**23.5**	**29.2**	**53.4**
Iron	30891	31	31	15	59100	17900	SW6010B	mg/kg	**22300**	**42700**	**48900**	**42100**	**41300**	**59100**	**55800**	**37900**	**58100**	**40300**	**22400**	**25100**	**27500**	**38400**	**22300**	**23500**	**37300**
Lead	10.00	31	31	16	32	6	SW6010B	mg/kg	**6**	**18**	**13**	**14**	**16**	**16**	**32**	**10**	**22**	**17**	**6**	**8**	**10**	**14**	**7**	**8**	**12**
Magnesium	3870	31	31	11	6000	460	SW6010B	mg/kg	**3380**	**460**	**700**	**1200**	**1350**	**490**	**750**	**980**	**510**	**6000**	**4430**	**4890**	**3680**	**1890**	**4810**	**4090**	**2420**
Manganese	465	31	31	21	4230	153	SW6010B	mg/kg	**313**	**844**	**854**	**723**	**1130**	**4230**	**1430**	**362**	**780**	**1040**	**340**	**323**	**529**	**1150**	**307**	**479**	**1050**
Mercury	1.86	31	31	21	174	0.05	SW7471A	mg/kg	**8**	**29**	**44**	**21**	**31**	**102**	**25**	**174**	**8**	**9**	**0.15 J**	**0.17 J**	**5.4 J**	**23 J**	**0.14 J**	**0.62 J**	**8.8 J**
Nickel	28.00	31	31	21	86	19	SW6010B	mg/kg	**31**	**78**	**67**	**64**	**55**	**86**	**78**	**31**	**61**	**64**	**24**	**27**	**32**	**47**	**26**	**29**	**52**
Potassium	954.1	31	31	18	2110	600	SW6010B	mg/kg	**890**	**2050**	**1780**	**1670**	**1670**	**1750**	**1820**	**1500**	**2110**	**1930**	**730**	**870**	**1110**	**1380**	**850**	**970**	**1510**
Selenium	NA	31	0	0			SW6010B	mg/kg	0.65 U	1.6 U	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	3.3 U	1.7 U	1.6 U	0.65 U	0.71 U	1.7 U	1.7 U	0.68 U	0.69 U	1.7 U
Silver	NA	31	0	0			SW6010B	mg/kg	0.044 U	0.107 U	0.112 U	0.112 U	0.112 U	0.111 U	0.109 U	0.22 U	0.114 U	0.106 U	0.044 U	0.048 U	0.116 U	0.114 U	0.046 U	0.047 U	0.116 U
Sodium	100	31	14	6	120	80	SW6010B	mg/kg	**80**	40.4 U	42.3 U	42.3 U	42.1 U	41.8 U	41 U	84.9 U	42.9 U	39.9 U	**120**	**100**	43.7 U	43.1 U	**120**	**100**	43.8 U
Thallium	NA	31	0	0			SW6010B	mg/kg	0.28 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	1.4 U	0.7 U	0.7 U	0.27 U	0.3 U	0.7 U	0.7 U	0.29 U	0.29 U	0.7 U
Vanadium	62.9	31	31	0	51.9	23	SW6010B	mg/kg	**30.8**	**23.4**	**29.4**	**32.1**	**36**	**32.3**	**25.3**	**25**	**33**	**28.6**	**42**	**44.3**	**43.6**	**36.4**	**42.4**	**41.4**	**39.5**
Zinc	66.7	31	31	20	159	45	SW6010B	mg/kg	**60**	**136**	**122**	**120**	**116**	**159**	**159**	**77**	**126**	**148**	**57**	**64**	**74**	**108**	**60**	**64**	**104**
SPLP Inorganic Elements (µg/L)																									
Aluminum		12	12		1.01	0.13	SW6010B SPLP	mg/L	**0.36 J**			**0.28**		**0.13**		**0.19**					**0.14**	**0.4**			
Antimony		12	3		1.43	0.11	SW6010B SPLP	mg/L	0.05 U			0.05 U		0.05 U		0.05 U					0.05 U	**0.11**			
Arsenic		12	5		0.56	0.07	SW6010B SPLP	mg/L	0.05 U			**0.17**		**0.56**		**0.3**					0.05 U	0.05 U			
Barium		12	12		0.021	0.003	SW6010B SPLP	mg/L	**0.007 J**			**0.006**		**0.003**		**0.003**					**0.003**	**0.011**			
Beryllium		12	0				SW6010B SPLP	mg/L	0.001 U			0.001 U		0.001 U		0.001 U					0.001 U	0.001 U			
Cadmium		12	0				SW6010B SPLP	mg/L	0.002 U			0.002 U		0.002 U		0.002 U					0.002 U	0.002 U			
Calcium		12	12		0.73	0.19	SW6010B SPLP	mg/L	**0.73**			**0.42**		**0.3**		**0.28**					**0.42**	**0.59**			
Chromium		12	0				SW6010B SPLP	mg/L	0.005 U			0.005 U		0.005 U		0.005 U					0.005 U	0.005 U			
Cobalt		12	0				SW6010B SPLP	mg/L	0.003 U			0.003 U		0.003 U		0.003 U					0.003 U	0.003 U			
Copper		12	9		0.006	0.003	SW6010B SPLP	mg/L	**0.005**			**0.003**		0.002 U		**0.004**					**0.004**	**0.006**			
Iron		12	12		1.5	0.16	SW6010B SPLP	mg/L	**0.48 J**			**0.52**		**0.29**		**0.26**					**0.16**	**0.69**			
Lead		12	0				SW6010B SPLP	mg/L	0.02 U			0.02 U		0.02 U		0.02 U					0.02 U	0.02 U			
Magnesium		12	12		0.9	0.05	SW6010B SPLP	mg/L	**0.9**			**0.09**		**0.05**		**0.06**					**0.1**	**0.14**			
Manganese		12	12		0.066	0.004	SW6010B SPLP	mg/L	**0.012 J**			**0.013**		**0.008**		**0.013**					**0.019**	**0.066**			
Mercury		12	10		0.0042	0.0002	SW7470A SPLP	mg/L	**0.0009 J**			**0.0013**		**0.0016**		**0.0042**					0.0001 U	**0.0013 J**			
Nickel		12	0				SW6010B SPLP	mg/L	0.01 U			0.01 U		0.01 U		0.01 U					0.01 U	0.01 U			
Potassium		12	4		0.9	0.5	SW6010B SPLP	mg/L	0.5 U			**0.8**		**0.7**		0.5 U					0.5 U	0.5 U			
Selenium		12	0				SW6010B SPLP	mg/L	0.05 U			0.05 U		0.05 U		0.05 U					0.05 U	0.05 U			
Silver		12	0				SW6010B SPLP	mg/L	0.003 U			0.003 U		0.003 U		0.003 U					0.003 U	0.003 U			
Sodium		12	9		0.9	0.5	SW6010B SPLP	mg/L	0.5 U			**0.6**		**0.5**		**0.5**					0.5 U	**0.8**			
Thallium		12	0				SW6010B SPLP	mg/L	0.05 U			0.05 U		0.05 U		0.05 U					0.05 U	0.05 U			
Vanadium		12	1		0.004	0.004	SW6010B SPLP	mg/L	0.003 U			0.003 U		0.003 U		0.003 U					0.003 U	0.003 U			
Zinc		12	1		0.01	0.01	SW6010B SPLP	mg/L	0.01 U			0.01 U		0.01 U		0.01 U					0.01 U	0.01 U			
Arsenic Speciation (mg/kg)																									
Arsenate		12	12		20100	24.6	EPA 1632	mg/kg	**367 J**			**3620 J**		**6480 J**		**20100 J**					**98.4 J**	**576 J**			
Arsenite		12	12		27.2	0.307	EPA 1632	mg/kg	**6.93 J**			**15.9 J**		**27.2 J**		**6.18 J**					**0.742 J**	**3.34 J**			
Inorganic Arsenic		12	12		20100	24.9	EPA 1632	mg/kg	**374 J**			**3640 J**		**6510 J**		**20100 J**					**99.1 J**	**579 J**			
Arsenic Bioavailability																									
Arsenic (IVBA)		3	3		0.4242	0.1611	M6020 ICP-MS	mg/L																	
Arsenic, total (3050)		3	3		558	45.7	M6020 ICP-MS	mg/kg																	
Arsenic IVBA% (In Vitro RBA)		3	3		43	3.9	Calculation (EPA 920	%																	
Total Solids		3	3		83.5	74.9	CLPSOW390, PART F, D	%																	
Mercury Selective Sequential Extraction																									
Hg(F0)		12	8		527	2.98	EPA 1631	ng/g	**2.98**			**6.36**		**54.2**		**527**					3.27 U	**4.06**			
Hg(F1)		12	12		1350	21.9	BRL SOP No. BR-0013	ng/g	**154**			**1350**		**544**		**830**					**32.2**	**233**			
Hg(F2)		12	12		7580	3.08	BRL SOP No. BR-0013	ng/g	**3.96**			**2880**		**924**		**7580**					**2.42**	**89.8**			
Hg(F3)		12	12		5990	648	BRL SOP No. BR-0013	ng/g	**3690 J**			**2540 J**		**3080 J**		**5990 J**					**837 J**	**1190 J**			
Hg(F4)		12	11		10300	157	BRL SOP No. BR-0013	ng/g	**1220**			**8470**		**9660**		**10300**					**306**	**3980**			
Hg(F5)		12	12		87200	443	BRL SOP No. BR-0013	ng/g	**22300**			**71000**		**56100**		**87200**					**3030**	**33300**			
Hg(F6)		12	9		9350	351	BRL SOP No. BR-0013	ng/g	**1640**			**6420 J**		**5200 J**		**9350 J**					4.44 U	**3230 J**			

Table 4-23 Surface Mined Area Surface Soil	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	SM17	SM18	SM19	SM20	SM21	SM22	SM23	SM24	SM25	SM26	SM27	SM28	SM29	SM30	SM13	SM18	SM28
							Soil Type*		N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	B/WB	N/DN	N/DN	N/DN
							Sample ID		10SM17SS	10SM18SS	10SM19SS	10SM20SS	10SM21SS	10SM22SS	10SM23SS	10SM24SS	10SM25SS	10SM26SS	10SM27SS	10SM28SS	10SM29SS	10SM30SS	11SM13SS	11SM18SS	11SM28SS
Analyte							Method																		
Total Inorganic Elements																									
Aluminum	19475	31	31	2	20300	4130	SW6010B	mg/kg	**12800**	**5660**	**6670**	**13900**	**16800**	**14600**	**13000**	**11900**	**9000**	**12400**	**11000**	**13900**	**13200**	**20300**			
Antimony	8	31	13	13	508	10	SW6010B	mg/kg	**20 J**	1.2 UJ	**20 J**	0.48 UJ	0.47 UJ	0.49 UJ	**508 J**	1.2 UJ	1.1 UJ	0.49 UJ	1.2 UJ	**109 J**	0.5 UJ	0.54 UJ			
Arsenic	28.58	31	30	21	8510	9	SW6010B	mg/kg	**361**	**230**	**670**	**9**	**39**	**17**	**223**	0.9 U	**40**	**13**	**20**	**177**	**11**	**46**			
Barium	266.0	31	31	5	339	97	SW6010B	mg/kg	**177**	**253**	**148**	**121**	**220**	**147**	**163**	**149**	**103**	**132**	**180**	**145**	**136**	**213**			
Beryllium	0.5	31	31	16	1.3	0.4	SW6010B	mg/kg	**0.6**	**1.3**	**0.9**	**0.4**	**0.5**	**0.5**	**0.4**	**0.5**	**0.5**	**0.4**	**0.5**	**0.4**	**0.4**	**0.6**			
Cadmium	0.4	31	18	7	1	0.2	SW6010B	mg/kg	**0.4**	**0.6**	0.054 U	**0.3**	**0.3**	**0.4**	0.023 U	**0.7**	**0.6**	**0.4**	**0.8**	0.023 U	**0.2**	**0.3**			
Calcium	10100	31	31	0	2580	600	SW6010B	mg/kg	**1940**	**2460**	**2090**	**1590**	**2200**	**2580**	**1990**	**940**	**600**	**1400**	**1420**	**1780**	**2350**	**2490**			
Chromium	28.57	31	31	2	32	11	SW6010B	mg/kg	**23.8**	**12**	**17**	**21**	**27.2**	**27**	**22.5**	**24**	**22**	**20.2**	**21**	**22.8**	**23.8**	**30.2**			
Cobalt	11.28	31	31	20	38.8	5.9	SW6010B	mg/kg	**14**	**19.2**	**18.6**	**5.9**	**11.1**	**12.1**	**9.5**	**17.3**	**18.5**	**11.1**	**19.1**	**9.8**	**8.7**	**12.2**			
Copper	23.02	31	31	28	100	17.8	SW6010B	mg/kg	**37.9**	**71.9**	**57.3**	**18.7**	**28.2**	**25.3**	**25**	**53.1**	**46.4**	**28.2**	**40.5**	**23.5**	**19.7**	**31.7**			
Iron	30891	31	31	15	59100	17900	SW6010B	mg/kg	**26400**	**35200**	**34300**	**17900**	**23700**	**23800**	**20100**	**36700**	**37100**	**23200**	**29500**	**19900**	**21000**	**28100**			
Lead	10.00	31	31	16	32	6	SW6010B	mg/kg	**9**	**16**	**12**	**6**	**9**	**7**	**6**	**12**	**11**	**8**	**11**	**6**	**6**	**11**			
Magnesium	3870	31	31	11	6000	460	SW6010B	mg/kg	**3470**	**710**	**1760**	**3430**	**4270**	**4260**	**3890**	**3690**	**1660**	**3130**	**2450**	**3950**	**4350**	**4970**			
Manganese	465	31	31	21	4230	153	SW6010B	mg/kg	**526**	**1250**	**776**	**153**	**476**	**367**	**316**	**870**	**1030**	**517**	**1090**	**435**	**319**	**481**			
Mercury	1.86	31	31	21	174	0.05	SW7471A	mg/kg	**12 J**	**11 J**	**14 J**	**0.11 J**	**2 J**	**0.05 J**	**8.2 J**	**0.26 J**	**0.9 J**	**0.64 J**	**1.9 J**	**17 J**	**0.17 J**	**1.9 J**			
Nickel	28.00	31	31	21	86	19	SW6010B	mg/kg	**37**	**57**	**59**	**19**	**28**	**23**	**25**	**46**	**55**	**26**	**35**	**26**	**22**	**33**			
Potassium	954.1	31	31	18	2110	600	SW6010B	mg/kg	**1090**	**1500**	**1520**	**600**	**820**	**810**	**750**	**690**	**760**	**810**	**1280**	**740**	**830**	**1100**			
Selenium	NA	31	0	0			SW6010B	mg/kg	0.67 U	1.7 U	1.6 U	0.7 U	0.68 U	0.7 U	0.67 U	1.7 U	1.6 U	0.7 U	1.7 U	0.68 U	0.72 U	0.78 U			
Silver	NA	31	0	0			SW6010B	mg/kg	0.045 U	0.113 U	0.108 U	0.047 U	0.046 U	0.048 U	0.045 U	0.112 U	0.112 U	0.048 U	0.117 U	0.046 U	0.049 U	0.053 U			
Sodium	100	31	14	6	120	80	SW6010B	mg/kg	**90**	42.5 U	40.6 U	**90**	**110**	**110**	**100**	42.4 U	42.1 U	**80**	44.3 U	**80**	**110**	**120**			
Thallium	NA	31	0	0			SW6010B	mg/kg	0.28 U	0.7 U	0.7 U	0.29 U	0.29 U	0.3 U	0.28 U	0.7 U	0.7 U	0.3 U	0.7 U	0.29 U	0.3 U	0.33 U			
Vanadium	62.9	31	31	0	51.9	23	SW6010B	mg/kg	**37.9**	**23**	**30.6**	**35.8**	**46.8**	**47.9**	**35.5**	**41.6**	**43.7**	**37.3**	**37.8**	**36.4**	**40**	**51.9**			
Zinc	66.7	31	31	20	159	45	SW6010B	mg/kg	**76**	**139**	**110**	**45**	**67**	**61**	**56**	**108**	**109**	**62**	**85**	**52**	**50**	**75**			
SPLP Inorganic Elements (µg/L)																									
Aluminum		12	12		1.01	0.13	SW6010B SPLP	mg/L		**0.34**	**1.01**		**0.26**		**0.66**				**0.78**	**0.35**					
Antimony		12	3		1.43	0.11	SW6010B SPLP	mg/L		0.05 U	0.05 U		0.05 U		**1.43**				0.05 U	**0.38**					
Arsenic		12	5		0.56	0.07	SW6010B SPLP	mg/L		0.05 U	**0.07**		0.05 U		**0.09**				0.05 U	0.05 U					
Barium		12	12		0.021	0.003	SW6010B SPLP	mg/L		**0.006**	**0.015**		**0.005**		**0.016**				**0.021**	**0.012**					
Beryllium		12	0				SW6010B SPLP	mg/L		0.001 U	0.001 U		0.001 U		0.001 U				0.001 U	0.001 U					
Cadmium		12	0				SW6010B SPLP	mg/L		0.002 U	0.002 U		0.002 U		0.002 U				0.002 U	0.002 U					
Calcium		12	12		0.73	0.19	SW6010B SPLP	mg/L		**0.31**	**0.44**		**0.19**		**0.44**				**0.6**	**0.41**					
Chromium		12	0				SW6010B SPLP	mg/L		0.005 U	0.005 U		0.005 U		0.005 U				0.005 U	0.005 U					
Cobalt		12	0				SW6010B SPLP	mg/L		0.003 U	0.003 U		0.003 U		0.003 U				0.003 U	0.003 U					
Copper		12	9		0.006	0.003	SW6010B SPLP	mg/L		0.002 U	**0.005**		0.002 U		**0.005**				**0.006**	**0.003**					
Iron		12	12		1.5	0.16	SW6010B SPLP	mg/L		**0.25**	**1.5**		**0.2**		**0.57**				**0.98**	**0.58**					
Lead		12	0				SW6010B SPLP	mg/L		0.02 U	0.02 U		0.02 U		0.02 U				0.02 U	0.02 U					
Magnesium		12	12		0.9	0.05	SW6010B SPLP	mg/L		**0.05**	**0.12**		**0.07**		**0.33**				**0.21**	**0.23**					
Manganese		12	12		0.066	0.004	SW6010B SPLP	mg/L		**0.01**	**0.03**		**0.004**		**0.018**				**0.066**	**0.044**					
Mercury		12	10		0.0042	0.0002	SW7470A SPLP	mg/L		**0.0003 J**	**0.002 J**		0.0001 U		**0.001 J**				**0.0002 J**	**0.0014 J**					
Nickel		12	0				SW6010B SPLP	mg/L		0.01 U	0.01 U		0.01 U		0.01 U				0.01 U	0.01 U					
Potassium		12	4		0.9	0.5	SW6010B SPLP	mg/L		0.5 U	**0.5**		0.5 U		0.5 U				**0.9**	0.5 U					
Selenium		12	0				SW6010B SPLP	mg/L		0.05 U	0.05 U		0.05 U		0.05 U				0.05 U	0.05 U					
Silver		12	0				SW6010B SPLP	mg/L		0.003 U	0.003 U		0.003 U		0.003 U				0.003 U	0.003 U					
Sodium		12	9		0.9	0.5	SW6010B SPLP	mg/L		**0.6**	**0.8**		**0.6**		**0.6**				**0.9**	0.5 U					
Thallium		12	0				SW6010B SPLP	mg/L		0.05 U	0.05 U		0.05 U		0.05 U				0.05 U	0.05 U					
Vanadium		12	1		0.004	0.004	SW6010B SPLP	mg/L		0.003 U	**0.004**		0.003 U		0.003 U				0.003 U	0.003 U					
Zinc		12	1		0.01	0.01	SW6010B SPLP	mg/L		0.01 U	**0.01**		0.01 U		0.01 U				0.01 U	0.01 U					
Arsenic Speciation (mg/kg)																									
Arsenate		12	12		20100	24.6	EPA 1632	mg/kg		**777 J**	**851 J**		**59.8 J**		**306 J**				**24.6 J**	**337 J**					
Arsenite		12	12		27.2	0.307	EPA 1632	mg/kg		**3.58 J**	**2.43 J**		**0.543 J**		**4.6 J**				**0.307 J**	**14.7 J**					
Inorganic Arsenic		12	12		20100	24.9	EPA 1632	mg/kg		**781 J**	**853 J**		**60.3 J**		**311 J**				**24.9 J**	**352 J**					
Arsenic Bioavailability																									
Arsenic (IVBA)		3	3		0.4242	0.1611	M6020 ICP-MS	mg/L															**0.4242 J**	**0.1611 J**	**0.1963 J**
Arsenic, total (3050)		3	3		558	45.7	M6020 ICP-MS	mg/kg															**558**	**407**	**45.7**
Arsenic IVBA% (In Vitro RBA)		3	3		43	3.9	Calculation (EPA 920	%															**7.6 J**	**3.9 J**	**43 J**
Total Solids		3	3		83.5	74.9	CLPSOW390, PART F, D	%															**77.9**	**83.5**	**74.9**
Mercury Selective Sequential Extraction																									
Hg(F0)		12	8		527	2.98	EPA 1631	ng/g		3.76 U	2.74 U		**4.57**		3.32 U				**9.31**	**4.21**					
Hg(F1)		12	12		1350	21.9	BRL SOP No. BR-0013	ng/g		**50**	**189**		**21.9**		**147**				**24.8**	**318**					
Hg(F2)		12	12		7580	3.08	BRL SOP No. BR-0013	ng/g		**73.2**	**130**		**3.08**		**8.33**				**3.56**	**177**					
Hg(F3)		12	12		5990	648	BRL SOP No. BR-0013	ng/g		**2350 J**	**1020 J**		**648 J**		**2880 J**				**1570 J**	**1870 J**					
Hg(F4)		12	11		10300	157	BRL SOP No. BR-0013	ng/g		45.4 U	**3770**		**311**		**1420**				**157**	**6550**					
Hg(F5)		12	12		87200	443	BRL SOP No. BR-0013	ng/g		**10800 J**	**25500**		**1490**		**8040**				**443**	**16900**					
Hg(F6)		12	9		9350	351	BRL SOP No. BR-0013	ng/g		**1750**	**3250 J**		2.25 U		**351 J**				2.15 U	**774 J**					

* Soil types defined in Appendix B.

Key

Bold = detection	J = The analyte was detected. The associated result is estimated.
Gray shading = exceedance of background	mg/kg = milligrams per kilogram
% = percent	mg/L = milligrams per liter
µg/L = micrograms per liter	ng/g = nanograms per gram
BRL SOP = Brooks Rand Labs Standard Operating Procedure	RBA = Relative bioavailability
EPA = United States Environmental Protection Agency	SPLP = synthetic precipitation leaching procedure
ICP-MS = Inductively Coupled Plasma - Mass Spectrometry	U = The analyte was analyzed for but not detected. The value provided is the reporting limit.
IVBA = In-vitro bioaccessibility	UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP45	MP45	MP45	MP46	MP46	MP47	MP47	MP47
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	T/WR	T/WR | N/DN	T/WR	T/WR	N/DN	T/WR	T/WR
							Sample ID		11MP45SB12	11MP45SB04	11MP45SB10	11MP46SB04	11MP46SB12	11MP47SB26	11MP47SB04	11MP47SB22
Analyte							Method									
Total Inorganic Elements																
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg	**4110**	**9560 J**	**3240 J**	**8830**	**2260 J**	**5130**	**2650 J**	**3180**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg	**16.5 J**	**11800 J**	**104 J**	**15800 J**	**3150 J**	**23.9 J**	**1750 J**	**481 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg	**152**	**3610 J**	**282 J**	**4650 J**	**449 J**	**111**	**3840 J**	**1470**
Barium	178	52	52	9	830	75	SW6020A	mg/kg	**126**	**521**	**132**	**830**	**141**	**138**	**139**	**133**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg	**0.441**	**0.613 J**	**0.542 J**	**0.69**	**0.595 J**	**0.756**	**0.582 J**	**0.542**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg	**0.595**	**0.451**	**0.449**	**0.39**	**0.509**	**0.496**	**0.452**	**0.621**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg	**1970 J**	**4370 J**	**6650 J**	**4830**	**5640 J**	**1970 J**	**4400 J**	**5270 J**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg	**13.8**	**18.7 J**	**12.8 J**	**26.9 J**	**12.4 J**	**16.7**	**11.90 J**	**17.9**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg	**13.9**	**9.17 J**	**16.5 J**	**11.4**	**18 J**	**9.57**	**17.4 J**	**17.7**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg	**47.1 J**	**54.6 J**	**51.6 J**	**81.6**	**78.70 J**	**57.2 J**	**61.3 J**	**61.6 J**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg	**36900**	**30800**	**38800**	**29200**	**43600**	**33400**	**40400**	**47300**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg	**12.3**	**0.043 J**	**12.4 J**	**0.074**	**7.5 J**	**15.7**	**6.99 J**	**12.1**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg	**1020 J**	**4590 J**	**4650 J**	**6510**	**10200 J**	**2020 J**	**8220 J**	**11400 J**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg	**767**	**536**	**957**	**626**	**845**	**326**	**707**	**794**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg	**1020 J**	**1310 J**	**265 J**	**167 J**	**219 J**	**16 J**	**939 J**	**303 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg	**41.5**	**36.7**	**46.6**	**50.7**	**64.3**	**30.2**	**61**	**62.3**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg	**1040**	**2780 J**	**1170 J**	**3240**	**1350 J**	**1270**	**1340 J**	**1360**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg	**0.58**	**0.38**	**0.58**	**2.73**	**1.03**	**0.68**	**1.49**	**0.84**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg	**0.173**	**0.239**	**0.189**	**0.222**	**0.358**	**0.325**	**0.324**	**0.255**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg	**49.9**	**221**	**54.8**	**279**	**67.4**	**66.9**	**68.6**	**71**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg	**0.116**	**0.299**	**0.087**	**0.414**	**0.096**	**0.088**	**0.134**	**0.111**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg	**25.3**	**20.9 J**	**25.7 J**	**19.1**	**17.6 J**	**34.3**	**21.4 J**	**20.8**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg	**96.2 J**	**83.3 J**	**97.8 J**	**90.8 J**	**108 J**	**108 J**	**98.2 J**	**107 J**
Low Level Mercury																
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g								
SPLP Inorganic Elements																
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L								
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L								
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L								
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L								
Beryllium		8	0				SW6010B-SPLP	µg/L								
Cadmium		8	0				SW6010B-SPLP	µg/L								
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L								
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L								
Cobalt		8	0				SW6010B-SPLP	µg/L								
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L								
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L								
Lead		8	0				SW6010B-SPLP	µg/L								
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L								
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L								
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L								
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L								
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L								
Selenium		8	0				SW6010B-SPLP	µg/L								
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L								
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L								
Thallium		8	0				SW6010B-SPLP	µg/L								
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L								
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L								
TCLP Inorganic Elements																
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L								
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L								
Cadmium		8	0				SW6010B-TCLP	mg/L								
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L								
Lead		8	0				SW6010B-TCLP	mg/L								
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L								
Selenium		8	0				SW6010B-TCLP	mg/L								
Silver		8	0				SW6010B-TCLP	mg/L								

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP45	MP45	MP45	MP46	MP46	MP47	MP47	MP47
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	T/WR	T/WR | N/DN	T/WR	T/WR	N/DN	T/WR	T/WR
							Sample ID		11MP45SB12	11MP45SB04	11MP45SB10	11MP46SB04	11MP46SB12	11MP47SB26	11MP47SB04	11MP47SB22
Analyte							**Method**									
Arsenic Speciation																
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg								
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg								
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg								
Mercury Selective Sequential Extraction																
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g								
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g								
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g								
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g								
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g								
Semi-Volatile Organic Compounds																
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		110 U						
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		70 U						
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		350 U						
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**81 J**						
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		160 U						
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**73 J**						
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**2700 J**						
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**7900 J**						
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**4400 J**						
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Diesel and Residual Range Organics																
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg		**3800 Y**						
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg		**68.00 J**						

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP48	MP48	MP48	MP49	MP49	MP49	MP50	MP51
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		T/WR	T/WR	T/WR | N/DN	N/DN	T/WR	T/WR | N/DN	T/WR | B/WB	B/WB
							Sample ID		11MP48SB04	11MP48SB08	11MP48SB12	11MP49SB14	11MP49SB06	11MP49SB10	11MP50SB04	11MP51SB14
Analyte							Method									
Total Inorganic Elements																
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg	**3670**	**3410 J**	**11200**	**12000 J**	**5320**	**13500**	**2230 J**	**1830 J**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg	**1010 J**	**324 J**	**361 J**	**94.6 J**	**303**	**1240 J**	**5 J**	**343 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg	**2730 J**	**2550 J**	**1090 J**	**35.6 J**	**2810**	**348 J**	**230 J**	**823 J**
Barium	178	52	52	9	830	75	SW6020A	mg/kg	**152**	**110**	**222**	**104**	**110**	**135**	**117**	**75**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg	**0.706**	**0.619 J**	**0.428**	**0.282 J**	**0.518**	**0.338 J**	**0.5 J**	**0.367 J**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg	**0.477**	**0.451**	**0.19**	**0.153**	**0.381**	**0.25**	**0.821**	**0.363**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg	**3020**	**4900 J**	**2120**	**2590 J**	**3280**	**3110**	**1150 J**	**2050 J**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg	**13.8**	**27.3 J**	**29.8**	**19.9 J**	**15.1**	**20.3 J**	**17.7 J**	**12.6 J**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg	**15.2**	**14.6 J**	**9.41**	**6.02 J**	**12.2**	**6.84 J**	**14.5 J**	**12.2 J**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg	**47.1**	**50.3 J**	**26.6**	**16 J**	**47.6**	**18.8**	**38.4 J**	**23.4 J**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg	**39200**	**44400**	**27300**	**17900**	**43400**	**24800**	**50700**	**57400**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg	**13.2**	**13.7 J**	**8.66**	**4.83 J**	**12.5**	**5.36 J**	**10.2 J**	**6.77 J**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg	**3120**	**5870 J**	**3580**	**4250 J**	**2080**	**5090**	**316 J**	**401 J**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg	**627**	**639**	**239**	**221**	**454**	**378**	**947**	**353**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg	**131 J**	**304 J**	**51.9 J**	**38.5 J**	**134**	**263 J**	**18 J**	**38.3 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg	**41.7**	**57.6**	**37.5**	**19.9**	**39.2**	**20.9**	**49.5**	**35.1**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg	**1170 J**	**1420 J**	**739 J**	**775 J**	**1370**	**1150 J**	**999 J**	**779 J**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg	**0.41 J**	**1.03 J**	**0.22**	**0.05 J**	**0.8**	**0.48**	**1.23**	**0.3 J**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg	**0.195**	**0.193**	**0.089**	**0.071**	**0.191**	**0.165**	**0.2**	**0.067**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg	**61.3**	**64.2**	**116**	**177**	**103**	**181**	**26.8 J**	**25.1 J**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg	**0.149**	**0.169**	**0.211**	**0.065**	**0.171**	**0.115**	**0.094**	**0.078**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg	**23.1**	**25.5 J**	**29.5**	**30.1 J**	**21**	**30.7 J**	**29.5 J**	**19.1 J**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg	**88.4 J**	**102 J**	**54.2 J**	**43.8 J**	**81.8**	**52.9**	**123 J**	**101 J**
Low Level Mercury																
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g								
SPLP Inorganic Elements																
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L			**539**					
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L			**721**					
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L			**80 J**					
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L			**11 J**					
Beryllium		8	0				SW6010B-SPLP	µg/L			0.2 U					
Cadmium		8	0				SW6010B-SPLP	µg/L			0.8 U					
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L			**2950**					
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L			3 U					
Cobalt		8	0				SW6010B-SPLP	µg/L			2 U					
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L			5 U					
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L			**1160**					
Lead		8	0				SW6010B-SPLP	µg/L			8 U					
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L			**1450**					
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L			**7.5**					
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L			**5.98**					
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L			2 U					
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L			**541**					
Selenium		8	0				SW6010B-SPLP	µg/L			30 U					
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L			**5.7 J**					
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L			**5750 J**					
Thallium		8	0				SW6010B-SPLP	µg/L			30 UJ					
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L			5 U					
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L			**76.6**					
TCLP Inorganic Elements																
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L		**0.12**						
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L		**0.366 J**						
Cadmium		8	0				SW6010B-TCLP	mg/L		0.002 U						
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L		0.003 U						
Lead		8	0				SW6010B-TCLP	mg/L		0.02 U						
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L		**0.0074**						
Selenium		8	0				SW6010B-TCLP	mg/L		0.02 U						
Silver		8	0				SW6010B-TCLP	mg/L		0.007 U						

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP48	MP48	MP48	MP49	MP49	MP49	MP50	MP51
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		T/WR	T/WR	T/WR | N/DN	N/DN	T/WR	T/WR | N/DN	T/WR | B/WB	B/WB
							Sample ID		11MP48SB04	11MP48SB08	11MP48SB12	11MP49SB14	11MP49SB06	11MP49SB10	11MP50SB04	11MP51SB14
Analyte							Method									
Arsenic Speciation																
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg								
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg								
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg								
Mercury Selective Sequential Extraction																
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g								
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g								
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g								
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g								
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g								
Semi-Volatile Organic Compounds																
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Diesel and Residual Range Organics																
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg								
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg								

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP51	MP51	MP51	MP52	MP52	MP52	MP53	MP53
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		F | N/DN	F | T/WR	T/WR | F	B/WB	N/DN	T/WR	F | T/WR	N/DN
							Sample ID		11MP51SB08	11MP51SB04	11MP51SB06	11MP52SB26	11MP52SB10	11MP52SB06	11MP53SB04	11MP53SB08
Analyte							Method									
Total Inorganic Elements																
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg		**3130**	**8410**	**5090**	**10800**	**7340**	**6420**	**6020**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg		**247 J**	**863 J**	**70.2 J**	**73.8 J**	**3770 J**	**2220 J**	**262 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg		**879**	**2210 J**	**174 J**	**76.1 J**	**2690 J**	**2110 J**	**625 J**
Barium	178	52	52	9	830	75	SW6020A	mg/kg		**90.1**	**189**	**267**	**107**	**300**	**177**	**103**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg		**0.576**	**0.386 J**	**0.727 J**	**0.278 J**	**0.551 J**	**0.607**	**0.541 J**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg		**0.461**	**0.319**	**0.838**	**0.21**	**0.522**	**0.42**	**0.455**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg		**2150**	**13700**	**4680**	**2950**	**4270**	**2610**	**2840**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg		**10.8**	**28.1 J**	**13.8 J**	**19.3 J**	**19.9 J**	**15.8**	**15.2 J**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg		**14.3**	**10.8 J**	**15 J**	**5.7 J**	**11.7 J**	**11.9**	**11.1 J**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg		**59.1**	**83.1**	**54.7**	**17.3**	**49.6**	**54.4**	**60.2**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg		**39600**	**36700**	**65900**	**14800**	**36900**	**49200**	**35500**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg		**13.1**	**18.2 J**	**11.9 J**	**6.25 J**	**0.767 J**	**13.2**	**13.7 J**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg		**1820**	**5300**	**1030**	**4130**	**4820**	**2440**	**1860**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg		**388**	**531**	**1790**	**170**	**760**	**494**	**430**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg		**70.7 J**	**438 J**	**25 J**	**18.8 J**	**500 J**	**6110 J**	**108 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg		**49.8**	**38.7**	**60.8**	**18.2**	**40.3**	**35.8**	**37.3**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg		**940**	**1520 J**	**1310 J**	**913 J**	**2120 J**	**1460 J**	**1150 J**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg		**1.06**	**0.62**	**0.81**	**0.04 J**	**0.81**	**0.35 J**	**0.53**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg		**0.181**	**0.187**	**0.184**	**0.066**	**0.21**	**0.125**	**0.14**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg		**37.1 J**	**241**	**60.5**	**263**	**266**	**89.5**	**52**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg		**0.154**	**0.264**	**0.159**	**0.084**	**0.207**	**0.142**	**0.11**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg		**18**	**42.1 J**	**27 J**	**27.6 J**	**19.6 J**	**25.9**	**28.1 J**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg		**94.7 J**	**288**	**136**	**50.9**	**88**	**96 J**	**123**
Low Level Mercury																
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g		**50800 J**			**306 J**	**1580000 J**		
SPLP Inorganic Elements																
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L			**1010 J**		**2320 J**	**809 J**		
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L			**2220 J**		**241 J**	**3100 J**		
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L			**614**		**86 J**	**841**		
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L			**11.1 J**		**27.9 J**	**20 J**		
Beryllium		8	0				SW6010B-SPLP	µg/L			0.2 U		0.2 U	0.2 U		
Cadmium		8	0				SW6010B-SPLP	µg/L			0.8 U		0.8 U	0.8 U		
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L			**55800**		**1210**	**2950**		
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L			3 U		**3.8 J**	3 U		
Cobalt		8	0				SW6010B-SPLP	µg/L			2 U		2 U	2 U		
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L			**17.8**		5 U	5 U		
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L			**4.2 J**		**2530**	**1870**		
Lead		8	0				SW6010B-SPLP	µg/L			8 U		8 U	8 U		
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L			**52.8 J**		**619**	**2660**		
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L			0.4 U		**20.1**	**17.8**		
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L			**0.88 J**		**4.51**	**9.4**		
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L			2 U		**4.3 J**	**2.1 J**		
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L			**323 J**		**445**	**1040**		
Selenium		8	0				SW6010B-SPLP	µg/L			30 U		30 U	30 U		
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L			5 U		**7.6 J**	5 U		
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L			**3360 J**		**7820 J**	**8440 J**		
Thallium		8	0				SW6010B-SPLP	µg/L			30 U		30 U	30 U		
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L			**9.2 J**		**9.8 J**	5 U		
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L			**34.8**		**47.60 J**	**20.8 J**		
TCLP Inorganic Elements																
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L			**0.14**		**0.13**	**0.53**		
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L			**0.551 J**		**0.492 J**	**0.323 J**		
Cadmium		8	0				SW6010B-TCLP	mg/L			0.002 U		0.002 U	0.002 U		
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L			0.003 U		0.003 U	**0.004 J**		
Lead		8	0				SW6010B-TCLP	mg/L			0.02 U		0.02 U	0.02 U		
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L			0.004 U		0.004 U	0.004 U		
Selenium		8	0				SW6010B-TCLP	mg/L			0.02 U		0.02 U	0.02 U		
Silver		8	0				SW6010B-TCLP	mg/L			0.007 U		0.007 U	0.007 U		

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**MP51**	**MP51**	**MP51**	**MP52**	**MP52**	**MP52**	**MP53**	**MP53**
							Geographic Area		**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**
							Soil Type*		**F | N/DN**	**F | T/WR**	**T/WR | F**	**B/WB**	**N/DN**	**T/WR**	**F | T/WR**	**N/DN**
							Sample ID		**11MP51SB08**	**11MP51SB04**	**11MP51SB06**	**11MP52SB26**	**11MP52SB10**	**11MP52SB06**	**11MP53SB04**	**11MP53SB08**
Analyte							**Method**									
Arsenic Speciation																
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg			**637**			**213**		
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg			**1860**			**1720**		
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg			**2500**			**1940**		
Mercury Selective Sequential Extraction																
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g		**508**			**22.5**	**8010**		
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g		**41.7**			0.2 U	**178000**		
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g		**605**			**109**	**30200**		
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g		**5770**			**125**	**109000 J**		
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g		**53800 J**			**172 J**	**1250000 J**		
Semi-Volatile Organic Compounds																
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	110 U			**77**				
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**2600 J**				
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	70 U			14 U				
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	350 U			70 U				
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	55 U			**27 J**				
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**3700 J**							
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	120 U			**130**				
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**2400 J**							
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**4700 J**			**1300 J**				
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	70 U			**30 J**				
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**2300 J**							
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**7200 J**			**230 J**				
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**5400 J**							
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**3800 J**							
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**210 J**				
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**2500 J**							
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**340 J**				
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**6400 J**			**540 J**				
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**230 J**				
Diesel and Residual Range Organics																
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg	**2100 J**			**75 J**				
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg	**1400 J**			**24 J**				

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**MP54**	**MP54**	**MP55**	**MP55**	**MP56**	**MP56**	**MP56**	**MP57**
							Geographic Area		**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**
							Soil Type*		**N/DN or F**	**N/DN or F**	**N/DN | B/WB**	**T/WR | N/DN**	**B/WB**	**N/DN**	**N/DN**	**N/DN**
							Sample ID		**11MP54SB04**	**11MP54SB06**	**11MP55SB06**	**11MP55SB04**	**11MP56SB10**	**11MP56SB04**	**11MP56SB06**	**11MP57SB06**
Analyte							**Method**									
Total Inorganic Elements																
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg	**6380**	**9710**	**4510**	**6270**	**2040**	**11300**	**10400**	**10300**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg	**110 J**	**40.5 J**	**23.9 J**	**50.6 J**	**27.7 J**	**696 J**	**1190 J**	**57.8 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg	**746 J**	**181**	**81**	**253**	**129**	**421**	**715 J**	**581 J**
Barium	178	52	52	9	830	75	SW6020A	mg/kg	**121**	**144**	**194**	**97.3**	**97.2**	**167**	**198**	**89.1**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg	**0.529 J**	**0.448**	**0.549**	**0.615**	**0.354**	**0.34**	**0.398**	**0.425 J**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg	**0.459**	**0.32**	**0.996**	**0.442**	**0.374**	**0.174**	**0.514**	**0.295**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg	**2190**	**2190**	**1320**	**1720**	**2080**	**2020**	**2190**	**1930**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg	**15.4 J**	**16.1**	**11.2**	**14.7**	**10.4**	**16.9**	**22**	**17.1 J**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg	**11.1 J**	**11.6**	**17.3**	**16.6**	**11.1**	**6.81**	**9.25**	**10.9 J**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg	**40.7**	**28.8**	**61.4**	**46.1**	**33**	**18.8**	**56.8**	**22.5**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg	**39400**	**22500**	**37100**	**35400**	**37900**	**16800**	**37200**	**37900**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg	**11.5 J**	**8.7**	**15.3**	**11.5**	**8.62**	**4.86**	**59.8**	**8.55 J**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg	**1540**	**3110**	**1060**	**1320**	**388**	**3830**	**3260**	**2510**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg	**452**	**317**	**1950**	**1240**	**308**	**317**	**378**	**492**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg	**4340 J**	**5.65 J**	**4.21 J**	**30.4 J**	**15.2 J**	**86.6 J**	**2030 J**	**15.2 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg	**37**	**28.3**	**59.7**	**48.5**	**46**	**19.6**	**27.2**	**25.7**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg	**1250 J**	**838 J**	**1150 J**	**1150 J**	**834 J**	**804 J**	**854**	**823 J**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg	**0.56**	**0.07 J**	**0.59**	**0.34**	**0.19**	**0.19**	**0.46**	**0.32**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg	**0.115**	**0.092**	**0.227**	**0.156**	**0.132**	**0.09**	**0.158**	**0.083**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg	**82.4**	**108**	**45.5**	**50.7**	**38.9 J**	**107**	**86.8**	**54.9**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg	**0.129**	**0.093**	**0.144**	**0.079**	**0.051**	**0.096**	**0.114**	**0.082**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg	**23.8 J**	**26.3**	**24.2**	**30.7**	**21.5**	**24.2**	**34.1**	**35.6 J**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg	**83.4**	**64 J**	**111 J**	**152 J**	**118 J**	**45.8 J**	**461 J**	**58.3**
Low Level Mercury																
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g							**126000 J**	
SPLP Inorganic Elements																
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L							**2260 J**	
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L							**2930**	
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L							**204**	
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L							**36.4 J**	
Beryllium		8	0				SW6010B-SPLP	µg/L							0.15 U	
Cadmium		8	0				SW6010B-SPLP	µg/L							2 U	
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L							10 U	
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L							**4.5 J**	
Cobalt		8	0				SW6010B-SPLP	µg/L							2 U	
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L							**5.6 J**	
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L							**2250**	
Lead		8	0				SW6010B-SPLP	µg/L							15 U	
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L							**818**	
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L							**24.2**	
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L							**65.5**	
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L							**3.1 J**	
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L							**493**	
Selenium		8	0				SW6010B-SPLP	µg/L							20 U	
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L							**8 J**	
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L							**6860 J**	
Thallium		8	0				SW6010B-SPLP	µg/L							20 U	
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L							**6.6 J**	
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L							**28.5 J**	
TCLP Inorganic Elements																
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L							**0.32**	
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L							**0.639 J**	
Cadmium		8	0				SW6010B-TCLP	mg/L							0.002 U	
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L							0.003 U	
Lead		8	0				SW6010B-TCLP	mg/L							0.02 U	
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L							**0.0158**	
Selenium		8	0				SW6010B-TCLP	mg/L							0.02 U	
Silver		8	0				SW6010B-TCLP	mg/L							0.007 U	

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**MP54**	**MP54**	**MP55**	**MP55**	**MP56**	**MP56**	**MP56**	**MP57**
							Geographic Area		**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**	**Pre-1955**
							Soil Type*		**N/DN or F**	**N/DN or F**	**N/DN | B/WB**	**T/WR | N/DN**	**B/WB**	**N/DN**	**N/DN**	**N/DN**
							Sample ID		**11MP54SB04**	**11MP54SB06**	**11MP55SB06**	**11MP55SB04**	**11MP56SB10**	**11MP56SB04**	**11MP56SB06**	**11MP57SB06**
Analyte							**Method**									
Arsenic Speciation																
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg							**69.1**	
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg							**579**	
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg							**649**	
Mercury Selective Sequential Extraction																
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g							**534**	
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g							**92.7**	
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g							**2420**	
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g							**12500**	
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g							**103000 J**	
Semi-Volatile Organic Compounds																
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**1900**		2.2 U					110 U
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**650 J**					
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**270 J**		1.4 U					70 U
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	700 U		**10 J**					350 U
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**850**		1.1 U					**270 J**
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								**5700 J**
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**810**		**24**					**200 J**
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**11000 J**							
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**56000 J**							**6400 J**
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**630**		**1.9 J**					**160 J**
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**5700 J**							**3200 J**
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**60 J**					
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								**11000 J**
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**15000 J**							
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**7900 J**							**5200 J**
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**8000 J**		**89 J**					**9700 J**
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**20000 J**		**76 J**					**2700 J**
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**5000 J**		**60 J**					
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Diesel and Residual Range Organics																
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg	**7300 J**		1.5 UJ					**760 J**
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg	**530 J**		3.3 UJ					**24 J**

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP57	MP57	MP58	MP58	MP58	MP59	MP59	MP59
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	T/WR	N/DN	T/WR	T/WR	N/DN (loess)	T/WR	T/WR | N
							Sample ID		11MP57SB08	11MP57SB04	11MP58SB12	11MP58SB04	11MP58SB08	11MP59SB14	11MP59SB04	11MP59SB12
Analyte							Method									
Total Inorganic Elements																
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg	**7640**	**9140**	**8020**	**2150**	**7310**	**10900**	**2340**	**13900**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg	**137 J**	**28900 J**	**117 J**	**40.7 J**	**19600 J**	**570 J**	**215 J**	**441 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg	**483 J**	**9460 J**	**323**	**819**	**4460 J**	**366 J**	**2870 J**	**319 J**
Barium	178	52	52	9	830	75	SW6020A	mg/kg	**85.9**	**161**	**98**	**138**	**446**	**101**	**139**	**144**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg	**0.388 J**	**0.313 J**	**0.481**	**0.763**	**0.327**	**0.286 J**	**0.874**	**0.404 J**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg	**0.318**	**0.826**	**0.338**	**0.487**	**0.271**	**0.198**	**0.623**	**0.192**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg	**1780**	**11600**	**1640**	**12700**	**3090**	**2090**	**4270**	**5170**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg	**17 J**	**14.1 J**	**16.9**	**11.2**	**16.8**	**19.7 J**	**12.6**	**20.2 J**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg	**10.9 J**	**7.38 J**	**12**	**21.9**	**5.5**	**10.7 J**	**20.9**	**9.29 J**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg	**28.8**	**28.1**	**25.9**	**74.8**	**26.9**	**19.1**	**82**	**26.2**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg	**29400**	**44700**	**31000**	**37500**	**27900**	**32400**	**37000**	**29600**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg	**6.57 J**	**0.25 J**	**7.29**	**19.1**	**0.047 J**	**5.2 J**	**26.4**	**6.91 J**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg	**2460**	**2370**	**1900**	**11300**	**2150**	**3730**	**7630**	**6580**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg	**395**	**435**	**561**	**1150**	**247**	**817**	**882**	**441**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg	**33.9 J**	**2070 J**	**40.3 J**	**69.4 J**	**622 J**	**16.4 J**	**423 J**	**31.1 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg	**30.4**	**20.2**	**31**	**61.4**	**18.6**	**22.4**	**73**	**26.8**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg	**1010 J**	**1010 J**	**856 J**	**1240 J**	**1440**	**743 J**	**1350 J**	**926.00 J**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg	**0.24**	**2.27**	**0.61**	**0.64**	**3.04**	**0.21**	**0.73**	**0.34**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg	**0.13**	**0.25**	**0.103**	**0.25**	**0.196**	**0.093**	**0.307**	**0.471**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg	**78.7**	**88**	**64.5**	**49**	**96.5**	**107**	**37.4 J**	**118**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg	**0.093**	**0.158**	**0.075**	**0.094**	**0.257**	**0.072**	**0.219**	**0.083**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg	**24.7 J**	**20.1 J**	**31.8**	**23.2**	**14.2**	**33.6 J**	**15.8**	**34.9 J**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg	**70**	**141**	**65.2 J**	**112 J**	**41.7 J**	**51.9**	**120 J**	**62**
Low Level Mercury																
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g					**1220000 J**			**6330 J**
SPLP Inorganic Elements																
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L					**325 J**			**1090 J**
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L					**26200**			**3080 J**
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L					**4880**			**208**
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L					**48.3 J**			**18.7 J**
Beryllium		8	0				SW6010B-SPLP	µg/L					0.15 U			0.2 U
Cadmium		8	0				SW6010B-SPLP	µg/L					2 U			0.8 U
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L					**6410 X**			**1380**
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L					2.5 U			3 U
Cobalt		8	0				SW6010B-SPLP	µg/L					2 U			2 U
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L					3 U			**5.1 J**
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L					**490**			**1690**
Lead		8	0				SW6010B-SPLP	µg/L					15 U			8 U
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L					**3920**			**2560**
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L					**74.9**			**15.7**
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L					**25.2**			**2.43**
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L					**2.8 J**			**3 J**
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L					**1030**			**399 J**
Selenium		8	0				SW6010B-SPLP	µg/L					20 U			30 U
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L					**7.7 J**			**10.4 J**
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L					**7150 J**			**1680 J**
Thallium		8	0				SW6010B-SPLP	µg/L					20 U			30 U
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L					3 U			5 U
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L					**6.7**			**22 J**
TCLP Inorganic Elements																
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L					**6.97**			**0.42**
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L					**0.385 J**			**0.906 J**
Cadmium		8	0				SW6010B-TCLP	mg/L					0.002 U			0.002 U
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L					0.003 U			0.003 U
Lead		8	0				SW6010B-TCLP	mg/L					0.02 U			0.02 U
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L					0.004 U			0.004 U
Selenium		8	0				SW6010B-TCLP	mg/L					0.02 U			0.02 U
Silver		8	0				SW6010B-TCLP	mg/L					0.007 U			0.007 U

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP57	MP57	MP58	MP58	MP58	MP59	MP59	MP59
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	T/WR	N/DN	T/WR	T/WR	N/DN (loess)	T/WR	T/WR | N
							Sample ID		11MP57SB08	11MP57SB04	11MP58SB12	11MP58SB04	11MP58SB08	11MP59SB14	11MP59SB04	11MP59SB12
Analyte							Method									
Arsenic Speciation																
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg				**69.6**			**1200 J**	
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg				**282**			**3020**	
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg				**352**			**4220**	
Mercury Selective Sequential Extraction																
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g					**4860 J**			**102**
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g					**120 J**			**2.92**
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g					**12200 J**			**2800**
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g					**31300 J**			**51.4**
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g					**670000 J**			**2660**
Semi-Volatile Organic Compounds																
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Diesel and Residual Range Organics																
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg								
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg								

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP60	MP60	MP60	MP61	MP61	MP62	MP62	MP62
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	T/WR	T/WR	N/DN	N/DN	B/WB	B/WB	T/WR | N/DN
							Sample ID		11MP60SB24	11MP60SB04	11MP60SB14	11MP61SB04	11MP61SB06	11MP62SB14	11MP62SB24	11MP62SB04
Analyte							Method									
Total Inorganic Elements																
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg	**4420**	**2160**	**2300 J**	**14300**	**14900 J**	**11800**	**17400**	**8510**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg	**64.9 J**	**181 J**	**240 J**	**2.33 J**	**1.25 J**	**3.23 J**	**4.55 J**	**973 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg	**496**	**2510**	**3120 J**	**52.9**	**19.7 J**	**27.3 J**	**26.4 J**	**416 J**
Barium	178	52	52	9	830	75	SW6020A	mg/kg	**87.1**	**145**	**116**	**119**	**121**	**75.7**	**141**	**112**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg	**0.516**	**0.88**	**0.746 J**	**0.315**	**0.353 J**	**0.187 J**	**0.431 J**	**0.37 J**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg	**0.313**	**0.387**	**0.5**	**0.156**	**0.217**	**0.143**	**0.286**	**0.199**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg	**1350 J**	**5980**	**5170 J**	**2490**	**1950 J**	**1920**	**2870**	**6350**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg	**12.4**	**10.1**	**17 J**	**18.4**	**20 J**	**17.1 J**	**19.7 J**	**15.4 J**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg	**7.31**	**17.7**	**22 J**	**6.07**	**6.55 J**	**6.33 J**	**7.71 J**	**9.59 J**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg	**35.4 J**	**57.9**	**66.4 J**	**16.7**	**19.1 J**	**17.5**	**22.5**	**24.2**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg	**30700**	**40800**	**46200**	**17900**	**15000**	**16200**	**13600**	**24900**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg	**9.55**	**15.1**	**15.2 J**	**7.34**	**7.96 J**	**9.18 J**	**7.95 J**	**8.18 J**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg	**1620 J**	**8040**	**8410 J**	**3540**	**3580 J**	**4260**	**4100**	**5770**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg	**501**	**845**	**976**	**211**	**173**	**102**	**116**	**463**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg	**38.6 J**	**276 J**	**348 J**	**2.62 J**	**0.702 J**	**0.493 J**	**0.787 J**	**906 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg	**27.2**	**56.1**	**82.8**	**17.1**	**19.8**	**51.7**	**29.4**	**35.8**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg	**1130**	**1240**	**1390 J**	**568**	**570 J**	**1140 J**	**780 J**	**1150 J**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg	**0.26**	**0.95**	**1.52**	**0.24**	**0.24**	**0.56**	**1.23**	**0.58**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg	**0.23**	**0.227**	**0.304**	**0.099**	**0.117**	**0.096**	**0.152**	**0.158**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg	**79.1**	**47.8**	**69**	**75.2**	**78.8**	**103**	**161**	**66.4**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg	**0.112**	**0.17**	**0.158**	**0.099**	**0.105**	**0.063**	**0.115**	**0.086**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg	**24**	**20.7**	**19.1 J**	**33.2**	**33 J**	**22.6 J**	**40.5 J**	**29.1 J**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg	**67.8 J**	**101 J**	**115 J**	**47.1 J**	**54.4 J**	**41.2**	**64.1**	**58.6**
Low Level Mercury																
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g			**456000 J**					
SPLP Inorganic Elements																
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L			**359 J**					
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L			**319**					
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L			**452**					
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L			**8.4 J**					
Beryllium		8	0				SW6010B-SPLP	µg/L			0.2 U					
Cadmium		8	0				SW6010B-SPLP	µg/L			0.8 U					
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L			**3330**					
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L			3 U					
Cobalt		8	0				SW6010B-SPLP	µg/L			2 U					
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L			5 U					
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L			**268**					
Lead		8	0				SW6010B-SPLP	µg/L			8 U					
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L			**4470**					
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L			**2.6 J**					
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L			**1.44**					
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L			2 U					
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L			**730**					
Selenium		8	0				SW6010B-SPLP	µg/L			30 U					
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L			**11.6 J**					
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L			**6510 J**					
Thallium		8	0				SW6010B-SPLP	µg/L			30 U					
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L			5 U					
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L			**55 J**					
TCLP Inorganic Elements																
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L			**0.8**					
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L			**0.55 J**					
Cadmium		8	0				SW6010B-TCLP	mg/L			0.002 U					
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L			**0.007 J**					
Lead		8	0				SW6010B-TCLP	mg/L			0.02 U					
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L			0.004 U					
Selenium		8	0				SW6010B-TCLP	mg/L			0.02 U					
Silver		8	0				SW6010B-TCLP	mg/L			0.007 U					

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP60	MP60	MP60	MP61	MP61	MP62	MP62	MP62
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	T/WR	T/WR	N/DN	N/DN	B/WB	B/WB	T/WR | N/DN
							Sample ID		11MP60SB24	11MP60SB04	11MP60SB14	11MP61SB04	11MP61SB06	11MP62SB14	11MP62SB24	11MP62SB04
Analyte							Method									
Arsenic Speciation																
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg			**488**					
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg			**1820**					
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg			**2310**					
Mercury Selective Sequential Extraction																
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g			**311**					
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g			**1.34**					
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g			**4370**					
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g			**15200**					
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g			**423000 J**					
Semi-Volatile Organic Compounds																
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg								
Diesel and Residual Range Organics																
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg								
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg								

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP63	MP63	MP66	MP66	MP66	MP66
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	N/DN	B/WB	B/WB	B/WB	N/DN
							Sample ID		11MP63SB04	11MP63SB06	11MP66SB10	11MP66SB16	11MP66SB18	11MP66SB06
Analyte							Method							
Total Inorganic Elements														
Aluminum	15300	52	52	1	17400	1830	SW6010B	mg/kg	**10700 J**	**10300 J**	**9950**		**3900 J**	**10600**
Antimony	52.2	52	52	38	28900	1.02	SW6010B/SW6020A	mg/kg	**115 J**	**223 J**	**24.6 J**		**1.02 J**	**131 J**
Arsenic	12.8	52	52	52	9460	19.7	SW6010B/SW6020A	mg/kg	**61.60 J**	**208 J**	**78**		**36.6 J**	**196**
Barium	178	52	52	9	830	75	SW6020A	mg/kg	**95.5**	**85.8**	**90.9**		**78.5**	**87.3**
Beryllium	0.484	52	52	25	0.88	0.187	SW6020A	mg/kg	**0.274 J**	**0.32 J**	**0.396**		**0.665 J**	**0.365**
Cadmium	1.3	52	52	0	0.996	0.143	SW6020A	mg/kg	**0.168**	**0.307**	**0.442**		**0.877**	**0.401**
Calcium	4640	52	52	13	13700	1150	SW6010B	mg/kg	**1600 J**	**2020 J**	**1760**		**1930 J**	**2520**
Chromium	23.4	52	52	4	29.8	10.1	SW6020A	mg/kg	**15.2 J**	**17.8 J**	**20.7**		**11.1 J**	**19.9**
Cobalt	19.1	52	52	3	22	5.5	SW6020A	mg/kg	**6.8 J**	**7.22 J**	**16.1**		**15.3 J**	**14.3**
Copper	59.7	52	52	11	83.1	14.2	SW6020A	mg/kg	**14.2 J**	**22.3 J**	**33.8**		**79.3 J**	**29.6**
Iron	39300	52	52	17	65900	13600	SW6010B	mg/kg	**21500**	**42700**	**45400**		**51100**	**21400**
Lead	14.3	52	52	9	59.8	0.043	SW6020A	mg/kg	**4.48 J**	**6.1 J**	**9.36**		**19.9 J**	**9.17**
Magnesium	4880	52	52	13	11400	316	SW6010B	mg/kg	**3470 J**	**3920 J**	**4210**		**1500 J**	**4710**
Manganese	951	52	52	6	1950	102	SW6010B	mg/kg	**472**	**470**	**731**		**374**	**360**
Mercury	3.92	52	52	46	6110	0.493	SW7471A	mg/kg	**0.509 J**	**7.89 J**	**1.87 J**		**6.86 J**	**31 J**
Nickel	52.2	52	52	11	82.8	17.1	SW6020A	mg/kg	**18.1**	**29.2**	**39.8**		**78.7**	**33**
Potassium	1080	52	52	28	3240	568	SW6010B	mg/kg	**687 J**	**849 J**	**897**		**1110 J**	**981**
Selenium	0.37	52	52	33	3.04	0.04	SW7742	mg/kg	**0.09 J**	**1.04**	**0.19**		**1.37**	**0.34**
Silver	10.5	52	52	0	0.471	0.066	SW6020A	mg/kg	**0.068**	**0.125**	**0.132**		**0.237**	**0.139**
Sodium	8170	52	52	0	279	25.1	SW6010B	mg/kg	**93.3**	**83.5**	**49.9**		**46.5**	**55.3**
Thallium	0.088	52	52	35	0.414	0.051	SW6020A	mg/kg	**0.068**	**0.063**	**0.067**		**0.092**	**0.074**
Vanadium	37.6	52	52	2	42.1	14.2	SW6020A	mg/kg	**22 J**	**23.6 J**	**29.1**		**28.5 J**	**29.2**
Zinc	106	52	52	16	461	39.8	SW6020A	mg/kg	**39.8 J**	**64.8 J**	**95.9 J**		**178 J**	**84.3 J**
Low Level Mercury														
Mercury		7	7	0	1580000	306	EPA 1631 Appendix	ng/g						
SPLP Inorganic Elements														
Aluminum		8	8		2320	325	SW6010B-SPLP	µg/L						
Antimony		8	8		26200	241	SW6010B-SPLP	µg/L						
Arsenic		8	8		4880	80	SW6010B-SPLP	µg/L						
Barium		8	8		48.3	8.4	SW6010B-SPLP	µg/L						
Beryllium		8	0				SW6010B-SPLP	µg/L						
Cadmium		8	0				SW6010B-SPLP	µg/L						
Calcium		8	7		55800	1210	SW6010B-SPLP	µg/L						
Chromium		8	2		4.5	3.8	SW6010B-SPLP	µg/L						
Cobalt		8	0				SW6010B-SPLP	µg/L						
Copper		8	3		17.8	5.1	SW6010B-SPLP	µg/L						
Iron		8	8		2530	4.2	SW6010B-SPLP	µg/L						
Lead		8	0				SW6010B-SPLP	µg/L						
Magnesium		8	8		4470	52.8	SW6010B-SPLP	µg/L						
Manganese		8	7		74.9	2.6	SW6010B-SPLP	µg/L						
Mercury		8	8		65.5	0.88	SW7470A-SPLP	µg/L						
Nickel		8	5		4.3	2.1	SW6010B-SPLP	µg/L						
Potassium		8	8		1040	323	SW6010B-SPLP	µg/L						
Selenium		8	0				SW6010B-SPLP	µg/L						
Silver		8	6		11.6	5.7	SW6010B-SPLP	µg/L						
Sodium		8	8		8440	1680	SW6010B-SPLP	µg/L						
Thallium		8	0				SW6010B-SPLP	µg/L						
Vanadium		8	3		9.8	6.6	SW6010B-SPLP	µg/L						
Zinc		8	8		76.6	6.7	SW6010B-SPLP	µg/L						
TCLP Inorganic Elements														
Arsenic		8	8		6.97	0.12	SW6010B-TCLP	mg/L						
Barium		8	8		0.906	0.323	SW6010B-TCLP	mg/L						
Cadmium		8	0				SW6010B-TCLP	mg/L						
Chromium		8	2		0.007	0.004	SW6010B-TCLP	mg/L						
Lead		8	0				SW6010B-TCLP	mg/L						
Mercury		8	2		0.0158	0.0074	SW7470A-TCLP	mg/L						
Selenium		8	0				SW6010B-TCLP	mg/L						
Silver		8	0				SW6010B-TCLP	mg/L						

Table 4-24 Pre-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP63	MP63	MP66	MP66	MP66	MP66
							Geographic Area		Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955	Pre-1955
							Soil Type*		N/DN	N/DN	B/WB	B/WB	B/WB	N/DN
							Sample ID		11MP63SB04	11MP63SB06	11MP66SB10	11MP66SB16	11MP66SB18	11MP66SB06
Analyte							Method							
Arsenic Speciation														
Arsenite		6	6		1200	69.1	EPA 1632-As3-CRYO-T	mg/kg						
Arsenate		6	6		3020	282	EPA 1632-As-Cryo-S-Speciation	mg/kg						
Inorganic Arsenic		6	6		4220	352	EPA 1632-Total Inorganic As - Solid	mg/kg						
Mercury Selective Sequential Extraction														
Hg(F1)		7	7		8010	22.5	'BRL SOP No. BR-0013	ng/g						
Hg(F2)		7	6		178000	1.34	'BRL SOP No. BR-0013	ng/g						
Hg(F3)		7	7		30200	109	'BRL SOP No. BR-0013	ng/g						
Hg(F4)		7	7		109000	51.4	'BRL SOP No. BR-0013	ng/g						
Hg(F5)		7	7		1250000	172	'BRL SOP No. BR-0013	ng/g						
Semi-Volatile Organic Compounds														
2-Methylnaphthalene		7	3		12000	77	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**12000**		
9-Octadecenamide, (Z)-		2	2		2600	650	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Acenaphthene		7	2		410	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**410 J**		
Bis(2-ethylhexyl) Phthalate		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				700 U		
Fluorene		7	5		1200	27	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**1200**		
Heptadecane		2	2		5700	3700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Heptylcyclohexane		1	1		3900	3900	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**3900 J**		
Naphthalene		7	5		3500	24	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**3500**		
Octadecane		2	2		11000	2400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Pentadecane, 2,6,10,14-tetramethyl		5	5		56000	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**39000 J**		
Pentadecane, 2,6,10-trimethyl-		1	1		6400	6400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**6400 J**		
Phenanthrene		7	6		980	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**980**		
Tetradecane		3	3		5700	2300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Tricosane, 2-methyl-		1	1		60	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Tridecane		3	3		11000	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Undecane		2	2		15000	5400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Undecane, 2,6-dimethyl-		3	3		7900	3800	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Undecane, 2-methyl-		1	1		210	210	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Unknown		6	6		9700	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**8500 J**		
Unknown Alkane		6	6		20000	76	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**4600 J**		
Unknown Branched Alkane		6	6		6400	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**4400 J**		
Unknown Branched Naphthalene		1	1		4600	4600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**4600 J**		
Unknown Substituted Aromatic		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						
Diesel and Residual Range Organics														
C10 - C25 DRO		7	6		7300	75	AK102-Alaska Diesel Range for Soil	mg/kg				**2500 J**		
C25 - C36 RRO		7	6		1400	24	AK103-Alaska Residual Range for Soil	mg/kg				**82 J**		

* Soil types defined in Appendix B.

Key

Bold = detection
% = percent
µg/kg = micrograms per kilogram
µg/L = micrograms per liter
BRL SOP = Brooks Rand Labs Standard Operating Procedure
DRO = diesel range organics
EPA = United States Environmental Protection Agency
Gray shading = exceedance of background
Hg = mercury
ID = identifier
J = The analyte was detected. The associated result is estimated.
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
ng/g = nanograms per gram
RRO = residual range organics
SPLP = synthetic precipitation leaching procedure
TCLP = toxicity characteristic leaching procedure
U = The analyte was analyzed for but not detected. The value provided is the repo
UJ = The analyte was analyzed for but not detected. The associated reporting limit

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP01	MP01	MP01	MP10	MP10	MP11	MP11	MP11	MP12	MP12	MP12	MP13
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	N/DN	N/DN	B/WB	B/WB	T/WR	N/DN	N/DN	F	N/DN	B/WB	F
							Sample ID		11MP01SB04	11MP01SB12	11MP01SB16	11MP10SB04	11MP10SB06	11MP11SB04	11MP11SB06	11MP11SB08	11MP12SB06	11MP12SB12	11MP12SB16	11MP13SB04
Analyte							Method													
Total Inorganic Elements																				
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	**14400 J**	**14200 J**	**5180**	**3000 J**	**2830 J**	**7280**	**12500**	**6980**	**4840**	**3490**	**3630**	**2440**
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	**0.94 J**	**0.245 J**	**0.501 J**	**8.09 J**	**3.38 J**	**5760 J**	**323 J**	**5.86 J**	**184 J**	**0.547 J**	**46.5 J**	**50.1 J**
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	**10.3 J**	**12.5 J**	**34**	**25.5 J**	**15.6 J**	**3740 J**	**471 J**	**38.2 J**	**562**	**91**	**665**	**126**
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	**147**	**148**	**75.4**	**133**	**126**	**394 J**	**194 J**	**188 J**	**147**	**90.5**	**86.6**	**99.4**
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	**0.431**	**0.536**	**0.597**	**0.334**	**0.305**	**0.636**	**0.535**	**0.578**	**0.483**	**0.584**	**0.781**	**0.386**
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	**0.331**	**0.372**	**0.449**	**0.413**	**0.303**	**0.543 J**	**0.431 J**	**0.495 J**	**0.527**	**0.648**	**0.901**	**0.48**
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	**1240**	**2430**	**1750 J**	**3090**	**2660**	**3930 J**	**1390 J**	**943 J**	**1410 J**	**1490 J**	**1710 J**	**1400 J**
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	**19.6**	**26.3**	**8.18 J**	**13.5**	**14.1**	**18 J**	**19.9 J**	**20.1 J**	**14.5 J**	**11.9**	**10.6 J**	**13.3**
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	**13.3**	**15.8**	**25**	**13.8**	**15.7**	**16.2**	**11.7**	**12.1**	**15**	**18.2**	**22**	**13.7**
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	**32.4 J**	**47.1 J**	**65.7 J**	**35.2 J**	**25.4 J**	**59 J**	**38.2 J**	**41.5 J**	**47.8 J**	**79.3 J**	**117 J**	**42.9 J**
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	**31200**	**53100**	**43300**	**51500**	**41300**	**45700**	**39800**	**25700**	**38000**	**42300**	**35400**	**35200**
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	**9.92**	**11.9**	**13.3 J**	**8.31**	**6.73**	**0.299 J**	**10.8 J**	**11.1 J**	**10.4 J**	**16.1 J**	**22.5 J**	**11 J**
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	**3630**	**4870**	**1760 J**	**680**	**758**	**4590 J**	**4420 J**	**2060 J**	**1120 J**	**732 J**	**865 J**	**626 J**
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	**611**	**507**	**563 J**	**731**	**697**	**900**	**701**	**219**	**913 J**	**758**	**661 J**	**974**
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	**0.435**	**0.361**	**1.56 J**	**3.6**	**5.63**	**163 J**	**71.2 J**	**0.914 J**	**55.4 J**	**1.5**	**11.5 J**	**16.6**
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	**34**	**47.6**	**70.7 J**	**47**	**43.8**	**47.6 J**	**40.4 J**	**43 J**	**45.8 J**	**53.5**	**92.4 J**	**46.9**
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	**855 J**	**1290 J**	**1130 J**	**876 J**	**816 J**	**1900 J**	**984 J**	**1130 J**	**1120 J**	**1280 J**	**1340 J**	**824 J**
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	**0.17**	**0.32**	**0.29**	**0.34**	**0.29**	**0.66**	**0.25**	**0.36**	**0.59**	**0.55**	**0.57**	**0.61**
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	**0.095**	**0.182**	**0.186**	**0.118**	**0.094**	**0.263 J**	**0.12 J**	**0.118 J**	**0.259**	**0.229**	**0.357**	**0.222**
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	**57**	**53.2**	**37.2**	**45.1**	**44.6**	**117**	**42.6**	**34.9**	**39.3**	**36.1**	**373**	**25.3**
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	**0.085**	**0.07**	**0.091**	**0.065**	**0.068**	**0.167**	**0.082**	**0.096**	**0.089**	**0.076**	**0.098**	**0.066**
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	**35.5**	**36.8**	**22.9**	**31.6**	**35.7**	**20.7**	**31.6**	**34.1**	**24.8**	**26.7**	**26.5**	**23.3**
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	**76.1 J**	**107 J**	**120**	**82.6 J**	**72.8 J**	**88.6 J**	**81.7 J**	**96.1 J**	**89.9**	**128**	**227**	**103**
Low Level Mercury																				
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g									**5100**			
SPLP Inorganic Elements																				
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L			**1870 J**		**1800**	**1490 J**						
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L			20 UJ		**24 J**	**5710 J**						
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L			20 U		20 U	**3080**						
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L			**34 J**		**47.8 J**	**35.5 J**						
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L			0.2 U		0.2 U	0.2 U						
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L			0.8 U		0.8 U	0.8 U						
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L			**697 J**		**1240**	**2730**						
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L			3 U		3 U	**3.9 J**						
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L			2 U		**2.4 J**	2 U						
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L			**12.2**		5 U	**6.5 J**						
Iron		17	17		7410	114	SW6010B-SPLP	µg/L			**4720 J**		**4530**	**2570**						
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L			8 U		8 U	8 U						
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L			**314**		**353**	**3680**						
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L			**35.4**		**120**	**43.6**						
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L			**1.08**		**2.24**	**37.8**						
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L			**7.2 J**		**6.5 J**	**5.7 J**						
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L			**1170**		**777**	**1070**						
Selenium		17	0		0	0	SW6010B-SPLP	µg/L			30 U		30 U	30 U						
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L			**11.2 J**		**9.4 J**	**6.2 J**						
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L			**7340 J**		**8310 J**	**7750 J**						
Thallium		17	0		0	0	SW6010B-SPLP	µg/L			30 U		30 U	30 U						
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L			**6.9 J**		**7.4 J**	**8.1 J**						
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L			**35.8 J**		**53.8 J**	**31.4 J**						
TCLP Inorganic Elements																				
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L					0.01 U	**7.58**						
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L					**0.423 J**	**0.332 J**						
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L					0.002 U	0.002 U						
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L					0.003 U	**0.003 J**						
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L					0.02 U	0.02 U						
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L					0.004 U	**0.0113**						
Selenium		12	0		0	0	SW6010B-TCLP	mg/L					0.02 U	0.02 U						
Silver		12	0		0	0	SW6010B-TCLP	mg/L					0.007 U	0.007 U						
Arsenic Speciation																				
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg			**0.346**			**209**						
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg			**42.6**			**2680**						
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg			**43**			**2890**						
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg												
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg												
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg												
Mercury Selective Sequential Extraction																				
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g									**162**			
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g									**360 J**			
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g									**323 J**			
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g									**1050**			
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g									**2300**			

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP01	MP01	MP01	MP10	MP10	MP11	MP11	MP11	MP12	MP12	MP12	MP13
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	N/DN	N/DN	B/WB	B/WB	T/WR	N/DN	N/DN	F	N/DN	B/WB	F
							Sample ID		11MP01SB04	11MP01SB12	11MP01SB16	11MP10SB04	11MP10SB06	11MP11SB04	11MP11SB06	11MP11SB08	11MP12SB06	11MP12SB12	11MP12SB16	11MP13SB04
Analyte							Method													
Semi-Volatile Organic Compounds																				
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diesel and Residual Range Organics																				
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg												
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg												

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP13	MP14	MP14	MP14	MP15	MP15	MP15	MP16	MP16	MP16	MP17	MP17
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	T/WR	N/DN	B/WB	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	T/WR	N/DN
							Sample ID		11MP13SB06	11MP14SB04	11MP14SB14	11MP14SB58	11MP15SB04	11MP15SB06	11MP15SB08	11MP16SB04	11MP16SB08	11MP16SB10	11MP17SB04	11MP17SB14
Analyte							Method													
Total Inorganic Elements																				
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	**2620**	**5490**	**5650**	**2140**	**3840**	**3660**	**3370**	**3660**	**3830**	**4670**	**4430**	**10300**
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	**11.5 J**	**6430 J**	**300**	**3.01 J**	**46.8 J**	**2.52 J**	**0.916 J**	**184 J**	**2.22**	**1.15**	**255**	**164 J**
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	**79.1**	**1790**	**427**	**51.9**	**80.4**	**44.5**	**29.1**	**200**	**46.7**	**35**	**1170**	**141 J**
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	**197**	**333 J**	**195**	**99.6 J**	**210 J**	**191 J**	**168**	**154**	**228**	**165**	**149**	**126 J**
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	**0.513**	**0.61**	**0.535**	**0.797**	**0.564**	**0.577**	**0.545**	**0.475**	**0.566**	**0.581**	**0.515**	**0.37**
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	**0.659**	**0.691 J**	**0.572**	**1.32 J**	**0.676 J**	**0.538 J**	**0.602**	**0.64**	**0.72**	**0.578**	**0.419**	**0.174 J**
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	**1590 J**	**2950 J**	**1090**	**3000 J**	**1950 J**	**1480 J**	**2040 J**	**1790 J**	**2280**	**2140**	**1430**	**1600 J**
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	**15.3 J**	**16 J**	**18.8**	**15.5 J**	**26.5 J**	**15.6 J**	**13.6 J**	**16.5 J**	**16.7**	**14.2**	**15**	**19 J**
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	**18.3**	**14.7**	**16.5**	**22.8**	**20.2**	**17.3**	**18.3**	**22.8**	**23.5**	**21.7**	**15.9**	**6.53**
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	**65.4 J**	**58.7 J**	**50.1**	**90.3 J**	**67.8 J**	**72.4 J**	**64.5 J**	**56.1 J**	**67.4**	**68.9**	**107**	**21.7 J**
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	**33700**	**40600**	**38200**	**47900**	**41100**	**47100**	**42100**	**41500**	**42200**	**41400**	**53200**	**29800**
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	**16 J**	**1.35 J**	**24.1**	**21.3 J**	**18.6 J**	**16.4 J**	**14.7 J**	**19.2 J**	**15.4**	**15.7**	**229**	**10.5 J**
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	**679 J**	**3440 J**	**1900**	**10500 J**	**956 J**	**812 J**	**804 J**	**1510 J**	**1000**	**1100**	**1630**	**2200 J**
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	**925 J**	**807**	**885**	**1260**	**993**	**1200**	**1040 J**	**1080 J**	**1380**	**1200**	**1630**	**443**
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	**23.9 J**	**1410 J**	**70.1**	**2.9 J**	**57.4 J**	**19.1 J**	**5.78 J**	**2170**	**0.625**	**14.9**	**274**	**22.7 J**
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	**55 J**	**44 J**	**47.7**	**77.9 J**	**56.7 J**	**56 J**	**55.4 J**	**56.3 J**	**65**	**52.4**	**49.1**	**21.3 J**
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	**902 J**	**1630 J**	**1090**	**1270 J**	**1130 J**	**1010 J**	**903 J**	**1090 J**	**995**	**1180**	**1040**	**965 J**
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	**0.7**	**4.92**	**0.36**	**2.59**	**0.67**	**0.51**	**0.53**	**0.75**	**0.61**	**0.33**	**0.53**	**0.38**
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	**0.208**	**0.262 J**	**0.161**	**0.461 J**	**0.297 J**	**0.181 J**	**0.255**	**0.194**	**0.218**	**0.209**	**0.204**	**0.119 J**
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	**23.4**	**85.5**	**37**	**41.2**	**27.9**	**23**	**25.7**	**43.9**	**30.5**	**36.6**	**38.4**	**61.1**
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	**0.088**	**0.162**	**0.124**	**0.099**	**0.117**	**0.096**	**0.08**	**0.096**	**0.096**	**0.11**	**0.259**	**0.107**
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	**33**	**22.8**	**34.1**	**35.9**	**34.2**	**32.8**	**29.4**	**31.7**	**34.8**	**32**	**31.1**	**35**
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	**118**	**111 J**	**99.9**	**165 J**	**117 J**	**117 J**	**105**	**110**	**125**	**105**	**106**	**48.9 J**
Low Level Mercury																				
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g		**1170000**										**2340**
SPLP Inorganic Elements																				
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L		**1270 J**										
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L		**4810 J**										
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L		**2900**										
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L		**35 J**										
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L		0.2 U										
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L		0.8 U										
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L		**3700**										
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L		3 U										
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L		2 U										
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L		5 U										
Iron		17	17		7410	114	SW6010B-SPLP	µg/L		**2250**										
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L		8 U										
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L		**2910**										
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L		**57.2**										
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L		**166**										
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L		**4.4 J**										
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L		**898**										
Selenium		17	0		0	0	SW6010B-SPLP	µg/L		30 U										
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L		5 UJ										
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L		**6880 J**										
Thallium		17	0		0	0	SW6010B-SPLP	µg/L		30 U										
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L		**6.4 J**										
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L		**26.1 J**										
TCLP Inorganic Elements																				
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L		**9.01**										
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L		**0.695 J**										
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L		0.002 U										
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L		0.003 U										
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L		0.02 U										
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L		**0.0758**										
Selenium		12	0		0	0	SW6010B-TCLP	mg/L		0.02 U										
Silver		12	0		0	0	SW6010B-TCLP	mg/L		0.007 U										
Arsenic Speciation																				
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg												
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg												
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg												
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg												
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg												
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg												
Mercury Selective Sequential Extraction																				
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g		**26400**										**28 J**
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g		**133000 J**										**4.53 J**
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g		**15200 J**										**2350 J**
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g		**107000**										**277 J**
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g		**1040000**										**5690 J**

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP13	MP14	MP14	MP14	MP15	MP15	MP15	MP16	MP16	MP16	MP17	MP17
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	T/WR	N/DN	B/WB	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	T/WR	N/DN
							Sample ID		11MP13SB06	11MP14SB04	11MP14SB14	11MP14SB58	11MP15SB04	11MP15SB06	11MP15SB08	11MP16SB04	11MP16SB08	11MP16SB10	11MP17SB04	11MP17SB14
Analyte							Method													
Semi-Volatile Organic Compounds																				
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diesel and Residual Range Organics																				
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg												
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg												

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP17	MP18	MP18	MP18	MP19	MP19	MP20	MP20	MP20	MP21	MP21	MP21
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN
							Sample ID		11MP17SB30	11MP18SB04	11MP18SB10	11MP18SB20	11MP19SB04	11MP19SB06	11MP20SB04	11MP20SB08	11MP20SB12	11MP21SB04	11MP21SB08	11MP21SB14
							Method													
Total Inorganic Elements																				
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	4750	7880	10200	4440	4970 J	3080	2670	5970 J	3950 J	6290	5000 J	2700
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	1.96 J	164 J	3.97 J	412 J	1.04 J	0.674 J	0.909 J	0.351 J	0.19 J	15.3 J	1.48 J	1.13 J
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	25.2	170	31.1 J	106	19.6 J	9.83	22.2	15.5 J	5.52 J	15.3	10.8 J	8.1
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	135	136 J	115 J	152 J	254	134	190	266	139	212	114	99.7
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	0.526	0.44	0.579	0.486	0.459	0.453	0.555	0.591	0.487	0.586	0.541	0.6
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	0.567	0.401 J	0.413 J	0.477 J	0.339	0.472	0.429	0.392	0.596	0.515	0.622	0.359
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	1830 J	1300 J	1160 J	1580 J	1710	1440 J	1160 J	1540	2000	1170 J	885	1150 J
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	16.4 J	14.5 J	15.4 J	17.3 J	11.6	10.4 J	14.1	22.8	15.5	16.1	16.3	14.2
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	19.8	14.3	15.6	16.4	14.7	18.5	14.1	17.1	18.6	18.5	16.2	16.2
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	57.2 J	35.4 J	42.6 J	55.6 J	37.4 J	38.9 J	59.2 J	46.1 J	59.7 J	59.2 J	67.4 J	48.2 J
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	45300	35600	36200	44300	40700	45300	45000	41600	54000	39800	46600	39800
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	12.9 J	10.7 J	11.8 J	12.6 J	9.82	10.9 J	12.3 J	13.1	14	15.7 J	11.6	12.1 J
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	1730 J	1770 J	2130 J	1200 J	875	603 J	666 J	1570	1020	1320 J	741	759 J
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	881 J	905	728	659	1060	695 J	1100	1320	1280	973	362	599
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	1.88 J	41 J	1.24 J	1.78 J	1.88	7.5 J	2.12	0.639	0.718	1.09	0.85	0.751
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	64.9 J	38.5 J	44 J	49.4 J	40.9	47.2 J	44.5	43.4	57.3	53.5	48.4	49.1
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	1100 J	850 J	862 J	1010 J	1200 J	1000 J	923 J	1190 J	1290 J	946 J	1320 J	987 J
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	0.56	0.43	0.37	0.43	0.38	0.52	0.63	0.5	0.61	0.67	0.68	0.45
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	0.34	0.121 J	0.115 J	0.196 J	0.116	0.15	0.277	0.169	0.208	0.252	0.142	0.097
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	34.7	45.8	53.3	37.5	71.1	41	24.5	50.1	43.9	27.4	35.3 J	21.3
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	0.083	0.084	0.088	0.076	0.074	0.069	0.082	0.072	0.078	0.093	0.077	0.053
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	36.5	30.9	32.6	34.6	36.4	35.5	28.2	38.3	30.2	34.5	33.3	36.1
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	110	87.7 J	92 J	110 J	89 J	97.2	89.1	102 J	108 J	119	122 J	93.4
Low Level Mercury																				
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g		67600				4940						
SPLP Inorganic Elements																				
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L		1910 J			1690							
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L		587 J		109 J	20 U							
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L		39 J		26 J	20 U							
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L		34.9 J		75.9 J	40.9 J							
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L		0.2 U		0.22 J	0.2 U							
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L		0.8 U		0.8 U	0.8 U							
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L		1010		1590	969 J							
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L		3 U		6.6 J	3.1 J							
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L		2 U		3 J	2 U							
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L		5 U		14.6	5 U							
Iron		17	17		7410	114	SW6010B-SPLP	µg/L		2700		7410	2570							
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L		8 U		8 U	8 U							
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L		571		964	206							
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L		81.3		117	101							
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L		0.82 J		3.71	1.58							
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L		4.1 J		14.3 J	4.5 J							
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L		690		1470	754							
Selenium		17	0		0	0	SW6010B-SPLP	µg/L		30 U		30 U	30 U							
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L		10.4 J		11.1 J	6.2 J							
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L		1870 J		1610 J	13500 J							
Thallium		17	0		0	0	SW6010B-SPLP	µg/L		30 U		30 U	30 U							
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L		5.2 J		13.3	5 U							
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L		26 J		75.4 J	54 J							
TCLP Inorganic Elements																				
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L		0.04 J		0.04 J	0.01 U							
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L		0.53 J		0.655 J	0.594 J							
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L		0.002 U		0.002 U	0.002 U							
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L		0.003 U		0.003 U	0.003 U							
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L		0.02 U		0.02 U	0.02 U							
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L		0.004 U		0.004 U	0.004 U							
Selenium		12	0		0	0	SW6010B-TCLP	mg/L		0.02 U		0.02 U	0.02 U							
Silver		12	0		0	0	SW6010B-TCLP	mg/L		0.007 U		0.007 U	0.007 U							
Arsenic Speciation																				
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg				9.04	0.244							
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg				117	36.5							
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg				126	36.7							
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg												
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg												
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg												
Mercury Selective Sequential Extraction																				
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g		677 J				66.8						
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g		518 J				50 J						
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g		483 UJ				213 J						
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g		3550 J				625						
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g		36200 J				4490						

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP17	MP18	MP18	MP18	MP19	MP19	MP20	MP20	MP20	MP21	MP21	MP21
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN	N/DN
							Sample ID		11MP17SB30	11MP18SB04	11MP18SB10	11MP18SB20	11MP19SB04	11MP19SB06	11MP20SB04	11MP20SB08	11MP20SB12	11MP21SB04	11MP21SB08	11MP21SB14
Analyte							Method													
Semi-Volatile Organic Compounds																				
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**1500**											
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	48 U											
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**66 J**											
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	43 U											
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	30 U											
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	38 U											
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	35 U											
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	53 U											
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**310 J**											
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	38 U											
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	38 U											
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**58 J**											
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	33 U											
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**230**											
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	38 U											
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**560**											
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	40 U											
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**1400 J**											
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**2600 J**											
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**11000 J**											
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**130 J**											
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	38 U											
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**1500 J**											
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**4400 J**											
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**5700 J**											
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**3100 J**											
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**2200 J**											
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**1300 J**											
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diesel and Residual Range Organics																				
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg	**1000 Y**											
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg	**6.8 J**											

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP22	MP22	MP22	MP23	MP23	MP23	MP24	MP24	MP24	MP25	MP25
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		T/WR	T/WR	T/WR	T/WR	T/WR	T/WR | N (RDCA)	T/WR	T/WR	T/WR	T/WR	T/WR
							Sample ID		11MP22SB04	11MP22SB08	11MP22SB12	11MP23SB10	11MP23SB14	11MP23SB20	11MP24SB04	11MP24SB12	11MP24SB18	11MP25SB08	11MP25SB14
Analyte							Method												
Total Inorganic Elements																			
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	11800 J	9420 J	5790 J	2100 J	2270 J	9180 J	2190	10900	6170	11500	12900 J
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	6370 J	19300 J	2680 J	61.3 J	1350 J	10200 J	201 J	16100 J	4430 J	13000 J	16800 J
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	4970 J	7320 J	2370 J	443 J	1420 J	5430 J	1900	9250	3150	5360	7020 J
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	565	608	286	111	157	352	139	855	463	1050	680
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	0.868	0.691	0.583	0.607	0.63	0.387	0.659	0.667	0.826	0.672	0.574
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	0.432	0.433	0.293	0.575	0.634	0.288	0.6	0.336	0.432	0.326	0.341
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	7090	3650	3120	4310	6140	2980	4060 J	7920 J	6910 J	4990 J	7160
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	18.1	12.6	17.7	11.1	14.1	18.3	27.5	32.1	37.9	38.9	21.8
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	11.3	11.5	9.52	19.5	29.7	6	24.6	13	17.6	13.9	10
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	47.8 J	67.4 J	39 J	73.6 J	74.1 J	29.3 J	71.3 J	55 J	62.7 J	56.2 J	51.8 J
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	35500	42800	25400	35500	39900	22300	38700	39600	35300	37100	37800
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	0.587	0.055	3.52	14.2	13.1	0.083	19 J	0.25 J	7.75 J	0.145 J	0.089
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	6460	5140	4340	9460	8420	3890	10200 J	9460 J	11100 J	7120 J	8000
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	978	532	677	595	1410	217	678	788	550	631	668
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	61.7	223	72.8	337	119	3410	390	1520	499	564	565
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	42.3	44.1	33.8	70	85.4	23.9	86.5	53	64.1	55.3	37.6
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	3650 J	2580 J	1570 J	1330 J	1420 J	1530 J	1080 J	2840 J	1970 J	2990 J	3650 J
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	0.71	1.39	0.55	0.88	0.84	1.73	0.78	1.58	0.96	1.4	1.25
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	0.253	0.398	0.209	0.237	0.237	0.174	0.266	0.254	0.208	0.237	0.274
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	310	195	105	49.2	53.6	193	44.2	295	185	287	353
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	0.475	0.332	0.213	0.087	0.131	0.164	0.297	0.344	0.244	0.512	0.393
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	20.1	17	18.9	20.5	20.7	21.4	30.6	22	29.4	22	17
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	78.2 J	104 J	54.2 J	126 J	126 J	43.5 J	116	76.2	97.3	74.2	78.3 J
Low Level Mercury																			
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g						1390000		983000			
SPLP Inorganic Elements																			
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L						361					
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L						31200					
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L						5330					
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L						32.2 J					
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L						0.2 U					
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L						0.8 U					
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L						4260					
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L						3 U					
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L						2 U					
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L						5 U					
Iron		17	17		7410	114	SW6010B-SPLP	µg/L						962					
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L						8 U					
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L						6080					
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L						54.2					
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L						312					
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L						2 U					
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L						1090					
Selenium		17	0		0	0	SW6010B-SPLP	µg/L						30 U					
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L						8.4 J					
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L						9540 J					
Thallium		17	0		0	0	SW6010B-SPLP	µg/L						30 U					
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L						6.3 J					
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L						29.9 J					
TCLP Inorganic Elements																			
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L						1.59					
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L						0.37 J					
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L						0.002 U					
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L						0.003 U					
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L						0.02 U					
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L						0.0406					
Selenium		12	0		0	0	SW6010B-TCLP	mg/L						0.02 U					
Silver		12	0		0	0	SW6010B-TCLP	mg/L						0.007 U					
Arsenic Speciation																			
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg						1740					
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg						1590 J					
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg						3330					
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg											
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg											
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg											
Mercury Selective Sequential Extraction																			
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g						6570		23100			
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g						20.8 J		814 J			
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g						84100 J		11300 J			
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g						47500		39400			
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g						1120000		941000			

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP22	MP22	MP22	MP23	MP23	MP23	MP24	MP24	MP24	MP25	MP25
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		T/WR	T/WR	T/WR	T/WR	T/WR	T/WR | N (RDCA)	T/WR	T/WR	T/WR	T/WR	T/WR
							Sample ID		11MP22SB04	11MP22SB08	11MP22SB12	11MP23SB10	11MP23SB14	11MP23SB20	11MP24SB04	11MP24SB12	11MP24SB18	11MP25SB08	11MP25SB14
Analyte							Method												
Semi-Volatile Organic Compounds																			
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Diesel and Residual Range Organics																			
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg											
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg											

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP25	MP25	MP26	MP26	MP26	MP27	MP27	MP28	MP28	MP28	MP29	MP29
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		RDCA	N/DN	T/WR	T/WR	T/WR | N/DN	N/DN	N/DN	T/WR	N/DN	N/DN	T/WR	T/WR
							Sample ID		11MP25SB20	11MP25SB26	11MP26SB04	11MP26SB10	11MP26SB16	11MP27SB04	11MP27SB06	11MP28SB06	11MP28SB08	11MP28SB10	11MP29SB06	11MP29SB10
Analyte							Method													
Total Inorganic Elements																				
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	**9800**	**8920**	**9440 J**	**10500 J**	**11400 J**	**11800**	**9270**	**9030**	**6720**	**12400 J**	**12100.0 J**	**9580**
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	**405 J**	**608 J**	**14600 J**	**12400 J**	**1280 J**	**131 J**	**53.8 J**	**15400 J**	**212 J**	**723 J**	**15800 J**	**12600 J**
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	**84.8**	**451**	**9530 J**	**8870 J**	**808 J**	**20.8**	**93.4**	**7350**	**361**	**222 J**	**7360 J**	**5580**
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	**120**	**341**	**609**	**743**	**196**	**175**	**154**	**619**	**208**	**135**	**717**	**664**
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	**0.483**	**0.495**	**0.61**	**0.624**	**0.452**	**0.538**	**0.435**	**0.724**	**0.509**	**0.387**	**0.597**	**0.676**
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	**0.337**	**0.927**	**0.324**	**0.402**	**0.352**	**0.381**	**0.321**	**0.371**	**0.603**	**0.27**	**0.353**	**0.354**
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	**1540 J**	**2570 J**	**5810**	**3980**	**2980**	**999 J**	**1320 J**	**5710 J**	**1310 J**	**1870**	**6490**	**6770 J**
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	**20.2**	**19.7**	**18.8**	**16.4**	**14.9**	**17.2 J**	**20.9 J**	**17.5 J**	**16.7**	**17.2**	**32.4**	**29.4**
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	**13**	**15.6**	**10.2**	**8.28**	**13.1**	**13.1**	**11.1**	**10.5**	**18.4**	**9.64**	**8.64**	**12.2**
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	**26.8 J**	**28.9 J**	**63.9 J**	**53.3 J**	**32.4 J**	**27.1 J**	**23.3 J**	**60.3 J**	**48.2 J**	**26.5 J**	**46.8 J**	**51.1 J**
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	**29700**	**43700**	**32500**	**32700**	**26700**	**34900**	**38100**	**31900**	**36700**	**24800**	**48500**	**32000**
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	**8.71 J**	**7.39 J**	**0.053**	**3.71**	**9.32**	**9.07 J**	**8.57 J**	**0.027 J**	**13.4 J**	**7.85**	**0.18**	**0.055 J**
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	**3490 J**	**3740 J**	**5910**	**4940**	**3630**	**3540 J**	**3190 J**	**5750 J**	**2210 J**	**3230**	**7620**	**6900 J**
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	**456**	**3510**	**518**	**499**	**671**	**887 J**	**687 J**	**570 J**	**664**	**775**	**1720**	**665**
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	**2.91**	**62.2**	**1270**	**1070**	**44.2**	**0.532 J**	**3.32 J**	**434 J**	**42.1**	**56.9**	**89.4**	**163**
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	**27.8**	**51.4**	**37.6**	**31.6**	**31.4**	**30 J**	**26.5 J**	**37.1 J**	**45.9**	**27.7**	**31**	**50.5**
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	**931 J**	**558 J**	**3220 J**	**4580 J**	**2050 J**	**754 J**	**845 J**	**3120 J**	**1020 J**	**1320 J**	**4140 J**	**3200 J**
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	**0.32**	**0.33**	**2.25**	**1.38**	**0.36 J**	**0.11**	**0.14**	**1.17**	**0.44**	**0.41**	**0.91**	**1.1**
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	**0.126**	**0.205**	**0.248**	**0.26**	**0.15**	**0.109**	**0.11**	**0.249**	**0.239**	**0.147**	**0.229**	**0.232**
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	**80.8**	**63**	**338**	**318**	**164**	**40.1**	**47.9**	**219**	**37.3**	**114**	**362**	**258**
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	**0.084**	**0.093**	**0.504**	**0.339**	**0.151**	**0.088**	**0.082**	**0.306**	**0.129**	**0.107**	**0.554**	**0.423**
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	**35.8**	**31**	**16.5**	**16.7**	**25.5**	**35**	**33.7**	**16.5**	**29.5**	**33.4**	**18**	**17**
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	**63.2**	**79.5**	**80 J**	**85.8 J**	**72.6 J**	**63.1**	**56.1**	**69.8**	**89**	**67.7 J**	**76 J**	**69.1**
Low Level Mercury																				
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g				**11300 J**				**231000**	**23000**			
SPLP Inorganic Elements																				
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L								**2020 J**				**155**
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L								**16400 J**				**75300 J**
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L								**4830**				**3730 J**
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L								**35 J**				**8 J**
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L								0.2 U				0.2 U
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L								0.8 U				0.8 UJ
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L								**3120**				**3880**
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L								**5.3 J**				3 U
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L								2 U				2 U
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L								5 U				5 U
Iron		17	17		7410	114	SW6010B-SPLP	µg/L								**1450 J**				**114**
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L								8 U				8 U
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L								**5940**				**10600**
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L								**15.6**				**8.5**
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L								**32.4**				**1.9**
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L								2 U				2 U
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L								**2090**				**3020**
Selenium		17	0		0	0	SW6010B-SPLP	µg/L								30 U				30 UJ
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L								**5.7 J**				**5 J**
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L								**7590 J**				**6120 J**
Thallium		17	0		0	0	SW6010B-SPLP	µg/L								30 U				30 U
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L								**11.3**				**8 J**
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L								**25.3 J**				**14.6 J**
TCLP Inorganic Elements																				
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L								**10.3**				
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L								0.3 U				
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L								0.002 U				
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L								0.003 U				
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L								0.02 U				
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L								**0.0064 J**				
Selenium		12	0		0	0	SW6010B-TCLP	mg/L								0.02 U				
Silver		12	0		0	0	SW6010B-TCLP	mg/L								0.007 U				
Arsenic Speciation																				
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg								**257**				
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg								**4560**				
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg								**4810**				
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg												
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg												
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg												
Mercury Selective Sequential Extraction																				
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g				**2420 J**				**6830**	**253 J**			
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g				**754 J**				**2000 J**	**13.5 J**			
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g				**675 J**				**3950 J**	**4360 J**			
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g				**5920 J**				**27500**	**777 J**			
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g				**21300 J**				**261000**	**5700 J**			

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP25	MP25	MP26	MP26	MP26	MP27	MP27	MP28	MP28	MP28	MP29	MP29
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		RDCA	N/DN	T/WR	T/WR	T/WR | N/DN	N/DN	N/DN	T/WR	N/DN	N/DN	T/WR	T/WR
							Sample ID		11MP25SB20	11MP25SB26	11MP26SB04	11MP26SB10	11MP26SB16	11MP27SB04	11MP27SB06	11MP28SB06	11MP28SB08	11MP28SB10	11MP29SB06	11MP29SB10
Analyte							Method													
Semi-Volatile Organic Compounds																				
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**160 J**										
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		2.2 U										
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.9 U										
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.4 U										
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.7 U										
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.2 U										
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.5 U										
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.4 U										
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		2.1 U										
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**52 J**										
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.5 U										
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.5 U										
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.2 U										
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.3 U										
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**230 J**										
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.1 U										
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.5 U										
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		2.3 U										
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.6 U										
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**130 J**										
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**2.3 J**										
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		1.5 U										
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**68 J**										
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**240 J**										
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg		**110 J**										
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diesel and Residual Range Organics																				
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg		**2.7 J**										
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg		**15 J**										

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP29	MP30	MP30	MP30	MP31	MP32	MP32	MP32	MP33	MP34	MP34	MP34
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		T/WR	T/WR	N/DN	N/DN	B/WB	FT	FT	FT	B/WB	FT	FT	FT | N/DN
							Sample ID		11MP29SB16	11MP30SB06	11MP30SB12	11MP30SB16	11MP31SB04	11MP32SB04	11MP32SB06	11MP32SB08	11MP33SB04	11MP34SB04	11MP34SB06	11MP34SB08
Analyte							Method													
Total Inorganic Elements																				
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	10300	8910	10700	10900	2640 J	1760 J	1890 J	6550 J	2110	2650 J	2770 J	9650 J
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	12900 J	12800 J	4310 J	195 J	2.34 J	128 J	214 J	186 J	3.68 J	1450 J	668 J	126 J
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	4540	8670	3990 J	255	19.7 J	3720 J	4170 J	4010 J	9.91	5780 J	4010 J	1120 J
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	1020	758	172 J	124 J	79.2	94	89.4	115	152 J	111	126	187
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	0.705	0.687	0.381	0.379	0.551	0.548	0.602	0.579	0.628	0.641	0.634	0.504
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	0.344	0.325	0.132 J	0.289 J	0.33	0.251	0.294	0.226	0.996	0.38	0.321	0.566
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	5440 J	9670 J	4230 J	2360 J	2200	6190	5470	8300	1470 J	3970 J	6750 J	3130 J
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	23.5 J	59.6 J	18.6 J	20.6 J	11	17.3	19.5	25.8	15.2 J	30.7	27.6	24.3
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	11.8	16.5	7.48	16	14.3	8.62	9.32	17.6	34.4	18.7	17.1	28.5
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	61.9 J	91.5 J	20.3 J	23.4 J	55.9 J	30.6 J	34.8 J	33.5 J	105 J	46.8	41.3	33.4
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	33400	35100	30800	18900	23600	36700	37800	37300	47300	42900	42900	41000
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	0.155 J	0.19 J	5.44 J	7.83 J	11.9	95.2	104	124	26.1 J	396	376	44.4
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	6960 J	8710 J	5550 J	4990 J	520	8500	7750	9610	663 J	3790 J	7290 J	5130 J
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	630 J	706 J	367	179	187	841	848	1050	1270 J	730	861	817
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	66.7 J	2370 J	136 J	73.7 J	1.92	134	214	378	3.4 J	211 J	212 J	73.4 J
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	42.9 J	81.4 J	24.1 J	36.8 J	41	23	26.9	67	74.4 J	65.5	56.7	51.6
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	3200 J	3320 J	2080 J	806 J	1160 J	1020 J	1130 J	1190 J	1010 J	1320	1310	912
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	0.54	6.07	0.59	3.04	0.47	0.59	0.72	0.7	1.32	0.38 J	0.48 J	2.52
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	0.223	0.212	0.186 J	0.096 J	0.129	0.126	0.165	0.14	0.436	0.173	0.172	0.108
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	259	246	150	119	46.8	40.9	42.9	64.4	24.4	39.6	43.1	61.7
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	0.281	0.432	0.126	0.084	0.068	0.307	0.324	0.437	0.135	0.32	0.347	0.166
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	18.3	24.6	26.1	27.9	32.1	19.9	20.6	27.9	32.8	21.4	22.6	41.3
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	75.4	77.3 J	51.1 J	68.6 J	95.1 J	65.1 J	71.9 J	65.2 J	160	77.8	65.9	78.3
Low Level Mercury																				
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g		2040000						1010000		302000		
SPLP Inorganic Elements																				
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L		558 J					892				1040	
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L		14500 J					450				585 J	
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L		5320					1390				673	
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L		17.8 J					17.9 J				17.5 J	
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L		0.2 U					0.2 U				0.2 U	
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L		0.8 U					0.8 U				0.8 U	
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L		4480					2680				3900	
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L		3 U					4.7 J				4.5 J	
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L		2 U					2 U				2 U	
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L		5 U					5 U				5 U	
Iron		17	17		7410	114	SW6010B-SPLP	µg/L		538 J					1450				1190 J	
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L		8 U					13.6 J				42.5 J	
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L		4000					2280				2810	
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L		9.3					15.6				12.9	
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L		356					7.42				5.35	
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L		2 U					2.7 J				3.5 J	
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L		1270					559				599	
Selenium		17	0		0	0	SW6010B-SPLP	µg/L		30 U					30 U				30 U	
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L		12.4 J					11.1 J				5 U	
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L		7330 J					6780 J				10700	
Thallium		17	0		0	0	SW6010B-SPLP	µg/L		30 U					30 U				30 U	
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L		6.7 J					5 U				5 U	
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L		14.6 J					43.4 J				16.3 J	
TCLP Inorganic Elements																				
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L		15.7						2.39			1.82	
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L		0.3 U						0.542 J			0.3 U	
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L		0.002 U						0.002 U			0.002 U	
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L		0.003 U						0.005 J			0.005 J	
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L		0.02 U						0.02 U			0.05 J	
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L		0.0051 J						0.004 U			0.004 U	
Selenium		12	0		0	0	SW6010B-TCLP	mg/L		0.02 U						0.02 U			0.02 U	
Silver		12	0		0	0	SW6010B-TCLP	mg/L		0.007 U						0.007 U			0.007 U	
Arsenic Speciation																				
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg	375						392					
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg	2840						3520					
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg	3210						3910					
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg											4560 J	
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg											377 J	
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg											4930	
Mercury Selective Sequential Extraction																				
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g		36600						1070 J		2860		
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g		96300 J						1.72 J		7.27 J		
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g		96900 J						28800 J		11200 J		
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g		106000						29300 J		42900 J		
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g		2020000						348000 J		178000 J		

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP29	MP30	MP30	MP30	MP31	MP32	MP32	MP32	MP33	MP34	MP34	MP34
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		T/WR	T/WR	N/DN	N/DN	B/WB	FT	FT	FT	B/WB	FT	FT	FT | N/DN
							Sample ID		11MP29SB16	11MP30SB06	11MP30SB12	11MP30SB16	11MP31SB04	11MP32SB04	11MP32SB06	11MP32SB08	11MP33SB04	11MP34SB04	11MP34SB06	11MP34SB08
Analyte							Method													
Semi-Volatile Organic Compounds																				
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg										**72 J**		
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**28**				**12**		
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.9 U				**8**		
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.4 U				1.4 U		
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.7 U				1.7 U		
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**3.1 J**				1.2 U		
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.5 U				1.5 U		
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.4 U				**3.7 J**		
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						2.1 U				**11 J**		
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						7 U				7 U		
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**2.9 J**				**4.4 J**		
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.5 U				1.5 U		
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.2 U				1.2 U		
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.3 U				**1.7 J**		
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**2 J**				**1.7 J**		
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg										**66 J**		
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.5 U				1.5 U		
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**15**				**8.3**		
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						1.6 U				**1.8 J**		
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**8.4**				**7.2**		
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**1.8 J**				**1.7 J**		
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**60 J**						
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**70 J**				**110 J**		
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**89 J**				0 U		
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg										**83 J**		
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diesel and Residual Range Organics																				
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg						**9.5 J**						
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg						**32 J**						

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP34	MP35	MP35	MP35	MP36	MP36	MP36	MP37	MP37	MP37	MP38
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	T/WR	T/WR	T/WR	FT	FT | F	B/WB	N/DN or F	N/DN or F	B/WB	T/WR (+ possible FT)
							Sample ID		11MP34SB12	11MP35SB06	11MP35SB12	11MP35SB16	11MP36SB04	11MP36SB08	11MP36SB16	11MP37SB06	11MP37SB08	11MP37SB16	11MP38SB10
Analyte							Method												
Total Inorganic Elements																			
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg		8620	6550 J	8980	2730 J	6380 J	3490 J	10500 J	8760 J	2880 J	10100 J
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg		4980 J	3480 J	4500 J	965 J	287 J	5.43	103 J	255 J	2.03	6080 J
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg		2350	2870 J	1300	7670 J	2440 J	208 J	97.2 J	126 J	71.3 J	3590 J
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg		321	574	309	100	87.7	61.1	122	159	201	589
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg		0.572	0.417	0.392	0.699	0.516	0.705	0.445	0.371	0.546	0.542
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg		0.39 J	0.234	0.21 J	0.417	0.379	0.655	0.308	0.303	0.567	0.3
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg		3070	3300 J	2770	1610 J	2280 J	2640 J	2190 J	5430 J	1640 J	3650 J
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg		34.7 J	15.3	14 J	11.6	19.4	12.3	21.7	17.9	15.1	30.1
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg		14.2 J	9.69	8.31 J	14.4	12.2	13.4	13.5	10.6	21	13
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg		44	29.9	27	61.7	39.8	90.7	35.9	24.1	53.4	53.9
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg		28500	24400	31400	46400	36400	51200	33700	16100	53600	32100
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg		6.1	6.15	8.87	384	112	27.5	16.3	12.3	12.7	9.26
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg		3480 J	3180 J	3510 J	1110 J	4050 J	6140 J	3420 J	2230 J	1080 J	5720 J
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg		465	497	359	1020	654	1660	609	501	1260	475
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg		335 J	504 J	636 J	311 J	14.3 J	14 J	9.74 J	20.6 J	4.32 J	315 J
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg		41.3 J	39.9	29.9 J	50.1	45	56.2	34.5	26.5	61.2	50.2
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg		1410 J	1800	1820 J	1480	869	1310	852	694	808	3000
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg		0.48 J	1.99	2.02	0.78	0.54	2	0.74	2.44	0.85	1.41
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg		0.179 J	0.152	0.132 J	0.423	0.155	0.384	0.133	0.127	0.265	0.203
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg		89.5	123	116	54.5	35.5	56.8	74.1	52	27.4	239
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg		0.18	0.4	0.159	0.678	0.202	0.11	0.085	0.1	0.118	0.395
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg		32.2 J	19.1	15 J	18.6	26.1	27.5	37.6	28.4	27.8	21.2
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg		75.3 J	68.6	48.5 J	96.8	88.9	107	77	56.6	125	69.6
Low Level Mercury																			
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g					207000						519000
SPLP Inorganic Elements																			
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L											434
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L											6720
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L											862
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L											19.2 J
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L											0.2 U
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L											0.9 J
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L											3000
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L											3.4 J
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L											2 U
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L											5 U
Iron		17	17		7410	114	SW6010B-SPLP	µg/L											333 J
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L											8 U
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L											2590
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L											4.8 J
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L											10.3
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L											2 U
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L											904
Selenium		17	0		0	0	SW6010B-SPLP	µg/L											30 U
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L											5 U
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L											8970 J
Thallium		17	0		0	0	SW6010B-SPLP	µg/L											30 U
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L											5 U
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L											14.1 J
TCLP Inorganic Elements																			
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L					1.3						
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L					0.3 U						
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L					0.002 U						
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L					0.003 U						
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L					0.02 U						
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L					0.004 U						
Selenium		12	0		0	0	SW6010B-TCLP	mg/L					0.02 U						
Silver		12	0		0	0	SW6010B-TCLP	mg/L					0.007 U						
Arsenic Speciation																			
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg											
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg											
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg											
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg					7760 J						2000 J
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg					74.6 J						1080 J
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg					7840						3080
Mercury Selective Sequential Extraction																			
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g					1400						3990
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g					141 J						18.9 J
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g					1860 J						9210 J
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g					14300 J						43800 J
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g					146000 J						475000 J

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP34	MP35	MP35	MP35	MP36	MP36	MP36	MP37	MP37	MP37	MP38
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		N/DN	T/WR	T/WR	T/WR	FT	FT | F	B/WB	N/DN or F	N/DN or F	B/WB	T/WR (+ possible FT)
							Sample ID		11MP34SB12	11MP35SB06	11MP35SB12	11MP35SB16	11MP36SB04	11MP36SB08	11MP36SB16	11MP37SB06	11MP37SB08	11MP37SB16	11MP38SB10
Analyte							Method												
Semi-Volatile Organic Compounds																			
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	11 U					220 U				2.2 U	
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	9.5 U					48 U				1.9 U	
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	7 U					**280**				1.4 U	
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**9.4 J**					17 U				1.7 U	
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**7.2 J**					12 U				**1.3 J**	
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**10 J**					15 U				1.5 U	
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	7 U					14 U				1.4 U	
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	11 U					21 U				2.1 U	
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	35 U					70 U				7 U	
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	7.5 U					15 U				**3.1 J**	
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**820 J**					
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**870 J**					
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**7.8 J**					15 U				1.5 U	
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	6 U					**57 J**				1.2 U	
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	6.5 U					13 U				1.3 U	
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**730 J**					
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**100 J**					
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	5.5 U					**260**				1.1 U	
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**1000 J**					
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**3300 J**					
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**1700 J**					
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg										**110 J**	
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**11 J**					15 U				1.5 U	
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	12 U					250 U				2.3 U	
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	8 U					16 U				1.6 U	
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg										**92 J**	
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**3100 J**					
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**28000 J**					
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	7 U					**170**				**3.4 J**	
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	7.5 U					15 U				1.5 U	
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**83000 J**					
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**73000 J**					
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**1300 J**					
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**540 J**					**1300 J**					
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**220 J**					**16000 J**				**150 J**	
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**1200 J**					**100000 J**				**180 J**	
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	**960 J**					**71000 J**				**190 J**	
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg											
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**9100 J**					
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg						**1300 J**					
Diesel and Residual Range Organics																			
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg						**1500 Y**				**21 J**	
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg						**69 J**				3.4 U	

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP38	MP38	MP39	MP39	MP39	MP40	MP40	MP40	MP41	MP41	MP89	MP89
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		TWR | N/DN	N/DN	T/WR	T/WR	N/DN or F	T/WR	T/WR	B/WB	B/WB	B/WB	F	N/DN
							Sample ID		11MP38SB14	11MP38SB16	11MP39SB06	11MP39SB08	11MP39SB12	11MP40SB06	11MP40SB08	11MP40SB10	11MP41SB04	11MP41SB06	11MP89SB06	11MP89SB12
Analyte							Method													
Total Inorganic Elements																				
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	**7340 J**	**6430 J**	**10100**	**13800 J**	**7270**	**11200 J**	**9900**	**7380**	**7330**	**2990**	**8300**	**13700**
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	**1250 J**	**413 J**	**5430 J**	**2180 J**	**527 J**	**347 J**	**1460 J**	**868 J**	**1.04 J**	**1.14 J**	**419 J**	**48.8 J**
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	**680 J**	**706 J**	**3240**	**866 J**	**666**	**276 J**	**2390**	**1150**	**30.7 J**	**59.8 J**	**490**	**123**
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	**152**	**113**	**936**	**358**	**205**	**120**	**370**	**347**	**154 J**	**152 J**	**146**	**99.8**
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	**0.347**	**0.416**	**0.463**	**0.368**	**0.403**	**0.346**	**0.44**	**0.356**	**0.638**	**0.784**	**0.428**	**0.387**
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	**0.215**	**0.21**	**0.263**	**0.224**	**0.26**	**0.155**	**0.253**	**0.335**	**0.494 J**	**0.912 J**	**0.271**	**0.153**
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	**1990 J**	**1510 J**	**4080 J**	**4060**	**3230 J**	**1950**	**1720 J**	**1680 J**	**825 J**	**1140 J**	**1570**	**1660**
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	**11.4**	**18.8**	**21.5**	**23.7**	**16.2**	**16.9**	**26.2 J**	**21.3**	**17.0 J**	**11.1 J**	**16**	**17.1**
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	**10.3**	**17.3**	**9.18**	**7.35**	**13**	**6.83**	**8.87**	**11.5**	**16.9**	**27**	**8.27**	**5.58**
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	**18.6**	**28.3**	**28.5 J**	**21.7 J**	**22.8 J**	**19.4 J**	**31.6 J**	**30.2 J**	**41.7 J**	**139 J**	**31**	**15.3**
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	**31800**	**39300**	**25200**	**18700**	**32100**	**23200**	**27200**	**33200**	**49300**	**41800**	**26300**	**19700**
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	**5.94**	**8.05**	**4.38 J**	**7.55**	**8.63 J**	**8.27**	**6.63 J**	**6.92 J**	**9.68**	**20.5**	**7.36**	**7.13**
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	**3720 J**	**3070 J**	**3980 J**	**3810**	**3580 J**	**3230**	**2750 J**	**3360 J**	**1480 J**	**578 J**	**3120**	**3770**
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	**367**	**404**	**432**	**322**	**697**	**246**	**359**	**743**	**942**	**1010**	**281**	**153**
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	**446 J**	**93.3 J**	**81.1**	**43.8**	**111**	**10.3**	**185 J**	**119**	**2.07**	**3.55**	**251 J**	**1.71 J**
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	**30.9**	**67.7**	**35.3**	**29.4**	**38.3**	**22.5**	**30.7 J**	**40**	**34.5 J**	**86.8 J**	**25.1**	**16.5**
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	**1500**	**1480**	**3100 J**	**1670 J**	**820 J**	**1030 J**	**2550 J**	**1310 J**	**832**	**1100**	**867 J**	**693 J**
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	**1.01**	**0.61**	**1.02**	**0.45 J**	**0.38**	**0.45**	**0.61**	**0.41**	**0.45**	**0.61**	**0.27**	**0.25**
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	**0.133**	**0.131**	**0.163**	**0.123**	**0.097**	**0.097**	**0.141**	**0.153**	**0.131**	**0.179**	**0.091**	**0.093**
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	**105**	**98**	**195**	**163**	**50.9**	**72.2**	**145**	**76.5**	**36 J**	**24 J**	**89.3**	**77.3**
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	**0.102**	**0.098**	**0.349**	**0.185**	**0.09**	**0.085**	**0.2**	**0.109**	**0.106**	**0.131**	**0.109**	**0.089**
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	**15.1**	**24.4**	**18.5**	**23.9**	**21.8**	**29.4**	**18**	**22.8**	**33**	**29.7**	**24.5**	**31.1**
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	**49.3**	**82.4**	**45.6**	**50.8 J**	**67**	**55 J**	**49.1**	**70.1**	**76.8 J**	**153 J**	**55.8 J**	**52.1 J**
Low Level Mercury																				
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g				**39700**			**161000**			**3140 J**		
SPLP Inorganic Elements																				
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L			**1180**				**1510 J**			**1400 J**		
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L			**4300 J**				**1290 J**			20 U		
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L			**2750 J**				**582**			20 U		
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L			**34.7 J**				**40.5 J**			**36.8 J**		
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L			0.2 U				0.2 U			0.2 U		
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L			0.8 UJ				0.8 U			0.8 U		
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L			**5560**				**2020**			**340 J**		
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L			**3.8 J**				**5.1 J**			**5.8 J**		
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L			2 U				2 U			2 U		
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L			5 U				5 U			**9.3 J**		
Iron		17	17		7410	114	SW6010B-SPLP	µg/L			**520**				**2660 J**			**2760**		
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L			8 U				8 U			8 U		
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L			**3080**				**1540**			**133 J**		
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L			**10.6**				**34.5**			**53.1**		
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L			**10.9**				**37.1**			**1.13**		
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L			**2.7 J**				**4.9 J**			**6 J**		
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L			**2200**				**948**			**831**		
Selenium		17	0		0	0	SW6010B-SPLP	µg/L			30 UJ				30 U			30 U		
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L			**12.3 J**				**6.3 J**			5 U		
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L			**5130 J**				**9350 J**			**8710 J**		
Thallium		17	0		0	0	SW6010B-SPLP	µg/L			30 U				30 U			30 U		
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L			**8.1 J**				**5.6 J**			**5.3 J**		
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L			**61.5 J**				**41.3 J**			**19.7 J**		
TCLP Inorganic Elements																				
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L												
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L												
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L												
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L												
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L												
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L												
Selenium		12	0		0	0	SW6010B-TCLP	mg/L												
Silver		12	0		0	0	SW6010B-TCLP	mg/L												
Arsenic Speciation																				
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg			**506**				**191**					
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg			**3230**				**1470**					
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg			**3730**				**1660**					
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg										**10 J**		
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg										**0.284 J**		
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg										**10.7**		
Mercury Selective Sequential Extraction																				
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g				**648 J**			**2570 J**			**26.7 J**		
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g				**2.2 J**			**322 J**			**55.7 J**		
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g				**33200 J**			**2770 J**			**113 J**		
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g				**2130 J**			**21800 J**			**1240 J**		
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g				**23700 J**			**240000 J**			**1580 J**		

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP38	MP38	MP39	MP39	MP39	MP40	MP40	MP40	MP41	MP41	MP89	MP89
							Geographic Area		Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955	Post 1955
							Soil Type*		TWR | N/DN	N/DN	T/WR	T/WR	N/DN or F	T/WR	T/WR	B/WB	B/WB	B/WB	F	N/DN
							Sample ID		11MP38SB14	11MP38SB16	11MP39SB06	11MP39SB08	11MP39SB12	11MP40SB06	11MP40SB08	11MP40SB10	11MP41SB04	11MP41SB06	11MP89SB06	11MP89SB12
Analyte							Method													
Semi-Volatile Organic Compounds																				
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg												
Diesel and Residual Range Organics																				
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg												
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg												

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP89
							Geographic Area		Post 1955
							Soil Type*		B/WB
							Sample ID		11MP89SB30
Analyte							Method		
Total Inorganic Elements									
Aluminum	15300	94	94	0	14400	1760	SW6010B	mg/kg	**5280**
Antimony	52	94	94	60	19300	0.19	SW6010B/SW6020A	mg/kg	**46.1 J**
Arsenic	13	94	94	87	9530	5.52	SW6010B/SW6020A	mg/kg	**28.7**
Barium	178	94	94	42	1050	61.1	SW6020A	mg/kg	**79.6**
Beryllium	0	94	94	62	0.868	0.305	SW6020A	mg/kg	**0.47**
Cadmium	1	94	94	1	1.32	0.132	SW6020A	mg/kg	**0.254**
Calcium	4640	94	94	17	9670	663	SW6010B	mg/kg	**663**
Chromium	23	94	94	18	59.6	8.18	SW6020A	mg/kg	**16.8**
Cobalt	19	94	94	15	34.4	5.58	SW6020A	mg/kg	**8.07**
Copper	60	94	94	25	139	15.3	SW6020A	mg/kg	**36.1**
Iron	39300	94	94	40	54000	16100	SW6010B	mg/kg	**33700**
Lead	14	94	94	26	396	0.027	SW6020A	mg/kg	**9.29**
Magnesium	4880	94	94	26	11100	520	SW6010B	mg/kg	**936**
Manganese	951	94	94	24	3510	153	SW6010B	mg/kg	**168**
Mercury	4	94	94	67	3410	0.361	SW7471A	mg/kg	**0.932 J**
Nickel	52	94	94	29	92.4	16.5	SW6020A	mg/kg	**39.7**
Potassium	1080	94	94	56	4580	558	SW6010B	mg/kg	**966**
Selenium	0	94	94	76	6.07	0.11	SW7742	mg/kg	**0.24**
Silver	11	94	94	0	0.461	0.091	SW6020A	mg/kg	**0.113**
Sodium	8170	94	94	0	373	21.3	SW6010B	mg/kg	**40.4**
Thallium	0	94	94	66	0.678	0.053	SW6020A	mg/kg	**0.09**
Vanadium	38	94	94	2	41.3	15	SW6020A	mg/kg	**31.9**
Zinc	106	94	94	23	227	43.5	SW6020A	mg/kg	**85.7 J**
Low Level Mercury									
Mercury		18	18	0	2040000	2340	EPA 1631 Appendix	ng/g	
SPLP Inorganic Elements									
Aluminum		16	16		2020	155	SW6010B-SPLP	µg/L	
Antimony		17	14		75300	24	SW6010B-SPLP	µg/L	
Arsenic		17	13		5330	26	SW6010B-SPLP	µg/L	
Barium		17	17		75.9	8	SW6010B-SPLP	µg/L	
Beryllium		17	1		0.22	0.22	SW6010B-SPLP	µg/L	
Cadmium		17	1		0.9	0.9	SW6010B-SPLP	µg/L	
Calcium		17	17		5560	340	SW6010B-SPLP	µg/L	
Chromium		17	10		6.6	3.1	SW6010B-SPLP	µg/L	
Cobalt		17	2		3	2.4	SW6010B-SPLP	µg/L	
Copper		17	4		14.6	6.5	SW6010B-SPLP	µg/L	
Iron		17	17		7410	114	SW6010B-SPLP	µg/L	
Lead		17	2		42.5	13.6	SW6010B-SPLP	µg/L	
Magnesium		17	17		10600	133	SW6010B-SPLP	µg/L	
Manganese		17	17		120	4.8	SW6010B-SPLP	µg/L	
Mercury		17	17		356	0.82	SW7470A-SPLP	µg/L	
Nickel		17	12		14.3	2.7	SW6010B-SPLP	µg/L	
Potassium		17	17		3020	559	SW6010B-SPLP	µg/L	
Selenium		17	0		0	0	SW6010B-SPLP	µg/L	
Silver		17	13		12.4	5	SW6010B-SPLP	µg/L	
Sodium		17	17		13500	1610	SW6010B-SPLP	µg/L	
Thallium		17	0		0	0	SW6010B-SPLP	µg/L	
Vanadium		17	13		13.3	5.2	SW6010B-SPLP	µg/L	
Zinc		17	17		75.4	14.1	SW6010B-SPLP	µg/L	
TCLP Inorganic Elements									
Arsenic		12	10		15.7	0.04	SW6010B-TCLP	mg/L	
Barium		12	8		0.695	0.332	SW6010B-TCLP	mg/L	
Cadmium		12	0		0	0	SW6010B-TCLP	mg/L	
Chromium		12	3		0.005	0.003	SW6010B-TCLP	mg/L	
Lead		12	1		0.05	0.05	SW6010B-TCLP	mg/L	
Mercury		12	5		0.0758	0.0051	SW7470A-TCLP	mg/L	
Selenium		12	0		0	0	SW6010B-TCLP	mg/L	
Silver		12	0		0	0	SW6010B-TCLP	mg/L	
Arsenic Speciation									
Arsenite		10	10		1740	0.244	EPA 1632-As3-CRYO-T	mg/kg	
Arsenate		10	10		4560	36.5	EPA 1632-As-Cryo-S-Speciation	mg/kg	
Inorganic Arsenic		10	10		4810	36.7	EPA 1632-Total Inorganic As - Solid	mg/kg	
Arsenate		4	4		7760	10.4	EPA 1632-Total Metals	mg/kg	
Arsenite		4	4		1080	0.284	EPA 1632-Total Metals	mg/kg	
Inorganic Arsenic		4	4		7840	10.7	EPA 1632-Total Metals	mg/kg	
Mercury Selective Sequential Extraction									
Hg(F1)		18	18		36600	26.7	'BRL SOP No. BR-0013	ng/g	
Hg(F2)		18	18		133000	1.72	'BRL SOP No. BR-0013	ng/g	
Hg(F3)		18	17		96900	113	'BRL SOP No. BR-0013	ng/g	
Hg(F4)		18	18		107000	277	'BRL SOP No. BR-0013	ng/g	
Hg(F5)		18	18		2020000	1580	'BRL SOP No. BR-0013	ng/g	

Table 4-25 Post-1955 Main Processing Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP89
							Geographic Area		Post 1955
							Soil Type*		B/WB
							Sample ID		11MP89SB30
Analyte							Method		
Semi-Volatile Organic Compounds									
.beta.-Sitosterol		1	1		160	160	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
.gamma.-Sitosterol		1	1		72	72	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
2-Methylnaphthalene		7	3		1500	12	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
4-Chloroaniline		7	1		8	8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Acenaphthene		7	2		280	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Benzo(a)pyrene		7	1		9.4	9.4	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Benzo(b)fluoranthene		7	3		7.2	1.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Benzo(g,h,i)perylene		7	1		10	10	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Benzo(k)fluoranthene		7	1		3.7	3.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Benzyl Alcohol		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Bis(2-ethylhexyl) Phthalate		7	2		310	52	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Chrysene		7	3		4.4	2.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Cyclopropane, 1-pentyl-2-propyl-		1	1		820	820	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Decane, 4-methyl-		1	1		870	870	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Dibenz(a,h)anthracene		7	1		7.8	7.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Dibenzofuran		7	2		58	57	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Diethyl Phthalate		7	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Docosanoic acid		1	1		230	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Dodecane		1	1		730	730	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Dodecane, 2,6,11-trimethyl-		1	1		100	100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Fluorene		7	4		260	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Heptadecane, 2,6,10,15-tetramethyl-		1	1		1000	1000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Heptadecane, 2,6-dimethyl-		1	1		3300	3300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Hexadecane, 2,6,10,14-tetramethyl-		1	1		1700	1700	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Hexadecanoic acid, butyl ester		2	2		110	66	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Indeno(1,2,3-cd)pyrene		7	1		11	11	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Naphthalene		7	3		560	8.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
N-Nitrosodiphenylamine		7	1		1.8	1.8	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Nonadecane		1	1		1400	1400	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Octadecane		1	1		2600	2600	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Octadecanoic acid, butyl ester		1	1		92	92	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Octane, 3,6-dimethyl-		1	1		3100	3100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Oleic Acid		1	1		130	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Pentadecane, 2,6,10,14-tetramethyl		2	2		28000	11000	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Phenanthrene		7	6		170	2.3	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Pyrene		7	2		1.8	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Tetradecane		2	2		83000	1500	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Tridecane		2	2		73000	60	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Undecane		2	2		4400	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Undecane, 2,6-dimethyl-		2	2		1300	540	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Unknown		7	7		16000	68	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Unknown Alkane		7	6		100000	89	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Unknown Branched Alkane		5	5		71000	83	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Unknown branched undecane		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Unknown Carboxylic Acid		1	1		110	110	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Unknown Cyclic Hydrocarbon		1	1		9100	9100	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Z-1,6-Undecadiene		1	1		1300	1300	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg	
Diesel and Residual Range Organics									
C10 - C25 DRO		6	6		1500	2.7	AK102-Alaska Diesel Range for Soil	mg/kg	
C25 - C36 RRO		6	5		69	6.8	AK103-Alaska Residual Range for Soil	mg/kg	

* Soil types defined in Appendix B.

Key

% = percent

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

BRL SOP = Brooks Rand Labs Standard Operating Procedure

DRO = diesel range organics

EPA = United States Environmental Protection Agency

Hg = mercury

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

ng/g = nanograms per gram

ng/L = nanograms per liter

RRO = residual range organics

SPLP = synthetic precipitation leaching procedure

TCLP - toxicity characteristic leaching procedure

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-26 Red Devil Creek Downstream Alluvial Area and Delta Subsurface Soil Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**RD01**	**RD01**	**RD01**	**RD02**	**RD02**	**RD02**	**RD03**	**RD03**	**RD03**
							Soil Type*		**N/DN**	**KRA**	**KRA**	**T/WR**	**T/WR**	**T/WR | N/DN**	**T/WR**	**T/WR**	**T/WR**
							Sample ID		**11RD01SB04**	**11RD01SB10**	**11RD01SB14**	**11RD02SB04**	**11RD02SB06**	**11RD02SB10**	**11RD03SB06**	**11RD03SB08**	**11RD03SB10**
Analyte							**Method**										
Total Inorganic Elements (mg/kg)																	
Aluminum	15300	24	24	0	14800	1530	SW6010B	mg/kg	**14800**	**14800**	**14600**	**12100**	**10600**	**8630**	**9160**	**5330**	**8240**
Antimony	52.20	24	24	9	2710	0.321	SW6010B/SW6020A	mg/kg	**0.657 J**	**0.352 J**	**0.359 J**	**1950 J**	**868 J**	**92 J**	**2710 J**	**844 J**	**545 J**
Arsenic	12.8	24	24	18	3510	3.36	SW6020A	mg/kg	**10.3 J**	**3.36 J**	**8.74 J**	**1880 J**	**1410 J**	**181 J**	**3510 J**	**1790 J**	**503 J**
Barium	178	24	24	6	553	63.1	SW6020A	mg/kg	**124 J**	**167 J**	**140 J**	**310 J**	**254 J**	**95.4 J**	**553 J**	**227 J**	**113 J**
Beryllium	0.484	24	24	11	0.798	0.353	SW6020A	mg/kg	**0.375**	**0.477**	**0.479**	**0.532**	**0.503**	**0.39**	**0.798**	**0.511**	**0.432**
Cadmium	1.3	24	24	0	0.709	0.157	SW6020A	mg/kg	**0.17 J**	**0.252 J**	**0.437 J**	**0.29 J**	**0.332 J**	**0.273 J**	**0.419 J**	**0.282 J**	**0.315 J**
Calcium	4640	24	24	3	117000	768	SW6010B	mg/kg	**1280 J**	**3120 J**	**3540 J**	**117000 J**	**32700 J**	**1740 J**	**6660 J**	**2380 J**	**1890 J**
Chromium	23.4	24	24	7	29	12.1	SW6020A	mg/kg	**22.6 J**	**28.2 J**	**27.6 J**	**29 J**	**25.6 J**	**19**	**27.1 J**	**23.5 J**	**21.1 J**
Cobalt	19.1	24	24	1	20.7	6.02	SW6020A	mg/kg	**6.02**	**9.65**	**10.8**	**13.1**	**12.3**	**16.4**	**16.7**	**12.6**	**16.5**
Copper	59.7	24	24	6	132	18.3	SW6020A	mg/kg	**19.1 J**	**30 J**	**29 J**	**74.5 J**	**45.1 J**	**20.4 J**	**57.1 J**	**34 J**	**32.6 J**
Iron	39300	24	24	5	96500	16700	SW6010B	mg/kg	**19600**	**23200**	**22900**	**30700**	**30800**	**61100**	**41100**	**32300**	**34600**
Lead	14.3	24	24	4	21.5	5.66	SW6020A	mg/kg	**8.06**	**9.64**	**10.1**	**8.05**	**10.3**	**5.66**	**5.78**	**11.7**	**8.8**
Magnesium	4880	24	24	6	8410	821	SW6010B	mg/kg	**3900 J**	**6180 J**	**6630 J**	**5710 J**	**4880 J**	**3740 J**	**7010 J**	**3370 J**	**3520 J**
Manganese	951	24	23	2	1850	117	SW6010B	mg/kg	**117**	**222**	**221**	**451**	**477**	**561**	**786**	**591**	**399**
Mercury	3.92	24	24	11	471	0.063	SW7471A	mg/kg	**0.154**	**0.064**	**0.063**	**94.5**	**30.6**	**1.78**	**340**	**471**	**70.3**
Nickel	52.2	24	24	2	78.6	20.9	SW6020A	mg/kg	**20.9 J**	**33.8 J**	**31.7 J**	**33.1 J**	**35.3 J**	**35 J**	**49.2 J**	**40.3 J**	**47.5 J**
Potassium	1080	24	24	9	3190	630	SW6010B	mg/kg	**657**	**1280**	**1570**	**2140**	**1680**	**792**	**3190**	**1470**	**874**
Selenium	0.37	24	24	18	1.35	0.2	SW7742	mg/kg	**0.54**	**0.54**	**0.48**	**0.34 J**	**0.4 J**	**0.46**	**0.8**	**0.8**	**0.67**
Silver	10.5	24	24	0	0.554	0.033	SW6020A	mg/kg	**0.139**	**0.175**	**0.216**	**0.106**	**0.132**	**0.033**	**0.191**	**0.142**	**0.089**
Sodium	8170	24	24	0	876	22.7	SW6010B	mg/kg	**81.2 J**	**210 J**	**230 J**	**876 J**	**335 J**	**39.5 J**	**259 J**	**393 J**	**50 J**
Thallium	0.088	24	24	16	0.754	0.051	SW6020A	mg/kg	**0.108**	**0.137**	**0.17**	**0.754**	**0.203**	**0.051**	**0.388**	**0.251**	**0.113**
Vanadium	37.6	24	24	4	44.6	22.4	SW6020A	mg/kg	**33.4**	**40.7**	**38.7**	**31.4**	**30**	**31.4**	**25.3**	**22.4**	**28.2**
Zinc	106	24	24	5	176	53.5	SW6020A	mg/kg	**55.9 J**	**87.4 J**	**90.4 J**	**176 J**	**120 J**	**76.1 J**	**97.2 J**	**75.1 J**	**88.2 J**
Low Level Mercury (ng/g)																	
Mercury		6	6	0	364000	10300	EPA 1631 Appendix	ng/g							**364000 J**	**332000 J**	**54100 J**
SPLP Inorganic Elements (µg/L)																	
Aluminum		2	2		1520	1050	SW6010B-SPLP	µg/L							**1050 J**		
Antimony		2	2		4450	269	SW6010B-SPLP	µg/L							**4450**		
Arsenic		2	1		2630	2630	SW6010B-SPLP	µg/L							**2630**		
Barium		2	2		35.2	24.1	SW6010B-SPLP	µg/L							**24.1 J**		
Beryllium		2	0				SW6010B-SPLP	µg/L							0.2 U		
Cadmium		2	0				SW6010B-SPLP	µg/L							0.8 U		
Calcium		2	2		4000	696	SW6010B-SPLP	µg/L							**4000**		
Chromium		2	2		5.3	4.5	SW6010B-SPLP	µg/L							**5.3 J**		
Cobalt		2	1		2.3	2.3	SW6010B-SPLP	µg/L							2 U		
Copper		2	1		8.7	8.7	SW6010B-SPLP	µg/L							5 U		
Iron		2	2		4430	747	SW6010B-SPLP	µg/L							**747 X**		
Lead		2	1		9.4	9.4	SW6010B-SPLP	µg/L							8 U		
Magnesium		2	2		4190	586	SW6010B-SPLP	µg/L							**4190**		
Manganese		2	2		102	9.7	SW6010B-SPLP	µg/L							**9.7**		
Nickel		2	1		5.6	5.6	SW6010B-SPLP	µg/L							2 U		
Potassium		2	2		1100	1040	SW6010B-SPLP	µg/L							**1100**		
Selenium		2	0				SW6010B-SPLP	µg/L							30 U		
Silver		2	0				SW6010B-SPLP	µg/L							5 U		
Sodium		2	2		12000	11300	SW6010B-SPLP	µg/L							**11300 J**		
Thallium		2	0				SW6010B-SPLP	µg/L							30 U		
Vanadium		2	2		8.2	8.1	SW6010B-SPLP	µg/L							**8.1 J**		
Zinc		2	2		18	14.1	SW6010B-SPLP	µg/L							**14.1 J**		
Mercury		2	2		18	1.09	SW7470A-SPLP	µg/L							**18**		
Arsenic Speciation (mg/kg dry)																	
Arsenate		4	4		3350	50.6	EPA 1632-As-Cryo-S-Speciation	mg/kg				**1360 J**			**3350 J**		
Arsenite		4	4		2200	0.602	EPA 1632-As3-CRYO-T	mg/kg				**730 J**			**2200 J**		
Inorganic Arsenic		4	4		5550	67.5	EPA 1632-Total Inorganic As - Solid	mg/kg				**2090**			**5550**		
Mercury Selective Sequential Extraction (ng/g dry)																	
Hg(F1)		6	6		15000	35.9	BRL SOP No. BR-0013	ng/g							**7080 J**	**15000 J**	**1950 J**
Hg(F2)		6	6		8040	0.82	BRL SOP No. BR-0013	ng/g							**44.7 J**	**8040.0 J**	**30.7 J**
Hg(F3)		6	6		8520	82.7	BRL SOP No. BR-0013	ng/g							**8010 J**	**8520 J**	**1490 J**
Hg(F4)		6	6		52900	894	BRL SOP No. BR-0013	ng/g							**52900 J**	**51900 J**	**12200 J**
Hg(F5)		6	6		250000	2260	BRL SOP No. BR-0013	ng/g							**250000 J**	**225000 J**	**40900 J**

Table 4-26 Red Devil Creek Downstream Alluvial Area and Delta Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD04	RD04	RD04	RD05	RD05	RD05	RD06	RD06	RD06
							Soil Type*		N/DN	N/DN	KRA	N/DN	N/DN	B/WB	F	N/DN	B/WB
							Sample ID		11RD04SB04	11RD04SB08	11RD04SB12	11RD05SB08	11RD05SB12	11RD05SB16	11RD06SB04	11RD06SB08	11RD06SB12
Analyte							Method										
Total Inorganic Elements (mg/kg)																	
Aluminum	15300	24	24	0	14800	1530	SW6010B	mg/kg	13000	13800	13400	11700	7370	2500	12700	9600	4350
Antimony	52.20	24	24	9	2710	0.321	SW6010B/SW6020A	mg/kg	149 J	95 J	1.09	1.33	18 J	0.669	6.23	11.3	0.763
Arsenic	12.8	24	24	18	3510	3.36	SW6020A	mg/kg	40.7	102	8.75	7.86	36	41.2	18.1	42.5	19.6
Barium	178	24	24	6	553	63.1	SW6020A	mg/kg	129	180	180	124	82.2	78.5	99.9	78.2	78.9
Beryllium	0.484	24	24	11	0.798	0.353	SW6020A	mg/kg	0.379	0.413	0.379	0.402	0.509	0.637	0.381	0.39	0.592
Cadmium	1.3	24	24	0	0.709	0.157	SW6020A	mg/kg	0.157 J	0.349 J	0.35 J	0.21 J	0.49 J	0.545 J	0.204 J	0.242 J	0.469 J
Calcium	4640	24	24	3	117000	768	SW6010B	mg/kg	2560	2700	2410	2410	1830	768	1660	1800	1660
Chromium	23.4	24	24	7	29	12.1	SW6020A	mg/kg	23.3 J	25.5 J	21.4 J	20.6 J	21.7 J	16.9 J	20.9 J	20.4 J	12.1 J
Cobalt	19.1	24	24	1	20.7	6.02	SW6020A	mg/kg	6.46 J	9.2 J	6.33 J	6.16 J	19 J	14.5 J	7.66 J	9.98 J	12.3 J
Copper	59.7	24	24	6	132	18.3	SW6020A	mg/kg	18.3	24.9	21.4	23.5	45.9	86.1	22.3	23.2	132
Iron	39300	24	24	5	96500	16700	SW6010B	mg/kg	28200	29600	16700	19300	23500	41400	19600	20900	19400
Lead	14.3	24	24	4	21.5	5.66	SW6020A	mg/kg	8.37	8.51	7.87	6.29	10.8	21.5	7.7	7.38	14.7
Magnesium	4880	24	24	6	8410	821	SW6010B	mg/kg	4790 J	5710	4030 J	4390 J	2650 J	821 J	3800 J	3410 J	3040 J
Manganese	951	24	23	2	1850	117	SW6010B	mg/kg	272	261	160	141	178	915	207	212	358
Mercury	3.92	24	24	11	471	0.063	SW7471A	mg/kg	1.26 J	4.95 J	0.137 J	0.283 J	1.04 J	1.25 J	14.1 J	5.53 J	1.61 J
Nickel	52.2	24	24	2	78.6	20.9	SW6020A	mg/kg	21.6 J	29.4 J	23 J	21.7 J	50.6 J	78.6 J	23.1 J	27.1 J	33.8 J
Potassium	1080	24	24	9	3190	630	SW6010B	mg/kg	904 J	1020 J	722 J	710 J	829 J	904 J	630 J	744 J	1810 J
Selenium	0.37	24	24	18	1.35	0.2	SW7742	mg/kg	0.37	0.26	0.7	0.2	0.38	0.59	0.23	0.3	1.03
Silver	10.5	24	24	0	0.554	0.033	SW6020A	mg/kg	0.126 J	0.17 J	0.141 J	0.08 J	0.192 J	0.321 J	0.102 J	0.107 J	0.554 J
Sodium	8170	24	24	0	876	22.7	SW6010B	mg/kg	110	136	98	96.1	50.5	22.7	74.6	73.6	45.4
Thallium	0.088	24	24	16	0.754	0.051	SW6020A	mg/kg	0.12	0.129	0.106	0.075	0.139	0.107	0.083	0.068	0.105
Vanadium	37.6	24	24	4	44.6	22.4	SW6020A	mg/kg	33.9 J	33.4 J	32.3 J	35.5 J	35.9 J	44.6 J	39.1 J	33.2 J	26 J
Zinc	106	24	24	5	176	53.5	SW6020A	mg/kg	61.2 J	76.2 J	61 J	53.5 J	89.1 J	128 J	56.9 J	71.6 J	110 J
Low Level Mercury (ng/g)																	
Mercury		6	6	0	364000	10300	EPA 1631 Appendix	ng/g									
SPLP Inorganic Elements (µg/L)																	
Aluminum		2	2		1520	1050	SW6010B-SPLP	µg/L									
Antimony		2	2		4450	269	SW6010B-SPLP	µg/L									
Arsenic		2	1		2630	2630	SW6010B-SPLP	µg/L									
Barium		2	2		35.2	24.1	SW6010B-SPLP	µg/L									
Beryllium		2	0				SW6010B-SPLP	µg/L									
Cadmium		2	0				SW6010B-SPLP	µg/L									
Calcium		2	2		4000	696	SW6010B-SPLP	µg/L									
Chromium		2	2		5.3	4.5	SW6010B-SPLP	µg/L									
Cobalt		2	1		2.3	2.3	SW6010B-SPLP	µg/L									
Copper		2	1		8.7	8.7	SW6010B-SPLP	µg/L									
Iron		2	2		4430	747	SW6010B-SPLP	µg/L									
Lead		2	1		9.4	9.4	SW6010B-SPLP	µg/L									
Magnesium		2	2		4190	586	SW6010B-SPLP	µg/L									
Manganese		2	2		102	9.7	SW6010B-SPLP	µg/L									
Nickel		2	1		5.6	5.6	SW6010B-SPLP	µg/L									
Potassium		2	2		1100	1040	SW6010B-SPLP	µg/L									
Selenium		2	0				SW6010B-SPLP	µg/L									
Silver		2	0				SW6010B-SPLP	µg/L									
Sodium		2	2		12000	11300	SW6010B-SPLP	µg/L									
Thallium		2	0				SW6010B-SPLP	µg/L									
Vanadium		2	2		8.2	8.1	SW6010B-SPLP	µg/L									
Zinc		2	2		18	14.1	SW6010B-SPLP	µg/L									
Mercury		2	2		18	1.09	SW7470A-SPLP	µg/L									
Arsenic Speciation (mg/kg dry)																	
Arsenate		4	4		3350	50.6	EPA 1632-As-Cryo-S-Speciation	mg/kg						66.9 J			
Arsenite		4	4		2200	0.602	EPA 1632-As3-CRYO-T	mg/kg						0.602 J			
Inorganic Arsenic		4	4		5550	67.5	EPA 1632-Total Inorganic As - Solid	mg/kg						67.5			
Mercury Selective Sequential Extraction (ng/g dry)																	
Hg(F1)		6	6		15000	35.9	BRL SOP No. BR-0013	ng/g									
Hg(F2)		6	6		8040	0.82	BRL SOP No. BR-0013	ng/g									
Hg(F3)		6	6		8520	82.7	BRL SOP No. BR-0013	ng/g									
Hg(F4)		6	6		52900	894	BRL SOP No. BR-0013	ng/g									
Hg(F5)		6	6		250000	2260	BRL SOP No. BR-0013	ng/g									

Table 4-26 Red Devil Creek Downstream Alluvial Area and Delta Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD07	RD07	RD07	RD20	RD20	RD20
							Soil Type*		F	N/DN	B/WB	N/DN	B/WB	B/WB
							Sample ID		11RD07SB04	11RD07SB10	11RD07SB12	11RD20SB06	11RD20SB18	11RD20SB20
Analyte							Method							
Total Inorganic Elements (mg/kg)														
Aluminum	15300	24	24	0	14800	1530	SW6010B	mg/kg	**12200**	**4330**	**1530**	**10400**	**3540**	**2880**
Antimony	52.20	24	24	9	2710	0.321	SW6010B/SW6020A	mg/kg	**4.96**	**1.32**	**0.321**	**7.69**	**163 J**	**13.5**
Arsenic	12.8	24	24	18	3510	3.36	SW6020A	mg/kg	**11.1**	**22.2**	**25.9**	**21.5**	**128**	**128**
Barium	178	24	24	6	553	63.1	SW6020A	mg/kg	**92.3**	**63.1**	**113**	**103**	**121**	**139**
Beryllium	0.484	24	24	11	0.798	0.353	SW6020A	mg/kg	**0.353**	**0.541**	**0.535**	**0.387**	**0.53**	**0.597**
Cadmium	1.3	24	24	0	0.709	0.157	SW6020A	mg/kg	**0.206 J**	**0.394 J**	**0.709 J**	**0.25 J**	**0.462 J**	**0.693 J**
Calcium	4640	24	24	3	117000	768	SW6010B	mg/kg	**2890**	**1520**	**3450**	**1960**	**1980**	**1650**
Chromium	23.4	24	24	7	29	12.1	SW6020A	mg/kg	**19.6 J**	**14.4 J**	**12.6 J**	**19.8 J**	**16.3 J**	**14.5 J**
Cobalt	19.1	24	24	1	20.7	6.02	SW6020A	mg/kg	**9.54 J**	**9.57 J**	**10.1 J**	**10.4 J**	**16.6 J**	**20.7 J**
Copper	59.7	24	24	6	132	18.3	SW6020A	mg/kg	**19.7**	**65**	**68.4**	**18.5**	**50**	**70.1**
Iron	39300	24	24	5	96500	16700	SW6010B	mg/kg	**21900**	**35500**	**96500**	**23700**	**37000**	**50400**
Lead	14.3	24	24	4	21.5	5.66	SW6020A	mg/kg	**7.87**	**12.1**	**15**	**6.54**	**11.9**	**14.4**
Magnesium	4880	24	24	6	8410	821	SW6010B	mg/kg	**3330 J**	**1780 J**	**8410 J**	**3120 J**	**1540 J**	**1330 J**
Manganese	951	24	23	2	1850	117	SW6010B	mg/kg	**253**	**583**	0.03 U	**242**	**1290**	**1850**
Mercury	3.92	24	24	11	471	0.063	SW7471A	mg/kg	**2.27 J**	**1.94 J**	**10.6 J**	**3.89 J**	**59.4 J**	**14.9 J**
Nickel	52.2	24	24	2	78.6	20.9	SW6020A	mg/kg	**26.4 J**	**41.7 J**	**38.5 J**	**29.1 J**	**48.2 J**	**73.4 J**
Potassium	1080	24	24	9	3190	630	SW6010B	mg/kg	**660 J**	**881 J**	**960 J**	**767 J**	**1330 J**	**1650 J**
Selenium	0.37	24	24	18	1.35	0.2	SW7742	mg/kg	**1.35**	**0.45**	**1.26**	**0.54**	**0.49**	**0.7**
Silver	10.5	24	24	0	0.554	0.033	SW6020A	mg/kg	**0.11 J**	**0.21 J**	**0.248 J**	**0.109 J**	**0.195 J**	**0.277 J**
Sodium	8170	24	24	0	876	22.7	SW6010B	mg/kg	**64.1**	**27.6**	**56.6**	**46.9**	**50.7**	**54.2**
Thallium	0.088	24	24	16	0.754	0.051	SW6020A	mg/kg	**0.088**	**0.075**	**0.139**	**0.066**	**0.08**	**0.095**
Vanadium	37.6	24	24	4	44.6	22.4	SW6020A	mg/kg	**32.5 J**	**29 J**	**31.5 J**	**30.6 J**	**33 J**	**34.3 J**
Zinc	106	24	24	5	176	53.5	SW6020A	mg/kg	**61.7 J**	**90.8 J**	**106 J**	**66.5 J**	**100 J**	**136 J**
Low Level Mercury (ng/g)														
Mercury		6	6	0	364000	10300	EPA 1631 Appendix	ng/g			**10800**		**44600**	**10300**
SPLP Inorganic Elements (µg/L)														
Aluminum		2	2		1520	1050	SW6010B-SPLP	µg/L						**1520**
Antimony		2	2		4450	269	SW6010B-SPLP	µg/L						**269 J**
Arsenic		2	1		2630	2630	SW6010B-SPLP	µg/L						20 U
Barium		2	2		35.2	24.1	SW6010B-SPLP	µg/L						**35.2 J**
Beryllium		2	0				SW6010B-SPLP	µg/L						0.2 U
Cadmium		2	0				SW6010B-SPLP	µg/L						0.8 U
Calcium		2	2		4000	696	SW6010B-SPLP	µg/L						**696 J**
Chromium		2	2		5.3	4.5	SW6010B-SPLP	µg/L						**4.5 J**
Cobalt		2	1		2.3	2.3	SW6010B-SPLP	µg/L						**2.3 J**
Copper		2	1		8.7	8.7	SW6010B-SPLP	µg/L						**8.7 J**
Iron		2	2		4430	747	SW6010B-SPLP	µg/L						**4430 J**
Lead		2	1		9.4	9.4	SW6010B-SPLP	µg/L						**9.4 J**
Magnesium		2	2		4190	586	SW6010B-SPLP	µg/L						**586**
Manganese		2	2		102	9.7	SW6010B-SPLP	µg/L						**102**
Nickel		2	1		5.6	5.6	SW6010B-SPLP	µg/L						**5.6 J**
Potassium		2	2		1100	1040	SW6010B-SPLP	µg/L						**1040**
Selenium		2	0				SW6010B-SPLP	µg/L						30 U
Silver		2	0				SW6010B-SPLP	µg/L						5 U
Sodium		2	2		12000	11300	SW6010B-SPLP	µg/L						**12000**
Thallium		2	0				SW6010B-SPLP	µg/L						30 U
Vanadium		2	2		8.2	8.1	SW6010B-SPLP	µg/L						**8.2 J**
Zinc		2	2		18	14.1	SW6010B-SPLP	µg/L						**18 J**
Mercury		2	2		18	1.09	SW7470A-SPLP	µg/L						**1.09**
Arsenic Speciation (mg/kg dry)														
Arsenate		4	4		3350	50.6	EPA 1632-As-Cryo-S-Speciation	mg/kg						**50.6 J**
Arsenite		4	4		2200	0.602	EPA 1632-As3-CRYO-T	mg/kg						**87 J**
Inorganic Arsenic		4	4		5550	67.5	EPA 1632-Total Inorganic As - Solid	mg/kg						**138**
Mercury Selective Sequential Extraction (ng/g dry)														
Hg(F1)		6	6		15000	35.9	BRL SOP No. BR-0013	ng/g			**97.1 J**		**71.2 J**	**35.9**
Hg(F2)		6	6		8040	0.82	BRL SOP No. BR-0013	ng/g			**33.3 J**		**2.25 J**	**0.82 J**
Hg(F3)		6	6		8520	82.7	BRL SOP No. BR-0013	ng/g			**510 J**		**647 J**	**82.7 J**
Hg(F4)		6	6		52900	894	BRL SOP No. BR-0013	ng/g			**1060 J**		**894 J**	**1380 J**
Hg(F5)		6	6		250000	2260	BRL SOP No. BR-0013	ng/g			**2260 J**		**29600 J**	**6590 J**

* Soil types defined in Appendix B.

Key

% = percent
Hg = mercury
ID = identifier
J = The analyte was detected. The associated result is estimated.
mg/kg = milligrams per kilogram
ng/g = nanograms per gram
ng/L = nanograms per liter
SPLP = synthetic precipitation leaching procedure
U = The analyte was analyzed for but not detected. The value provided is the reporting limit.
µg/kg = micrograms per kilogram
µg/L = micrograms per liter
UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-27 Dolly Sluice Delta Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	DS01	DS01	DS01	DS02	DS02	DS02
							Soil Type*		SO	SO	KRA	SO	SO	KRA
							Sample ID		11DS01SB06	11DS01SB10	11DS01SB16	11DS02SB04	11DS02SB10	11DS02SB14
Analyte							Method							
Total Inorganic Elements (mg/kg)														
Aluminum	15300	6	6	0	12100	4080	SW6010B	mg/kg	4080	4940	9690	5930	4950	12100
Antimony	52.2	6	6	1	122	0.886	SW6020A	mg/kg	11.6	11.4	1.4	31.5 J	122 J	0.886 J
Arsenic	12.8	6	6	5	1200	12	SW6020A	mg/kg	1200	234	13.3	360 J	205 J	12 J
Barium	178	6	6	1	317	110	SW6020A	mg/kg	317	141	123	123 J	110 J	149 J
Beryllium	0.484	6	6	4	0.776	0.375	SW6020A	mg/kg	0.623	0.608	0.375	0.637	0.776	0.424
Cadmium	1.3	6	6	0	0.54	0.268	SW6020A	mg/kg	0.532 J	0.509 J	0.268 J	0.466 J	0.54 J	0.396 J
Calcium	4640	6	6	0	2970	960	SW6010B	mg/kg	960	1220	2170	1560 J	1410 J	2970 J
Chromium	23.4	6	6	1	24.8	14.7	SW6020A	mg/kg	23.1 J	14.7 J	23.4 J	17.2 J	18.5 J	24.8 J
Cobalt	19.1	6	6	0	16.2	9.55	SW6020A	mg/kg	16 J	13.4 J	9.87 J	12	16.2	9.55
Copper	59.7	6	6	1	62.9	19.8	SW6020A	mg/kg	53.7	40.9	19.8	46.9 J	62.9 J	26 J
Iron	39300	6	6	3	64000	19400	SW6010B	mg/kg	41500	37400	19400	47900	64000	22100
Lead	14.3	6	6	0	12.4	6.76	SW6020A	mg/kg	12.1	10	6.76	10.7	12.4	8.55
Magnesium	4880	6	6	1	5160	895	SW6010B	mg/kg	895	1200 J	4470 J	2070 J	1180 J	5160 J
Manganese	951	6	6	1	965	224	SW6010B	mg/kg	822	851	250	965	832	224
Mercury	3.92	6	6	4	326	0.168	SW7471A	mg/kg	326 J	48.2 J	1.46 J	133	16.4	0.168
Nickel	52.2	6	6	0	51	27.3	SW6020A	mg/kg	39.7 J	36.9 J	27.3 J	38.2 J	51 J	29.7 J
Potassium	1080	6	6	0	1020	759	SW6010B	mg/kg	759 J	878 J	871 J	947	962	1020
Selenium	0.37	6	6	5	0.74	0.31	SW7742	mg/kg	0.65	0.55	0.31	0.74	0.48	0.51
Silver	10.5	6	6	0	0.222	0.088	SW6020A	mg/kg	0.141 J	0.146 J	0.088 J	0.222	0.143	0.134
Sodium	8170	6	6	0	171	25.3	SW6010B	mg/kg	25.3	30.3	102	68.8 J	39.4 J	171 J
Thallium	0.088	6	6	6	0.138	0.093	SW6020A	mg/kg	0.123	0.107	0.102	0.112	0.093	0.138
Vanadium	37.6	6	6	0	35.3	23.6	SW6020A	mg/kg	27 J	24.9 J	31.2 J	23.6	28.2	35.3
Zinc	106	6	6	1	117	68.3	SW6020A	mg/kg	93.6 J	83.3 J	68.3 J	93.5 J	117 J	80.4 J
Low Level Mercury (ng/g)														
Mercury		1	1	0	227000	227000	EPA 1631 Appendix	ng/g	227000					
SPLP Inorganic Elements (µg/L)														
Aluminum		1	1		948	948	SW6010B-SPLP	µg/L	948					
Antimony		1	1		42.5	42.5	SW6010B-SPLP	µg/L	42.5 J					
Arsenic		1	1		38	38	SW6010B-SPLP	µg/L	38 J					
Barium		1	1		24.5	24.5	SW6010B-SPLP	µg/L	24.5 J					
Beryllium		1	0		0	0	SW6010B-SPLP	µg/L	0.2 U					
Cadmium		1	0		0	0	SW6010B-SPLP	µg/L	0.8 U					
Calcium		1	1		305	305	SW6010B-SPLP	µg/L	305 J					
Chromium		1	0		0	0	SW6010B-SPLP	µg/L	3 U					
Cobalt		1	0		0	0	SW6010B-SPLP	µg/L	2 U					
Copper		1	0		0	0	SW6010B-SPLP	µg/L	5 U					
Iron		1	1		3230	3230	SW6010B-SPLP	µg/L	3230 J					
Lead		1	1		8.9	8.9	SW6010B-SPLP	µg/L	8.9 J					
Magnesium		1	1		113	113	SW6010B-SPLP	µg/L	113 J					
Manganese		1	1		64.4	64.4	SW6010B-SPLP	µg/L	64.4					
Nickel		1	1		4.8	4.8	SW6010B-SPLP	µg/L	4.8 J					
Potassium		1	1		471	471	SW6010B-SPLP	µg/L	471					
Selenium		1	0		0	0	SW6010B-SPLP	µg/L	30 U					
Silver		1	0		0	0	SW6010B-SPLP	µg/L	5 U					
Sodium		1	1		8660	8660	SW6010B-SPLP	µg/L	8660 J					
Thallium		1	0		0	0	SW6010B-SPLP	µg/L	30 U					
Vanadium		1	0		0	0	SW6010B-SPLP	µg/L	5 U					
Zinc		1	1		21	21	SW6010B-SPLP	µg/L	21 J					
Mercury		1	1		5.92	5.92	SW7470A-SPLP	µg/L	5.92 J					
Arsenic Speciation (mg/kg dry)														
Arsenate		1	1		1100	1100	EPA 1632-As-Cryo-S-Speciation	mg/kg	1100 J					
Arsenite		1	1		11.8	11.8	EPA 1632-As3-CRYO-T	mg/kg	11.8 J					
Inorganic Arsenic		1	1		1110	1110	EPA 1632-Total Inorganic As - Solid	mg/kg	1110					
Mercury Selective Sequential Extraction (ng/g dry)														
Hg(F1)		1	1		527	527	BRL SOP No. BR-0013	ng/g	527					
Hg(F2)		1	1		2900	2900	BRL SOP No. BR-0013	ng/g	2900 J					
Hg(F3)		1	1		2090	2090	BRL SOP No. BR-0013	ng/g	2090 J					
Hg(F4)		1	1		5560	5560	BRL SOP No. BR-0013	ng/g	5560 J					
Hg(F5)		1	1		204000	204000	BRL SOP No. BR-0013	ng/g	204000 J					

* Soil types defined in Appendix B.

Key

% = percent
µg/L = micrograms per liter
BRL SOP = Brooks Rand Labs Standard Operating Procedure
EPA = United States Environmental Protection Agency
Hg = mercury
ID = identifier
J = The analyte was detected. The associated result is estimated.
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
ng/g = nanograms per gram
SPLP = synthetic precipitation leaching procedure
U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-28 Rice Sluice Delta Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RS01	RS01	RS01	RS02	RS02	RS02
							Soil Type*		SO	SO	SO	SO	SO	KRA
							Sample ID		11RS01SB04	11RS01SB08	11RS01SB12	11RS02SB04	11RS02SB08	11RS02SB14
Analyte							Method							
Total Inorganic Elements (mg/kg)														
Aluminum	15300.0	6	6	0	14000	3940	SW6010B	mg/kg	**11500**	**6180**	**11800**	**8920**	**3940**	**14000**
Antimony	52.2	6	6	1	68.7	1.17	SW6020A	mg/kg	**24.7 J**	**68.7 J**	**25.8 J**	**24.4 J**	**34.5 J**	**1.17 J**
Arsenic	12.8	6	6	5	142	8.01	SW6020A	mg/kg	**54.7 J**	**142 J**	**50 J**	**138 J**	**93.4 J**	**8.01 J**
Barium	178	6	6	0	154	94.6	SW6020A	mg/kg	**137 J**	**104 J**	**124 J**	**103 J**	**94.6 J**	**154 J**
Beryllium	0.484	6	6	2	0.64	0.354	SW6020A	mg/kg	**0.354**	**0.484**	**0.384**	**0.584**	**0.64**	**0.481**
Cadmium	1.3	6	6	0	0.492	0.281	SW6020A	mg/kg	**0.326 J**	**0.43 J**	**0.281 J**	**0.464 J**	**0.492 J**	**0.429 J**
Calcium	4640	6	6	2	11100	1550	SW6010B	mg/kg	**11100 J**	**1690 J**	**2370 J**	**6250 J**	**1550 J**	**3210 J**
Chromium	23.4	6	6	3	28	19.1	SW6020A	mg/kg	**21.1 J**	**25.1 J**	**22.3 J**	**19.1 J**	**27.4 J**	**28 J**
Cobalt	19.1	6	6	1	23.9	8.08	SW6020A	mg/kg	**8.08**	**12.9**	**8.67**	**23.9**	**15.5**	**9.93**
Copper	59.7	6	6	0	55.2	22.2	SW6020A	mg/kg	**22.2 J**	**55.2 J**	**26.7 J**	**39.6 J**	**46 J**	**29.2 J**
Iron	39300	6	6	3	66100	23300	SW6010B	mg/kg	**29400**	**66100**	**41400**	**38300**	**51400**	**23300**
Lead	14.3	6	6	2	28.6	9.79	SW6020A	mg/kg	**9.79**	**28.6**	**17.6**	**11.6**	**12.9**	**9.89**
Magnesium	4880	6	6	2	6160	1070	SW6010B	mg/kg	**6160 J**	**1930 J**	**4860 J**	**3810 J**	**1070 J**	**5940 J**
Manganese	951	6	6	2	1190	235	SW6010B	mg/kg	**526**	**509**	**292**	**1160**	**1190**	**235**
Mercury	3.92	6	6	5	33.1	0.198	SW7471A	mg/kg	**6.44**	**27.9**	**7.44**	**33.1**	**8.07**	**0.198**
Nickel	52.2	6	6	0	49.8	25	SW6020A	mg/kg	**25 J**	**43.3 J**	**26.5 J**	**42.3 J**	**49.8 J**	**30.4 J**
Potassium	1080	6	6	2	1230	878	SW6010B	mg/kg	**1230**	**1060**	**893**	**998**	**878**	**1210**
Selenium	0.37	6	6	4	0.5	0.32	SW7742	mg/kg	**0.38**	**0.4**	**0.35**	**0.32**	**0.48**	**0.5**
Silver	10.5	6	6	0	0.261	0.099	SW6020A	mg/kg	**0.145**	**0.261**	**0.153**	**0.099**	**0.11**	**0.156**
Sodium	8170	6	6	0	226	28.8	SW6010B	mg/kg	**226 J**	**57.5 J**	**149 J**	**114 J**	**28.8 J**	**184 J**
Thallium	0.088	6	6	4	0.166	0.082	SW6020A	mg/kg	**0.14**	**0.083**	**0.104**	**0.093**	**0.082**	**0.166**
Vanadium	37.6	6	6	2	39.7	28.1	SW6020A	mg/kg	**28.1**	**30.7**	**30.5**	**35.5**	**39.7**	**39.3**
Zinc	106	6	6	1	114	71.6	SW6020A	mg/kg	**73.6 J**	**103 J**	**71.6 J**	**83.1 J**	**114 J**	**87.5 J**
Low Level Mercury (ng/g)														
Mercury		1	1	0	5290	5290	EPA 1631 Appendix	ng/g			**5290 J**			
SPLP Inorganic Elements (µg/L)														
Aluminum		1	1		1720	1720	SW6010B-SPLP	µg/L			**1720 J**			
Antimony		1	1		87.6	87.6	SW6010B-SPLP	µg/L			**87.6**			
Arsenic		1	0		0	0	SW6010B-SPLP	µg/L			20 U			
Barium		1	1		26.1	26.1	SW6010B-SPLP	µg/L			**26.1 J**			
Beryllium		1	0		0	0	SW6010B-SPLP	µg/L			0.2 U			
Cadmium		1	0		0	0	SW6010B-SPLP	µg/L			0.8 U			
Calcium		1	1		2850	2850	SW6010B-SPLP	µg/L			**2850**			
Chromium		1	1		4.8	4.8	SW6010B-SPLP	µg/L			**4.8 J**			
Cobalt		1	0		0	0	SW6010B-SPLP	µg/L			2 U			
Copper		1	0		0	0	SW6010B-SPLP	µg/L			5 U			
Iron		1	1		1920	1920	SW6010B-SPLP	µg/L			**1920**			
Lead		1	1		11.2	11.2	SW6010B-SPLP	µg/L			**11.2 J**			
Magnesium		1	1		2030	2030	SW6010B-SPLP	µg/L			**2030**			
Manganese		1	1		14.1	14.1	SW6010B-SPLP	µg/L			**14.1**			
Nickel		1	1		2.9	2.9	SW6010B-SPLP	µg/L			**2.9 J**			
Potassium		1	1		492	492	SW6010B-SPLP	µg/L			**492**			
Selenium		1	0		0	0	SW6010B-SPLP	µg/L			30 U			
Silver		1	0		0	0	SW6010B-SPLP	µg/L			5 U			
Sodium		1	1		11900	11900	SW6010B-SPLP	µg/L			**11900 J**			
Thallium		1	0		0	0	SW6010B-SPLP	µg/L			30 U			
Vanadium		1	0		0	0	SW6010B-SPLP	µg/L			5 U			
Zinc		1	1		26.2	26.2	SW6010B-SPLP	µg/L			**26.2 J**			
Mercury		1	0		0	0	SW7470A-SPLP	µg/L			0.4 U			
Arsenic Speciation (mg/kg dry)														
Arsenate		1	1		55.2	55.2	EPA 1632-As-Cryo-S-Speciation	mg/kg				**55.2 J**		
Arsenite		1	1		16.7	16.7	EPA 1632-As3-CRYO-T	mg/kg				**16.7 J**		
Inorganic Arsenic		1	1		71.9	71.9	EPA 1632-Total Inorganic As - Solid	mg/kg				**71.9**		
Mercury Selective Sequential Extraction (ng/g dry)														
Hg(F1)		1	1		18	18	BRL SOP No. BR-0013	ng/g			**18 J**			
Hg(F2)		1	1		0.7	0.7	BRL SOP No. BR-0013	ng/g			**0.7 J**			
Hg(F3)		1	1		776	776	BRL SOP No. BR-0013	ng/g			**776 J**			
Hg(F4)		1	1		1950	1950	BRL SOP No. BR-0013	ng/g			**1950 J**			
Hg(F5)		1	1		1680	1680	BRL SOP No. BR-0013	ng/g			**1680 J**			

* Soil types defined in Appendix B.

Key

% = percent	J = The analyte was detected. The associated result is estimated.
µg/L = micrograms per liter	mg/kg = milligrams per kilogram
BRL SOP = Brooks Rand Labs Standard Operating Procedure	ng/g = nanograms per gram
EPA = United States Environmental Protection Agency	ng/L = nanograms per liter
Hg = mercury	SPLP = synthetic precipitation leaching procedure
ID = identifier	U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-29 Surface Mined Area Subsurface Soil Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	SM10	SM11	SM10	SM10	SM11	SM11	SM31
							Soil Type*		N/DN	N/DN (Loess)	B/WB	B/WB	B/WB	B/WB	B/WB
							Sample ID		11SM10SB04	11SM11SB04	11SM10SB10	11SM10SB12	11SM11SB14	11SM11SB16	11SM31SB06
Analyte							Method								
Total Inorganic Elements (mg/kg)															
Aluminum	15300	7	7	1	16800	2130	SW6010B	mg/kg	10000	16800	2210	2790	5980	3080	2130
Antimony	52.2	7	7	0	8.57	0.25	SW6020A	mg/kg	2.49 J	0.25 J	6.15 J	4.28 J	1.5 J	1.43 J	8.57 J
Arsenic	12.8	7	7	6	6240	8.67	SW6020A	mg/kg	200 J	8.67 J	6240 J	1690 J	122 J	261 J	273 J
Barium	178	7	7	2	220	71.7	SW6020A	mg/kg	139 J	157 J	220 J	81.5 J	220 J	118 J	71.7 J
Beryllium	0.484	7	7	6	0.981	0.403	SW6020A	mg/kg	0.595	0.403	0.588	0.828	0.76	0.905	0.981
Cadmium	1.3	7	7	0	1.22	0.249	SW6020A	mg/kg	0.358 J	0.249 J	0.457 J	0.855 J	1.13 J	1.22 J	0.776 J
Calcium	4640	7	7	0	1860	1380	SW6010B	mg/kg	1860 J	1770 J	1430 J	1380 J	1720 J	1740 J	1440 J
Chromium	23.4	7	7	0	22.4	8.22	SW6020A	mg/kg	16.9 J	22.4 J	11.9 J	9.8 J	10.3 J	12 J	8.22 J
Cobalt	19.1	7	7	2	25.8	10.4	SW6020A	mg/kg	13.2	10.4	10.8	19.8	17.9	25.8	12.3
Copper	59.7	7	7	4	96.8	17.6	SW6020A	mg/kg	39.6 J	17.6 J	52 J	91.7 J	76.7 J	96.8 J	70.4 J
Iron	39300	7	7	5	66400	28500	SW6010B	mg/kg	35400	28500	64700	49100	66400	55000	54900
Lead	14.3	7	7	5	25	7.54	SW6020A	mg/kg	9.59	7.54	15.7	25	15.8	21.3	16.8
Magnesium	4880	7	7	1	5170	381	SW6010B	mg/kg	2740 J	5170 J	385 J	527 J	1300 J	692 J	381 J
Manganese	951	7	7	2	2170	459	SW6010B	mg/kg	635	525	549	802	2170	1330	459
Mercury	3.92	7	7	6	48.3	0.032	SW7471A	mg/kg	11.8	0.032	48.3	17.9	7.18	6.93	15.2
Nickel	52.2	7	7	3	99.1	23	SW6020A	mg/kg	35 J	23 J	35.6 J	59.5 J	64.3 J	99.1 J	52.1 J
Potassium	1080	7	7	5	1350	667	SW6010B	mg/kg	846	667	1220	1350	1180	1290	1190
Selenium	0.37	7	7	5	2.59	0.23	SW7742	mg/kg	0.23	0.25	2.59	0.62	0.87	1.01	0.5
Silver	10.5	7	7	0	0.377	0.083	SW6020A	mg/kg	0.139	0.083	0.179	0.292	0.244	0.377	0.243
Sodium	8170	7	7	0	153	38	SW6010B	mg/kg	78.4 J	153 J	53.1 J	49.9 J	47 J	38 J	38 J
Thallium	0.088	7	7	6	1.54	0.087	SW6020A	mg/kg	0.11	0.097	1.54	0.54	0.146	0.121	0.087
Vanadium	37.6	7	7	1	37.8	14.8	SW6020A	mg/kg	29.4	37.8	19.1	18.9	19.7	25.3	14.8
Zinc	106	7	7	4	168	60.8	SW6020A	mg/kg	75.1 J	60.8 J	77 J	137 J	109 J	168 J	113 J
Low Level Mercury (ng/g)															
Mercury		2	2	0	31300	24800	EPA 1631 Appendix	ng/g			31300 J				24800 J
SPLP Inorganic Elements (µg/L)															
Aluminum		2	2		1630	1560	SW6010B-SPLP	µg/L			1560 J				1630 J
Antimony		2	0				SW6010B-SPLP	µg/L			20 U				20 U
Arsenic		2	2		661	42	SW6010B-SPLP	µg/L			661				42
Barium		2	2		40.5	37.5	SW6010B-SPLP	µg/L			40.5 J				37.5 J
Beryllium		2	0				SW6010B-SPLP	µg/L			0.2 U				0.2 U
Cadmium		2	2		1.4	1.2	SW6010B-SPLP	µg/L			1.4 J				1.2
Calcium		2	2		486	384	SW6010B-SPLP	µg/L			486 J				384 J
Chromium		2	2		5.4	4.8	SW6010B-SPLP	µg/L			5.4 J				4.8 J
Cobalt		2	1		3.1	3.1	SW6010B-SPLP	µg/L			3.1 J				2 U
Copper		2	2		10.1	7.4	SW6010B-SPLP	µg/L			7.4 J				10.1
Iron		2	2		6080	4840	SW6010B-SPLP	µg/L			4840				6080
Lead		2	1		9.6	9.6	SW6010B-SPLP	µg/L			9.6 J				8 U
Magnesium		2	2		142	136	SW6010B-SPLP	µg/L			142 J				136 J
Manganese		2	2		69.2	45.4	SW6010B-SPLP	µg/L			69.2				45.4
Nickel		2	2		8	5.7	SW6010B-SPLP	µg/L			5.7 J				8 J
Potassium		2	2		1050	827	SW6010B-SPLP	µg/L			827				1050
Selenium		2	0				SW6010B-SPLP	µg/L			30 U				30 U
Silver		2	0				SW6010B-SPLP	µg/L			5 U				5 U
Sodium		2	2		9450	9290	SW6010B-SPLP	µg/L			9290 J				9450 J
Thallium		2	0				SW6010B-SPLP	µg/L			30 U				30 U
Vanadium		2	2		6.3	6.3	SW6010B-SPLP	µg/L			6.3 J				6.3 J
Zinc		2	2		34.6	33.7	SW6010B-SPLP	µg/L			33.7 J				34.6
Mercury		2	2		9.58	4.2	SW7470A-SPLP	µg/L			9.58				4.2
Arsenic Speciation (mg/kg dry)															
Arsenate		2	2		4120	468	EPA 1632-As-Cryo-S-Speciation	mg/kg			4120 J				468 J
Arsenite		2	2		50.9	8.44	EPA 1632-As3-CRYO-T	mg/kg			50.9 J				8.44 J
Inorganic Arsenic		2	2		4170	476	EPA 1632-Total Inorganic As - Solid	mg/kg			4170				476
Mercury Selective Sequential Extraction (ng/g dry)															
Hg(F1)		2	2		514	403	BRL SOP No. BR-0013	ng/g			403 J				514 J
Hg(F2)		2	2		2390	1700	BRL SOP No. BR-0013	ng/g			2390 J				1700 J
Hg(F3)		2	2		1290	1100	BRL SOP No. BR-0013	ng/g			1100 J				1290 J
Hg(F4)		2	2		7450	5930	BRL SOP No. BR-0013	ng/g			7450 J				5930 J
Hg(F5)		2	2		11200	8770	BRL SOP No. BR-0013	ng/g			8770 J				11200 J

* Soil types defined in Appendix B.

Key

% = percent
µg/L = micrograms per liter
EPA = United States Environmental Protection Agency
Hg = mercury
ID = identifier
J = The analyte was detected. The associated result is estimated.
mg/kg = milligrams per kilogram
ng/g = nanograms per gram
SPLP = synthetic precipitation leaching procedure
U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-30 Groundwater Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**MW01**	**MW03**	**MW04**	**MW06**	**MW07**	**MW08**	**MW10**	**MW14**	**MW15**	**MW16**	**MW18**
							Geographic Area		**Post-1955 MPA**	**Post-1955 MPA**	**Pre-1955 MPA**	**Pre-1955 MPA**	**Post-1955 MPA**	**Post-1955 MPA**	**Post-1955 MPA**	**Post-1955 MPA**	**Post-1955 MPA**	**Post-1955 MPA**	**Post-1955 MPA**
							Sample ID		**10MW01GW**	**10MW03GW**	**10MW04GW**	**10MW06GW**	**10MW07GW**	**11MP01GW**	**11MP14GW**	**11MP25GW**	**11MP29GW**	**11MP30GW**	**11MP31GW**
							Sample Date		**9/20/2010**	**9/21/2010**	**9/21/2010**	**9/21/2010**	**9/21/2010**	**8/30/2011**	**8/29/2011**	**8/31/2011**	**8/30/2011**	**8/30/2011**	**8/31/2011**
Analyte							**Method**												
Total Inorganic Elements																			
Aluminum	405	28	24	5	1460	8.8	SW6010B	µg/L	14.8 U	14.8 U	14.8 U	14.8 U		**175**	**108**	**125 J**	**28.3 J**	**202**	**525**
Antimony	0.505 J	28	28	28	13100	0.6	SW6020A	µg/L	**1.8**	**748**	**29.1**	**5.4**		**1.59**	**6.49**	**79.5 J**	**13100**	**678**	**1.04 J**
Arsenic	13.5	28	28	17	6650	0.6	SW6020A	µg/L	**10.6**	**57.8**	**8.8**	**28.1**		**0.6**	**96.9**	**6650**	**5620**	**1020**	**1.3**
Barium	83.3	28	28	8	365	28.2	SW6020A	µg/L	**100**	**31.4**	**35**	**79.3**		**39.1**	**88.1**	**73.6**	**93.6**	**46.9**	**83.7**
Beryllium	0.018 J	28	17	11	0.11	0.006	SW6020A	µg/L	0.027 U	0.027 U	0.027 U	0.027 U		**0.01 J**	**0.021**	**0.007 J**	0.006 U	**0.015**	**0.068**
Cadmium	0.017 J	28	25	18	0.224	0.005	SW6020A	µg/L	0.022 U	0.022 U	**0.2**	0.022 U		**0.013 J**	**0.011 J**	**0.032**	**0.027**	**0.151**	**0.028 J**
Calcium	20600	28	28	19	96700	10600	SW6010B	µg/L	**26300**	**20200**	**33000**	**32600**		**10600**	**21200**	**21000**	**50300**	**24800**	**16700**
Chromium	4.95	28	24	3	10.6	0.05	SW6020A	µg/L	0.053 U	0.053 U	0.053 U	0.053 U		**0.67**	**2.27**	**0.88**	**0.59**	**0.83**	**1.67**
Cobalt	1.14	28	27	16	40.5	0.045	SW6020A	µg/L	**0.7**	0.007 U	**1.6**	**1.4**		**0.103**	**0.582**	**6.81**	**0.299**	**7.36**	**2.28**
Copper	0.48	28	25	21	6.29	0.09	SW6020A	µg/L	0.232 U	0.232 U	**1.5**	0.232 U		**0.45**	**1.3**	**1.25**	**1.63**	**1.08**	**2.29**
Iron	8990	28	26	4	22400	5.8	SW6010B	µg/L	**22400**	7.2 U	7.2 U	**1780**		**299**	**1150**	**18700**	**33.6**	**10600**	**1720**
Lead	0.311	28	24	8	2.02	0.019	SW6020A	µg/L	0.2 U	0.2 U	0.2 U	0.2 U		**0.102**	**0.339**	**0.218**	**0.029**	**0.201**	**0.861**
Magnesium	11300	28	28	26	71900	7820	SW6010B	µg/L	**16300**	**20700**	**43700**	**29700**		**7820**	**31400**	**17100**	**71900**	**42400**	**14200**
Manganese	1120	28	27	4	7370	1.12	SW6020A	µg/L	**914**	0.02 U	**1040**	**569**		**3.68**	**128**	**3310**	**11.7**	**4750**	**543**
Nickel	2.68	28	28	17	35.9	0.9	SW6020A	µg/L	**1**	**1.3**	**35.4**	**2.3**		**1.16**	**2.64**	**4.97**	**13.2**	**4.01**	**6.5**
Potassium	708	28	27	21	4930	259	SW6010B	µg/L	69.1 U	**830**	**880**	**750**		**485**	**1060**	**706**	**2380**	**2000**	**932**
Selenium	ND	28	10	10	5.4	0.3	SW6020A	µg/L	0.125 U	**0.9**	0.125 U	0.125 U		**0.4 J**	0.3 U	0.2 U	**5.4**	0.3 U	0.3 U
Silver	0.016 J	28	19	5	0.049	0.004	SW6020A	µg/L	0.009 U	0.009 U	0.009 U	0.009 U		**0.005 J**	**0.006 J**	0.004 U	0.004 U	**0.004 J**	**0.012 J**
Sodium	2800	28	28	18	20000	1150	SW6010B	µg/L	**7580**	**2580**	**4880**	**4340**		**1150**	**3720**	**3020**	**5400**	**4950**	**2330 J**
Thallium	0.009 J	28	16	10	0.075	0.006	SW6020A	µg/L	0.003 U	0.003 U	0.003 U	0.003 U		0.005 U	0.005 U	0.005 U	0.005 U	**0.015 J**	**0.008 J**
Vanadium	0.55	28	25	15	3.88	0.09	SW6020A	µg/L	**1.7**	**0.2**	0.026 U	0.026 U		**0.27**	**0.59**	**1.34**	**2.11**	**1.06**	**1.06**
Zinc	1.3	28	25	22	22	0.8	SW6020A	µg/L	0.81 U	0.81 U	**13**	0.81 U		**0.8**	**1.9**	**5.4**	**5.6**	**3.6**	**4.1**
Total Low Level Mercury																			
Mercury, Total	58.4	28	28	20	56500	1.85	EPA 1631	ng/L	**16.7**	**16.5**	**150**	**1.85**		**21.5**	**532**	**759**	**2910**	**1210**	**50.4**
Dissolved Inorganic Elements																			
Aluminum, Dissolved	8.3 J	29	20	9	140	2.1	SW6010B-Diss	µg/L	14.8 U	14.8 U	14.8 U	14.8 U	**140**	**3.4 J**	**4 J**	**14.2 J**	**3.7 J**	**15.3 J**	2 U
Antimony, Dissolved	0.522 J	29	29	27	13100	0.317	SW6020A-Diss	µg/L	**1.4**	**724**	**30**	**5.2**	**4.9**	**1.58**	**0.5**	**53.8 J**	**13100**	**658**	**0.654 J**
Arsenic, Dissolved	13.9	29	29	15	6660	0.4	SW6020A-Diss	µg/L	**9**	**55.8**	**8.8**	**26.3**	**0.4**	**0.5 J**	**92.1**	**6660**	**5590**	**1010**	**0.7**
Barium, Dissolved	87.7	29	29	5	348	23.3	SW6020A-Diss	µg/L	**85.9**	**31.8**	**35.7**	**79.2**	**29**	**36.7**	**85.2**	**68.5**	**92.3**	**43.4**	**72**
Beryllium, Dissolved	0.01 J	29	11	7	0.041	0.006	SW6020A-Diss	µg/L	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.006 U	0.006 U	**0.01 J**	0.006 U	**0.009 J**	0.006 U
Cadmium, Dissolved	0.008 J	28	24	19	0.229	0.006	SW6020A-Diss	µg/L		0.022 U	**0.2 J**	0.022 U	0.022 U	**0.009 J**	0.005 U	**0.019 J**	**0.023**	**0.13**	**0.014 J**
Calcium, Dissolved	20400	29	29	20	100000	7180	SW6010B-Diss	µg/L	**23900**	**22200**	**34000**	**32000**	**7180**	**10500**	**21000**	**20700**	**49400**	**25500**	**16200**
Chromium, Dissolved	1.43	29	25	2	2.81	0.09	SW6020A-Diss	µg/L	0.053 U	0.053 U	0.053 U	0.053 U	**1.8**	**0.5**	**0.44**	**0.73**	**0.71**	**0.43**	**0.24**
Cobalt, Dissolved	1.21	29	28	15	41.5	0.027	SW6020A-Diss	µg/L	**0.7**	0.007 U	**1.7**	**1.4**	**0.2**	**0.027**	**0.23**	**6.85**	**0.298**	**7.14**	**1.65**
Copper, Dissolved	0.34	29	26	16	1.8	0.08	SW6020A-Diss	µg/L	0.232 U	0.232 U	**1.8**	0.232 U	**1.1**	**0.21**	**0.1**	**0.38**	**1.59**	**0.48**	**0.22**
Iron, Dissolved	8760	29	22	4	19100	3.4	SW6010B-Diss	µg/L	**19100**	7.2 U	7.2 U	**1680**	**60**	3 U	**529**	**17600**	**7.2 J**	**10600**	**621**
Lead, Dissolved	0.244	29	20	0	0.046	0.005	SW6020A-Diss	µg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.008 J**	**0.008 J**	**0.046**	**0.014 J**	**0.008 J**	**0.012 J**
Magnesium, Dissolved	11400	29	29	26	73500	2900	SW6010B-Diss	µg/L	**14900**	**22700**	**45200**	**29100**	**2900**	**7740**	**31700**	**16900**	**73500**	**43600**	**14000**
Manganese, Dissolved	1190	29	28	4	7050	0.606	SW6020A-Diss	µg/L	**712**	0.02 U	**1030**	**575**	**10.1**	**0.649**	**116**	**3370**	**11**	**5070**	**493**
Nickel, Dissolved	1.84	29	29	20	34.6	0.79	SW6020A-Diss	µg/L	**0.9**	**1.1**	**34.6**	**2.3**	**1.8**	**0.85**	**1.01**	**5.14**	**12.9**	**3.59**	**4.75**
Potassium, Dissolved	730	29	28	18	4620	211	SW6010B-Diss	µg/L	69.1 U	**870**	**880**	**730**	**500**	**453**	**1010**	**628**	**2480**	**2000**	**719**
Selenium, Dissolved	ND	29	10	10	4.9	0.3	SW6020A-Diss	µg/L	0.125 U	**0.9**	0.125 U	0.125 U	0.125 U	**0.3 J**	0.3 U	0.2 U	**4.9**	0.3 U	0.3 U
Silver, Dissolved	0.004 J	29	3	3	0.013	0.007	SW6020A-Diss	µg/L	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Sodium, Dissolved	2810	29	29	19	20000	1160	SW6010B-Diss	µg/L	**7040**	**2730**	**4850**	**4120**	**2480**	**1160**	**3760**	**3030**	**5620**	**5070**	**2310**
Thallium, Dissolved	ND	29	8	8	0.059	0.006	SW6020A-Diss	µg/L	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.005 U	0.005 U	**0.007 J**	0.005 U	**0.012 J**	0.005 U
Vanadium, Dissolved	0.74	29	24	5	2.03	0.03	SW6020A-Diss	µg/L	**1.4**	0.026 U	0.026 U	0.026 U	**1**	**0.04 J**	**0.09 J**	**1.06**	**2.03**	**0.71**	**0.03 J**
Zinc, Dissolved	0.4 J	29	26	23	20.7	0.2	SW6020A-Diss	µg/L	0.81 U	0.81 U	**15**	0.81 U	**17**	**0.3 J**	**0.2 J**	**4.3**	**5.7**	**2.8**	**1.1**
Dissolved Low Level Mercury																			
Mercury, Dissolved	1.14	29	28	23	2200	0.54	EPA 1631	ng/L	**8.5**	**6.47**	**149**	0.15 U	**12.1**	**1**	**0.62 J**	**141**	**2200**	**285**	**2.7**
Arsenic Speciation																			
Arsenate		16	16	0	4520	0.161	EPA 1632	µg/L	**2.34**					**0.161**	**2.61 J**		**4520**		**0.415**
Arsenite		16	15	0	89.6	0.245	EPA 1632	µg/L	**7.23**					0.003 U	**89.6 J**		**13 J**		**0.306 J**
Inorganic Arsenic		16	16	0	4530	0.17	EPA 1632	µg/L	**9.57**					**0.17**	**92.2**		**4530**		**0.721**
Methlymercury																			
Methylmercury	ND	28	19	19	1.71	0.06	EPA 1630	ng/L	**1.71**	0.02 U	**0.081**	0.02 U		**0.1 J**	0.05 U	**0.54**	**0.52 J**	**0.9 J**	0.05 UJ

Table 4-30 Groundwater Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MW01	MW03	MW04	MW06	MW07	MW08	MW10	MW14	MW15	MW16	MW18
							Geographic Area		Post-1955 MPA	Post-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA
							Sample ID		10MW01GW	10MW03GW	10MW04GW	10MW06GW	10MW07GW	11MP01GW	11MP14GW	11MP25GW	11MP29GW	11MP30GW	11MP31GW
							Sample Date		9/20/2010	9/21/2010	9/21/2010	9/21/2010	9/21/2010	8/30/2011	8/29/2011	8/31/2011	8/30/2011	8/30/2011	8/31/2011
Analyte							Method												
Semi-Volatile Organic Compounds																			
Toluene		2	2		1.8	0.09	SW8260C Volatile Organics in Water	µg/L								**0.09 J**			
Bis(2-ethylhexyl) Phthalate		9	1		5.7	5.7	SW8270C Base Neutral/Acid Semivolatile Organic compounds	µg/L											1.9 U
Unknown Hydrocarbon		2	1		2	2	SW8270D	µg/L	**2 J**		0 U								
Gasoline, Diesel and Residual Range Organics																			
Gasoline Range Organics		3	0				AK101 AK 101 Gasoline Range Organics	µg/L	60 U							13 U			
Diesel Range Organics		12	10		200	14	AK102 Alaska Diesel Range for Water	µg/L	20 U		**110**					**43 J**			11 U
Residual Range Organics		12	4		620	60	AK103 Alaska Residual Range for Water	µg/L	50 U		50 U					**82 J**			19 UJ
PCBs																			
PCB-1016		2	0				EPA 8082	µg/L											
PCB-1221		2	0				EPA 8082	µg/L											
PCB-1232		2	0				EPA 8082	µg/L											
PCB-1242		2	0				EPA 8082	µg/L											
PCB-1248		2	0				EPA 8082	µg/L											
PCB-1254		2	0				EPA 8082	µg/L											
PCB-1260		2	0				EPA 8082	µg/L											
General Chemistry																			
Bicarbonate		29	29		398	30.3	A2320 General Chemistry Parameters	mg/L	**124**	**113**	**92.8**	**180**	**30.3**	**56.5**	**181**	**99.5**	**91.7**	**148**	**95.5**
Carbonate		29	0				A2320 General Chemistry Parameters	mg/L	1 U	1 U	1 U	1 U	1 U	3 U	3 U	3 U	3 U	3 U	3 U
Hydroxide		5	0				SM 2320	mg/L	1 U	1 U	1 U	1 U	1 U						
Chloride		29	29		1.25	0.34	EPA 300.0 General Chemistry Parameters	mg/L	**0.7**	**0.5**	**0.5**	**0.8**	**0.8**	**0.6**	**0.59**	**0.55**	**0.54**	**0.51**	**0.4**
Fluoride		29	27		0.3	0.06	EPA 300.0 General Chemistry Parameters	mg/L	**0.1**	0.022 U	**0.1**	**0.1**	0.022 U	**0.11 J**	**0.18 J**	**0.22 J**	**0.06 J**	**0.3 J**	**0.18 J**
Sulfate		29	29		345	3.5	EPA 300.0 General Chemistry Parameters	mg/L	**38.9**	**35.4**	**180**	**29**	**3.5**	**4.41**	**11.3**	**34.7**	**345**	**112**	**10.4 J**
Nitrate+Nitrite as Nitrogen		28	13		0.841	0.011	EPA 353.2 General Chemistry Parameters	mg/L	0.005 U	**0.109**	**0.011**	0.001 U		**0.501**	0.009 U	0.009 U	**0.641**	0.009 U	0.009 UJ
Total Dissolved Solids		28	28		656	65	A2540C/EPA 160.1	mg/L	**230**	**158**	**343**	**218**		**65**	**185**	**157**	**586**	**310**	**91**
Total Suspended Solids		28	16		154	2.4	A2540D/EPA 160.2	mg/L	**20.4**	1.1 U	2.1 U	**2.4**		**5**	**21**	**50**	5 U	**35.5**	**48.5**
Field Parameters																			
Temperature		28			13.16	2.47	Field Test	°C	13.16	5.41	6.67	5.14		3.60	5.37	3.75	5.79	5.56	3.04
pH		28			7.72	6.08	Field Test	N/A	6.330	6.30	6.16	6.72		6.49	7.59	6.53	6.73	6.66	6.54
ORP		28			230	-137	Field Test	mV	-41	0.00	0.00	0.00		211	-137	-36	202	-33	41
Conductance		28			0.878	0.103	Field Test	mS/cm	0.355	0.307	0.565	0.432		0.103	0.289	0.336	0.677	0.419	0.218
Turbidity		28			207	0	Field Test	NTU	2.2	0.00	0.00	0.00		0.00	50.10	0.00	0.00	0.00	36.20
Dissolved Oxygen		28			30.89	0	Field Test	mg/L	0.27	2.97	0.00	0.00		NR	NR	30.89	NR	NR	0.45

Table 4-30 Groundwater Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MW19	MW20	MW21	MW22	MW29	MW26	MW27	MW24	MW23	MW28	MW25
							Geographic Area		Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Surface Mined Area	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA
							Sample ID		11MP33GW	11MP38GW	11MP39GW	11MP40GW	11MP41GW	11MP52GW	11MP60GW	11MP62GW	11MP66GW	11MP88GW	11MP89GW
							Sample Date		9/1/2011	8/31/2011	8/31/2011	8/31/2011	9/1/2011	8/30/2011	8/30/2011	8/30/2011	8/30/2011	8/30/2011	8/30/2011
Analyte							Method												
Total Inorganic Elements																			
Aluminum	405	28	24	5	1460	8.8	SW6010B	µg/L	1460 J	8.8 J	12.1 J	36.9 J	397	43 J	20.90 J	553	81.7	316	240
Antimony	0.505 J	28	28	28	13100	0.6	SW6020A	µg/L	0.6 J	566 J	5860	297	1.21	26.2	9.16 J	101 J	2.4 J	19.3 J	5.86 J
Arsenic	13.5	28	28	17	6650	0.6	SW6020A	µg/L	5.6	161	1760	80.4	36.9	78	22.6	7.4	9.2	32.8	6.2
Barium	83.3	28	28	8	365	28.2	SW6020A	µg/L	73.4	38.3	114	52.9	224	365	56.6	29.4	210	59.7	55
Beryllium	0.018 J	28	17	11	0.11	0.006	SW6020A	µg/L	0.11	0.006 U	0.006 U	0.006 U	0.059	0.026	0.017 J	0.033	0.019 J	0.06	0.021
Cadmium	0.017 J	28	25	18	0.224	0.005	SW6020A	µg/L	0.087	0.005 J	0.008 J	0.018 J	0.076	0.094	0.139	0.032 J	0.013 J	0.052	0.117
Calcium	20600	28	28	19	96700	10600	SW6010B	µg/L	19700	20100	31200	14700	64800	65700	96700	35500	37300	43900	35000
Chromium	4.95	28	24	3	10.6	0.05	SW6020A	µg/L	6.46	0.16 J	0.08 J	0.22	10.6	1.39	1.36	1.15	0.31	6.29	1.03
Cobalt	1.14	28	27	16	40.5	0.045	SW6020A	µg/L	3.89	0.18	0.071	0.106	9.48	40.5	1.74	2.12	3.01	5.26	4.77
Copper	0.48	28	25	21	6.29	0.09	SW6020A	µg/L	6.29	0.29	1.11	1.4	3.6	1	1.57	1.97 J	0.73	3.48	2.32
Iron	8990	28	26	4	22400	5.8	SW6010B	µg/L	5570	24.1	5.8 J	104	2670	12500	39.5	1370	6450	3510	609
Lead	0.311	28	24	8	2.02	0.019	SW6020A	µg/L	2.02	0.024	0.019 J	0.137	0.63	0.154	0.076	0.81 J	0.187	0.728	0.257
Magnesium	11300	28	28	26	71900	7820	SW6010B	µg/L	13700	15100	27500	11900	68800	42500	55400	27100	30000	31400	24200
Manganese	1120	28	27	4	7370	1.12	SW6020A	µg/L	141	5.65	5.55	17.6	778	7370	1040	107	905	1480	207
Nickel	2.68	28	28	17	35.9	0.9	SW6020A	µg/L	12.1	1.3	1.51	2.06	28.3	32.9	35.9	4.11	4.74	16	13.9
Potassium	708	28	27	21	4930	259	SW6010B	µg/L	1380	523	1800	259 J	2190	4930	2080	1050	1390	3140	972
Selenium	ND	28	10	10	5.4	0.3	SW6020A	µg/L	1	1.1	0.3 J	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Silver	0.016 J	28	19	5	0.049	0.004	SW6020A	µg/L	0.035	0.005 J	0.011 J	0.013 J	0.009 J	0.004 U	0.007 J	0.049 J	0.005 J	0.015 J	0.017 J
Sodium	2800	28	28	18	20000	1150	SW6010B	µg/L	2350 J	2330	5210	2560	4570	7640	20000	19400	8710	13000	6410
Thallium	0.009 J	28	16	10	0.075	0.006	SW6020A	µg/L	0.029	0.005 U	0.007 J	0.006 J	0.015 J	0.075	0.016 J	0.006 J	0.008 J	0.012 J	0.012 J
Vanadium	0.55	28	25	15	3.88	0.09	SW6020A	µg/L	3.88	0.24	1.38	0.43	1.56	0.12 J	0.15 J	1.96	0.26	1.19	0.44
Zinc	1.3	28	25	22	22	0.8	SW6020A	µg/L	9.4	1.4	1.1	1.6	15	13.9	22	5.4 J	4.7	11.9	11.4
Total Low Level Mercury																			
Mercury, Total	58.4	28	28	20	56500	1.85	EPA 1631	ng/L	413	1610	141	981	247	237	411	56500	261	4000	452
Dissolved Inorganic Elements																			
Aluminum, Dissolved	8.3 J	29	20	9	140	2.1	SW6010B-Diss	µg/L	2.1 J	4.9 J	5.1 J	16.8 J	2 U	2 U	19.6 J	2.6 J	6.7 J	8.3 J	12.7 J
Antimony, Dissolved	0.522 J	29	29	27	13100	0.317	SW6020A-Diss	µg/L	0.317 J	616 J	5950	294	0.837	32.3	8.48 J	79.9 J	1.87 J	9.18 J	3.71 J
Arsenic, Dissolved	13.9	29	29	15	6660	0.4	SW6020A-Diss	µg/L	2.9	173	1770	77.3	31.1	68.3	22.1	5.1	8	8.4	3.6
Barium, Dissolved	87.7	29	29	5	348	23.3	SW6020A-Diss	µg/L	46.3	39.8	115	51.1	206	348	52	23.3	197	50	54.1
Beryllium, Dissolved	0.01 J	29	11	7	0.041	0.006	SW6020A-Diss	µg/L	0.006 U	0.006 U	0.006 U	0.006 U	0.016 J	0.021	0.024	0.006 U	0.016 J	0.007 J	0.013 J
Cadmium, Dissolved	0.008 J	28	24	19	0.229	0.006	SW6020A-Diss	µg/L	0.029	0.008 J	0.007 J	0.007 J	0.058	0.071	0.122	0.006 J	0.007 J	0.022	0.086
Calcium, Dissolved	20400	29	29	20	100000	7180	SW6010B-Diss	µg/L	18700	20000	31400	14500	62700	66000	100000	34500	36600	42000	34400
Chromium, Dissolved	1.43	29	25	2	2.81	0.09	SW6020A-Diss	µg/L	0.66	0.5	0.2 J	0.33	2.81	0.42	0.84	0.26	0.18 J	0.81	0.86
Cobalt, Dissolved	1.21	29	28	15	41.5	0.027	SW6020A-Diss	µg/L	1.41	0.171	0.074	0.08	8.32	41.5	1.55	1.32	2.67	4.18	4.76
Copper, Dissolved	0.34	29	26	16	1.8	0.08	SW6020A-Diss	µg/L	0.14	0.28	1.07	1.19	0.95	0.5	1.34	0.22	0.13	0.82	1.45
Iron, Dissolved	8760	29	22	4	19100	3.4	SW6010B-Diss	µg/L	51.7	3.4 J	6.6 J	15.8 J	1040	11300	8.9 J	3 U	5970	211	10.9 J
Lead, Dissolved	0.244	29	20	0	0.046	0.005	SW6020A-Diss	µg/L	0.014 J	0.005 U	0.007 J	0.044	0.024	0.012 J	0.014 J	0.005 U	0.013 J	0.009 J	0.014 J
Magnesium, Dissolved	11400	29	29	26	73500	2900	SW6010B-Diss	µg/L	12900	15200	27500	12000	67400	41400	54500	27000	29900	29300	24300
Manganese, Dissolved	1190	29	28	4	7050	0.606	SW6020A-Diss	µg/L	54.1	5.63	6.52	15.6	694	7050	1020	79.8	851	1340	206
Nickel, Dissolved	1.84	29	29	20	34.6	0.79	SW6020A-Diss	µg/L	5.74	1.46	1.47	1.93	24.8	32.7	34.5	2.33	4.21	10.8	13.5
Potassium, Dissolved	730	29	28	18	4620	211	SW6010B-Diss	µg/L	323 J	535	1810	211 J	1860	4620	1890	861	1300	2260	788
Selenium, Dissolved	ND	29	10	10	4.9	0.3	SW6020A-Diss	µg/L	0.9 J	0.8 J	0.4 J	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Silver, Dissolved	0.004 J	29	3	3	0.013	0.007	SW6020A-Diss	µg/L	0.013 J	0.004 U	0.008 J	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.007 J
Sodium, Dissolved	2810	29	29	19	20000	1160	SW6010B-Diss	µg/L	2300 J	2330	5230	2590	4300	7510	19600	20000	8800	11700	6450
Thallium, Dissolved	ND	29	8	8	0.059	0.006	SW6020A-Diss	µg/L	0.012 J	0.005 U	0.005 U	0.005 U	0.007 J	0.059	0.012 J	0.005 U	0.005 U	0.005 U	0.006 J
Vanadium, Dissolved	0.74	29	24	5	2.03	0.03	SW6020A-Diss	µg/L	0.16 J	0.19 J	1.28	0.34	0.1 J	0.06 J	0.12 J	0.34	0.06 J	0.04 J	0.09 J
Zinc, Dissolved	0.4 J	29	26	23	20.7	0.2	SW6020A-Diss	µg/L	0.3 J	0.8	1	1	11.3	13.5	20.7	1.6	3.1	6.3	10.1
Dissolved Low Level Mercury																			
Mercury, Dissolved	1.14	29	28	23	2200	0.54	EPA 1631	ng/L	0.54 J	277	80.2	527	0.71 J	33.8	277	6.11	2.39	10.9	44.7
Arsenic Speciation																			
Arsenate		16	16	0	4520	0.161	EPA 1632	µg/L	3.08	188	1640		28.2		18	6.05		7.43	5
Arsenite		16	15	0	89.6	0.245	EPA 1632	µg/L	2.07 J	1.1	5.19 J		10.9		2.57 J	1.16 J		6.75 J	0.42 J
Inorganic Arsenic		16	16	0	4530	0.17	EPA 1632	µg/L	5.15	189	1640		39.1		20.6	7.21		14.2	5.42
Methlymercury																			
Methylmercury	ND	28	19	19	1.71	0.06	EPA 1630	ng/L	0.06 J	0.07 J	0.09 J	1.14	0.05 U	0.48 J	0.07 J	0.23 J	0.05 UJ	0.4 J	0.07 J

Table 4-30 Groundwater Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MW19	MW20	MW21	MW22	MW29	MW26	MW27	MW24	MW23	MW28	MW25
							Geographic Area		Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Surface Mined Area	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Pre-1955 MPA
							Sample ID		11MP33GW	11MP38GW	11MP39GW	11MP40GW	11MP41GW	11MP52GW	11MP60GW	11MP62GW	11MP66GW	11MP88GW	11MP89GW
							Sample Date		9/1/2011	8/31/2011	8/31/2011	8/31/2011	9/1/2011	8/30/2011	8/30/2011	8/30/2011	8/30/2011	8/30/2011	8/30/2011
Analyte							Method												
Semi-Volatile Organic Compounds																			
Toluene		2	2		1.8	0.09	SW8260C Volatile Organics in Water	µg/L											
Bis(2-ethylhexyl) Phthalate		9	1		5.7	5.7	SW8270C Base Neutral/Acid Semivolatile Organic compounds	µg/L	2.1 U	1.9 U	1.9 U	1.9 U							
Unknown Hydrocarbon		2	1		2	2	SW8270D	µg/L											
Gasoline, Diesel and Residual Range Organics																			
Gasoline Range Organics		3	0				AK101 AK 101 Gasoline Range Organics	µg/L											
Diesel Range Organics		12	10		200	14	AK102 Alaska Diesel Range for Water	µg/L	**110 J**	**14 J**	**62 J**	**38 J**							
Residual Range Organics		12	4		620	60	AK103 Alaska Residual Range for Water	µg/L	**60 J**	19 UJ	**69 J**	19 U							
PCBs																			
PCB-1016		2	0				EPA 8082	µg/L											
PCB-1221		2	0				EPA 8082	µg/L											
PCB-1232		2	0				EPA 8082	µg/L											
PCB-1242		2	0				EPA 8082	µg/L											
PCB-1248		2	0				EPA 8082	µg/L											
PCB-1254		2	0				EPA 8082	µg/L											
PCB-1260		2	0				EPA 8082	µg/L											
General Chemistry																			
Bicarbonate		29	29		398	30.3	A2320 General Chemistry Parameters	mg/L	**100**	**103**	**172**	**84.5**	**398**	**276**	**242**	**192**	**226**	**225**	**162**
Carbonate		29	0				A2320 General Chemistry Parameters	mg/L	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Hydroxide		5	0				SM 2320	mg/L											
Chloride		29	29		1.25	0.34	EPA 300.0 General Chemistry Parameters	mg/L	**0.36 J**	**0.38 J**	**0.39 J**	**0.54**	**0.69**	**0.65**	**1.25**	**0.66**	**0.71**	**0.64**	**1.09**
Fluoride		29	27		0.3	0.06	EPA 300.0 General Chemistry Parameters	mg/L	**0.14 J**	**0.11 J**	**0.15 J**	**0.15 J**	**0.15 J**	**0.23 J**	**0.14 J**	**0.15 J**	**0.12 J**	**0.2 J**	**0.11 J**
Sulfate		29	29		345	3.5	EPA 300.0 General Chemistry Parameters	mg/L	**6**	**17.9**	**25.7**	**4.4**	**45.1**	**107**	**293**	**38.3**	**12.7**	**46**	**36.8**
Nitrate+Nitrite as Nitrogen		28	13		0.841	0.011	EPA 353.2 General Chemistry Parameters	mg/L	**0.136**	**0.132**	0.009 U	0.009 U	0.009 U	0.009 UJ	0.009 U	**0.351**	0.009 UJ	0.009 UJ	**0.162**
Total Dissolved Solids		28	28		656	65	A2540C/EPA 160.1	mg/L	**80**	**96**	**182**	**69**	**405**	**418**	**656**	**237**	**225**	**266**	**206**
Total Suspended Solids		28	16		154	2.4	A2540D/EPA 160.2	mg/L	**154**	5 U	5 U	5 U	**65**	**23**	5 U	**29**	**23.5**	**48.5**	**14**
Field Parameters																			
Temperature		28			13.16	2.47	Field Test	°C	2.47	3.77	4.34	8.07	5.83	5.02	4.67	5.77	4.63	5.32	4.06
pH		28			7.72	6.08	Field Test	N/A	7.31	6.76	6.88	6.64	6.69	7.05	6.65	6.87	6.87	7.06	6.52
ORP		28			230	-137	Field Test	mV	49	201	194	171	20	-18	170	12.9	-58	-82	165
Conductance		28			0.878	0.103	Field Test	mS/cm	0.217	0.232	0.383	0.178	0.782	0.691	0.878	0.336	0.368	0.472	0.359
Turbidity		28			207	0	Field Test	NTU	207.00	0.00	0.00	0.00	41.00	6.30	0.30	19.90	0.00	50.70	34.20
Dissolved Oxygen		28			30.89	0	Field Test	mg/L	3.98	NR	NR	NR	1.38	0.99	2.63	NR	NR	0.89	0.33

Table 4-30 Groundwater Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MW17	MW01	MW03	MW04	MW06	MW32	MW33	MW04	MW27
							Geographic Area		Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Red Devil Creek Delta	Red Devil Creek Delta	Pre-1955 MPA	Pre-1955 MPA
							Sample ID		11MP91GW	11MW01GW	11MW03GW	11MW04GW	11MW06GW	11RD05GW	11RD20GW	0912MW04GW	0912MW27GW
							Sample Date		8/30/2011	8/24/2011	8/26/2011	8/22/2011	8/24/2011	8/31/2011	8/31/2011	9/10/2012	9/9/2012
Analyte							Method										
Total Inorganic Elements																	
Aluminum	405	28	24	5	1460	8.8	SW6010B	µg/L	**440**	**37.9 J**	**14.2 J**	**13.3 J**	**22.3 J**	**533**	**103**		
Antimony	0.505 J	28	28	28	13100	0.6	SW6020A	µg/L	**53.9**	**1.9**	**917**	**27.9**	**5.51**	**2.15 J**	**427 J**		
Arsenic	13.5	28	28	17	6650	0.6	SW6020A	µg/L	**28.5**	**3.3**	**58.9**	**8**	**25.8**	**7.3**	**15.2**		
Barium	83.3	28	28	8	365	28.2	SW6020A	µg/L	**53**	**69.9**	**28.2**	**34.8**	**75.9**	**44.3**	**41.5**		
Beryllium	0.018 J	28	17	11	0.11	0.006	SW6020A	µg/L	**0.028**	**0.016 J**	0.006 U	0.006 U	0.006 U	**0.089**	**0.006 J**		
Cadmium	0.017 J	28	25	18	0.224	0.005	SW6020A	µg/L	**0.028**	**0.017 J**	**0.022**	**0.224**	**0.013 J**	**0.22**	**0.045**		
Calcium	20600	28	28	19	96700	10600	SW6010B	µg/L	**23100**	**18800**	**22300**	**34900**	**31100**	**13200**	**18400**		
Chromium	4.95	28	24	3	10.6	0.05	SW6020A	µg/L	**4.7**	**0.52**	**0.28**	**0.42**	**0.05 J**	**1.02**	**0.43**		
Cobalt	1.14	28	27	16	40.5	0.045	SW6020A	µg/L	**0.843**	**0.333**	**0.045**	**1.71**	**1.24**	**7.48**	**0.745**		
Copper	0.48	28	25	21	6.29	0.09	SW6020A	µg/L	**1.54**	**0.45**	**0.53**	**1.29**	**0.09 J**	**3.82**	**0.87**		
Iron	8990	28	26	4	22400	5.8	SW6010B	µg/L	**1100**	**4620**	**15.3 J**	**33.6**	**1720**	**1590**	**294**		
Lead	0.311	28	24	8	2.02	0.019	SW6020A	µg/L	**0.794**	**0.149**	**0.025**	**0.035**	**0.035**	**0.755**	**0.166**		
Magnesium	11300	28	28	26	71900	7820	SW6010B	µg/L	**16500**	**11400**	**26900**	**44300**	**29000**	**9800**	**13200**		
Manganese	1120	28	27	4	7370	1.12	SW6020A	µg/L	**62.2**	**306**	**1.12**	**1120**	**536**	**597**	**212**		
Nickel	2.68	28	28	17	35.9	0.9	SW6020A	µg/L	**4.7**	**0.9**	**1.6**	**32.6**	**2.28**	**29.9**	**7.94**		
Potassium	708	28	27	21	4930	259	SW6010B	µg/L	**627**	**454**	**1150**	**846**	**837**	**1750**	**1120 J**		
Selenium	ND	28	10	10	5.4	0.3	SW6020A	µg/L	**0.4 J**	**0.5 J**	**0.7 J**	0.3 U	0.3 U	**1.1**	0.3 U		
Silver	0.016 J	28	19	5	0.049	0.004	SW6020A	µg/L	**0.015 J**	**0.004 J**	0.004 U	0.004 U	**0.01 J**	**0.028**	**0.024**		
Sodium	2800	28	28	18	20000	1150	SW6010B	µg/L	**2760**	**2780**	**2550**	**4560**	**4430**	**1780**	**5710**		
Thallium	0.009 J	28	16	10	0.075	0.006	SW6020A	µg/L	**0.016 J**	0.005 U	0.005 U	0.005 U	**0.007 J**	**0.024**	**0.011 J**		
Vanadium	0.55	28	25	15	3.88	0.09	SW6020A	µg/L	**0.75**	**0.81**	**0.25**	**0.09 J**	0.03 U	**1.82**	**0.56**		
Zinc	1.3	28	25	22	22	0.8	SW6020A	µg/L	**2.7**	**2.5**	**1.3**	**13.2**	**1.9**	**13.8**	**3.1**		
Total Low Level Mercury																	
Mercury, Total	58.4	28	28	20	56500	1.85	EPA 1631	ng/L	**6070**	**25.4**	**47.7**	**155**	**7.25**	**306**	**115**		
Dissolved Inorganic Elements																	
Aluminum, Dissolved	8.3 J	29	20	9	140	2.1	SW6010B-Diss	µg/L	2 U	**11 J**	**5.5 J**	**11 J**	**2.4 J**	**11 J**	2 U		
Antimony, Dissolved	0.522 J	29	29	27	13100	0.317	SW6020A-Diss	µg/L	**9.16**	**1.64**	**861**	**27.2**	**5.3**	**1.74 J**	**420 J**		
Arsenic, Dissolved	13.9	29	29	15	6660	0.4	SW6020A-Diss	µg/L	**4.9**	**3**	**56**	**7.8**	**24.8**	**6.3**	**14.4**		
Barium, Dissolved	87.7	29	29	5	348	23.3	SW6020A-Diss	µg/L	**39.9**	**68**	**27.9**	**34.4**	**73.6**	**40.6**	**38**		
Beryllium, Dissolved	0.01 J	29	11	7	0.041	0.006	SW6020A-Diss	µg/L	0.006 U	**0.012 J**	0.006 U	**0.006 J**	0.006 U	**0.041**	0.006 U		
Cadmium, Dissolved	0.008 J	28	24	19	0.229	0.006	SW6020A-Diss	µg/L	**0.012 J**	**0.011 J**	**0.016 J**	**0.229**	**0.011 J**	**0.187**	**0.03**		
Calcium, Dissolved	20400	29	29	20	100000	7180	SW6010B-Diss	µg/L	**23000**	**18200**	**22000**	**35400**	**31100**	**14000**	**18600**		
Chromium, Dissolved	1.43	29	25	2	2.81	0.09	SW6020A-Diss	µg/L	**0.83**	**0.24**	**0.49**	**0.3**	**0.09 J**	**0.1 J**	**0.28**		
Cobalt, Dissolved	1.21	29	28	15	41.5	0.027	SW6020A-Diss	µg/L	**0.196**	**0.308**	**0.037**	**1.64**	**1.19**	**7.83**	**0.598**		
Copper, Dissolved	0.34	29	26	16	1.8	0.08	SW6020A-Diss	µg/L	**0.14**	**0.24**	**0.41**	**1.34**	**0.08 J**	**1.06**	**0.44**		
Iron, Dissolved	8760	29	22	4	19100	3.4	SW6010B-Diss	µg/L	**10.1 J**	**4820**	3 U	**24**	**1680**	3 U	3 U		
Lead, Dissolved	0.244	29	20	0	0.046	0.005	SW6020A-Diss	µg/L	**0.005 J**	**0.015 J**	0.005 U	**0.012 J**	**0.011 J**	**0.009 J**	0.005 U		
Magnesium, Dissolved	11400	29	29	26	73500	2900	SW6010B-Diss	µg/L	**16400**	**12000**	**26200**	**46200**	**29000**	**10500**	**13400**		
Manganese, Dissolved	1190	29	28	4	7050	0.606	SW6020A-Diss	µg/L	**2.62**	**310**	**0.606**	**1120**	**547**	**602**	**196**		
Nickel, Dissolved	1.84	29	29	20	34.6	0.79	SW6020A-Diss	µg/L	**2.63**	**0.79**	**1.65**	**30.3**	**2.42**	**29.1**	**7.02**		
Potassium, Dissolved	730	29	28	18	4620	211	SW6010B-Diss	µg/L	**415**	**422**	**1100**	**897**	**820**	**1470**	**1030**		
Selenium, Dissolved	ND	29	10	10	4.9	0.3	SW6020A-Diss	µg/L	**0.6 J**	**0.7 J**	**0.5 J**	0.3 U	0.3 U	**0.9 J**	0.3 U		
Silver, Dissolved	0.004 J	29	3	3	0.013	0.007	SW6020A-Diss	µg/L	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U		
Sodium, Dissolved	2810	29	29	19	20000	1160	SW6010B-Diss	µg/L	**2770**	**3020**	**2530**	**4820**	**4430**	**1880**	**5770**		
Thallium, Dissolved	ND	29	8	8	0.059	0.006	SW6020A-Diss	µg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.014 J**	0.005 U		
Vanadium, Dissolved	0.74	29	24	5	2.03	0.03	SW6020A-Diss	µg/L	0.03 U	**0.65**	**0.23**	**0.1 J**	0.03 U	**0.08 J**	**0.29**		
Zinc, Dissolved	0.4 J	29	26	23	20.7	0.2	SW6020A-Diss	µg/L	**0.5 J**	**0.9**	**1.1**	**12.8**	**1.2**	**9.2**	**2.3**		
Dissolved Low Level Mercury																	
Mercury, Dissolved	1.14	29	28	23	2200	0.54	EPA 1631	ng/L	**9.49**	**6.19**	**9.09**	**83.8**	**0.9 J**	**3.65**	**4.58**		
Arsenic Speciation																	
Arsenate		16	16	0	4520	0.161	EPA 1632	µg/L		**1.93 J**				**1.7 J**	**15.2**		
Arsenite		16	15	0	89.6	0.245	EPA 1632	µg/L		**1.44 J**				**5.23 J**	**0.245**		
Inorganic Arsenic		16	16	0	4530	0.17	EPA 1632	µg/L		**3.37 J**				**6.92**	**15.4**		
Methlymercury																	
Methylmercury	ND	28	19	19	1.71	0.06	EPA 1630	ng/L	**0.2 J**	**0.85**	0.05 UJ	**0.07 J**	0.05 U	**0.08 J**	0.05 U		

Table 4-30 Groundwater Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MW17	MW01	MW03	MW04	MW06	MW32	MW33	MW04	MW27
							Geographic Area		Post-1955 MPA	Post-1955 MPA	Post-1955 MPA	Pre-1955 MPA	Pre-1955 MPA	Red Devil Creek Delta	Red Devil Creek Delta	Pre-1955 MPA	Pre-1955 MPA
							Sample ID		11MP91GW	11MW01GW	11MW03GW	11MW04GW	11MW06GW	11RD05GW	11RD20GW	0912MW04GW	0912MW27GW
							Sample Date		8/30/2011	8/24/2011	8/26/2011	8/22/2011	8/24/2011	8/31/2011	8/31/2011	9/10/2012	9/9/2012
Analyte							Method										
Semi-Volatile Organic Compounds																	
Toluene		2	2		1.8	0.09	SW8260C Volatile Organics in Water	µg/L		**1.8**							
Bis(2-ethylhexyl) Phthalate		9	1		5.7	5.7	SW8270C Base Neutral/Acid Semivolatile Organic compounds	µg/L		1.9 U		**5.7 J**		1.9 U	1.9 U		
Unknown Hydrocarbon		2	1		2	2	SW8270D	µg/L									
Gasoline, Diesel and Residual Range Organics																	
Gasoline Range Organics		3	0				AK101 AK 101 Gasoline Range Organics	µg/L		13 U							
Diesel Range Organics		12	10		200	14	AK102 Alaska Diesel Range for Water	µg/L		**22**		**200 J**		**40 J**	**59 J**		
Residual Range Organics		12	4		620	60	AK103 Alaska Residual Range for Water	µg/L		19 UJ		**620 J**		19 UJ	19 UJ		
PCBs																	
PCB-1016		2	0				EPA 8082	µg/L								0.042 UJ	0.042 UJ
PCB-1221		2	0				EPA 8082	µg/L								0.058 UJ	0.058 UJ
PCB-1232		2	0				EPA 8082	µg/L								0.039 UJ	0.039 UJ
PCB-1242		2	0				EPA 8082	µg/L								0.039 UJ	0.039 UJ
PCB-1248		2	0				EPA 8082	µg/L								0.067 UJ	0.067 UJ
PCB-1254		2	0				EPA 8082	µg/L								0.042 UJ	0.042 UJ
PCB-1260		2	0				EPA 8082	µg/L								0.037 UJ	0.037 UJ
General Chemistry																	
Bicarbonate		29	29		398	30.3	A2320 General Chemistry Parameters	mg/L	**124**	**81.3**	**118**	**95.4**	**183**	**61**	**89.7**		
Carbonate		29	0				A2320 General Chemistry Parameters	mg/L	3 U	3 U	3 U	3 U	3 U	3 U	3 U		
Hydroxide		5	0				SM 2320	mg/L									
Chloride		29	29		1.25	0.34	EPA 300.0 General Chemistry Parameters	mg/L	**0.47**	**0.51**	**0.41**	**0.34 J**	**0.56**	**0.41**	**0.74**		
Fluoride		29	27		0.3	0.06	EPA 300.0 General Chemistry Parameters	mg/L	**0.13 J**	**0.11 J**	**0.05 J**	**0.13 J**	**0.14 J**	**0.11 J**	**0.13 J**		
Sulfate		29	29		345	3.5	EPA 300.0 General Chemistry Parameters	mg/L	**8.13**	**21.3**	**53.5**	**183**	**25.5**	**17.5**	**20.7**		
Nitrate+Nitrite as Nitrogen		28	13		0.841	0.011	EPA 353.2 General Chemistry Parameters	mg/L	0.009 U	**0.241**	**0.151**	**0.043 J**	0.009 U	**0.841**	**0.282**		
Total Dissolved Solids		28	28		656	65	A2540C/EPA 160.1	mg/L	**124**	**115**	**182**	**351 J**	**195**	**82**	**130**		
Total Suspended Solids		28	16		154	2.4	A2540D/EPA 160.2	mg/L	**21.5**	5 U	5 U	5 UJ	5 U	**25**	5 U		
Field Parameters																	
Temperature		28			13.16	2.47	Field Test	°C	3.83	7.41	7.06	7.28	4.01	4.29	3.19		
pH		28			7.72	6.08	Field Test	N/A	7.72	6.41	6.7	6.38	6.73	6.08	6.6		
ORP		28			230	-137	Field Test	mV	147	32	230	162	-24	224	196		
Conductance		28			0.878	0.103	Field Test	mS/cm	0.239	0.22	0.301	0.577	0.399	0.143	0.228		
Turbidity		28			207	0	Field Test	NTU	11.20	2.65	0.00	6.61	0.00	21.40	0.00		
Dissolved Oxygen		28			30.89	0	Field Test	mg/L	5.37	0.00	5.62	0.00	0.00	NR	NR		

Key

Bold = detection

°C = Degrees Celsius

µg/L = micrograms per liter

Gray shading = exceedance of background

EPA = United States Environmental Protection Agency

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/L = milligrams per liter

mS/cm = Millisiemens per Centimeter

mV = Millivolt

N/A = not applicable

ND = not detected

ng/L = nanograms per liter

NR = not recorded

NTU = Nephelometric Turbidity Unit

ORP = Oxidation reduction potential

PCBs = polychlorinated biphenyls

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-31 Surface Water Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD02	RD03	RD04	RD05	RD09	RD06	RD07
							Sample ID		10RD02SW	10RD03SW	10RD04SW	10RD05SW	10RD09SW	10RD06SW	10RD07SW
							Sample Date		9/22/2010	9/22/2010	9/22/2010	9/22/2010	9/22/2010	9/22/2010	9/22/2010
Analyte							Method								
Total Inorganic Elements															
Aluminum	80	19	11	0	30.9	6.5	SW6010B-Total	µg/L	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U
Antimony	1.52	19	19	15	184	1.3	SW6020A-Total	µg/L	**1.3**	**1.5**	**11**	**26.7**	**108**	**141**	**158**
Arsenic	1.1	19	19	14	1030	0.8	SW6020A-Total	µg/L	**1**	**0.9**	**8.2**	**903**	**73.1**	**79.6**	**80.5**
Barium	26.4	19	19	9	103	21.2	SW6020A-Total	µg/L	**25.2**	**23.4**	**24**	**102**	**29.2**	**29.5**	**29.8**
Beryllium	ND	19	1	1	0.009	0.009	SW6020A-Total	µg/L	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U
Cadmium	ND	19	2	2	0.006	0.005	SW6020A-Total	µg/L	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U
Calcium	18400	19	19	8	36000	8580	SW6010B-Total	µg/L	**18500**	**18400**	**18600**	**34400**	**18700**	**19600**	**18900**
Chromium	0.43	19	11	2	0.57	0.15	SW6020A-Total	µg/L	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U
Cobalt	0.066	19	16	11	5.3	0.046	SW6020A-Total	µg/L	0.007 U	0.007 U	0.007 U	**5.3**	**0.3**	**0.3**	**0.2**
Copper	0.37	19	12	8	0.71	0.28	SW6020A-Total	µg/L	0.232 U	0.232 U	0.232 U	0.232 U	0.232 U	0.232 U	0.232 U
Iron	138	19	19	15	2470	118	SW6010B/SW6020A-Total	µg/L	**190**	**140**	**190**	**2160**	**190**	**180**	**150**
Lead	0.021	19	11	4	0.079	0.008	SW6020A-Total	µg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Magnesium	9680	19	19	13	37100	4460	SW6010B-Total	µg/L	**9660**	**9690**	**9870**	**33700**	**10900**	**11600**	**11300**
Manganese	17.5	19	19	13	379	11.8	SW6020A-Total	µg/L	**29.5**	**11.8**	**15.4**	**379**	**26.5**	**30.5**	**27.6**
Nickel	0.44	19	16	13	19.2	0.36	SW6020A-Total	µg/L	0.081 U	0.081 U	0.081 U	**19.2**	**1.1**	**1.1**	**1**
Potassium	218 J	19	11	10	1210	214	SW6010B-Total	µg/L	69.1 U	69.1 U	69.1 U	**1130**	69.1 U	69.1 U	69.1 U
Selenium	0.5 J	19	8	0	0.5	0.3	SW6020A-Total	µg/L	0.125 U	0.125 U	0.125 U	0.125 U	0.125 U	0.125 U	0.125 U
Silver	ND	19	2	2	0.012	0.008	SW6020A-Total	µg/L	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U
Sodium	1580	19	19	16	12900	1440	SW6010B-Total	µg/L	**1700**	**1730**	**1820**	**12800**	**2320**	**2580**	**2440**
Thallium	ND	19	1	1	0.007	0.007	SW6020A-Total	µg/L	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Vanadium	0.3	19	11	0	0.22	0.1	SW6020A-Total	µg/L	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U
Zinc	0.5 J	19	8	2	2.1	0.3	SW6020A-Total	µg/L	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U
Total Low Level Mercury															
Mercury, Total	2.63	18	18	17	385	2.33	EPA 1631-Total	ng/L	**2.83**	**2.33**	**15.8**	**43.4**	**183**	**208**	**233**
Dissolved Inorganic Elements															
Aluminum, Dissolved	11.9 J	17	9	2	19.7	3.5	SW6010B-Diss	µg/L	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U
Antimony, Dissolved	1.4 J	18	18	15	184	1.2	SW6020A-Diss	µg/L	**1.2**	**1.4**	**10.4**	**3.2**	**101**	**130**	**143**
Arsenic, Dissolved	0.9	18	18	14	857	0.8	SW6020A-Diss	µg/L	**0.9**	**0.8**	**7.8**	**857**	**67.8**	**74.2**	**73.7**
Barium, Dissolved	24	18	18	11	99.5	20.7	SW6020A-Diss	µg/L	**24.3**	**22.8**	**23.6**	**98.7**	**28.2**	**28.6**	**28.5**
Beryllium, Dissolved	ND	18	1	1	0.012	0.012	SW6020A-Diss	µg/L	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U
Cadmium, Dissolved	ND	18	0	0			SW6020A-Diss	µg/L	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U
Calcium, Dissolved	19200	17	17	4	36000	16700	SW6010B-Diss	µg/L	**19000**	**18600**	**18600**	**35000**	**19400**	**19200**	**19100**
Chromium, Dissolved	0.23	18	10	4	0.39	0.11	SW6020A-Diss	µg/L	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U
Cobalt, Dissolved	0.056	18	13	9	4.9	0.042	SW6020A-Diss	µg/L	0.007 U	0.007 U	0.007 U	**4.9**	**0.2**	**0.2**	0.007 U
Copper, Dissolved	0.27	18	10	8	0.5	0.15	SW6020A-Diss	µg/L	0.232 U	0.232 U	0.232 U	0.232 U	0.232 U	0.232 U	0.232 U
Iron, Dissolved	100	17	17	12	2180	70	SW6010B-Diss	µg/L	**150**	**100**	**140**	**2020**	**130**	**110**	**90**
Lead, Dissolved	ND	18	5	5	0.037	0.005	SW6020A-Diss	µg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Magnesium, Dissolved	10200	17	17	10	36400	8930	SW6010B-Diss	µg/L	**9990**	**9870**	**9930**	**34800**	**11400**	**11500**	**11500**
Manganese, Dissolved	15.9	18	18	12	380	8.2	SW6020A-Diss	µg/L	**24.9**	**8.2**	**13.6**	**380**	**24.9**	**28.8**	**24.6**
Nickel, Dissolved	0.35	18	15	14	17	0.32	SW6020A-Diss	µg/L	0.081 U	0.081 U	0.081 U	**17**	**0.8**	**1**	**0.9**
Potassium, Dissolved	220 J	17	10	9	1170	215	SW6010B-Diss	µg/L	69.1 U	69.1 U	69.1 U	**1130**	69.1 U	69.1 U	69.1 U
Selenium, Dissolved	0.5 J	18	7	1	0.6	0.3	SW6020A-Diss	µg/L	0.125 U	0.125 U	0.125 U	0.125 U	0.125 U	0.125 U	0.125 U
Silver, Dissolved	ND	18	1	1	0.009	0.009	SW6020A-Diss	µg/L	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U	0.009 U
Sodium, Dissolved	1610	17	17	15	13000	1450	SW6010B-Diss	µg/L	**1680**	**1690**	**1770**	**13000**	**2300**	**2430**	**2460**
Thallium, Dissolved	ND	18	0	0			SW6020A-Diss	µg/L	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Vanadium, Dissolved	0.13 J	18	10	1	0.14	0.07	SW6020A-Diss	µg/L	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U
Zinc, Dissolved	ND	18	3	3	1	0.3	SW6020A-Diss	µg/L	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U
Dissolved Low Level Mercury															
Mercury, Dissolved	6.37	18	18	10	16.4	1.92	EPA 1631-Diss	ng/L	**2.23**	**1.92**	**5.6**	**3.04**	**14.1**	**15.4**	**16.4**
Arsenic Speciation															
Arsenate		12	12		234	0.595	EPA 1632 As-Cryo-W-Speciation	µg/L	**0.862**		**1.58**	**70**		**51.5**	
Arsenite		12	12		667	0.089	EPA 1632 As3-CRYO-W	µg/L	**0.122**		**0.342**	**667**		**14.7**	
Inorganic Arsenic		12	12		745	0.822	EPA 1632 Total Inorganic As - Water	µg/L	**0.984**		**1.92**	**737**		**66.2**	
Methlymercury															
Methylmercury	0.08 J	18	18	15	0.62	0.08	EPA 1630	ng/L	**0.101**	**0.091**	**0.115**	**0.491**	**0.144**	**0.141**	**0.123**
Semi-Volatile Organic Compounds															
1-Methylnaphthalene		7	1		1.5	1.5	SW8270D	µg/L		0.48 U	0.48 U	**1.5**	0.48 U	0.48 U	0.48 U
2-Methylnaphthalene		17	2		1.5	1.2	SW8270C	µg/L		0.48 U	0.48 U	**1.5**	0.48 U	0.48 U	0.48 U
Naphthalene		10	1		0.68	0.68	SW8270C	µg/L							
Unknown Hydrocarbon		7	2		3	2	SW8270D	µg/L		**2 J**	0 U	0 U	**3 J**	0 U	0 U

Table 4-31 Surface Water Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD02	RD03	RD04	RD05	RD09	RD06	RD07
							Sample ID		10RD02SW	10RD03SW	10RD04SW	10RD05SW	10RD09SW	10RD06SW	10RD07SW
							Sample Date		9/22/2010	9/22/2010	9/22/2010	9/22/2010	9/22/2010	9/22/2010	9/22/2010
Analyte							Method								
General Chemistry															
Bicarbonate		18	18		243	72.4	A2320 General Chemistry Parameters	mg/L	**79.5**	**78.9**	**77.3**	**229**	**85.4**	**87.8**	**87.8**
Carbonate		18	0				A2320 General Chemistry Parameters	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hydroxide		8	0				A2320 General Chemistry Parameters	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total Dissolved Solids		18	18		244	51	A2540C/EPA 160.1	mg/L	**84**	**81.5**	**87.5**	**110**	**116**	**83**	**115**
Total Suspended Solids		18	1		3.6	3.6	A2540D/EPA 160.2	mg/L	1 U	1.1 U	1.1 U	**3.6**	1.1 U	1.1 U	1.1 U
Chloride		18	18		0.6	0.35	EPA 300.0 General Chemistry Parameters	mg/L	**0.4**	**0.5**	**0.5**	**0.6**	**0.5**	**0.5**	**0.5**
Fluoride		18	11		0.13	0.04	EPA 300.0 General Chemistry Parameters	mg/L	0.022 U	0.022 U	0.022 U	**0.1**	0.022 U	0.022 U	0.022 U
Sulfate		18	18		28.5	8.63	EPA 300.0 General Chemistry Parameters	mg/L	**10.8**	**10.1**	**10.3**	**28.5**	**13**	**13.2**	**13.2**
Nitrate+Nitrite as Nitrogen		18	16		0.192	0.115	EPA 353.2 Nitrogen, Total Nitrate-Nitrite	mg/L	**0.14**	**0.145**	**0.148**	0.001 U	**0.116**	**0.127**	**0.143**
Field Parameters															
Temperature		19			6.77	3.79	Field Test	^{o}C	5.84	5.95	5.66	3.79	4.84	4.43	4.22
pH		19			7.71	5.37	Field Test	N/A	7.45	7.39	7.34	6.11	7.16	6.98	6.56
ORP		19			177	-143	Field Test	mV	101	87	42	-143	57	113	177
Conductance		19			0.524	0.072	Field Test	mS/cm	0.194	0.190	0.190	0.524	0.215	0.072	0.220
Turbidity		19			60.6	0	Field Test	NTU	0.79	0.00	0.77	2.19	0.98	4.06	0.21
Dissolved Oxygen		19			18.68	9	Field Test	mg/L	14.1	13.13	16.32	16.29	14.55	15.06	16.96

Table 4-31 Surface Water Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD08	RD02	RD03	RD10	RD11	RD04	RD05
							Sample ID		10RD08SW	11RD02SW	11RD03SW	11RD10SW	11RD11SW	11RD04SW	11RD05SW
							Sample Date		9/22/2010	8/27/2011	8/27/2011	8/27/2011	8/27/2011	8/27/2011	8/27/2011
Analyte							Method								
Total Inorganic Elements															
Aluminum	80	19	11	0	30.9	6.5	SW6010B-Total	µg/L	14.8 U	**16.6 J**	**18.4 J**	**20.10 J**	**30.9 J**	**14.1 J**	**6.5 J**
Antimony	1.52	19	19	15	184	1.3	SW6020A-Total	µg/L	**170**	**1.42 J**	**1.51**	**1.95**	**8.81**	**17.3**	**32.6**
Arsenic	1.1	19	19	14	1030	0.8	SW6020A-Total	µg/L	**85.6**	**1**	**0.8**	**1**	**6.7**	**11.3 J**	**1030**
Barium	26.4	19	19	9	103	21.2	SW6020A-Total	µg/L	**30.8**	**21.6**	**21.2**	**22.3**	**32.1**	**22**	**103**
Beryllium	ND	19	1	1	0.009	0.009	SW6020A-Total	µg/L	0.027 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	**0.009 J**
Cadmium	ND	19	2	2	0.006	0.005	SW6020A-Total	µg/L	0.022 U	0.005 U	**0.006 J**	0.005 U	0.005 U	0.005 U	0.005 U
Calcium	18400	19	19	8	36000	8580	SW6010B-Total	µg/L	**19600**	**17300**	**16800**	**17200**	**8580**	**16600**	**36000**
Chromium	0.43	19	11	2	0.57	0.15	SW6020A-Total	µg/L	0.053 U	**0.22**	**0.23**	**0.37**	**0.22**	**0.28**	**0.15 J**
Cobalt	0.066	19	16	11	5.3	0.046	SW6020A-Total	µg/L	**0.2**	**0.061**	**0.046**	**0.06**	**0.677**	**0.059**	**5.24**
Copper	0.37	19	12	8	0.71	0.28	SW6020A-Total	µg/L	**0.5**	**0.29**	**0.28**	**0.35**	**0.71**	**0.33**	**0.45**
Iron	138	19	19	15	2470	118	SW6010B/SW6020A-Total	µg/L	**140**	**131**	**118**	**128**	**2470**	**147**	**2390**
Lead	0.021	19	11	4	0.079	0.008	SW6020A-Total	µg/L	0.2 U	**0.008 J**	**0.013 J**	**0.018 J**	**0.021**	**0.012 J**	**0.079**
Magnesium	9680	19	19	13	37100	4460	SW6010B-Total	µg/L	**11600**	**9370**	**9070**	**9410**	**4460**	**9010**	**37100**
Manganese	17.5	19	19	13	379	11.8	SW6020A-Total	µg/L	**24.5**	**19.1**	**11.8**	**13.3**	**86.4**	**14.6**	**354**
Nickel	0.44	19	16	13	19.2	0.36	SW6020A-Total	µg/L	**1**	**0.36**	**0.39**	**0.46**	**1.38**	**0.43**	**17.1**
Potassium	218 J	19	11	10	1210	214	SW6010B-Total	µg/L	69.1 U	**233 J**	**239 J**	**214 J**	50 U	**254 J**	**1210**
Selenium	0.5 J	19	8	0	0.5	0.3	SW6020A-Total	µg/L	0.125 U	**0.5 J**	**0.4 J**	0.3 U	0.3 U	**0.4 J**	0.2 U
Silver	ND	19	2	2	0.012	0.008	SW6020A-Total	µg/L	0.009 U	0.004 U	**0.012 J**	0.004 U	0.004 U	0.004 U	0.004 U
Sodium	1580	19	19	16	12900	1440	SW6010B-Total	µg/L	**2590**	**1460**	**1440**	**1740**	**2370**	**1530**	**12900**
Thallium	ND	19	1	1	0.007	0.007	SW6020A-Total	µg/L	0.003 U	0.005 U	**0.007 J**	0.005 U	0.005 U	0.005 U	0.005 U
Vanadium	0.3	19	11	0	0.22	0.1	SW6020A-Total	µg/L	0.026 U	**0.1 J**	**0.16 J**	**0.15 J**	**0.22**	**0.12 J**	**0.1 J**
Zinc	0.5 J	19	8	2	2.1	0.3	SW6020A-Total	µg/L	0.81 U	0.2 U	0.2 U	**0.4 J**	**2.1**	0.2 U	**1.7**
Total Low Level Mercury															
Mercury, Total	2.63	18	18	17	385	2.33	EPA 1631-Total	ng/L	**385**	**3.94**	**4.5**	**4.27**		**20.4**	**63**
Dissolved Inorganic Elements															
Aluminum, Dissolved	11.9 J	17	9	2	19.7	3.5	SW6010B-Diss	µg/L	14.8 U	**9 J**		**10 J**		**7 J**	**3.5 J**
Antimony, Dissolved	1.4 J	18	18	15	184	1.2	SW6020A-Diss	µg/L	**158**	**1.4 J**	**1.5**	**1.57**		**17.4**	**1.37**
Arsenic, Dissolved	0.9	18	18	14	857	0.8	SW6020A-Diss	µg/L	**75.4**	**1**	**0.9**	**0.8**		**10.6**	**856**
Barium, Dissolved	24	18	18	11	99.5	20.7	SW6020A-Diss	µg/L	**29.5**	**21**	**21.2**	**20.7**		**21.8**	**99.5**
Beryllium, Dissolved	ND	18	1	1	0.012	0.012	SW6020A-Diss	µg/L	0.027 U	0.006 U	0.006 U	0.006 U		0.006 U	**0.012 J**
Cadmium, Dissolved	ND	18	0	0			SW6020A-Diss	µg/L	0.022 U	0.005 U	0.005 U	0.005 U		0.005 U	0.005 U
Calcium, Dissolved	19200	17	17	4	36000	16700	SW6010B-Diss	µg/L	**19400**	**17200**		**16800**		**16700**	**36000**
Chromium, Dissolved	0.23	18	10	4	0.39	0.11	SW6020A-Diss	µg/L	0.053 U	**0.2**	**0.21**	**0.3**		**0.28**	**0.16 J**
Cobalt, Dissolved	0.056	18	13	9	4.9	0.042	SW6020A-Diss	µg/L	0.007 U	**0.058**	**0.042**	**0.044**		**0.049**	**4.35**
Copper, Dissolved	0.27	18	10	8	0.5	0.15	SW6020A-Diss	µg/L	0.232 U	**0.36**	**0.26**	**0.29**		**0.34**	**0.15**
Iron, Dissolved	100	17	17	12	2180	70	SW6010B-Diss	µg/L	**70**	**105**		**88.8**		**111**	**2180**
Lead, Dissolved	ND	18	5	5	0.037	0.005	SW6020A-Diss	µg/L	0.2 U	**0.014 J**	0.005 U	0.005 U		**0.006 J**	**0.005 J**
Magnesium, Dissolved	10200	17	17	10	36400	8930	SW6010B-Diss	µg/L	**11600**	**9280**		**9440**		**8930**	**36400**
Manganese, Dissolved	15.9	18	18	12	380	8.2	SW6020A-Diss	µg/L	**20.1**	**18.5**	**8.49**	**9.41**		**12.1**	**345**
Nickel, Dissolved	0.35	18	15	14	17	0.32	SW6020A-Diss	µg/L	**0.8**	**0.58**	**0.32**	**0.37**		**0.44**	**10.9**
Potassium, Dissolved	220 J	17	10	9	1170	215	SW6010B-Diss	µg/L	69.1 U	**256 J**		**215 J**		**267 J**	**1170**
Selenium, Dissolved	0.5 J	18	7	1	0.6	0.3	SW6020A-Diss	µg/L	0.125 U	**0.6 J**	**0.3 J**	0.3 U		**0.4 J**	0.2 U
Silver, Dissolved	ND	18	1	1	0.009	0.009	SW6020A-Diss	µg/L	0.009 U	0.004 U	0.004 U	0.004 U		0.004 U	0.004 U
Sodium, Dissolved	1610	17	17	15	13000	1450	SW6010B-Diss	µg/L	**2490**	**1450**		**1760**		**1500**	**12500 J**
Thallium, Dissolved	ND	18	0	0			SW6020A-Diss	µg/L	0.003 U	0.005 U	0.005 U	0.005 U		0.005 U	0.005 U
Vanadium, Dissolved	0.13 J	18	10	1	0.14	0.07	SW6020A-Diss	µg/L	0.026 U	**0.11 J**	**0.11 J**	**0.12 J**		**0.1 J**	**0.07 J**
Zinc, Dissolved	ND	18	3	3	1	0.3	SW6020A-Diss	µg/L	0.81 U	0.2 U	0.2 U	0.2 U		0.2 U	0.2 U
Dissolved Low Level Mercury															
Mercury, Dissolved	6.37	18	18	10	16.4	1.92	EPA 1631-Diss	ng/L	**15.5**	**2.13**	**3.02**	**3.53**		**6.81**	**2.42**
Arsenic Speciation															
Arsenate		12	12		234	0.595	EPA 1632 As-Cryo-W-Speciation	µg/L	**83**	**0.828 J**		**0.595**		**8.36 J**	**234**
Arsenite		12	12		667	0.089	EPA 1632 As3-CRYO-W	µg/L	**3.76**	**0.089 J**		**0.227**		**0.961 J**	**510**
Inorganic Arsenic		12	12		745	0.822	EPA 1632 Total Inorganic As - Water	µg/L	**86.8**	**0.917 J**		**0.822**		**9.32 J**	**745**
Methlymercury															
Methylmercury	0.08 J	18	18	15	0.62	0.08	EPA 1630	ng/L	**0.129**	**0.08**	**0.09**	**0.08**		**0.08**	**0.62**
Semi-Volatile Organic Compounds															
1-Methylnaphthalene		7	1		1.5	1.5	SW8270D	µg/L	0.48 U						
2-Methylnaphthalene		17	2		1.5	1.2	SW8270C	µg/L	0.48 U		0.24 U	0.24 U	0.24 U	0.24 U	**1.2 J**
Naphthalene		10	1		0.68	0.68	SW8270C	µg/L			0.37 U	0.37 U	0.37 U	0.37 U	**0.68 J**
Unknown Hydrocarbon		7	2		3	2	SW8270D	µg/L	0 U						

Table 4-31 Surface Water Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD08	RD02	RD03	RD10	RD11	RD04	RD05
							Sample ID		10RD08SW	11RD02SW	11RD03SW	11RD10SW	11RD11SW	11RD04SW	11RD05SW
							Sample Date		9/22/2010	8/27/2011	8/27/2011	8/27/2011	8/27/2011	8/27/2011	8/27/2011
Analyte							Method								
General Chemistry															
Bicarbonate		18	18		243	72.4	A2320 General Chemistry Parameters	mg/L	**87**	**74.2**	**74**	**73.1**		**72.4**	**243**
Carbonate		18	0				A2320 General Chemistry Parameters	mg/L	1 U	3 U	1 U	3 U		3 U	3 U
Hydroxide		8	0				A2320 General Chemistry Parameters	mg/L	1 U						
Total Dissolved Solids		18	18		244	51	A2540C/EPA 160.1	mg/L	**220**	**76**	**51**	**71**		**82**	**244**
Total Suspended Solids		18	1		3.6	3.6	A2540D/EPA 160.2	mg/L	1.1 U	5 U	5 U	5 U		5 U	5 U
Chloride		18	18		0.6	0.35	EPA 300.0 General Chemistry Parameters	mg/L	**0.5**	**0.36**	**0.39**	**0.38**		**0.38**	**0.46**
Fluoride		18	11		0.13	0.04	EPA 300.0 General Chemistry Parameters	mg/L	0.022 U	**0.05**	**0.08**	**0.06**		**0.07**	**0.13 J**
Sulfate		18	18		28.5	8.63	EPA 300.0 General Chemistry Parameters	mg/L	**13.1**	**9.55**	**8.63**	**8.69**		**9.1**	**27.7**
Nitrate+Nitrite as Nitrogen		18	16		0.192	0.115	EPA 353.2 Nitrogen, Total Nitrate-Nitrite	mg/L	**0.115**	**0.192**	**0.178**	**0.169**		**0.185**	0.009 U
Field Parameters															
Temperature		19			6.77	3.79	Field Test	°C	4.40	6.69	6.38	5.13	5.75	5.00	6.77
pH		19			7.71	5.37	Field Test	N/A	6.27	7.66	7.58	7.08	7.06	6.66	5.37
ORP		19			177	-143	Field Test	mV	2.53	114	94	68	-26	15	-38
Conductance		19			0.524	0.072	Field Test	mS/cm	0.229	0.163	0.161	0.160	0.091	0.162	0.387
Turbidity		19			60.6	0	Field Test	NTU	0.59	0.00	0.00	0.00	60.60	0.00	4.63
Dissolved Oxygen		19			18.68	9	Field Test	mg/L	13.9	12.11	10.06	11.50	18.68	16.00	9.00

Table 4-31 Surface Water Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD12	RD09	RD06	RD07	RD08
							Sample ID		11RD12SW	11RD09SW	11RD06SW	11RD07SW	11RD08SW
							Sample Date		8/27/2011	8/26/2011	8/26/2011	8/26/2011	8/26/2011
Analyte							Method						
Total Inorganic Elements													
Aluminum	80	19	11	0	30.9	6.5	SW6010B-Total	µg/L	**18.7 J**	**22.6 J**	**20 J**	**19 J**	**19 J**
Antimony	1.52	19	19	15	184	1.3	SW6020A-Total	µg/L	**61.6**	**126 J**	**162 J**	**167 J**	**184**
Arsenic	1.1	19	19	14	1030	0.8	SW6020A-Total	µg/L	**22.5**	**73.1**	**85.3**	**80**	**78.1**
Barium	26.4	19	19	9	103	21.2	SW6020A-Total	µg/L	**22.8**	**25.5**	**28.3**	**26.5**	**26.2**
Beryllium	ND	19	1	1	0.009	0.009	SW6020A-Total	µg/L	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U
Cadmium	ND	19	2	2	0.006	0.005	SW6020A-Total	µg/L	0.005 U	0.005 U	0.005 U	**0.005 J**	0.005 U
Calcium	18400	19	19	8	36000	8580	SW6010B-Total	µg/L	**17400**	**17500**	**17800**	**18000**	**17900**
Chromium	0.43	19	11	2	0.57	0.15	SW6020A-Total	µg/L	**0.25**	**0.57**	**0.27**	**0.28**	**0.52**
Cobalt	0.066	19	16	11	5.3	0.046	SW6020A-Total	µg/L	**0.058**	**0.244**	**0.274**	**0.23**	**0.23**
Copper	0.37	19	12	8	0.71	0.28	SW6020A-Total	µg/L	**0.38**	**0.47**	**0.45**	**0.53**	**0.48 J**
Iron	138	19	19	15	2470	118	SW6010B/SW6020A-Total	µg/L	**137**	**205**	**199**	**186**	**189**
Lead	0.021	19	11	4	0.079	0.008	SW6020A-Total	µg/L	**0.013 J**	**0.024**	**0.02 J**	**0.026**	**0.029 J**
Magnesium	9680	19	19	13	37100	4460	SW6010B-Total	µg/L	**9800**	**10500**	**10600**	**10700**	**11000**
Manganese	17.5	19	19	13	379	11.8	SW6020A-Total	µg/L	**13.3**	**26.4**	**32.7**	**28.2**	**32**
Nickel	0.44	19	16	13	19.2	0.36	SW6020A-Total	µg/L	**0.45**	**1.25**	**1.18**	**1.13**	**1.23**
Potassium	218 J	19	11	10	1210	214	SW6010B-Total	µg/L	**225 J**	**312 J**	**299 J**	**292 J**	**312 J**
Selenium	0.5 J	19	8	0	0.5	0.3	SW6020A-Total	µg/L	**0.5 J**	**0.4 J**	**0.3 J**	**0.4 J**	**0.5 J**
Silver	ND	19	2	2	0.012	0.008	SW6020A-Total	µg/L	0.004 U	0.004 U	0.004 U	0.004 U	**0.008 J**
Sodium	1580	19	19	16	12900	1440	SW6010B-Total	µg/L	**1810**	**2050**	**2130**	**2150**	**2430**
Thallium	ND	19	1	1	0.007	0.007	SW6020A-Total	µg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Vanadium	0.3	19	11	0	0.22	0.1	SW6020A-Total	µg/L	**0.15 J**	**0.14 J**	**0.15 J**	**0.12 J**	**0.14 J**
Zinc	0.5 J	19	8	2	2.1	0.3	SW6020A-Total	µg/L	**0.3 J**	**0.5**	**0.3 J**	**0.3 J**	**0.5 J**
Total Low Level Mercury													
Mercury, Total	2.63	18	18	17	385	2.33	EPA 1631-Total	ng/L	**71.1**	**312**	**214**	**200**	**239**
Dissolved Inorganic Elements													
Aluminum, Dissolved	11.9 J	17	9	2	19.7	3.5	SW6010B-Diss	µg/L	**7 J**	**11.1 J**	**15 J**	**11.1 J**	**19.7 J**
Antimony, Dissolved	1.4 J	18	18	15	184	1.2	SW6020A-Diss	µg/L	**60.1**	**124 J**	**148 J**	**163 J**	**184**
Arsenic, Dissolved	0.9	18	18	14	857	0.8	SW6020A-Diss	µg/L	**21.8**	**69.8**	**74.7**	**73.1**	**80.9**
Barium, Dissolved	24	18	18	11	99.5	20.7	SW6020A-Diss	µg/L	**22.3**	**25.2**	**25.9**	**26.2**	**27.3**
Beryllium, Dissolved	ND	18	1	1	0.012	0.012	SW6020A-Diss	µg/L	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U
Cadmium, Dissolved	ND	18	0	0			SW6020A-Diss	µg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Calcium, Dissolved	19200	17	17	4	36000	16700	SW6010B-Diss	µg/L	**16900**	**17700**	**17900**	**17800**	**17900**
Chromium, Dissolved	0.23	18	10	4	0.39	0.11	SW6020A-Diss	µg/L	**0.21**	**0.18 J**	**0.11 J**	**0.33**	**0.39**
Cobalt, Dissolved	0.056	18	13	9	4.9	0.042	SW6020A-Diss	µg/L	**0.049**	**0.21**	**0.229**	**0.197**	**0.236**
Copper, Dissolved	0.27	18	10	8	0.5	0.15	SW6020A-Diss	µg/L	**0.35**	**0.35**	**0.32**	**0.32**	**0.5**
Iron, Dissolved	100	17	17	12	2180	70	SW6010B-Diss	µg/L	**89.7**	**149**	**140**	**104**	**176**
Lead, Dissolved	ND	18	5	5	0.037	0.005	SW6020A-Diss	µg/L	0.005 U	**0.008 J**	0.005 U	0.005 U	**0.037**
Magnesium, Dissolved	10200	17	17	10	36400	8930	SW6010B-Diss	µg/L	**9460**	**10600**	**10900**	**11000**	**11000**
Manganese, Dissolved	15.9	18	18	12	380	8.2	SW6020A-Diss	µg/L	**10.8**	**23.6**	**27.5**	**24.3**	**27.5**
Nickel, Dissolved	0.35	18	15	14	17	0.32	SW6020A-Diss	µg/L	**0.43**	**0.92**	**0.99**	**1**	**1.26**
Potassium, Dissolved	220 J	17	10	9	1170	215	SW6010B-Diss	µg/L	**230 J**	**293 J**	**287 J**	**286 J**	**382 J**
Selenium, Dissolved	0.5 J	18	7	1	0.6	0.3	SW6020A-Diss	µg/L	**0.4 J**	**0.3 J**	**0.3 J**	**0.3 J**	0.3 U
Silver, Dissolved	ND	18	1	1	0.009	0.009	SW6020A-Diss	µg/L	0.004 U	0.004 U	0.004 U	0.004 U	**0.009 J**
Sodium, Dissolved	1610	17	17	15	13000	1450	SW6010B-Diss	µg/L	**1720**	**2060**	**2180**	**2190**	**2430**
Thallium, Dissolved	ND	18	0	0			SW6020A-Diss	µg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Vanadium, Dissolved	0.13 J	18	10	1	0.14	0.07	SW6020A-Diss	µg/L	**0.14 J**	**0.13 J**	**0.09 J**	**0.09 J**	**0.13 J**
Zinc, Dissolved	ND	18	3	3	1	0.3	SW6020A-Diss	µg/L	**0.3 J**	**0.5 J**	0.2 U	0.2 U	**1**
Dissolved Low Level Mercury													
Mercury, Dissolved	6.37	18	18	10	16.4	1.92	EPA 1631-Diss	ng/L	**13.9 J**	**10.9 J**	**13.3**	**13.5**	**12.4**
Arsenic Speciation													
Arsenate		12	12		234	0.595	EPA 1632 As-Cryo-W-Speciation	µg/L	**21.3**		**55.7**		**76.9 J**
Arsenite		12	12		667	0.089	EPA 1632 As3-CRYO-W	µg/L	**0.714**		**19.5 J**		**10.2**
Inorganic Arsenic		12	12		745	0.822	EPA 1632 Total Inorganic As - Water	µg/L	**22**		**75.1**		**87.1 J**
Methlymercury													
Methylmercury	0.08 J	18	18	15	0.62	0.08	EPA 1630	ng/L	**0.1 J**	**0.1 J**	**0.14**	**0.14**	**0.12**
Semi-Volatile Organic Compounds													
1-Methylnaphthalene		7	1		1.5	1.5	SW8270D	µg/L					
2-Methylnaphthalene		17	2		1.5	1.2	SW8270C	µg/L	0.24 U	0.24 U	0.24 U	0.24 U	0.24 U
Naphthalene		10	1		0.68	0.68	SW8270C	µg/L	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U
Unknown Hydrocarbon		7	2		3	2	SW8270D	µg/L					

Table 4-31 Surface Water Results

Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD12	RD09	RD06	RD07	RD08
							Sample ID		11RD12SW	11RD09SW	11RD06SW	11RD07SW	11RD08SW
							Sample Date		8/27/2011	8/26/2011	8/26/2011	8/26/2011	8/26/2011
							Method						
General Chemistry													
Bicarbonate		18	18		243	72.4	A2320 General Chemistry Parameters	mg/L	**73.3**	**80.3**	**81.2**	**81.3**	**81.9**
Carbonate		18	0				A2320 General Chemistry Parameters	mg/L	3 U	3 U	3 U	3 U	3 U
Hydroxide		8	0				A2320 General Chemistry Parameters	mg/L					
Total Dissolved Solids		18	18		244	51	A2540C/EPA 160.1	mg/L	**72**	**81**	**78**	**84**	**89**
Total Suspended Solids		18	1		3.6	3.6	A2540D/EPA 160.2	mg/L	5 U	5 U	5 U	5 U	5 U
Chloride		18	18		0.6	0.35	EPA 300.0 General Chemistry Parameters	mg/L	**0.35 J**	**0.36 J**	**0.37 J**	**0.45**	**0.37 J**
Fluoride		18	11		0.13	0.04	EPA 300.0 General Chemistry Parameters	mg/L	**0.07 J**	**0.05 J**	**0.04 J**	**0.09 J**	**0.06 J**
Sulfate		18	18		28.5	8.63	EPA 300.0 General Chemistry Parameters	mg/L	**9.07**	**11.9**	**12.2**	**11.9**	**12.1**
Nitrate+Nitrite as Nitrogen		18	16		0.192	0.115	EPA 353.2 Nitrogen, Total Nitrate-Nitrite	mg/L	**0.156**	**0.192**	**0.182**	**0.173**	**0.169**
Field Parameters													
Temperature		19			6.77	3.79	Field Test	°C	5.09	6.77	6.59	6.31	5.60
pH		19			7.71	5.37	Field Test	N/A	5.97	7.71	7.62	7.57	7.49
ORP		19			177	-143	Field Test	mV	71	9	86	80	36
Conductance		19			0.524	0.072	Field Test	mS/cm	0.177	0.166	0.168	0.170	0.120
Turbidity		19			60.6	0	Field Test	NTU	0.00	0.00	0.00	0.00	0.00
Dissolved Oxygen		19			18.68	9	Field Test	mg/L	13.61	15.61	9.77	10.75	11.66

Key

Bold = detection

°C = Degrees Celsius

Gray shading = exceedance of background

EPA = United States Environmental Protection Agency

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/L = milligrams per liter

mS/cm = Millisiemens per Centimeter

mV = Millivolt

N/A = not applicable

ND = not detected

ng/L = nanograms per liter

NTU = Nephelometric Turbidity Unit

ORP = Oxidation reduction potential

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

µg/L = micrograms per liter

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-32 Red Devil Creek and Seep Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	RD02	RD03	RD11	RD10	RD04	RD05	RD12	RD09	RD06	RD07	RD08
							Sample ID		10RD02SD	10RD03SD	11RD11SD	11RD10SD	10RD04SD	10RD05SD	11RD12SD	10RD09SD	10RD06SD	10RD07SD	10RD08SD
Analyte							Method												
Total Inorganic Elements																			
Aluminum	10800	11	11	2	14700	910	SW6010B-Total	mg/kg	**14700**	**9340**	**9930**	**7290**	**9350**	**910**	**10600**	**11900**	**10200**	**9620**	**8440**
Antimony	ND	11	9	9	6360	5.71	SW6010B/SW6020A-Total	mg/kg	1.2 UJ	1.2 UJ	**7.39 J**	**5.71 J**	**2510 J**	**1590 J**	**6360 J**	**3600 J**	**4060 J**	**3430 J**	**1900 J**
Arsenic	65	11	11	7	130000	32.5	SW6010B/SW6020A-Total	mg/kg	**50**	**60**	**32.5**	**62**	**2290**	**130000**	**3610 J**	**2920**	**2950**	**2370**	**1890**
Barium	159	11	11	8	1990	119	SW6010B/SW6020A-Total	mg/kg	**278**	**146**	**130 J**	**119**	**401**	**1990**	**985 J**	**521**	**459**	**542**	**379**
Beryllium	0.5	11	10	7	0.9	0.311	SW6010B/SW6020A-Total	mg/kg	**0.4**	**0.6**	**0.311**	**0.417**	**0.9**	1.39 U	**0.705**	**0.9**	**0.8**	**0.8**	**0.7**
Cadmium	0.3	11	3	1	0.317	0.163	SW6010B/SW6020A-Total	mg/kg	0.059 U	0.06 U	**0.163 J**	**0.232**	0.062 U	1.4 U	**0.317 J**	0.057 U	0.059 U	0.06 U	0.057 U
Calcium	2380	11	11	8	23400	1660	SW6010B-Total	mg/kg	**6170**	**1960**	**2070 J**	**1660 J**	**5530**	**23400**	**3450 J**	**4080**	**3910**	**5000**	**4190**
Chromium	20.4	11	10	7	47.4	11.8	SW6010B/SW6020A-Total	mg/kg	**25**	**19**	**14.9 J**	**11.8 J**	**29**	18.1 U	**47.4 J**	**29**	**31**	**32**	**25**
Cobalt	12.3	11	11	9	50	8.69	SW6010B/SW6020A-Total	mg/kg	**13.7**	**16.5**	**8.69**	**11.9**	**17.8**	**50**	**12.5**	**20.5**	**21.5**	**22.3**	**14.7**
Copper	21.7	11	11	9	58.2	13.2	SW6010B/SW6020A-Total	mg/kg	**23.4**	**24.4**	**13.2 J**	**14.9 J**	**45.7**	**30 J**	**45.7 J**	**55.6 J**	**58.2 J**	**55.5 J**	**39.9 J**
Iron	32100	11	11	8	344000	28900	SW6010B-Total	mg/kg	**29200**	**38300**	**33200**	**36100**	**52000**	**344000**	**28900**	**35200**	**39200**	**34000**	**31000**
Lead	8	11	10	4	14	1.72	SW6010B/SW6020A-Total	mg/kg	**7**	**8**	**6.22 J**	**7.99 J**	**14**	12.5 U	**1.72 J**	**12**	**11**	**13**	**7**
Magnesium	2990	11	11	9	8690	2710	SW6010B-Total	mg/kg	**4110**	**2710**	**3250 J**	**2780 J**	**8690**	**6440**	**5200 J**	**5440**	**5530**	**7700**	**4960**
Manganese	579	11	11	10	2610	552	SW6010B-Total	mg/kg	**2610**	**1310**	**854**	**1480**	**1350**	**986**	**552**	**1250**	**1560**	**1690**	**784**
Mercury	0.18	11	11	11	79	0.232	SW7471A-Total	mg/kg	**0.55**	**0.42**	**1.57 J**	**0.232 J**	**36**	**8.6 J**	**77 J**	**46 J**	**63 J**	**60 J**	**79 J**
Nickel	32	11	11	8	240	22	SW6010B/SW6020A-Total	mg/kg	**30**	**38**	**22 J**	**26 J**	**67**	**240**	**47.2 J**	**64**	**61**	**62**	**49**
Potassium	1200	11	10	7	2870	510	SW6010B-Total	mg/kg	**1300**	**900**	**636 J**	**510 J**	**2660**	814 U	**2870 J**	**2850**	**2810**	**2770**	**2320**
Selenium	ND	11	3	3	0.62	0.33	SW6010B/SW7742-Total	mg/kg	1.7 U	1.8 U	**0.39**	**0.33**	1.8 U	41 U	**0.62**	1.7 U	1.7 U	1.8 U	1.7 U
Silver	ND	11	3	3	0.135	0.04	SW6010B/SW6020A-Total	mg/kg	0.117 U	0.12 U	**0.062 J**	**0.04**	0.124 U	2.8 U	**0.135 J**	0.113 U	0.117 U	0.12 U	0.113 U
Sodium	ND	11	8	8	270	21.1	SW6010B-Total	mg/kg	44.3 U	45.4 U	**39.6**	**21.1**	**240**	1050 U	**225**	**270**	**250**	**230**	**210**
Thallium	ND	11	3	3	0.297	0.043	SW6010B/SW6020A-Total	mg/kg	0.7 U	0.8 U	**0.055**	**0.043**	0.8 U	17.4 U	**0.297**	0.7 U	0.7 U	0.7 U	0.7 U
Vanadium	35.4	11	10	2	39.3	22.8	SW6010B/SW6020A-Total	mg/kg	**39.3**	**37.9**	**24.7**	**25.9**	**32.2**	4.2 U	**22.8**	**26.8**	**25**	**27.6**	**25.1**
Zinc	80	11	11	7	120	51.1	SW6010B/SW6020A-Total	mg/kg	**78**	**91**	**51.1 J**	**58.6**	**106**	**120**	**65.7 J**	**96**	**100**	**91**	**83**
Arsenic Speciation																			
Arsenate		10	10		182000	50.4	EPA 1632-As-Cryo-S-Speciation	mg/kg	**50.4 J**	**53.7 J**		**53.9**	**2480 J**	**182000 J**	**2160**	**2930 J**	**4180 J**	**3680 J**	**2330 J**
Arsenite		10	10		5960	1.34	EPA 1632-As3-CRYO-T	mg/kg	**4.39 J**	**1.34 J**		**1.7**	**57.8 J**	**5960 J**	**333**	**104 J**	**155 J**	**88.2 J**	**63.2 J**
Inorganic Arsenic		10	10		188000	54.8	EPA 1632-Total Inorganic As - Solid	mg/kg	**54.8 J**	**55 J**		**55.6**	**2540 J**	**188000 J**	**2490**	**3030 J**	**4340 J**	**3770 J**	**2390 J**
Mercury Selective Sequential Extraction																			
Hg(F0)		7	3		41500	18.5	EPA 1631	ng/g		2.48 U		**297**	2.92 U	13.2 U	**41500**		2.36 U		**18.5**
Hg(F1)		7	7		1180	2.55	BRL SOP No. BR-0013	ng/g		**2.55 J**		**3**	**529 J**	**7.24 J**	**79.4 J**		**640 J**		**1180 J**
Hg(F2)		7	7		166	0.39	BRL SOP No. BR-0013	ng/g		**0.39 J**		**1.14 J**	**107 J**	**7.09 J**	**4.94 J**		**166 J**		**27.6 J**
Hg(F3)		7	7		6580	194	BRL SOP No. BR-0013	ng/g		**212 J**		**194 J**	**3840 J**	**6580 J**	**1890 J**		**5090 J**		**1360 J**
Hg(F4)		7	7		23700	37.3	BRL SOP No. BR-0013	ng/g		**146 J**		**37.3**	**23700 J**	**1280 J**	**4090 J**		**21900 J**		**17700 J**
Hg(F5)		7	7		969000	166	BRL SOP No. BR-0013	ng/g		**643**		**166**	**969000**	**2500**	**17200 J**		**100000**		**142000**
Hg(F6)		5	5		63000	22.9	BRL SOP No. BR-0013	ng/g		**25.9 J**			**22.9 J**	**63000 J**			**3040 J**		**7550 J**
Methylmercury																			
Methylmercury	0.000177	10	10	10	12.7	0.1	CAS SOP/EPA 1630	ng/g	**7.02**	**0.218**		**0.1 J**	**0.766**	**12.7**	**0.4 J**	**0.69**	**0.993**	**0.578**	**1**
Semi-volatile Organic Compounds																			
.gamma.-Sitosterol		2	2		390	230	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**390 J**	**230 J**							
Benzo(b)fluoranthene		2	1		1.5	1.5	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**1.5 J**	1.2 U							
Benzoic Acid		2	1		220	220	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**220**	96 U							
Benzyl Alcohol		2	1		3.1	3.1	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**3.1 J**	2.1 U							
Diethyl Phthalate		2	1		1.7	1.7	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**1.7 J**	1.3 U							
Di-n-butyl Phthalate		2	1		9	9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**9 J**	7.9 U							
Docosanoic acid		2	2		710	190	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**710 J**	**190 J**							
Heptacosane		1	1		270	270	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**270 J**							
Pentachlorophenol (PCP)		2	1		22	22	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**22 J**	20 U							
Phenanthrene		2	2		2.1	1.9	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**1.9 J**	**2.1 J**							
Phenol		2	1		4.1	4.1	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**4.1 J**	2 U							
Unknown		2	2		700	180	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**700 J**	**180 J**							
Unknown Alkane		1	1		99	99	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**99 J**							
Unknown Alkene		1	1		240	240	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg				**240 J**							
Unknown Carboxylic Acid		2	2		370	130	SW8270C-Low Level Semivolatile Organics using LVI	µg/kg			**370 J**	**130 J**							
Total Organic Carbon																			
Carbon, Total Organic (TOC)		11	11		8.33	0.476	SW9060M-Total Organic Carbon, Modified for Matrix	%	**8.33**	**0.951**	**1.3**	**0.501**	**1.02**	**2.28**	**0.476**	**0.882**	**0.868**	**0.827**	**0.94**

Key
Bold = detection
Gray shading = exceedance of background
% = percent
µg/kg = micrograms per kilogram
BRL = Brooks Rand Labs
CAS = Chemical Abstract Service
EPA = United States Environmental Protection Agency
J = The analyte detected. The associated result is estimated.
LVI = large volume injection
mg/kg = milligrams per kilogram
ND = not detected
ng/g = nanograms per gram
SOP = Standard Operating Procedure
U = The analyte was analyzed for but not detected. The value provided is the reporting limit.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-33 Kuskokwim River Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR02	KR03	KR04	KR07	KR10	KR11	KR05	KR06
							Sample ID		10KR02SD	10KR03SD	10KR04SD	10KR07SD	10KR10SD	10KR11SD	11KR05SD	11KR06SD
Analyte							Method									
Total Inorganic Elements																
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	**9750**	**17000**	**12600**	**4510**	**7080**	**10600**	**6460 J**	**7480 J**
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	**1280 J**	**10 J**	0.62 U	**40 J**	1.2 U	0.56 U	**99**	**2.1**
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	**1790**	**60**	**30**	**800**	**160**	**21**	**135 J**	**17.5 J**
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	**418**	**227**	**161**	**145**	**151**	**138**	**91.6 J**	**128 J**
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	**0.8**	**0.6**	**0.5**	**0.8**	**0.6**	**0.4**	**0.344**	**0.293**
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	0.058 U	**0.6**	**0.4**	0.061 U	0.056 U	**0.4**	**0.27 J**	**0.281 J**
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	**2920**	**6020**	**5920**	**1630**	**2950**	**6440**	**1810 J**	**6830 J**
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	**25**	**36**	**26.7**	**18**	**17**	**23.3**	**14.2 J**	**20.1 J**
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	**14.8**	**12.8**	**9.9**	**18**	**15.1**	**9.2**	**9.36 J**	**7.14 J**
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	**37.2 J**	**31 J**	**22 J**	**56.5 J**	**41.9 J**	**19.6 J**	**25.1**	**19**
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	**29100**	**33900**	**25100**	**48100**	**31200**	**23200**	**33400**	**25900**
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	**7**	**10**	**7**	**10**	**10**	**6**	**7.78 J**	**7.32 J**
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	**4530**	**6450**	**5410**	**990**	**2580**	**4970**	**2890**	**6150**
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	**750**	**712**	**429**	**684**	**735**	**451**	**708**	**557**
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	**56 J**	**2.1 J**	**0.82 J**	**13.2 J**	**3.6 J**	**0.52 J**	**119 J**	**0.169 J**
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	**48**	**35**	**28**	**55**	**38**	**27**	**25.7**	**23.1**
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	**2190**	**1960**	**1440**	**1120**	**1070**	**1250**	**749**	**1380**
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	1.7 U	1.2 U	0.9 U	1.8 U	1.7 U	0.81 U	**0.39**	**0.39**
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	0.116 U	0.081 U	0.061 U	0.121 U	0.113 U	0.055 U	**0.198**	**0.167**
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	**220**	**240**	**210**	45.7 U	42.6 U	**180**	**77.5**	**187**
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.7 U	0.5 U	0.38 U	0.8 U	0.7 U	0.34 U	**0.076**	**0.12**
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	**27.3**	**48.5**	**36.9**	**32.5**	**31.4**	**31.8**	**22.4 J**	**26.1 J**
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	**83**	**105**	**80**	**119**	**99**	**75**	**76.6 J**	**71.7 J**
Arsenic Speciation																
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg	**1900 J**	**40.9 J**	**29.1 J**	**1020 J**	**175 J**	**23.2 J**	**184**	**20.5**
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg	**42.5 J**	**15.1 J**	**2.63 J**	**2.49 J**	**3.24 J**	**1.46 J**	**47.3 J**	**5.56 J**
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg	**1940 J**	**56 J**	**31.7 J**	**1020 J**	**178 J**	**24.7 J**	**231**	**26**
Mercury Selective Sequential Extraction																
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g	3.49 U		3.88 U	**6.13**		3.97 U		
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g	**797 J**		**5.2 J**	**93.1 J**		**7.34 J**		
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g	**38.7 J**		0.28 U	**12.5 J**		**1.54 J**		
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g	**1520 J**		**572 J**	**684 J**		**351 J**		
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g	**10700 J**		**403 J**	**2040 J**		**343 J**		
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g	**175000**		**4380**	**831000**		**259**		
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g	**288 J**		**91.5 J**	**16200 J**		**32.5 J**		
Methylmercury																
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g	**0.592**	**0.812**	**0.285**	0.009 U	**0.654**	**0.184**	**0.73**	**0.24 J**
Total Organic Carbon																
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	**0.594**	**1.64**	**0.612**	**0.586**	**0.513**	**0.426**	**0.342**	**0.511**

Table 4-33 Kuskokwim River Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR08	KR09	KR14	KR15	KR16	KR17	KR28	KR29
							Sample ID		11KR08SD	11KR09SD	11KR14SD	11KR15SD	11KR16SD	11KR17SD	11KR28SD	11KR29SD
Analyte							Method									
Total Inorganic Elements																
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	9550 J	9770 J	11300 J	6810 J	13500 J	8610 J	7170	4340
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	5.48	9.51	5.41 J	272 J	15.2	4.26	589 J	360 J
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	52 J	20.9 J	12.5 J	414 J	39.2 J	17.5 J	304 J	502 J
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	120 J	122 J	116 J	124 J	152 J	111 J	105	187
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	0.297	0.501	0.283	0.268	0.339	0.334	0.245	0.357
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	0.282 J	0.338 J	0.251 J	0.219 J	0.342 J	0.345 J	0.254	0.222
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	5230 J	5670 J	3930 J	1550 J	7480 J	4390 J	19400	1960
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	18.3 J	21.1 J	19.7 J	11.1 J	21.9 J	17.7 J	6.22 J	15.1 J
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	7.78 J	10.8 J	6.93 J	7.69 J	8.14 J	10 J	9.02	11.3
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	18.8	26.8	15	20.3	23.2	24.9	13.2 J	24.4 J
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	24000	32400	24200	19800	29900	26000	34900	25700
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	6.71 J	9.34 J	6.62 J	6.06 J	8.82 J	9.27 J	5.5	5.79
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	4910	4800	5330	2410	6720	4060	11400	1660
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	505	649	404	5410	586	527	949	522
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	1.15 J	0.566 J	0.387 J	39.2 J	2.36 J	0.442 J	33.6 J	38.9 J
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	23.8	30.9	19.4	21	25.3	26.1	21.1	31.5
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	1080	1280	1070	1070	1520	996	803	791
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	0.31	0.5	0.42	0.55 J	0.52	0.39	0.33	0.22
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	0.128	0.172	0.141	0.098	0.229	0.15	0.111	0.156
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	144	145	143	82.5	200	113	62.6	48
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.105	0.123	0.104	0.09	0.136	0.109	0.653	0.084
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	23.6 J	30.1 J	25.5 J	16.6 J	28.6 J	27.7 J	10.9	19.5
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	67.9 J	93.9 J	65.3 J	53.8 J	80 J	82.1 J	50.7 J	67.6 J
Arsenic Speciation																
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg	47.5	58.4	54.7	1710	38.7	34.5		
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg	7.49 J	9.75 J	12.7 J	152 J	31.8 J	5.48 J		
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg	55	68.2	67.4	1860	70.5	39.9		
Mercury Selective Sequential Extraction																
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g								
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g								
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g								
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g								
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g								
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g								
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g								
Methylmercury																
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g	0.43 J	0.30 J	0.20 J	2.64	1.33	0.32 J	1.34 J	
Total Organic Carbon																
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	0.486	0.538	0.534	0.32	1.43	1	0.621	0.627

Table 4-33 Kuskokwim River Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR30	KR34	KR35	KR36	KR37	KR38	KR39	KR40
							Sample ID		11KR30SD	11KR34SD	11KR35SD	11KR36SD	11KR37SD	11KR38SD	11KR39SD	11KR40SD
Analyte							Method									
Total Inorganic Elements																
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	4530	7050	7020	18400	12400	6010	2050	9750
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	894 J	1060 J	1420 J	7.72 J	5.57 J	753	149	57.1 J
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	938 J	958 J	1280 J	19.2 J	19.4 J	918	79.3	123 J
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	242	220	398	131	130	179 J	88.4 J	132
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	0.374	0.47	0.438	0.347	0.336	0.367	0.469	0.363
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	0.204	0.301	0.294	0.256	0.272	0.213 J	0.663 J	0.308
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	2270	2770	2740	8550	7570	2280	2060	4250
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	19.7 J	16.5 J	18.4 J	22.8 J	21.5 J	18.9 J	11.4 J	17.6 J
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	8.64	11.1	10.6	8.54	8.16	7.3	18.2	9.08
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	23.5 J	29.5 J	28.2 J	18.8 J	18.7 J	23 J	87.5 J	21.3 J
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	24400	28300	31100	43300	28700	19600	32300	26800
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	5.84	6.88	5.94	7.03	6.7	3.94	14.1	6.74
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	3290	4890	5100	9370	6340	3090 J	6030 J	4600
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	828	908	666	849	555	466 J	1220 J	567
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	24.2 J	104 J	46.1 J	0.827 J	0.208 J	19 J	1.73 J	40 J
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	29.5	37.8	31.1	25.6	24.3	27.5 J	65.1 J	25.5
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	1150	1590	1320	1830	1390	1500 J	1280 J	990
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	0.19 J	0.24	0.16 J	0.39	0.35	0.15 U	2.11	0.36
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	0.112	0.111	0.097	0.201	0.145	0.108	0.41	0.127
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	75.5	139	125	262	193	163	56.1	119
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.419	0.158	0.229	0.109	0.125	0.145	0.107	0.107
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	20.7	20.7	15.1	29.5	28.3	16	25.8	24.1
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	56.7 J	84.1 J	68.6 J	72.1 J	69.9 J	50.8 J	132 J	65.4 J
Arsenic Speciation																
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg								
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg								
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg								
Mercury Selective Sequential Extraction																
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g								
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g								
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g								
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g								
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g								
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g								
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g								
Methylmercury																
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g	.64 J	1.25 J			0.17 J			1.45 J
Total Organic Carbon																
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	0.378	0.563	0.471	0.757	0.84	0.307	2.05	1.16

Table 4-33 Kuskokwim River Sediment Results	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**	**Units**	**KR41**	**KR42**	**KR43**	**KR44**	**KR45**	**KR46**	**KR47**	**KR54**
							Sample ID		**11KR41SD**	**11KR42SD**	**11KR43SD**	**11KR44SD**	**11KR45SD**	**11KR46SD**	**11KR47SD**	**0912KR54SD**
Analyte							**Method**									
Total Inorganic Elements																
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	**6390**	**3850**	**9110**	**3450**	**9560**	**7600**	**7380**	**4000**
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	**25 J**	**64.1 J**	**40.2**	**21.6 J**	**0.237 J**	**31.9**	**24.6**	**4.4**
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	**54.8 J**	**254 J**	**55**	**0.57 J**	**4.41 J**	**87.2**	**77.8**	**17**
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	**66.6**	**193**	**118 J**	**4.12**	**89.8**	**107 J**	**70.1 J**	**57 J**
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	**0.211**	**0.546**	**0.587**	**0.008 J**	**0.505**	**0.411**	**0.289**	**0.18**
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	**0.16**	**0.657**	**0.515 J**	**0.017 J**	**0.153**	**0.561 J**	**0.202 J**	**0.1**
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	**2000**	**1320**	**2090**	**2110**	**10900**	**1710**	**1950**	**1600**
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	**15.3 J**	**8.78 J**	**27.2 J**	**0.65 J**	**18.8 J**	**25 J**	**15 J**	**12 J**
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	**7.14**	**14.8**	**11.4**	**0.369**	**15.8**	**13.9**	**8.44**	**5.5**
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	**11.6 J**	**40.4 J**	**48.5 J**	**.68 J**	**21.5 J**	**41.5 J**	**21.1 J**	**8.5 J**
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	**37900**	**39400**	**31100**	**55600**	**26200**	**25200**	**22800**	**14000**
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	**3.13**	**9.28**	**14.8**	**0.05**	**8.97**	**9.78**	**5.95**	**2.2**
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	**2910**	**2050**	**4550 J**	**1760**	**4250**	**3770 J**	**3960 J**	**2500 J**
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	**2530**	**1250**	**1220 J**	**1170**	**1730**	**1060 J**	**626 J**	**560**
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	**14.2 J**	**4.36 J**	**12 J**	**7.19 J**	**.199 J**	**4.75 J**	**7.18 J**	**0.2**
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	**21.3**	**39.5**	**48.2 J**	**0.78**	**31.1**	**50.4 J**	**23.2 J**	**15**
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	**764**	**964**	**784 J**	**854**	**922**	**824 J**	**1080 J**	**480**
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	**0.3**	**0.36**	**0.87**	**0.61**	**0.17**	**0.58**	**0.46**	**0.27**
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	**0.118**	**0.099**	**0.122**	**0.106**	**0.086**	**0.153**	**0.087**	**0.02**
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	**74.7**	**42.8**	**52.8**	**40.4**	**61.6**	**57.7**	**66.2**	**59**
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	**0.056**	**0.128**	**0.096**	**0.011 J**	**0.06**	**0.08**	**0.07**	0.14 U
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	**19.5**	**11.4**	**29.3**	**1.72**	**30.8**	**23.5**	**21.2**	**16**
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	**50.1 J**	**87.6 J**	**19 J**	**1.2 J**	**81.8 J**	**92 J**	**54.1 J**	**32 J**
Arsenic Speciation																
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg								
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg								
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg								
Mercury Selective Sequential Extraction																
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g								
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g								
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g								
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g								
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g								
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g								
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g								
Methylmercury																
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g					**.15 J**			
Total Organic Carbon																
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	**0.274**	**0.313**	**0.643**	**0.379**	**0.326**	**0.722**	**0.567**	**0.21**

Table 4-33 Kuskokwim River Sediment Results

Analyte	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR55	KR56	KR58	KR59	KR60	KR61	KR62
							Sample ID		0912KR55SD	0912KR56SD	0912KR58SD	0912KR59SD	0912KR60SD	0912KR61SD	0912KR62SD
							Method								
Total Inorganic Elements															
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	**5900**	**4600**	**4700**	**4300**	**6900**	**5300**	**4200**
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	**0.18**	**0.19**	**44**	**13**	**26**	**0.49**	**18 J**
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	**8.5**	**6.6**	**180**	**210**	**66**	**7**	**40 J**
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	**94 J**	**66 J**	**130**	**110**	**120**	**66 J**	**67 J**
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	**0.35**	**0.18**	**0.79**	**0.45**	**0.56**	**0.16**	**0.34**
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	**0.22**	**0.11**	**0.5**	**0.36**	**1.1**	**0.14**	**0.24 J**
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	**2900**	**1700**	**2400**	**2000**	**3100**	**1600**	**1400**
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	**17 J**	**14 J**	**20**	**18**	**19**	**14 J**	**15**
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	**9.1**	**4.9**	**27**	**13**	**17**	**5.6**	**10**
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	**23 J**	**7.7 J**	**63**	**33**	**83**	**10 J**	**28 J**
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	**23000**	**11000**	**47000**	**29000**	**23000**	**13000**	**24000**
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	**7.2**	**2.4**	**16**	**8.6**	**18**	**5.5**	**5.9**
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	**4000 J**	**2500 J**	**1600**	**1700**	**3500**	**2600 J**	**1900 J**
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	**670**	**400**	**1200**	**1200**	**700**	**450**	**550 J**
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	**0.16**	**0.03**	**260**	**8.4**	**29000**	**0.027**	**1.7 J**
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	**29**	**15**	**67**	**31**	**54**	**18**	**29**
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	**1100**	**590**	**1000**	**700**	**1900**	**700**	**630**
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	**0.65**	**0.29**	**1**	**0.81**	**2.5**	**0.35**	**0.54 J**
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	**0.088**	**0.032**	**0.13**	**0.078**	**0.57**	**0.037**	**0.043 J**
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	**120**	**59**	**70**	**54**	**110**	**100**	**72**
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.15 U	0.16 U	**0.12**	0.12 U	**0.32**	0.14 U	0.15 U
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	**24**	**18**	**33**	**21**	**30**	**17**	**25**
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	**62 J**	**31 J**	**140**	**77**	**270**	**40 J**	**76 J**
Arsenic Speciation															
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg							
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg							
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg							
Mercury Selective Sequential Extraction															
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g							
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g							
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g							
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g							
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g							
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g							
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g							
Methylmercury															
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g			**3.73**				**0.436**
Total Organic Carbon															
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	**0.63**	**0.091**	**0.43**	**0.25**	**1.1**	**0.21**	**0.4**

Table 4-33 Kuskokwim River Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR63	KR64	KR66	KR67	KR68	KR69	KR70
							Sample ID		0912KR63SD	0912KR64SD	0912KR66SD	0912KR67SD	0912KR68SD	0912KR69SD	0912KR70SD
Analyte							Method								
Total Inorganic Elements															
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	**340**	**6300**	**6100**	**7200 J**	**5900**	**5900**	**3900**
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	**1.1**	**4.7**	**4.8 J**	**9.8**	**42**	**0.17**	**1.9**
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	**3.8**	**18**	**34**	**49 J**	**75**	**7.6**	**26**
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	**7.1**	**50**	**110 J**	**160 J**	**73**	**81**	**97**
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	**0.046**	**0.37**	**0.54**	**0.39 J**	**0.32**	**0.19**	**0.74**
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	**0.03**	**0.47**	**0.38**	**0.26**	**0.21**	**0.13**	**0.68**
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	**160**	**1900**	**3000**	**2700**	**2200**	**2100**	**11000**
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	**1.7**	**18**	**18 J**	**18 J**	**16**	**15**	**18**
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	**0.95**	**11**	**9.9**	**11**	**8.7**	**6.4**	**8.2**
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	**4.2 J**	**47**	**46 J**	**29 J**	**20 J**	**8.3**	**38 J**
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	**4000**	**29000**	**38000**	**30000**	**21000**	**14000**	**42000**
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	**0.84**	**8.7**	**11**	**7.6 J**	**5.6**	**2.8**	**11**
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	**180 J**	**3100**	**3400 J**	**3400 J**	**3100 J**	**3300**	**2000 J**
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	**53**	**210**	**740**	**960**	**800**	**510**	**1200**
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	**1.2**	**0.22**	**3.1 J**	**7.6 J**	**3.1**	**0.011**	**0.98**
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	**4**	**36**	**35**	**31**	**26**	**19**	**33**
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	**61**	**750**	**1400**	**1200 J**	**720**	**630**	**940**
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	**0.075**	**1.3**	**1**	**.79 J**	**0.5**	**0.36**	**1.1**
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	**0.0072**	**0.12**	**0.14**	**0.075 J**	**0.064**	**0.033**	**0.15**
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	**5.8**	**51**	**120**	**100 J**	**76**	**83**	**140**
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.014 U	0.15 U	0.15 U	0.14 U	0.15 U	0.15 U	0.13 U
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	**3**	**24**	**33**	**30 J**	**23**	**22**	**38**
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	**10 J**	**110**	**110 J**	**80 J**	**59 J**	**42**	**86 J**
Arsenic Speciation															
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg							
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg							
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg							
Mercury Selective Sequential Extraction															
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g							
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g							
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g							
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g							
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g							
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g							
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g							
Methylmercury															
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g			**2.45**				**0.676**
Total Organic Carbon															
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	**0.5**	**0.63**	**1.4**	**0.54**	**0.47**	**0.11**	**1.1**

Table 4-33 Kuskokwim River Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR71	KR72	KR74	KR75	KR76	KR77	KR78
							Sample ID		0912KR71SD	0912KR72SD	0912KR74SD	0912KR75SD	0912KR76SD	0912KR77SD	0912KR78SD
Analyte							Method								
Total Inorganic Elements															
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	**5600**	**4800**	**5800**	**9300**	**3400**	**4900**	**6900**
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	**8.3**	**0.7**	**11**	**18**	**11**	**0.62**	**2**
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	**35**	**44**	**17**	**22**	**14**	**9**	**19**
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	**100 J**	**93**	**74**	**120**	**70**	**200 J**	**80**
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	**0.31**	**0.44**	**0.22**	**0.36**	**0.43**	**0.19**	**0.28**
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	**0.28**	**0.46**	**0.17**	**0.33**	**0.25**	**0.11**	**0.16**
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	**2500**	**4100**	**1900**	**3400**	**3500**	**1900**	**2000**
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	**15 J**	**19**	**16**	**23**	**18**	**25 J**	**21**
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	**8.2**	**23**	**6.2**	**10**	**9.3**	**4.9**	**7.6**
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	**20 J**	**66**	**14 J**	**23**	**38 J**	**11 J**	**23**
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	**21000**	**64000**	**15000**	**21000**	**48000**	**10000**	**19000**
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	**5.5**	**13**	**4.1**	**6.4**	**5**	**3.1**	**5.3**
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	**2700 J**	**8700**	**2900 J**	**4400**	**5200 J**	**2600 J**	**3800**
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	**1000**	**2800**	**240**	**380**	**2200**	**340**	**250**
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	**0.99**	**2.5**	**7.1**	**1.9**	**0.066**	0.0062 U	**2.4**
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	**22**	**64**	**19**	**28**	**26**	**18**	**21**
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	**750**	**1800**	**670**	**1100**	**820**	**840**	**820**
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	**0.58**	**1.5**	**0.4**	**0.83**	**0.78**	**0.34**	**0.56**
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	**0.079**	**0.23**	**0.055**	**0.09**	**0.085**	**0.049**	**0.056**
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	**110**	**67**	**120**	**150**	**75**	**150**	**97**
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.13 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.16 U
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	**22**	**34**	**23**	**35**	**30**	**22**	**29**
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	**61 J**	**99**	**45 J**	**72**	**67 J**	**37 J**	**54**
Arsenic Speciation															
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg							
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg							
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg							
Mercury Selective Sequential Extraction															
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g							
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g							
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g							
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g							
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g							
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g							
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g							
Methylmercury															
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g				**1.9**			**0.308**
Total Organic Carbon															
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	**0.26**	**2.3**	**0.8**	**1.3**	**1.6**	**0.1**	**0.49**

Table 4-33 Kuskokwim River Sediment Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	KR79	KR80	KR81
							Sample ID		0912KR79SD	0912KR80SD	0912KR81SD
Analyte							Method				
Total Inorganic Elements											
Aluminum	12500	56	56	4	18400	340	SW6010B-Total	mg/kg	**6200**	**7200**	**4300**
Antimony	0.473	56	56	48	1420	0.17	SW6010B/SW6020A-Total	mg/kg	**4.3**	**12**	**0.17**
Arsenic	12.7	56	56	45	1790	0.57	SW6010B/SW6020A-Total	mg/kg	**27**	**12**	**6.2**
Barium	146	56	56	13	418	4.12	SW6010B/SW6020A-Total	mg/kg	**90 J**	**84 J**	**55**
Beryllium	0.408	56	56	20	0.8	0.008	SW6010B/SW6020A-Total	mg/kg	**0.23**	**0.25**	**0.16**
Cadmium	0.288	56	53	21	1.1	0.017	SW6010B/SW6020A-Total	mg/kg	**0.17**	**0.21**	**0.11**
Calcium	2960	56	56	21	19400	160	SW6010B-Total	mg/kg	**2000**	**3000**	**1700**
Chromium	22.2	56	56	9	36	0.65	SW6010B/SW6020A-Total	mg/kg	**17 J**	**21 J**	**12**
Cobalt	13.5	56	56	10	27	0.369	SW6010B/SW6020A-Total	mg/kg	**7.5**	**8**	**4.6**
Copper	36.9	56	56	14	87.5	0.68	SW6010B/SW6020A-Total	mg/kg	**12 J**	**15 J**	**6.4**
Iron	33600	56	56	12	64000	4000	SW6010B-Total	mg/kg	**18000**	**14000**	**11000**
Lead	13.34	56	56	4	18	0.05	SW6010B/SW6020A-Total	mg/kg	**4.1**	**3.5**	**2.4**
Magnesium	5900	56	56	8	11400	180	SW6010B-Total	mg/kg	**3000 J**	**3600 J**	**2300**
Manganese	743	56	56	21	5410	53	SW6010B-Total	mg/kg	**680**	**480**	**410**
Mercury	0.143	56	55	50	29000	0.011	SW7471A-Total	mg/kg	**20**	**2.5**	**0.035**
Nickel	37	56	56	11	67	0.78	SW6010B/SW6020A-Total	mg/kg	**20**	**23**	**13**
Potassium	934.1	56	56	31	2190	61	SW6010B-Total	mg/kg	**760**	**880**	**470**
Selenium	1.03	56	49	5	2.5	0.075	SW7742-Total	mg/kg	**0.47**	**0.67**	**0.35**
Silver	0.124	56	50	18	0.57	0.0072	SW6010B/SW6020A-Total	mg/kg	**0.048**	**0.055**	**0.026**
Sodium	121.7	56	54	18	262	5.8	SW6010B-Total	mg/kg	**83**	**150**	**59**
Thallium	0.105	56	27	14	0.653	0.011	SW6010B/SW6020A-Total	mg/kg	0.12 U	0.15 U	0.16 U
Vanadium	29.8	56	56	15	48.5	1.72	SW6010B/SW6020A-Total	mg/kg	**24**	**29**	**16**
Zinc	78	56	56	20	270	1.2	SW6010B/SW6020A-Total	mg/kg	**47 J**	**46 J**	**31**
Arsenic Speciation											
Arsenate		14	14		1900	20.5	EPA 1632-As-Cryo-S-Speciation	mg/kg			
Arsenite		14	14		152	1.46	EPA 1632-As3-CRYO-T	mg/kg			
Inorganic Arsenic		14	14		1940	24.7	EPA 1632-Total Inorganic As - Solid	mg/kg			
Mercury Selective Sequential Extraction											
Hg(F0)		4	1		6.13	6.13	EPA 1631	ng/g			
Hg(F1)		4	4		797	5.2	BRL SOP No. BR-0013	ng/g			
Hg(F2)		4	3		38.7	1.54	BRL SOP No. BR-0013	ng/g			
Hg(F3)		4	4		1520	351	BRL SOP No. BR-0013	ng/g			
Hg(F4)		4	4		10700	343	BRL SOP No. BR-0013	ng/g			
Hg(F5)		4	4		831000	259	BRL SOP No. BR-0013	ng/g			
Hg(F6)		4	4		16200	32.5	BRL SOP No. BR-0013	ng/g			
Methylmercury											
Methylmercury	0.49	26	25	14	3.73	0.15	CAS SOP/EPA 1630	ng/g			
Total Organic Carbon											
Carbon, Total Organic (TOC)		56	56		2.3	0.086	SW9060M-Total Organic Carbon, Modified for Matrix	%	**0.34**	**0.86**	**0.086**

Key

Bold = detection

Gray shading = exceedance of background

% = percent

BRL = Brooks Rand Labs

CAS = Chemical Abstract Service

EPA = United States Environmental Protection Agency

Hg = mercury

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ng/g = nanograms per gram

SOP = standard operating procedure

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is an estimated value.

Table 4-34 Blueberry Leaves and Stems Vegetation Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	SM18	SM24
							Sample ID		11SM18BL	11SM24BL
Analyte							Method		Blueberry Leaves and Stems	Blueberry Leaves and Stems
Total Metals										
Aluminum	56.7	2	2	2	64.6	59.7	SW6010B	mg/kg dry weight	**59.7**	**64.6**
Antimony	0.441	2	2	0	0.131	0.096	SW6020A	mg/kg dry weight	**0.096 J**	**0.131 J**
Arsenic	0.16	2	2	0	0.15	0.08	SW6020A	mg/kg dry weight	**0.15 J**	**0.08 J**
Barium	56.4	2	2	1	68	50.4	SW6020A	mg/kg dry weight	**68**	**50.4**
Beryllium	0.019	2	1	0	0.003	0.003	SW6020A	mg/kg dry weight	0.003 U	**0.003 J**
Cadmium	0.432	2	2	1	1.2	0.332	SW6020A	mg/kg dry weight	**1.2**	**0.332**
Calcium	3100	2	2	0	2430	2400	SW6010B	mg/kg dry weight	**2400**	**2430**
Chromium	ND	2	1	1	0.2	0.2	SW6010B	mg/kg dry weight	**0.2 J**	0.2 U
Cobalt	0.105	2	2	0	0.099	0.035	SW6020A	mg/kg dry weight	**0.035**	**0.099**
Copper	7.87	2	2	0	5.97	3.58	SW6020A	mg/kg dry weight	**3.58**	**5.97**
Iron	37.3	2	2	0	25.6	20.3	SW6010B	mg/kg dry weight	**20.3**	**25.6**
Lead	0.085	2	2	0	0.067	0.061	SW6020A	mg/kg dry weight	**0.061**	**0.067**
Magnesium	1360	2	2	0	1120	902	SW6010B	mg/kg dry weight	**902**	**1120**
Manganese	1530	2	2	1	1630	1430	SW6010B	mg/kg dry weight	**1430**	**1630**
Mercury	0.05	2	2	0	0.034	0.023	SW7471B	mg/kg dry weight	**0.034 J**	**0.023 J**
Nickel	2.01	2	2	1	6.68	1.89	SW6020A	mg/kg dry weight	**6.68**	**1.89**
Potassium	5080	2	2	0	4340	3930	SW6010B	mg/kg dry weight	**3930**	**4340**
Selenium	ND	2	0	0			SW7742	mg/kg dry weight	0.15 U	0.15 U
Silver	0.035	2	0	0			SW6020A	mg/kg dry weight	0.008 U	0.008 U
Sodium	17.5	2	2	0	12.9	12.2	SW6010B	mg/kg dry weight	**12.9 J**	**12.2 J**
Thallium	0.019	2	2	0	0.006	0.005	SW6020A	mg/kg dry weight	**0.005 J**	**0.006 J**
Vanadium	0.07	2	2	0	0.03	0.03	SW6020A	mg/kg dry weight	**0.03 J**	**0.03 J**
Zinc	48.9	2	2	0	42.6	31.3	SW6020A	mg/kg dry weight	**31.3 J**	**42.6 J**
Total Solids										
Total Solids		2	2		36.9	34.7	60˚C Oven Dry	%	**36.9**	**34.7**
Methylmercury (ng/g)										
Methylmercury	ND	2	0	0			CAS SOP	ng/g dry weight	4 U	4 U

Key:

Bold = detection

% = percent

Gray shading = exceedance of background

CAS = Chemical Abstract Service

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ND = not detected

ng/g = nanograms per gram

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

˚C = Degrees Celsius

SOP = Standard operating procedure

Table 4-35 Green Alder Bark Vegetation Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP20	MP27	MP34	MP38	MP44	SM07	SM11	SM18
							Sample ID		11MP20GA	11MP27GA	11MP34GA	11MP38GA	11MP44GA	11SM07GA	11SM11GA	11SM18GA
Analyte							Method		Green Alder Bark	Green Alder Bark	Green Alder Bark	Green Alder Bark	Green Alder Bark	Green Alder Bark	Green Alder Bark	Green Alder Bark
Total Metals																
Aluminum	8.7	8	8	5	24.2	3.7	SW6010B	mg/kg dry weight	**8**	**8.4**	**9.2**	**12.2**	**3.7**	**17.3**	**24.2**	**9.7**
Antimony	0.139	8	7	7	3.35	0.165	SW6020A	mg/kg dry weight	**1.96 J**	**3.35 J**	**0.635 J**	**2.58 J**	**0.435 J**	**0.375 J**	0.009 U	**0.165 J**
Arsenic	0.1	8	7	7	0.91	0.13	SW6020A	mg/kg dry weight	**0.26**	**0.43**	**0.91**	**0.35**	**0.23 J**	**0.47 J**	0.06 U	**0.13 J**
Barium	34	8	8	7	203	2.35	SW6020A	mg/kg dry weight	**117**	**51.1**	**2.35**	**86.1**	**46.5**	**167**	**203**	**181**
Beryllium	ND	8	4	4	0.015	0.005	SW6020A	mg/kg dry weight	0.003 U	0.003 U	**0.013 J**	0.003 U	**0.005 J**	**0.015 J**	0.003 U	**0.007 J**
Cadmium	0.029	8	6	5	0.129	0.014	SW6020A	mg/kg dry weight	**0.036**	0.003 U	**0.014 J**	0.003 U	**0.056**	**0.107**	**0.061**	**0.129**
Calcium	5070	8	8	5	10800	4560	SW6010B	mg/kg dry weight	**5350**	**5050**	**5990**	**4650**	**4560**	**10300**	**5980**	**10800**
Chromium	1.1	8	2	1	1.4	0.3	SW6010B	mg/kg dry weight	0.2 U	**1.4 J**	0.2 U	**0.3 J**	0.2 U	0.2 U	0.2 U	0.2 U
Cobalt	0.079	8	8	6	0.528	0.064	SW6020A	mg/kg dry weight	**0.148**	**0.064**	**0.191**	**0.267 J**	**0.074**	**0.528**	**0.177**	**0.171**
Copper	6.4	8	8	1	6.64	4.33	SW6020A	mg/kg dry weight	**6.28**	**4.62**	**5.22**	**5.52**	**5.19**	**6.64**	**5.59**	**4.33**
Iron	27.9	8	8	3	34.9	17.6	SW6010B	mg/kg dry weight	**19.3**	**34.9**	**24.5**	**30.6**	**17.6**	**32.2**	**18.7**	**19.9**
Lead	0.07	8	8	4	0.113	0.06	SW6020A	mg/kg dry weight	**0.066**	**0.067**	**0.113**	**0.108**	**0.06**	**0.102**	**0.068**	**0.106**
Magnesium	637	8	8	4	967	529	SW6010B	mg/kg dry weight	**537**	**871**	**967**	**965**	**731**	**582**	**630**	**529**
Manganese	229	8	8	6	1140	91.2	SW6010B	mg/kg dry weight	**602**	**91.2**	**477**	**197**	**707**	**1140**	**245**	**462**
Mercury	0.056	8	8	4	0.289	0.017	SW7471B	mg/kg dry weight	**0.157**	**0.243**	**0.289 J**	**0.252**	**0.027 J**	**0.043 J**	**0.036**	**0.017 J**
Nickel	0.32	8	8	8	4.15	0.72	SW6020A	mg/kg dry weight	**2.17**	**0.72**	**3.47**	**1.93**	**2.42**	**4.15**	**0.96**	**2.66**
Potassium	2760	8	8	0	2610	1530	SW6010B	mg/kg dry weight	**1680**	**2090**	**2220**	**2010**	**2610**	**2150**	**2070**	**1530**
Selenium	ND	8	1	1	0.22	0.22	SW7742	mg/kg dry weight	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.03 U	**0.22 J**
Silver	ND	8	1	1	0.193	0.193	SW6020A	mg/kg dry weight	**0.193**	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
Sodium	51.3 J	8	8	0	17	9.8	SW6010B	mg/kg dry weight	**12.7 J**	**15.4 J**	**13.4 J**	**12.9 J**	**12.2 J**	**14.1 J**	**17 J**	**9.8 J**
Thallium	ND	8	4	4	0.03	0.006	SW6020A	mg/kg dry weight	0.002 U	0.002 U	**0.013 J**	0.002 U	**0.008 J**	**0.03**	0.002 U	**0.006 J**
Vanadium	0.05	8	8	5	0.07	0.03	SW6020A	mg/kg dry weight	**0.06**	**0.05**	**0.06 J**	**0.07**	**0.03 J**	**0.06 J**	**0.07**	**0.04 J**
Zinc	66.9 J	8	8	1	108	35.9	SW6020A	mg/kg dry weight	**43.7**	**42.4**	**35.9 J**	**43.5**	**54.9 J**	**108 J**	**43.4**	**49 J**
Total Solids																
Total Solids		8	8		41.1	30.8	60˚C Oven Dry	%	**41.1**	**36.4**	**33.5**	**38.8**	**32.6**	**30.8**	**31.9**	**40.1**
Methylmercury (ng/g)																
Methylmercury	ND	4	0	0			CAS SOP	ng/g dry weight		3.7 U	4 U			4 U	4 U	

Key:

Bold = detection

Gray shading = exceedance of background

% = percent

˚C = Degrees Celsius

CAS = Chemical Abstract Service

ID = identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ND = non detect

ng/g = nanograms per gram

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-36 White Spruce Needles Vegetation Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP20	MP31	MP34	MP38	MP91	SM07	SM11	SM18
							Sample ID		11MP20WS	11MP31WS	11MP34WS	11MP38WS	11MP91WS	11SM07WS	11SM11WS	11SM18WS
Analyte							Method		White Spruce Needles	White Spruce Needles	White Spruce Needles	White Spruce Needles	White Spruce Needles	White Spruce Needles	White Spruce Needles	White Spruce Needles
Total Metals																
Aluminum	68.8	8	7	1	172	5.1	SW6010B	mg/kg dry weight	**172**	**15**	**7.5**	**52.8**	**5.1**	0.4 U	**56.5**	**8.6**
Antimony	1.49	8	8	1	15.1	0.199	SW6020A	mg/kg dry weight	**0.667 J**	**1.22 J**	**0.686 J**	**15.1 J**	**0.343 J**	**0.226 J**	**0.199 J**	**0.573 J**
Arsenic	0.11	8	8	7	11.1	0.11	SW6020A	mg/kg dry weight	**0.82**	**0.71**	**0.41 J**	**11.1**	**0.23 J**	**0.31**	**0.11 J**	**0.13**
Barium	80.4	8	8	1	85.3	4.16	SW6020A	mg/kg dry weight	**70.8**	**14.4**	**4.16**	**36.2**	**37.4**	**57.1**	**23**	**85.3**
Beryllium	0.007	8	2	2	0.008	0.008	SW6020A	mg/kg dry weight	**0.008 J**	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	**0.008 J**	0.003 U
Cadmium	0.032	8	8	5	0.191	0.01	SW6020A	mg/kg dry weight	**0.069**	**0.191**	**0.028**	**0.017**	**0.052**	**0.053**	**0.01 J**	**0.043**
Calcium	7590	8	8	1	9920	3940	SW6010B	mg/kg dry weight	**9920**	**5790**	**6710**	**4650**	**3940**	**6810**	**4650**	**6610**
Chromium	ND	8	4	4	1.3	0.5	SW6010B	mg/kg dry weight	**0.5 J**	0.2 U	0.2 U	**1.3 J**	0.2 U	**0.7 J**	0.2 U	**0.8**
Cobalt	0.094	8	8	6	0.303	0.051	SW6020A	mg/kg dry weight	**0.303**	**0.258**	**0.224**	**0.217**	**0.074**	**0.14**	**0.051**	**0.106**
Copper	2.335	8	8	3	4.42	1.22	SW6020A	mg/kg dry weight	**4.42**	**2.41**	**2.13**	**2.26**	**2.77**	**2.04**	**1.32**	**1.22**
Iron	24.96	8	8	5	206	20.1	SW6010B	mg/kg dry weight	**201**	**31.8**	**23.3**	**206**	**20.2**	**29.4**	**29.9**	**20.1**
Lead	0.044	8	8	4	0.466	0.02	SW6020A	mg/kg dry weight	**0.466**	**0.05**	**0.053**	**0.128**	**0.027 J**	**0.02**	**0.039 J**	**0.034**
Magnesium	988	8	8	0	958	548	SW6010B	mg/kg dry weight	**958**	**548**	**773**	**894**	**904**	**637**	**683**	**600**
Manganese	1590	8	8	1	2990	162	SW6010B	mg/kg dry weight	**1340**	**2990**	**963**	**162**	**218**	**810**	**312**	**589**
Mercury	0.056	8	8	4	5.64	0.032	SW7471B	mg/kg dry weight	**0.641 J**	**0.965**	**0.264 J**	**5.64**	**0.036 J**	**0.04**	**0.032 J**	**0.05**
Nickel	1.39	8	8	6	6.35	0.67	SW6020A	mg/kg dry weight	**5.23**	**4.28**	**3.26**	**4.35**	**1.29**	**4.02**	**0.67**	**6.35**
Potassium	5930	8	8	3	7740	3450	SW6010B	mg/kg dry weight	**4300**	**5700**	**6090**	**7000**	**7740**	**4030**	**3450**	**4500**
Selenium	ND	8	0	0			SW7742	mg/kg dry weight	0.15 U	0.03 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
Silver	0.154	8	7	0	0.114	0.016	SW6020A	mg/kg dry weight	**0.016 J**	**0.029**	**0.016 J**	**0.114**	**0.016 J**	**0.034**	0.008 U	**0.043**
Sodium	13.5	8	8	2	24.8	5	SW6010B	mg/kg dry weight	**24.8 J**	**13.9 J**	**8.6 J**	**6.2 J**	**6 J**	**7.1 J**	**9.5 J**	**5 J**
Thallium	0.015	8	2	1	0.021	0.005	SW6020A	mg/kg dry weight	0.002 U	0.002 U	0.002 U	**0.021 J**	**0.005 J**	0.002 U	0.002 U	0.002 U
Vanadium	0.05	8	8	2	0.47	0.03	SW6020A	mg/kg dry weight	**0.47**	**0.05**	**0.04 J**	**0.21**	**0.03 J**	**0.03**	**0.04 J**	**0.03**
Zinc	54.8	8	8	0	53.2	18.4	SW6020A	mg/kg dry weight	**44.8 J**	**19.4**	**18.4 J**	**44.7**	**53.2 J**	**35.6**	**19 J**	**48.5**
Total Solids																
Total Solids		8	8		40.4	28.7	60˚C Oven Dry	%	**28.7**	**31.7**	**37.1**	**39.6**	**32.3**	**36.6**	**36.2**	**40.4**
Methylmercury (ng/g)																
Methylmercury	ND	4	0	0			CAS SOP	ng/g dry weight	3.9 U		3.9 U			3.7 U	4 U	

Key:
Bold = detection
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˚C = Degrees Celsius
CAS = Chemical Abstract Service
ID - identifier
J = The analyte was detected. The associated result is estimated.
mg/kg = milligrams per kilogram
ND = not detected
ng/g = nanograms per gram
SOP = Standard Operating Procedure
U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-37 Horestail Pond Vegetation Results	Background Screening Criteria	No. of Samples	No. of Detections	No. of Detected Results Exceeding Background	Maximum Detected Value	Minimum Detected Value	Station ID	Units	MP84	MP85	MP86	MP87
							Sample ID		11MP84PV	11MP85PV	11MP86PV	11MP87PV
Analyte							Method		Horsetail Pond Veg	Horsetail Pond Veg	Horsetail Pond Veg	Horsetail Pond Veg
Total Metals												
Aluminum	292	4	4	0	74.3	8.3	SW6010B	mg/kg dry weight	**74.3**	**12.2**	**8.3**	**54.6**
Antimony	1.05	4	4	4	97.4	4.92	SW6020A	mg/kg dry weight	**4.92 J**	**42.2 J**	**97.4 J**	**71.3 J**
Arsenic	3.23	4	4	4	309	32.1	SW6020A	mg/kg dry weight	**32.1**	**175**	**309**	**72.5**
Barium	120	4	4	0	30	18.2	SW6020A	mg/kg dry weight	**28.2**	**18.2**	**23.1**	**30**
Beryllium	0.013 J	4	4	0	0.006	0.003	SW6020A	mg/kg dry weight	**0.006 J**	**0.003 J**	**0.004 J**	**0.005 J**
Cadmium	0.053	4	4	1	0.22	0.009	SW6020A	mg/kg dry weight	**0.22**	**0.017 J**	**0.009 J**	**0.01 J**
Calcium	20300	4	4	0	15700	13300	SW6010B	mg/kg dry weight	**13300**	**15700**	**14100**	**14700**
Chromium	0.5 J	4	1	0	0.2	0.2	SW6010B	mg/kg dry weight	0.2 U	0.2 U	**0.2 J**	0.2 U
Cobalt	0.77	4	4	1	0.886	0.308	SW6020A	mg/kg dry weight	**0.438**	**0.886**	**0.308**	**0.62**
Copper	5.02	4	4	2	9.62	3.4	SW6020A	mg/kg dry weight	**9.62**	**5.48**	**3.4**	**3.67**
Iron	618	4	4	0	282	124	SW6010B	mg/kg dry weight	**282**	**124**	**163**	**177**
Lead	0.207	4	4	4	1.18	0.32	SW6020A	mg/kg dry weight	**1.18**	**0.395**	**0.32**	**0.472**
Magnesium	6020	4	4	4	13400	6340	SW6010B	mg/kg dry weight	**6340**	**9870**	**13400**	**9990**
Manganese	1480	4	4	0	199	46.8	SW6010B	mg/kg dry weight	**199**	**145**	**46.8**	**71**
Mercury	0.071 J	4	4	4	3.17	0.78	SW7471B	mg/kg dry weight	**2.7 J**	**3.17 J**	**0.923 J**	**0.78 J**
Nickel	1.45	4	4	3	3.14	1.11	SW6020A	mg/kg dry weight	**1.11**	**3.09**	**3.14**	**3.06**
Potassium	15300	4	4	4	39500	15400	SW6010B	mg/kg dry weight	**22300**	**39500**	**30300**	**15400**
Selenium	0.18 J	4	1	1	0.81	0.81	SW7742	mg/kg dry weight	**0.81**	0.15 U	0.15 U	0.15 U
Silver	0.048	4	0	0			SW6020A	mg/kg dry weight	0.008 U	0.008 U	0.008 U	0.008 U
Sodium	2010	4	4	0	377	56	SW6010B	mg/kg dry weight	**377**	**76.8**	**57.1**	**56**
Thallium	0.018 J	4	4	3	0.083	0.017	SW6020A	mg/kg dry weight	**0.017 J**	**0.066**	**0.083**	**0.026**
Vanadium	0.73	4	4	0	0.29	0.05	SW6020A	mg/kg dry weight	**0.29**	**0.05 J**	**0.09 J**	**0.17 J**
Zinc	38.2 J	4	4	3	55.7	36	SW6020A	mg/kg dry weight	**55.7 J**	**45 J**	**36 J**	**44.2 J**
Total Solids												
Total Solids		4	4		25.8	10.3	60˚C Oven Dry	%	**10.3**	**15.9**	**19**	**25.8**
Methylmercury (ng/g)												
Methylmercury	ND	1	1	1	6.9	6.9	CAS SOP	ng/g dry weight	**6.9 J**			

Key:

Bold = detection

Gray shading = exceedance of background

% = percent

˚C = Degrees Celsius

CAS = Chemical Abstract Service

ID - identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ND = not detected

ng/g = nanograms per gram

SOP = Standard Operating Procedure

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

Table 4-38 **2012 Blueberry Fruit Vegetation Results**	**Background Screening Criteria**	**No. of Samples**	**No. of Detections**	**No. of Detected Results Exceeding Background**	**Maximum Detected Value**	**Minimum Detected Value**	**Station ID**		**Units**	**SM24**
							Sample ID			**12SM24BF**
Analyte							**Method**			
Total Inorganic Elements										
Aluminum	840	1	1	0	410	410	SW846 6020	Metals (ICP/MS)	mg/kg	**410**
Antimony	1.4	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.33 U
Arsenic	4.4	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	1.4 U
Barium	20	1	1	0	10	10	SW846 6020	Metals (ICP/MS)	mg/kg	**10**
Beryllium	ND	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.18 U
Cadmium	0.14	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.064 U
Calcium	2100	1	1	0	1200	1200	SW846 6020	Metals (ICP/MS)	mg/kg	**1200**
Chromium	1.8	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.9 U
Cobalt	0.84	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.15 U
Copper	7.2	1	1	0	4.1	4.1	SW846 6020	Metals (ICP/MS)	mg/kg	**4.1**
Iron	2100	1	1	0	410	410	SW846 6020	Metals (ICP/MS)	mg/kg	**410**
Lead	0.32	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.1 U
Magnesium	1100	1	1	0	650	650	SW846 6020	Metals (ICP/MS)	mg/kg	**650**
Manganese	330	1	1	0	170	170	SW846 6020	Metals (ICP/MS)	mg/kg	**170**
Mercury	0.053	1	0	0			SW846 7471A	Mercury (CVAA)	mg/kg	0.038 U
Nickel	2.8	1	1	0	0.98	0.98	SW846 6020	Metals (ICP/MS)	mg/kg	**0.98**
Potassium	10000	1	1	0	6600	6600	SW846 6020	Metals (ICP/MS)	mg/kg	**6600**
Selenium	ND	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	1.6 U
Silver	ND	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	0.096 U
Sodium	21.8	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	310 U
Thallium	ND	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	1 U
Vanadium	0.06	1	0	0			SW846 6020	Metals (ICP/MS)	mg/kg	3.8 U
Zinc	37	1	1	0	14	14	SW846 6020	Metals (ICP/MS)	mg/kg	**14**

Key:

Bold = detection

Gray shading = exceedance of background

% = percent

CVAA = cold vapor atomic absorption

ICP-MS = inductively coupled plasma - mass spectrometry

ID - identifier

J = The analyte was detected. The associated result is estimated.

mg/kg = milligrams per kilogram

ND = not detected

U = The analyte was analyzed for but not detected. The value provided is the reporting limit.

5

Contaminant Fate and Transport

This chapter presents information on the fate and transport of the contaminants discussed in Chapter 4. The fate and transport discussion is based on site observations and measurements, as well as analytical tests run on selected samples collected during the RI field investigations. The discussion of fate and transport is focused on the principal COPCs at the site. This chapter provides an evaluation of the physical and chemical processes of the primary contaminant release and migration mechanisms at the RDM. A conceptual site model that includes these mechanisms is provided in Chapter 6.

5.1 Wind Transport and Deposition

Contaminants contained in or adsorbed to tailing/waste rock, flotation tailings, and/or soil can be transported both within a site and offsite as windblown particles. The potential for aeolian (wind) transport of contaminated particles is dependent on snow cover, vegetative cover, soil moisture, and grain size distribution of the soil exposed to wind action. No field studies were performed during the RI field investigations to quantify wind transport of contaminants. It is assumed that this contaminant migration mechanism is minor in comparison to other migration mechanisms at the RDM based on the following factors:

- The ground surface at the site is covered with snow for approximately seven months of the year.
- Much of the ground surface at the site is vegetated.
- Much of the surface that is not vegetated, including much of the Main Processing Area, is covered with coarse-grained material.

Assessment of potential risk associated with this mechanism is summarized in Chapter 6.

5.2 Volatilization and Emission

One pathway for release of mercury from both naturally enriched areas and anthropogenic sources, including mercury-contaminated sites, is emission to the atmosphere. Such emissions are an important part of the bio-geochemical cycle of mercury, which includes volatilization of mercury from the lithosphere and hydrosphere, transport in the atmosphere, wet and dry deposition to land and surface water, sorption to soil and sediment particulates, re-volatilization from land and surface water, and bioaccumulation in both terrestrial and aquatic food chains (e.g., ATSDR 1999). Forms of mercury that may be volatilized and emitted include elemental mercury (Hg(0)), dimethylmercury, and Hg^{2+} as $HgCl_2$, $HgBr_2$, or $HgOH_2$ (e.g., ATSDR 1999; Nacht et al. 2004). Mercury salts and organic mercury compounds are far less volatile than liquid mercury under most conditions (ATSDR 1999).

Mercury fluxes to the atmosphere from mineralized areas can range from background rates of 0 to 15 nanograms per square meter per hour to tens of thousands of nanograms per square meter per hour. Mercury emissions are influenced by light, temperature, precipitation, and substrate mercury concentration and occur during both day and night. Light-enhanced emissions are driven by desorption of elemental mercury accumulated at the soil: air interface and photo reduction of mercury containing phases. The contributions of atmospheric mercury from small areas of mining disturbance with relatively high mercury concentrations are generally less than those from surrounding large areas of low levels of mercury enrichment (Gustin et al. 2003).

No field studies were performed during the RI to quantify volatilization and emission of mercury. Although volatilization of mercury from mine waste and naturally mineralized materials at the RDM are likely a source of mercury to the atmosphere, the resulting mercury levels are not expected to pose a risk to human health or ecological receptors.

5.3 Mobility of Inorganic Elements

Leaching is the process by which inorganic elements are released from the solid phase into the aqueous phase by dissolution and desorption processes. Leaching of inorganics from contaminant sources is occurring at the RDM. Leaching of inorganic elements from naturally mineralized bedrock and soil also is occurring.

In general, the potential for leaching of inorganic elements is related to the solubility of the various forms of the element, the amount of water (rain and snowmelt) percolating through the materials containing the elements, pH and oxidation-reduction (redox) potential, tendencies of various species of the elements to form complexes and adsorb to solids materials, and microbiological activity. The amounts of inorganic elements leached to groundwater are controlled primarily by the amounts of the elements present; rate of release; hydrologic factors such as dispersion, advection, and dilution; and geochemical processes such as interrelated processes of redox, adsorption-desorption, and precipitation/dissolution, and aqueous speciation.

Some of the inorganic elements present at the RDM are in the form of sulfide minerals formed as a result of the hydrothermal mineralization that gave rise to the Red Devil ore deposit. These sulfide minerals are present in mine wastes as well as naturally mineralized bedrock and soil.

Specific factors controlling release and migration of inorganic elements in sulfide minerals include presence and flux of water and oxygen, which are required for oxidation reactions that dissolve sulfide minerals. These factors are controlled by hydrogeologic/hydrologic factors such as diffusion of oxygen, flow of oxygenated groundwater, and fluctuation of the water table. Other factors associated with oxidation of sulfide minerals are ferric iron; bacteria that catalyze the oxidation reactions; heat generated from the exothermic oxidation reactions; mineralogy of the sulfides and the materials in which oxidation is occurring; and acid neutralization reactions.

The flow pathways of both groundwater and surface water determine the chemical, physical, and biological environments in which leaching and mobilization of inorganic elements may occur. The groundwater flow pathways at the RDM are complex and include flow through fractured bedrock, overlying unconsolidated materials comprising mixed mine wastes and native soils and stream and river sediments, and a network of underground mine workings that underlie part of the site. Flow within the unconsolidated materials is further complicated by localized hydraulic segregation, variable gaining/losing conditions along Red Devil Creek, localized discharge from the underground mine workings, and seasonal variation in water levels and flow rates. Groundwater and surface water flow through each of the various environments results in various chemical impacts. As part of the RI, the various chemical impacts imparted by these environments were evaluated by integrating groundwater and surface water chemical data with the understanding of the physical groundwater/surface water flow framework and general and site-specific information on the chemical state and mobility of inorganics in mine wastes, bedrock, native soils, sediment, groundwater, and surface water.

General factors that affect mobility of mercury, arsenic, and antimony are summarized in Sections 5.3.1 through 5.3.3.

SPLP and TCLP analyses of soil and sediment materials were performed on RI samples to evaluate the leaching potential of selected site-related inorganic elements under slightly acidic conditions. SPLP and TCLP results are discussed in Section 5.3.4. Other analyses were performed to provide further insight into mobility as well as toxicity of arsenic and mercury. Mercury SSE analysis was performed on soil and sediment to better understand the solubility behavior of mercury in soil and sediment under a variety of chemical conditions. The SSE results provide insight into the various chemical/mineralogical forms of mercury within RDM soils and sediments. Mercury SSE results are discussed in Section 5.3.5.

Methylmercury is the most toxic form of mercury. As noted in Section 5.3.1, factors controlling methylation of mercury are complicated. To better understand the processes of mercury methylation at the RDM and provide data for methylmercury concentrations in affected media, selected samples of various media were analyzed directly for methylmercury. Methylmercury results for sediment samples are discussed in Section 5.3.6. Methylmercury results for groundwater and surface water are discussed in Sections 5.4.6 and 5.6.2.4, respectively.

As noted in Section 5.3.2, one factor that affect the mobility of arsenic in the environment is arsenic speciation. In order to better understand the fate and transport of arsenic, selected samples of various media were analyzed directly for arsenic speciation. Arsenic speciation results for soil and sediment samples are discussed in Section 5.3.7. Arsenic speciation results for groundwater and surface water are discussed in Sections 5.4.5 and 5.6.2.3, respectively.

5.3.1 Occurrence and Processes and Factors Affecting Mobility of Mercury

This section summarizes general information on occurrence and solubility and mobility of mercury in the environment. Numerous studies on this subject have been published. Except as noted, the information in this section is adapted from one recent literature review of such studies presented by Barringer et al. (2013). The information is presented for the purpose of providing background information on the many mechanisms and factors that affect mercury mobility in the environment. Where these general mechanisms or factors are thought to be specifically applicable to the RDM based on RI data, they are discussed in the sections that follow.

Occurrence of Mercury

In general, concentrations of mercury in rocks of the upper continental crust typically range over several orders of magnitude. Hydrothermal mineralization, such as that which formed the Red Devil Mine mineral body, locally results in deposition of mercury minerals at concentrations significantly higher than seen in the host rocks. The most abundant mercury mineral in such deposits is cinnabar, a mercuric sulfide (HgS).

At the RDM, the predominant mercury species is cinnabar, the naturally occurring ore mineral that was targeted by mining. Occurrence of natural mercury mineralization at the RDM is discussed in detail in Section 4.1.7. Cinnabar was visually identified locally in tailings/waste rock materials in both the Pre-1955 and Post-1955 Main Processing Areas and Red Devil Creek Downstream Alluvial Area. Cinnabar also was visually identified in native soils, sluiced overburden, and sediment in Red Devil Creek and the Kuskokwim River. Elemental mercury ($Hg(0)$) was recovered by thermal processing of cinnabar ore at the mine. Elemental mercury was visually identified in RI soil samples associated with the former ore processing facilities. Methylmercury was detected in environmental media sampled as part of the RI. Other forms of mercury are expected to be present at the RDM. For example, iron oxide/hydroxide and clay are commonly seen on weathered surfaces of bedrock, soils, and waste rock. Mercury may be adsorbed onto these and other weathering products in a variety of soils and aquifer materials at the RDM. The various forms of mercury and their behavior in the environment are discussed further below.

Redox, precipitation-dissolution, aqueous complexation, and adsorption and desorption reactions strongly influence the fate and transport of mercury in the environment. Biogeochemical reactions also are of great importance to the fate and transport of mercury. Methylation of mercury results in the formation of methylmercury, which is significantly more toxic than inorganic forms of mercury. Characteristics of soils and sediments, including pH, carbon content, mineralogy, drainage properties, slope, and texture, all play a role in mercury mobility. These factors and processes are discussed further below.

Oxidation-Reduction

Mercury exists in the environment in three stable oxidation states: Hg(0), Hg(I), and Hg(II). The mercurous (Hg(I)) species is stable over a more limited range of conditions in sulfidic aqueous systems than it is when sulfur is absent. The mercury oxidation states and the various chemical forms that exist for each oxidation state vary in their toxicity as well as their solubility, their tendency to form complexes and adsorb, and their availability for microbial processes. As such, Redox reactions have a profound influence on mercury concentrations and mobility in groundwater. Both abiotic and biotic (primarily microbial) processes can drive mercury redox transformations.

Adsorption and Desorption

Iron geochemistry is intimately associated with mercury geochemistry. Studies show that Hg(II) (as a Hg-Cl complex) sorbs to pyrite (FeS_2) under anaerobic conditions, and Hg(II) sorbs to iron oxides at pH >5.5. Evidence from field studies, including some at mine sites, suggests that sorption of mercury to iron hydroxides serves to reduce the mobility of mercury in the aqueous environment. Formation of aqueous and solid-phase sulfides appears to control Hg(II) concentrations in tailings-contaminated sediments at some mines.

Complicating the attenuation of mercury by sorption to iron sulfides, Fe(II) hydroxides can be reductively dissolved by sulfide, resulting in the release of sorbed mercury. Similarly, experiments showed that, in the presence of sulfide (S^{2-}), Fe (III) was reduced and concentrations of dissolved mercury increased. Field examples also demonstrate that oxygen-depleted conditions led to reductive dissolution of iron hydroxides, resulting in release of sorbed Hg(II). The Fe(II) generated by this reduction reaction may adsorb to minerals where it could reduce Hg(II) to Hg(0). Studies show that Fe(II) within minerals also can reduce Hg(II) to Hg(0). Mercury as Hg(II) may be reduced in anoxic solutions by Fe(II) under varying pH conditions, with aqueous $Fe(OH)^+$ being the species that best described the electron transfer that occurred in the experiments. Metals other than iron, such as tin, are also known to reduce Hg(II) to Hg(0).

Natural organic matter has been shown to abiotically reduce Hg(II) to Hg(0). Experiments under dark anoxic conditions showed that dissolved organic matter (DOM) reduced Hg(II) to Hg(0) when low concentrations of DOM were present. At higher DOM concentrations, however, complexation of DOM and mercury inhibited mercury reduction reactions. Mercury complexation is discussed further below.

Microbially mediated redox reactions involving mercury also have been demonstrated. Hg(II) was reduced to gaseous Hg(0) by a *Pseudomonas* strain. A recently isolated *Bradyrhizobium* bacterium also was recently found to reduce Hg(II) to Hg(0).

Organic and Inorganic Complexation

Mercury (Hg(II)) can be present as $Hg(OH)_2$, $HgCl_2$, and other minor hydroxide (OH^-) and chloride (Cl^-) complexes, as well as in complexes with various organic anions, depending on pH, redox potential, chloride concentrations, and concentrations of DOM. It has been observed that where DOM is absent or present in low concentrations in fresh waters, mercury could be present as hydroxide and chloride complexes. At low to moderate pH and moderate to high chloride concentrations, chloride complexes would be most likely. In the presence of dissolved sulfide, mercury sulfide species may form.

Mercury tends to form strong complexes with S^{2-} and, in DOM, Hg(II) binds preferentially to sulfur-containing functional groups such as thiols.

In environments under anoxic conditions, mercury can form complexes such as dissolved HgS, HgS_2^{2-}, $Hg(SH)_2$, $HgSH^+$, HgOHSH, and HgClSH. Although metals typically bind to acid sites (carboxyls, phenols, ammonium, alcohols, and thiols), in organic matter Hg(II) binds preferentially to thiols and other reduced sulfur groups, forming strong covalent-like bonds. These sulfur-bearing groups are found in moderate abundance in organic matter in soils, in some surface water, and in wastewater. When the mercury/DOM ratio is high (e.g., greater than 10,000 nanograms (ng) mercury to 1 milligram of DOM), however, mercury also binds to the more abundant but less Hg-selective oxygen functional groups (i.e., carboxyl). Binding of Hg(II) with DOM is less strong at low pH than at high pH because the extent of protonation of functional groups serving as Hg(II) ligands on DOM increases as pH decreases. It has been shown that, due to the affinity of Hg(II) for thiol groups on DOM, DOM can dissolve cinnabar, inhibiting or preventing precipitation of metacinnabar and aggregation of HgS nanoparticles.

Methylation and Demethylation

An important transformation of inorganic mercury that affects the mobility and toxicity of mercury is methylation to methylmercury (including monomethylmercury or dimethylmercury) in soil, sediment, and waters. Methylmercury, a form of Hg(II), is the most common form of organic mercury and is soluble, mobile, and quickly enters the aquatic food chain. Methylmercury is substantially more toxic than other forms of mercury and is accumulated to a greater extent in biological tissue than are inorganic forms of mercury (ATSDR 1999). The processes of methylation are complex and not fully understood. Factors understood to affect methylation of mercury are total mercury concentrations, organic matter content, acid-volatile sulfide in sediment, and pH, dissolved organic carbon, and dissolved sulfate in water. Methylation of Hg(II) in soils and surface-water occurs under anoxic conditions by dissimilatory sulfate-reducing bacteria. Dissimilatory iron-reducing bacteria also are able to methylate

Hg(II). Populations of both types of bacteria have been found to coexist in stream-bottom sediments.

At low sulfate (SO_4^{2-}) concentrations, the methylating activity of sulfate-reducing bacteria is stimulated, but at high sulfate concentrations the methylating activity may be inhibited because precipitated sulfides may incorporate the mercury. However, the mercury in aqueous HgS complexes, which may form in the presence of dissolved sulfide, was found to be bioavailable to the methylating bacteria.

High concentrations of DOM and salinity also were shown to inhibit Hg(II) methylation because the Hg was complexed into forms that were not bioavailable to the methylating bacteria. The mercury in aqueous HgS complexes, which form in the presence of dissolved sulfide, was found to be bioavailable to the methylating bacteria, however. Although DOM can inhibit mercury bioavailability by complexing the mercury, DOM can also prevent HgS nanoparticles from aggregating, thereby leaving the HgS nanoparticles bioavailable.

Mercury demethylation also occurs in stream and lake sediments. In sediment experiments, demethylation of methylmercury was shown to be carried out by sulfidogenic and methanogenic bacteria, which are obligate anaerobes. One study showed that, although the mercury methylation process was inhibited by low pH (4.4) conditions, demethylation of methylmercury did not appear to be similarly affected for the pH range 4.4 to 8; however, inhibition of demethylation occurred at $pH < 4.4$.

Methylmercury was analyzed directly in sediment as well as groundwater and surface water samples as part of the RI. Methylmercury results for sediment samples are discussed in Section 5.3.6. Methylmercury results for groundwater and surface water are discussed in Sections 5.4.6 and 5.6.2.4, respectively.

Colloids and Particles

Formation of colloids in groundwater and surface water may provide a means of either immobilizing or facilitating transport for various contaminants. Sorption of Hg(II) onto stable and immobile aquifer solids can limit concentration and mobility of mercury in groundwater; on the other hand, if the Hg(II) binds to colloids under conditions where the colloids are stable and mobile, concentrations and mobility of Hg(II) in groundwater can increase. Because of their large surface area relative to their volume, small particles and colloids can provide many sorption sites for strongly sorbing contaminants whose mobility would otherwise be minimal through soils and groundwater. Movement of such colloids can be triggered by chemical or physical disturbance of soils and sediments.

Colloids can be formed by clay minerals; oxides and hydroxides of iron, aluminum, and manganese; silica; humic and fulvic acids; carbonates; phosphates; and bacteria and viruses. Colloids are found in surface water, soil, sediment pore waters, and groundwater. Changes in pH and redox reactions can cause dissolution or precipitation reactions that can form or release colloidal particles. For example, precipitation of colloidal iron hydroxide particles may occur when Fe(II) is oxidized. One study of an aquifer with mercury contamination found that colloids were more abundant in anoxic groundwater than in oxic groundwater. The greater abundance of colloids in that study likely occurred because iron hydroxide cements that bound clays to quartz-grain surfaces were dissolved, thereby liberating both Fe(II) and clay particles to solution. In aquifers with fluctuating water tables, some of the Fe(II) could be re-oxidized, forming colloidal precipitates.

In groundwater, colloids are subject to forces exerted by pumping. Further discussion of colloidal transport of contaminants in groundwater and surface water contaminant migration is presented in Sections 5.4 and 5.6, respectively.

5.3.2 Occurrence and Processes and Factors Affecting Mobility of Arsenic

This section summarizes general information on occurrence and solubility and mobility of arsenic in the environment. Numerous studies on the occurrence and solubility and mobility of arsenic in the environment have been published. Except as noted, the information presented below is adapted from ATSDR (2007), Nordstrom (2007), and Hinkle and Polette (1999). The information is presented for the purpose of providing background information on the many mechanisms and factors that affect arsenic mobility in the environment. Where these mechanisms or factors are thought to be specifically applicable to the RDM based on RI data, they are discussed in the sections that follow.

Occurrence of Arsenic

In general, arsenic is widely distributed in the earth's crust, occurring in several hundred arsenic-bearing minerals, including arsenides (X As), arsenites ($XAsO_3Y$), arsenates ($XAsO_4Y$), arsenic sulfides (X AsS), and sulfosalts. The primary source of arsenic in the environment is the weathering of arsenic containing rocks. The concentrations of arsenic in soil and sedimentary rocks are generally higher than the average in the earth’s crust due to movement and concentration of the arsenic as a result of weathering. Arsenic commonly is preferentially concentrated in shales relative to other major rock types, reflecting its tendency to adsorb to clay minerals. As with mercury, hydrothermal processes may mobilize arsenic from sedimentary and volcanic rocks, concentrating arsenic in hydrothermal fluids and resulting hydrothermal mineral deposits. Such mineral deposits often contain sulfide minerals. Arsenic is commonly present as an impurity in arsenian pyrite, a common iron sulfide (FeS_2), due to its strong affinity for the sulfur site in pyrite. Other arsenic-rich minerals include arsenopyrite (FeAsS), realgar (As_4S_4), orpiment (As_2S_3), and enargite (Cu_3AsS_4). Arsenic trioxide (As_2O_3) is commonly produced as a by-product of mining and processing of sulfide ore deposits.

In soil, arsenic generally is found as a complex mixture of mineral phases, including sulfides, co-precipitated and sorbed species, and dissolved species. The various oxidation states and chemical species present depend upon the original soil mineralogy, soil pH, and redox potential, discussed further below. Arsenic typically exists in the environment in two valence states: As^{3+}, or arsenic (III); and As^{5+} or arsenic (V). Under most environmental conditions, inorganic As(V) will exist as a mixture of arsenate oxyanions, $H_2AsO_4^-$ and $HAsO_4^{-2}$, and inorganic As(III) will exist as the neutrally charged arsenite species H_3AsO_3. In the arsenic sulfide species realgar (As_4S_4) and orpiment (As_2S_3), arsenic is in the As^{3+} valence state. Arsenic is also in the As^{3+} valence state in arsenic trioxide.

Arsenic may be bound onto sediment or soil materials, particularly clays, iron oxides/hydroxides, aluminum hydroxides, manganese compounds, and organic material. Arsenate commonly is bound to minerals such as ferrihydrite and alumina, limiting its mobility and bioavailability. Arsenite commonly partitions to the aqueous phase in anoxic environments and is generally more mobile. In general, arsenate is predominant under oxidizing conditions, and arsenite is predominant under reducing conditions. Arsenite is moderately unstable in the presence of oxygen; however, it can be found under aerobic conditions as well. Although arsenate is strongly sorbed by soils under aerobic conditions, it is rapidly desorbed as the system becomes anaerobic. Once it is desorbed, arsenate can be reduced to arsenite, increasing its mobility. Organic arsenic species in soil include the comparably less toxic methyl arsenates monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA).

At the RDM, sulfide species realgar and orpiment were reported in historical mine operations reports and visually identified during the RI in tailings/waste rock materials in both the Pre-1955 and Post-1955 Main Processing Areas. As noted in Sections 1.4.2.2, 1.4.2.3, and 3.1.2, thermal processing of cinnabar ore that contained, at times, stibnite, along with some arsenic sulfides realgar and orpiment, generated antimony and arsenic oxides as part of the furnacing and condensing process. During the RI, brown glassy material was visually identified locally in tailings/waste rock materials in both the Pre-1955 and Post-1955 Main Processing Areas; the nature of this material is not certain, but it appears likely that it represents arsenic-antimony oxide glass. Iron oxide/hydroxide and clay are commonly seen on weathered surfaces of bedrock, soils, and mine wastes. Arsenic is likely a component of, or adsorbed (as arsenite and arsenate) onto these and other weathering products at the RDM. Both arsenite and arsenate species are present in groundwater and surface water. Speciation of arsenic in various media at the RDM is discussed further below.

The solubility of arsenic in soil depends in large part on the distribution of arsenic between the various mineral phases as well as by particle size. The distribution between these mineral phases may depend on the original source of the arsenic and may vary as a result of weathering and associations with iron and manganese oxides and phosphate minerals in the soil. Transformations between the various oxidation states and species of arsenic occur as a result of biotic or abiotic processes, discussed further below.

In groundwater and surface water, as in soil, inorganic arsenic occurs primarily as As(V) in the form of arsenate oxyanions $H_2AsO_4^-$ or $HAsO_4^{2-}$, or as As(III) in the form of the arsenite species $H_3AsO_3^0$. Arsenic in both valence states generally co-exist, although As(V) predominates under oxidizing conditions and As(III) predominates under reducing conditions. The main organic arsenic species in fresh water are the less toxic methyl arsenates MMA and DMA.

In general, the mobility of arsenic in the environment and the toxicity of arsenic compounds vary depending their valence state; whether the arsenic is in organic or inorganic form; physical state (e.g., gas, solution, powder, or mineral solid); and factors such as solubility, particle size, rates of absorption and elimination, and presence of impurities. The processes controlling mobility of arsenic are redox reactions, adsorption-desorption reactions, precipitation-dissolution reactions, and biotransformation. The factors that most strongly influencing these processes in water include redox state, pH, metal sulfide and sulfide ion concentrations, iron concentrations, temperature, salinity, distribution and composition of the biota, season, and the nature and concentration of natural organic matter. Arsenic adsorption and desorption reactions are affected by pH, redox, concentrations of competing anions, and solid-phase structural changes at the atomic level. Precipitation and dissolution are controlled by solution chemistry, including pH, redox state, and solid chemical composition. These interrelated factors and processes are discussed further below.

Oxidation-Reduction

Redox reactions transform arsenic from As(III) to As(V) and vice versa. Transformations between the various oxidation states and species of arsenic may occur as a result of biotic or abiotic processes. As noted above, within the range of pH of most groundwater, As(V) exists in the form of arsenate oxyanions $H_2AsO_4^-$ or $HAsO_4^{2-}$, whereas As(III) exists in the form of the neutrally charged arsenite species $H_3AsO_3^0$. The tendencies of each of these species to adsorb to solid-phase surfaces in water vary in part because of these differences in charge. Reduction of arsenate to arsenite may result in increased arsenic mobility because arsenite is generally less strongly adsorbed than is arsenate. Adsorption and desorption are discussed further below.

Adsorption and Desorption

Arsenate and arsenite both adsorb to surfaces of a variety of solid phase materials in aquifers, including iron oxides, aluminum oxides, and clay minerals. Arsenate adsorbs strongly to iron oxide surfaces in acidic and circum-neutral pH water. However, under alkaline pH conditions, arsenate tends to desorb from iron oxide surfaces. Adsorption of arsenite to iron oxide surfaces is generally weaker than for arsenate under typical environmental pH conditions. Adsorption of arsenite to iron oxide surfaces tends to decrease as pH increases within the range of pH 6 to 9.

Dissolution and Precipitation

Arsenic may occur within solid phase materials, either as a primary structural component (e.g., mineral lattice of arsenic sulfide minerals (e.g., realgar, orpiment, or arsenopyrite), as a minor constituent in iron minerals (e.g., arsenial pyrite, iron oxide/hydroxide/oxyhydroxide) or other minerals. Such arsenic is released when those solid phases dissolve. Similarly, arsenic is removed from solution when solid phases precipitate and incorporate arsenic as a primary structural component or as an impurity. For example, arsenic often co-precipitates with iron oxide, which is a common source or sink of arsenic in groundwater and or surface water systems.

High concentrations of arsenic often are commonly associated with iron oxides and sulfide minerals. Iron oxides commonly dissolve under reducing conditions and precipitate under oxidizing conditions. Sulfide minerals generally are unstable under oxidizing conditions and may precipitate under reducing conditions. Therefore, transfer of arsenic between iron oxides and sulfides and water by precipitation and dissolution reactions may be a significant factor controlling the total concentration and mobility of arsenic in water.

5.3.3 Occurrence and Processes and Factors Affecting Mobility of Antimony

This section summarizes available general information on occurrence and solubility and mobility of antimony in the environment. Compared to many other elements, little is known about the environmental behavior of antimony, especially with respect to its mobility in soil and sediment. Except as noted, the information summarized in this section is adapted from Krupka and Serne (2002) and ATSDR (1992). The information is presented for the purpose of providing background information on the mechanisms and factors that affect antimony mobility in the environment. Where these general mechanisms or factors are thought to be specifically applicable to the RDM based on RI data, they are discussed in the sections that follow.

Occurrence of Antimony

Antimony generally occurs in in the earth's crust in low concentrations, but is commonly concentrated in mineral deposits such as the Red Devil Mine hydrothermal deposit. Antimony combines readily with other elements, including sulfur, to form over 100 different minerals. The most common antimony mineral is the sulfide stibnite (Sb_2S_3). The various forms of antimony and the transformations between these forms are poorly understood.

At the RDM, stibnite is common and was visually identified locally in tailings/waste rock in both the Pre-1955 and Post-1955 Main Processing Areas and the Red Devil Creek Downstream Alluvial Area. As noted in Sections 1.4.2.2, 1.4.2.3, and 3.1.2, thermal processing of cinnabar ore that contained, at times, stibnite, along with some arsenic sulfides realgar and orpiment, generated antimony and arsenic oxides as part of the furnacing and condensing process.

Brown glassy material was visually identified locally in tailings/waste rock materials in both the Pre-1955 and Post-1955 Main Processing Areas; it appears likely that this material is arsenic-antimony oxide glass.

In general, antimony is considered relatively mobile in the environment, particularly under oxic conditions. Under reducing conditions, antimony concentrations may be limited by the solubility of antimony sulfides, including stibnite. The interrelated factors and processes controlling solubility and mobility of arsenic in groundwater and surface water include valence state and adsorption and desorption reactions, discussed further below.

Oxidation-Reduction

Under natural environmental conditions, antimony exists in the Sb(V) (Sb^{+5}) or Sb(III) (Sb^{+3}) valence states. In natural aqueous systems, Sb(V) and Sb(III) are the stable oxidation states under oxidizing and reducing conditions, respectively. Under oxic conditions, the hydrolytic anion species $Sb(OH)_6^-$ is the dominant aqueous species over a large range of pH and redox conditions, specifically at pH values greater than approximately 2.5, and from oxidizing to slightly reducing conditions. At moderately reducing conditions, the speciation is dominated by the Sb(III) hydrolytic cation species $Sb(OH)_2^+$ at pH values less than 2, by $Sb(OH)_3^0$ (aqueous) at pH values from 2 to 12, and by the anion $Sb(OH)_4^-$ at pH values greater 12. Antimony associated with some types of ore deposits may form complexes with chloride and sulfide. Under reducing conditions in low temperature, chloride-rich, acidic aqueous solutions, the aqueous speciation of Sb(III) is dominated by complexes such as $SbCl_2^+$, $SbCl^{2+}$, $SbCl_3^0$ (aqueous), and $SbCl_4^-$. Under reducing conditions in the presence of dissolved sulfide at low chloride concentrations and low temperatures, sulfide species such as $HSb_2S_4^-$ and $Sb_2S_4^{2-}$ are dominant. Sb(V) sulfide complexes also may exist under reducing conditions.

Adsorption and Desorption

Little is known about the adsorption/desorption behavior of Sb(V) or Sb(III). However, the concentrations of antimony in soils and sediments are likely controlled by adsorption reactions to iron and aluminum compounds. Based on geochemical principles, some general trends can be expected for the adsorption-desorption behavior of antimony. Because adsorption of anions in general is coupled with a release of displaced OH^- ions, adsorption of anions is greatest at low pH where mineral surfaces are positively charged and decreases with increasing pH. On the other hand, the adsorption of cations generally is coupled with a release of displaced H^+ ions. Therefore, cation adsorption is greatest at high pH where mineral surfaces are negatively charged, and decreases with decreasing pH. As such, for antimony, the tendency to adsorb depends on the ionic species present. Because dissolved Sb(V) is present primarily as the anionic hydrolytic species $Sb(OH)_6^-$ over almost the entire pH range in oxic waters, the adsorption of Sb(V) to hydroxide and oxide mineral surfaces should range from limited to negligible as pH increases from circum-neutral to higher pH values. Under these conditions, antimony should be highly mobile in the geochemical environment. Mobility under other conditions is dependent on the other geochemical factors discussed above.

5.3.4 Leach Testing

Analyses of soil and sediment materials were performed on RI samples to directly evaluate the leaching potential of selected site-related contaminants under test conditions specified by the SPLP and TCLP. Results are discussed in the subsections below.

5.3.4.1 Synthetic Precipitation Leaching Procedure

The EPA SPLP was developed to evaluate mobility of organic and inorganic constituents in materials using a batch leach approach. The SPLP is generally regarded as the preferred technique for evaluating potential metals leaching of mine waste materials under slightly acidic conditions such as are seen locally and temporally at the RDM (see spring baseline groundwater monitoring results, Appendix A. Selected samples of surface and subsurface soil types were tested using the SPLP and analyzing the extract for TAL inorganic elements. Results of the SPLP tests are provided in Chapter 4 and summarized in Table 5-1. In addition to overall SPLP leachability, the ratios of SPLP concentrations and total metals concentrations are evaluated in order to assess relative leachability of mine wastes and soils. Key findings of these results are discussed below.

Antimony

The SPLP leachability and relative SPLP leachability of antimony in various mine waste materials and soil types were evaluated by soil type (as designated in Chapter 3) and geographic area. Key findings are illustrated in Figures 5-1 through 5-4) and summarized below.

- The soil types that exhibited the highest SPLP concentrations at the RDM are tailings/waste rock, followed by flotation tailings.
- Tailings/waste rock exhibited SPLP concentrations ranging up to 75,300 µg/L, with most results below 20,000 µg/L. SPLP concentrations are generally proportional to corresponding total antimony concentrations, which ranged up to 19,600 mg/kg (estimated). Flotation tailings SPLP results ranged up to 3,660 µg/L and are generally proportional to total antimony concentrations, which ranged up to 1,430 mg/kg.
- Native and disturbed native soils generally have lower total and SPLP concentrations than both tailings/waste rock and flotation tailings.
- A sample of tailings (calcine material, sample 10OP01SS) exhibited total and SPLP antimony concentrations of 3,520 mg/kg and 1,950 µg/L, respectively. The ratio of the SPLP concentration to the total antimony concentration in this sample is lower than for tailings/waste rock and flotation tailings samples.

Collectively, these observations suggest that tailings/waste rock and, to a lesser degree, flotation tailings, may be a significant source of antimony leaching at the RDM under slightly acidic conditions. Ratios of SPLP concentrations to total antimony concentrations in tailings/waste rock and flotation tailings are generally similar. The similarities may be partly attributable to the presence of stibnite in both of these waste types. This is consistent with information on historical mining operations indicating that stibnite was commonly mined along with cinnabar in Red Devil Mine ore. Attempts were made to separate stibnite from cinnabar prior to retorting and furnacing, including manual separation of waste rock and, during the final stage of mine operations, flotation. Reportedly, flotation was used after 1969 to generate cinnabar and stibnite concentrates (Buntzen and Miller 2004).

Information on the leachability of antimony in the tailings (calcines) component of tailings/waste is limited. However, based on the results of one calcine sample (10OP01SS), which exhibited lower relative SPLP leachability than for samples of mixed tailings/waste rock and flotation tailings, it appears that the antimony in tailings may be relatively less leachable than that in waste rock and flotation tailings. This is supported by information on the thermal ore processing at the mine. As noted in Sections 1.4.2.2, 1.4.2.3, and 3.1.2, antimony oxides formed as a result of thermal processing of cinnabar ore that contained, at times, large amounts of stibnite, along with some arsenic sulfides realgar and orpiment. Any antimony remaining in the tailings is likely in the form of arsenic-antimony glass generated as part of the furnacing and condensing process. Antimony contained in arsenic-antimony glass would be expected to be generally less leachable than other forms of antimony, at least in part, due to its physical state. Any antimony oxides in the form of dust present in the tailings/waste rock would likely be more leachable than oxides in the form of glass due to greater surface area subject to leaching.

Arsenic

The SPLP leachability and relative SPLP leachability of arsenic in various mine waste materials and soil types were evaluated by soil type (as designated in Chapter 3) and geographic area. Key findings are illustrated in Figures 5-5 through 5-8) and summarized below.

- The soil types exhibiting the highest SPLP arsenic concentrations at the RDM are tailings/waste rock, with concentrations ranging up to 6,000 µg/L. Corresponding total arsenic concentrations ranged up to 8,670 mg/kg.
- Both SPLP and total arsenic concentrations are generally higher for tailings/waste rock from the Post-1955 Main Processing Area than tailings/waste rock from the Pre-1955 Main Processing Area. The ratios of SPLP to total arsenic for tailings/waste rock from the Post-1955 Main Processing Area also are generally higher than those for tailings/waste rock from the Pre-1955 Main Processing Area.

- A sample of tailings (calcine material, sample 10OP01SS) exhibited total and SPLP arsenic concentrations of 4,430 mg/kg and 5,340 µg/L, respectively. The ratio of SPLP concentration to total arsenic concentration in this sample is similar to those for tailings/waste rock from the Post-1955 Main Processing Area.
- Flotation tailings SPLP arsenic results ranged up to 2,310 µg/L, with corresponding total arsenic concentrations ranging up to 9,880 mg/kg. The ratios of SPLP to total arsenic concentrations for flotation tailings are generally lower than those for tailings/waste rock.
- A sample of presumed stockpiled ore exhibited a SPLP arsenic concentration of 440 µg/L, corresponding to a total arsenic concentration of 7,310 mg/kg. The ratio of SPLP to total arsenic is similar to that for flotation tailings.
- Samples of surface soil from the mineralized zones in the Surface Mined Area exhibited SPLP arsenic concentrations ranging up to 560 µg/L, with corresponding total arsenic concentrations ranging up to 8,510 mg/kg. The ratios of SPLP to total arsenic are similar to those for stockpiled ore and flotation tailings.
- With several exceptions, disturbed native soils, sluiced overburden, and weathered bedrock in the surface mined area, exhibit lower total and SPLP arsenic concentrations than tailings/waste rock and flotation tailings. The ratios of SPLP to total arsenic vary widely but are typically low compared to tailings/waste rock.

Collectively, the observations noted above suggest that tailings/waste rock, particularly the tailings (calcines) component, is a significant source of arsenic leaching at the RDM under slightly acidic conditions. Tailings/waste rock from the Post-1955 Main Processing Area appears more leachable than tailings/waste rock at the Pre-1955 Main Processing Area. These observations are consistent with information regarding site geology and mine and ore processing operations. Some of the arsenic in the tailings (calcines) is likely in the form of arsenic oxides formed as a result of furnacing of cinnabar ore that contained impurities realgar and orpiment along with stibnite (see Sections 1.4.2.2, 1.4.2.3, and 3.1.2). Arsenic oxides generally exhibit greater solubility in dilute acid than arsenic sulfides realgar and orpiment.

Comparatively low ratios of SPLP to total arsenic for flotation tailings suggest that these waste materials are a less significant source of leaching at the RDM than tailings/waste rock. At least some of the arsenic in the flotation tailings is likely in the form of the comparably less leachable sulfides realgar and orpiment, which, unlike the arsenic in the calcines, did not undergo furnacing. The ratios of SPLP to total arsenic for samples of stockpiled ore and soil from the mineralized zones in the Surface Mined Area are also relatively low; as with the flotation tailings, at least some of the arsenic is likely in the form of realgar and orpiment.

The comparatively low SPLP concentrations and ratios of SPLP to total arsenic for most disturbed native soils in the Surface Mined Area and sluiced overburden suggest that these materials are a less significant source of arsenic leaching at the RDM than tailings/waste rock and other soil types.

Mercury

The SPLP leachability and relative SPLP leachability of mercury in various mine waste materials and soil types were evaluated by soil type (as designated in Chapter 3) and geographic area. Key findings are illustrated in Figures 5-9 through 5-12) and summarized below.

- All but four of the 73 samples analyzed for SPLP mercury had SPLP concentrations of 40 µg/L or lower.
- Tailings/waste rock exhibited the highest SPLP mercury concentrations, ranging up to 356 µg/L, with corresponding total mercury concentrations ranging up to 2,370 mg/kg (estimated). Ratios of SPLP to total mercury range over two orders of magnitude.
- A sample of tailings (calcine material, sample 10OP01SS) exhibited total and SPLP mercury concentrations of 170 mg/kg and 4.8 µg/L (estimated), respectively. The ratio of SPLP to total mercury in this sample is fairly low, near the low end of the range for those of tailings/waste rock samples.
- A sample of waste rock had total and SPLP mercury concentrations of 115 mg/kg and 0.2 µg/L, respectively. The ratio of SPLP to total mercury concentrations in this sample is lower than those for most tailings/waste rock samples.
- Flotation tailings SPLP mercury results ranged up to 7.42 µg/L, with corresponding total mercury concentrations ranging up to 214 mg/kg. The ratios of SPLP to total mercury concentrations for flotation tailings are generally similar to or lower than those for tailings/waste rock samples.
- Samples of surface soil from the mineralized zones in the Surface Mined Area exhibited SPLP mercury concentrations ranging up to 4.2 µg/L, with corresponding total mercury concentrations ranging up to 174 mg/kg. The ratios of SPLP to total mercury are similar to those for flotation tailings.
- With several exceptions, disturbed native soils, sluiced overburden, and weathered bedrock in the surface mined area, exhibit lower total and SPLP mercury concentrations than tailings/waste rock and flotation tailings. The ratios of SPLP to total mercury vary widely.

Collectively, the observations noted above suggest that mercury in tailings/waste rock and flotation tailings is considerably less leachable (in terms of proportion of the concentration leached under the SPLP to the total concentration) than antimony or arsenic under slightly acidic conditions. This is consistent with information regarding site geology and mine and ore processing operations. Cinnabar, the minimally soluble ore mineral at the mine, is likely the predominant form of mercury in most waste rock, flotation tailings, ore, and mineralized native and disturbed native soils. Calcines are expected to have had most of the mercury removed from them by the thermal processing in furnaces or retorts. Any remaining cinnabar present in these materials likely is minimally leached by the SPLP. Other forms of mercury, including comparably more soluble oxidized forms, may be present in calcines as well. Solubility of mercury in various mine wastes and soils at the RDM is further evaluated using an SSE procedure, discussed in Section 5.3.5.

5.3.4.2 Toxicity Characteristic Leaching Procedure

The EPA TCLP was designed to evaluate the mobility of organic and inorganic constituents under slightly acidic conditions in a sanitary landfill. Selected samples of surface and subsurface soil types were evaluated for TCLP metals. Results of the TCLP tests are provided in Chapter 4 and summarized in Table 5-1. The RCRA TCLP results are compared to regulatory limits for arsenic and mercury, 5,000 μg /L and 200 μg/L, respectively. Key findings are discussed below.

Arsenic

Arsenic TCLP results were evaluated by comparing to the RCRA regulatory limit. In addition, the relative leachability of arsenic in various mine waste materials and soil types was evaluated by comparing TCLP concentrations to total arsenic concentrations by soil type (as designated in Chapter 3) and geographic area. Key findings are illustrated in graphs provided in Figures 5-13 and 5-14, and summarized below:

- The soil types exhibiting the highest TCLP arsenic concentrations at the RDM are tailings/waste rock and tailings (calcines).
- Tailings/waste rock TCLP concentrations for samples in the Pre-1955 Main Processing Area included one result of 6,970 μg/L (exceeding the RCRA regulatory limit), one result of 2,800 μg/L, and the remainder at concentrations of 1,000 μg/L or less. Corresponding total arsenic concentrations ranged up to 4,460 mg/kg (estimated).
- Tailings/waste rock TCLP concentrations for samples in the Post-1955 Main Processing Area ranged as high as 15,700 μg/L, with most results between 5,000 and 10,000 μg/L (exceeding the RCRA regulatory limit). Corresponding total arsenic concentrations ranged up to 8,670 mg/kg.
- The TCLP concentration of one tailings (calcine material) sample (10OP01SS) was 29,100 μg/L. The total arsenic concentration was 5,340 mg/kg.
- A sample of waste rock with a total arsenic concentration of 1,130 mg/kg had a non-detect TCLP result (method detection limit [MDL] 36 μg/L).

- Flotation tailings TCLP arsenic results ranged up to 2,800 µg/L, with corresponding total arsenic concentrations ranging up to 9,880 mg/kg.
- Native and disturbed native soils generally have relatively lower total and TCLP concentrations.
- TCLP arsenic concentrations are generally higher than and proportional to SPLP concentrations (discussed above) for samples that were tested by both procedures.

Consistent with the SPLP results, collectively, the observations noted above further suggest that tailings/waste rock, particularly the tailings component, is a significant source of arsenic leaching at the RDM under slightly acidic conditions. Tailings/waste rock from the Post-1955 Main Processing Area appears more leachable than tailings/waste rock at the Pre-1955 Main Processing Area. As noted with the SPLP results, relatively low ratios of TCLP to total arsenic for flotation tailings suggest that these materials are a less significant source of leaching at the RDM than tailings/waste rock. These observations are consistent with the understanding of mine geology and mining and ore processing operations (see discussion in Section 5.3.4.1)

Mercury

Mercury TCLP results were all below 78.5 µg/L, with most concentrations below 10 µg/L. These values are all significantly less than the RCRA regulatory limit of 200 µg/L. TCLP mercury results are generally proportional to SPLP results (see Section 5.3.4.1) for samples that were analyzed by both procedures. Solubility of mercury at the RDM is further evaluated using an SSE procedure, discussed in Section 5.3.5.

5.3.5 Mercury Selective Sequential Extraction

As noted in Section 5.3.1, multiple interrelated factors affect the fate and transport of mercury in the environment. Chemical processes (redox, precipitation-dissolution, aqueous complexation, adsorption and desorption reactions, and formation and mobilization of colloids) and biogeochemical processes (methylation and demethylation) impact the mobility and toxicity of mercury. In addition, the various forms of mercury that these chemical and biogeochemical processes act upon also affect the fate and transport of mercury. For example, mercury in cinnabar—the mercury (II) sulfide that makes up the primary ore mineral at the RDM—is only minimally soluble under a broad range of conditions, whereas other forms of mercury (II) or elemental mercury (Hg(0)) are relatively more soluble and susceptible to methylation or volatilization. The form of mercury also controls how much mercury is bioavailable for the direct ingestion exposure pathway.

Historical information on operations at the RDM indicates that cinnabar is the dominant mercury ore mineral at the RDM. Cinnabar ore was subjected to thermal processing, either in retorts or furnaces at the mine, breaking down the cinnabar and allowing recovery of the resulting elemental mercury in a condenser system. No historical information on the specific chemical forms of mercury in RDM ore processing wastes (e.g., calcines) is available. However, at other mercury mine sites, extended X-ray adsorption fine structure spectroscopy studies indicate that the mercury species metacinnabar (m-HgS), corderoite ($Hg_3S_2Cl_2$), schuetteite ($HgSO_4$ -$H_2$0), and mercury chlorides are likely to form during the roasting of mercury ores. Each of these species is more soluble than cinnabar (Rytuba 2002).

To better understand what forms of mercury are present in RDM site soils (including native soils and mine wastes) and sediment, a mercury SSE method was employed. Although the SSE technique does not identify specific minerals, chemical species, or oxidation states, it does differentiate between and quantify groups of mercury-containing materials based upon their solubility behavior. The results may be useful for inferring the mineralogical or chemical species present. The mercury SSE method distinguishes between water soluble, stomach acid (weak acid) soluble, organo-complexed, strong complexed, and mineral bound forms of mercury. Each sequential extraction step dissolves a less soluble fraction of mercury-containing material in the sample. A summary of the selective sequential extraction steps and typical mercury species identified by each extraction step is provided below.

SSE Step	**Extractant**	**Fraction Description**	**Typical Mercury Compounds**
F0	De-ionized Water	Volatile	Hg_0 (vapor phase elemental mercury)
F1	De-ionized Water	Water soluble	$HgCl_2$, $HgSO_4$ (salts)
F2	pH 2 HCl/HOAc	Stomach acid soluble (weak acid)	HgO
F3	1 M KOH	Organo-complexed	Hg-humics, Hg_2Cl_2
F4	12 M HNO_3	Strong complexed	Mineral lattice, Hg_2Cl_2, Hg_0 (liquid phase elemental mercury)
F5	Aqua Regia (concentrated HCl and HNO_3)	Mineral bound/cinnabar	HgS (cinnabar), m-HgS (metacinnabar), HgSe, HgAu
F6	Hydrofluoric Acid	Mineral bound	Hg-silicates

Mercury SSE results for RDM soil and sediment samples are provided in Chapter 4 and are discussed below.

5.3.5.1 Soil Mercury Selective Sequential Extraction

Selected samples of surface and subsurface soil, including tailings/waste rock, waste rock, flotation tailings, sluiced overburden, fill, and a variety of disturbed and undisturbed native soils, were analyzed by mercury SSE. Mercury SSE results were evaluated by calculating the proportion of mercury represented by each SSE fraction as a percentage of the total mercury in the SSE samples. The total concentration of mercury was calculated by adding the concentration values for all the SSE fractions analyzed for a given sample. Depending on the sample, fractions F1 through F5 or fractions F0 through F6 were analyzed. The relative solubility of mercury under various conditions in various mine waste materials and soil types was evaluated by comparing the calculated percentages to total mercury by soil type (as designated in Chapter 3) and geographic area. The SSE results are provided in Chapter 4. Results of the evaluation approach are summarized in Table 5-2. Key results are briefly discussed below.

The comparably less soluble SSE fractions F5 and F6, which include cinnabar, and mercury silicates, generally made up most of the mercury in samples with relatively higher concentrations of total mercury, including tailings/waste rock, waste rock, and flotation tailings. High proportions of F5 and F6 also were observed in samples of other soil types, including weathered bedrock and a variety of disturbed and undisturbed native soil types and sluiced overburden. This is consistent with visual observations of cinnabar in tailings/waste rock, tailings, and disturbed soils and overburden. The more soluble SSE fractions F0 through F4 also were detected in lower proportions in most soil types, including mine wastes and native bedrock and soils.

The more soluble SSE fractions F0 through F4 were detected in comparatively higher proportions relative to total mercury only in those samples that had relatively low total mercury concentrations. The SSE fractions F0 through F4 were dominant in a limited number of these samples, all of which exhibited comparatively very low total mercury concentrations.

The general tendency of various soil types at the RDM with higher total mercury concentrations to have lower proportions of the more soluble fractions F0 through F4 is illustrated in Figures 5-15 and 5-16.

5.3.5.2 Sediment Mercury Selective Sequential Extraction

Selected bed sediment samples from Red Devil Creek and the Kuskokwim River were analyzed by mercury SSE. Results are provided in Chapter 4 and briefly discussed below. As was done for soil results (see Section 5.3.5.1), the proportion of mercury represented by each SSE fraction as a percentage of the total mercury in the SSE samples was calculated. The relative solubility of mercury under various conditions in the sediment samples was evaluated by comparing the calculated percentages to total mercury for each sediment sample. Key results are briefly summarized below.

In Red Devil Creek sediment samples, the comparably less soluble SSE fractions F5 and F6 generally made up most of the mercury in the sediment samples collected within and downstream of the Main Processing Area. This was also the case for the sample of yellowboy at the seep (RD05). The comparably more soluble SSE fractions F0 through F4 were collectively observed in a fairly high proportion only in samples with comparatively low total mercury concentrations. These observations are similar to those for soils at the RDM, including the tailings/waste rock material that underlies most of the Main Processing Area (see Section 5.3.5.1). This is expected since tailings/waste rock materials make up a portion of Red Devil Creek bed sediments (see Section 5.6.5). Cinnabar was visually observed locally in Red Devil Creek sediments. The tendency of Red Devil Creek sediment with higher total mercury concentrations to have lower proportions of the more soluble fractions F0 through F4 is illustrated in Figure 5-17.

A similar trend was seen in Kuskokwim River sediment samples. The less soluble fractions F5 and F6 were dominant in three of the four samples analyzed for mercury SSE. The fourth sample, with fractions F0 through F4 making up 71 percent of the total, had a low total mercury concentration of 0.52 mg/kg (estimated).

5.3.6 Methylmercury in Bed Sediment

As summarized in Section 5.3.1, methylation and demethylation of mercury are generally complicated processes governed by multiple variables. To better understand the processes of mercury methylation at the RDM and provide data on methylmercury concentrations in bed sediment, selected bed sediment samples collected in Red Devil Creek and the Kuskokwim River were analyzed directly for methylmercury. Results are provided in Chapter 4 and discussed below.

5.3.6.1 Red Devil Creek Bed Sediment Methylmercury

The highest concentration of methylmercury detected in Red Devil Creek bed sediment samples was 7.02 ng/g, detected at sample location RD02, which is located upstream of the Main Processing Area. The remaining creek sediment samples had concentrations of 1 ng/g or less. The seep sediment sample collected at RD05 (yellowboy) had a methylmercury concentration of 12.7 ng/g.

Methylmercury concentrations in Red Devil Creek sediments show no readily discernible spatial trends or relationship to total mercury concentrations. For most of the Red Devil Creek bed sediment samples within and downstream of the Main Processing Area, relatively higher methylmercury concentrations appear to be associated with relatively higher concentrations of TOC and percent fines, factors which themselves appear to be related in those samples.

5.3.6.2 Kuskokwim River Bed Sediment Methylmercury

The highest concentration of methylmercury detected in Kuskokwim River bed sediment samples was 3.73 ng/g, detected at offshore sample location KR58.

Concentrations of methylmercury showed no readily discernible spatial trends or relationships to total mercury concentrations, percent fines, or percent TOC.

5.3.7 Arsenic Speciation in Soil and Bed Sediment

As noted in Section 5.3.2, one factor that affects the mobility and toxicity of arsenic in the environment is the chemical form of the arsenic. In order to better understand the toxicity and fate and transport of arsenic at the RDM, selected samples of soil and bed sediment collected in Red Devil Creek and the Kuskokwim River were analyzed for arsenic speciation using modified EPA Method 1632.

The modified EPA Method 1632 used in the RI is designed to provide an estimate of the concentrations of the common forms of inorganic arsenic seen in environmental samples—arsenate and arsenite—as well as total inorganic arsenic. Results for inorganic arsenic are reported in concentrations of total inorganic arsenic, As(III) or arsenite, and As(V) or arsenate. The values for As(III) and total inorganic arsenic are determined directly by analysis. The value for As(V) is calculated indirectly by subtracting the As(III) value from the total inorganic arsenic value. The distinction between As(III) and total inorganic arsenic in soil and sediment is operationally defined based on differences in solubility. The fraction used to estimate As(III) is extracted from the sample using a 0.1 molar (M) phosphoric acid solution. Total inorganic arsenic is determined by digestion using a 2 M hydrochloric acid solution.

Modified EPA Method 1632 method assumes that the inorganic arsenic in a given soil or sediment sample is limited to the forms arsenite and arsenate. For samples with other forms of arsenic, such as the sulfides realgar and orpiment known to be present in some RDM soils, modified EPA Method 1632 results require careful interpretation. The arsenic in sulfides realgar and orpiment has a valence of As^{3+}. Any arsenic extracted from realgar and orpiment using the phosphoric acid solution would be in the form of As(III). However, these sulfides are of fairly low solubility and are expected to be only minimally dissolved by the 0.1M phosphoric acid solution. The sulfides are expected to be extracted under the 2M hydrochloric acid digestion used to determine the total inorganic arsenic concentration. Therefore, the reported As(III) concentrations are not expected to account for all the As^{3+} present in samples with realgar, orpiment, or other possible forms of As^{3+} with relatively low solubility. These less soluble species are expected to be accounted for in the reported total inorganic arsenic values. Because the reported As(V) concentration is calculated by subtracting the As(III) value from the total inorganic arsenic value, As(V) concentrations are expected to be biased high for samples with the sulfides and other less soluble minerals.

Results of arsenic speciation analysis are provided in Chapter 4 and briefly discussed below.

5.3.7.1 Soil Arsenic Speciation

A total of 68 selected surface and subsurface soil samples were analyzed for arsenic speciation using modified EPA Method 1632. The proportion of arsenite as a percent of total inorganic arsenic ranged from approximately 0 to 71 percent. Arsenite made up less than 20 percent of total inorganic arsenic in all but 11 samples. The species making up the remaining inorganic arsenic include arsenate and, for some samples, the sulfide species realgar and orpiment. The proportion of arsenite in soil tends to be higher at depth, generally corresponding to less oxic conditions.

5.3.7.2 Red Devil Creek Bed Sediment Arsenic Speciation

A total of 11 bed sediment samples from Red Devil Creek and the seep (station RD05) were analyzed for arsenic speciation using modified EPA Method 1632. Total inorganic arsenic concentrations of creek sediment samples ranged from 52.8 mg/kg (at station RD01, located upstream of the Main Processing area) to 4,340 mg/kg (at station RD06). Arsenite made up 2 to 13 percent of total inorganic arsenic. These observations are generally similar to those for soils at the RDM, including the tailings/waste rock material that underlies most of the Main Processing Area (see Section 5.3.7.1). This is expected since tailings/waste rock materials comprise a portion of Red Devil Creek bed sediments (see Section 5.6.5). The apparent slightly lower percentage of arsenite in stream bed samples may be due to comparably more oxic conditions in the stream environment.

Total inorganic arsenic in the seep sediment sample (RD05), consisting of yellowboy, was 188,000 mg/kg. Arsenite made up only approximately 3 percent of the total inorganic arsenic. It is likely that much of the remaining inorganic arsenic in the yellowboy is in the form of arsenate. The high total arsenic concentration and the high proportion of arsenate in the yellowboy sample may be explained by the strong affinity of arsenate to adsorb onto iron oxides, such as those of the yellowboy, under acidic conditions. This is supported by the arsenic speciation results of the RD05 seep water sample, in which arsenate made up only 31 percent of the total arsenic and arsenite made up the remaining 69 percent (see Section 5.6.2.3). The dominance of arsenite in the seep water sample is likely the result of preferential adsorption of arsenate from the seep water and/or co-precipitation into the yellowboy materials, thereby increasing the proportion of arsenite in the water.

5.3.7.3 Kuskokwim River Bed Sediment Arsenic Speciation

A total of 17 selected bed sediment samples from the Kuskokwim River were analyzed for arsenic speciation using modified EPA Method 1632. Results are presented in Chapter 4. Total inorganic arsenic concentrations of the selected sediment samples ranged from 17.1 to 1,940 mg/kg. Arsenite composed up to 45 percent of the total inorganic arsenic. Arsenite percentages were higher in samples with lower total inorganic arsenic concentrations.

5.4 Groundwater Transport

Groundwater at the RDM is locally impacted by contaminants in mine waste consisting of tailings/waste rock, flotation tailings, and contaminated soils, as evidenced by detection of contaminants in monitoring wells installed within and hydraulically downgradient of known contaminant source areas.

Groundwater at the RDM also is locally impacted by inorganic elements present in naturally mineralized bedrock and native soils. As noted in Section 4.1.7, it has not been possible with available RI data to determine the extent and concentrations of naturally mineralized soil at the RDM. As a result, the background levels presented in Section 4.1, including those for groundwater, are considered to be conservative and likely underestimate pre-mining background concentrations of inorganic elements associated with natural mineralization.

Migration of inorganic elements in groundwater at the RDM is complicated and is affected by multiple complex groundwater migration pathways and varied geochemical conditions present at any given time at any given location along those pathways. Factors that control mobility of inorganics in groundwater in general are further discussed in Section 5.4.1. Groundwater transport of inorganics at the RDM is discussed in Sections 5.4.2 through 5.4.6.

5.4.1 Factors Affecting Transport of Inorganic Elements in Groundwater

In general, inorganic elements can migrate directly into groundwater from sources that lie within the saturated zone or by leaching from overlying source materials. Transport and concentrations of contaminants in groundwater are governed by the processes of advection, hydrodynamic dispersion (including mechanical dispersion and molecular diffusion), adsorption/desorption, precipitation and dissolution, and recharge. Release and migration of inorganics in sulfide minerals are controlled by presence and flux of water and oxygen; ferric iron; bacteria that catalyze the oxidation reactions; heat generated from the exothermic oxidation reactions; mineralogy of the sulfides and the materials in which the oxidation is occurring; and acid neutralization reactions.

In general, many trace inorganics are strongly adsorbed onto surfaces of minerals and organic compounds in soils and sediments, limiting their mobility in the environment. The strong adsorptive capabilities of secondary clay minerals, hydrous iron, aluminum and manganese oxides and humic material have been well demonstrated, and may be responsible for retardation of transport of trace metals in groundwater.

Some of the materials onto which trace inorganics adsorb may be in the form of colloids. Colloids are generally considered to be particles with diameters less than 10 micrometers (Puls et al. 1991), and can be composed of both organic and inorganic materials. In addition to having a high surface area per mass and volume, colloidal particles consisting of dissolved organic carbon, clay minerals, and iron oxides also are highly reactive sorbents for a variety of contaminants, including inorganic elements. Migration of inorganic elements in groundwater may be significantly affected by the formation of and adsorption of trace inorganics onto colloids. As with other aquifer solids, if the colloidal particles are immobile, the colloids will serve to inhibit the migration of inorganics that adsorb to the colloids. On the other hand, if the colloids are mobile in groundwater, they could facilitate transport of the inorganics rather than inhibit it.

Multiple factors control the formation and mobilization of colloids in groundwater and surface water. Large changes in aqueous geochemistry can result in supersaturated conditions in which inorganic colloidal species are formed. Decreases in pH or changes in redox conditions can cause the dissolution of soil materials or geologic matrix cementing agents, promoting the release of colloidal particles. Decreases in the ionic strength of an aqueous phase can enhance stability of colloids and promote their transport. Studies have shown that particles with diameters greater than 1 micrometer may actually move faster in groundwater than the average groundwater flow velocity in porous media due to effects such as size exclusion from smaller pore spaces. The significance of colloidal mobility as a transport mechanism ultimately depends on the presence of sufficient quantities of reactive particles in groundwater (e.g., Puls et al. 1991).

5.4.2 Groundwater Flow Pathways at the Red Devil Mine

The groundwater flow pathways at the RDM lie within bedrock and overlying materials that locally consist of disturbed and undisturbed native soils, tailings/waste rock, and flotation tailings. The three-dimensional framework of these materials at the RDM is locally complex and includes localized low-permeability zones that result in perching and other compartmentalization of the groundwater regime, as discussed in Section 3.2. The configuration of bedrock fracture flow pathways also is complex. In addition to flow within bedrock fractures, the system of underground mine workings at the site likely dominates groundwater flow pathways in bedrock within those parts of the Surface Mined Area and Main Processing Area where underground mining took place (see Figures 1-4 and 1-7). The underground workings approach the surface locally, including locations within the Red Devil Creek valley where the vertical gradient is likely predominantly upward. At those locations along Red Devil Creek, groundwater flow within the mine workings and connected fracture systems likely exerts a strong influence on groundwater flow and chemistry within the overlying unconsolidated soils (see Section 3.2.6). Such influence would also affect conditions in surface water (see Section 3.3). The nature of the impact of underground mine workings on groundwater flow is not fully understood. The groundwater chemical data from several wells installed in bedrock or weathered bedrock provide some insight into groundwater conditions in bedrock locally, as discussed further below.

Groundwater chemistry is impacted by bedrock, mine workings, mine wastes, and native soils. Observations of these impacts are discussed in Section 5.4.3.

Ultimately, groundwater within the site flows to the Red Devil Creek valley and emerges as surface water in Red Devil Creek or flows down the valley to the Kuskokwim River. Based on groundwater elevation and stream gaging data (see potentiometric surface maps presented in Chapter 3), groundwater throughout the Main Processing Area, which is the most impacted groundwater at the RDM, emerges into Red Devil Creek and enters the Kuskokwim River as surface water rather than as groundwater.

5.4.3 Sources of Inorganics in Groundwater at the RDM

Groundwater contamination at the RDM occurs due to leaching of inorganic elements from mine wastes. Groundwater at the RDM also is locally impacted by inorganic elements present in naturally mineralized bedrock and native soils. The contributions of each of these groups of materials to groundwater impacts at the RDM are difficult to determine due to the complex groundwater flow pathways (see Section 5.4.2) and the complex geochemical settings along each of the various flow pathways, with interrelated processes (redox reactions, adsorption-desorption, dissolution-precipitation, complexation, and formation and transport of colloids), as well as potential interference between individual constituents involved in these processes (see Sections 5.3 and 5.4.1). Groundwater impacts at the RDM are further complicated by the spatially overlapping influences of the different flow pathways and their geochemical conditions, as briefly outlined below.

Bedrock is a source of some groundwater impacts at the RDM, as discussed further in Section 5.4.3.2. As noted in Section 4.1.7, in addition to the rich ore zones targeted during mining, a broader zone of mineralized bedrock envelops the ore zones and includes deposits of cinnabar and sulfides of arsenic and antimony. Such naturally mineralized bedrock is a likely source of some of the arsenic, antimony, and mercury groundwater impacts at the RDM. Similarly, native soils derived from mineralized bedrock are likely locally a source of some groundwater impacts. Some of these impacts likely existed prior to development of the RDM. Superimposed on the pre-mining groundwater conditions are impacts associated with mine development and operations. As is the case for soil (see Section 4.1.7), distinguishing between naturally elevated concentrations of inorganics in groundwater and contamination resulting from mining-related activities is complicated by the superposition of mining-related impacts on natural bedrock and native soils and the physical hydrogeologic conditions within them. Key complicating factors are:

- Underground mine workings were developed within the heavily mineralized zone in bedrock.
- Surface mining was conducted over a large area overlapping the mineralized zone (see Section 4.1.7) and overlying much of the area of the underground mine workings.
- Ore processing activities, including disposal of mine wastes, occurred in the Main Processing Area, which overlaps with the zone of naturally

mineralized bedrock, the underground mine workings, and likely naturally mineralized soils.

- Within part of the Main Processing Area near Red Devil Creek, where the largest groundwater impacts are observed, the vertical hydraulic gradient is likely predominantly upward, resulting in upward flow of groundwater through a combination of naturally mineralized bedrock, mine workings, native soils, and mine wastes, each of which impart various impacts on groundwater chemistry.
- Variable gaining and losing conditions between groundwater and Red Devil Creek are observed within the part of the Main Processing Area exhibiting the conditions specified above, further complicating the flow paths and geochemical impacts imparted by various influences along the flow pathways.

Despite the complexities outlined above, some impacts on groundwater chemistry from various sources can be inferred. Key observations of impacts associated with the various flow pathways and geochemical settings at the RDM are summarized below.

5.4.3.1 Groundwater Contamination Associated with Mine Wastes

Groundwater at the RDM is significantly impacted by leaching of contaminants from mine wastes, including tailings/waste rock, flotation tailings, and contaminated soils. The greatest impacts, particularly for antimony and arsenic, occur where tailings/waste rock materials within the Main Processing Area are within the saturated zone at least part of the time. Where the water table elevation fluctuates, such waste materials would be subjected to repeated wetting/drying cycles that would promote mobilization of contaminants, including oxidation of sulfide minerals. Where the waste materials are above the water table at any given time, contaminants from these sources are subject to leaching and migration to groundwater.

The monitoring wells that most clearly exhibit the impacts from tailings/waste rock and flotation tailings are either screened within those materials or are located downgradient of locations where those materials are saturated at least some of the time (see Table 5-3). Those wells are:

- MW15 (partially screened in and located downgradient of saturated tailings/waste rock);
- MW20 (partially screened in and located downgradient of saturated tailings/waste rock);
- MW21 (partially screened in and located downgradient of saturated tailings/waste rock and flotation tailings in Settling Pond #2);
- MW22 (partially screened in and located downgradient of saturated tailings/waste rock);

- MW14 (located downgradient of saturated tailings/waste rock);
- MW16 (located downgradient of saturated tailings/waste rock); and
- MW03 (located downgradient of saturated tailings/waste rock and flotation tailings in Settling Pond #1).

Mine waste materials also contribute to mercury groundwater contamination; however, it appears that some of the mercury groundwater impacts at the RDM are associated with flow through the bedrock system, discussed in Section 5.4.3.2. As noted above, within part of the Main Processing Area near Red Devil Creek, the upward vertical hydraulic gradient results in upward flow of groundwater through a combination of naturally mineralized bedrock, mine workings, native soils, and mine wastes, each of which impart various impacts on groundwater chemistry. As such, some of the mercury in groundwater, including the relatively high mercury concentrations observed in wells MW14, MW15, MW16, and MW20 (which are screened in unconsolidated materials rather than bedrock) and MW22 (which is screened in both bedrock and tailings/waste rock), may be attributable to impacts from bedrock and weathered bedrock, native and disturbed native soils, and/or Red Devil Creek alluvium in addition to impacts from the tailings/waste rock (see Table 5-3).

5.4.3.2 Groundwater Impacts Associated with Bedrock

Groundwater within bedrock and weathered bedrock at the RDM is locally impacted. Wells that appear to represent groundwater conditions in bedrock (based on location, screen depth, and available information on groundwater gradient) show significantly lower (by an average of about two orders of magnitude) concentrations of antimony and arsenic than those wells that appear to reflect contamination from the tailings/waste rock in the Main Processing Area (see Section 5.4.3.1 and Table 5-3). On the other hand, those wells that appear to represent groundwater conditions in bedrock typically exhibit higher total mercury concentrations (with exceptions for wells MW14, MW15, MW16, MW20, and MW22, as noted in Section 5.4.3.1). The wells that appear to most clearly reflect bedrock and weathered bedrock groundwater conditions, and the characteristics of the wells that lend them to assessment of bedrock groundwater conditions, are listed below and summarized in Table 5-3:

- Wells screened in bedrock upgradient of the Post-1955 Main Processing Area:
    - MW18
    - MW19
- A well screened in bedrock in Surface Mined Area upgradient of the Pre-1955 Main Processing Area:
    - MW29

- Wells screened in bedrock or weathered bedrock within Main Processing Area near Red Devil Creek where the vertical hydraulic gradient is expected to predominantly upward:
    - MW28 (screened in bedrock and a cavity apparently associated with underground mine workings)
    - MW17 (screened in bedrock in close proximity to underground mine workings)
    - MW25 (screened in weathered bedrock)
    - MW24 (screened in weathered bedrock and bedrock)
- A well screened in weathered bedrock and bedrock at location down-valley of Main Processing Area:
    - MW23

In general, groundwater impacts exhibited in bedrock wells could be attributable to the bedrock itself, natural weathering of the bedrock, disturbance of the bedrock by underground mining, and/or migration of contaminants from surficial or near-surface sources downward into bedrock. These potential influences on groundwater occurring in bedrock are further discussed below.

Bedrock and Weathered Bedrock as a Source of Groundwater Impacts

Well MW19 exhibits mercury concentrations that are higher than some other wells in the vicinity. Since well MW19 is located upgradient of the mine wastes in the Main Processing Area, outside of the area of known underground mine workings, and in an area with comparatively little surface disturbance or contamination, the relatively high mercury concentrations in the well likely reflect natural conditions in bedrock and/or weathered bedrock. It is likely that some of the elevated concentrations of inorganics that are present in bedrock and mobilize into groundwater are associated with naturally occurring mineralization, either as primary hydrothermal minerals associated with the mineralized zone (see Section 4.1.7) or as secondary minerals resulting from natural weathering of the primary minerals and transport and deposition of the associated inorganics, either within the structure of the secondary minerals or adsorbed onto them (e.g., iron oxide coatings or clay minerals).

Other wells screened in bedrock also suggest that bedrock and weathered bedrock are sources of groundwater impacts; however, interpretation of results for these other wells is complicated by the possible influence of underground mine workings and presence of mine wastes, discussed below.

Some of the impacts on groundwater from bedrock likely existed prior to development of the RDM. Distinguishing between groundwater impacts attributable to natural mineralization and contamination resulting from mining-related impacts is complicated. Such impacts are further discussed below.

Influence of Underground Mine Workings on Groundwater Impacts

Underground mine workings are developed within naturally mineralized bedrock. The mine workings followed rich ore bodies formed in association with fractures and faults. Associated with the ore bodies are zone(s) of natural mineralization with deposits of cinnabar as well as antimony and arsenic minerals (see Section 4.1.7). The mine workings form a network of conduits that may facilitate rapid groundwater flow (see Sections 3.2.6 and 5.4.2). In addition, the mine workings also provide a conduit exposing the mineralized bedrock and groundwater to oxygen (in air) and other possible surface influences on groundwater geochemistry.

Two wells that appear likely to reflect groundwater conditions in at least part of the underground mine workings are MW28 and MW17. In particular, well MW28, which is screened within bedrock and a cavity apparently associated with the underground mine workings, likely closely reflects groundwater conditions in at least that portion of the mine workings, which appears to be near the upper end of a stope (see Figures 1-4 and 3-4). Well MW17, which is screened in bedrock in close proximity to, and is likely connected via fractures to, underground mine workings, also may reflect some groundwater conditions associated with the mine workings. As noted above, wells MW28 and MW17 exhibit relatively high total mercury concentrations and relatively low concentrations of arsenic and antimony (see Table 5-3).

Based on available hydrogeologic and geophysical data on groundwater flow pathways (see Sections 3.2.6 and 5.4.2), the seep (RD05) on the north bank of Red Devil Creek and the baseflow along Red Devil Creek in the vicinity of RD05 appear to be associated with the underground mine workings (see Section 3.2.6). However, the groundwater flow pathways and impacts on groundwater along the flow pathways are not well understood. Some of the chemical characteristics of the surface water at the seep, particularly the relatively high arsenic concentrations, are not readily understood simply based on the apparent association between the seep and underground mine workings (see Sections 5.4.5 and 5.6).

5.4.3.3 Groundwater Impacts Associated with Native Soils

Native soils with elevated concentrations of inorganics may be a source of elevated concentrations in groundwater. Native soils throughout much of the Main Processing Area and Surface Mined Area likely are derived from naturally mineralized bedrock (see Section 4.1.7). As with bedrock and weathered bedrock, inorganics may be present in native soils as a result of with natural mineralization. Inorganic elements, including mercury (see Section 5.3.1) and arsenic (see Section 5.3.2), may be present within the mineral structures or adsorbed to surfaces of weathering products. Native soils with naturally elevated concentrations of inorganics that are within the saturated zone at least part of the time and subjected to repeated wetting/drying would likely be more susceptible to leaching of contaminants to groundwater.

As with bedrock, impacts on groundwater from naturally mineralized native soils are difficult to distinguish from mining-related impacts.

5.4.4 Colloidal Groundwater Transport

In general, high ratios of total-to-dissolved inorganics in groundwater may be attributed to excessive turbidity that is either artificial or natural. Artificial turbidity may be the result of poor well design or construction; inadequate or improper well development; corrosion, degradation, or leaching of well construction materials; and/or improper well purging, sampling, sample processing, transportation, and storage. Natural turbidity may exist where conditions are favorable for the production of stable suspensions (e.g., low ionic strength waters, geochemical supersaturation, high clay content) and includes formation of colloids, which may be either mobile or immobile under any given set of chemical and physical conditions.

The groundwater and surface water sampling for the RDM RI employed the commonly used designation of 0.45 micrometer as an operational cutoff point for determining total and dissolved concentrations. Groundwater and surface water results indicate large differences between total and dissolved concentrations in some samples for some inorganic elements, particularly mercury. To a large degree, the differences are likely attributable to formation and adsorption of mercury and other inorganic elements to mobile colloids.

As noted in Section 5.4.1, multiple factors control the formation and mobilization of colloids in groundwater and surface water. Due to many complexities in the groundwater and surface water environment at the RDM, the factors controlling the possible formation and transport of colloids and associated contaminants at the RDM are not well understood. Nonetheless, it appears likely that colloidal transport of mercury is a significant process at the RDM based observations of RI groundwater results summarized below and in Table 5-3:

- Ratios of total-to-dissolved concentrations for mercury are generally higher than for most other inorganic elements in most samples.
- Wells with high total-to-dissolved ratios for mercury typically correspond to wells with high ratios for iron and/or aluminum, metals whose oxides commonly form strongly adsorptive colloids. Ratios of total-to-dissolved iron and aluminum in these wells range up to two orders of magnitude.
- Ratios for most other inorganic elements are typically much lower than for mercury and iron and/or aluminum.
- Most of the wells with the characteristics listed above are screened in bedrock or weathered bedrock, including:

- Wells with high total-to-dissolved mercury ratios that exhibit relatively high total mercury concentrations (particularly MW17, MW24, and MW28); and
- Wells with high total-to-dissolved ratios for mercury and iron and/or aluminum that do not exhibit high mercury concentrations.

The characteristics shared by most of the wells with high total mercury concentrations—high total-to-dissolved ratios for mercury and iron and/or aluminum and screens in bedrock—suggest that the geochemical and/or flow characteristics of the bedrock promote formation and mobilization of colloids and adsorbed mercury. Fracture flow likely facilitates transport of colloidal particles due to the large pore size of the fractures.

Adsorption of mercury to colloids consisting of organic matter also is possible; however, because no data on DOM or related parameters (e.g., TOC) for groundwater are available, formation and transport of such colloids and associated contaminants cannot be fully evaluated.

Colloidal transport of mercury in groundwater is supported by surface water results, discussed in Section 5.6.

5.4.5 Groundwater Arsenic Speciation

As summarized in Sections 5.3.2 and 5.4.1, the factors controlling mobility of arsenic in groundwater are complicated. One of the key factors affecting mobility of arsenic in groundwater is the valence state of the arsenic. In most fresh water, inorganic arsenic occurs in the form of arsenate and arsenite. In order to better understand the fate and transport of arsenic and provide data on concentrations of the various arsenic species in groundwater, selected groundwater samples were analyzed directly for arsenic speciation using EPA Method 1632 to determine total inorganic arsenic, arsenite, and arsenate. The values for As(III) and total inorganic arsenic are determined directly by analysis. Total inorganic arsenic is operationally defined as all sodium borohydride-reducible As^{3+} and As^{5+} in the sample. The value for As(V) is calculated indirectly by subtracting the As(III) value from the total inorganic arsenic value. Results are provided in Chapter 4 and discussed below.

A total of 10 groundwater samples were analyzed for arsenic speciation in 2011. The proportion of arsenate to total inorganic arsenic ranged widely, from approximately 3 to 100 percent. Arsenate made up most of the total inorganic arsenic in samples with relatively high total inorganic arsenic concentrations, except for the sample from monitoring well MW10. Arsenite made up 97 percent of total inorganic arsenic in the sample from monitoring well MW10, which contained total and dissolved arsenic at 96.9 and 92.1 µg/L, respectively. The reason for the high proportion of arsenite in this well is not known. However, the proportion of arsenate is commonly lower (as low as 52 percent in well MW28 in 2011) in those monitoring wells (including MW10) that are screened in bedrock/weathered bedrock and mine workings, suggesting somewhat more reduced conditions in groundwater in the portions of bedrock/weathered bedrock and underground mine workings in which those wells are screened. It is likely that geochemical conditions are different in other portions of the bedrock groundwater environment, particularly those portions subject to atmospheric exposure (e.g., parts of the mine workings at the water table).

As noted in Section 5.4.3.2, the seep (RD05) on the north bank of Red Devil Creek and the base flow along Red Devil Creek in the vicinity of RD05 appear to be associated with the underground mine workings. As discussed in Section 5.6.2.3, the proportion of arsenate in the seep water sample was 31 percent. The particularly low proportion of arsenate in the seep sample appears to be due in part to the adsorption and/or co-precipitation of arsenate in the seep water onto or into the yellowboy, thereby leaving a higher proportion of more mobile arsenite in solution. The low proportion of arsenate in the seep sample also is generally consistent with the observation that wells screened in bedrock and mine workings commonly have generally low proportions of arsenate. However, the proportion of arsenate in the seep sample is lower than those for the wells screened in bedrock (see Table 5-3). Further, as noted in Section 5.4.3.2, the relatively high arsenic concentrations (total and dissolved) in the seep sample are not consistent with the generally low arsenic concentrations for wells screened in bedrock. As such, conditions at the seep do not appear to simply reflect conditions in bedrock and the underground mine workings.

5.4.6 Groundwater Methylmercury

As noted in Section 5.3.1, the processes of methylation are complex and not fully understood. To better understand the processes of mercury methylation at the RDM and provide data on methylmercury concentrations in groundwater, selected groundwater samples were analyzed directly for methylmercury. Results are provided in Chapter 4 and discussed below.

Methylmercury was detected in most of the monitoring wells sampled at concentrations ranging up to 1.14 ng/L (see Figure 4-35). The controls on this methylation are uncertain. In general, factors known to affect methylation of mercury are total mercury concentrations, organic matter content, and acid-volatile sulfide content in soil; and pH, dissolved organic carbon, and dissolved sulfate concentrations in water (see Section 5.3.1). Among these factors, available data for RDM media include total mercury concentrations in soil; and pH, and total and dissolved mercury, methylmercury, and sulfate concentrations in groundwater. In addition, information is available on mercury solubility behavior based on SSE results.

Available information does not clearly indicate how or where methylation is occurring at the RDM. However, it appears likely that some of the methylation of mercury occurs in groundwater in the Main Processing Area (see Section 5.6.2.4).

5.5 Erosion and Mass Wasting

Erosion includes the physical processes by which moving surface water transports solid materials. In general, mass wasting is the downslope movement of soil and rock under the influence of gravity; it includes creep, slides, debris flows, slumps, rock flows, rockfalls, and block glides. Generally, the potential for transport by erosion is dependent on the slope of the erosional surface; the surface area of exposed materials subjected to erosion; the size, shape, and density of the grains; the cohesiveness of the material; and the frequency and magnitude of precipitation/runoff events.

Erosion and mass wasting of contaminated soils, tailings/waste rock, and flotation tailings are relatively important contaminant release and migration mechanisms at the RDM. Observations made during the RI field investigations indicate that erosion and mass wasting of tailings/waste rock in the Main Processing Area are occurring. These processes are discussed further below.

Within the Post-1955 Main Processing Area, rills and gullies within the tailings/waste rock areas indicate erosion of these materials and transportation to Red Devil Creek.

The steep embankments of Red Devil Creek in the vicinity of the former culvert and road crossing are subject to mass wasting. The stream embankment in this area is steep and underlain by exposed tailings/waste rock. The stream bed in this area includes tailings/waste rock, some of which likely entered the creek by mass wasting. Tailings/waste rock and/or soil and fill and debris materials associated with the former culvert and road crossing likely underlie the stream bed to some depth in this area. No soil borings were installed within the stream bed to assess conditions beneath the stream bed. However, in soil boring 11MP29SB, installed near Red Devil Creek in this area, tailings/waste rock extended from the surface to a depth of approximately 16 feet bgs, approximately 2 feet below the elevation of the bed of Red Devil Creek. The stream bed substrate in the area of the former culvert/road crossing and the high gradient section of the creek extending downstream from this area are likely subject to erosion by downcutting due to the relatively high stream gradient along that reach.

Materials that enter Red Devil Creek by erosion and mass wasting have been in the past, and presently are, subject to surface water transport downstream within Red Devil Creek (discussed further below). Some of the materials transported down Red Devil Creek to its mouth have been in the past, and likely still are, deposited in the Red Devil Creek delta. These materials may be subject to further erosion by Red Devil Creek as it flows over the delta, and by the Kuskokwim River. Similarly, sluiced overburden that was historically deposited in the Dolly Sluice and Rice Sluice deltas is presently subject to erosion by the Kuskokwim River.

5.6 Surface Water Transport

In general, surface water transport processes include transport of dissolved and suspended particulate phase materials and bed load transport. Materials transported as suspended load are deposited at locations downstream under low energy conditions. These general processes are discussed below.

5.6.1 Factors Affecting Suspended and Dissolved Phase Transport

Surface water transport of contaminants generally entails the physical movement of dissolved or suspended particulate phase chemicals with the flow direction of surface water systems. Transport of contaminants adsorbed to colloids in surface water also is an important transport mechanism; therefore, it is discussed separately below.

5.6.1.1 Suspended Phase Transport

Suspended phase transport of particulates depends primarily on flow velocity and turbulence, grain size and shape, and grain density. Temporal changes in the flow regime, especially flow velocity, determine whether particulate materials at a given location are subject to erosion or deposition at a given time. Materials that are deposited under one set of physical and chemical conditions may be subject to subsequent entrainment and transport under another set of conditions. At the RDM, particle density is likely a significant physical factor for some mine waste materials due to the relatively high specific gravity of cinnabar (8.1) and stibnite (4.56), and other minerals that make up a portion of waste rock and flotation tailings. Larger grains that make up or contain a significant proportion of these minerals will be less prone to erosion and suspended transport than material grains of similar size and shape that do not contain appreciable amounts of these minerals.

5.6.1.2 Dissolved Phase Transport

Dissolved phase chemicals enter surface water by influx of groundwater under gaining flow conditions and by dissolution and/or desorption of chemicals from rock and mineral particles in contact with the surface water. In general, the magnitude of surface water dissolved transport is dependent on groundwater influx and tendency of contaminants to dissolve or desorb from the bed or suspended sediments.

5.6.1.3 Colloidal Transport

Transportation of contaminants via colloids in groundwater is likely occurring at the RDM, as discussed in Sections 5.4.1 and 5.4.4. Such colloids likely enter into surface water along gaining stream reaches and the seep. In addition, colloids may form in surface water, also affecting surface water transport of contaminants.

5.6.2 Red Devil Creek and Seep Surface Water Contaminant Concentrations

RI results indicate that transport of contaminants in surface water is occurring presently at the RDM. Contaminants are migrating via groundwater pathways into Red Devil Creek along gaining reaches and are being transported downstream by surface water. Contaminants also are likely being dissolved or desorbed from stream bed sediments and being transported downstream. It also is possible that some contaminants in surface water may be adsorbed onto stream bed sediments (e.g., see Section 5.6.2.3). Particulates are being transported downstream as bed load (see Section 5.6.5) and suspended phase transport within Red Devil Creek and the Kuskokwim River. Some of the particulates are likely in colloidal form. General processes affecting dissolved and suspended surface water transport are discussed in Section 5.6.1. Surface water transport processes at the RDM and associated trends are discussed below and in Section 5.6.3.

5.6.2.1 Suspended and Dissolved Phase Concentrations

Surface water data for Red Devil Creek exhibited generally increasing total and dissolved antimony, arsenic, and mercury concentrations within and downstream of the Main Processing Area, from approximately sample stations RD10 and RD11 downstream (see Figures 4-36 through 4-39). Total concentrations of antimony and arsenic were only slightly higher than the dissolved concentrations at each sample location throughout most of the stream in both 2010 and 2011, indicating that transport of antimony and arsenic in Red Devil Creek surface water is dominated by dissolved phase transport.

Total concentrations of mercury were significantly higher (up to more than an order of magnitude) than the dissolved concentrations at each sample location within and downstream of the Main Processing Area in both 2010 and 2011, indicating that mercury transport in surface water in Red Devil Creek is dominated by particulate (including colloidal) phases. Colloidal transport is discussed further in Section 5.6.2.2.

At the seep (location RD05), both total and dissolved concentrations of arsenic were higher than in Red Devil Creek surface water locations upstream and downstream in 2010 and 2011. These concentrations and the arsenic loading estimate (see Table 5-4) suggest that the seep and associated groundwater entering Red Devil Creek via baseflow near the seep is a significant source of arsenic to Red Devil Creek. Total and dissolved concentrations of antimony were lower in the seep sample (location RD05) than in Red Devil Creek at locations upstream and downstream in 2010 and 2011. These comparatively low concentrations and loading values suggest that the seep and associated groundwater entering Red Devil Creek via baseflow are not a significant source of antimony to the creek. Dissolved mercury concentrations were lower in the seep samples than in adjacent creek samples. However, total mercury concentrations in the seep samples were similar to the total mercury concentrations in the adjacent stream samples.

Methylmercury concentrations in Red Devil Creek surface water generally increase downstream from the beginning of the Main Processing Area through about station RD06, and slightly decrease further downstream. Methylmercury results are discussed further in Section 5.6.2.4.

5.6.2.2 Colloidal Transport

As for RI groundwater sampling, surface water sampling employed the commonly used designation of 0.45 micrometer as an operational cutoff point for determining total and dissolved concentrations. As also seen in groundwater results (see Section 5.4.4), surface water results indicate significant differences between total and dissolved concentrations for mercury. The differences are likely attributable to formation of, and adsorption of mercury and other inorganic elements onto, mobile colloids.

The transport of contaminants, particularly mercury, in Red Devil Creek surface water in association with colloids appears to be occurring at the site based on the following observations:

- Ratios of total-to-dissolved mercury concentrations are relatively high (as high as 29 in the 2011 RI sample at station RD09), whereas ratios for most other inorganics are generally much lower. A similar situation was observed for groundwater (see Section 5.4.4)
- Total-to-dissolved ratios for iron and aluminum also were generally relatively high. A similar situation existed in groundwater. Iron and aluminum precipitates may form colloids in groundwater and surface waters (see Section 5.3.4).
- Even though the total-to-dissolved ratios are comparatively high for mercury, iron, and aluminum, the field turbidity and total suspended solids results (recovered using either a 1.2 or 1.5 micrometer filter) are low, suggesting that a large proportion of the particulates contributing to the concentrations of total mercury, iron, and aluminum are between 0.45 and 1.2 to 1.5 micrometers in size.

Based on similarities between mercury, iron, and aluminum concentrations and total-to-dissolved ratios in groundwater and surface water, it appears that colloids in surface water are at least in part the result of influx from groundwater.

Adsorption of mercury to colloids consisting of organic matter also is possible; however, because no data for DOM or related parameters (e.g., TOC) for surface water are available, formation and transport of such colloids and associated contaminants in surface water cannot be fully evaluated.

5.6.2.3 Arsenic Speciation

Factors affecting arsenic mobility in groundwater at the RDM are discussed in Section 5.4. As with groundwater, one of the key factors affecting mobility of arsenic in surface water is valence state. As noted above, most inorganic arsenic in fresh water inorganic arsenic occurs in the form of arsenate and arsenite. To better understand the fate and transport of arsenic and provide data on concentrations of the various arsenic species in surface water, selected groundwater samples were analyzed directly for arsenic speciation using EPA

Method 1632 to determine total inorganic arsenic, arsenite, and arsenate. Use of EPA Method 1632 to assess speciation of inorganic arsenic in waters in described in Section 5.4.5. Results are provided in Chapter 4 and discussed below.

A total of seven surface water samples collected from Red Devil Creek and the seep were analyzed for arsenic speciation in 2011. The proportion of arsenate to total inorganic arsenic ranged from 72 to 97 percent in 2011 Red Devil Creek surface water samples. The decrease from the high arsenate value of 97 percent at location RD12 to 74 percent at location RD06 suggest the influx along that reach of groundwater with generally higher proportions of arsenite, such as is commonly seen in monitoring wells that are screened in bedrock/weathered bedrock and mine workings (see Section 5.4.5). This is consistent with information on groundwater flow pathways and other evidence indicating influx into Red Devil Creek of groundwater impacted by bedrock and underground mine workings in the Main Processing Area.

The proportion of arsenate in the seep water sample was 31 percent, much lower than the percentage observed in creek water. This is likely due in part to the adsorption of much of the arsenate in the seep water onto the yellowboy (iron oxyhydroxide) deposit at the mouth of the seep, leaving a higher proportion of more mobile arsenite in solution. This hypothesis is supported by the very high total arsenic concentration (130,000 mg/kg) and predominance of arsenate (97 percent of total inorganic arsenic) in the yellowboy sediment sample (see Section 5.3.7.2). The high proportion of arsenite in the seep water is also likely partly attributable to the apparent connection of the seep to the underground mine workings; as noted in Section 5.4.5, wells screened in bedrock and mine workings commonly have generally lower proportions of arsenate than other wells. However, as noted in Section 5.4.5, the proportion of arsenate in the seep sample is lower than those for the wells screened in bedrock, and the concentrations of arsenic in the seep are lower than concentrations for wells screened in bedrock. Thus, conditions at the seep do not appear to simply reflect conditions in bedrock and the underground mine workings.

The ratios of groundwater concentrations to Red Devil Creek surface water concentrations generally are higher for arsenic than for antimony. This is likely because in circum-neutral pH, oxidizing environments such as Red Devil Creek, arsenic is expected to undergo oxidation, transforming from the more mobile arsenite to arsenate, and thus becoming more prone to adsorption onto iron hydroxides (see Section 5.3.2). In contrast, antimony, even in its most oxidized form (Sb[V]), has a comparatively lower affinity for adsorption to iron or aluminum hydroxides (see Section 5.3.3) and thus tends to remain dissolved in surface water.

5.6.2.4 Methylmercury

As noted in Section 5.3.1, the processes of methylation are complex and not fully understood. In order to better understand the processes of mercury methylation at the RDM and provide data on methylmercury concentrations in surface water, surface water samples were analyzed directly for methylmercury. Results are provided in Chapter 4 and discussed below.

Methylmercury concentrations in Red Devil Creek surface water generally increase downstream from the beginning of the Main Processing Area through about station RD06, and slightly decrease further downstream. As noted in Section 5.4.6, methylation is occurring in soil and/or groundwater at the RDM. Methylmercury in surface water appears to result from influx of methylmercury-impacted groundwater into Red Devil Creek and the seep. This is supported by sulfate concentration data. As indicated in Section 5.4.6, the presence of sulfate in groundwater appears to result from oxidation of sulfide minerals in bedrock/weathered bedrock, soil, and mine wastes, and to facilitate methylation of mercury in soil and/or groundwater. In Red Devil Creek surface water samples, methylmercury concentrations correlate well with sulfate concentrations (with R^2 values of 73 percent for 2010 samples and 88 percent for 2011 RI samples), suggesting a common source, which is most likely groundwater.

5.6.3 Red Devil Creek Surface Water Contaminant Loading

Contaminant loading in Red Devil Creek and seep surface water was estimated based on concentrations of total antimony, arsenic, mercury, and methylmercury in surface water samples collected on August 26 and 27, 2011, and stream discharge rates measured on August 18, 2011. Results are presented in Table 5-4. Contaminant loading for the spring and fall 2012 baseline monitoring events also was estimated; results are presented in the 2012 Red Devil Mine Baseline Monitoring Report (E & E 2013), provided in Appendix A.

Contaminant loading (e.g., antimony, arsenic, mercury, and methylmercury) along Red Devil Creek as it flows through the Main Processing Area are attributable primarily to groundwater migration into the stream along gaining reaches. Sources of inorganics in groundwater include leaching from mine wastes as well as naturally mineralized bedrock and native soils (see Section 5.4). Other sources of surface water loading along the creek may include entrainment of contaminants within or adsorbed to particulates, and dissolution/desorption of contaminants from bed and suspended sediment.

5.6.4 Kuskokwim River Suspended and Dissolved Phase Transport

Tailings/waste rock and sluiced overburden materials deposited in the Red Devil Creek delta and the Dolly and Rice Sluice deltas are subject to surface water erosion and transport within the Kuskokwim River. Suspended and dissolved loading of RDM contaminants in the Kuskokwim River were not directly evaluated as part of the RI. Suspended load would be deposited within lower energy environments within the river. The Kuskokwim River is a highly dynamic system, with widely varying river levels, discharge rates, and flow velocities. The river bed and banks also are subject to ice scouring during annual breakup. As such, changes in these factors should result in significant variation in erosion, transport, and deposition conditions both spatially and temporally.

Results of sediment sampling indicate that sediments are impacted by contaminants from the RDM at locations downriver of the Red Devil Creek delta and Dolly and Rice Sluice deltas. A portion of these sediments likely represents material that was transported by suspended load and deposited under lower energy conditions. Some of the material also represents bed load, discussed further below.

5.6.5 Bed Load Sediment Transport

In general, sediment bed load transport is the process by which solid materials are moved downstream by moving water—including movement by rolling, sliding, and saltation—and deposited in a downstream location. Bed load transport is primarily dependent on sediment grain size and shape, flow velocity, stream or river bed morphology (including bottom slope), and particle density. As with suspended load transport (see Section 5.6.1.1), particle density is likely a significant factor at the RDM because of the relatively high specific gravity of cinnabar and stibnite in waste rock. Clasts that make up or contain a significant proportion of cinnabar or stibnite would require greater stream or river energy (usually in the form of higher velocity) in order to migrate along the stream or river bed than would be the case for clasts of similar size and shape that do not contain appreciable amounts of these minerals, including some native soils and alluvium.

At the RDM, bed load transport of contaminants has historically occurred. Sediment bed load transport of contaminants from the RDM is likely an important migration mechanism in Red Devil Creek and the Kuskokwim River. Tailings/waste rock and other materials that entered the Red Devil Creek channel were historically transported, and likely locally deposited downstream within the creek, as evidenced by the occurrence of tailings/waste rock in bed sediments collected in the Red Devil Creek channel. Results of Red Devil Creek sediment sampling are provided in Chapter 4.

Some of the materials were transported within Red Devil Creek downstream to its mouth in the Kuskokwim River. Some of that material was deposited as bed load in the Red Devil Creek delta, and some was further transported by the Kuskokwim River, as evidenced by Kuskokwim River bed load sediment results (see Chapter 4). Transport of overburden from the surface mined area by sluicing resulted in formation of the Dolly and Rice Sluice deltas. Results of surface and subsurface soil samples collected from the Red Devil Creek delta and Dolly and Rice Sluice deltas provide information on these deposits. Results are provided in Chapter 4.

Results of Kuskokwim River bed sediment samples indicate that transportation of materials from Red Devil Creek and its delta, and likely the Dolly and Rice Sluice deltas, has occurred. Results of Kuskokwim River sediment sampling are provided in Chapter 4.

To better understand the processes of mercury methylation at the RDM and provide data on methylmercury concentrations in bed sediment, selected bed sediment samples were analyzed directly for methylmercury. Results of methylmercury analyses are provided in Chapter 4. Methylmercury results for bed sediment collected in Red Devil Creek and the Kuskokwim River are discussed in Sections 5.3.6.1 and 5.3.6.2, respectively.

In order to better understand the fate and transport of arsenic and provide data on concentrations of the various arsenic species in bed sediment, selected samples of bed sediment collected in Red Devil Creek and the Kuskokwim River were analyzed directly for arsenic speciation. Results are discussed in Sections 5.3.7.2 and 5.3.7.3, respectively.

Contaminated soil and sediment (including tailings/waste rock) within the Red Devil Creek channel and delta, sluiced overburden within the Dolly and Rice Sluice deltas, and any such materials the Kuskokwim River are expected to be further transported as bed load, particularly under relatively high energy conditions such as those that occur during spring breakup or intense rainfall events.

Table 5-1 Total, SPLP, and TCLP Antimony, Arsenic, and Mercury Results for Soil

Geographic Area	Sample ID	Soil Type[1]	Total Antimony (mg/kg)	SPLP Antimony (µg/L)	Total Arsenic (mg/kg)	SPLP Arsenic (µg/L)	TCLP Arsenic (µg/L)	Total Mercury (mg/kg)	SPLP Mercury (µg/L)	TCLP Mercury (µg/L)
Pre-1955 Main Processing Area	10MP424344SS	T/WR	880	1,580	1,840	590 J	1,000	136	3.9 J	1.3
	10MP5051525354SS	T/WR	10,100 J	9,140	3,610	2,000	2,800	144	174	7.6
	10MP55565758SS	T/WR	764 J	960	1,100	920	900	114	15	4
	10MP59SS	WR	170 J	110	1,130	370	36 U	115	0.2	-
	11MP48SB08	T/WR	324 J	-	2,550 J	-	120	304	-	-
	11MP48SB12	T/WR | N	361 J	721	1,090 J	80 J	-	51.9	5.98	-
	11MP51SB06	T/WR | F	863 J	2,220 J	2,210 J	614	140	438	0.88 J	-
	11MP52SB06	T/WR	3,770 J	3,100 J	2,690 J	841	530	500	9.4	4 U
	11MP52SB10	N or DN	73.8 J	241 J	76.1 J	86 J	130	18.8	4.51	-
	11MP56SB06	N or DN	1,190 J	2,930	715 J	204	320	2,030	65.5	-
	11MP58SB08	T/WR	19,600 J	26,200	4,460 J	4,880	6,970	622	25.2	-
	11MP59SB12	WR | N	441 J	3,080 J	319 J	208	420	31.1	2.43	-
	11MP60SB14	T/WR	240 J	319	3,120 J	452	800	348	1.44	-
Post-1955 Main Processing Area	10MP01SS	N	20 J	70	100	50 U	-	2.6	0.1	-
	10MP02SS	Ore Pile	210 J	90	7,310	440	-	88	0.6	-
	10MP030405SS	T/WR	5,500 J	9,250	5,580	3,050	5,700	680	30	5
	10MP06070809SS	T/WR	4,420 J	8,190	4,520	2,810	5,400	750	8	3.1
	10MP16SS	T/WR	1,570 J	2,790	6,950	3,870	3,200	290	5.7	-
	10MP17SS	T/WR	6,180 J	7,740	5,540	4,900	11,000	460	14.7	-
	10MP25SS	T/WR	14,100	9,240	5,400	3,820	5,700	1,340	21 J	-
	10MP26SS	T/WR	15,100	11,200	6,420	4,890	9,000	1,620	12 J	-
	10MP27SS	T/WR	8,480	10,700	6,100	3,660	7,300	250	1.5 J	-
	10MP29SS	T/WR	16,700	31,300	6,170	6,000	13,800	440	7 J	-
	10MP32SS	FT	1,430	3,660	9,880	2,310	2,800	127	3.3 J	-
	10MP34SS	FT	780	480	8,510	700 J	900	79	1.2 J	-
	10MP36SS	FT	690	510	7,050	570 J	700	75	1.4 J	4 U
	10OP01SS	Calcine Pile	3,520 J	1,950	5,340	4,430	29,100	170	4.8 J	0.3
	11MP01SB16	N	0.501 J	20 UJ	34	20 U	-	1.56	1.08	-
	11MP10SB06	WB	3.38 J	24 J	15.6 J	20 U	10 U	5.63	2.24	-
	11MP11SB04	T/WR	5,760 J	5,710 J	3,740 J	3,080	7,580	163	37.8	-
	11MP14SB04	T/WR	6,430 J	4,810 J	1,790	2,900	9,010	1,410	166	-
	11MP18SB04	DN (cut & fill)	164 J	587 J	170	39 J	40 J	41	0.82 J	-
	11MP18SB20	DN (cut & fill)	412 J	109 J	106	26 J	40 J	1.78	3.71	-

Table 5-1 Total, SPLP, and TCLP Antimony, Arsenic, and Mercury Results for Soil

Geographic Area	Sample ID	Soil Type[1]	Total Antimony (mg/kg)	SPLP Antimony (µg/L)	Total Arsenic (mg/kg)	SPLP Arsenic (µg/L)	TCLP Arsenic (µg/L)	Total Mercury (mg/kg)	SPLP Mercury (µg/L)	TCLP Mercury (µg/L)
	11MP19SB04	N	1.04 J	20 U	19.6 J	20 U	10 U	1.88	1.58	-
	11MP28SB06	T/WR	15,400 J	16,400 J	7,350	4,830	10,300	434	32.4	-
	11MP29SB10	T/WR	12,600 J	75,300 J	5,580	3,730 J	-	163	1.9	-
	11MP30SB06	T/WR	12,800 J	14,500 J	8,670	5,320	15,700	2,370	356	-
	11MP32SB06	FT	214 J	450	4,170 J	1,390	-	214	7.42	-
	11MP34SB06	FT	668 J	585 J	4,010 J	673	1,820	212	5.35	-
	11MP36SB04	FT	965 J	-	7,670 J	-	1,300	311	-	-
	11MP38SB10	T/WR (+ possible FT)	6,080 J	6,720	3,590 J	862	-	315	10.3	-
	11MP39SB06	T/WR	5,430 J	4,300 J	3,240	2,750 J	-	81.1	10.9	-
	11MP40SB08	T/WR	1,460 J	1,290 J	2,390	582	-	185	37.1	-
Red Devil Creek Downstream Alluvial Area and Delta	10RD04SS	T/WR	381 J	620	1,210	540	-	99	37	-
	10RD06SS	DN with F	677 J	1,290	1,250	660	-	186	40	-
	11RD03SB06	RDCA, DN, and T/WR	2,710 J	4,450	3,510 J	2,630	-	340	18	-
	11RD20SB20	WB	13.5	269 J	128	20 U	-	14.9	1.09	-
Red Devil Creek Upstream Alluvial Area	10RD09SS	DN (KG)	1.4 UJ	50 U	20	50 J	-	2	0.1 UJ	-
	10RD11SS	RDCA	14 J	50 U	41	50 UJ	-	6.6	0.7 J	-
	10RD12SS	RDCA	0.69 UJ	50 U	25	50 U	-	0.79	0.1 U	-
	10RD18SS	RDCA	0.8 UJ	50 U	40	50 U	-	1.57	0.1 U	-
	10RD19SS	RDCA	0.76 UJ	50 U	12	50 U	-	1.86	0.1 U	-
	11RD13SB06	RDCA	6.25 J	28.3 J	8.63	20 U	-	0.287	0.4 U	-
	11RD13SB10	RDCA	-	52.2 J	-	20 UJ	-		0.4 U	-
Dolly Sluice and Delta	10DS01SS	SO	40 J	60	1,010	50 U	-	71	1.6 J	-
	11DS01SB06	SO	11.6	42.5 J	1,200	38 J	-	326	5.92 J	-
Rice Sluice and Delta	10RS01SS	SO	34 J	50 U	29	50 U	-	1.25	0.1 U	-
	11RS01SB12	SO	25.8 J	87.6	50 J	20 U	-	7.44	0.4 U	-
	10MP41SS	DN	39	50 U	516	50 U	-	8	0.9 J	-
	10SM03SS	DN (KG, MZ)	90 J	50 U	2,290	170	-	21	1.3	-
	10SM05SS	DN (KG, MZ)	140 J	50 U	5120	560	-	102	1.6	-
	10SM07SS	DN (KG, MZ)	2.3 UJ	50 U	8510	300	-	174	4.2	-
	10SM12SS	DN (KG and loess)	1.2 UJ	50 U	90	50 U	-	5.4	0.1 U	-
	10SM13SS	DN (KG)	40 J	110	670	50 U	-	23	1.3 J	-
	10SM18SS	DN (KG)	1.2 UJ	50 U	230	50 U	-	11	0.3 J	-

Table 5-1 Total, SPLP, and TCLP Antimony, Arsenic, and Mercury Results for Soil

Geographic Area	Sample ID	Soil Type[1]	Total Antimony (mg/kg)	SPLP Antimony (µg/L)	Total Arsenic (mg/kg)	SPLP Arsenic (µg/L)	TCLP Arsenic (µg/L)	Total Mercury (mg/kg)	SPLP Mercury (µg/L)	TCLP Mercury (µg/L)
Surface Mined Area	10SM19SS	DN (KG)	20 J	50 U	670	70	-	14	2 J	-
	10SM21SS	DN (KG)	0.47 UJ	50 U	39	50 U	-	2	0.1 U	-
	10SM23SS	DN (KG)	508 J	1,430	223	90	-	8.2	1 J	-
	10SM27SS	DN (KG)	1.2 UJ	50 U	20	50 U	-	1.9	0.2 J	-
	10SM28SS	DN (KG and loess)	109 J	380	177	50 U	-	17	1.4 J	-
	11MP41SB06	WB	1.14 J	20 U	59.8 J	20 U	-	3.55	1.13	-
	11SM10SB10	WB	6.15 J	20 U	6,240 J	661	-	48.3	9.58	-
	11SM31SB06	WB	8.57 J	20 U	273 J	42 J	-	15.2	4.2	-
Upland Background Area	10UP09SS	N (KG)	0.56 UJ	50 U	23	50 U	-	0.25	0.1 U	-
	10UP10SS	N (KG)	0.59 UJ	50 U	16	50 U	-	0.22	0.1 U	-
	11UP11SB04	N (KG)	0.277 J	20 U	7.21 J	20 U	-	0.22	0.4 U	-

Key:

% = percent

µg/L = micrograms per liter

J = Analyte detected but relative percent difference was outside control limits; therefore, concentration is estimated.

mg/kg = milligrams per kilogram

SPLP = synthetic precipitation leaching procedure

TCLP - toxicity characteristic leaching procedure

U = Analyte was analyzed for but not detected. Value provided is reporting limit.

UJ = Indicates the compound of analyte was analyzed for but not detected. The sample detection limit is an estimated value.

Notes:

[1] See Chapter 3 for description of soil types.

Table 5-2 Mercury Selective Sequential Extraction Soil Sample Results

Geographic Area	Sample ID	Soil Type	Hg SSE F0 (ng/g)	Hg SSE F1 (ng/g)	Hg SSE F2 (ng/g)	Hg SSE F3 (ng/g)	Hg SSE F4 (ng/g)	Hg SSE F5 (ng/g)	Hg SSE F6 (ng/g)	Hg SSE Total F0 - F6 (ng/g)	Hg SSE F0 % of Total F0 - F6	Hg SSE F1 % of Total F0 - F6	Hg SSE F2 % of Total F0- F6	Hg SSE F3 % of Total F0 - F6	Hg SSE F4 % of Total F0 - F6	Hg SSE F5 % of Total F0 - F6	Hg SSE F6 % of Total F0 - F6
Pre-1955 Main Processing Area	10MP52SS	T/WR	11.9	2,970	36.5	4,080 J	32,300	296,000	16,900 J	352,298.4	0.0	0.8	0.0	1.2	9.2	84.0	4.8
	10MP57SS	T/WR	11.2	2,170	36	1,950 J	28,500	1,110,000	58,200 J	1,200,867.2	0.0	0.2	0.0	0.2	2.4	92.4	4.8
	10MP59SS	WR	3.79	170	0.8	6,250 J	15,600	436,000	26,300 J	484,324.6	0.0	0.0	0.0	1.3	3.2	90.0	5.4
	11MP51SB04	F | T/WR	-	508	41.7	605	5,770	53,800 J	-	60,724.7	-	0.8	0.1	1.0	9.5	88.6	-
	11MP52SB06	T/WR	-	8,010	178,000	30,200	109,000 J	1,250,000 J	-	1,575,210	-	0.5	11.3	1.9	6.9	79.4	-
	11MP52SB10	N or DN	-	22.5	0.2 U	109	125	172 J	-	428.5	-	5.3	-	25.4	29.2	40.1	-
	11MP56SB06	N or DN	-	534	92.7	2,420	12,500	103,000 J	-	118,546.7	-	0.5	0.1	2.0	10.5	86.9	-
	11MP58SB08	T/WR	-	4,860 J	120 J	12,200 J	31,300 J	670,000 J	-	718,480.0	-	0.7	0.0	1.7	4.4	93.3	-
	11MP59SB12	WR | N	-	102	2.92	2,800	51.4	2,660	-	5,616.32	-	1.8	0.1	49.9	0.9	47.4	-
	11MP60SB14	T/WR	-	311	1.34	4,370	15,200	423,000 J	-	442,882.34	-	0.1	0.0	1.0	3.4	95.5	-
Post-1955 Main Processing Area	10MP01SS	N	3.74 U	4.37 J	7.96 J	1,050 J	26.9 J	21.7	10.7 J	1,121.63	-	0.4	0.7	93.6	2.4	1.9	1.0
	10MP16SS	T/WR	11	3,610 J	17 J	12,900 J	55,900 J	782,000	15,400 J	869,838	0.0	0.4	0.0	1.5	6.4	89.9	1.8
	10MP17SS	T/WR	34.1	9,730 J	124 J	9,780 J	39,100 J	425,000	13,500 J	497,268.1	0.0	2.0	0.0	2.0	7.9	85.5	2.7
	10MP25SS	T/WR	174	17,100 J	1,830 J	17,100 J	46,100 J	1,390,000	45,400 J	1,517,704	0.0	1.1	0.1	1.1	3.0	91.6	3.0
	10MP26SS	T/WR	253	15,600 J	1,280 J	14,500 J	42,100 J	1,560,000	30,700 J	1,664,433	0.0	0.9	0.1	0.9	2.5	93.7	1.8
	10MP27SS	T/WR	128	1,980 J	34.4 J	33,300 J	26,900 J	5,060,000	106000 J	5,228,342.4	0.0	0.0	0.0	0.6	0.5	96.8	2.0
	10MP32SS	FT	7.54	1,090 J	406 J	980 J	27,000 J	215,000	7,160 J	251,643.54	0.0	0.4	0.2	0.4	10.7	85.4	2.8
	10MP34SS	FT	2.98 U	560 J	318 J	1,380 J	23,800 J	195,000	7,230 J	228,288	-	0.2	0.1	0.6	10.4	85.4	3.2
	10MP36SS	FT	3.07 U	442 J	51.3 J	727 J	14,900 J	218,000	7,600 J	241,720.3	-	0.2	0.0	0.3	6.2	90.2	3.1
	10MP67SS	T/WR	137	15,000 J	193 J	10,600 J	52,400 J	941,000	35,700 J	1,055,030	0.0	1.4	0.0	1.0	5.0	89.2	3.4
	11MP12SB06	F	-	162	360 J	323 J	1,050	2,300	-	4,195	-	3.9	8.6	7.7	25.0	54.8	-
	11MP14SB04	T/WR	-	26,400	133,000 J	15,200 J	107,000	1,040,000	-	1,321,600	-	2.0	10.1	1.2	8.1	78.7	-
	11MP17SB14	DN (cut & fill)	-	28 J	5 J	2,350 J	277 J	5,690 J	-	8,349.53	-	0.3	0.1	28.1	3.3	68.1	-
	11MP18SB04	DN (cut & fill)	-	677 J	518 J	483 UJ	3,550 J	36,200 J	-	40,945	-	1.7	1.3	-	8.7	88.4	-
	11MP19SB06	WB	-	66.8	50 J	213 J	625	4,490	-	5,444.80	-	1.2	0.9	3.9	11.5	82.5	-
	11MP24SB12	T/WR	-	23,100	814 J	11,300 J	39,400	941,000	-	1,015,614	-	2.3	0.1	1.1	3.9	92.7	-
	11MP26SB10	T/WR	-	2,420 J	754 J	675 J	5,920 J	21,300 J	-	31,069	-	7.8	2.4	2.2	19.1	68.6	-
	11MP28SB06	T/WR	-	6,830	2,000 J	3,950 J	27,500	261,000	-	301,280	-	2.3	0.7	1.3	9.1	86.6	-
	11MP28SB08	N	-	253 J	13.5 J	4,360 J	777 J	5,700 J	-	11,103.50	-	2.3	0.1	39.3	7.0	51.3	-
	11MP30SB06	T/WR	-	36,600	96,300 J	96,900 J	106,000	2,020,000	-	2,355,800	-	1.6	4.1	4.1	4.5	85.7	-
	11MP32SB08	FT	-	1,070 J	1.72 J	28,800 J	29,300 J	348,000 J	-	407,171.72	-	0.3	0.0	7.1	7.2	85.5	-
	11MP34SB04	FT	-	2,860	7.27 J	11,200 J	42,900 J	178,000 J	-	234,967.27	-	1.2	0.0	4.8	18.3	75.8	-
	11MP36SB04	FT	-	1,400	141 J	1,860 J	14,300 J	146,000 J	-	163,701	-	0.9	0.1	1.1	8.7	89.2	-

Table 5-2 Mercury Selective Sequential Extraction Soil Sample Results

Geographic Area	Sample ID	Soil Type	Hg SSE F0 (ng/g)	Hg SSE F1 (ng/g)	Hg SSE F2 (ng/g)	Hg SSE F3 (ng/g)	Hg SSE F4 (ng/g)	Hg SSE F5 (ng/g)	Hg SSE F6 (ng/g)	Hg SSE Total F0 - F6 (ng/g)	Hg SSE F0 % of Total F0 - F6	Hg SSE F1 % of Total F0 - F6	Hg SSE F2 % of Total F0- F6	Hg SSE F3 % of Total F0 - F6	Hg SSE F4 % of Total F0 - F6	Hg SSE F5 % of Total F0 - F6	Hg SSE F6 % of Total F0 - F6
	11MP38SB10	T/WR (+ possible FT)	-	3,990	18.9 J	9,210 J	43,800 J	475,000 J	-	532,018.90	-	0.7	0.0	1.7	8.2	89.3	-
	11MP39SB08	T/WR	-	648 J	2.23 J	33,200 J	2,130 J	23,700 J	-	59,680.23	-	1.1	0.0	55.6	3.6	39.7	-
	11MP40SB08	T/WR	-	2,570 J	322 J	2,770 J	21,800 J	240,000 J	-	267462		1.0	0.1	1.0	8.2	89.7	
Red Devil Creek Downstream Alluvial Area and Delta	10RD04SS	T/WR	12.5	1,910	206	5,260 J	23,900	158,000	7,040 J	196328.5	0.0	1.0	0.1	2.7	12.2	80.5	3.6
	10RD06SS	DN with local fill	3.82 U	1,550	63	4,510 J	64,500	597,000	28,800 J	696,423	-	0.2	0.0	0.6	9.3	85.7	4.1
	11RD03SB06	Mixed RDCA, Soil, and T/WR	-	7,080 J	44.7 J	8,010 J	52,900 J	250,000 J	-	318,034.70	-	2.2	0.0	2.5	16.6	78.6	-
	11RD03SB08	Mixed RDCA, Soil, and T/WR	-	15,000 J	8,040 J	8,520 J	51,900 J	225,000 J	-	308,460	-	4.9	2.6	2.8	16.8	72.9	-
	11RD03SB10	Mixed RDCA, Soil, and T/WR	-	1,950 J	30.7 J	1,490 J	12,200 J	40,900 J	-	565,70.7	-	3.4	0.1	2.6	21.6	72.3	-
	11RD07SB12	B	-	97.1 J	33.3 J	510 J	1,060 J	2,260 J	-	3,960.40	-	2.5	0.8	12.9	26.8	57.1	-
	11RD20SB18	WB	-	71.2 J	2.25 J	647 J	894 J	29,600 J	-	31,214.45	-	0.2	0.0	2.1	2.9	94.8	-
	11RD20SB20	WB	-	35.9	0.82 J	83 J	1,380 J	6,590 J	-	8,089.42	-	0.4	0.0	1.0	17.1	81.5	-
Red Devil Creek Upstream Alluvial Area	10RD09SS	DN (KG)	3.29 U	38.3	4.9	2,550 J	360	999	2.2 U	3,952.20	-	1.0	0.1	64.5	9.1	25.3	-
	10RD11SS	RDCA	5.68 U	10.8	56.9	4,140 J	259	2,000	3.18 U	6,466.70	-	0.2	0.9	64.0	4.0	30.9	-
	10RD12SS	RDCA	5.29 U	2.2	1.25	485 J	21	24.8	3.38 U	534.35	-	0.4	0.2	90.8	3.9	4.6	-
	10RD18SS	RDCA	5.84 U	1.65	0.63 B	482 J	24	65	689 J	1,261.98	-	0.1	0.0	38.2	1.9	5.2	54.6
	10RD19SS	RDCA	4.11 U	2.59	0.85	1,210 J	33	22.1	3.04 U	1,268.84	-	0.2	0.1	95.4	2.6	1.7	-
Dolly Sluice and Delta	10DS01SS	SO	3.82 U	446	125	7,810 J	194,000	1,630,000	79,600 J	1,911,981	-	0.0	0.0	0.4	10.1	85.3	4.2
	11DS01SB06	SO		527	2,900 J	2,090 J	5,560 J	204,000 J	-	215,077	-	0.2	1.3	1.0	2.6	94.8	-
Rice Sluice and Delta	10RS01SS	SO	4.94 U	3.46	0.63 B	1,090 J	268	254	3.03 U	1,616.09	-	0.2	0.0	67.4	16.6	15.7	-
	11RS01SB12	SO		18 J	0.7 J	776 J	1,950 J	1,680 J	-	4,424.70	-	0.4	0.0	17.5	44.1	38.0	-
	10MP41SS	DN	2.98	154	3.96	3,690 J	1,220	22,300	1,640 M	29,010.94	0.0	0.5	0.0	12.7	4.2	76.9	-
	10SM03SS	DN (KG, MZ)	6.36	1,350	2,880	2,540 J	8,470	71,000	6,420 J	92,666.36	0.0	1.5	3.1	2.7	9.1	76.6	6.9
	10SM05SS	DN (KG, MZ)	54.2	544	924	3,080 J	9,660	56,100	5,200 J	75,562.20	0.1	0.7	1.2	4.1	12.8	74.2	6.9

Table 5-2 Mercury Selective Sequential Extraction Soil Sample Results

Geographic Area	Sample ID	Soil Type	Hg SSE F0 (ng/g)	Hg SSE F1 (ng/g)	Hg SSE F2 (ng/g)	Hg SSE F3 (ng/g)	Hg SSE F4 (ng/g)	Hg SSE F5 (ng/g)	Hg SSE F6 (ng/g)	Hg SSE Total F0 - F6 (ng/g)	Hg SSE F0 % of Total F0 - F6	Hg SSE F1 % of Total F0 - F6	Hg SSE F2 % of Total F0- F6	Hg SSE F3 % of Total F0 - F6	Hg SSE F4 % of Total F0 - F6	Hg SSE F5 % of Total F0 - F6	Hg SSE F6 % of Total F0 - F6
Surface Mined Area	10SM07SS	DN (KG, MZ)	527	830	7,580	5,990 J	10,300	87,200	9,350 J	121,777	0.4	0.7	6.2	4.9	8.5	71.6	7.7
	10SM12SS	DN (KG and loess)	3.27 U	32.2	2.42	837 J	306	3,030	4.44 U	4,207.62		0.8	0.1	19.9	7.3	72.0	-
	10SM13SS	DN (KG)	4.06	233	89.8	1,190 J	3,980	33,300	3,230 J	42,026.86	0.0	0.6	0.2	2.8	9.5	79.2	7.7
	10SM18SS	DN (KG)	3.76 U	50	73.2	2,350 J	45.4 U	10,800 J	1,750	15,023.20		0.3	0.5	15.6		71.9	11.6
	10SM19SS	DN (KG)	2.74 U	189	130	1,020 J	3,770	25,500	3,250 J	33,859		0.6	0.4	3.0	11.1	75.3	9.6
	10SM21SS	DN (KG)	4.57	21.9	3.08	648 J	311	1,490	2.25 U	2,478.55	0.2	0.9	0.1	26.1	12.5	60.1	-
	10SM23SS	DN (KG)	3.32 U	147	8.33	2,880 J	1,420	8,040	351 J	12,846.33		1.1	0.1	22.4	11.1	62.6	2.7
	10SM27SS	DN (KG)	9.31	24.8	3.56	1,570 J	157	443	2.15 U	2,207.67	0.4	1.1	0.2	71.1	7.1	20.1	
	10SM28SS	DN (KG and loess)	4.21	318	177	1,870 J	6,550	16,900	774 J	26,593.21	0.0	1.2	0.7	7.0	24.6	63.6	2.9
	11MP41SB06	WB	-	26.7 J	55.7 J	113 J	1,240 J	1,580 J	-	3,015.40	-	0.9	1.8	3.7	41.1	52.4	-
	11SM10SB10	WB	-	403 J	2,390 J	1,100 J	7,450 J	8,770 J	-	20,113	-	2.0	11.9	5.5	37.0	43.6	-
	11SM31SB06	WB	-	514 J	1,700 J	1,290 J	5,930 J	11,200 J	-	20,634	-	2.5	8.2	6.3	28.7	54.3	-
Upland Background Area	10UP09SS	N (KG)	4.15 U	1.26	4.11	207 J	12.9	9.72 M	2.84 U	234.99	-	0.5	1.7	88.1	5.5		-
	10UP10SS	N (KG)	4.53 U	0.54 B	1.62	116 J	9.66	6.76	2.53 U	134.58	-	0.4	1.2	86.2	7.2	5.0	-
	11UP11SB04	N (KG)	-	0.24 UJ	0.24 J	40.8 J	20 J	7.41 J	-	68.45	-		0.4	59.6	29.2	10.8	-

Key:

% = percent

J = Analyte detected but relative percent difference was outside control limits; therefore, concentration is estimated.

ng/g = nanograms per gram

SSE = Selective sequential extraction

U = Analyte was analyzed for but not detected. Value provided is reporting limit.

UJ = Indicates the compound of analyte was analyzed for but not detected. The sample detection limit is an estimated value.

Notes:

1) See Chapter 3 for description of soil types.

2) Analysis for the requested fractions F1 through F5 was performed for all samples submitted for SSE analysis. Analysis for SSE fractions F0 and F6 was performed only for a subset of samples.

Table 5-3 Evaluation of Selected 2011 Groundwater Sample Results

		Wells Reflective of Impacts Associated with Bedrock									Wells Reflective of Impacts Associated with Mine Wastes						
Station ID		MW31	MW18	MW19	MW29	MW28	MW17	MW25	MW24	MW23	MW15	MW20	MW21	MW22	MW14	MW16	MW03
Screen Interval Lithology		Bedrock	Bedrock	Bedrock	Bedrock	Bedrock and cavity apparently associated with underground mine workings	Bedrock	Weathered bedrock	Weathered bedrock and bedrock	Weathered bedrock and bedrock	Tailings/waste rock, native/disturbed native soil; and Red Devil Creek Alluvium	Tailings/waste rock and native/disturbed native soil	Tailings/waste rock; native soil, native/disturbed native soil, or fill; and weathered bedrock	Tailings/waste rock and bedrock	Red Devil Creek Alluvium	Native soil or disturbed native soil	Native soil or disturbed native soil
Hydrogeologic Setting		Upland Area West of Surface Mined Area	Upgradient of the Post-1955 Main	Upgradient of the Post-1955 Main	Surface Mined Area upgradient of the Pre-	Main Processing Area near Red Devil Creek	Main Processing Area near Red Devil Creek	Main Processing Area near Red Devil Creek	Main Processing Area near Red Devil Creek	Red Devil Creek valley downstream of Main	Main Processing within and	Main Processing within and	Main Processing within and	Main Processing within and	Main Processing downgradient of area	Main Processing downgradient of area	Main Processing downgradient of area
Analyte	Units																
Total Inorganic Elements																	
Aluminum	µg/L	**405**	**525**	**1460 J**	**397**	**316**	**440**	**240**	**553**	**81.7**	**28.3 J**	**8.8 J**	**12.1 J**	**36.9 J**	**125 J**	**202**	**14.2 J**
Antimony	µg/L	**0.098**	**1.04 J**	**0.6 J**	**1.21**	**19.3 J**	**53.9**	**5.86 J**	**101 J**	**2.4 J**	**13100**	**566 J**	**5860**	**297**	**79.5 J**	**678**	**917**
Arsenic	µg/L	0.1 U	**1.3**	**5.6**	**36.9**	**32.8**	**28.5**	**6.2**	**7.4**	**9.2**	**5620**	**161**	**1760**	**80.4**	**6650**	**1020**	**58.9**
Barium	µg/L	**11.1**	**83.7**	**73.4**	**224**	**59.7**	**53**	**55**	**29.4**	**210**	**93.6**	**38.3**	**114**	**52.9**	**73.6**	**46.9**	**28.2**
Beryllium	µg/L	**0.018 J**	**0.068**	**0.11**	**0.059**	**0.06**	**0.028**	**0.021**	**0.033**	**0.019 J**	0.006 U	0.006 U	0.006 U	0.006 U	**0.007 J**	**0.015**	0.006 U
Cadmium	µg/L	**0.017 J**	**0.028 J**	**0.087**	**0.076**	**0.052**	**0.028**	**0.117**	**0.032 J**	**0.013 J**	**0.027**	**0.005 J**	**0.008 J**	**0.018 J**	**0.032**	**0.151**	**0.022**
Calcium	µg/L	**7730**	**16700**	**19700**	**64800**	**43900**	**23100**	**35000**	**35500**	**37300**	**50300**	**20100**	**31200**	**14700**	**21000**	**24800**	**22300**
Chromium	µg/L	**4.95**	**1.67**	**6.46**	**10.6**	**6.29**	**4.7**	**1.03**	**1.15**	**0.31**	**0.59**	**0.16 J**	**0.08 J**	**0.22**	**0.88**	**0.83**	**0.28**
Cobalt	µg/L	**0.314**	**2.28**	**3.89**	**9.48**	**5.26**	**0.843**	**4.77**	**2.12**	**3.01**	**0.299**	**0.18**	**0.071**	**0.106**	**6.81**	**7.36**	**0.045**
Copper	µg/L	**0.48**	**2.29**	**6.29**	**3.6**	**3.48**	**1.54**	**2.32**	**1.97 J**	**0.73**	**1.63**	**0.29**	**1.11**	**1.4**	**1.25**	**1.08**	**0.53**
Iron	µg/L	**777**	**1720**	**5570**	**2670**	**3510**	**1100**	**609**	**1370**	**6450**	**33.6**	**24.1**	**5.8 J**	**104**	**18700**	**10600**	**15.3 J**
Lead	µg/L	**0.311**	**0.861**	**2.02**	**0.63**	**0.728**	**0.794**	**0.257**	**0.81 J**	**0.187**	**0.029**	**0.024**	**0.019 J**	**0.137**	**0.218**	**0.201**	**0.025**
Magnesium	µg/L	**5390**	**14200**	**13700**	**68800**	**31400**	**16500**	**24200**	**27100**	**30000**	**71900**	**15100**	**27500**	**11900**	**17100**	**42400**	**26900**
Manganese	µg/L	**19.2**	**543**	**141**	**778**	**1480**	**62.2**	**207**	**107**	**905**	**11.7**	**5.65**	**5.55**	**17.6**	**3310**	**4750**	**1.12**
Mercury	ng/L	**58.4**	**50.4**	**413**	**247**	**4000**	**6070**	**452**	**56500**	**261**	**2910**	**1610**	**141**	**981**	**759**	**1210**	**47.7**
Nickel	µg/L	**2.68**	**6.5**	**12.1**	**28.3**	**16**	**4.7**	**13.9**	**4.11**	**4.74**	**13.2**	**1.3**	**1.51**	**2.06**	**4.97**	**4.01**	**1.6**
Potassium	µg/L	**417 J**	**932**	**1380**	**2190**	**3140**	**627**	**972**	**1050**	**1390**	**2380**	**523**	**1800**	**259 J**	**706**	**2000**	**1150**
Selenium	µg/L	0.3 U	0.3 U	**1**	0.3 U	0.3 U	**0.4 J**	0.3 U	0.3 U	0.3 U	**5.4**	**1.1**	**0.3 J**	0.3 U	0.2 U	0.3 U	**0.7 J**
Silver	µg/L	**0.016 J**	**0.012 J**	**0.035**	**0.009 J**	**0.015 J**	**0.015 J**	**0.017 J**	**0.049 J**	**0.005 J**	0.004 U	**0.005 J**	**0.011 J**	**0.013 J**	0.004 U	**0.004 J**	0.004 U
Sodium	µg/L	**1560**	**2330 J**	**2350 J**	**4570**	**13000**	**2760**	**6410**	**19400**	**8710**	**5400**	**2330**	**5210**	**2560**	**3020**	**4950**	**2550**
Thallium	µg/L	**0.009 J**	**0.008 J**	**0.029**	**0.015 J**	**0.012 J**	**0.016 J**	**0.012 J**	**0.006 J**	**0.008 J**	0.005 U	0.005 U	**0.007 J**	**0.006 J**	0.005 U	**0.015 J**	0.005 U
Vanadium	µg/L	**0.51**	**1.06**	**3.88**	**1.56**	**1.19**	**0.75**	**0.44**	**1.96**	**0.26**	**2.11**	**0.24**	**1.38**	**0.43**	**1.34**	**1.06**	**0.25**
Zinc	µg/L	**1.3**	**4.1**	**9.4**	**15**	**11.9**	**2.7**	**11.4**	**5.4 J**	**4.7**	**5.6**	**1.4**	**1.1**	**1.6**	**5.4**	**3.6**	**1.3**
Dissolved Inorganic Elements																	
Aluminum, Dissolved	µg/L	**8 J**	2 U	**2.1 J**	2 U	**8.3 J**	2 U	**12.7 J**	**2.6 J**	**6.7 J**	**3.7 J**	**4.9 J**	**5.1 J**	**16.8 J**	**14.2 J**	**15.3 J**	**5.5 J**
Antimony, Dissolved	µg/L	**0.027 J**	**0.654 J**	**0.317 J**	**0.837**	**9.18 J**	**9.16**	**3.71 J**	**79.9 J**	**1.87 J**	**13100**	**616 J**	**5950**	**294**	**53.8 J**	**658**	**861**
Arsenic, Dissolved	µg/L	0.1 U	**0.7**	**2.9**	**31.1**	**8.4**	**4.9**	**3.6**	**5.1**	**8**	**5590**	**173**	**1770**	**77.3**	**6660**	**1010**	**56**
Barium, Dissolved	µg/L	**4.05**	**72**	**46.3**	**206**	**50**	**39.9**	**54.1**	**23.3**	**197**	**92.3**	**39.8**	**115**	**51.1**	**68.5**	**43.4**	**27.9**
Beryllium, Dissolved	µg/L	0.006 U	0.006 U	0.006 U	**0.016 J**	**0.007 J**	0.006 U	**0.013 J**	0.006 U	**0.016 J**	0.006 U	0.006 U	0.006 U	0.006 U	**0.01 J**	**0.009 J**	0.006 U
Cadmium, Dissolved	µg/L	**0.008 J**	**0.014 J**	**0.029**	**0.058**	**0.022**	**0.012 J**	**0.086**	**0.006 J**	**0.007 J**	**0.023**	**0.008 J**	**0.007 J**	**0.007 J**	**0.019 J**	**0.13**	**0.016 J**
Calcium, Dissolved	µg/L	**7620**	**16200**	**18700**	**62700**	**42000**	**23000**	**34400**	**34500**	**36600**	**49400**	**20000**	**31400**	**14500**	**20700**	**25500**	**22000**
Chromium, Dissolved	µg/L	**1.43**	**0.24**	**0.66**	**2.81**	**0.81**	**0.83**	**0.86**	**0.26**	**0.18 J**	**0.71**	**0.5**	**0.2 J**	**0.33**	**0.73**	**0.43**	**0.49**
Cobalt, Dissolved	µg/L	**0.043**	**1.65**	**1.41**	**8.32**	**4.18**	**0.196**	**4.76**	**1.32**	**2.67**	**0.298**	**0.171**	**0.074**	**0.08**	**6.85**	**7.14**	**0.037**
Copper, Dissolved	µg/L	**0.13**	**0.22**	**0.14**	**0.95**	**0.82**	**0.14**	**1.45**	**0.22**	**0.13**	**1.59**	**0.28**	**1.07**	**1.19**	**0.38**	**0.48**	**0.41**
Iron, Dissolved	µg/L	**7.5 J**	**621**	**51.7**	**1040**	**211**	**10.1 J**	**10.9 J**	3 U	**5970**	**7.2 J**	**3.4 J**	**6.6 J**	**15.8 J**	**17600**	**10600**	3 U
Lead, Dissolved	µg/L	0.005 U	**0.012 J**	**0.014 J**	**0.024**	**0.009 J**	**0.005 J**	**0.014 J**	0.005 U	**0.013 J**	**0.014 J**	0.005 U	**0.007 J**	**0.044**	**0.046**	**0.008 J**	0.005 U
Magnesium, Dissolved	µg/L	**5410**	**14000**	**12900**	**67400**	**29300**	**16400**	**24300**	**27000**	**29900**	**73500**	**15200**	**27500**	**12000**	**16900**	**43600**	**26200**
Manganese, Dissolved	µg/L	**1.78**	**493**	**54.1**	**694**	**1340**	**2.62**	**206**	**79.8**	**851**	**11**	**5.63**	**6.52**	**15.6**	**3370**	**5070**	**0.606**
Mercury, Dissolved	ng/L	**0.7 J**	**2.7**	**0.54 J**	**0.71 J**	**10.9**	**9.49**	**44.7**	**6.11**	**2.39**	**2200**	**277**	**80.2**	**527**	**141**	**285**	**9.09**
Nickel, Dissolved	µg/L	**1.84**	**4.75**	**5.74**	**24.8**	**10.8**	**2.63**	**13.5**	**2.33**	**4.21**	**12.9**	**1.46**	**1.47**	**1.93**	**5.14**	**3.59**	**1.65**
Potassium, Dissolved	µg/L	**162 J**	**719**	**323 J**	**1860**	**2260**	**415**	**788**	**861**	**1300**	**2480**	**535**	**1810**	**211 J**	**628**	**2000**	**1100**
Selenium, Dissolved	µg/L	0.3 U	0.3 U	**0.9 J**	0.3 U	0.3 U	**0.6 J**	0.3 U	0.3 U	0.3 U	**4.9**	**0.8 J**	**0.4 J**	0.3 U	0.2 U	0.3 U	**0.5 J**
Silver, Dissolved	µg/L	0.004 U	0.004 U	**0.013 J**	0.004 U	0.004 U	0.004 U	**0.007 J**	0.004 U	0.004 U	0.004 U	0.004 U	**0.008 J**	0.004 U	0.004 U	0.004 U	0.004 U
Sodium, Dissolved	µg/L	**1500**	**2310**	**2300 J**	**4300**	**11700**	**2770**	**6450**	**20000**	**8800**	**5620**	**2330**	**5230**	**2590**	**3030**	**5070**	**2530**
Thallium, Dissolved	µg/L	0.005 U	0.005 U	**0.012 J**	**0.007 J**	0.005 U	0.005 U	**0.006 J**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.007 J**	**0.012 J**	0.005 U
Vanadium, Dissolved	µg/L	**0.05 J**	**0.03 J**	**0.16 J**	**0.1 J**	**0.04 J**	0.03 U	**0.09 J**	**0.34**	**0.06 J**	**2.03**	**0.19 J**	**1.28**	**0.34**	**1.06**	**0.71**	**0.23**
Zinc, Dissolved	µg/L	**0.4 J**	**1.1**	**0.3 J**	**11.3**	**6.3**	**0.5 J**	**10.1**	**1.6**	**3.1**	**5.7**	**0.8**	**1**	**1**	**4.3**	**2.8**	**1.1**
Ratio of Total-to-Dissolved Concentrations[a]																	
Aluminum	Unitless	51	263	695	199	38	220	19	213	12	7.6	1.8	2.4	2.2	8.8	13	2.6
Antimony	Unitless	3.6	1.6	1.9	1.4	2.1	5.9	1.6	1.3	1.3	1.0	0.9	1.0	1.0	1.5	1.0	1.1
Arsenic	Unitless	1.0	1.9	1.9	1.2	3.9	5.8	1.7	1.5	1.2	1.0	0.9	1.0	1.0	1.0	1.0	1.1
Barium	Unitless	2.7	1.2	1.6	1.1	1.2	1.3	1.0	1.3	1.1	1.0	1.0	1.0	1.0	1.1	1.1	1.0
Beryllium	Unitless	3.0	11	18	3.7	8.6	4.7	1.6	5.5	1.2	1.0	1.0	1.0	1.0	0.7	1.7	1.0
Cadmium	Unitless	2.1	2.0	3	1.3	2.4	2.3	1.4	5.3	1.9	1.2	0.6	1.1	2.6	1.7	1.2	1.4
Calcium	Unitless	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chromium	Unitless	3.5	7.0	9.8	3.8	7.8	5.7	1.2	4.4	1.7	0.8	0.3	0.4	0.7	1.2	1.9	0.6
Cobalt	Unitless	7.3	1.4	2.8	1.1	1.3	4.3	1.0	1.6	1.1	1.0	1.1	1.0	1.3	1.0	1.0	1.2
Copper	Unitless	3.7	10	45	3.8	4.2	11	1.6	9.0	5.6	1.0	1.0	1.0	1.2	3.3	2.3	1.3
Iron	Unitless	104	2.8	108	2.6	17	109	56	457	1.1	4.7	7.1	0.9	6.6	1.1	1.0	5.1
Lead	Unitless	62	72	144	26	81	159	18	162	14	2.1	4.8	2.7	3.1	4.7	25	5.0
Magnesium	Unitless	1.0	1.0	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Manganese	Unitless	11	1.1	2.6	1.1	1.1	24	1.0	1.3	1.1	1.1	1.0	0.9	1.1	1.0	0.9	1.8
Mercury	Unitless	83	19	765	348	367	640	10	9247	109	1.3	5.8	1.8	1.9	5.4	4.2	5.2
Nickel	Unitless	1.5	1.4	2.1	1.1	1.5	1.8	1.0	1.8	1.1	1.0	0.9	1.0	1.1	1.0	1.1	1.0
Potassium	Unitless	2.6	1.3	4.3	1.2	1.4	1.5	1.2	1.2	1.1	1.0	1.0	1.0	1.2	1.1	1.0	1.0
Selenium	Unitless	1.0	1.0	1.1	1.0	1.0	0.7	1.0	1.0	1.0	1.1	1.4	0.8	1.0	1.0	1.0	1.4
Silver	Unitless	4.0	3.0	2.7	2.3	3.8	3.8	2.4	12	1.3	1.0	1.3	1.4	3.3	1.0	1.0	1.0
Sodium	Unitless	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Thallium	Unitless	1.8	1.6	2.4	2.1	2.4	3.2	2.0	1.2	1.6	1.0	1.0	1.4	1.2	0.7	1.3	1.0
Vanadium	Unitless	10	35	24	16	30	25	4.9	5.8	4.3	1.0	1.3	1.1	1.3	1.3	1.5	1.1
Zinc	Unitless	3.3	3.7	31	1.3	1.9	5.4	1.1	3.4	1.5	1.0	1.8	1.1	1.6	1.3	1.3	1.2
Arsenic Speciation																	
Arsenate	µg/L	**0.057**	**0.415**	**3.08**	**28.2**	**7.43**	-	**5**	**6.05**		**4520**	**188**	**1640**	-	-	-	-
Arsenite	µg/L	0.003 U	**0.306 J**	**2.07 J**	**10.9**	**6.75 J**	-	**0.42 J**	**1.16 J**		**13 J**	**1.1**	**5.19 J**	-	-	-	-
Inorganic Arsenic	µg/L	**0.061**	**0.721**	**5.15**	**39.1**	**14.2**	-	**5.42**	**7.21**		**4530**	**189**	**1640**	-	-	-	-
Proportion of Arsenate to Total Inorganic Arsenic	Percent	95%	58%	60%	72%	52%	-	92%	84%		100%	99%	100%	-	-	-	-

Key

Bold = detection

µg/L = micrograms per liter

J = Analyte detected but relative percent difference was outside control limits therefore concentration is estimated.

ng/L = nanograms per liter

U = Analyte was analyzed for but not detected. Value provided is reporting limit.

Notes:

[a] = If either or both of the total or dissolved inorganic element concentrations was nondetect (U), the total-to-dissolved ratio was calculated using the reporting limit(s).

Table 5-4 Surface Water Loading, August 2011 – Antimony, Arsenic, Mercury, and Methylmercury (kg/day)

Station ID	RD03	RD10	RD04	RD05	RD12	RD09	RD06	RD07	RD08
Sample ID	11RD03SW	11RD10SW	11RD04SW	11RD05SW	11RD12SW	11RD09SW	11RD06SW	11RD07SW	11RD08SW
Total Antimony	0.015	0.026	0.25	0.014	1.24	1.84	2.70	3.11	3.24
Total Arsenic	0.008	0.014	0.16	0.45	0.45	1.07	1.42	1.49	1.37
Total Mercury	4.50E-05	5.77E-05	2.97E-04	2.77E-05	1.43E-03	4.56E-03	3.57E-03	3.72E-03	4.20E-03
Methyl-mercury	9.01E-07	1.08E-06	1.16E-06	2.73E-07	1.81E-06	1.90E-06	2.33E-06	2.61E-06	2.11E-06

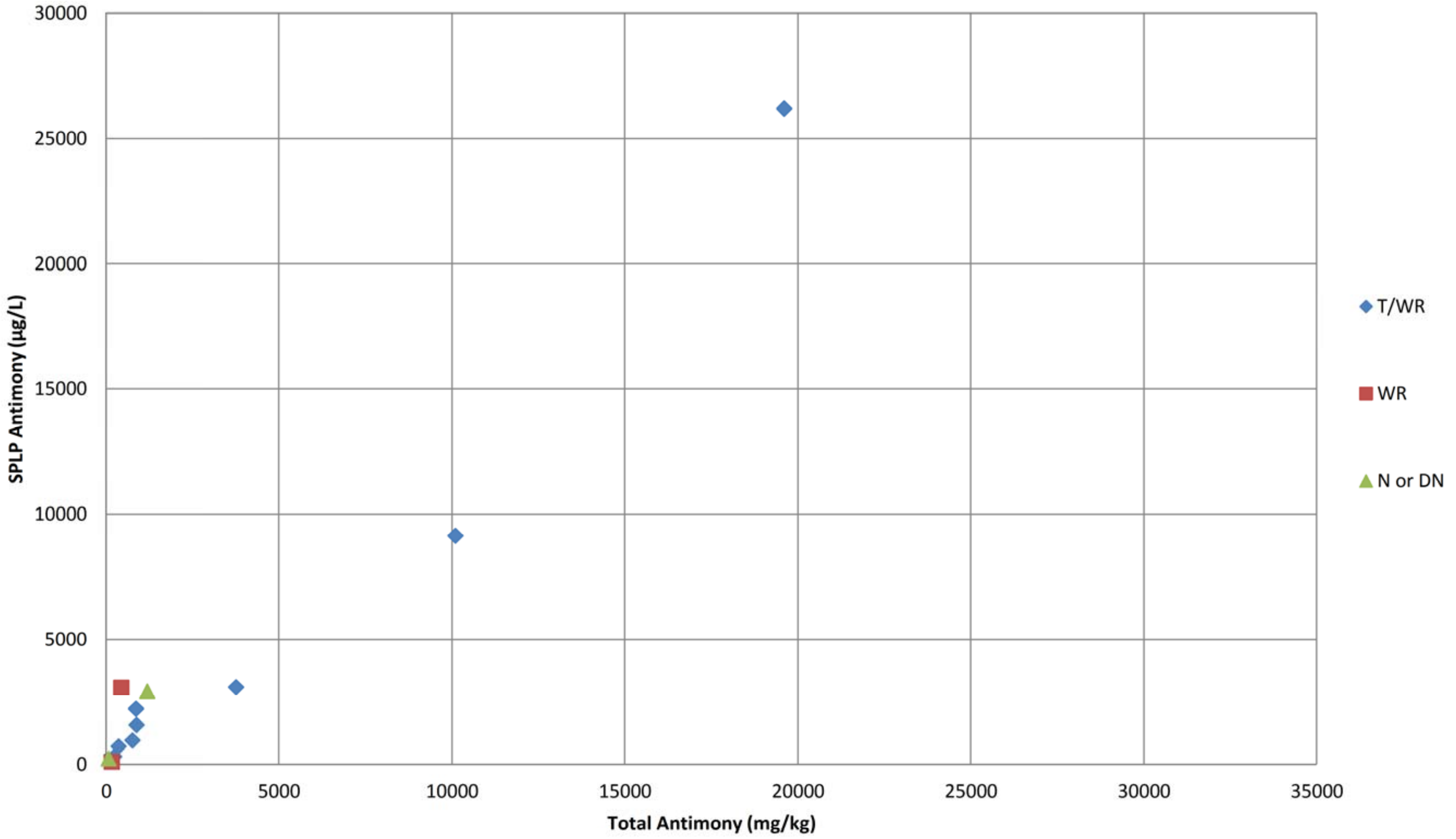


Figure 5-1 Antimony - SPLP vs. Total
Pre-1955 Main Processing Area

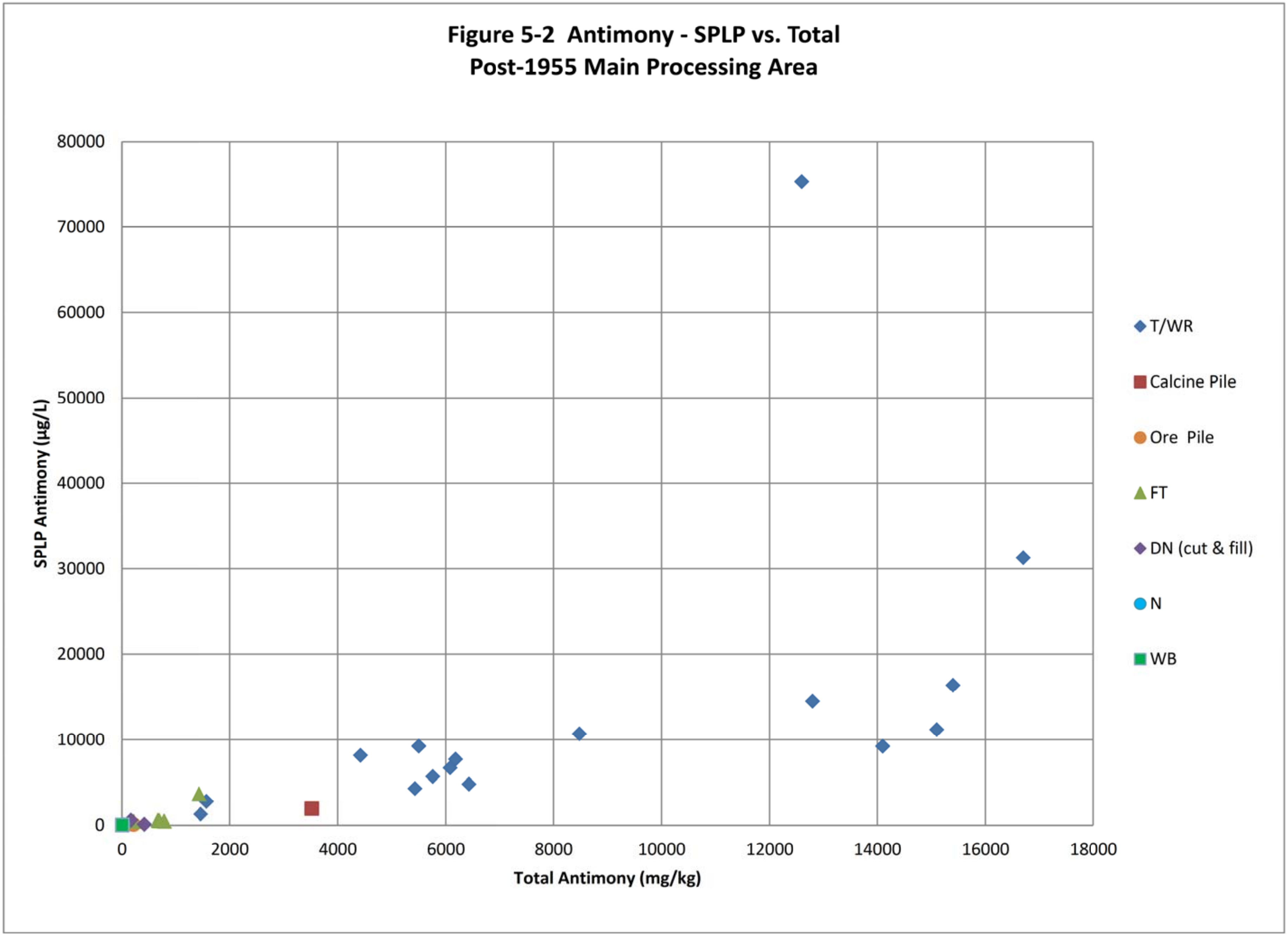
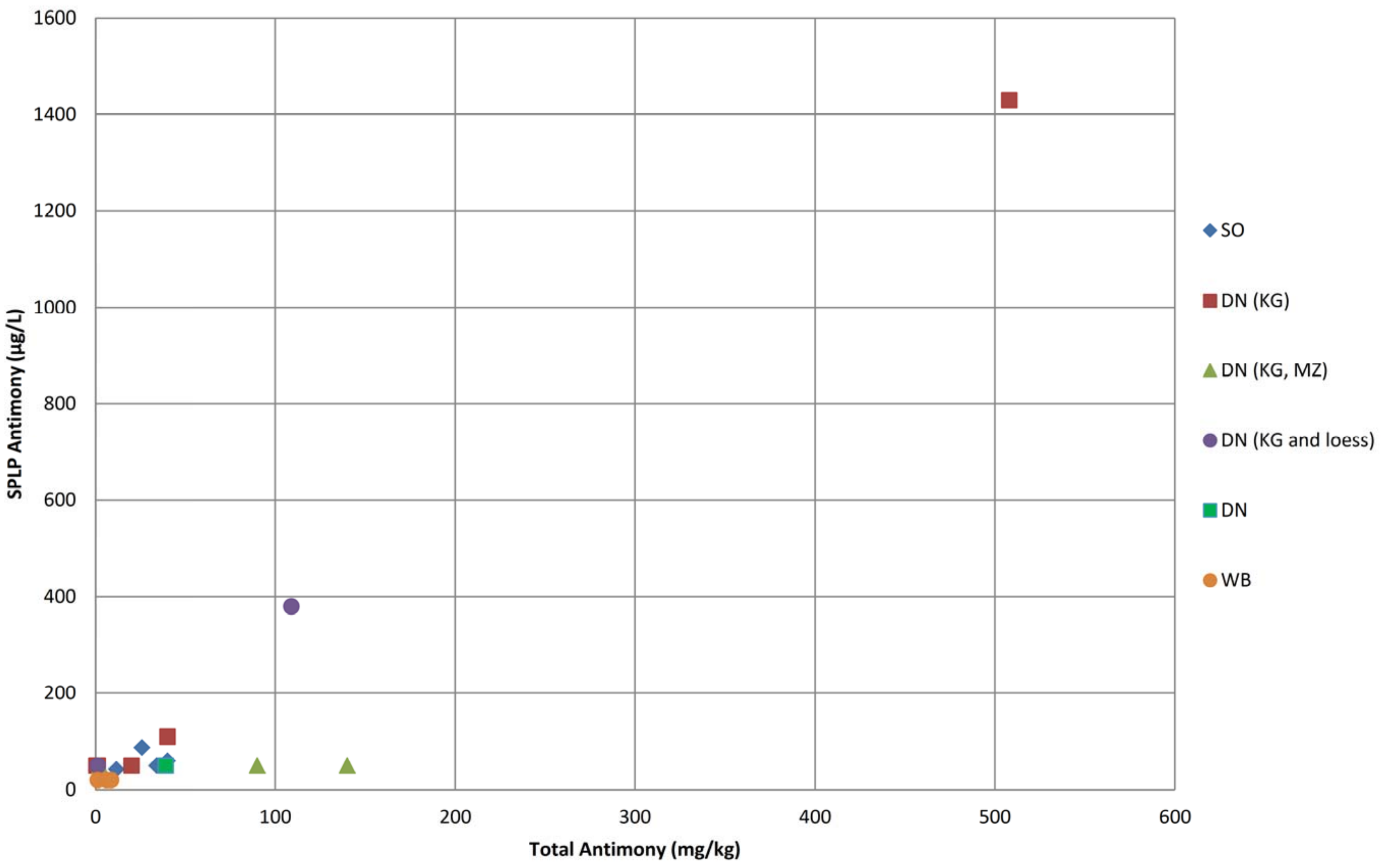


Figure 5-2 Antimony - SPLP vs. Total
Post-1955 Main Processing Area

Figure 5-3 Antimony - SPLP vs. Total
Surface Mined Area, Dolly Sluice Delta, and Rice Sluice Delta



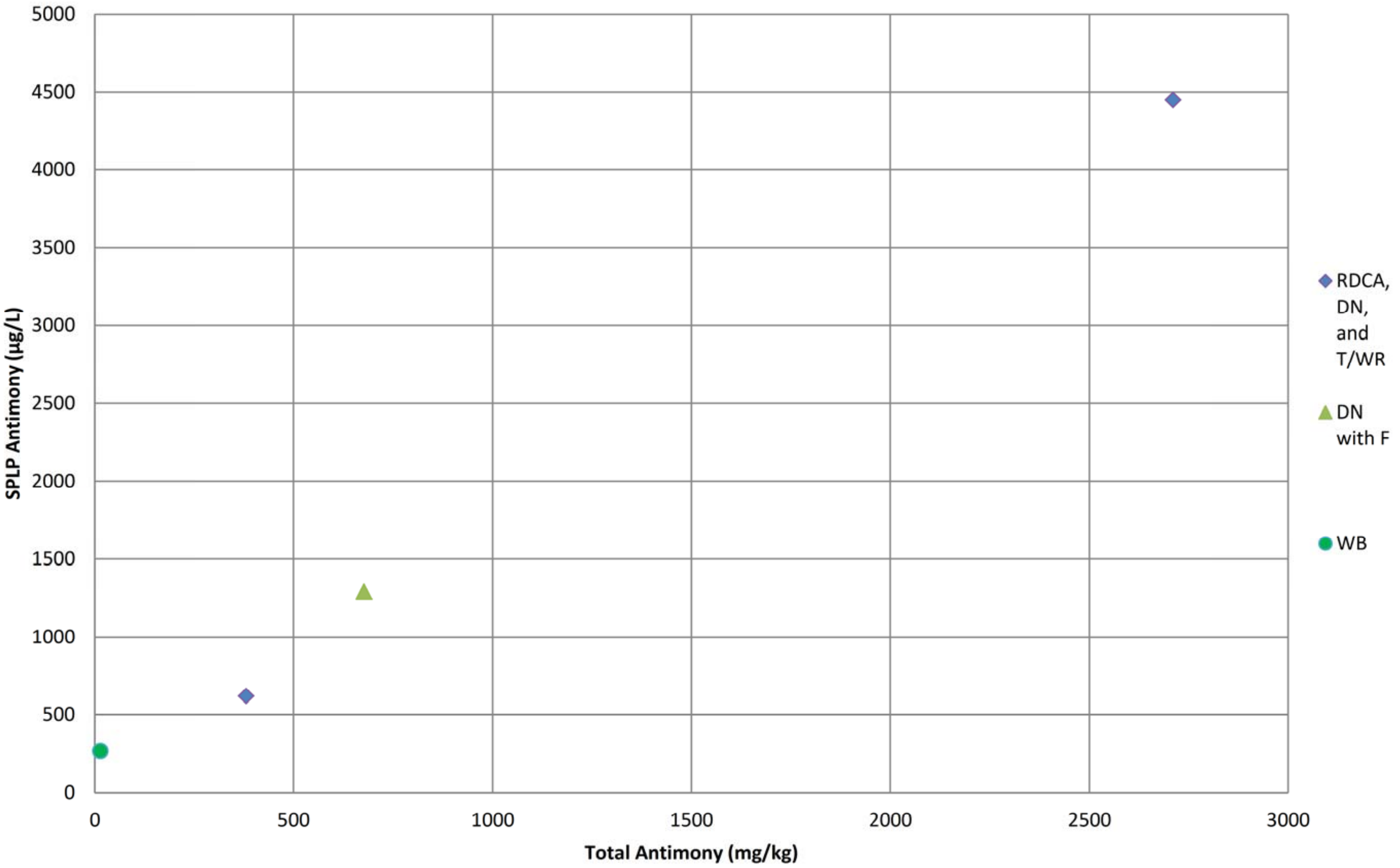


Figure 5-4 Antimony - SPLP vs. Total
Red Devil Creek Downstream Alluvial Area and Delta

Figure 5-5 Arsenic - SPLP vs. Total
Pre-1955 Main Processing Area

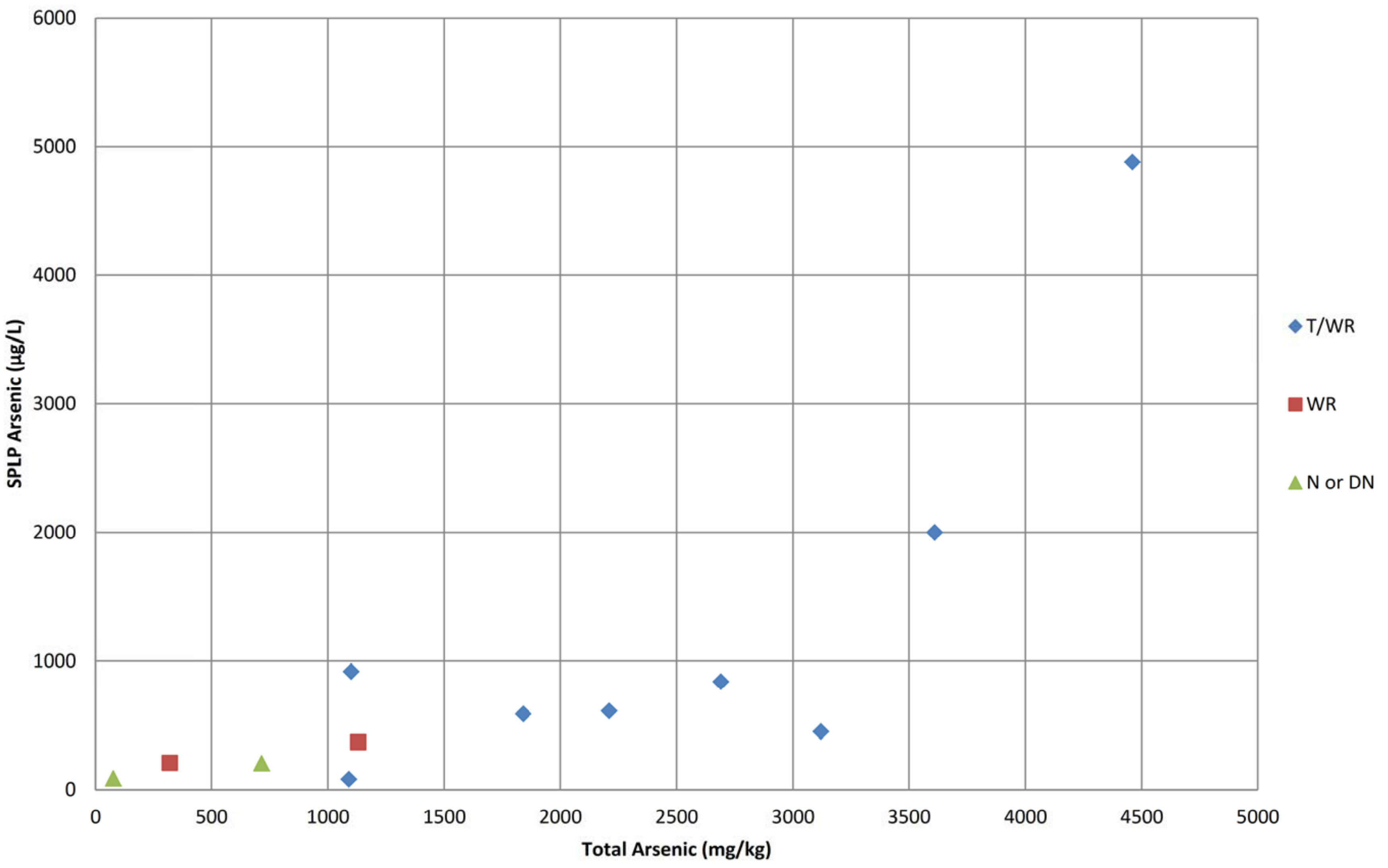


Figure 5-6 Arsenic - SPLP vs. Total
Post-1955 Main Processing Area

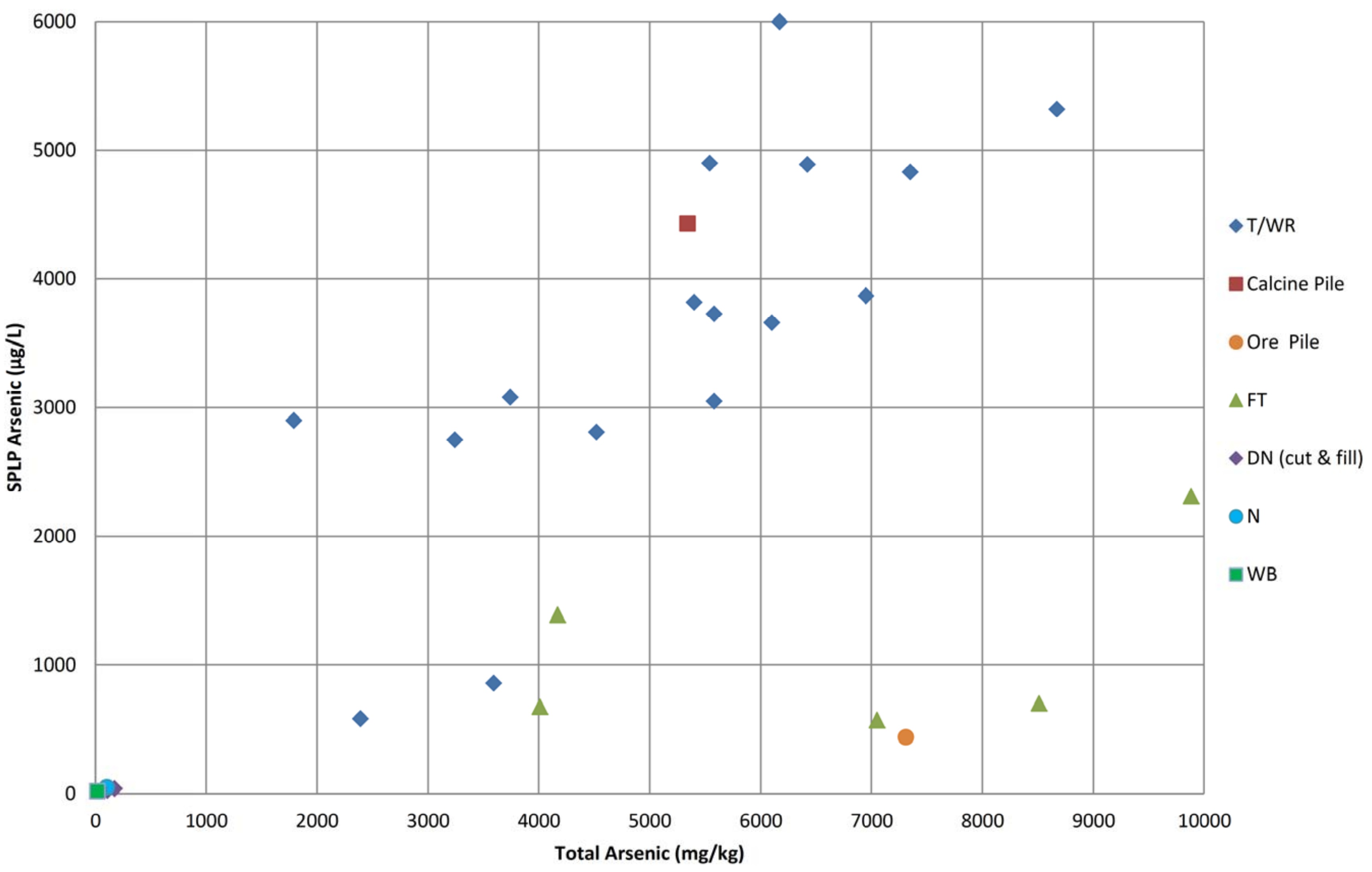


Figure 5-7 Arsenic - SPLP vs. Total
Surface Mined Area, Dolly Sluice Delta, and Rice Sluice Delta

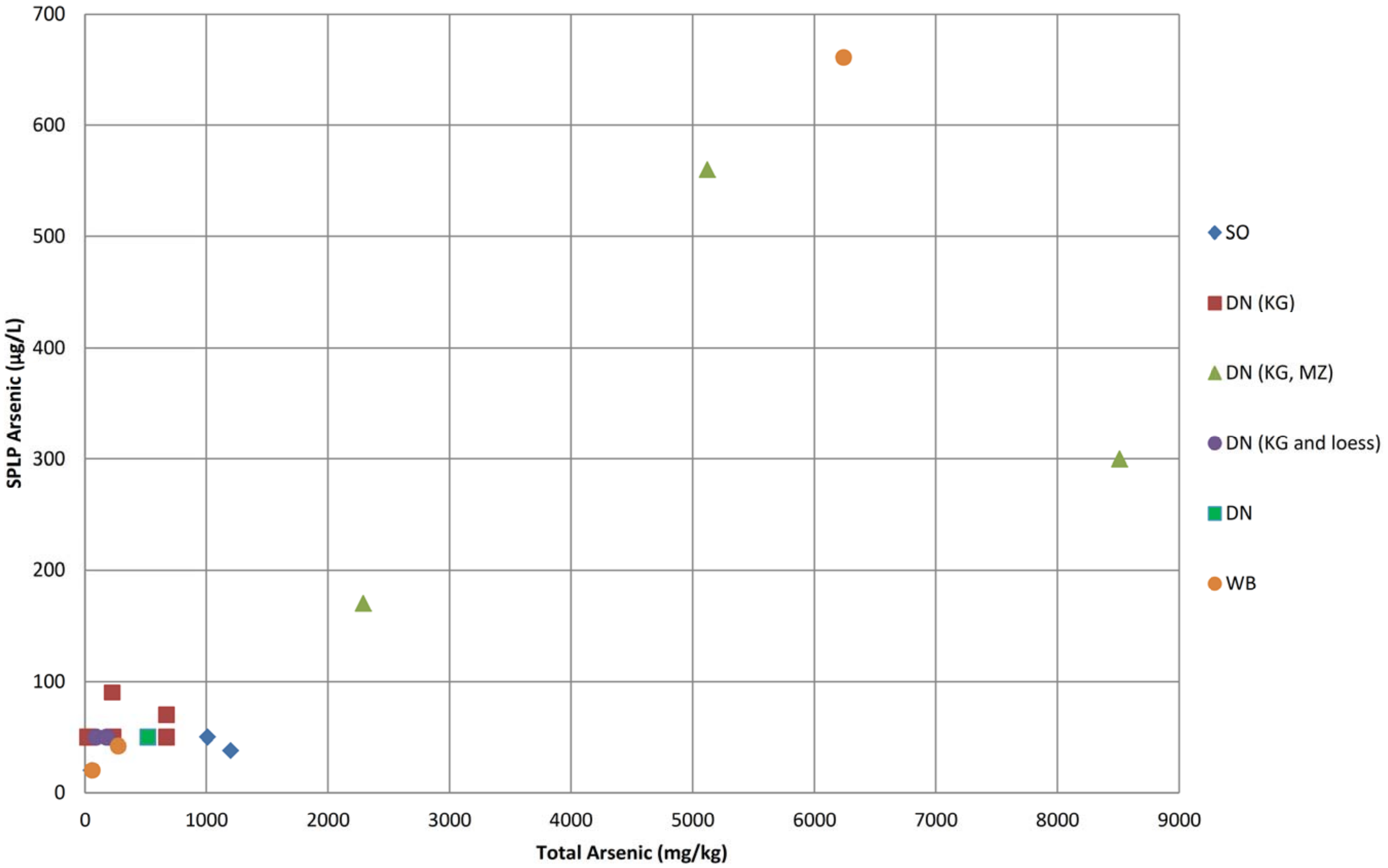


Figure 5-8 Arsenic - SPLP vs. Total
Red Devil Creek Downstream Alluvial Area and Delta

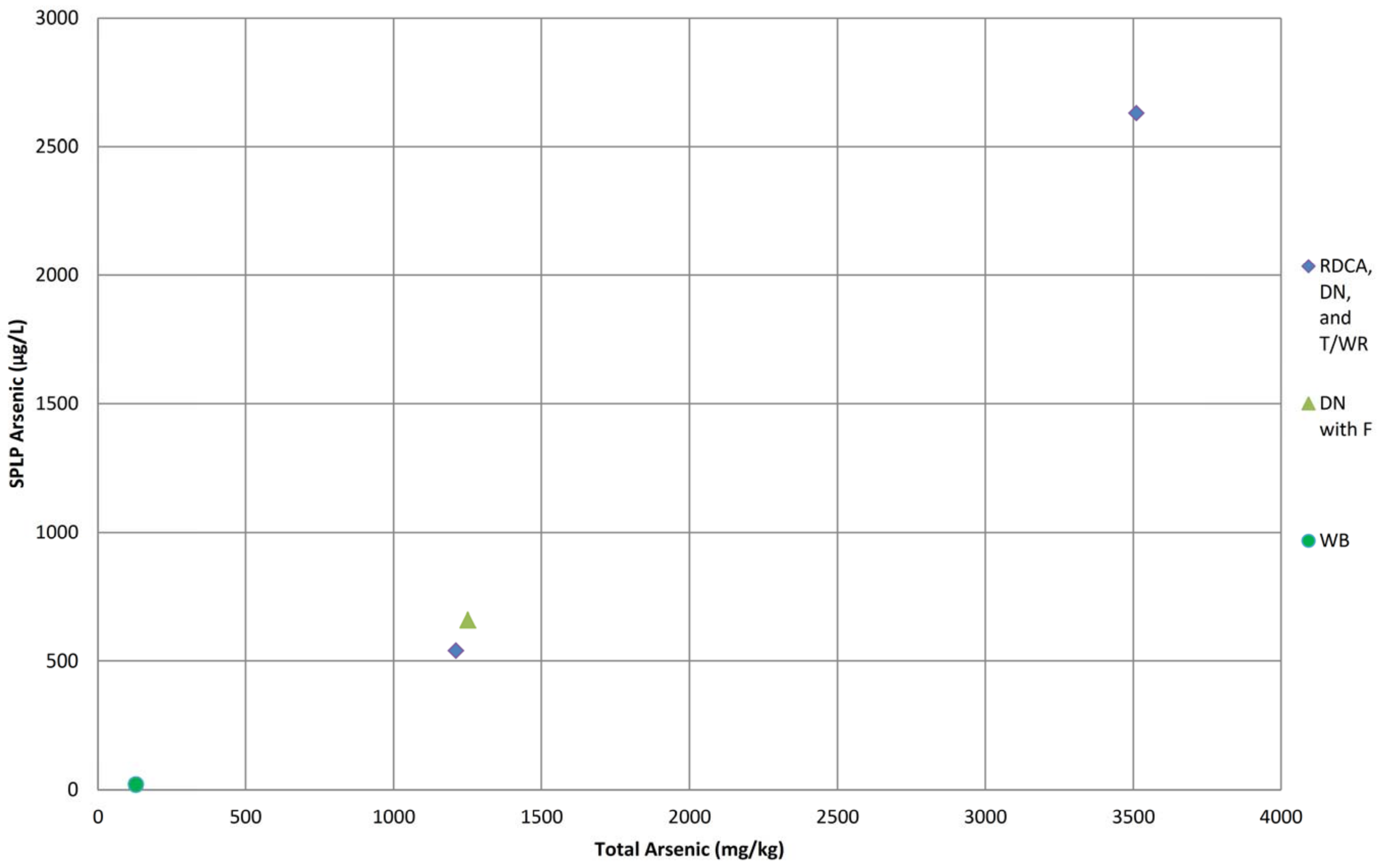


Figure 5-9 Mercury - SPLP vs. Total
Pre-1955 Main Processing Area

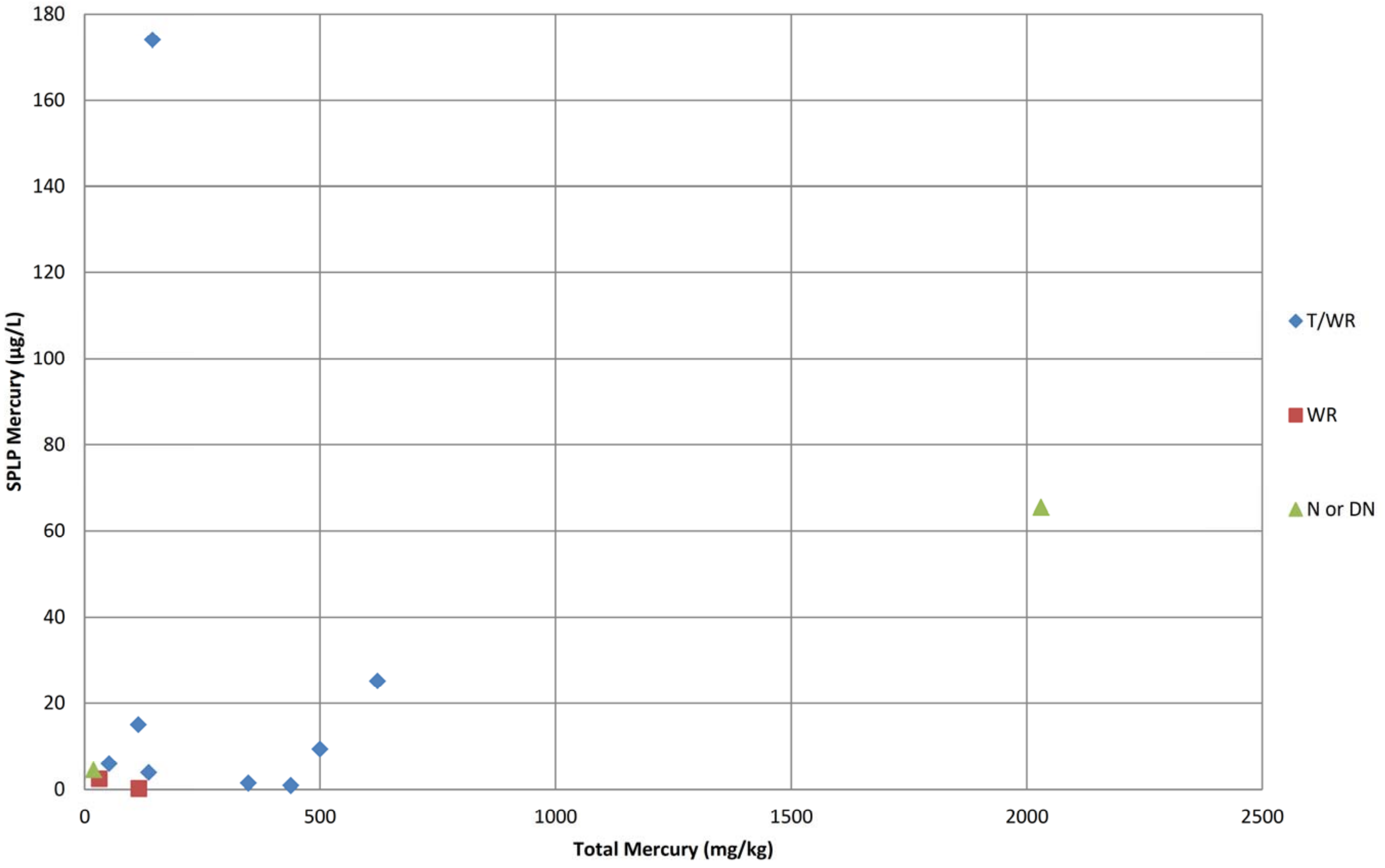


Figure 5-10 Mercury - SPLP vs. Total
Post-1955 Main Processing Area

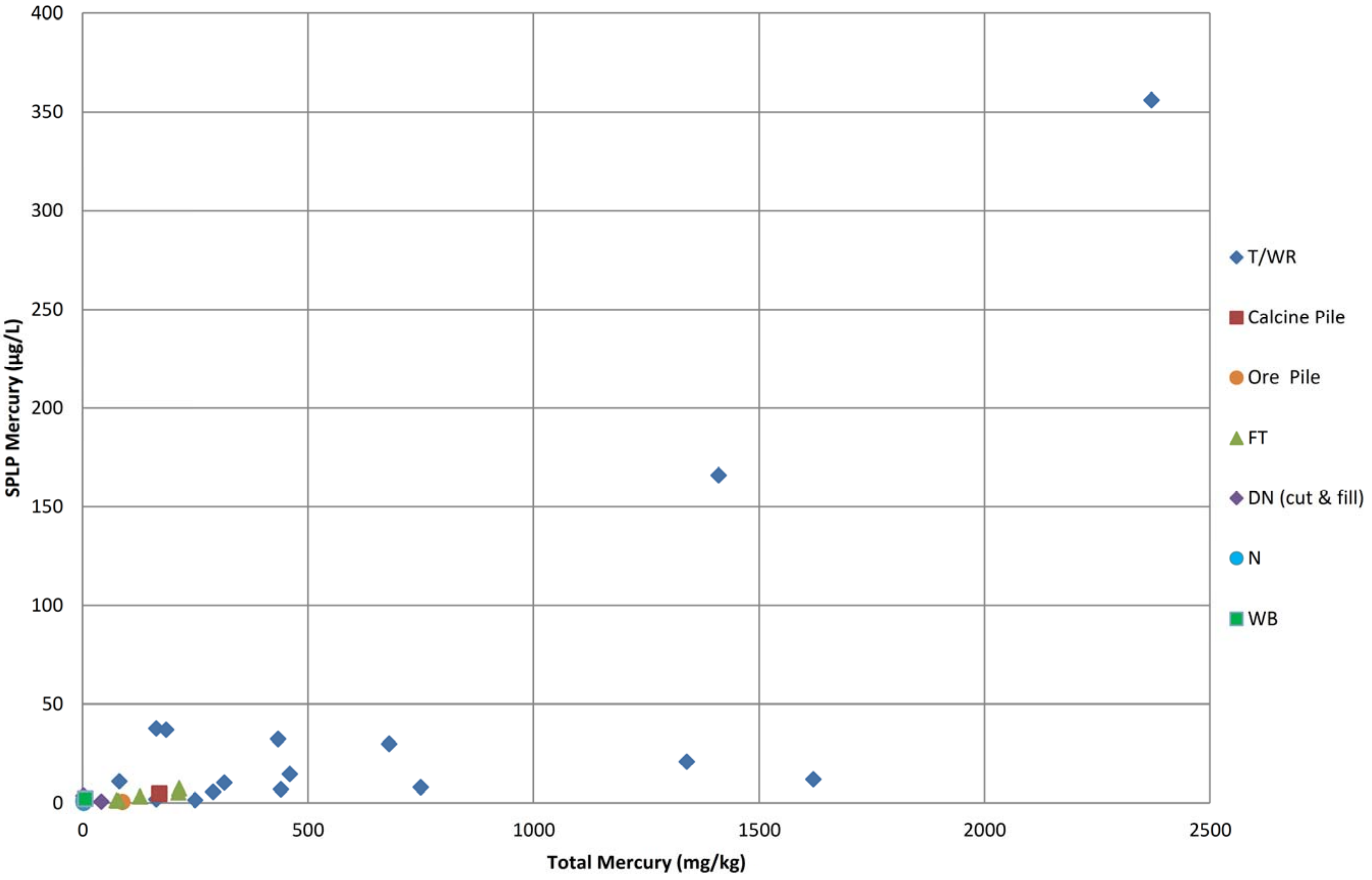
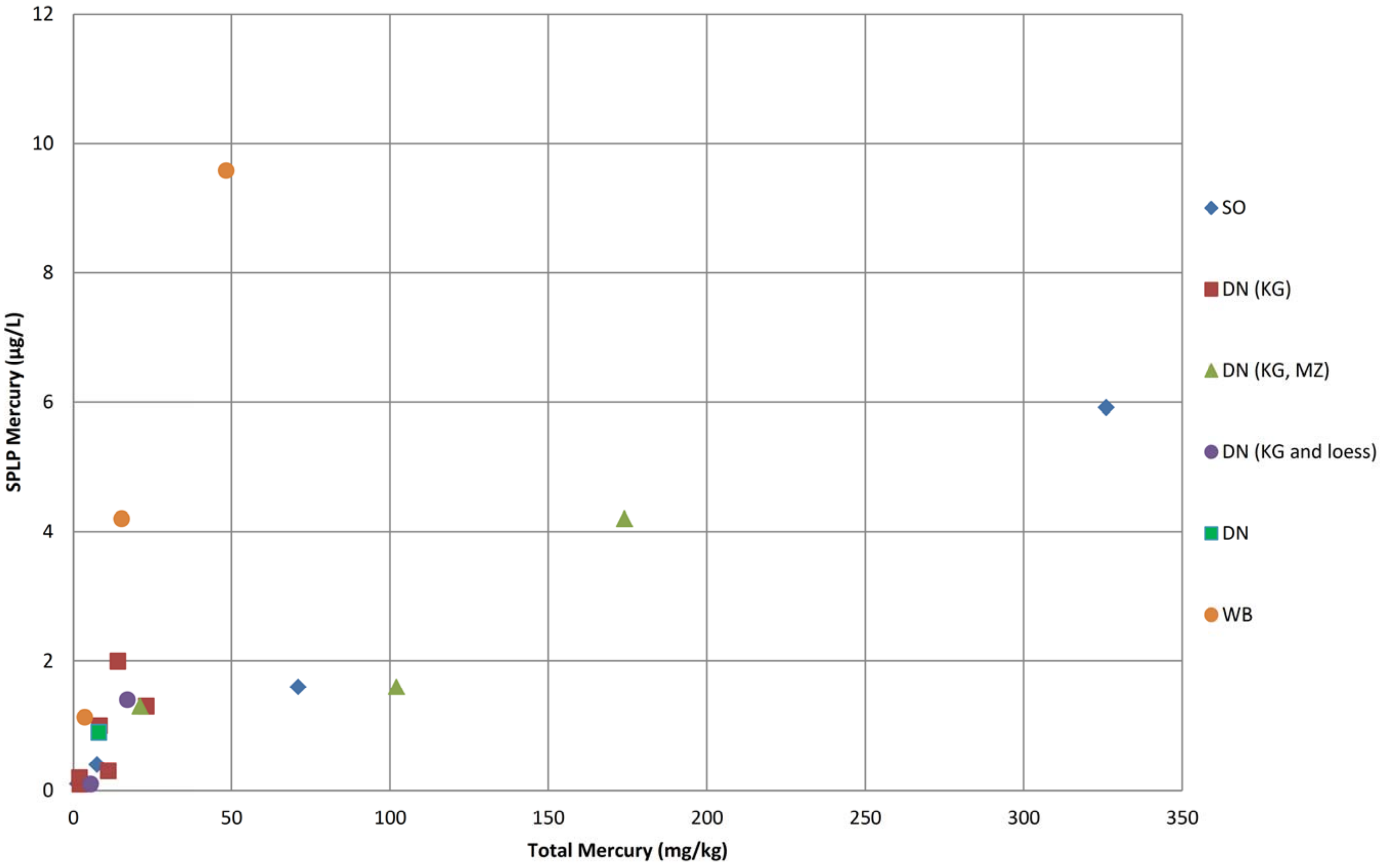


Figure 5-11 Mercury - SPLP vs. Total
Surface Mined Area, Dolly Sluice Delta, and Rice Sluice Delta



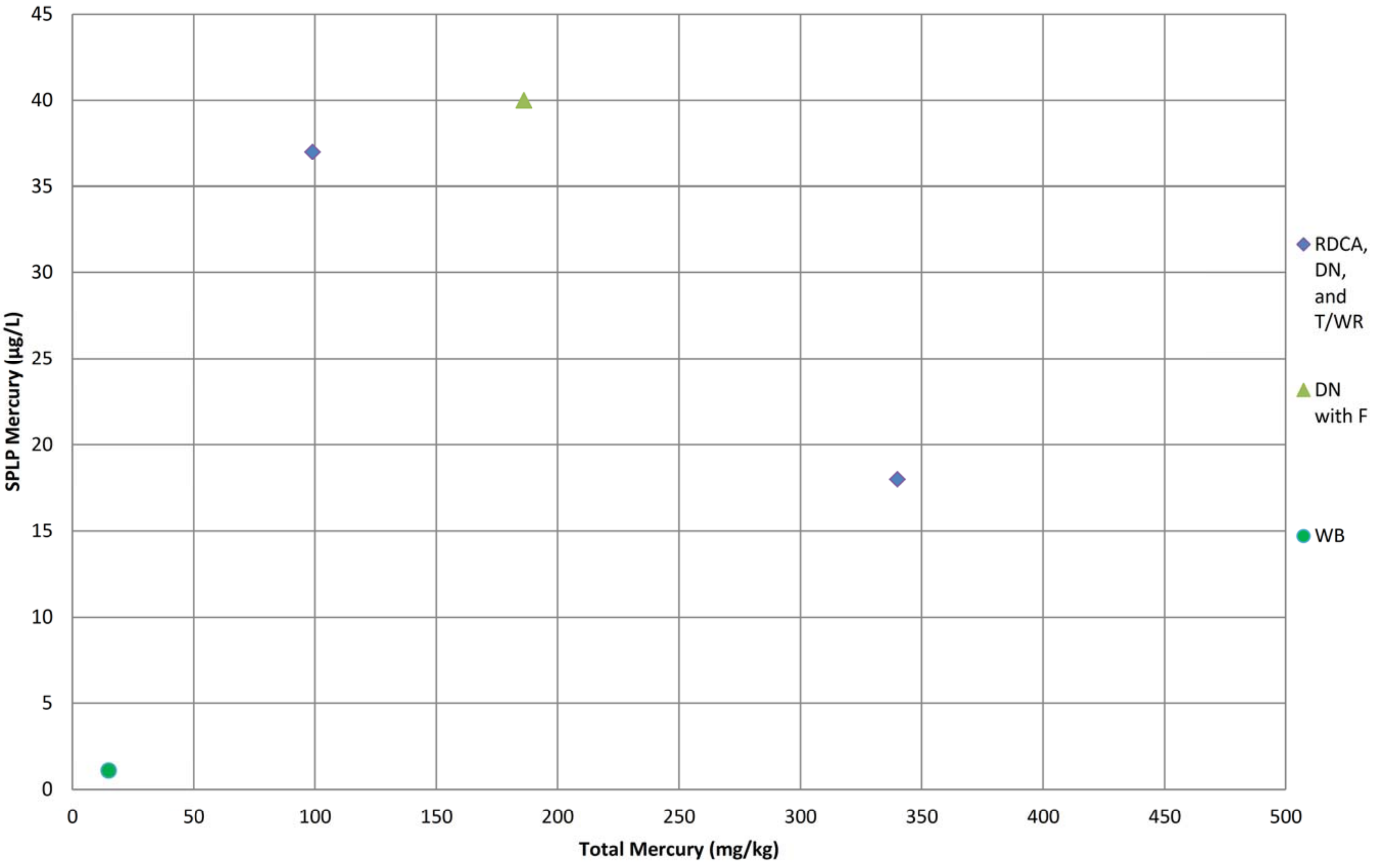
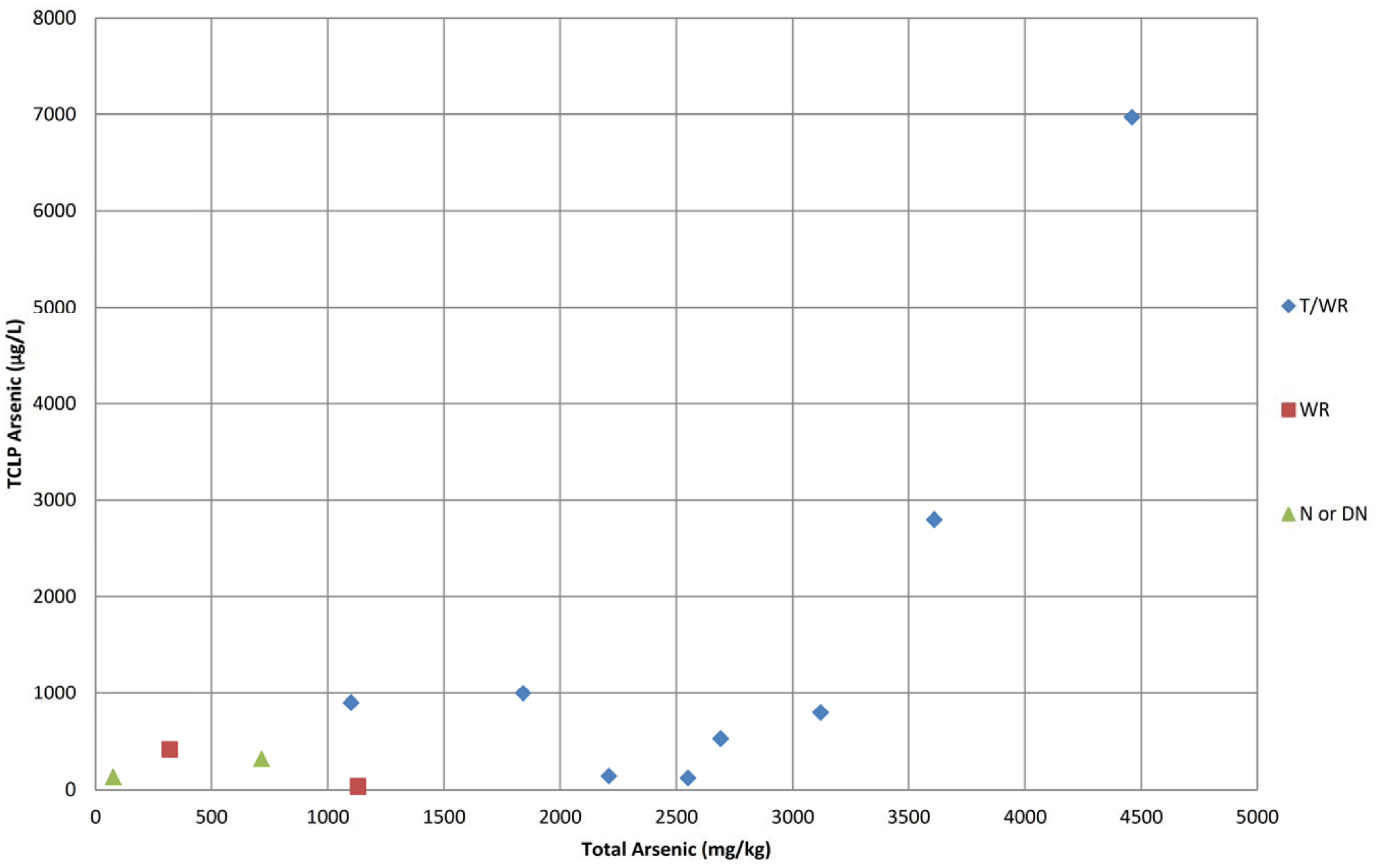


Figure 5-12 Mercury - SPLP vs. Total
Red Devil Creek Downstream Alluvial Area and Delta

Figure 5-13 Arsenic - TCLP vs. Total
Pre-1955 Main Processing Area



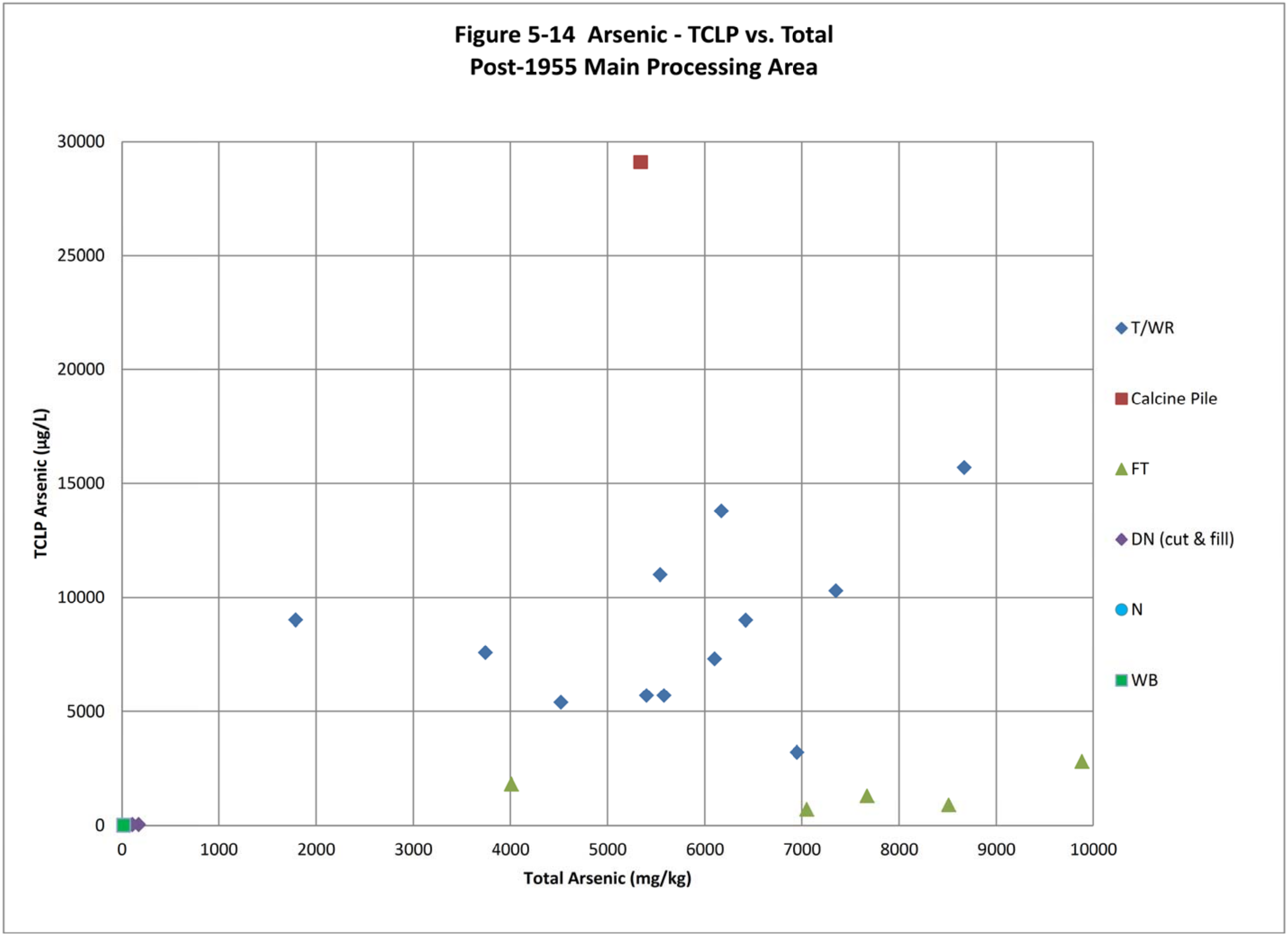


Figure 5-14 Arsenic - TCLP vs. Total
Post-1955 Main Processing Area
TCLP Arsenic (µg/L)
30000
25000
20000
15000
10000
5000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Total Arsenic (mg/kg)
T/WR
Calcine Pile
FT
DN (cut & fill)
N
WB

Figure 5-15
Mercury SSE Percent Fractions F0 - F4 vs. Total F0 - F6 Concentration Main Processing Area, Red Devil Creek Downstream Alluvial Area and Delta, and Sluice Deltas Soils

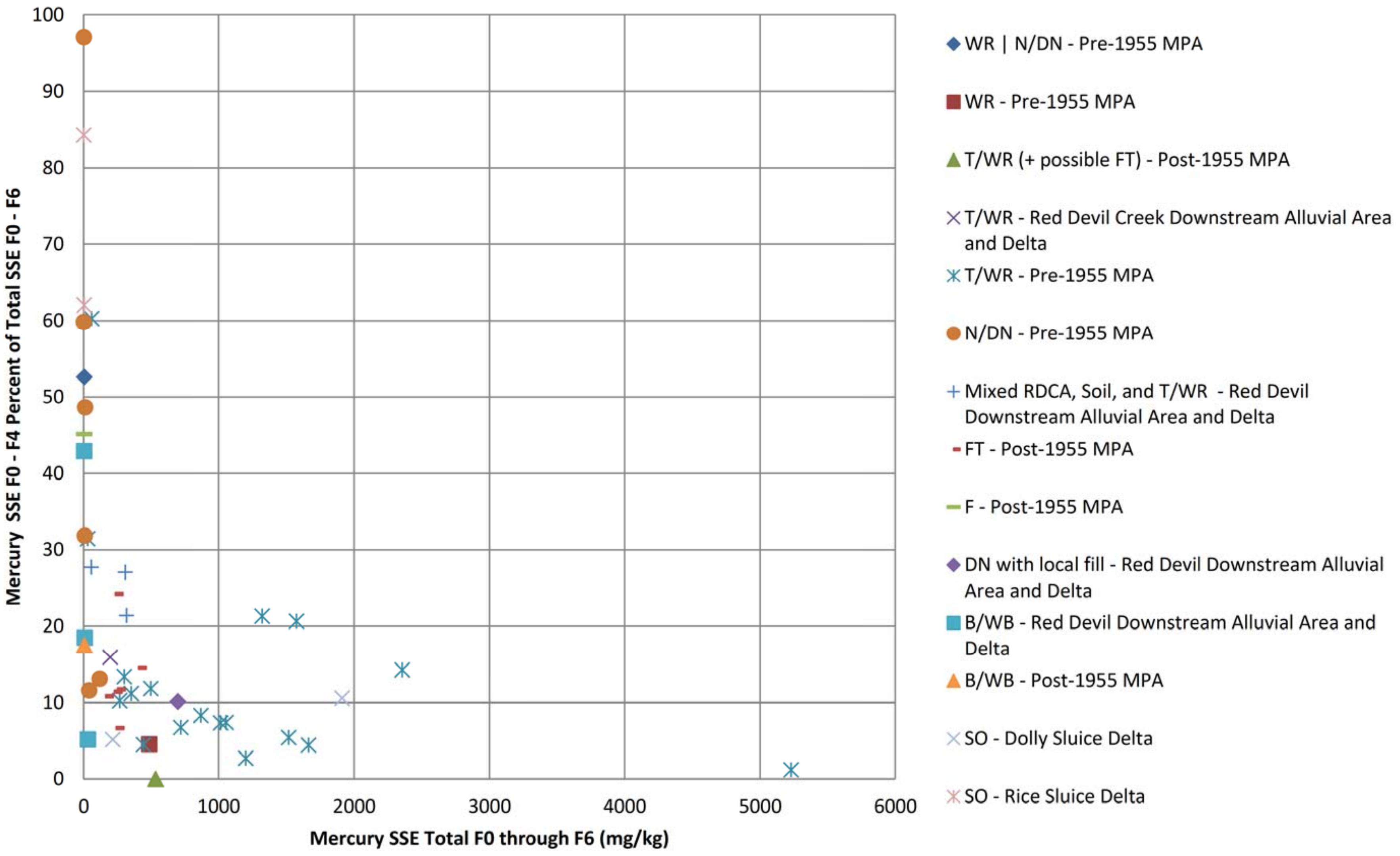


Figure 5-16
Mercury SSE Percent Fractions F0 - F4 vs. Total F0 - F6 Concentration
Surface Mined Area, Red Devil Creek Upstream Alluvial Area, and Upland Background Area Soils

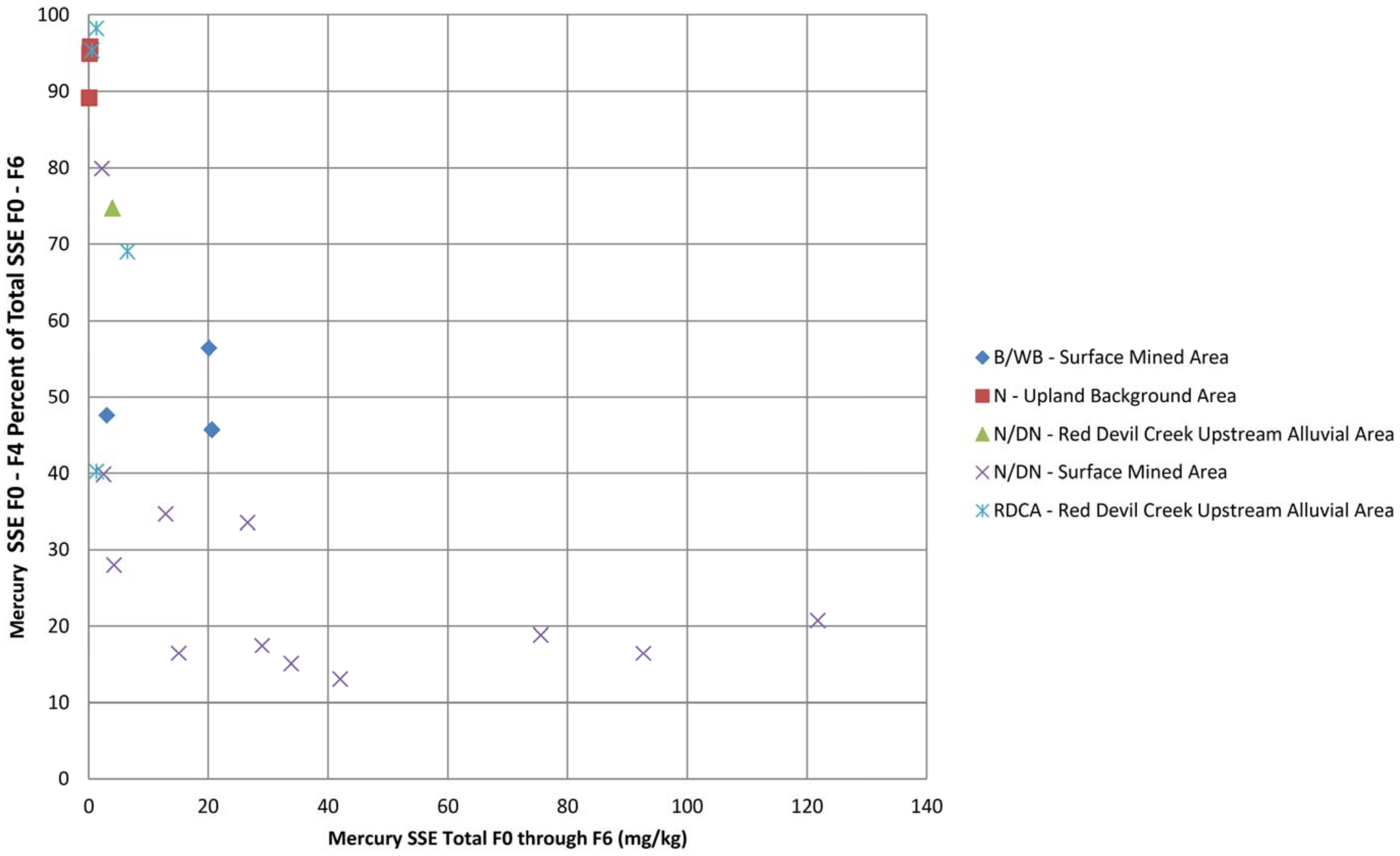
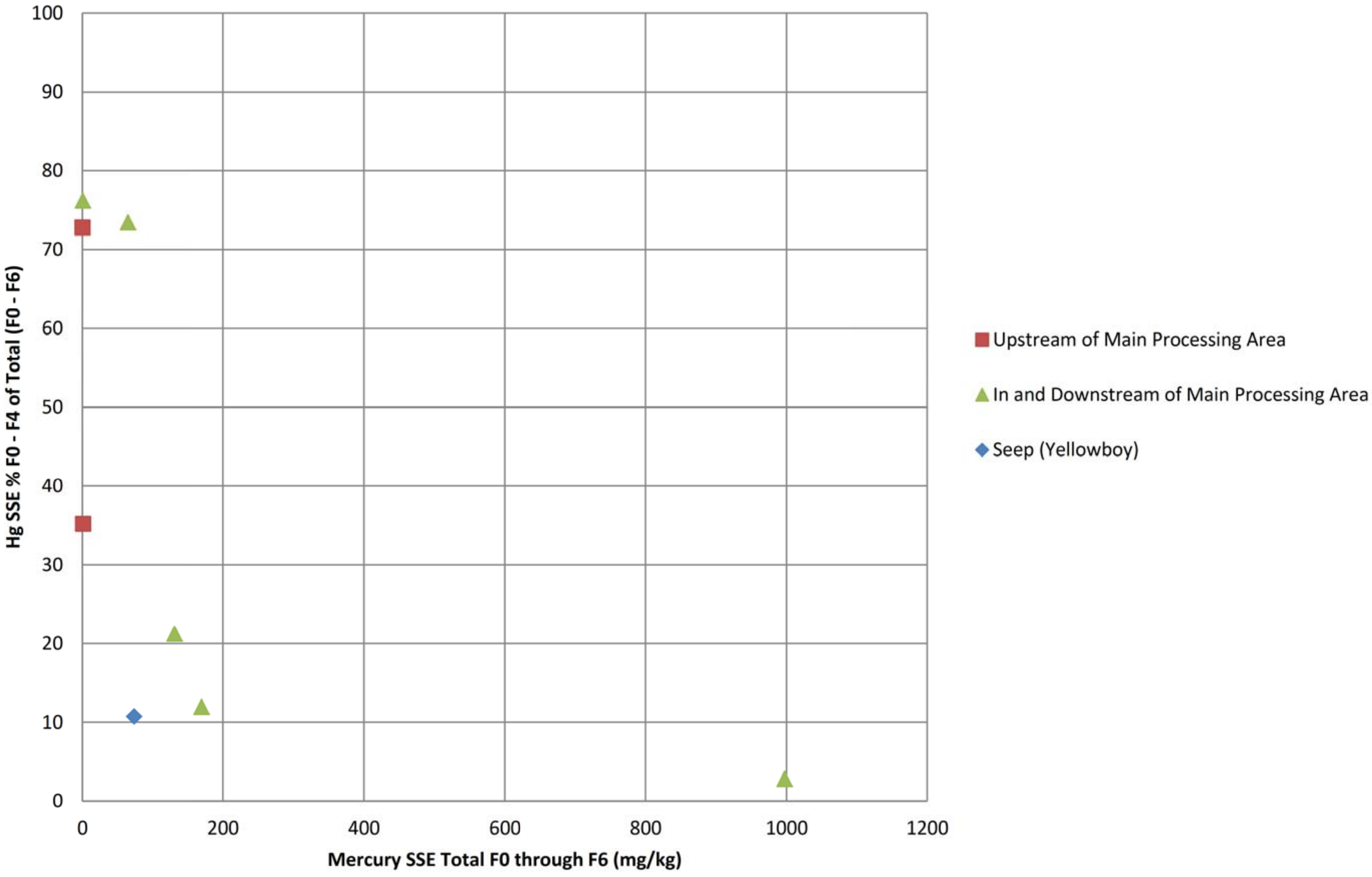


Figure 5-17
Mercury SSE Percent Fractions F0 - F4 vs. Total F0 - F6 Concentration
Red Devil Creek Sediment



6 Baseline Risk Assessment

This risk assessment provides the methodology and results for the human health and ecological risk assessment. This assessment follows the protocol outlined in the Risk Assessment Work Plan (RAWP) submitted as Appendix B of the *Work Plan, Remedial Investigation/Feasibility Study, Red Devil Mine, Alaska* (E & E 2011) and the technical memorandum, *Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2* (E & E 2012c; Appendix G).

This baseline risk assessment (BRA) consists of the following sections:

Section 6.1, Data Usability: Provides the evaluation of site data for usability in risk assessment.

Section 6.2, Human Health Risk Assessment: Presents the identification of human health COPCs, exposure assessment, toxicity assessment, and risk characterization.

Section 6.3, Ecological Risk Assessment: Presents the baseline ecological risk assessment (BERA) based on the revised screening level ecological risk assessment (SLERA) prepared in March 2012. The revised SLERA is provided as Appendix M.

Section 6.4, Risk-Based Cleanup Levels: Presents the preliminary cleanup levels based on the results of the HHRA and ERA.

6.1 Data Usability

Regional studies, contaminant investigations, and sampling programs associated with cleanup activities have been conducted at and near the RDM site over the past 40 years. A review of historical data usability is presented in Section 1.4.4.

A summary of the history of environmental sampling and monitoring at the RDM site was provided in Section 3.1 of the RI/FS Work Plan (E & E 2011). Five major removal/cleanup actions were performed at the RDM site between 1999 and 2006. These actions have included offsite disposal of hazardous waste and materials and onsite consolidation of mine structure debris. To date, all mine structures have been demolished, and three debris burial areas (monofills) have been constructed. The major removal/cleanup actions that have been conducted at the RDM site are summarized in Section 1.4.4.

6.1.1 Data Used for the BRA

Due to the extensive nature of the sampling conducted in 2010, 2011, and 2012 for surface soil, subsurface soil, groundwater, sediment, surface water, and biota, data collected for this report are the most current and relevant data for use in the risk assessment. Results from additional vegetation and fish studies also were used. Specifically, data in this risk assessment were derived from the following sources:

- Remedial Investigation (2013) – including data results from the 2010 Limited Sampling Event, 2011 sampling and 2012 vegetation sampling, and 2012 Kuskokwim River sediment sampling.
- BLM Fish and Macroinvertebrate Tissue Sampling from 2010 and 2011 (BLM 2010, 2011 and 2012; USFWS 2012a and 2012b).
- USGS Mercury Studies (Bailey and Gray 1997; Bailey et al. 2002).

6.1.2 Quality Assurance/Quality Control Results

The risk assessment highlights chemicals associated with historical operations that are thought or known to have been released to the environment. A review of existing data and a list of target analytes are provided in Section 1.4.4.

As noted in Chapter 4, analytical data generated from the samples collected in 2010, 2011, and 2012, which are used in this chapter to assessment risk and hazards from potential exposure with contaminants at the site, were validated by E & E chemists in accordance with following:

- Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2010f).
- Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 2008a).
- Guidelines for Data Reporting, Data Reduction, and Treatment of Non-Detect Values (ADEC 2008a).
- Quality assurance guidelines in Standard Operating Procedure BR-0013 for mercury selective sequential extraction analyses (Brooks Rand 2010).
- Quality assurance guidelines in EPA Method 1632 for arsenic speciation analysis (EPA 1998a).
- Quality assurance guidelines in EPA Method 9200.1-86 for arsenic bioaccessibility assays (EPA 2008e).

The results of data validation are presented in Analytical Data Review Summary memoranda for each laboratory data deliverable and are contained in Appendix C. In general, all data generated for the RI are considered usable for the risk assessment, with qualifications.

6.1.3 Data Reduction

Consistent with ADEC requirements (ADEC 2008a), the most conservative and health-protective concentrations (i.e., highest concentrations for exposure point concentrations) between duplicate and original samples were used in the risk assessment and for determining exposure point concentrations (EPCs), except as otherwise noted. NDs were assigned the method detection limit (MDL) and flagged with a "U" to designate NDs. ProUCL 4.1.00 was used to extrapolate values for NDs used in the calculation of the EPC using the 95-percent upper confidence limit on the mean (UCL), consistent with ADEC (2008a) and EPA (2010b). Specifically, the EPA (2010b) recommends avoiding the use of the one-half detection limit method to compute the summary statistics and various other limits, including the UCL. Kaplan-Meier and Regression on Order Statistics (ROS) methods available through ProUCL 4.1.00 were used when non-detect results were present.

6.1.4 Detection Limits

6.1.4.1 Human Health Evaluation

Detection limits were compared to the risk-based screening concentrations (RBSCs) to ensure that detection limits were sufficiently low enough to identify any potential risk drivers at the site. Table 1-2 of the Quality Assurance Program Plan, submitted as Appendix C of the Work Plan (E & E 2011) included an analysis of methods, detection limits and risk-based criteria to ensure that appropriate methods were used in sampling and analysis. This table includes risk-based criteria for metals, including methylmercury, and BTEX for soil, sediment, groundwater, surface water, and biota.

Comparison to RBSCs for human health show that for soil (both surface and subsurface soil) and sediment results, the minimum detection limits for all non-detected compounds were below the RBSCs. For groundwater and surface water results, there were a number of analytes with detection limits that exceeded the RBSCs: p-chloroaniline, bis(2-chloro-1-methylethyl) ether, bis(2-chloroethyl)ether, hexachlorobenzene, 2,4-dinitrotoluene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, 4,6-dinitro-o-cresol, dibenz(a,h)anthracene, benz(a)anthracene, N-nitroso-di-N-propylamine, N-nitrosodimethylamine, hexachlorobutadiene, pentachlorophenol, naphthalene, 3,3'-dichlorobenzidine, and nitrobenzene. Of these, the following compounds had detection limits within an order of magnitude above the RBSC: p-chloroaniline, bis(2-chloro-1-methylethyl) ether, 2,4-dinitrotoluene, benzo(k)fluoranthene, 4,6-dinitro-o-cresol, hexachlorobutadiene, naphthalene, 3,3'-dichlorobenzidine, and nitrobenzene. Impacts of the elevated detection limits are discussed in Section 6.2.2.3.

6.1.4.2 Ecological Evaluation

E & E reviewed the surface soil, sediment, surface water, and vegetation data collected for the RI to judge its adequacy for ecological risk assessment (ERA) purposes. This was done by reviewing the qualifiers associated with the reported results and, for non-detected results, comparing the MDLs with risk-based screening levels from the final SLERA, revised BERA, final Quality Assurance Project Plan, and/or other sources (Buchman 2008, EPA 2003e, Sample et al. 1996). Based on that review, the data are of sufficient quality for ERA purposes, with the following minor exceptions.

Soil

Thallium was reported as not detected in 133 of 135 surface soil samples from the RDM site. The range of MDLs was 0.26 to 2.7 mg/kg. The reported MDL for 22 samples exceeded the lowest thallium soil screening level (1 mg/kg for effects on plants, see SLERA Table 4-1). For the remaining 113 samples, the MDLs were less than 1 mg/kg; that is, sufficiently low to provide useful data for evaluating ecological risk from thallium in soil.

Selenium was reported as not detected in 133 of 135 surface soil samples from the RDM site and the MDLs (0.61 to 6.4 mg/kg) were greater than the lowest soil screening level for selenium used in the SLERA (0.52 mg/kg for effects on plants, see SLERA Table 4-1). The two samples (11MP70SS and 11MP71SS) in which selenium was detected were collected from the Main Processing Area (MPA) and the reported concentrations (0.42 and 0.24 mg/kg, respectively) were less than the screening level (0.52 mg/kg). The large number of non-detected results for selenium in surface soil are not considered to be a serious shortcoming for two reasons: (1) the two detected concentrations from the MPA, where contaminant levels are expected to be greatest, did not exceed the available soil screening levels for selenium (see SLERA Table 4-1) and (2) selenium is not expected to be a site-related contaminant based on past site activities.

Sediment

For thallium, 16 of 73 samples were U-qualified and the MDLs (range 0.34 to 17.4 mg/kg) were greater than the screening level for thallium in sediment (0.24 mg/kg, MacDonald et al. 1999). However, in all other sediment samples analyzed for thallium, thallium was detected, or reported as not detected with an MDL (range 0.014 to 0.16 mg/kg) less than the screening level (0.24 mg/kg). Hence, the thallium sediment dataset as a whole is informative from an ERA perspective.

4-Nitrophenol and 2,4-dichlorophenol were not detected in site sediment samples, but their respective MDLs (18 and 1 µg/kg) exceeded their respective sediment screening levels (13.3 µg/kg and 0.21 µg/kg, Buchman 2008). We consider this shortcoming to be minor because the MDLs only marginally exceeded the screening levels and because 4-nitrophenol and 2,4-dichlorophenol are not expected to be site-related contaminants.

Surface Water

Eight SVOCs (2-chloronaphthalene, anthracene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, hexachlorobenzene, hexachlorobutadiene, and pyrene) were not detected in surface water samples from Red Devil Creek, but the MDLs were greater than surface water screening levels for these chemicals.

6.1.5 Suitability for Risk Assessment

For data to be considered adequate for a risk assessment, the following criteria must be met:

- Analytical data sufficient for adequate site characterization should be available.
- Data must have been collected consistent with ADEC and EPA guidance.
- Sampling and analytical procedures must give accurate chemical specific concentrations.
- Validated analytical laboratory data are required.
- MDLs and sample quantitation limits must be below screening criteria.
- Qualified data must be appropriately used and explained in the uncertainty section (i.e. discussion on potential bias from qualified data and how it might result in the over or under estimation of risk).
- Rejected data shall not be used for risk assessment purpose (ADEC 2011).

All the criteria listed above were met for data used to prepare the BRA with the minor exceptions noted in the Section 6.1.4.

6.2 Human Health Risk Assessment

6.2.1 Overview

This chapter contains the results of the HHRA developed consistent with the protocol outlined in the risk assessment work plan submitted as Appendix B of the *Work Plan, Remedial Investigation/Feasibility Study, Red Devil Mine, Alaska* (E & E 2011) and the technical memorandum, *Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2* (E & E 2012c). This HHRA describes the results of the determination of COPCs (Section 6.2.2), exposure assessment (Section 6.2.3), toxicity assessment (Section 6.2.4), risk characterization (Section 6.2.5), and analysis of uncertainty (Section 6.2.6).

COPC determination identifies which compounds are quantitatively and qualitatively evaluated in the HHRA. The exposure assessment describes how exposures to receptors are quantified for each potentially complete exposure pathway, while the toxicity assessment explains how the toxicity of carcinogenic and noncarcinogenic COPCs is estimated. The information from the exposure and toxicity assessments is then combined to generate quantitative estimates of risk and hazard at the site.

The HHRA report provides a detailed discussion of the uncertainty associated with each step of the HHRA and indicates how each issue may impact the overall risk and hazard estimates. The HHRA was developed to be consistent with federal and state guidance, in addition to information presented in peer-reviewed publications, including, but not limited to, the following documents:

- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final (EPA 1989).
- Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (EPA 2004).
- Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) (EPA 2009c).
- Human Health Evaluation Manual, Supplemental Guidance, "Standard Default Exposure Factors," Interim Final (OSWER Directive 9285.6-02; EPA 1991).
- Exposure Factors Handbook (EPA 1997a; EPA 2011a).
- Child-Specific Exposure Factors Handbook (EPA 2008c).
- ProUCL Version 4.1.00 User Guide (EPA 2010c).
- ProUCL Version 4.1.00 Technical Guide (EPA 2010b).
- Framework for Metals Risk Assessment (EPA 2007g).
- Risk Assessment Procedures Manual (ADEC 2000, 2011).

6.2.2 Selection of Contaminants of Potential Concern

COPCs were identified based on the following criteria:

1. Screening values based on toxicological characteristics of each chemical.
2. Evaluation of essential nutrients.

This approach is consistent with the EPA document *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) and the ADEC *Risk Assessment Procedures Manual* (2000, 2011) and is discussed in further detail throughout this section.

As described in Chapter 4, a number of inorganic compounds were found at the RDM site in background samples for all media. For many of these compounds, the levels are elevated above risk-based screening criteria. Consistent with EPA policy (EPA 2002a), no COPC was eliminated based on comparison to background concentrations or frequency of detection. Section 6.2.5.4 includes an analysis of contribution from elevated background concentrations to overall risks and hazards at the site.

6.2.2.1 Screening Values

Maximum site concentrations in each medium (soil, sediment, groundwater, and surface water) were compared to RBSCs. As noted in the conceptual site model (CSM) (discussed in Section 6.2.3.1), human receptors that may have contact with exposure media at the RDM site include future onsite residents, recreational or subsistence users, and industrial or mine workers. Exposure media include soil, sediment, surface water, groundwater, and biota. For exposure assessment, tailings are treated as soil or sediment based on their location and potential for exposure.

Soil RBSCs include EPA Regional Screening Levels (RSLs) for residential soils (EPA 2012) adjusted to a cancer risk of 10^{-6} or a hazard quotient (HQ) equal to 0.1, one-tenth of the direct contact and inhalation Alaska Method 2 soil cleanup level for the Under 40 inch zone (18 AAC 75.341; and values provided in Appendix B of the *Cumulative Risk Guidance* [ADEC 2008b]). Although criteria from BLM's Risk Management Criteria for Metals at BLM Sites (BLM 2004) were to be used per the RAWP (E & E 2011), the guidance is no longer used by BLM and therefore not included in this assessment.

There are no screening criteria from the EPA or ADEC for human exposure to sediments. Soil criteria (e.g., RSLs and one-tenth Method 2 values) were used as sediment RBSCs. Red Devil Creek sediments, as well as both near-shore and off-shore Kuskokwim River sediment samples, were screened against these RBSCs to ensure that all COPCs were identified, although human receptors have no direct exposure to off-shore Kuskokwim River sediments. All sediment samples were measured on a dry weight basis.

Groundwater RBSCs include one-tenth Alaska groundwater cleanup levels (18 AAC 75.345, Table C), EPA RSLs (EPA 2012) for tap water adjusted to a cancer risk of 10^{-6} or an HQ equal to 0.1, and federal MCLs (EPA 2009b). COPCs exceeding any of the applicable screening criteria were included in the assessment for quantitative determination of risk.

As a health-protective measure, groundwater RBSCs were applied to surface water to determine surface water COPCs. Comparison of surface water results to water quality standards for surface water (18 AAC 70) and ambient water quality criteria (EPA 2009a) are discussed in Chapter 7. For groundwater and surface water, total and dissolved metal results were evaluated separately in the COPC screening. Consistent with EPA *Risk Assessment Guidelines for Superfund, Part A* (1989), data from unfiltered water samples (total metals) were used to estimate exposure in the HHRA.

If the maximum site concentration did not exceed any of the RBSCs for each medium, the compound was eliminated as a COPC. There are no RBSCs for 4-bromophenyl phenyl ether, so it was retained as a COPC for further evaluation.

Bioaccumulative compounds detected in sediment and surface water were retained as COPCs regardless of their comparison to screening criteria. ADEC defines bioaccumulative compounds as those that have a bioconcentration factor equal to or greater than 1,000 for organic compounds or are identified by the EPA (2000a) as bioaccumulative inorganic compounds (ADEC 2010). The following compounds were identified as COPCs in sediment and surface water solely based their bioaccumulative properties (i.e., they did not exceed an RBSC): cadmium, copper, lead, methylmercury, selenium, silver, and zinc.

There are no available screening criteria that are representative of subsistence use of biota. Therefore, biota were not compared to screening benchmarks. For evaluating consumption of fish, any inorganic compound identified as a COPC in sediment or surface water, including bioaccumulative chemicals, was evaluated as a COPC in fish. For evaluating consumption of land mammals, birds, berries and plants, any inorganic compounds identified as COPCs in surface or subsurface soil were included as a COPC for these biota.

6.2.2.2 Essential Nutrients

The EPA (1989) recommends removing chemicals from further consideration if they are considered “essential nutrients”; present at low concentrations (i.e., only slightly elevated above naturally occurring levels); and toxic only at very high doses. The essential nutrients that were eliminated from the list of COPCs are magnesium, calcium, sodium, and potassium. These chemicals are toxic only at very high doses and are expected to be present at concentrations that would not be due to chemical sources at the RDM site. In addition, no screening criteria were available from the sources identified in Section 6.2.2.1.

6.2.2.3 Final Compounds of Potential Concern

The results of the surface and subsurface soil screening are presented in Tables 6-1 and 6-2. Results of the sediment, groundwater, and surface water screening are presented in Tables 6-3, 6-4, and 6-5, respectively.[2] The final list of COPCs is provided in Table 6-6.

For compounds that had no detected result, the detection limits were compared to the RBSC as described in Section 6.2.2.1, to ensure that detection limits were sufficiently low enough to identify any potential risk drivers at the site. For soil (both surface and subsurface soil) and sediment results, the minimum detection limits for all non-detected compounds were below the RBSC.

For groundwater and surface water results, there were a number of analytes with detection limits that exceeded the RBSC: p-chloroaniline, bis(2-chloro-1-methylethyl) ether, bis(2-chloroethyl)ether, hexachlorobenzene, 2,4-dinitrotoluene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, 4,6-dinitro-o-cresol, dibenz(a,h)anthracene, benz(a)anthracene, N-nitroso-di-N-propylamine, N-

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[2] Tables not appearing within the text are included at the end of this chapter.

nitrosodimethylamine, hexachlorobutadiene, pentachlorophenol, naphthalene, 3,3’-dichlorobenzidine, and nitrobenzene. Of these, the following compounds had detection limits very close to the RBSC (within an order of magnitude): p-chloroaniline, bis(2-chloro-1-methylethyl) ether, 2,4-dinitrotoluene, benzo(k)fluoranthene, 4,6-dinitro-o-cresol, hexachlorobutadiene, naphthalene, 3,3’-dichlorobenzidine, and nitrobenzene.

Although the following nine compounds had detection limits above the RBSC, these compounds are not expected to be found in groundwater or surface water at appreciable levels based on either their chemical properties or use at the site: bis(2-chloroethyl)ether, hexachlorobenzene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, N-nitroso-di-N-propylamine, N-nitrosodimethylamine, and pentachlorophenol. In addition, none of these compounds were identified as COPCs in soil or sediment. Based on this, it is not expected that elevated detection limits would have an appreciable impact on overall risk at the site. The impacts of the detection limits are discussed in Section 6.2.6.

6.2.3 Exposure Assessment

The purpose of the exposure assessment is to quantify potential exposures of human populations that could result from contact with COPCs from the RDM site. Each complete exposure pathway contains four necessary components:

- A contaminant source and a mechanism of COPC release.
- An environmental medium and mechanism of COPC transport within the medium.
- A potential point of human contact with the affected environmental media, also called the exposure point.
- An exposure route.

The exposure assessment characterizes the exposure setting; identifies receptors that may be exposed; identifies direct and indirect pathways by which exposures could occur (i.e., pathways for direct ingestion of COPCs from soil and indirect uptake from ingestion of harvested wild food items); and describes how the rate, frequency, and duration of these exposures is estimated. The exposure assessment includes the following subsection components:

- A CSM.
- Exposure scenarios.
- A quantification of exposure.

6.2.3.1 Conceptual Site Model

The CSM for the RDM site is presented in Figure 6-1 and discussed in this section. The RDM site is located on BLM land on the southwest bank of the Kuskokwim River, approximately 2 miles southeast from the village of Red Devil (Figure 1-1). The mine is in a remote part of Alaska and only has occasional visitors. Access to the site is obtained by boat/barge on the Kuskokwim River, by means of an airstrip at Red Devil Village, and dirt roads and woodland trails via all-terrain vehicles (ATVs) during summer months. Public access to the RDM is restricted by a locked gate installed by BLM on the road between the RDM and the village of Red Devil

Contaminants from mine waste, groundwater, or air emissions may enter the surface water or sediment through surface water runoff, erosion and transport by surface water, or direct placement of waste and tailings in Red Devil Creek. Contaminants may enter groundwater through infiltration or leaching from source areas. Contaminants may also be directly released to soils, erode from sources, or be deposited from air emissions during previous mine operations. Volatile chemicals in soil (i.e., mercury) may volatilize into the air; other contaminants may be entrained in fugitive dust. Contaminants may bioaccumulate from soils, surface water, or sediment into plants, animals, and fish. See Chapter 5 for additional information regarding contaminant fate and transport.

Currently, no one lives permanently or temporarily at the RDM site. Residents of Red Devil Village and nearby communities currently use the site for recreational and subsistence activities. Future use of the site is unknown but may include maintaining the site as an occasional recreational or subsistence harvest area. Potential changes in land use could result in the site being used for industrial or mining activities or as a residential area.

Based on the known and possible future land uses at the RDM site, the following receptors were selected to represent current or potential future use of the site:

- Future Onsite Resident (adult and child).
- Recreational or Subsistence User (adult and child).
- Industrial/Mine Worker (adult only).

Each scenario is discussed in further detail in this subsection.

6.2.3.1.1 Future Onsite Adult and Child Resident

The future adult and child residential scenario represents potential exposures for a hypothetical person who lives at the site and leaves the site for two weeks per year. It is assumed that the adults would live and work at the site and the children would live at the site and go to school at the site. It is assumed that the drinking water supply would be from groundwater. Other assumptions are detailed below. Residents may be exposed to COPCs in groundwater through ingestion and dermal contact. In addition, people may be exposed to volatile COPCs (i.e., elemental mercury) in groundwater during household uses of groundwater (e.g., showering). Indirect exposure through consumption of native wild foods such as fish, game, and plants through subsistence activities is included in this scenario; however, only a percentage of native food consumed would be anticipated to be gathered from the site. Adults and children may come in contact with surface water by wading or playing in Red Devil Creek. They may come into contact with sediments during wading or playing near Red Devil Creek or near the shores of the Kuskokwim River. The adult and child resident scenario includes the following exposure pathways:

- Dermal (skin) contact with surface water from Red Devil Creek.
- Dermal (skin) contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Ingestion of and dermal contact with groundwater.
- Incidental ingestion of and dermal contact with soil.
- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals from soil.
- Inhalation of volatile chemicals in groundwater.

6.2.3.1.2 Recreational Visitor or Subsistence User

It is assumed that recreational visitors and subsistence users would visit the site a portion of the year during harvest time and camp in the area. It is assumed that recreational or subsistence users would access the site via ATVs. It is assumed that they would be exposed during the period they were onsite and that they would obtain drinking water from Red Devil Creek. It is also assumed that the recreational or subsistence user would consume local plants and hunt game or catch fish from the site. However, only a percentage of total wild food consumed by the recreational user or subsistence user would be gathered from the site. Therefore, it is assumed that the recreational or subsistence user could be exposed to contaminants at the RDM site through the following pathways:

- Ingestion of and dermal contact with surface water from Red Devil Creek.
- Dermal contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Incidental ingestion of and dermal contact with soil.

- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals.

6.2.3.1.3 Industrial/Mine Worker

If the RDM site is redeveloped in the future as a mine or industrial facility, it is assumed that industrial or mine workers would work at the site and live in nearby Red Devil Village. If the mine worker lives at the site, as well, this would be covered under the residential scenario, which assumes that the adult residents would live and work at the site. It is assumed that the drinking water supply would come from groundwater during work times. It is also assumed the workers would fish, hunt, and gather edible plant material. Therefore, indirect exposure through consumption of wild foods such as fish, game, and plants is included in this scenario; however, only a percentage of food is assumed to be gathered from the site. The worker scenario includes the following exposure pathways:

- Dermal (skin) contact with surface water from Red Devil Creek.
- Dermal (skin) contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Ingestion of and dermal contact with groundwater.
- Incidental ingestion of and dermal contact with soil.
- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals.

6.2.3.2 Quantification of Exposure

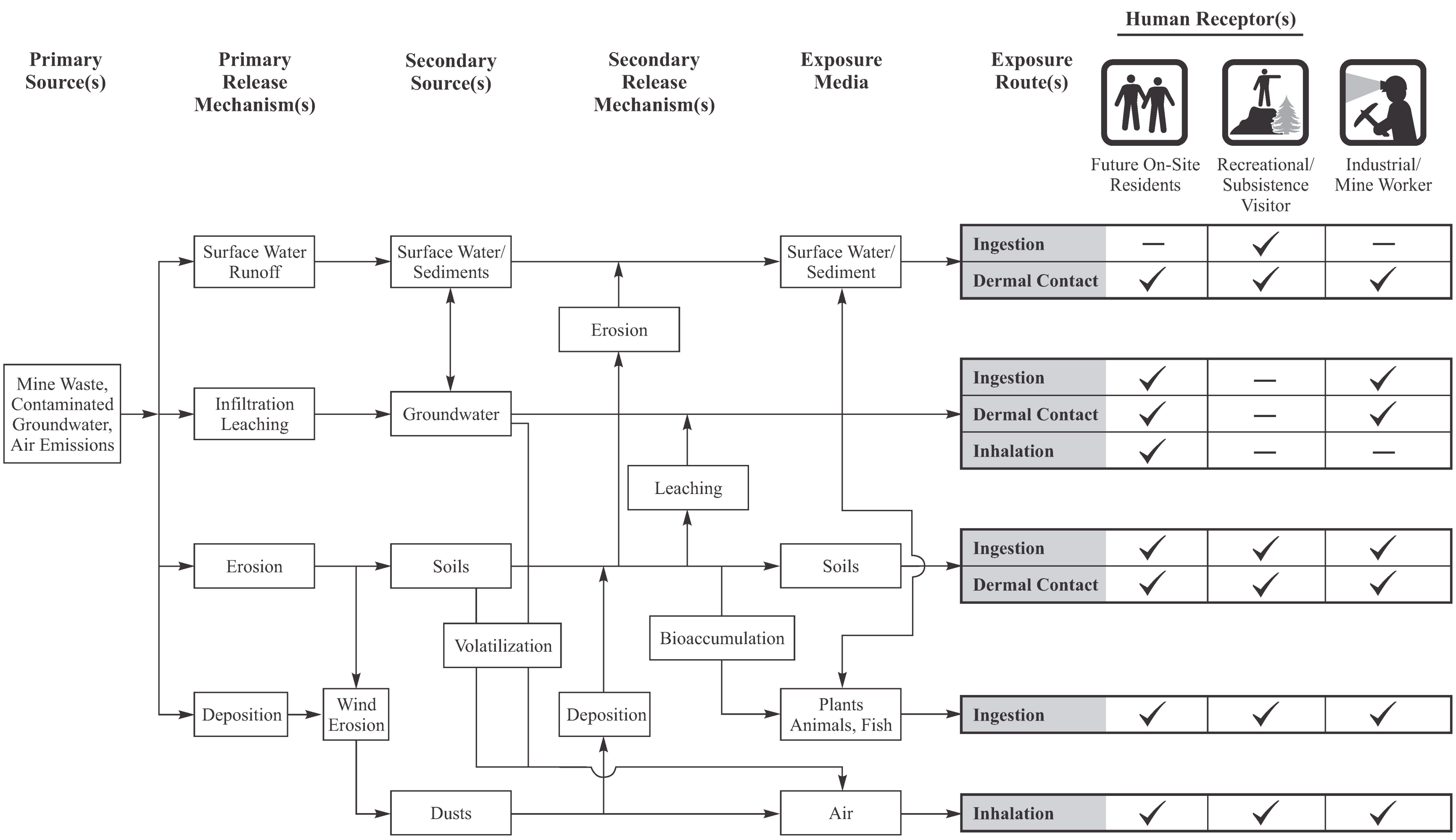
In the exposure quantification portion of the HHRA, estimates are made regarding the magnitude, frequency, and duration of exposure for each complete pathway identified above. For discussion, this portion can be divided into the following sequential tasks:

- Determination of exposure units.
- Estimating EPCs.
- Calculating the amount of COPCs potentially taken into the body (dose).

Exposure Units

Exposure units can be designated based on different uses of subareas within the site or the uneven distribution of contamination across the site.

For residents, soil and subsurface soil was divided into three separate exposure units: Surface Mined Area (SMA), the Main Processing Area (MPA) and the Red Devil Creek Downstream Alluvial Area (DA), based on historical operations at the site. Figure 4-1 in Chapter 4 shows the geographic areas of the site. Table 6-7 compares the maximum concentration and 95-percent UCL for COPCs at the site for the three exposure units and geographical areas.



Exposure Media	Exposure Route(s)	Future On-Site Residents	Recreational/ Subsistence Visitor	Industrial/ Mine Worker
Surface Water/ Sediment	**Ingestion**	—	✓	—
	Dermal Contact	✓	✓	✓
Groundwater	**Ingestion**	✓	—	✓
	Dermal Contact	✓	—	✓
	Inhalation	✓	—	—
Soils	**Ingestion**	✓	✓	✓
	Dermal Contact	✓	✓	✓
Plants Animals, Fish	**Ingestion**	✓	✓	✓
Air	**Inhalation**	✓	✓	✓

Key:

→ Potentially Complete Pathway

— Incomplete/Insignificant Route

✓ Complete Exposure Route

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RED DEVIL MINE

Figure 6-1
HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RED DEVIL MINE SITE

Date: 4/2/12

Drawn by: AGM

02:001096.0070.08TTO\Fig6-1.cdr

The SMA exposure unit consists of 55 samples (excluding duplicates); this includes surface soil samples and subsurface soil sample to a depth of 15 feet bgs. For the purposes of the BRA, the SMA exposure unit consists of the SMA and the nearby Dolly Sluice and Rice Sluice and their respective deltas on the bank of the Kuskokwim River (see Figure 4-1). This area extends over approximately 72 acres. The sluices and their deltas are included in the SMA exposure unit because of their close association with the SMA. The sluices and deltas are located adjacent to the SMA and were formed as a result of the some of the surface mining activities that occurred in the SMA. The mine waste materials present within the sluices and deltas consist of soil sluiced from the SMA (see Chapter 3 for a discussion of soil types present at the RDM). The SMA exposure unit consists of 55 samples (excluding duplicates); this includes surface soil samples and subsurface soil sample to a depth of 15 feet bgs. Based on location, soil type, and historical exploration, these areas are similar and can be combined into a single exposure unit. Therefore, the SMA exposure unit incorporates the following geographic areas, as depicted on Figure 4-1:

- Dolly Sluice and Delta.
- Rice Sluice and Delta.
- Surface Mined Area.

The MPA exposure unit consists of 212 surface and subsurface soil samples (excluding duplicates) and is approximately 12 acres in size. The MPA exposure unit incorporates the Post-1955 Main Processing Area and Pre-1955 Main Processing Area, as depicted on Figure 4-1. The Main Processing Area contains most of the former site structures and is where ore beneficiation and mineral processing were conducted. Underground mine openings (shafts and adits) and ore processing and mine support facilities (housing, warehousing, and so forth) were located on the west side of Red Devil Creek until 1955. After 1955, ore processing was conducted at structures and facilities on the east side of Red Devil Creek. The Main Processing Area includes three monofills. The following soil types were identified in the surface soil samples in the Post-1955 Main Processing Area: tailings/waste rock, flotation tailings, tailings, fill, native/disturbed native soil, and bedrock/weathered bedrock.

The DA exposure unit consists of 32 surface and subsurface soil samples in the Red Devil Creek Downstream Alluvial Area and Delta, which covers approximately 3 acres. Three soil types were identified in the surface soil samples in the DA: tailings/waste rock, native/disturbed native soil, and fill.

For recreational/subsistence users and mine workers, it is assumed that recreational and subsistence activities would be equally spread throughout the site. Therefore, for these receptors, the full site area was treated as a single exposure unit.

6.2.3.3 Estimation of Exposure Concentration

The concentrations of COPCs to which human receptors potentially are exposed over time were estimated according to EPA guidance (EPA 2006b, 2010b). The EPA (1992) and ADEC (2011) indicate that a 95-percent UCL on the mean of COPC concentrations should be used as the EPC. Inherent in this approach is the assumption that receptors that contact an environmental medium containing a COPC do so randomly. Thus, an estimate of average concentration (or in this case the upper bound of the average) is the concentration to which a receptor might be exposed. Consistent with ADEC policy (ADEC 2011), maximum concentrations in groundwater were used to evaluate risk at the site.

To determine the 95-percent UCL, the EPA's ProUCL program, version 4.1.00 (EPA 2010b) was used. ProUCL 4.1 includes goodness-of-fit tests (e.g., normal, lognormal, and gamma) for data sets with and without NDs. For data sets with NDs, ProUCL 4.1 can create additional columns to store extrapolated values for NDs obtained using ROS methods, including normal ROS, gamma ROS, and lognormal ROS (robust ROS) methods. ProUCL 4.1 also has parametric (e.g., maximum likelihood estimate, t-statistic, gamma distribution), nonparametric (e.g., Kaplan-Meier), and computer intensive bootstrap (e.g., percentile, bias-corrected accelerated) methods to compute UCLs for uncensored data sets and also for data sets with ND observations.

The calculated soil EPCs, including distribution and EPC statistics, for the SMA, MPA, and DA exposure units, as derived using ProUCL, are provided in Tables 6-8 through 6-10. The soil EPCs for the site as a whole, as used for the recreational/subsistence user and the mine worker scenarios, are provided in Table 6-11a.

Soil EPCs were calculated using both surface and subsurface soil samples up to 15 feet bgs. Fifteen feet below the surface of the ground is the depth above which it is reasonably likely for affected soils to be excavated and brought to the surface where residents may come in direct contact with them. The combined surface and subsurface soil EPC values were used to calculate risks and hazards for each receptor. To show the vertical distribution of chemical concentrations, the EPCs for antimony, arsenic, and mercury were calculated for surface soil samples (surface to 6 inches bgs) and subsurface soil samples (6 inches to 15 feet bgs), separately. These EPCs were not used to calculate risks and hazards at the site. The surface and subsurface soil EPCs for all four exposure areas (SMA, MPA, DA, and all areas combined) are presented in Table 6-11b and are compared to the combined (surface and subsurface soil) EPC. The location of the surface and subsurface soil samples can be found in Figures 2-3 through 2-6. In general, the antimony and arsenic EPCs in the surface soil exceed those in the subsurface soil. The subsurface EPC for mercury was greater than the surface EPC for all exposure areas.

Calculated EPCs for sediment, surface water, and groundwater are provided in Tables 6-12 through 6-14. Appendix H provides the ProUCL input and output tables. As indicated in Chapters 3 and 5, groundwater generally flows toward Red Devil Creek and the Kuskokwim River. As such, any impacts to groundwater in the MPA and DA are not expected to affect groundwater concentrations in the SMA, but groundwater within the SMA may be expected to affect groundwater in the MPA and/or the DA. Therefore, for the resident in the MPA and DA exposure units, groundwater EPCs were calculated based on groundwater concentrations in all wells that lie within the MPA, DA, and SMA. For the SMA exposure unit, the groundwater EPCs were based on the results from the single monitoring well located within the SMA (MW29). Although EPCs were calculated for groundwater to show the range of concentrations, consistent with ADEC policy (ADEC 2011), the maximum groundwater concentrations in these two areas (MPA/DA and SMA) were used to calculate risks and hazards at the site.

In the case of EPCs for wild food and air (both from volatiles and particulates), fate and transport modeling was used in conjunction with the statistical analysis of the environmental data to determine the EPC values. Determination of concentrations in local food resources (fish and wildlife) is based on concentrations of COPCs in slimy sculpin, green alder bark, and white spruce needles, as discussed in Section 6.2.3.7. The EPCs for slimy sculpin, green alder bark, and white spruce needles are presented in Tables 6-15, 6-16, and 6-17, respectively.

6.2.3.4 Calculation of Intake

Potential exposures to the receptors described in the above scenarios were quantified using intakes (or dose), which are expressed as the amount of COPCs (in milligrams [mg]) internalized per unit body weight (in kilograms [kg]) per unit time (in days). That is, estimated intakes are generally provided in units of milligrams per kilogram per day (mg/kg-day). When evaluating carcinogenic COPCs, the intake is referred to as the lifetime average daily intake (LADI), because the intake is averaged over a lifetime.

The generic equation and variables for calculating chemical intakes are described below:

$$I = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

Where:

I = Intake; the amount of chemical at the exchange boundary (mg/kg body weight/day).

C = EPC in specific media (e.g., milligrams per liter of water).

CR = Contact rate; the amount of contaminated medium contacted per unit time or event (e.g., liters per day; L/day).

EF = Exposure frequency, which describes how often exposure occurs (days per year).

ED = Exposure duration, which describes how long exposure occurs (years).

BW = Body weight; the average body weight over the exposure period (kg).
AT = Averaging time; the period over which exposure is averaged (days).

Exposure to carcinogenic compounds was evaluated based on exposure to a combined child and adult receptor. The LADI was calculated using age adjustments to account for the total exposure duration. Specifically, the LADI was calculated as shown in the following general intake equation:

$$LADI = \frac{C}{AT} \times \left(\frac{EDc \times EFc \times CRc}{BWc} + \frac{(EDa - EDc) \times EFa \times CRa}{BWa} \right)$$

Where:
$CR_{a\ or\ c}$ = Contact rate for adult or child (varies).
$EF_{a\ or\ c}$ = Exposure frequency for adult or child (days/year).
$ED_{a\ or\ c}$ = Exposure duration for adult or child (years).
$BW_{a\ or\ c}$ = Body weight for adult or child (kg).

These generic equations were modified to account for scenario-specific exposures to COPCs. For the inhalation route of exposure, intake is depicted as an exposure concentration (EC; EPA 2009c).

For dermal exposure to COPCs in water, the dermally absorbed dose was determined using equations and chemical-specific parameters from the EPA's Dermal Assessment Guidance (2004).

Dermal contact with groundwater and surface water inorganic COPCs was evaluated consistent with the EPA's Risk Assessment Guidance for Superfund (RAGS) Part E (2004). Specifically, intake was calculated as shown in the following equation. The absorbed dose per event (DA_{event}) for inorganic compounds was calculated using the following equation:

$$DA_{event} = Kp\ x\ Cw\ x\ t_{event}\ x\ CF$$

Where:
DA_{event} = Absorbed dose per event (milligrams per square centimeter per event).
Kp = Dermal permeability coefficient of compound in water (centimeters per hour/), provided in Table 6-18.
t_{event} = event duration (hour per event).
Cw = chemical concentration in water based on unfiltered samples (mg/L).
CF = conversion factor, 0.001 liters per cubic centimeter.

The only organic COPC identified in groundwater was bis(2-ethylhexyl)phthalate, which is not recommended for quantitative evaluation of the dermal exposure pathway per EPA (2004). Naphthalene and 1-methylnapthalene were identified as

COPCs in surface water. 1-methylnaphthalene is not recommended for quantitative evaluation for the dermal exposure pathway per EPA (2004). The following equation was used to determine the DA_{event} for naphthalene, where the event duration is less than the lag time:

$$DAevent \ = 2FA \times Kp \times Cw \times CF \times \sqrt{\frac{6 \times \tau event \times tevent}{\pi}}$$

Where:

FA = fraction absorbed water, 1 for naphthalene.

T_{event} = lag time per event (hours per event), 0.56 hours per event for naphthalene.

t_{event} = event duration (hours per event).

The dermal absorption (ABS_{dermal}) values were obtained from the EPA's RAGS *(Part E, Supplemental Guidance for Dermal Risk Assessment)*, Exhibit 3-4 (2004) and are presented in Table 6-18. Absorption values are available for only some of the COPCs. The dermal pathway was not evaluated quantitatively for compounds without ABS_{dermal} values. This approach is consistent with the EPA's recommendations (2004).

The intakes calculated for each scenario are intended to represent the reasonable maximum exposure (RME) conditions. An RME scenario is a combination of high-end and average exposure values and is used to represent the highest exposure that is reasonably expected to occur. The RME scenario is a health-protective exposure scenario that is plausible yet well above the average exposure level.

For soil ingestion and dust inhalation of arsenic, soil intakes are multiplied by an estimate of relative bioavailability to quantify the level of arsenic that reaches systemic circulation. See Section 6.2.3.6 for additional information on arsenic bioavailability.

Exposure route and media-specific intake equations and proposed values for exposure parameters are presented in Table 6-19a through j and are discussed in this section.

6.2.3.5 Exposure Factors

In addition to intake rates, exposure factors for body weight (BW), exposure frequency (EF), exposure duration (ED), and averaging time (AT) are included in the intake equation. Values used for BW, EF, ED, and AT vary among scenarios. For exposure pathways related to skin exposure, an additional variable for skin surface area (SA) may be included in the intake equation. Intake rates used to estimate exposure are discussed in Section 6.2.3.3.

6.2.3.5.1 Body Weight

A BW value of 70 kg (154 pounds) is used for all adults and is based on an average of male and female adult BWs. The average BW for all children is 15 kg (33 pounds) for a child up to age 6. These values are consistent with EPA and ADEC guidance (EPA 1989, 2002b; ADEC 2011).

6.2.3.5.2 Exposure Frequency and Time

The EF describes how often someone may have contact with affected media over a one-year period. The EPA (1989, 1991) recommends an assumption that the future resident (adults and children) may be exposed through a specific exposure pathway for 350 days per year. The underlying assumption is that people spend at least two weeks at a location other than the exposure scenario location each year (i.e., a two-week vacation). Due to snow cover during winter months, the ADEC recommends that the EF for soil exposure be adjusted to 270 days per year for sites in the under 40-inch precipitation region, which includes the RDM site (ADEC 2011). This adjusted EF is used for soil contact (ingestion and dermal) for the adult and child future onsite resident.

An EF of 250 days per year is used for the mine worker, consistent with EPA and ADEC recommendations (ADEC 2011; EPA 2002b) for an industrial scenario. This value assumes that workers are onsite an average of five days per week for 50 weeks (assuming two weeks of vacation). Alternatively, mining operations in remote Alaska may use a two-weeks-on and two-weeks-off work schedule. The ED of 250 days recommended by the EPA and ADEC provides a health-protective estimate under this scenario, as well. The ED of 250 days per year is used for both soil and groundwater exposure, since people would potentially only be exposed to site-related contaminants in either media while at the site.

For exposure to surface water, the event frequency for the residential and mine worker scenarios was determined based on best professional judgment, assuming that people would wade in the water no more than half the days during the summer months (mid-May through mid-September). This results in approximately 60 days per year for the residential scenario and 40 days per year for the mine worker scenario. It is assumed that true exposure would be less than this. For the recreational/subsistence user, EF to surface water during recreational/subsistence activities is derived based on the maximum fraction ingested (FI) from the site for all wild food resources (0.33, as determined in Section 6.2.3.5) multiplied by the residential EF of 60 days per year for surface water. The resulting EF for the recreational and subsistence user is set at 20 days per year.

For the recreational/subsistence user, EF to soil during recreational/subsistence activities was derived based on the maximum FI (0.33) multiplied by the residential EF, 270 days per year for soil. The resulting EF for the recreational and subsistence user is set at 90 days per year. It is assumed that children will accompany their parents or adults during their time onsite. This value was also used for the resident and mine worker scenario, since residential exposure to sediment will occur during similar recreational activities at the site.

For the inhalation route of exposure, the exposure time (i.e., time per day exposed to contaminants in air) is also included with the EF. For inhalation of volatiles in soil, the exposure time is equal to 24 hours per day for residents and recreational/ subsistence users and 8 hours per day for workers, consistent with the EPA's recommendations (EPA 2009c). For inhalation of volatile COPCs in groundwater during showering, an exposure time of 45 minutes per showering event (0.75 hours) including time spent in the bathroom after showering is used for both the adult and child residential scenarios. The EPA 95th percentile exposure time for showering for children is 44 minutes and for adults is 45 minutes (EPA 2009c). Therefore, 45 minutes is an appropriate estimate for both scenarios.

6.2.3.5.3 Exposure Duration

The ED is the length of time in years for which someone may be exposed through a specific exposure pathway. An ED of six years was assumed for all child scenarios (EPA 1989, 2002b; ADEC 2011) representing a child up to 6 years of age. Exposures occurring beyond age 6 are accounted for in the adult exposure scenarios.

The default ED for the adults is 30 years for future onsite residents (EPA 2002b; ADEC 2011). The Alaska Department of Fish and Game (ADF&G) completed a survey in Red Devil Village (see Section 6.2.3.5) (Brown et al. 2012). This survey included questions regarding how long a respondent had lived at the current location in Red Devil Village and from where he or she moved (i.e., from a community in Alaska or state in the United States or other country) prior to residing in the current location. It is assumed that the residential patterns of a new community established near the RDM site would be similar to the pattern seen in residents of Red Devil Village. Based on the ADF&G report, on average, residents lived in Red Devil approximately 23 years. The intake for non-carcinogenic compounds is averaged over the exposure duration and calculated on a daily basis. Therefore, the ED does not impact the intake calculation for noncarcinogenic compounds. Because of this, the EPA and ADEC default ED of 30 years was considered representative for the adult residential and recreational/subsistence user ED and was used for calculating non-cancer intake and hazard quotients.

In late 2013, at the request of the EPA, the ADF&G calculated the 90th percentile for residence time for adults in Red Devil Village. Each household in Red Devil Village was surveyed in 2009 and asked questions about how many years each individual in the household was resident in the community. This question was designed to include the sum of all periods the member had been resident, rather than just the most recent period (Koster 2013). Based on responses from 15 households reporting on 54 residents in Red Devil Village, the 90th percentile was calculated at 54 years (Kissinger 2013). This value was used to calculate the LADI used for calculating cancer risk for the residents and recreational/subsistence user.

The default ED for a commercial/industrial worker is 25 years (ADEC 2011), but time in mining occupations is substantially less than that. The median occupational tenure for mining activities is 8.6 years (EPA 1997a). For consistency with EPA and ADEC guidance, a health-protective ED of 25 years was used for a mine worker.

For carcinogens, the ED for residential and recreational/subsistence user scenarios is calculated as an aggregate of child and adult exposure; the first six years of the ED is based on the child intake and the remaining time is based on an adult intake (24 years), as described in Section 6.2.5.1.

6.2.3.5.4 Averaging Time

The AT is the number of days over which an exposure is averaged. The AT varies depending on whether the COPC in the affected media is a carcinogen or noncarcinogen. A longer AT is used for carcinogenic COPCs to account for the long latency period before exposure effects are seen. The EPA (1989) recommends an AT of 70 years × 365 days per year, or 25,550 days, for exposure to carcinogenic COPCs for the residential scenarios. For noncarcinogenic COPCs, the EPA (1989) recommends using an AT equal to the ED. These values are used in the risk assessment. For the ingestion and dermal routes of exposure, the AT is displayed in days. For the inhalation route of exposure, the AT is displayed in hours (EPA 2011a).

6.2.3.5.5 Surface Area of Skin

COPCs are absorbed by the skin through contact with soil and water. Dermal (skin) absorption of COPCs in soil may occur during outdoor activities. COPCs in groundwater may be absorbed by the skin during activities such as bathing or showering. COPCs in surface water may be absorbed through limited contact with surface water during recreational activities (e.g., washing hands or limited play in the creek).

Exposure to COPCs is affected by the surface area of skin coming into contact with the contaminated soil or sediment and the adherence of the soil to the skin. For skin contact with soil, the EPA (2004) and ADEC (2011) recommend using a skin surface area of 5,700 square centimeters (cm^2) for an adult wearing a short-sleeved shirt, shorts, and shoes, with exposed skin surface limited to the head, hands, lower legs, and forearms. The recommended skin surface area for children is 2,800 cm^2, for exposed head, hands, lower legs, and forearms (EPA 2004; ADEC 2011). These values are used for the residential and recreational/subsistence user scenarios. If event-specific values were used, this activity might include hands, lower legs, forearms, and feet. The net result would be adding feet and subtracting head from the SA value. These values are approximately equal and would result in no impact to overall risk. Therefore, the default surface areas used in this HHRA are health-protective.

The SA of 3,300 cm^2 (ADEC 2011; EPA 2004) for an industrial worker is used for the mine worker scenario. This represents exposure to the head, hands and forearms (EPA 2004).

Soil-to-skin adherence factor (AF) assumptions are based on values provided by the ADEC (2011) and in the EPA's Dermal Assessment Guidance (2004) and are consistent with residential and industrial scenarios, as appropriate. Based on the EPA's risk assessment guidance (2004), the residential setting is based on residential activities such as landscaping, gardening, and a child playing in the soil. The residential default values were chosen for the recreational/subsistence user, as well. The mine worker scenario used the default commercial/industrial value, which includes construction and utility work. These are appropriate assumptions of activities that would occur onsite. No values are available for sediment-to-skin AFs, so the soil-to-skin AFs used for sediment dermal exposure, as well.

For dermal absorption of COPCs in groundwater during showering or bathing activities, surface area values of 18,000 cm^2 for adults and 6,600 cm^2 for children are used, consistent with the RME recommendations presented by the EPA (2004, Exhibit 3-2). For each showering or bathing event the duration (t_{event}) is equal to 0.58 hours per event for adults and 1.0 hours per event for children, consistent with RME values (EPA 2004).

Dermal absorption of COPCs in surface water could occur while people wade or play in the water. This exposure would be limited to short times during the summer months. It is assumed that adults and children would have their hands, forearms, lower legs, and head exposed to surface water, resulting in a skin surface area consistent with that for exposure to sediment of 5,700 cm^2 for adults and 2,800 cm^2 for children (EPA 2004). It is assumed that the t_{event} would not exceed 1 hour.

6.2.3.6 Intake Rates

The consumption rate is the amount of an environmental exposure medium (e.g., soil, air, surface water, or food) ingested or inhaled over a period of time or per event. Default consumption rates of soil, water, and food are provided by the EPA (1989, 1997a, and 2000b) and ADEC (2011) for use in assessing each exposure pathway for adults and children. Intake rates for soil, groundwater and surface water, and food are provided in this subsection.

6.2.3.6.1 Soil Intake Rate

People are assumed to have contact with COPCs through the incidental ingestion of soil. The soil ingestion rate represents the amount of outdoor soil and indoor dust ingested through hand-to-mouth contact. The ADEC (2011) recommends an incidental soil ingestion rate of 100 milligrams per day (mg/day) for adults and 200 mg/day for children. These values are health-protective and slightly higher than the EPA values of 100 mg/day for children (soil and dust ingestion) (EPA 2011a) and 50 mg/day for adults (EPA 1997a). The ADEC's (2011) recommendation for outdoor workers is 100 mg/day, consistent with EPA recommendations (EPA 2002b). The ADEC values were used for all scenarios.

6.2.3.6.2 Groundwater and Surface Water Intake Rate

People may have contact with COPCs through the ingestion of groundwater or surface water used as a drinking water source. Under the residential scenario, people may use groundwater as the primary drinking water source. The recommended drinking water ingestion rate for an adult resident is 2 L/day (ADEC 2011) and for a child resident is 1 liter per day (EPA 2008c). It is also assumed that groundwater would be used for drinking water in an industrial setting while people are working at the site. ADEC (2011) recommends an ingestion rate of 2 L/day under this scenario, as well.

Surface water ingestion rates for adults and children are consistent with the drinking water ingestion rates used for groundwater exposure. These rates were determined to be health-protective and based on the assumption that surface water would be used as the primary drinking water while at the RDM site during recreational or subsistence activities.

6.2.3.6.3 Food Intake Rate

Plants harvested within the assessment area may take up COPCs from soil into their leaves and roots. In addition, wildlife may take up COPCs through ingestion of soil and consumption of local vegetation and animals. People who consume local vegetation and wildlife, therefore, may indirectly take up COPCs from the RDM site. Human intake of COPCs through food ingestion is determined by the types of food ingested, the amount of each type of food ingested per day, the concentration of COPCs in the food, and the percentage of the diet constituting food within the assessment area.

To develop the appropriate wild food intake rates for use in the HHRA, representatives from E & E met with representatives from the EPA, ADEC, BLM, Alaska Department of Health and Social Services, and the Agency for Toxic Substances and Disease Registry on February 14, 2012, and February 23, 2012, to discuss incorporation of the results from the ADF&G report, summarized in the *Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2* (E & E 2012c), into the HHRA. Development of wild food intake rates for use in the HHRA is discussed further below.

Available Harvest and Consumption Data, Prior to 2012

Previously, there was limited subsistence harvest or consumption data available for the Red Devil area. Although harvest data can provide information on site use patterns, it does not often provide quantitative evaluation of consumption patterns. The following discussion presents harvest and/or consumption reports that are available and relevant to the site.

The ADEC recommends that wild food ingestion rates be obtained from the ADF&G Community Profile Database (ADEC 2011), now incorporated in the

Community Subsistence Information System (CSIS). Big game data from the Central Kuskokwim Big Game Surveys for 2003, 2004, and 2005 are available for Red Devil in the CSIS (ADF&G 2011). The CSIS was also queried for harvest data for the neighboring communities of Sleetmute, Crooked Creek, and Stony River. Only big game data from the Central Kuskokwim Big Game Surveys of 2003, 2004, and 2005 are available for Crooked Creek and Stony River. For Sleetmute, in addition to the large game data, harvest data for other wild food resources are available in the CSIS; however, the data are from 1983, prior to use of the consumption adjustments for use in risk assessments, as described by Wolfe and Utermohle (2000).

ADF&G conducted household interviews in Red Devil in 1986 to determine resource use patterns (Brelsford et al. 1987). Although this report provides information on some harvest patterns, it does not provide sufficient detail to determine quantitative ingestion rates, and it is more than 20 years old.

Ballew et al. (2004) conducted a 12-month recall consumption survey in 13 villages throughout Alaska. The regional health corporation serving the village of Red Devil is the Yukon–Kuskokwim Health Corporation (YKHC) (Alaska Community Database 2010). Four villages from the YKHC region are represented in the Ballew et al. report, although the names of the specific villages are not provided. The following subsistence foods were identified in the top 50 foods reported to be consumed in greatest quantities by the participants in the YKHC region:

- King salmon
- Moose muscle and organs
- Chum salmon
- Caribou muscle and organs
- Whitefish
- Silver salmon
- Crowberries
- Lowbush salmonberries
- Moose fat and marrow
- Pike
- Seal oil
- Herring
- Tomcod
- Caribou fat and marrow
- Blackfish

- Blueberries
- Goose

For each of the subsistence foods, information is provided on the median and maximum amounts (in pounds per year) consumed in that region. These values are presented in Table 6-20, as adjusted to grams per day based year-round consumption (i.e., ED = 365 days per year) and broken up into major wild food source categories. The harvest rates were calculated by summing all food into the major categories of salmon, non-salmon fish, large land mammal, berries, and birds.

IDM Consulting (1997) was contracted by the ADEC to evaluate existing subsistence information in an effort to define subsistence regions and develop subsistence consumption parameter distributions for use in human health risk assessment. IDM (1997) concluded that, although harvest data significantly overestimate consumption for some resources, in the absence of more extensive consumption data, harvest data may be reasonably used as a surrogate for preliminary estimation of consumption (IDM 1997). IDM (1997) provides harvest rates for the following major resource categories: salmon, non-salmon fish, large land mammals, marine mammals, and marine invertebrates. Harvest rates are provided on per capita, 50th percentile, 90th percentile, 95th percentile, and maximum levels. The 50th and 95th percentiles are provided in Table 6-20 for the Subarctic Interior region which includes Red Devil Village. Marine mammals and marine invertebrates harvest rates are not included in Table 6-20 due to the large distance to a marine mammal or invertebrate harvest area from the site and that marine mammals were not harvested by any household in Red Devil Village in 2011 (Brown et al. 2012).

Harvest rate data from Ballew et al. (2004) and IDM (1997) are summarized in Table 6-20. For comparison, ingestion rates recommended by the EPA's Exposure Factors Handbook (2011) also are included. The berry values represent mean ingestion rates, body weight adjusted for adults, for the Native American consumers (EPA 2011a, Table 9-17).

A number of Native American fish intake rates are summarized in the Exposure Factors Handbook (EPA 2011a). Of those studies, one conducted in Alaska (Wolfe and Walker 1987) and two conducted in Washington (Toy et al. 1996; Duncan 2000) were chosen as the most representative for the Red Devil Mine site. In addition, Toy et al. (1996) and Duncan (2000) were recommended for review by EPA Region 10's Lon Kissinger (Kissinger 2011). The 95th percentile and mean ingestion rates are provided in Table 6-21. For comparison, the IDM (1997) fish ingestion rates are also provided in Table 6-21.

Alaska Department of Fish and Game Harvest Report, 2012

Between January and December 2010, residents of Aniak, Chuathbaluk, Crooked Creek Lower, Kalskag, Red Devil, Sleetmute, Stony River, and Upper Kalskag were surveyed regarding the subsistence and harvest use of wild foods in those communities. The principal questions addressed the number of wild foods that were harvested for subsistence, the harvest amounts, and how these foods were distributed within and between communities (Brown et al. 2012).

The survey represents a 12-month recall study, covering 2009, used to estimate subsistence harvests and uses of wild fish, game, and plant resources. Information was obtained on a household basis. The survey questions are provided in the ADF&G report (Brown et al. 2012). Maps of the area used for hunting, fishing, and gathering during the study year were developed.

The population trend in Red Devil has decreased since the census count in the 1960’s. During the study, the estimated population of Red Devil was 32 residents. Eleven households in Red Devil were surveyed, which included 27 residents. On average, residents lived in Red Devil approximately 23 years. The surveyed population was 44 percent female and 56 percent male. Eighty-two percent were Alaska Native.

Of the households surveyed, 100 percent used some kind of wild food, and 82 percent reported that they harvested wild food. Of the top 10 resources making up the majority of the wild foods harvested by edible weight, salmon species contributed 40 percent, whitefish species contributed 27 percent, other non-salmon fish species contributed 11 percent, black bears contributed 5 percent, and beaver contributed 3 percent of the total subsistence harvest. Estimated uses and harvest rates of wild foods are provided in Tables 7-1 through 7-6 of the ADF&G report (Brown et al. 2012). These tables present the percentage of households that use, attempt to harvest, harvest, receive, or give away each resource. Estimates of pounds harvested are provided as a total for the community, mean per household, mean per capita, and total estimated amount of harvest by the community.

Per ADEC (2011), high end user rates from ADF&G should be used to estimate ingestion rates for specific resources. The high end user is represented by the 95th percentile per capita use, which is the amount of wild food used by the consumer at the 95th percentile rank in a rural population during a survey year, expressed as a per person measure of grams per day (Wolfe and Utermohle 2000). This is the value recommended for use in an HHRA.

The 95th percentile use is determined by:

1. Harvest rate for a resource class developed on a household basis;
2. Households grouped into three classes based on reported use and sharing patterns during a survey year:
    a. Used the resource and did not share: Harvest per household/ number in household
    b. Used the resource and shared: Harvest for all households/ number of individuals in all households

   c. Did not use the resource
3. Rank order individuals by consumption rate; and
4. Selection individual at the 95th percentile rank.

The 95th percentile use value was calculated by ADF&G consistent with the methodology outlined in Wolfe and Utermohle (2000) and provided to the BLM (Koster 2012).

Potential Suppression Effect

A "suppression effect" occurs when a consumption rate for a given population reflects a current level of consumption that is artificially diminished from an appropriate baseline level of consumption for that population (National Environmental Justice Advisory Committee 2002). Although a suppression effect has primarily been studied in the context of fish harvests, discussion of this effect has been expanded to include all wild food harvest. A suppression effect can be caused by a number of factors, including situations when an environment has become contaminated or an individual perceives the environment to be contaminated to the point that humans refrain from harvesting from a particular area. A suppression effect also may arise when wild foods upon which humans rely are no longer available in historical quantities (and kinds), such that humans are unable to catch and consume as much wild food as they previously had or otherwise would.

Harvest data from nearby areas were reviewed to determine if a suppression effect was occurring in the Red Devil area, as compared to other nearby communities (Table 6-22; see Figure 1-1 from Brown et al. 2012 for the locations of nearby communities). Family relationships exist between current residents of Red Devil and Sleetmute who once lived along the Holitna River (Brown et al. 2012); therefore, Sleetmute was included for comparison. Due to geographical location, Crooked Creek and Stony River were also included for comparison. The other communities surveyed by ADF&G in 2011 (Brown et al. 2012) were also included to provide a range of harvest levels in the region. Harvest rates, on a 95th percentile use basis, were evaluated for the primary harvest categories identified by Red Devil households.

Based on this comparison, for non-salmon fish, Red Devil households showed the highest harvest rate, on a per capita basis, compared to Sleetmute, Stony River, Crooked Creek, Aniak, Chuathbaluk, Lower Kalskag and Upper Kalskag. For small land mammals, the Red Devil harvest rates were low compared to Stony River and Sleetmute but comparable or higher than the other six communities. For birds, the three most commonly harvested birds in Red Devil Village: spruce grouse, ruffed grouse, and ptarmigan. Red Devil Village harvest rates are consistent with the other communities and fall in the middle of harvest levels for the eight communities. This is similar for the commonly harvested berries (blueberries, lowbush cranberries, and crowberries/blackberries). For these resources—non-salmon fish, small land mammals, birds, and plants—no suppression effect is evident when compared to harvest rates in neighboring communities. Therefore, the harvest rates for Red Devil for these resources are appropriate estimates of consumption for use in the HHRA.

For large land mammals, black bears contributed the largest harvest amount, followed by beavers and caribou. Reports from interviews conducted in 2010 concluded that severe declines in the availability of moose in the region have led to an increase in the harvest and use of black bears by village residents. While limited by the lack of historical data, a rise in black bear uses and harvests by Red Devil households may indicate an adaption to declines in the availability of other large game resources, such as moose and caribou. Several respondents reported during the harvest survey that, prior to the moose hunting closure in Game Management Unit 19A, moose were the primary subsistence resource for the village. While caribou were never heavily harvested by the Red Devil community, a reported decline in caribou harvests is, in part, explained by both a lack of hunting activity in traditional areas, where caribou have most often been found, and the general migration of the Mulchatna caribou herd away from the region (Brown et al. 2012).

Large game mammal harvest data are available for Red Devil from 2003, 2004, 2005 (ADF&G 2011) and the ADF&G 2012 report (harvest data from 2009). In 2006, following at least a decade of severe moose declines in Game Management Unit 19A, the majority of the game management unit, including the Holitna and Hoholitna river drainages, was closed to moose hunting, and the remainder was limited to hunt opportunities requiring Tier II permits. In 2003, Red Devil residents harvested an estimated 36 pounds of moose per person. However, zero moose harvests were reported in 2004, 2005, and 2009. Similar declines were shown for caribou, with black bear harvests increasing (Brown et al. 2012). Based on this, it appears that the moose harvest rates from 2003 would represent the harvest not impacted by a suppression effect.

In June 2011, Alaska Department of Health and Social Services released preliminary consumption guidelines for women and children who eat pike and burbot (lush) from the Middle Kuskokwim River Area (ADH&S 2011). Potential suppression of the consumption of fish from the Kuskokwim River from the result of this consumption guideline would not have impacted results from the ADF&G survey since the consumption guidelines were released after the surveys were conducted.

Intake of Wild Food Exposure Parameters

Based on the discussion above, harvest rates from Red Devil for 2009 (Brown et al. 2012) represent the most appropriate estimates of consumption for most resource categories and are recommended for use in the HHRA, with the exception of large land mammals. Harvest rates for large land mammals were derived from the 2003 ADF&G survey results to account for potential suppression of harvest of these resources due to hunting restrictions or resource availability. Although harvest data significantly overestimate consumption for some resources

(IDM 1997) and the data were obtained on a household rather than individual basis, these harvest rates are the most applicable, site-specific values available and allow for a health-protective approach for evaluating risk from consumption of subsistence resources.

As previously discussed, harvest rates for adults were calculated as the sum of all use rates for food within specified food categories and household harvest data was divided by the number of individuals within a household to estimate per capita consumption. Because harvest rates are provided on an annual basis, the EF for wild foods is equal to a full year, 365 days per year. Harvest rates for the resident, subsistence/recreational user, and mine worker receptors are equal with differing FIs. The specified food categories used to calculate the harvest rates are:

1. Non-salmon fish
2. Large land mammals
3. Small land mammals
4. Birds and eggs
5. Berries and plants

For each category, a representative species was chosen as the indicator for the category. For example, Red Devil households indicated that they harvested the following berries and plants for consumption in 2009:

- Blueberry
- Lowbush cranberry
- Crowberry (blackberry)
- Wild rhubarb
- Hudson’s Bay tea
- Stinkweed

The harvest rate for the berries and plants category is set at the 95th percentile use rate for all six resources. The indicator species for the category was chosen as blueberries, based on the high harvest rate compared to other resources, as well as the availability of contaminant level data. Table 6-23 shows the food source categories, indicator species, study, and statistics that are used for the estimation of ingestion or consumption rate.

The harvest data were collected on a household basis and divided by the number of individuals in a household to derive an estimate of per capita consumption. The survey did not obtain data on an individual basis. At the time of the survey, the age of people from households surveyed ranged from 10 to 90 years of age, with an average age of 41 years old. Therefore, the values obtained from the survey are representative of an adult exposure scenario. No child rates were available.

A ratio of children to adult estimated energy requirements (EERs) is used to develop estimates of children’s consumption of subsistence resources from adult consumption data based on the approach presented in “Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids” (NAS 2002). This approach assumes that caloric intake and energy requirements are directly related to each other.

For children, the EER includes both total energy expenditure in kilocalories per day (TEE) plus energy required for growth and development. For young children, ages 0 through 2 years, physical activity levels are generally similar and gender differences were not observed. The equation used to develop EERs for young children is:

$$\text{EER} = \text{TEE} + \text{energy deposition}$$

This equation was used for children aged 0 through 35 months. EERs for boys and girls with “active” physical activity levels for the age ranges of 3–4 years, 4–5 years, and 5–6 years were obtained from Tables 5-20 and 5-21 in Institute of Medicine of the National Academies (2002). The EERs for each of these age ranges were averaged across genders. The time period associated with each EER was used to develop a time weighted average (TWA).

A similar analysis was done for individuals aged 6 through 70 using Tables 5-20, 5-21, and 5-22 in the Institute of Medicine of the National Academies (2002). For the adult EER analysis, data were used from the physical activity class of “active” and a body mass index (BMI) of 24.99 kilograms per square meter. This BMI is somewhat below the average BMI for Americans, but it was the highest BMI for which EERs were available in NAS 2002. For each age class, EERs were averaged across genders.

The ratio of the TWA EERs for children to adults was 0.48.

For this assessment, the adult consumption rates are multiplied by 0.48 to produce estimates of children’s consumption. This value is similar the value derived from the Columbia River Inter-Tribal Fish Commission (1994) study based on a ratio of child to adult consumption rates for fish of 0.4.

As requested by the ADEC, healthprotective estimates of risk are calculated based on an FI=1 (all food consumed is harvested from the site) for the residential scenario. This value is health-protective and would over-estimate true exposure, based on the harvest areas identified in the ADF&G report (Brown et al. 2012). Additional FI values for the residential scenario are discussed below and are consistent with the FIs for the recreation/subsistence user.

Recreational visitors and subsistence users would visit the site a portion of the year during harvest time and presumably would camp in the area. If the RDM site is redeveloped in the future as a mine, it is assumed that industrial or mine workers would work at the site and live in nearby Red Devil. It is assumed that these receptors (recreational/subsistence user and mine worker) would also harvest in other areas outside of the RDM site.

Based on discussions with the ADEC and EPA, the FI for recreational visitors/subsistence users and mine workers is calculated based on a ratio of the area of the RDM site to the total harvest area for the food source category of interest. Harvest maps for trout and whitefish, large land mammals, small land mammals, ducks and geese, and berries and greens are available from the 2009 survey (Brown et al. 2012, Figures 7-11 through 7-15). This approach assumes that the fraction of the food harvested is based on harvest area. The total site area is approximately 246 acres.

For large land mammals, small land mammals, and berries and greens, the FI was calculated using the following equation:

$$FI = \frac{Area\ of\ site\ (acres)}{Area\ of\ harvest\ locations\ for\ wild\ food\ (acres)}$$

For fish and birds, harvest locations were identified during the 2009 survey as single locations instead of harvest site area. For these resources, the FI was calculated based on the number of harvest locations. For instance, five harvesting locations were identified for trout and whitefish, including an area near the site. Therefore, the FI was set at 0.2 (20 percent) based on one location near the RDM divided by five total harvesting locations. For birds, two harvest locations were reported in the ADF&G report (Brown et al. 2012), although no harvest locations were identified near the RDM. It is assumed that if grouse or other birds were available near the RDM, they would be harvested in that area. Therefore, the FI was set at 0.33 (33 percent) based on one harvest location divided by three total harvesting locations (two reported in the ADF&G report and one near the RDM, not reported during survey).

For many resources, the RDM site is not within the harvest areas identified by ADF&G (no wild food harvested within the mine area); therefore, the respective FIs are health-protective by assuming that the mine area is within the harvest area.

Exposure parameters for the FI and exposure frequency to subsistence resources are provided in Table 6-19j.

6.2.3.7 Arsenic Bioavailability

Using total soil arsenic concentrations to quantify daily chemical intake typically results in estimated carcinogenic risk results greater than 10^{-6} for soils in naturally occurring background settings (Rodriguez et al. 2003).

These estimated cancer risk results are skewed high because the amount of arsenic that can be extracted from soil in the laboratory is greater than the amount that actually would be taken up by an organism. One method of reducing uncertainty and obtaining more reasonable risk estimates is to quantify that amount of arsenic in soils that is bioavailable. Bioavailability is the fraction of an ingested dose that crosses the gastrointestinal epithelium and becomes available for distribution to internal target tissues and organ and is a measure of the fraction of a contaminant that is absorbed by an organism via a specific exposure route (EPA 2007j).

The bioavailability of absorbed inorganic arsenic depends on the matrix in which it is contained. Arsenic taken into the body through drinking water is in a water-soluble form, and it is generally assumed that its absorption from the gastrointestinal tract is nearly complete. Arsenic in soils, however, may be incompletely absorbed because some of the arsenic may be present in water-insoluble forms or may interact with other constituents in the soil.

EPA Region 10 recommends use of 60 percent relative bioavailability of total arsenic if contamination is primarily a result of impacts by the mineral industry activities of extraction or beneficiation such as mining, milling, tailings disposal, and other similar activities, and if there are also no associated smelting activities (EPA 2000d). The default value of 60 percent was obtained from the EPA Region 10 animal study (EPA 1996c). EPA Region 10 indicates there is a high level of uncertainty associated with this default assumption of relative bioavailability because there are no acceptable *in vivo* studies comparing the uptake of arsenic in these matrices with the uptake of soluble arsenic from orally ingested water, and therefore, there are no quantitative data from which to develop a default value (EPA 2000d). In addition, the EPA has recommended where development of site-specific bioavailability estimates is not feasible, a default value of 60% can be used, recognizing that the default value is an estimate that is not likely to be exceeded at most sites and is preferable to the assumption of a relative bioavailability equal to 100% (EPA 2012b).

As directed by the EPA and ADEC, and consistent with the EPA recommendations on assessing bioavailability of arsenic in soil (EPA 2012b), for soil ingestion and dust inhalation exposures, soil intakes are multiplied by the default relative bioavailability of 60 percent to estimate the level of arsenic that reaches systemic circulation. Impacts are assuming 100 percent bioavailability for arsenic are discussed in Section 6.2.6.3.

6.2.3.8 Estimation of Contaminants of Potential Concern Concentrations in Media

As discussed above, concentrations of COPCs to which human receptors would potentially be exposed to over time were estimated per EPA guidance (EPA 1992) using the 95-percent UCL as the EPC for soil, sediment, and surface water. Maximum concentrations in groundwater were used.

Estimated media concentrations are used for exposure pathway calculations and estimating COPC concentrations in wild food. Uptake of COPCs from various media by plants and animals may cause exposures to ecological receptors and humans who consume local plants and animal products. The following subsections describe how COPC concentrations were obtained for food items such as berries, plants, game, and fish. Determination of concentrations of COPCs in air is also discussed in this section.

6.2.3.8.1 Contaminants of Potential Concern Concentrations in Fish

In 2010, the BLM conducted a study of Kuskokwim River, Red Devil Creek, and other tributaries to the Kuskokwim River near the RDM site (BLM 2012). Forage fish (e.g., slimy sculpin—whole fish samples) were collected and analyzed for site-related chemicals. It is assumed that people may be catching and consuming game fish from the Kuskokwim River near the mouth of Red Devil Creek and potentially, to a lesser extent, in Red Devil Creek, that may be impacted from COPCs from the site.

BLM sculpin whole-fish tissue data from Red Devil Creek is used to estimate concentrations of chemicals in game fish using a food chain multiplier (FCM) approach. The concentration of COPCs in game fish is estimated from the slimy sculpin concentration from Red Devil Creek multiplied by an FCM. For methylmercury, an FCM of three is assumed to account for biomagnification (i.e., the game fish concentration of methylmercury is set equal to three times the concentration in sculpin). This approach is supported by the fact that the biomagnification of methylmercury typically is three-fold with each trophic transfer (McGeer et al. 2004). For inorganic mercury and other metals, an FCM of one is assumed. This approach is defensible because biomagnification of metals (other than methylmercury) in aquatic organisms is rare. In fact, an inverse relationship has been shown for the trophic transfer of metals (except methylmercury) via the diet—that is, concentrations decrease from one trophic level to the next (McGeer et al. 2004). Hence, use of an FCM of one for inorganic mercury and other metals is health-protective.

Based on the ADF&G report (Brown et al. 2012), non-salmon game fish ingested by residents of Red Devil include Dolly Varden, sheefish, round whitefish, whitefish (other), burbot, grayling, and Northern pike. The trophic levels for slimy sculpin and the game fish of interest are provided below (FishBase Consortium 2011):

- Slimy scuplin – 3.37
- Dolly Varden – 4.23
- Sheefish – 4.15
- Round whitefish – 4.03
- Burbot – 4.03

- Grayling – 3.1
- Northern pike – 4.4

Based on these data, it was assumed that the game fish of interest are one trophic level above the slimy scuplin, except for grayling, which feed at a slightly lower trophic level than scuplin. This is a health-protective assumption. Using the sculpin data to estimate game fish concentrations in the Kuskokwim River is a health-protective approach because sculpin are more resident than the fish taken from the Kuskokwim River. This approach likely overestimates the true concentrations of fish that people are catching and consuming from the Kuskokwim River.

Slimy sculpin data for Red Devil Creek from the BLM June 2010, August 2010, June 2011, and September 2011 sampling events are presented in Table 6-53 and 6-54 and Appendix I. During 2011, the BLM analyzed fish tissue for inorganic arsenic and methylmercury in addition to a suite of total metals (BLM 2012). The EPCs for COPCs in slimy sculpin are provided in Table 6-15.

Preliminary telemetric studies on burbot and northern pike conducted by the BLM show that movements can be highly variable and difficult to predict for a given river system. Impacts of contamination from Red Devil Mine to fish harvested for subsistence use in the Kuskokwim River are unknown. Ongoing data collection and analyses will better inform discussions about the transfer of mercury, arsenic, and antimony, their various chemical forms, and other trace elements within the middle Kuskokwim River region from cinnabar deposits, Red Devil, and other abandoned mines (BLM 2012). For this assessment, data from fish from Red Devil Creek are used to estimate concentrations of COPCs in fish harvested for consumption. Based on the ADF&G harvest survey results (Brown et al. 2012), households in Red Devil Village harvest fish primarily from the Kuskokwim River. In 2010, the BLM harvested 17 northern pike, 11 burbot, two sheefish, and one humpback whitefish from the Kuskokwim River in the reach near Red Devil Creek, Reach C. Northern pike samples had the highest sample number and represent a high harvest rate compared to other game fish; therefore, northern pike was used for comparison to the game fish modeled results. Table 6-24a shows the modeled concentrations of arsenic, antimony, and mercury compared to the results from Reach C of the Kuskokwim River for Northern Pike muscle and liver tissue.

As shown in Table 6-24a, the concentrations of antimony, arsenic, and mercury of game fish modeled from the sculpin from Red Devil Creek exceed the measured concentrations in northern pike collected from the reach of the Kuskokwim River nearest to the RDM. Based on the BLM data, it was found that small, sedentary fish (slimy sculpin, juvenile Dolly Varden and juvenile Arctic grayling) and insects from Red Devil and Cinnabar Creeks had significantly greater mercury concentrations than the same fish in other Tributaries. Northern pike, burbot (lush), and Arctic grayling collected in the rivers sampled had variable mercury levels across the area. Northern pike from the George River had significantly higher mercury concentrations compared to other pike. There were no spatial differences in mercury concentrations in sheefish (BLM 2012). Impacts of using the modeled concentrations of COPCs in game fish versus the game fish collected from the Kuskokwim River are discussed in Section 6.2.6.2.

6.2.3.8.2 Contaminants of Potential Concern Concentrations in Large Land Mammals

No data on levels of site-related chemicals in wild game are available for the RDM site. According to ADF&G (Brown et al. 2012; ADF&G 2011), people in Red Devil harvest and consume black bear, moose, and caribou. In lieu of actual measured concentrations, metal concentrations in beef cattle, adjusted for moose, are estimated from metal concentrations in moose diet. This is based on the approach developed by Baes et al. (1984) and recommended by the EPA (2007h, 2005k). The general equation is:

$$C_M = F_f \text{ x } 27 \text{ x } C_D$$

Where:

C_M = Metal concentration in moose tissue (mg/kg dry)
F_f = Ingestion-to-beef transfer coefficient (days/kg) (from Baes et al. 1984)
27 = Constant; moose consume 27 kg/day of feed
C_D = Diet metal concentration (mg/kg dry) based on plant sample results collected in 2011

During the fall and winter, moose consume large quantities of willow, birch, and aspen twigs; during the summer, moose feed on forbs, vegetation in shallow ponds, and the leaves of birch, willow, and aspen (ADF&G 2012a, 2012b). Moose forage rates were estimated by Moen et al. (1997) as an average of 10.5 kg dry mass per day, with a range of 9.45 to 11.55 kg dry mass per day. In the fall, a moose can eat about 50–60 pounds (22–27 kg) of food per day (The Wilderness Classroom Organization 2002). The equation above was adjusted to incorporate moose forage rate, or consumption of feed, at a rate of 27 kg per day, a high-end health-protective estimate of year-round consumption. This approach is used to estimate the concentrations in moose, an indicator species for large land mammals.

The metal concentration in moose diet is obtained from results from the green alder bark samples. The green alder bark samples that were collected in 2011 represent the best surrogate for metals levels in alder twigs, leaves, and buds, the primary source of food for moose. Metal concentrations in the moose diet from the green alder bark samples were estimated using the FCM approach described above for fish (FCM = 3 for methylmercury and 1 for all other metals), although no methylmercury was detected in the green alder bark samples. EPCs for COPCs in green alder bark are presented in Table 6-16.

6.2.3.8.3 Contaminants of Potential Concern Concentrations in Small Land Mammals and Birds

Based on the ADF&G report (Brown et al. 2012), within Red Devil people harvest and consume beaver, snowshoe hare, river otter, mink, muskrat, and porcupine. Beaver is consumed at the highest rate and is used as an indicator for this resource category. Beavers primarily eat bark, as well as aquatic plants of all kinds, roots, and grasses. Green alder bark from the site was sampled and analyzed for metals in 2011. These data are used to represent the beaver diet, and the EPCs are presented in Table 6-16. Metal concentrations in small mammals were estimated from concentrations in their diet (i.e., green alder bark) using the FCM approach described for fish (FCM = 3 for methylmercury and 1 for all other metals). The concentration of COPCs in edible beaver tissue is estimated from the green alder bark concentration multiplied by an FCM. For methylmercury, an FCM of three is assumed to account for biomagnification. This approach is supported by the fact that the biomagnification of methylmercury typically is three-fold with each trophic transfer (McGeer et al. 2004). For inorganic mercury and other metals, an FCM of one is assumed.

Based on the ADF&G report (Brown et al. 2012), within Red Devil people harvest and consume primarily spruce grouse and ruffed grouse. Grouse primarily eat blueberries, high bush cranberries, rose hips, and aspen buds in the fall and the buds and twigs of aspen, willow, and soapberry in the winter. White spruce needles from the site were sampled and analyzed for metals in 2011. These data are used to represent the spruce grouse diet. Metals concentrations in spruce grouse muscle were estimated from the concentration in their diet using the FCM approach described for fish (FCM = 3 for methylmercury and 1 for all other metals), although no methylmercury was detected in the white spruce needle samples. The concentration of COPCs in grouse is estimated from the white spruce needle concentration multiplied by an FCM. EPCs for COPCs in white spruce needles are presented in Table 6-17.

6.2.3.8.4 Contaminants of Potential Concern Concentrations in Native Vegetation

Based on the ADF&G report (Brown et al. 2012), people in Red Devil harvest and consume blueberries, lowbush cranberries, crowberries (blackberries), wild rhubarb, Hudson’s Bay tea, and stinkweed. Based on the amount consumed and the availability of limited concentration data, blueberry fruit is used to represent this wild food category.

Total mercury and methylmercury have been measured in several terrestrial plant species from the RDM site, including willow, white spruce, black spruce, and blueberries (Bailey et al. 2002; Bailey and Gray 1997). A summary of the previous plant data is provided in Tables 1-3 and 1-6. Mercury and methylmercury were measured in blueberry fruit near the retort and mined areas of Red Devil Mine (Bailey and Gray 1997). Additional sampling of alder, blueberry, white spruce, and pond plants was conducted in summer 2011, although there were not sufficient blueberry fruit samples available for analysis. A second attempt to collect blueberry fruit was conducted in the summer of 2012. During the 2012 sampling event, eight blueberry fruit samples were collected. One sample, 12SM24BF, was within the potentially impacted area and was analyzed for the TAL metals, inorganic arsenic and methylmercury. These data are presented in Appendix E.

Although no soil samples were taken at the time of collecting the onsite blueberry sample, the soil samples near the area of collection indicate concentrations of some metals (i.e., arsenic, mercury, and antimony) below general site concentrations. Conducting the risk analysis for this pathway using the single onsite sample would introduce a high level of uncertainty. Although no other blueberry fruit were found onsite during two separate years of sampling attempts, it was determined that modeling the potential metals concentrations in blueberry fruit would be a health-protective approach. Chemical concentrations in blueberry fruit is modeled based on the following uptake equations from Baes et al. (1984):

$$Cv = Cs \times Br$$

Where,
Cv = Concentration in non-vegetative (reproductive) portion of food
Cs = Concentration in soil (mg/kg)
Br = Soil-to-plant elemental transfer coefficient for non-vegetative (reproductive) portions of food crops

The transfer coefficient for reproductive portions of plants is obtained from Figure 2-2 of Baes et al. (1984) and presented in Table 6-24b for the COPCs.

The uncertainty of estimating blueberry fruit concentrations based on the modeling approach is described in the Uncertainty Analysis, Section 6.2.6.2.

6.2.3.8.5 Contaminants of Potential Concern Concentrations in Air

To estimate the concentration of particulates in dust at the RDM site, the concentration of particulates in air used in the EC equation is calculated using the concentration in soil (C_S) and a particulate emission factor (PEF). Specifically, the concentration in air (C_a) is calculated using the following equation:

$$Ca = \frac{Cs}{PEF}$$

The PEF relates the concentration of contaminant in soil to the concentration of dust particles in the air generated from a “fugitive” or open source. PEFs for the residential and worker scenarios are calculated using the equations and parameters identified in the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA 2002b).

Specifically, the PEF is calculated using the following equation:

$$PEF = \frac{Q}{Cw} \times \frac{3{,}600}{0.036 \times (1 - V) \times \left(Um/_{Ut}\right)^{3} \times F(x)}$$

Where:

PEF = particulate emission factor (cubic meters per kilogram [m^3/kg)

Q/C = inverse of mean concentration at center of a 0.5-acre-square source wind (grams per square meter per second, per kilograms per cubic meter [g/m^2-s per kg/m^3])

V = fraction of vegetative cover (unitless), 0.5 (50 percent)

Um = mean annual windspeed (meters per second [m/s]), 4.69 m/s

Ut = equivalent threshold value of wind speed at 7m (m/s), 11.32 m/s

F(x) = function dependent on Um/Ut, 0.194

The term Q/C is set equal to the value for Minneapolis, Minnesota, for the largest source area 46.92 g/m^2-s per kg/m^3. Consistent with the ADEC's Cleanup Level Guidance (2008d), Minneapolis was used to represent the under 40-inch climate zone. The calculated site-specific PEF is 6.8 x 10^8 m^3/kg.

The airborne dust concentrations during ATV use for the recreational and subsistence users are estimated using equation E-18 of the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA 2002b). This equation is designed to calculate a PEF associated with construction traffic over unpaved roads but was modified to reflect ATV usage of an unpaved road or trail. The equations and input parameters are provided in Appendix J, Table J-17. The calculated site-specific PEF for ATV use is 3.1 x 10^9 m^3/kg.

Mercury, in the elemental form, and naphthalene (in the SMA, only) are the only volatile COPCs identified in soil. To estimate the concentration of volatile compounds in the air from soil at the RDM site, the air concentration was determined based on the soil concentration and the volatilization factor using the equation from EPA (1996a). Default soil parameter values were obtained from ADEC (2008c), and chemical-specific values were obtained from EPA (2012a). The value for Q/C was calculated using the equation described above. The equations and input parameters are provided in Appendix J, Table J-18. The resulting volatizing factor for elemental mercury is 2.26 x 10^4 m^3/kg. Total mercury results were used as the EPC for elemental mercury. Elemental mercury, the volatile form of mercury, can be estimated to be much lower based on the SSE results for Hg^0 reported in the F0 and F4 steps of the SSE results, see Section 5.2.2. The resulting volatizing factor for naphthalene is 1.58 x 10^4 m^3/kg.

Elemental mercury is the only volatile COPC identified in groundwater. The concentration of elemental mercury in air from household uses of groundwater was calculated by multiplying the concentration in groundwater by the default volatilization factor for water of 0.5 liters per cubic meter consistent with the

EPA's RAGS Part B (1991). As with soil, the total mercury results were used as the EPC for elemental mercury. Elemental mercury is relatively insoluble in water and therefore expected to be in lower concentrations in groundwater than the total mercury concentration.

6.2.4 Toxicity Assessment

The objectives of the toxicity assessment are to compile information on the nature of the adverse health effects of COPCs and to provide an estimate of the dose-response relationship for each COPC selected (i.e., determine the relationship between the extent of exposure and the likelihood and/or severity of adverse effects).

For the risk assessment, COPCs are divided into two groups: agents known or suspected to be human carcinogens (carcinogens) and noncarcinogens. As used here, the term "carcinogen" denotes any chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or laboratory animals. The risks posed by these two groups are assessed differently because noncarcinogenic chemicals generally exhibit a threshold dose below which no adverse effects occur, whereas for carcinogens, the simplifying assumption has been made that carcinogenic responses are linearly related to dosage even in the unobservable area of the dose-response curve. That is, it is assumed for carcinogens that each incremental increase in dosage produces a proportional incremental increase in the risk for cancer.

6.2.4.1 Quantitative Indices of Toxicity

The EPA consensus toxicity indices (e.g., chronic reference doses [RfDs] and carcinogenic slope factors [SFs]) were used in the assessment. Toxicity values were obtained using the following hierarchy (EPA 2003a; ADEC 2011) and are consistent with the toxicity values provided in the EPA's Regional Screening Level tables (2012a):

- The Integrated Risk Information System (EPA 2010d) and cited references.
- The Provisional Peer Reviewed Toxicity Values (EPA 2010e) and cited references developed for the EPA Office of Solid Waste and Emergency Response Office of Superfund Remediation and Technology Innovation programs.
- The Agency for Toxic Substances and Disease Registry Minimal Risk Levels (addressing non-cancer effects only).
- The EPA Superfund Health Effects Assessment Summary Tables (EPA 1997c) database and cited references.
- Other criteria as needed.

Noncarcinogenic and carcinogenic indices are tabulated separately.

Assessment of Non-carcinogens

To evaluate noncarcinogenic effects, the EPA (1989) defines acceptable exposure levels as those to which the human population, including sensitive subgroups, may be exposed without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety. The potential for adverse health effects associated with noncarcinogens (for example, organ damage, immunological effects, birth defects, and skin irritation) usually is assessed by comparing the estimated average daily intake (that is, exposure dose) to an RfD for oral exposure and to a reference concentration (RfC) for inhalation exposure.

RfDs are expressed in units of mg/kg-day, and RfCs are expressed in milligrams per cubic meter (mg/m^3). The RfD or RfC is an estimate (with uncertainty possibly spanning an order of magnitude) of the daily intake to humans (including sensitive subgroups) that should not result in an appreciable risk of deleterious effects. The EPA assigns a qualitative level of confidence (low, medium, or high) to the study used to derive the toxicity value, database, and RfD or RfC. The relative degree of uncertainty associated with the RfDs and the level of confidence that the EPA assigns to the data and the toxicity value are considered when evaluating the quantitative results of the risk assessment.

The EPA (2004) has not developed RfDs for dermal exposure to all chemicals, but it has provided a method for extrapolating dermal RfDs from oral RfDs. If adequate data regarding the gastrointestinal (GI) absorption of a COPC are available, then dermal RfDs may be derived by applying a GI absorbance factor to the oral toxicity value (EPA 2004). For chemicals lacking a GI absorbance value, absorbance is assumed to be 100 percent, and the oral RfDs are used to estimate toxicity via dermal absorption.

Oral and dermal toxicity data, including oral and dermal RfDs and GI absorption factor, are presented in Table 6-25. Inhalation RfCs and target organs are presented in Table 6-26.

Assessment of Carcinogens

The EPA (2005l) uses a weight-of-evidence (WOE) approach to evaluate the likelihood that a substance is a carcinogen. The EPA uses standard descriptors as part of the hazard narrative to express the conclusion regarding the WOE for carcinogenic hazard potential. The EPA recommends five standard hazard descriptors: “Carcinogenic to Humans,” “Likely to Be Carcinogenic to Humans,” “Suggestive Evidence of Carcinogenic Potential,” “Inadequate Information to Assess Carcinogenic Potential,” and “Not Likely to Be Carcinogenic to Humans.” Under the EPA’s previous (1986a) guidelines for carcinogen risk assessment, the WOE was described by categories A through E. These categories are (A) human carcinogen, (B1 or B2) probable human carcinogen, (C) possible human carcinogen, and (D) not classifiable as a human carcinogen, and (E) not a carcinogen to humans (EPA 1996b).

The toxicity of a chemical at low doses is often estimated from high-dose cancer bioassays. The most versatile forms of low-dose extrapolation are dose-response models that characterize risk as a probability over a range of environmental exposure levels. When a dose-response model is not developed for lower doses, another form of low-dose extrapolation is a safety assessment that characterizes the safety of one lower dose, with no explicit characterization of risks above or below that dose. Although this type of extrapolation may be adequate for evaluation of some decision options, it may not be adequate for other purposes that require a quantitative characterization of risks across a range of doses. At this time, safety assessment is the default approach for tumors that arise through a nonlinear mode of action; however, the EPA continues to explore methods for quantifying dose-response relationships over a range of environmental exposure levels for tumors that arise through a nonlinear mode of action (EPA 2005l). The carcinogenic potency is represented by a COPC's SF for oral exposure and is expressed as risk per milligram per kilogram per day [$(\text{mg/kg-day})^{-1}$]. The carcinogenic potency is represented by a COPC's inhalation unit risk (IUR) for inhalation exposure and is expressed as risk per microgram per cubic meter [$(\mu\text{g/m}^3)^{-1}$].

The EPA (2004) has not developed SFs for dermal exposure to all chemicals, but it has provided a method for extrapolating dermal SFs from oral SFs. This route-to-route extrapolation has a scientific basis because an absorbed chemical's distribution, metabolism, and elimination patterns are usually similar regardless of exposure route. However, dermal toxicity values are typically based on absorbed dose, whereas oral exposures are usually expressed in terms of administered dose. Consequently, if adequate data on the GI absorption of a COPC are available, then dermal SFs may be derived by applying a GI absorbance factor to the oral toxicity value (EPA 2004). For chemicals lacking a GI absorbance value, absorbance is assumed to be 100 percent, and the oral SF is used to estimate toxicity via dermal absorption.

Table 6-27 includes SFs for oral and dermal exposure, and Table 6-28 includes IUR for inhalation exposure. Mutagen potential, and SF basis or source, are also included in these tables.

Hexavalent chromium is the only COPC identified as a mutagen. EPA guidance (EPA 2005j) provides a protocol on how to evaluate exposure to carcinogenic compounds having a mutagenic mode of action. EPA age-dependent adjustments factors (ADAFs) of cancer potency are based on the assumption that cancer risks generally are higher from early-life exposures than from similar exposures later in life. The EPA (2005j) recommends the following age adjustment:

1. For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth until a child's 2nd birthday), a 10-fold adjustment.

2. For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's 2nd birthday until his or her 16th birthday), a 3-fold adjustment.
3. For exposures after 16 years of age, no adjustment.

The EPA is recommending the ADAFs described above only for mutagenic carcinogens because the data for non-mutagenic carcinogens were considered to be too limited and the modes of action too diverse to use non-mutagenic carcinogens as a category for which a general default adjustment factor approach can be applied. ADEC's risk assessment guidelines recommend the application of ADAFs only for those compounds that display a mutagenic mode of action for carcinogenicity (ADEC 2011). Exposure to hexavalent chromium is evaluated based on exposure to a combined child and adult receptor.

Many default or exposure factors, specifically wild food ingestion rates, are not available for the age ranges identified for analysis. Therefore an age adjusted exposure factor was used, consistent with the approach applied in development of the EPA RSLs (EPA 2012a). Specifically, intake was evaluated based on dose estimates adjusted upward to account for potential greater susceptibility of children from 0 to 2 years of age, 2 to 6, and 6 to 16 as compared with older children and adults in the following manner. Intake of hexavalent chromium uses the following equation:

$$I = \frac{C \times EF}{AT} \times \left[\left(\frac{ED_{0-2} \times CR_{child} \times 10}{BW_{child}} \right) + \left(\frac{ED_{2-6} \times CR_{child} \times 3}{BW_{child}} \right) + \left(\frac{ED_{6-16} \times CR_{adult} \times 3}{BW_{adult}} \right) + \left(\frac{ED_{16-54} \times CR_{adult} \times 1}{BW_{adult}} \right) \right]$$

The EPA's *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA 1993b) indicates that carcinogenic polycyclic aromatic hydrocarbons (PAHs) include benzo(a)anthracene; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(a)pyrene; chrysene; dibenzo(a,h,)anthracene; and indeno(1,2,3-cd)pyrene. None of these carcinogenic polycyclic aromatic hydrocarbons were identified as COPCs at the site. Both naphthalene and 1-methylnaphthalene are classified by California Environmental Protection Agency as carcinogens. These compounds were evaluated consistent with other carcinogens as described in this section.

6.2.4.2 Assessment of Arsenic and Mercury

Inorganic arsenic has been implicated as the primary toxic form to both aquatic life and humans. The toxicity data (i.e., reference dose and slope factor) for arsenic is from the inorganic form. Inorganic arsenic was analyzed in samples collected in soil, sediment, surface water, groundwater, and fish. Total arsenic analysis was also conducted for these samples. The inorganic arsenic results are used to determine the hazards and risks posed by arsenic at the site.

In 2010, total arsenic was measured in fish tissue results from the BLM study (Matz 2011). In 2011, inorganic arsenic concentration was measured in sculpin from Red Devil Creek. The inorganic arsenic data in sculpin were used to determine the hazards and risks from exposure to arsenic in fish tissue. The EPA has stated that approximately 85 to 90 percent of the arsenic found in the edible parts of fish and shellfish is organic arsenic (e.g., arsenobetaine, arsenochloline, dimethylarsinic acid), and approximately 10 percent is inorganic arsenic (EPA 2003c). The inorganic arsenic concentrations found in sculpin were greater than this estimate (Matz 2011; data are shown in Table I-3). The inorganic arsenic 95-percent UCL is 19.23 milligrams per kilogram wet weight (mg/kg-wet), which is greater than the total arsenic 95-percent UCL of 12.98 mg/kg-wet.

Both mercury and methylmercury were identified as COPCs in fish based on sediment and surface water screening. Methylmercury was measured in a total of seven sculpin from Red Devil Creek: one sculpin sample from June 2010, one from August, three from July 2011, and two from September 2011. For the current HHRA, mercury in fish was assumed to be 100 percent in the methylmercury form (EPA 1993a), and the methylmercury results in sculpin from Red Devil Creek were used to determine the hazards from exposure to mercury in fish.

6.2.4.3 Assessment of Lead

Lead was identified as a COPC in soil, sediment, surface water, and groundwater. Although the toxic effects from lead exposure are well known, there are no verified or consensus toxicity values available for lead in the Integrated Risk Information System, Superfund Health Effects Assessment Summary Tables, or other sources. The absence of authoritative toxicity values reflects the scientific community's inability to agree on a threshold dose for lead's noncarcinogenic effects or to satisfactorily estimate its carcinogenic potency, despite a large body of scientific literature on its toxicological effects.

Due to the lack of toxicity values, exposure to lead is assessed using physiologically based toxicokinetic models for children and adults. The exposure estimates derived using these models are then compared with accepted limits.

Models have been adopted to assess blood lead dose-response relationships in adults and children in lead-contaminated areas. Young children are the segment of the population at greatest risk from lead exposure because, in comparison to adults, their intake of lead from the GI tract is greater (50 percent for children versus 5 percent for adults), and their developing organ systems are more sensitive to the toxic effects of lead. Therefore, the lead Integrated Exposure Uptake Biokinetic (IEUBK) model is recommended (EPA 2007f) to assess potential impacts to children from exposure to lead.

The IEUBK model predicts blood lead levels in young children resulting from multiple pathways of exposure, including intake via air, soil, drinking water, and diet. Default parameters exist in the model for intake of lead via the listed pathways. Site-specific data can also be input into the model to derive site-specific results. For this assessment, the IEUBK Model Win32 v.1.1 was used. All input values used in the model are presented in Appendix K and are discussed in this section. Because lead was identified as a COPC in wild food, adjustments to default input parameters were made based on lead concentrations in locally caught wild food.

The IEUBK dietary intake parameter does include consumption of wild food from local sources as a default parameter; therefore, intake via wild food consumption was included as an "alternate" dietary source of lead. The default daily dietary lead intake values for each age apply to a typical child in the United States. These estimates are derived from U.S. Food and Drug Administration food monitoring data collected 1995–2003 (EPA 2007f). Site-specific data can be used to alter the default dietary intake rates due to the consumption of locally caught food.

Information on lead concentrations in wild food and the proportion of locally caught and consumed wild food to all consumed food is input into the model. The concentration for game from hunting was set at the calculated lead concentration in moose based on the average lead concentration in green alder bark, which represents the highest ingestion rate for game. It is assumed that locally caught fish and meat represent 100 percent of all meat consumed. The percentage of fish and meat to total meat was calculated by dividing the fish or game meat (sum of moose, beaver and grouse) by the total meat consumed (sum of game meat plus fish). This approach results in fish representing approximately 70 percent of the total meat consumed and hunted game represented approximately 30 percent of all meat consumed. The percentage of locally harvested berries and plants to all fruit ingested was calculated by dividing the site-specific berries and plant ingestion rate by the adjusted 95th percentile of all fruit consumed from the EFH (EPA 2011a, Table ES-1). These are health-protective assumptions used in the model. These inputs are presented in Table K-1.

The IEUBK model has been validated using central tendency input parameters. IEUBK guidance (EPA 2007i) calls for central tendency (i.e., average) inputs and, specifically, arithmetic means should be used for the lead concentration term (EPA 2007d). Therefore, average concentrations of detected values for soil, groundwater, and all wild food sources were used as the EPC. Since lead did not represent a risk to the most sensitive receptor, child residents in the MPA, no further modeling of lead was performed.

6.2.4.4 Assessment of Chromium

Chromium is an element existing in several different forms. Trivalent chromium is naturally occurring and is essential for good health. Hexavalent chromium does not occur naturally but is produced by certain industrial processes. Hexavalent chromium is the most toxic form of chromium and has been shown to cause lung cancer when workers are exposed to high air levels for long time periods.

Total chromium was identified as a COPC in soil, sediment, surface water, groundwater, and biota based on comparison of site concentrations to health-protective screening levels for hexavalent chromium. There are no known sources of release of hexavalent chromium at the site and the site concentrations (22.36

mg/kg in the SMA to 24.06 mg/kg in the MPA) indicate no source release and are consistent with surface soil background concentration of 22.88 mg/kg. Hexavalent chromium compounds are reduced to the trivalent form in the presence of oxidizable organic matter (ATSDR 2012).

Chromium samples were not speciated in the laboratory because of the cost, technical difficulties with conducting the analysis, and there was no known release. Since only total chromium concentration data are available, the ADEC requires that total chromium results be assessed assuming 100 percent of the total chromium is in the hexavalent form. The uncertainties associated with this approach are discussed in Section 6.2.6.2.

6.2.5 Risk Characterization

Risk characterization, the final component of the risk assessment process, integrates the findings of the first two components (exposure and toxicity) by quantitative estimation of human health risks. For each scenario evaluated, incremental lifetime cancer probability is estimated for an RME exposure scenario.

6.2.5.1 Assessment of Carcinogens

Any exposure to a carcinogen theoretically entails some finite risk of cancer. However, depending on the potency of a specific carcinogen and the level of exposure, such a risk could be practically negligible.

Scientists have developed several mathematical models to estimate low-dose carcinogenic risks from observed high-dose risks. Consistent with current theories of carcinogenesis, the EPA has selected the linearized multistage model based on prudent public health policy (EPA 1986a). As another health-protective measure, the EPA uses the upper 95-percent UCL on the dose-response relationship from animal or human studies data to estimate a low-dose SF. By employing these procedures, the regulatory agencies are likely to overestimate the actual SF for humans.

Using the SF (oral and dermal), excess lifetime cancer risks (ELCR) can be estimated by:

$$ELCR = \sum LADI_i \times SF_i$$

Where:

$LADI_i$ = Exposure route-specific lifetime average daily intake (mg/kg-day).

SF_i = Route-specific (oral and dermal) slope factor $(\text{mg/kg-day})^{-1}$.

Using the IUR (inhalation), the ELCR is determined by multiplying the EC by the IUR (EPA 2009c) as shown below:

$$ELCR = \sum EC_i \times IUR_i$$

Where:

EC_i = Exposure concentration (micrograms per cubic meter [µg/m^3]).

IUR_i = Inhalation unit risk (µg/m^3)$^{-1}$.

Assuming risk additivity, the ELCR for the oral, dermal, and inhalation routes of exposure are summed for exposure to soil, sediment, groundwater, surface water, and biota, as applicable. For carcinogens, the residential and recreational/subsistence user scenarios are calculated as an aggregate of child and adult exposure; the first six years of the ED is determined based on the child intake and the remaining time at an adult intake.

Calculated ELCR are provided in Appendix J, Tables J-1 through J-5, and summarized in Table 6-29, presented as one significant figure. The ADEC has set acceptable target levels at 1×10^{-5} for multiple exposure pathways. The EPA allows for a risk range of 10^{-6} to 10^{-4}.

The linear equation for risks, shown above, is valid only at low risk levels, below estimated risks of 0.01. If the chemical intake might be high at a site, resulting in a risk above 0.01, EPA recommends use of the one-hit equation (EPA 1989). Using this equation, the ELCR is calculated as shown below:

$$ELCR = \sum 1 - \exp(-LADI_i \times SF_i)$$

At this site, intake of arsenic results near and for some receptors above 0.01; therefore, the one-hit equation was also used to estimate risks at the site.

6.2.5.2 Assessment of Noncarcinogens

In accordance with EPA guidelines (1989), an HQ for noncarcinogenic risks is derived for each chemical and exposure route and, based on the assumption of dose additivity, the individual HQs are summed over all contaminants to determine the hazard index (HI).

Risks associated with non-cancer effects (e.g., organ damage, immunological effects, birth defects, and skin irritation) are usually assessed by comparing the estimated average exposure to an acceptable daily dose, RfD, or RfC. There are two standard approaches for determining RfDs and RfCs, discussed below.

In one approach, the RfD is selected by identifying the lowest reliable no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) in the scientific literature, then applying an uncertainty factor (usually ranging from 10 to 1,000) to allow for differences between the study conditions and the human exposure situation to which the RfD is to be applied. NOAELs and LOAELs can be derived from either human epidemiological studies or animal studies; however, they are usually based on laboratory experiments on animals in which relatively high doses are used. Consequently, uncertainty or safety factors are applied when deriving RfDs to compensate for data limitations inherent in the underlying experiments and for the lack of precision created by extrapolating from high doses in animals to lower doses in humans.

The second approach for determining RfDs and RfCs entails development of a benchmark dose (BMD). In 1995, the EPA's Risk Assessment Forum published guidance on the BMD approach in the assessment of non-cancer health risk. The BMD approach provides a more quantitative alternative in the dose-response assessment than the NOAEL/LOAEL process for non-cancer health effects (EPA 2000c). In addition, the BMD approach uses all of the data in the dose response curve as opposed to the LOAEL or NOAEL approaches, which rely on one dose value to develop dose response metrics. The use of BMD methods involves fitting mathematical models to dose-response data and using the different results to select a BMD that is associated with a predetermined benchmark response. As an example, the BMD method was used to derive the oral reference dose for methylmercury (EPA 2001b).

Non-cancer hazards are usually assessed by calculating an HQ, which is the ratio of the estimated exposure to the RfD (oral and dermal), as follows:

$$HQ = \frac{CDIi}{RfDi}$$

Where:

CDI_i = Chronic Daily Intake (mg/kg-day).
RfD_i = Reference Dose (mg/kg-day).

Likewise, inhalation hazard is assessed by comparing the EC to the RfC, as follows:

$$HQ = \frac{ECi}{RfCi}$$

Where:

EC_i = Exposure concentration (mg/m^3).
RfC_i = Reference concentration (mg/m^3).

The HI calculated for a single mode of action is a measure of how close the estimated exposure comes to the RfD. If the HI is less than 1, adverse effects would not be expected. If the HI is greater than 1, adverse effects are possible, but not certain. The ADEC and EPA have set the HI standard at 1.0.

Calculated HIs are provided in Appendix J, Tables J-6 through J-10, and summarized in Table 6-30.

If the HI exceeds 1, major chemical-specific effects identified in the derivation of the RfD by mechanisms of action and target organ can be reviewed. Upon segregation, HIs can be recalculated for specific effects or target organs to further define potential risks. Since a single compound, arsenic, contributed significantly to the HI, the hazards were not segregated by target organ in this assessment.

6.2.5.3 Risk Characterization Results

The estimated ELCR values are summarized in Table 6-29 and estimated HIs are summarized in Table 6-30. These results are discussed in this this section by potential receptor. As discussed in Section 6.2.3.4.3, cancer risks were calculated based on an ED of 54 years, while the non-cancer HIs were calculated based on an ED of 30 years for an adult.

Table 6-29 Summary of Excess Lifetime Cancer Risks for Red Devil Mine

Medium	Exposure Route	Future Resident - Surface Mined Area	Future Resident - Main Processing Area	Future Resident - RDC Downstream Alluvial Area	Recreational/ Subsistence User	Mine Worker
Soil	Ingestion	8E-03	1E-02	5E-03	3E-03	2E-03
	Dermal	1E-03	2E-03	8E-04	5E-04	5E-04
Sediment	Dermal	5E-03	5E-03	5E-03	5E-03	2E-03
Groundwater	Ingestion	1E-03	2E-01	2E-01	--	6E-02
	Dermal	8E-06	9E-04	9E-04	--	4E-04
Surface Water	Ingestion	--	--	--	1E-03	--
	Dermal	1E-05	1E-05	1E-05	3E-06	5E-06
Air	Inhalation of Fugitive Dust/Volatiles from Soil	2E-05	2E-05	1E-05	2E-06	8E-06
Fish	Ingestion	1E-01	1E-01	1E-01	2E-02	7E-03
Large Land Mammals	Ingestion	4E-05	4E-05	4E-05	6E-07	2E-07
Small Land Mammals	Ingestion	4E-04	4E-04	4E-04	7E-06	2E-06
Birds	Ingestion	2E-03	2E-03	2E-03	5E-04	2E-04
Berries and Plants	Ingestion	9E-03	1E-02	5E-03	9E-05	3E-05
Total Excess Lifetime Cancer Risk		**1E-01**	**3E-01**	**3E-01**	**3E-02**	**7E-02**

Note: Shaded cell indicates excess lifetime cancer risk greater than 10^{-5}.

Table 6-30 Summary of Hazard Indices for Red Devil Mine

Medium	Exposure Route	Future Resident - Surface Mined Area		Future Resident - Main Processing Area		Future Resident - RDC Downstream Alluvial Area		Recreational/ Subsistence User		Mine Worker
		Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult
Soil	Ingestion	12	116	30	284	10	94	8	74	22
	Dermal	2.4	16	3.3	22	1.4	9.4	0.8	5.4	3.8
Sediment	Dermal	8	55	8	55	8	55	8	55	14
Ground-water	Ingestion	6	13	1330	3102	1330	3102	--	--	950
	Dermal	0.2	0.5	34.9	103.0	34.9	103.0	--	--	24.9
Surface Water	Ingestion	--	--	--	--	--	--	0.0	0.0	--
	Dermal	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Air	Inhalation of Fugitive Dust/ Volatiles from Soil	4.6	4.6	56	56	18	18	14	14	13
	Inhalation of Volatiles from Ground-water	0.0	0.0	2.8	2.8	2.8	2.8	--	--	--
Fish	Ingestion	441	987	441	987	441	987	88	197	60
Large Land Mammals	Ingestion	8	18	8	18	8	18	0.1	0.3	0.1
Small Land Mammals	Ingestion	10	22	10	22	10	22	0.2	0.4	0.1
Birds	Ingestion	14	30	14	30	14	30	4.5	10	3.1
Berries and Plants	Ingestion	29.4	66	170.1	381	48.4	108	1.3	3.0	0.9
Total Hazard Index		535	1329	2107	5063	1926	4550	125	360	1092

Notes:
Shaded cell indicates HI greater than 1.0.
Hazards were calculated based on an exposure duration of 30 years, as described in Section 6.2.4.3. See Appendix J, Tables J-6 through J-9.

6.2.5.3.1 Future Resident

Cancer risks and HIs are calculated for a hypothetical future resident who will live and work at the RDM site. Risks and hazards are calculated separately for three different exposure units: SMA, MPA and DA, based on differing COPC concentrations in soil. COPC concentrations in other media sediment, surface water, groundwater, and air remained the same for all three exposure units, except as described below. Note, the air concentrations from fugitive dust or volatilization from soil are modeled from soil concentrations, so those concentrations differ between exposure units, as well.

Surface Mined Area – A resident within the SMA may come in contact with COPCs in soil, sediment, groundwater, surface water, air, and biota. As described in Section 6.2.3.2, it is assumed that residents within the SMA may be exposed only to groundwater within the SMA. Therefore, the risks and hazards from exposure to COPCs in groundwater are based on the maximum concentrations in the single SMA well (MW29).

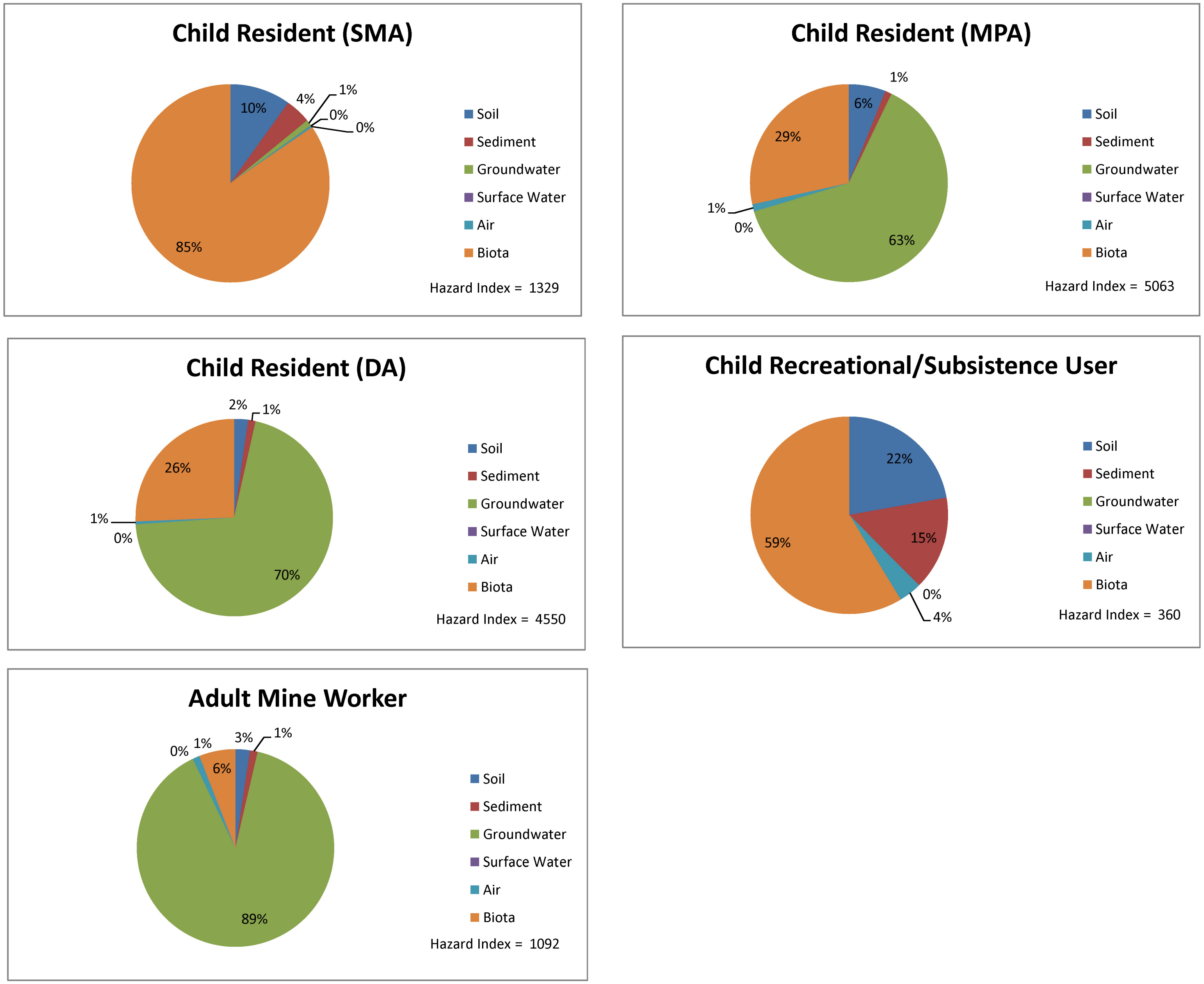
The ELCR, including all exposure pathways, for a hypothetical resident in the SMA is 1 x 10^{-1} (or 1 in 10), exceeding both ADEC and EPA risk standards of 10^{-5} and 10^{-4} through 10^{-6}, respectively. A summary of the cancer risk by medium and pathway is presented in Table 6-29. All exposure pathways except for dermal contact with groundwater and dermal contact with surface water exceeded the risk standards. Arsenic is the only carcinogenic COPC onsite contributing significantly to the ELCR, contributing over 99 percent to the overall risk at the site. Figure 6-2 shows the contribution to risk by medium (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to cancer risk include biota (88 percent overall risk), soil (7 percent), and sediment (4 percent). Risk from consumption of arsenic in fish is 1 x 10^{-1}, contributing approximately 90 percent of the risk from exposure to biota. For the resident, it is assumed that all wild food consumed was harvested from the site.

The HI, including all exposure pathways, for a hypothetical resident in the SMA is 535 for adults and 1,329 for children, exceeding both ADEC and EPA HI criteria of 1.0. A summary of the hazards by medium and pathway is presented in Table 6-30. Figure 6-3 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child resident. Child HIs are shown since they represented the potentially highest exposed receptor. Ingestion of biota (primarily fish consumption) contributes 85 percent (HI = 1,123) to the overall HI for children. Exposure to soil (ingestion and dermal contact) contribute 10 percent (HI = 132) to the overall HI.

The HI values for ingestion and dermal contact with soil, dermal contact with sediment, ingestion of groundwater, inhalation of fugitive dust from soil and ingestion of biota all exceed 1.0. These HI values are driven primarily by arsenic in soil and sediment. Ingestion of antimony and mercury in soil for children also slightly exceeded an HQ of 1.0, with HQs of 1.2 for antimony and 1.3 for mercury.

Figure 6-2. Cancer Risk Contribution by Media, Red Devil Mine

Figure 6-3. Hazard Index Contribution by Media, Red Devil Mine



Note: Hazards were calculated based on an exposure duration of 30 years as described in Section 6.2.3.4.3.

Main Processing Area – The total ELCR, including all exposure pathways, for a hypothetical resident in the MPA is 3 x 10^{-1} (or 3 in 10), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing significantly to the ELCR. A summary of the risk by medium and pathway is presented in Table 6-29. The risk at the site is driven by arsenic in groundwater with a ELCR of 2 x 10^{-1}. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include groundwater (56 percent), biota (38 percent), and soil (4 percent).

The HI, including all exposure pathways, for a hypothetical resident in the MPA is 2,107 for adults and 5,063 for children, exceeding both ADEC and EPA HI criteria of 1.0. A summary of the hazards by media and pathway are presented in Table 6-30. Figure 6-3 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child resident. As for the SMA, child HIs are shown since they represented the potentially highest exposed receptor. Ingestion of groundwater contributes 63 percent to the overall risk in the MPA, driven primarily by antimony and arsenic in groundwater. Ingestion of biota (primarily fish consumption) contributes 29 percent to the overall HI for children and ingestion and dermal contact with soil contributes 6 percent to the overall HI.

The HI for ingestion and dermal contact with soil, dermal contact with sediment, ingestion and dermal contact with groundwater, inhalation of fugitive dust and volatiles from soil, inhalation of volatiles from groundwater and consumption of biota all exceed an HI of 1.0.

Red Devil Creek Downstream Alluvial Area – The ELCR and HIs for the DA are similar to those for the MPA, due to the same potential drinking water source. The total ELCR, including all exposure pathways, for a hypothetical resident in the DA is 3 x 10^{-1} (or 3 in 10), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing significantly to the ELCR. A summary of the risk by medium and pathway is presented in Table 6-29. Figure 6-2 shows the contribution to risk by medium (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include groundwater (59 percent), biota (37 percent), and soil and sediment (2 percent each).

The HI, including all exposure pathways, for a hypothetical resident in the DA is 1,926 for adults and 4,550 for children, exceeding both ADEC and EPA HI criteria of 1.0. A summary of the hazards by medium and pathway is presented in Table 6-30. Figure 6-3 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child resident. As for the SMA and MPA, child HIs are shown since they represented the potentially highest exposed receptor.

Ingestion and dermal contact with groundwater contributed 70 percent to the overall HI for children. Exposure to groundwater is driven primarily by antimony and arsenic in groundwater. The HQs for cobalt, iron, manganese, and mercury also exceed an HQ of 1.0.

The HI values for ingestion and dermal contact with soil, dermal contact with sediment, ingestion and dermal contact with groundwater, and inhalation of particulates or volatiles from soil, inhalation of mercury from groundwater, and consumption of biota all exceed 1.0.

6.2.5.3.2 Recreational/Subsistence User

Cancer risks and HIs are calculated for a recreational or subsistence user at the RDM site. The total ELCR, including all exposure pathways, for a recreational/subsistence user is 3 x 10^{-2} (or 3 in 100), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing significantly to the ELCR. A summary of the risk by medium and pathway is presented in Table 6-29. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include biota (69 percent), sediment (16 percent), soil (11 percent), and surface water (4 percent). Unlike the resident, it is assumed that the recreational/subsistence user ingests surface water as a drinking water source while at the site.

The HI, including all exposure pathways, for a recreational/subsistence user is 125 for adults and 360 for children, exceeding both ADEC and EPA HI criteria of 1.0. A summary of the risk by medium and pathway is presented in Table 6-30. Figure 6-3 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child recreational/subsistence user. Child HIs are shown since they represented the potentially highest exposed receptor. Ingestion of biota (primarily fish consumption) contributes 59 percent to the overall HI for children.

For the child recreational/subsistence user, the HI for ingestion and dermal contact with soil, dermal contact with sediment, inhalation of fugitive dust or volatiles from soil and ingestion of fish, birds, and berries all exceed an HI of 1.0.

6.2.5.3.3 Future Mine Worker

Cancer risks and HIs are calculated for a hypothetical future mine worker at the RDM site. The total ELCR, including all exposure pathways, for a future mine worker is 7 x 10^{-2} (or 7 in 100), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing significantly to the ELCR. A summary of the risk by medium and pathway is presented in Table 6-29. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include groundwater (83 percent), biota (10 percent), soil (4 percent) and sediment (3 percent).

The HI, including all exposure pathways, for a future mine worker is 1,092, exceeding both ADEC and EPA HI criteria of 1.0. A summary of the risk by medium and pathway is presented in Table 6-30. Figure 6-3 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota). Ingestion and dermal contact with groundwater (primarily consumption) contributes 89 percent to the overall HI. Consumption of biota contributes 6 percent, and ingestion and dermal contact with soil contributes 3 percent to the overall HI.

6.2.5.4 Assessment of Background Contribution to Risk

Consistent with EPA policy (EPA 2002a), COPCs at the RDM site include all compounds that exceed risk-based concentrations, including chemicals that are below background levels. Background levels are presented in Section 4.1. Cancer risks and hazards are presented in Section 6.2.5.3 and include risks and hazards from naturally occurring background levels. Risks from exposure to background level are provided in Appendix J, Tables J-13 through J-15, for the residential, recreational/subsistence user, and mine worker scenarios, respectively. ELCR values from exposure to background levels are summarized in Table 6-31. ELCRs are 7 x 10^{-4} for a resident, 3 x 10^{-5} for a recreational/subsistence user, and 2 x 10^{-4} for a mine worker. Risks based on the calculated background concentrations account for less than 1 percent of the total cancer risks for all three receptors.

HIs from exposure to background levels are provided in Appendix J, Table J-16, and are summarized in Table 6-32 for the residential scenario, the most highly exposed receptor. The HI based on calculated background concentrations are 14 for the adult resident and 33 for a child resident and account for less than 1 percent of the over HI for a resident in the MPA and DA exposure units.

As stated in Section 6.2.6.1, characterization of background concentrations of metals at mine sites is important because mines are developed in naturally mineralized areas. In such areas, the concentrations of not only the metals targeted by the mining, but other metals as well, are commonly elevated. Characterization of background conditions at mine sites may be complicated by the mining and ore processing activities that occur in the vicinity of the site. Such is the case at the RDM site.

In order to assess site-specific background conditions at the RDM site, background samples were collected from locations that were recognized as being clearly outside of and upgradient of potential impacts by mining, ore processing, and waste disposal operations. Results of soil samples collected from the selected locations indicate significantly lower concentrations than might be expected in a mining area in general. The likely explanation for this is that the areas excluded from consideration for background soil characterization lie outside of not only the narrow cinnabar ore zones that were mined, but also the somewhat broader generally mineralized zone. As a result of the difficulties characterizing representative background soil conditions at the RDM site with the available data, the contribution of background to risk at the site is likely underestimated. Further information on characterization of naturally mineralized background conditions at the RDM is presented in Section 4.1.7.

6.2.5.5 Lead Modeling Results

As discussed in Section 6.2.4.3, risks from exposure to lead were not quantified as they were for other COPCs. Lead modeling was conducted for children using the IEUBK model.

The IEUBK model was run using default parameters except for the inclusion of the concentration of lead in soil, drinking water, and locally harvested wild food, as described in Section 6.2.4.3. Input parameters are provided in Appendix K. The model was run for the most highly exposed receptor, the future child resident in the SMA. Model output is provided in the form of a probability density curve that shows the probability of blood lead concentrations occurring in a hypothetical population of children. This curve shows a plausible distribution of blood lead concentrations centered on the geometric mean blood lead concentration predicted by the model from available information about children's exposure to lead. From this distribution, the model calculates the probability that children's blood lead concentrations will exceed a level of concern (EPA 1994).

The EPA and the Centers for Disease Control and Prevention have determined that childhood blood lead concentrations at or above 10 micrograms of lead per deciliter (μg Pb/dL) present risks to children's health (CDC 1991). In 2012, the Centers for Disease Control and Prevention responded to an Advisory Committee on Childhood Lead Poisoning Prevention Recommendations (CDC 2012). Based on that response, the CDC now uses a reference level of 5 μg Pb/dL to identify children with blood lead levels that are much higher than most children’s levels. This new level is based on the U.S. population of children ages one to five years who are in the highest 2.5 percent of children when tested for lead in their blood. Therefore, a value of 5 μg Pb/dL is generally used as the blood lead level of concern and is the threshold used in this assessment. The probability density curves designate the percentage of children predicted to have blood lead levels that exceed the threshold. Probability density curves were generated for this site comparing to both the 10 μg Pb/dL and the 5 μg Pb/dL criteria and are provided in Appendix K. The EPA’s risk reduction goal for contaminated sites is that no more than 5 percent of the population exposed to lead will have blood lead levels greater than the criteria (EPA 2003b). The IEUBK model gives potential percentages of children with blood lead levels above 5 μg Pb/dL for the future resident of 0.024 percent. These results are approximately an order of magnitude below the EPA’s 5 percent, indicating that lead does not pose an unacceptable risk at the site.

6.2.6 Uncertainty Analysis

Uncertainty is inherent in every step of the risk assessment process. This section addresses uncertainty and its impact on the risk assessment results. The risk characterization combines and integrates the results of data collection and evaluation, the exposure assessment, and the toxicity assessment to obtain quantitative estimates of the potential risks posed by site contamination. The following sections and Table 6-33 present some uncertainties associated with each step of the process and the ways they are likely to affect the overall risk estimates.

6.2.6.1 Environmental Sampling and Analysis

Samples collected during the investigations were intended largely to characterize the nature and extent, and fate and transport, of contamination at the site. While this sampling approach is sound for site characterization, it can result in uncertainties in estimating the average concentration, or EPC, that people may contact over time.

For example, many sampling locations were selected in a purposeful or directed manner to focus on particular areas where contamination was known or suspected to be present. Samples collected in this manner provide considerable information about the site but are not statistically representative of contamination that may be present on the site and may overestimate the average concentration to which people may be exposed. For example, biased sampling was conducted in the SMA targeting the “F” ore zone and the Dolly and Rice ore zone. Results from these samples showed elevated metal concentrations. Biased sediment sampling in resulted in inclusion of a sample consisting of yellowboy material deposited at a spring, with a total arsenic concentration of 130,000 mg/kg, which is much higher than arsenic concentrations the sediment samples collected in Red Devil Creek. Inclusion of results from biased sampling results in higher EPC concentrations than would be assumed from random exposure.

Characterization of background concentrations of metals at mine sites is important because mines are developed in naturally mineralized areas. In such areas, the concentrations of not only the metals targeted by the mining, but other metals as well, are commonly elevated. Characterization of background conditions at mine sites may be complicated by the mining and ore processing activities that occur in the vicinity of the site. Such is the case at the RDM site, as discussed in Section 4.1.7 and below.

As stated in Section 4.1.7, in order to assess site-specific background conditions at the RDM site, background samples were collected from locations that were recognized as being clearly outside of and upgradient of potential impacts by mining, ore processing, and waste disposal operations. Results of soil samples collected from the selected background locations indicate significantly lower concentrations than might be expected in a mining area in general. The likely explanation for this is that the areas excluded from consideration for background soil characterization lie outside of not only the localized cinnabar ore zones that were mined, but also the somewhat broader mineralized zone. As noted in Section 4.1.7, although cinnabar ore mining was focused on discrete localized ore zones, natural mineralization in the RDM area extends beyond the discrete ore zones that were targeted by mining. It appears that the available soil samples for background characterization are not representative of actual background geological conditions at parts of the RDM. As a result of the difficulties characterizing representative background soil conditions at the RDM site with the available data, the contribution of background to risk at the site is likely underestimated.

Analytical methods or laboratory practices can result in elevated detection limits. A number of compounds were not detected in surface water or groundwater, yet had detection limits above an RBSC. Many of these compounds had detection limits at the same order of magnitude as the EPA's health-protective RSLs. The following compounds exceeded the RSL by greater than an order of magnitude: bis(2-chloroethyl)ether, bis(2-ethylhexyl)phthalate, hexachlorobenzene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, N-nitroso-di-N-propylamine, N-nitrosodimethylamine, and pentachlorophenol. The MDLs for these compounds ranged from 11 to 165 times the RSL, except for N-nitrosodimethylamine, which has a screening level of 0.00042 μg/L and an MDL of 0.48 μg/L. Although the compounds had detection limits above the RBSC, these compounds are not expected to be found in groundwater or surface water at appreciable levels based on either their chemical properties or use at the site. In addition, none of these compounds were identified as COPCs in soil or sediment. Based on this, it is not expected that that elevated detection limits would have an appreciable impact on overall risk at the site.

6.2.6.2 Exposure Point Concentration Uncertainties

Because of the variability and uncertainty inherent in the sampling and analysis processes, the chemical concentrations reported may differ from the actual chemical concentrations. Uncertainty is introduced by the use of estimated, or J-qualified, results, which may not have the same precision and accuracy as data meeting all standard QC criteria. There is also uncertainty associated with the use of nondetect results, or assuming that COPC concentrations are based on the reported limits, which may overestimate or underestimate the true concentrations present.

EPCs in biota were modeled from soil, vegetation, or fish samples. Biota uptake modeling generally results in estimated concentrations that are higher than actual concentrations. As shown in Table 6-24a, the modeled concentrations of COPCs in fish are significantly higher than measured concentrations in game fish.

EPCs in birds were modeled from concentrations of COPCs in white spruce needles. The arsenic white spruce needle EPC is highly impacted by a single, elevated sample (11MP38WS), located near Red Devil Creek downhill from Settling Ponds #1 and #2. The concentration of arsenic in this single sample is 11.1 mg/kg; the next highest concentration is 0.82 mg/kg. The EPC would change from 7.58 mg/kg to 0.59 mg/kg if this sample were excluded from the data set, and the ELCR for the resident from consumption of arsenic in birds would change from 2×10^{-3} to 1×10^{-4}.

EPCs in berries were modeled from concentrations of COPCs in soil. As an example of the impact of using the modeled concentration, the resulting HIs for consumption of berries for residents (child) in the MPA and recreational/ subsistence users (child) are 381 and 3, respectively, compared to HIs of 1 and 0.01, respectively, when using the results from the single onsite blueberry sample. The ELCR from ingestion of arsenic in blueberries based on the modeled concentrations for the residents in the MPA and recreational/subsistence users are 1×10^{-2} and 9×10^{-5}, respectively. Since arsenic was not detected in the onsite blueberry sample, no cancer risk was associated with exposure to blueberries based on the onsite sample.

Based on the analysis above, use of modeled concentrations of COPCs in biota, including fish, birds and berries, overestimates risks and hazards from consumption of these food sources.

Methylmercury concentrations in sculpin from Red Devil Creek were used to determined potential hazards of ingesting game fish from the Kuskokwim River. The methylmercury concentration in sculpin was multiplied by three to account for the bioaccumulation properties of methylmercury into game fish. There are seven sculpin samples that were analyzed for methylmercury, six of which were whole body samples that also had total mercury results. Of these six samples, the methylmercury percentage compared to total mercury ranged from 23 to 83 percent. The total mercury concentrations in these six samples ranged from 0.10 mg/kg-wet weight to 0.68 mg/kg-wet. Forty-five whole fish sculpin samples were analyzed for total mercury. The total mercury results from this data set ranged from 0.05 to 3.7009 mg/kg-wet. The small data set for methylmercury could potentially underestimate methylmercury in sculpin from Red Devil Creek. Although there is uncertainty in the methylmercury concentration in sculpin based on the small sample size, the actual methylmercury concentration in fish is preferable to estimating methylmercury concentrations and percentages based on total mercury concentrations and literature values. In addition, the health-protective assumptions used to model the methylmercury concentration in game fish reduce the potential impacts of this uncertainty.

Total mercury concentrations in soil and groundwater were used to estimate elemental mercury concentrations for assessment potential inhalation exposure. Based on results from the SSE in soil from the F0 and F4 fractions, mercury in the volatile form was generally much lower than the total mercury EPC. For this pathway assessment, the assumption that all the total mercury in soil is in the elemental form overestimates risk from exposure to volatile, elemental mercury at the site. Exposure to elemental mercury in soil or groundwater, however, did not pose an unacceptable risk or hazard at the site even based on these health-protective estimates.

Total chromium was identified as a COPC in soil, sediment, surface water, groundwater, and biota based on comparison of site concentrations to health-protective screening levels for hexavalent chromium. There are no known sources of release of hexavalent chromium. Since only total chromium concentration data are available, the ADEC requires that total chromium results be assessed assuming that 100 percent of the total chromium is in the hexavalent form. This assumption will over-estimate the true risk of exposure to chromium.

Risks and hazards from consumption of groundwater were determined based on unfiltered sample results. Filtered (or dissolved) metal results are lower in concentration than the total metal results. Construction of new drinking water wells would likely incorporate mechanisms to filter turbid water, resulting in true exposure to COPCs that would more likely be represented by filtered sample results. Use of the total metal concentrations in groundwater overestimates risks and hazards at the site.

Groundwater and surface water EPCs were derived based on data collected for the RI, including data from the 2010 and 2011 sampling events. During the spring and fall of 2012, a set of groundwater wells and stream and spring surface water locations were monitored to characterize the seasonal variability in groundwater and surface water, characterize the long-term variability of surface water and groundwater, and determine any trends. The baseline data were collected at a subset of the monitoring well and surface water locations sampled for the RI. The data from the 2012 groundwater and surface water monitoring effort are presented in Appendix A. Well by well comparison for those wells sampled during both the RI and baseline monitoring showed that total arsenic, antimony, and mercury in groundwater were generally greater during the spring 2012 monitoring event than the RI sampling events. Risks and hazards at the site were calculated using the maximum concentration in RI groundwater samples. The maximum site-wide concentrations of arsenic and mercury were found during the RI sampling events in 2010 and 2011. For antimony, the maximum site-wide concentration was found during spring 2012, but the concentration was only slightly higher than the concentration from the RI sampling events. On a location by location comparison, total surface water concentrations of arsenic, antimony, and mercury are generally one to two times higher in the spring 2012 monitoring data than the RI data. Including the baseline monitoring data at the seven surface water locations would be expected to have limited impact of the surface water EPC. Since exposure to non-carcinogens in surface water resulted in very low HIs, slight changes in the EPC would not impact the overall results of hazard at the site from exposure to surface water. For carcinogenic risk, ingestion of arsenic in surface water by recreational and subsistence users is 1×10^{-3}, above the ADEC threshold of 1×10^{-5}. Dermal exposure to arsenic in surface water for all receptors was below the ADEC threshold, with site risks ranging from 3×10^{-6} to 1×10^{-5}. Slight changes to the arsenic EPC in surface water could result in slight changes in risk at the site from exposure to surface water. Overall, excluding the baseline monitoring data has limited impact on the overall risks and hazards at the site but generally may underestimate true risk and hazard at the site. For additional information on seasonal variability and well and surface water location comparisons, see Appendix A.

6.2.6.3 Exposure Assessment Uncertainties

Selection of appropriate exposure parameters is typically a challenging exercise in conducting an HHRA because it is difficult to generalize about potentially impacted populations and site-specific exposure studies are very rare. Nevertheless, the risk assessor must make the best assumptions possible based on available information. While there are limited studies available for contact with soil, even fewer studies have been conducted to estimate exposures to sediment, in terms of frequency of contact, adherence of sediment to skin, and incidental ingestion of sediment through hand-to-mouth contact. For this reason, many sediment ingestion and dermal exposure parameters are based on studies of human contact with soil, which may result in an under- or overestimation of risk.

The individual exposure parameter values used in the RME calculations were selected to represent a high-end estimate of exposure for an individual that is a health-protective estimate of actual exposures. The exposure values selected were either standard default values consistent with ADEC and EPA guidelines, or were health-protective estimates selected based on best professional judgment. As a result, the calculated potential exposures probably overestimate the actual exposure for most individuals in the receptor populations.

As briefly mentioned above, additional uncertainty is associated with the procedures used to estimate dermal absorption of chemicals from sediment, specifically ABS_{dermal} and AFs. Uncertainties with this approach arise from the limited information available on sediment-specific values and the application of soil values to represent exposure to sediment. Dermal absorption of COPCs in sediment was estimated using conservative absorption factors for soil recommended by EPA. The recommended default values, which generally fall at the upper ends of the ranges that have been observed in absorption studies, may not reflect actual dermal absorption for sediment. However, use of the central tendency exposure estimates to assess risks and develop risk-based cleanup levels would result in unacceptable risk for a substantial portion of the population.

Dermal exposure to bis(2-ethylhexyl)phthalate in groundwater and 1-methylnaphthalene in surface water were not evaluated quantitatively, consistent with EPA guidelines (2004). EPA recommends quantitative evaluation of the dermal exposure pathway for those chemicals where the dermal pathway has been estimated to contribute more than 10 percent of the oral pathway, using conservative residential exposure criteria. Not including bis(2-ethylhexyl)phthalate and 1-methylnaphthalene in the quantitative assessment could slightly underestimate overall risk and hazard at the site.

In late 2013, at the request of the EPA, the ADF&G calculated the 90th percentile for residence time for adults in Red Devil Village at 54 years (Kissinger 2013). This value was used to calculate the LADI used for calculating cancer risk for the residents and recreational/subsistence user. The intake for non-cancer compounds is averaged over the exposure duration and calculated on a daily basis. Therefore, the intake is averaged and calculated on a daily basis, and the ED does not impact the calculation. Because of this, the EPA and ADEC default ED of 30 years was considered representative for the adult residential and recreational/subsistence user ED for calculating non-cancer intake and hazard quotients. Use of an ED equal to 30 years for the non-cancer dose does not appreciably impact the hazard quotient.

Arsenic concentrations in soil and air were adjusted to reflect the bioaccessibility of arsenic at RDM. A default value of 60 percent was used for arsenic bioavailability, but this EPA value is known to be highly uncertain (EPA 2003a). EPA supports the use of validated *in vitro* methods to estimate bioavailability with the caution that the protocol specified in the methodology be followed for making the extrapolation from *in vitro* data to *in vivo* values (EPA 2007j). Even with validated in vitro methods, there is some uncertainty or variability in actual relative bioavailability values.

Site-specific arsenic bioaccessibility was measured in 14 surface soil samples, as an estimate of bioavailability of arsenic at the site. Soil samples were analyzed using EPA Method 9200.1-86 (EPA 2008e) modified for arsenic. The EPA method is an *in vitro* bioaccessibility assay for lead in soil. Bioavailability of arsenic is expressed either in absolute terms (absolute bioavailability) or in relative terms (relative bioavailability). Absolute bioavailability is the ratio of the amount of arsenic absorbed compared to the amount ingested. Relative bioavailability is the ratio of the absolute bioavailability of arsenic present in some test material compared to the absolute bioavailability of arsenic in some appropriate reference material. The EPA method has been validated for bioaccessibility of lead in soil but has not been approved for the determination of arsenic bioavailability.

Results from arsenic bioaccessibility soil samples are presented in Chapter 4 and Table 6-34. Arsenic bioaccessibility samples were collected from seven of the soil types introduced in Chapter 3. Samples were sieved to less than 250 micrometers for use in the HHRA.

The relative bioavailability for arsenic ranged from 2.7 percent in the MPA to 68.1 percent in background soil samples. No strong correlation between total arsenic concentrations and arsenic bioaccessibility was found. Arsenic bioaccessibility in the two background samples showed the highest percent bioaccessibility ranging from 34.9 to 68.1 percent. There was one sample collected from the DA exposure unit with a result of 36.1 percent. The MPA results ranged from 2.7 to 47.3 percent. The SMA results ranged from 4 to 43 percent. Although there is uncertainty in estimating bioavailability from the *in vitro* method, the site-specific data provide some additional support that the EPA default value of 60 percent appears to be a health-protective estimate of true bioavailability at the site.

Use of a default adjustment for bioavailability factor likely overestimates risk at the site based on the site-specific bioaccessibility results provided in Table 6-34, but to ensure a health-protective approach, risks from exposure to arsenic were also assessed based on 100 percent bioavailability for the most highly exposed receptor, a resident in the MPA exposure unit. A summary of the risks and hazards from exposure to arsenic using the default 60 percent bioavailability value and at the 100 percent bioavailability assumption are shown in Table 6-35. Full risks and hazards are presented in Tables J-19 and J-20 of Appendix J. As shown in the table, although the pathway-specific risks and hazards for exposure to arsenic varied with bioavailability, the overall risks and hazards showed no or very little change. Note that the EPA has recommended where development of site-specific bioavailability estimates is not feasible, a default value of 60 percent can be used, recognizing that the default value is an estimate that is not likely to be exceeded at most sites and is preferable to the assumption of a relative bioavailability equal to 100% (EPA 2012b).

All other metals at the site were assumed to be 100 percent bioavailable, which likely overestimates risks and hazards at the site.

Ingestion rates for consumption of wild food used in this HHRA are based on a 12-month recall survey of harvested data. The survey was conducted on a household basis, and an estimate of per capita consumption was calculated based on household size. As previously mentioned, harvest data significantly overestimates consumption for some resources (IDM 1997). The harvest rates were adjusted to estimate ingestion on an individual basis. Only household harvest data were available, and energy requirement estimates were used to assign an ingestion rate for children. These adjustments likely overestimate true ingestion of wild food at the site. In addition, the residential scenario was determined based on the assumption that all wild food was harvested from the site. Based on Brown et al. (2012), this assumption greatly overestimates actual harvest patterns, as shown for the resident in Figure 6-4. In addition, for all resources except moose, 95th percentile use values were used as an estimate for consumption. This represents a high-end user, which would over-estimate risks and hazards at the site. However, use of central tendency exposure estimates to assess risks and develop risk-based cleanup levels would result in unacceptable risk for a substantial portion of the population.

Consumption of home grown fruits and vegetables was not evaluated in this assessment. Based on a consumption survey reported by Ballew et al. (2004), only oranges, bananas, apples, potatoes, and other “store bought vegetables” are fruits or vegetables reported to be consumed in the top 50 foods for the YKHC region that are not grown wildly and harvested from subsistence activities. Of these items, only potatoes can be grown in the climate at the site. Consumption of potatoes ranked 49th out of the top 50 food items (Ballew et al. 2004). Therefore, it can be estimated that consumption of fruits or vegetables from a garden does not and would not in the future represent a significant portion of the diet of people from the area. Not quantitatively evaluating the consumption of home grown fruits and vegetables could possibly under-estimate the total risk or hazard at the site.

6.2.6.4 Toxicity Assessment Uncertainties

The basic uncertainties associated with the derivation of toxicity values in the toxicity assessment include:

- Uncertainties arising from the design, execution, or relevance of the scientific studies that form the basis of the assessment.
- Uncertainties involved in extrapolation from the underlying scientific studies to the exposure situation being evaluated, including variable responses to chemical exposure within human and animal populations, between species, and between routes of exposure.

These uncertainties could result in a toxicity estimate based directly on the underlying studies that either underestimates or overestimates the true toxicity of a chemical. The toxicity assessment process compensates for these basic uncertainties through: the use of uncertainty factors and modifying factors in the derivation of RfDs for assessing noncarcinogenic effects; and the method of calculating the 95-percent UCL value from the linearized multistage model to derive low-dose SFs for assessing cancer risks. This approach ensures that the potential toxicity of a chemical to humans is unlikely to be underestimated; however, actual toxicity may be substantially overestimated as a result. There is significant uncertainty in how to address risks from mutagenic compounds.

The use of adjusted oral toxicity values to evaluate dermal risks is an additional source of uncertainty to the dermal risk estimates because the biokinetics (uptake, distribution, metabolism, and elimination) from dermal exposure may be different from ingestion.

In the absence of information to the contrary, EPA guidelines indicate that carcinogenic risks should be treated as additive and that HIs for similar noncarcinogenic effects should also be treated as additive. The assumption of risk additivity ignores possible synergisms or antagonisms among different chemicals, which would increase or decrease their toxic effects and could tend to underestimate or overestimate total site risks.

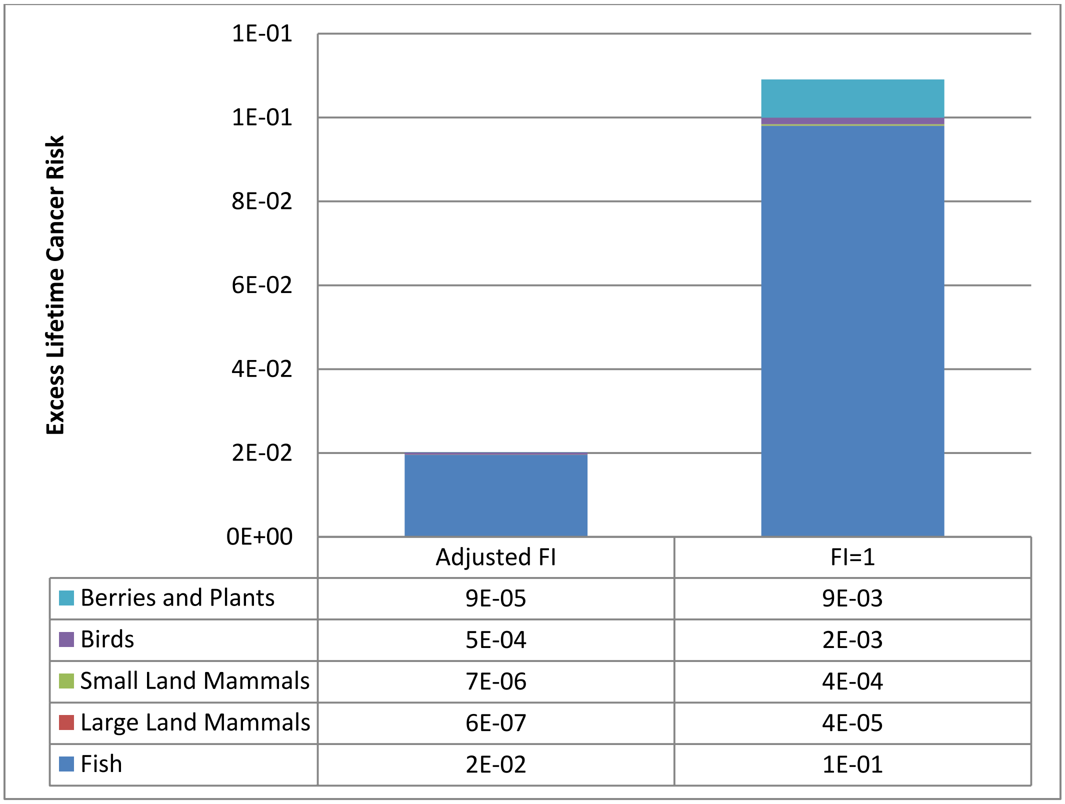
No toxicity data were available for 4-bromophenyl phenyl ether. 4-Bromophenyl phenyl ether was detected in surface soil once out of 12 samples. The detected concentration was 1.9 J µg/kg. 4-Bromophenyl phenyl ether is primarily used for research purposes and, in the past, was used as a flame retardant (HSDB 2012). Not quantitatively evaluating 4-bromophenyl phenyl ether may slightly underestimate potential hazards at the site. In some instances, toxicity data for surrogate compounds were used, which may over- or underestimate the toxicity of the compound.

6.2.6.5 Risk Characterization Uncertainties

As explained earlier, intentionally health-protective assumptions are used throughout the risk assessment process so that the true risk is unlikely to be underestimated. The cumulative effect of this approach could be to substantially overestimate the true risk at the site. However, use of central tendency exposure estimates to assess risks and develop risk-based cleanup levels would result in unacceptable risk for a substantial portion of the population.

The IEUBK model was not specifically designed to account for lead in locally caught food, especially at consumption rates consistent with a subsistence level. The model was adjusted to account for this exposure pathway, but uncertainty in the adjustments may over- or underestimate the risk at the site.

For the resident, it is conservatively assumed that all wild food consumed was harvested from the site. Based on harvest studies and consumption surveys, a more realistic estimate would be to use the FI calculated for the recreational/subsistence user, which is based on data obtained from the ADF&G survey of residents of Red Devil Village (Brown et al. 2012). Figure 6-4 shows the impacts of using adjusted FIs in calculating risks and hazards to the resident. The adjusted FI results in lower ELCR from ingestion of biota. Similar issues are shown with the hazards. Use of an FI equal to one for residents over-estimates risks and hazards at the site.



	Adjusted FI	FI=1
🟦 Berries and Plants	9E-05	9E-03
🟪 Birds	5E-04	2E-03
🟩 Small Land Mammals	7E-06	4E-04
🟥 Large Land Mammals	6E-07	4E-05
🟦 Fish	2E-02	1E-01

Figure 6-4 Impacts of Fraction Ingested from Contaminated Source (FI), Resident Scenario

Although ingestion of fish contributes significantly to the overall risk at the site, the concentrations in fish were conservatively modeled from sculpin collected in

Red Devil Creek. As discussed in Section 6.2.3.7, the concentrations of antimony, arsenic, and mercury of game fish modeled from the sculpin from Red Devil Creek exceed the concentrations in Northern Pike collected from the reach of the Kuskokwim River nearest to the RDM. The 95-percent UCL of measured arsenic in northern pike muscle is 0.626 mg/kg-wet, compared to the modeled concentration of 12.98 mg/kg. Using the arsenic fish concentrations in northern pike (assuming 10 percent of the arsenic is in the inorganic form), as shown in Table 6-24a, the ELCR from ingestion of game fish is 6 x 10^{-5} for a recreational/ subsistence user or residents in all exposure units (i.e., fish ingestion is calculated on a site-specific basis and not influenced by the exposure units) based on the adjusted FI, as described above.

The risks and hazards for the MPA are calculated based on the inorganic arsenic EPC in groundwater. The inorganic arsenic EPC is impacted significantly by two elevated sample results of 4,530 µg/L in 11MP29GW and 1,640 µg/L in 11MP39GW. These results are identified as outliers through analysis with ProUCL and associated Q-Q plots, but review of total arsenic concentration in groundwater in the MPA shows a number of wells with elevated total arsenic, indicating that these two elevated inorganic arsenic levels may not be true outliers. If these two samples are removed from the data set, the groundwater 95-percent UCL decreases from 1,802 µg/L to 50 µg/L, showing that the groundwater EPC is significantly skewed based on two sample results for inorganic arsenic.

Consistent with ADEC guidance (2011), risks and hazards were calculated based on the maximum COPC concentrations in groundwater. Using the 95-percent UCL for the COPC groundwater concentrations, as presented in Table 6-14, the ELCR from exposure to groundwater is 7 in 100 (compared to 2 in 10 when using the maximum concentrations) and the HI is 569 for adults and 1,340 for children (compared to 1,368 and 3,205, respectively, using the maximum concentrations). Risks and hazards based on the 95-percent UCL in groundwater are presented in Appendix J, Tables J-11 and J-12, respectively.

Risks and hazards were assessed based on whole food concentrations; impact on chemical intake based on food preparation, or on an "as consumed" level, was not considered. Food preparation methods could have an impact on chemical concentrations, which could result in an over- or underestimation of risks.

As discussed in Section 6.2.6.1, characterization of background concentrations of metals at mine sites is important because mines are developed in naturally mineralized areas. The characterization of risk and hazards at this site included levels of some metals that may be naturally occurring. The attribution of the background risk, based on the assessment of background concentrations in Section 4.1, is discussed in Section 6.2.5.4. In addition, it appears that the available soil samples for background characterization are not representative of actual background geological conditions at parts of the RDM site. As a result of the difficulties in characterizing representative background soil conditions at the

RDM site with the available data, the contribution of background to risk at the site is likely underestimated, and the overall risk and hazard based on site-related COPCs and concentrations is likely overestimated.

Telemetric studies on burbot and northern pike show that movements can be highly variable and difficult to predict for a given river system. In a system comparable to the Holitna River, 70 northern pike were radio-tagged in the lower 40 kilometers (km) of the Nowitna River, which is a major tributary to the Yukon River. The lower 40 km is excellent feeding and spawning habitat because it is dominated by large sloughs. For overwintering, all the northern pike vacated the lower river; approximately half of these fish migrated to the mainstem Yukon River to overwinter for approximately six months, whereas the other half traveled up to 160 km upstream to riffle-pool sections of the Nowitna River, where higher dissolved oxygen concentration were likely present. Additional telemetry data and results will assist in determining site contribution of mercury levels in fish (Varner 2012).

6.3 Baseline Ecological Risk Assessment

6.3.1 Introduction

This section presents the BERA for the RDM site. The purpose of the BERA is to determine whether or not residual contamination from historical mining activities poses risks to ecological receptors at the site. The results of the BERA will be used to determine whether or not remedial measures may be necessary to protect the natural environment and, if so, aid in the selection of appropriate remedial goals. The BERA is consistent with federal and state ecological risk assessment guidance documents including:

- *Ecological Risk Assessment Guidance for Superfund* (ERAGS)*: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997d).
- *Guidelines for Ecological Risk Assessment* (EPA 1998b).
- *Wildlife Exposure Factors Handbook* (EPA 1993a).
- *Guidance for Developing Ecological Soil Screening Levels* (EPA 2005a).
- *Risk Assessment Procedures Manual* (ADEC 2011).
- *Ecoscoping Guidance: A Tool for Developing an Ecological Conceptual Site Model* (ADEC 2012).
- *EPA Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund* (EPA 1997b).

In addition to the state and federal guidance documents noted above, this assessment also used publications from Oak Ridge National Laboratory (ORNL) and articles from the peer-reviewed literature, as appropriate.

The remainder of this section is organized as follows:

- Section 6.3.2 describes the RDM site and its ecological resources.
- Section 6.3.3 presents a summary of the SLERA for the RDM site (ERAGS Steps 1 and 2).
- Section 6.3.4 presents a problem formulation for the BERA (ERAGS Step 3).
- Section 6.3.5 describes the study design for the field efforts used to collect data for the BERA (ERAGS Steps 4 and 5).
- Section 6.3.6 includes and Ecological Effects Assessment (ERAGs Step 6a)
- Section 6.3.7 presents the exposure assessment and risk characterization for the assessment endpoints evaluated in the BERA, including terrestrial plants, soil invertebrates, benthic macroinvertebrates, fish and other aquatic organisms exposed to surface water, and wildlife (ERAGS Steps 6b and 7a).
- Section 6.3.8 discusses sources of uncertainty in the BERA (ERAGS Step 7b).
- Section 6.3.9 provides a summary and recommendations.
- Section 6.3.10 discusses ecological risks resulting from background contaminant concentrations.

6.3.2 Site Location and Ecology

This section focuses on the habitats and ecological characteristics of the site that are pertinent to the BERA. The information provided below is based on earlier site reports (HLA/Wilder 2001) and observations made by E & E and BLM personnel during field activities at the site (BLM 2010; E & E 2010a).

6.3.2.1 Site Overview

The RDM site is an abandoned mercury mine and ore processing site on the south bank of the Kuskokwim River in a remote area of Alaska, approximately 250 air miles west of Anchorage, Alaska (see Figure 1-1). The site is located on public land managed by the BLM and for the purposes of the BERA consists of four main areas: Surface Mined Area, Main Processing Area, Red Devil Creek Area, and Kuskokwim River Area (see Figure 1-2). Significant mine area surface features, lithologic units, and soil types are shown on Figures 1-5, 1-7, and 3-1, respectively. A detailed description of the site and its operational history is provided in Section 1.4.

6.3.2.2 Climate

The RDM site is located in the upper Kuskokwim River Basin and lies in a climatic transition between the continental zone of Alaska’s interior and the maritime zone of the coastal regions. Average temperatures can vary from –7 to

65 °F (–22 to 18 °C). Annual snowfall averages 56 inches (142 cm), with a total mean annual precipitation of 18.8 inches (48 cm). The Kuskokwim River is ice-free from mid-June through October.

6.3.2.3 Vegetation

The vegetation around the RDM site is characterized by spruce-poplar forests and upland spruce-hardwood forests. During the 2010 sampling season, vegetation characteristics were recorded at surface soil sample locations. Observations documented include the percent cover of vegetation in each of three layers or strata: (1) trees (woody vegetation with diameter at breast height [DBH] > 3 inches and over 15 feet tall); (2) saplings/shrubs (woody vegetation with DBH < 3 inches); and (3) herbs (non-woody vegetation). Trees observed included Sitka alder (*Alnus sinuata*), black cottonwood (*Populus trichocarpa Torr. & Gray*), quaking aspen (*Populus tremuloides*), and willow (*Salix sp.*). Saplings and shrubs observed included Sitka alder, black cottonwood, and willow. The dominant species in the herb strata included horsetail (*Equisetum sp.*), various grasses (*Poa sp.* and other unidentified species), ferns (*Athyrium sp.*), various weedy plants (e.g., *Epilobium sp.*), and moss.


Main Processing Area with Settling Pond 1 in Background (Spring 2012).

Vegetative cover in the Main Processing Area was limited, often consisting of only moss and occasional patches of grass. Cover in this area ranged widely, from 0 to 90 percent, represented almost entirely by moss. If moss were removed from this category, vegetative cover would likely be less than 10 percent. These areas offer limited soils and were heavily compacted in locations subjected to vehicular travel; a majority of the surface material consisted of rock. On the perimeter of the disturbed areas, such as around the processing areas, on the sides of the roads, and along the slopes leading to the creek, saplings were more common, making up 15 to 100 percent of vegetative cover. Sitka alder and black cottonwood were the prevalent species occurring in these areas. In areas that showed no sign of disturbance in recent years, vegetation cover was dominated by trees (between 10 and 75 percent) and saplings (between 20 and 100 percent).

The area of Red Devil Creek north of the Main Processing Area, between the two roads, and in the vicinity of Settling Ponds #2 and #3, was dominated by Sitka alder and black cottonwood trees and saplings with ferns, grasses, and horsetail in the lower strata. Settling Pond #1 was dominated by horsetails.

In general, the disturbed Surface Mined Area of the RDM site had a thick growth of saplings and trees with moderate understory coverage. Vegetation in the upper strata consisted largely of Sitka alder saplings and trees with black cottonwood and occasional quaking aspen trees. The herb layer in this area was dominated by ferns, grasses, and weedy plants. The vegetation in the Dolly Sluice and Rice Sluice areas was similar in nature, and neither appeared to have any stressed vegetation. The vegetation did not consist of any large alder trees in the channel area of either sluice.

Representative Vegetative Cover in Surface Mined Area (Fall 2010

6.3.2.4 Red Devil Creek and Kuskokwim River Biota

Red Devil Creek

Red Devil Creek runs through the middle of the Main Processing Area and discharges to the Kuskokwim River. A historical bridge, now collapsed, crossed the creek and connected the two sides of the Main Processing Area. In the vicinity of the former bridge location, large piles of tailings and/or waste rock make up the creek banks. The creek contains some metal and other debris, likely from past mining activities.

Red Devil Creek riparian zone near Main Processing Area (Fall 2010).

During field work in fall 2010, water depth in the creek varied from 3 to 12 inches at locations where surface water and sediment were sampled. Current velocity appeared to decrease upstream of the Main Processing Area, and pool/riffle structure was more frequently observed in addition to woody material. Stream discharge was measured on August 18, 2011, at locations along Red Devil Creek collocated with sediment and surface water sampling stations. Estimated discharge rates showed a general increase from 5.5 cubic feet/second near the upstream end of the Main Processing Area (station RD10) to 7.2 cubic feet/second at the confluence with the Kuskokwim River. Further discussion of discharge is provided in Section 3.3.1.

In 2010, BLM staff collected fish from Red Devil Creek for contaminant analysis (BLM 2010). Slimy sculpin (*Cottus cognatus*, 6 to 9 cm in length), juvenile Dolly Varden (*Salvelinus malma,* 11 to 17 cm in length), and juvenile salmon (two chinook [*Oncorhynchus tshawytscha*] and one coho [*O. kisutch*]; 8 to 11 cm in length) were collected for analysis. In 2011, the BLM collected additional slimy sculpin and juvenile Dolly Varden and one juvenile Arctic grayling (*Thymallus arcticus*) from the creek for chemical analysis. No large game fish were found by the BLM in Red Devil Creek in 2010 or 2011, likely due to the creek's shallow depth and narrow width. Red Devil Creek was not considered an anadromous fish stream before remedial investigation activities. However, it is now being added to the State's list of anadromous fish streams.

Also in 2010 and 2011, the BLM collected composite samples of larval mayflies (*Baetis* spp. and *Cinygmula* spp.) and stoneflies (*Zapata* spp.) from the creek for chemical analysis. The mayflies and stoneflies collected were small, requiring the BLM to collect several hundred individual organisms for each 1-gram composite sample. In fall 2010, the E & E field team that collected sediment from the creek reported seeing numerous small benthic invertebrates and their casings on the undersides of rocks throughout the creek. The small benthic invertebrates observed by the E & E field team may have been mayfly and/or stonefly larvae. The E & E field team also observed other benthic invertebrates, including midge (Family Chironomidae) and cranefly (Family Tipulidae) larvae, during sediment sampling. Lastly, the E & E field team reported that moss and brown-colored, attached algae (i.e., periphyton) were present in the creek and generally appeared to trend toward increased coverage as sample locations progressed upstream from the Kuskokwim River, but that moss and periphyton were not present at all sample locations.

Red Devil Creek at Kuskokwim River (Fall 2010)

Seep Discharging to Red Devil Creek near Main Processing Area (sample location RD05)

Kuskokwim River

The Kuskokwim River is a major anadromous fish river (HLA/Wilder 2001). Fish found in the river in the vicinity of RDM site include whitefish (*Coregonus sp.*), Arctic grayling, sheefish (*Stendous leucichthys nelma*), Dolly Varden, burbot (*Lota lota*) and northern pike (*Esox lucius*), as well as chinook, sockeye (*O. nerka*), coho, and chum salmon (*O. keta*) (HLA/Wilder 2001; BLM 2010). Additional information on the Kuskokwim River is provided in Section 3.3.2.

6.3.2.5 Mammals

Moose (*Alces alces*), wolves (*Canis lupis*), black bears (*Ursus americanus*), brown bears (*Ursus arctos*), lynx (*Lynx canadensis*), martens (*Martes spp*.), foxes (*Vulpes vulpes*), beavers (*Castor canadensis*), minks (*Mustela vison*), muskrats (*Ondatra zibenthicus*), otters (*Lutra canadensis*), and various small rodents are known to occur in the area (HSA/Wilder 2001). During field activities in September 2010, three river otters (*Lontra canadensis*) were observed in the Kuskokwim River near the mouth of Red Devil Creek. In addition, moose and bear (*Ursus sp.*) tracks were observed near the upper pond, and bear tracks were also observed near the mouth of Red Devil Creek.

6.3.2.6 Birds

The upper Kuskowkim River is a low density waterfowl area (HLA/Wilder 2001). Nonetheless, ADEC and BLM staff and local residents have observed waterfowl (species not specified) using the settling ponds near the Main Processing Area. Songbird species that migrate through the area include the olive-sided flycatcher (*Contopus cooperi*), gray-cheeked thrush (*Catharus minimus*), Townsend's warbler (*Dendroica townsendi*), blackpoll warbler (*D. striata*), and Hudsonian godwit (*Limosa haemastica*) (HLA/Wilder 2001). A raptor survey done on the Kuskokwim River in July 2000 found an active peregrine falcon (*Falco peregrinus*) nest seven miles downstream from the RDM, on rock cliffs on the north side of the river (BLM 2001b). Finally, during field work in September 2010, many spruce grouse (*Dendragapus canadensis*) were observed on and near the RDM site, and an osprey (*Pandion haliaetus*) was observed foraging in the Kuskokwim River near the site.

6.3.2.7 Special Concern Species

Federally Listed Species

The United States Fish and Wildlife Service (USFWS 2011) lists four species as being either endangered, threatened, or candidate species for Bethel County, Alaska. These species are:

- Short-tailed albatross (*Phoebastria albatrus*), federally listed endangered.
- Spectacled eider (*Somateria fischeri*), federally listed threatened.
- Steller's eider (*Polysticta stelleri*), federally listed threatened.
- Kittlitz's murrelet (*Brachyramphus brevirostris*), federal candidate species.

Given their habitat preferences, none of these species are likely to occur at the RDM site. The short-tailed albatross is a sea bird that is sighted occasionally along the west coast of Alaska. The two eider species breed on wet low-lying tundra along the north and west coasts of Alaska (Kaufman 1996). In other seasons, the spectacled eider and Steller's eider occur along the coast, where they forage by diving, mostly for mollusks. Kittlitz's murrelet is found along the

Alaska coastline, being common mainly from Kodiak Island east to Glacier Bay (Kaufman 1996). It prefers cold sea waters, mostly in calm protected bays and among islands, usually close to shore.

State Listed Species

The Alaska Natural Heritage Program (ANHP) was contacted for information on plant and animal species of concern in the vicinity of the RDM site. A summary of the information provided by the ANHP is given in Table 6-36 for birds and mammals and Table 6-37 for plants. Appendix L contains a copy of the correspondence received from the ANHP.

Regarding rare or uncommon birds and mammals, the ANHP indicated that their database includes no observations of rare or uncommon birds or mammals within a 2-mile radius of the RMD site. The list of birds and mammals in Table 6-36 was generated by the ANHP by overlying range maps of rare or uncommon species with the RDM site. Hence, it is possible that these species may occur at the RDM site if suitable habitat is present. Table 6-36 provides information regarding the summer habitat requirements and preferred diet of the listed species and indicates the likelihood that the listed species may occur at the site.

Regarding rare or uncommon plants, the list provided by the ANHP (see Table 6-37) includes species that have been observed within 100 km of the RDM site. These species may occur at the RDM site if suitable habitat is present.

6.3.3 Summary of Screening Level Ecological Risk Assessment and Decision to Proceed with Baseline Ecological Risk Assessment (ERAGS Steps 1 and 2)

A draft SLERA for the RDM site was submitted to the EPA and ADEC in mid-January 2012. The draft SLERA was revised based on agency comments and is included in this report as Appendix M. Also included in Appendix M are responses to agency comments.

The SLERA was conducted in accordance with the EPA ERAGS and State of Alaska ecological risk assessment guidance. A full set of ecologically relevant assessment endpoints were evaluated, including: terrestrial-plant community, soil-invertebrate community, benthic-macroinvertebrate community, fish and other aquatic biota in Red Devil Creek, terrestrial wildlife, and aquatic-dependent wildlife. Potential risks to communities of terrestrial plants, soil invertebrates, benthic macroinvertebrates, and fish and other aquatic biota were evaluated by comparing maximum detected chemical concentrations in surface soil, sediment, surface water, and whole-body sculpin samples with health-protective screening levels for these media. Media screening levels were taken from the final RAWP for the RDM site, except those for fish tissue and a second water quality criterion for mercury, which were added to the revised SLERA based on agency comments. Potential risks to terrestrial and aquatic-dependent wildlife were evaluated by calculating screening-level exposure estimates and HQs as per EPA guidance. The 11 wildlife endpoint species identified in the final RAWP were included in the evaluation. These species are: American robin (*Turdus migratorius*), masked shrew (*Sorex cinereus*), spruce grouse, tundra vole (*Microtus oeconomus*), northern shrike (*Lanius excubitor*), least weasel (*Mustela nivalis*), common snipe (*Gallinago gallinag*), beaver, green-winged teal (*Anas crecca*), belted kingfisher (*Ceryle alcyon*), and mink. Exposure parameters and toxicity reference values were taken from the final RAWP. The wildlife evaluation was based on maximum measured chemical concentrations in site surface soil, sediment, surface water, vegetation, and fish and benthic macroinvertebrates from Red Devil Creek. Health-protective modeling approaches were used to estimate chemical concentrations in the prey of terrestrial predatory wildlife species (robin, shrew, weasel, and mink).

The primary purpose of the SLERA was to select COPCs for the BERA. Table 6-38 provides a summary of the chemical and receptor combinations that were evaluated in the BERA based on the SLERA. For each assessment endpoint, chemicals were retained for evaluation in the BERA if the screening-level HQ was greater than or equal to 1 or if the chemical was detected in site media and no toxicity information was available for that chemical. The latter group of chemicals included several organic compounds that were detected infrequently at low (part per billion) levels in soil or sediment (see Table 6-38 for listing [under Other SVOCs]). In Table 6-38, an “x” in the cell for a given chemical-receptor pair means that a screening-level HQ was not calculated because toxicity data were not identified for that chemical-receptor pair during the SLERA.

Based on discussions between E & E and the BLM regarding the results of the SLERA, the BLM directed E & E to perform a BERA for the site.

6.3.4 Baseline Ecological Risk Assessment Problem Formulation (ERAGs Step 3)

Problem formulation is the first step in the baseline risk assessment process. It identifies the goals, breadth, and focus of the assessment ((EPA 1997d, 1998b). The problem formulation step identifies COPCs, potential ecological receptors, and potential exposure pathways. A CSM is then developed to summarize the relationship between COPCs and receptors. Lastly, assessment endpoints and measures are developed to guide the remaining steps of the risk assessment process. The BERA problem formulation and CSM for the RDM site are presented in this section.

6.3.4.1 Contaminant Sources and Migration Pathways

The RDM was Alaska’s largest mercury mine, producing 1.2 million kg (2.73 million pounds) of mercury between 1933 and 1971 (Bailey et al. 2002). Cinnabar and stibnite are the principal metallic minerals associated with the mineralized zone targeted by mining, with minor amounts of realgar, orpiment, and pyrite (FeS_2) also locally present. High-grade ore contained as much as 30 percent mercury by weight, but most ore contained 2 to 5 percent. Several hundred meters of trenches and extensive areas of dozing and sluicing where surface mining took place are present on the site. In addition, accumulations of tailings, waste rock, and flotation tailings are located on the site, and several of these lie along Red Devil Creek. During a site investigation by the USGS (Bailey et al. 2002), abundant cinnabar, lesser amounts of stibnite, and a few beads of liquid mercury were visible in Red Devil Creek. Additional information on the RDM site and previous site investigations is provided in Chapter 1.

Contaminated soil, tailings, waste rock, flotation tailings, and other wastes from the RDM have been exposed at the surface for decades. Mercury and other metals in these wastes were subject to transport primarily by water and soil erosion to Red Devil Creek, the Kuskokwim River, groundwater beneath the site, and surrounding terrestrial areas. In addition, liquid mercury at the site was subject to volatilization to the atmosphere. Chapters 4 and 5 discuss the nature and extent of contamination and contaminant fate and transport in detail based on soil, sediment, surface water, and groundwater data collected in 2010 and 2011. Particular attention is given to arsenic, antimony, and mercury because they are the principal contaminants at the site. Elevated levels of arsenic, antimony, and mercury were found across the site in surface and subsurface soil. The greatest concentrations were found in the Pre-1955 and Post-1955 Main Processing Areas that are situated on either side of Red Devil Creek. Elevated levels of these elements also were found in sediment and surface water in Red Devil Creek near and downstream from the Main Processing Area and in the Kuskokwim River near the point of entry of the creek into the river. Details can be found in the Chapters 4 and 5.

6.3.4.2 Contaminants of Potential Concern and Refinement of COPC List

The SLERA identified antimony, arsenic, and mercury as the principal COPCs at the RDM site based on the magnitude of the HQs for these elements and their widespread distribution at high levels across the site (see Table 6-38). The HQs for the other metals identified as COPCs in Table 6-38 were considerably lower. All metals identified as COPCs in the SLERA were carried forward into the BERA.

Low molecular weight PAHs (LPAHs) and nine SVOCs were identified as COPCs in the SLERA for some receptor groups because they were detected in surface soil or sediment, but no toxicity data were available to quantitatively evaluate them (see Table 6-38 for listing [under Other SVOCs]). However, a supplemental evaluation done for the BERA (see Table 6-39) suggests that only three of these chemicals—benzoic acid, bis(2-ethylhexyl)phthalate, and diethylphthalate—may be COPCs at the site. Because no toxicity data were identified for benzoic acid, this chemical could not be quantitatively evaluated in the BERA. Instead, benzoic acid is identified in the uncertainty section and risk summary as a possible COPC in surface soil at the one location in the Main Processing Area where it was detected. Bis(2-ethylhexyl)phthalate and diethylphthalate each exceeded a conservative soil screening level from Buchman (2008) at one sample location in the Main Processing Area (see Table 6-39). These two chemicals are identified in the risk summary as COPCs in surface soil that may pose a localized risk to one or more assessment endpoints.

6.3.4.3 Ecological Receptors

Based on the site ecology, the following ecological receptor groups have the potential to be affected by site-related contaminants at the RDM site:

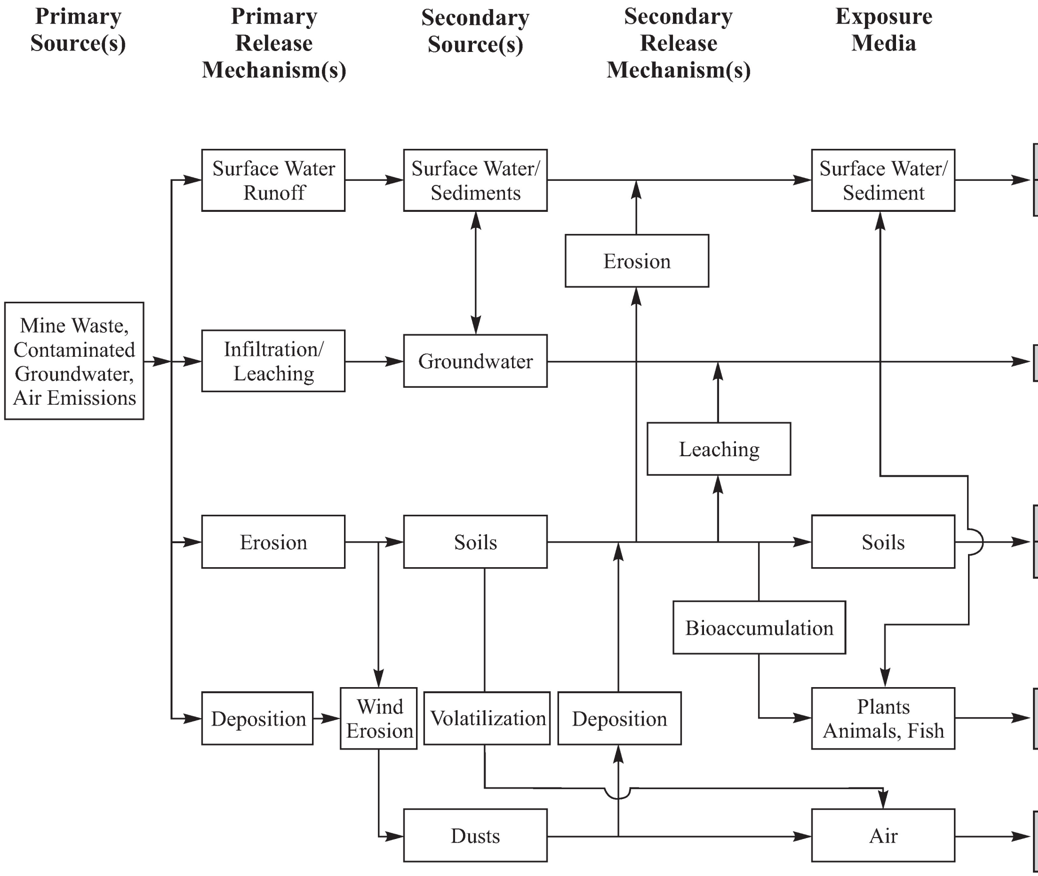
- Terrestrial plants and invertebrates.
- Mammals and birds that use the mine site, Red Devil Creek, and Kuskokwim River near the site to satisfy their food and habitat needs.
- Aquatic biota (e.g., aquatic plants, amphibians, benthos, and fish) in Red Devil Creek and the Kuskokwim River.

6.3.4.4 Ecological Conceptual Site Model

The ecological CSM used in the revised SLERA is considered complete. Figure 6-5 provides the ecological CSM for the BERA featuring the receptor groups identified in the previous section and that were initially evaluated in the SLERA. Terrestrial plants may be exposed to site-related chemicals by direct contact with contaminated soils, tailings/waste rock, flotation tailings, and overburden. Terrestrial invertebrates may be exposed to site-related contaminants through direct contact with contaminated soils, tailings/waste rock, flotation tailings, and overburden; ingestion of contaminated soils, tailings/waste rock, flotation tailings, and overburden; and through the food chain. Birds and mammals may be exposed to site-related chemicals through incidental ingestion of soil/sediment, tailings/waste rock, flotation tailings, and overburden; consumption of contaminated prey; and ingestion of contaminated surface water. It should be noted, however, that surface water ingestion typically accounts for only a small fraction (less than 1 percent) of total exposure for wildlife and therefore is considered a minor pathway. Dermal exposure of wildlife to site-related chemicals is expected to be negligible due to the protection provided by their external coverings (heavy fur and feathers). Fish and benthic invertebrates in Red Devil Creek and the Kuskokwim River may be exposed to site-related chemicals through direct contact with and ingestion of contaminated sediment and surface water and through the food chain. Periphyton and other aquatic plants in the creek and river may be exposed to contaminants in surface water and sediment.

6.3.4.5 Assessment Endpoints, Measures, and Associated Risk Questions

Assessment endpoints are expressions of the ecological resources that are to be protected (EPA 1997d). An assessment endpoint consists of an ecological entity and a characteristic of the entity that is important to protect. According to the EPA (1998a), assessment endpoints do not represent a desired achievement or goal and should not contain words such as “protect” or “restore,” or indicate a direction for change such as loss or increase. Assessment endpoints are distinguished from management goals by their neutrality (EPA 1998a).



Potential Ecological Receptors

Exposure Route(s)	Terrestrial Plants	Soil Invertebrates	Birds and Mammals	Fish	Benthic Invertebrates	Aquatic Plants
Direct Contact	✓	–	–	✓	✓	✓
Ingestion	–	–	✓	✓	✓	–
Ingestion	–	–	–	–	–	–
Direct Contact	✓	✓	–	–	–	–
Ingestion	–	✓	✓	–	–	–
Ingestion (Food Chain)	–	✓	✓	✓	✓	–
Inhalation	–	–	–	–	–	–

Key:

→ Potentially Complete Pathway

– Incomplete/Insignificant Route

✓ Complete Exposure Route

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

RED DEVIL MINE

Figure 6-5

ECOLOGICAL CONCEPTUAL SITE MODEL FOR RED DEVIL MINE SITE

Date:	Drawn by:	
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Measurements used to evaluate risks to the assessment endpoints are termed "measures" and may include measures of effect, measures of exposure, and/or measures of ecosystem or receptor characteristics (EPA 1998a). Based on the site ecology, COPCs, and CSM, the ecological resources potentially at risk at the RDM site include terrestrial vegetation and invertebrates, mammals, birds, and aquatic biota (fish, amphibians, benthos, periphyton, and other aquatic organisms). The assessment endpoints and measures for the BERA are listed in Table 6-40.

6.3.5 Study Design (ERAGS Steps 4 and 5)

The study design and data quality objectives for collection and analysis of soil, sediment, surface water, vegetation, fish, and benthic invertebrates from the site are included in the following planning documents:

- 2010 RI/FS Work Plan (E & E 2010b).
- 2011 RI/FS Work Plan (E & E 2011).
- Addendum to 2011 RI/FS Work Plan to support vegetation sampling at the RDM site.
- Addendum to 2011 RI/FS Work Plan to support off-shore sediment sampling in the Kuskokwim River in 2011 and 2012.
- Addendum to 2011 RI/FS Work Plan to support additional soil characterization in 2012.
- Final Operations Plan (BLM 2010) for collection of fish and benthic macroinvertebrates from Red Devil Creek, nearby reference creeks, and the middle Kuskokwim River.

These planning documents were reviewed by the ADEC and EPA and revised as appropriate based on agency comments. The sampling and analysis described in these documents provided the data used in the BERA.

6.3.6 Ecological Effects Assessment (ERAGs Step 6a)

Media screening levels and wildlife toxicity reference values (TRVs) were taken from the SLERA and augmented as follows for the BERA:

- Soil screening levels for plants for antimony, arsenic, and beryllium were identified and incorporated into the BERA.
- Soil screening levels for soil invertebrates for arsenic, chromium, cobalt, silver, and vanadium were identified and incorporated into the BERA.
- Sediment screening levels for barium, beryllium, methylmercury, and thallium were identified and incorporated into the BERA.
- Tissue screening concentrations (TSCs) for benthic macroinvertebrates were developed for antimony, arsenic, barium, beryllium, chromium,

copper, iron, manganese, mercury, methylmercury, nickel, vanadium, and zinc. The approach used to develop the TSCs is described below.

- TSCs specific to fish for antimony, barium, manganese, and vanadium were developed and added to the BERA. The approach used to develop the TSC is described below.

Adding the above-mentioned screening levels to the BERA reduces uncertainty in the risk conclusions and increases the usefulness of the BERA for risk management purposes. Table 6-41 summarizes the sources of types of all toxicity data used in the BERA. Tables 6-42, 6-43, 6-44, 6-45, 6-48, 6-49, and 6-63present the media screening levels and wildlife TRVs used in the BERA.

6.3.6.1 Benthic Macroinvertebrate Tissue Screening Concentrations

TSCs for benthic macroinvertebrates were developed from site-specific bioconcentration factors (BCFs) and chronic water quality criteria (WQC) using the following equation from Shephard (1998):

$$\text{TSC (mg/kg-wet)} = \text{WQC (mg/L)} \times \text{BCF (L/kg)}$$

Site-specific BCFs were calculated from geometric mean metals concentrations in benthic macroinvertebrate composite samples (C_{bm}) and filtered surface water samples (C_w) from Red Devil Creek using the following equation:

$$\text{BCF (L/kg)} = C_{bm}\ \text{(mg/kg-wet)} / C_w\ \text{(mg/L)}$$

The benthic macroinvertebrate BCFs and TSCs are listed in Table 6-42. Appendix N describes the benthic macroinvertebrate samples collected from Red Devil Creek and provides the metals data for the samples. Metals data for filtered surface water samples collected from Red Devil Creek in 2010 and 2011 are provided in Chapter 4.

6.3.6.2 Fish Tissue Screening Concentrations

TSCs specific to fish were developed from site-specific BCFs (water-to-fish) and chronic WQC using the following equation from Shephard (1998):

$$\text{TSC (mg/kg wet)} = \text{WQC (mg/L)} \times \text{BCF (L/kg)}$$

Site-specific BCFs were calculated from geometric mean metals concentrations in whole-body slimy sculpin samples (C_f) and filtered surface water samples (C_w) from Red Devil Creek using the following equation:

$$\text{BCF (L/kg)} = C_f\ \text{(mg/kg wet)} / C_w\ \text{(mg/L)}$$

The site-specific fish BCFs and TSCs are listed in Table 6-43. Appendix I provides the metals data for the sculpin samples from Red Devil Creek. Metals data for filtered surface water samples collected from Red Devil Creek in 2010 and 2011 are provided in Chapter 4. In addition to the fish TSCs listed in Table 6-43, fish TSCs from Dyer et al. (2000), Sandheinrich and Weiner (2011), and other sources were used in the BERA (see Table 6-49).

6.3.7 Analysis of Ecological Exposures and Risk Characterization (ERAGS Steps 6b and 7a)

Analysis of ecological exposures and risk characterization is discussed under seven main headings: (1) Data Used in the BERA; (2) Terrestrial Vegetation Community; (3) Soil Invertebrate Community; (4) Benthic Macroinvertebrate Community; (5) Aquatic Biota Exposed to Surface Water; (6) Fish Community; and (7) Wildlife. A primary objective of this section is to further evaluate the COPCs identified in the SLERA to arrive at a reduced list of contaminants of concern (COCs) for ecological receptors at the site. The COCs thus identified may become the focus of risk management actions.

6.3.7.1 Data Used in the BERA

The BERA is based on chemical data for surface soil (0 to 2 feet bgs), sediment (0 to 4 inches below the sediment surface), surface water, and vegetation samples collected from the RDM site in 2010 and 2011 for the RI/FS. Full analytical results for surface soil are presented earlier in this report for surface soil (Tables 4-17 to 4-23), surface water (Table 4-31), sediment (Tables 4-32 and 4-33), and vegetation (Table 4-34 to 4-37). Summaries of these data are included in this chapter as appropriate. In addition, metals data for benthic-macroinvertebrates and sculpin from Red Devil Creek collected by the BLM in 2010 and 2011 were used in the BERA; summaries of these data are provided in Tables 6-51 to 6-54. Analytical results for these samples were provided to E & E by the BLM in electronic form and are presented in part in several reports prepared by the BLM and USFWS (BLM 2011 and 2012; USFWS 2012a and 2012b). The metals data for the sculpin and benthic macroinvertebrate samples used in the BERA are provided in Appendices I and N, respectively.

Chapter 2 of this RI report includes sample locations maps for surface soil (Figures 2-3 and 2-4), surface water (Figure 2-8), sediment (Figures 2-9 to 2-11), and vegetation (Figure 2-12). Chapter 2 also identifies the analyses performed for surface soil (Table 2-2), surface water (Table 2-6), sediment (Tables 2-7 to 2-9), and vegetation (Table 2-10). Metals, including arsenic, antimony, and mercury, were the principal target analytes in all media. A limited number of soil, sediment, and surface water samples were analyzed for SVOCs. A limited number of soil samples also were analyzed for PCBs, as Aroclors. However, as noted in Section 6.3.3, no organic contaminants were carried forward into the BERA.

Section 6.1 provides a discussion of the usability of the RI data for risk assessment purposes. For analytes that were carried forward into the BERA, EPCs were calculated with the latest version of ProUCL (EPA 2010b). In most cases, the 95-percent UCL on the average concentration was used as the EPC. If too few samples were available to calculate a 95-percent UCL, the maximum detected concentration was used as the EPC. Appendix O includes summaries of the

ProUCL output. Field duplicate sample results were handled as per ADEC (2008a) guidance.

6.3.7.2 Terrestrial Vegetation Exposure Assessment and Risk Characterization

The 13 metals identified in the SLERA as COPCs for the terrestrial plant community (see Section 6.3.3) are evaluated further in this section. COCs for this community were identified by calculating an HQ for each metal based on its surface soil EPC and soil screening level. The results are shown in Table 6-44. The following points are noteworthy:

- The HQs for antimony, arsenic, cobalt, manganese, mercury, nickel, and vanadium exceeded 1.
- The greatest HQs were for antimony (847), arsenic (198), and mercury (839), and a large percentage of samples exceeded the screening levels for these analytes.
- The cobalt HQ (1.4) and nickel HQ (1.4) at the RDM site were only marginally greater than 1.

In summary, it appears that antimony, arsenic, and mercury are the analytes with the greatest potential to adversely affect the terrestrial plant community at the RDM site.

6.3.7.3 Soil Invertebrate Community Exposure Assessment and Risk Characterization

The 13 metals identified in the SLERA as COPCs for the soil invertebrate community (see Section 6.3.3) are evaluated further in this section. COCs for this community were identified by calculating an HQ for each metal based on the surface soil EPC and soil screening level. The results are shown in Table 6-44. The following points are noteworthy:

- The HQs for antimony, arsenic, barium, manganese, mercury, and vanadium exceeded 1.
- The greatest HQs were for antimony (54), arsenic (59), and mercury (2516), and a large percentage of site samples exceeded the screening levels for these analytes.
- The barium HQ (1.3) and manganese HQ (1.7) at the RDM site were only marginally greater than 1.
- Thallium was identified as a COC for the soil invertebrate community because it was detected in site surface soil, but no screening level was available. However, thallium was detected in only two of 135 samples (see Table 6-44), so potential risks to the soil invertebrate community from thallium, if any, are localized in extent.

In summary, it appears that antimony, arsenic, and mercury are the analytes with the greatest potential to adversely affect the soil invertebrate community at the RDM site.

6.3.7.4 Benthic Macroinvertebrate Community Exposure Assessment and Risk Characterization

As noted in Table 6-40, four measures were used to evaluate potential risks to the benthic macroinvertebrate community at the site: (1) comparing sediment chemical concentrations to sediment screening levels; (2) benthic macroinvertebrate community survey in Red Devil Creek (BLM 2010); (3) comparing contaminant concentrations in benthic macroinvertebrate composite samples from Red Devil Creek with tissue screening concentrations and (4) comparing chemical concentrations in surface water with chronic water criteria for protection of freshwater aquatic life.

Comparing Sediment Chemical Concentrations with Sediment Screening Levels

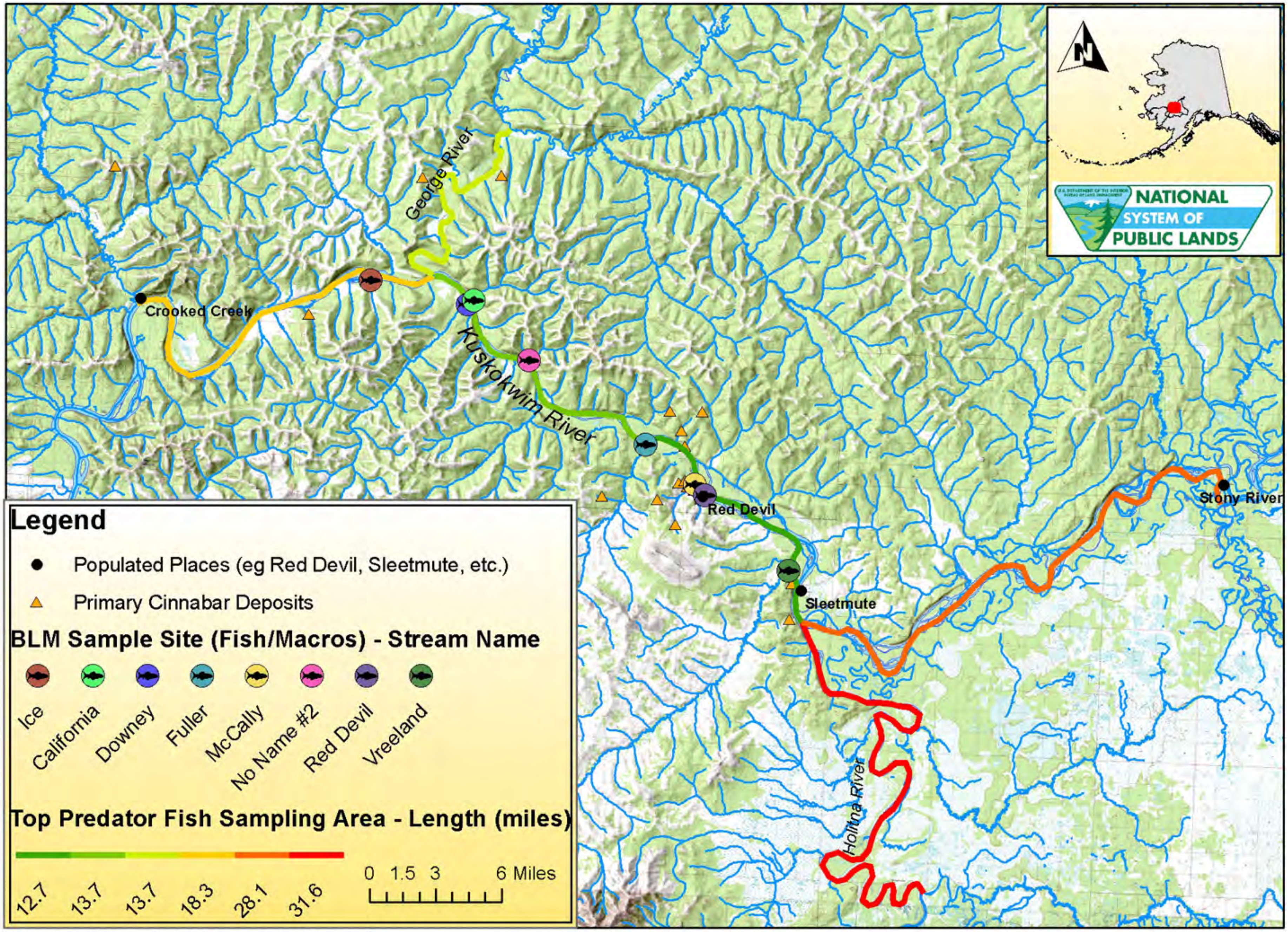
The 15 metals identified in the SLERA as COPCs for the benthic macroinvertebrate community (see Section 6.3.3) are evaluated further in this section. COCs in sediment for this community were identified by calculating an HQ for each metal based on the sediment EPC and sediment screening level. The results are shown in Table 6-45. The following points are noteworthy:

- The HQs for antimony, arsenic, barium, beryllium, iron, manganese, mercury, methylmercury, and nickel exceeded 1.
- The greatest HQs were for antimony (463), arsenic (634), mercury (6437), and methylmercury (408) and a large percentage of samples exceeded the screening levels for these analytes.
- The HQs for iron (2.6), manganese (2.4), and nickel (1.4) slightly exceeded 1.

In summary, based on comparisons with screening levels, it appears that antimony, arsenic, mercury, and methylmercury are the analytes with the greatest potential to adversely affect the benthic macroinvertebrate community at the RDM site.

Red Devil Creek Benthic Macroinvertebrate Survey

In 2010, the BLM surveyed the benthic macroinvertebrate community in Red Devil Creek and six nearby reference creeks (Vreeland, Ice, California, Downey, No-Name, and Fuller Creeks), as per their *Final Operations Plan* (BLM 2010). The locations of the reference creeks in relation to Red Devil Creek are shown in Figure 6-6. An array of standard metrics and indices were calculated from the benthic macroinvertebrate survey data collected from the creeks (see Table 6-46).



Source: BLM Alaska Field Office, Anchorage, AK (2012)

Figure 6-6 Benthic Macroinvertebrate Survey Streams in the Middle Kuskokwim River Region

The values of the metrics and indices for Red Devil Creek were similar to or greater than the average values of the metrics and indices for the six reference creeks (see Figure 6-7 and Table 6-46). For two metrics—total abundance and intolerant taxa abundance—the index values for Red Devil Creek exceeded the average for the reference creeks, suggesting better habitat quality in Red Devil Creek compared with the reference creeks. Overall, the survey results suggest that the benthic community in Red Devil Creek is not impaired. Additional details are provided in BLM (2011 and 2012), including sediment concentrations for antimony (1.2 to 7 mg/kg), arsenic (10 to 14 mg/kg), and mercury (0.12 to 3.6 mg/kg) in the reference creeks, which are orders of magnitude lower than in Red Devil Creek (see Table 6-45).

These findings appear to be at odds with the results of the sediment screening level comparisons described above. Possible explanations for the presence of a healthy benthic community in Red Devil Creek despite high total concentrations of arsenic, antimony, and mercury in sediment include: (1) very little of the total concentrations of arsenic, antimony, and mercury are bioavailable and/or (2) the benthic macroinvertebrate community in Red Devil Creek has adapted to elevated levels of metals in creek sediments over time.

Contaminant Concentrations in Benthic Macroinvertebrates Compared With Tissue Screening Concentrations

In 2010 and 2011, composite samples of benthic macroinvertebrates were collected from Red Devil Creek by the BLM and analyzed for metals. In all, eight mayfly composite samples and two stonefly composite samples were collected. Details regarding the composition the samples (i.e., family and genus, number of individuals per sample, and sample weight) are provided in Appendix N. Appendix N also includes sample-by-sample analytical results. COCs for the benthic community were identified by calculating an HQ for each contaminant based on the benthic macroinvertebrate tissue EPC and TSCs (see Table 6-47). Only mercury was identified as a COC for the benthic community using this approach.

Comparing Surface Water Chemical Concentrations with Surface Water Standards

The following section addresses potential risks to benthic macroinvertebrates from chemicals in surface water.

Source: BLM, Alaska State Office, Anchorage, AK (2012)

Figure 6-7 Benthic Community Metrics for Red Devil Creek Compared with Average Metrics Values for Six Nearby Reference Creeks (California, Downey, Fuller, Ice, No Name, and Vreeland Creeks).

6.3.7.5 Fish and Other Aquatic Biota Exposure Assessment and Risk Characterization

This section further evaluates the six metals identified in the SLERA as COPCs for fish, benthic macroinvertebrates, amphibians, periphyton, and other organisms exposed to surface water (see Section 6.3.3). COCs for these groups of organisms were identified by calculating an HQ for each metal based on the surface water EPC and chronic water quality criterion. The results are shown in Table 6-48. The following points are noteworthy.

- HQ values for antimony, arsenic, iron, manganese, and mercury in surface water exceeded 1.
- Two HQs are presented for arsenic, iron, and manganese based on EPCs calculated with and without two water samples (10RD05SW and 11RD05DW) collected from a seep that discharges to Red Devil Creek in the Main Processing Area. Arsenic, iron, and manganese concentrations in water from the seep are considerably greater than in Red Devil Creek and have a significant influence on the magnitude of the surface water EPC for these three elements (see Table 6-48). Arsenic, iron, and manganese are not identified as COCs when the seep samples are omitted from consideration. Hence, it appears that potential risks from arsenic, iron, and manganese in surface water in Red Devil Creek are localized to the vicinity of the seep. A photograph of the seep is provided in Section 6.3.2.4.
- The greatest HQ (20.2) is for mercury based on the mercury water quality criterion of 0.012 µg/L from EPA (1986b).

In summary, five metals (antimony, arsenic, iron, manganese, and mercury) were identified as COCs for fish and other aquatic organisms based on comparing surface water contaminant concentrations with water quality criteria.

6.3.7.6 Fish Community Exposure Assessment and Risk Characterization

The 10 metals identified in the SLERA as COPCs for the fish community based on chemical residues in sculpin whole-body samples (see Section 6.3.3) are evaluated further in this section. COCs for the fish community were identified by calculating an HQ for each metal based on the whole-body sculpin EPC and fish tissue screening concentrations (TSCs). The results are shown in Table 6-49. The following points are noteworthy:

- The HQs for antimony, arsenic, mercury, and selenium exceeded 1.
- The greatest HQs were for arsenic (7.6) and mercury (3.0). Regarding mercury, it is interesting to note that the (total) mercury HQ (3.0) was considerable greater than the methylmercury HQ (0.69). This result is due to the fact that methylmercury is a comparatively low percentage of total mercury in Red Devil Creek sculpin (range 23–83 percent, average 50

percent, n = 6, see Table I-2). In most aquatic systems, methylmercury accounts for nearly 100 percent of total mercury in fish. The high percentage of inorganic mercury in sculpin from Red Devil Creek likely is related to the elevated levels of inorganic mercury in sediment and surface water from the creek.

- For selenium, two HQs based on different TSCs were calculated. The HQ based on a TSC from Dyer et al. (2000) was marginally greater than 1, whereas the HQ based on the draft EPA selenium TSC was marginally less than 1 (see Table 6-49).

In summary, it appears that antimony, arsenic, mercury, and perhaps selenium have the potential to adversely affect fish in Red Devil Creek.

6.3.7.7 Wildlife Exposure Assessment and Risk Characterization

A total of 17 metals were identified in the SLERA as COPCs for wildlife; up to 13 metals were identified as COPCs for any given species evaluated. These metals are further evaluated in this section. The wildlife risk evaluation was performed in accordance with state, federal, and other available guidance for ecological risk assessment, including ADEC (2011), EPA (1997d, 1998b), and Sample et al. (1996). The evaluation consists of three parts: (1) exposure assessment, (2) ecological effects assessment, and (3) risk characterization. The exposure assessment estimates wildlife exposure to site-related chemicals using measured concentrations of chemicals in environmental media and exposure parameters for the chosen receptor species. The ecological effects assessment summarizes the potential toxic effects of site-related chemicals on wildlife by establishing a toxicity reference value for each chemical for each receptor. The risk characterization combines the results of the exposure and ecological effects assessments to provide an estimate of risk to wildlife at the site.

6.3.7.7.1 Wildlife Exposure Assessment

This section describes the data, receptors, and methods used to derive EPCs and exposure estimates for wildlife at the RDM site.

Datasets Used to Calculate Exposure Estimates

Analytical data for surface soil, sediment, surface water, and vegetation samples collected from the RDM site in 2010 and 2011 were used to calculate EPCs for these media. Full analytical results are presented earlier in this report for surface soil (Tables 4-17 to 4-23), surface water (Table 4-31), sediment (Tables 4-32 and 4-33), and vegetation (Table 4-34 to 4-37). A summary of the 2011 vegetation data is provided in Table 6-50. Also, metals data for benthic-macroinvertebrate and slimy-sculpin samples from Red Devil Creek collected by the BLM in 2010 and 2011 were used to evaluate exposures to aquatic-dependent wildlife; summaries of these data are provided in Tables 6-51 to 6-54. Analytical results for the fish and benthic macroinvertebrate samples were provided to E & E by the BLM in electronic form and are presented in part in several reports prepared by the BLM and USFWS (BLM 2011 and 2012; USFWS 2012a and 2012b). The metals data for sculpin and benthic macroinvertebrate samples used in the BERA are provided in Appendices I and N respectively.

Exposure Scenarios and Pathways

Exposure estimates were calculated for the 11 wildlife receptors identified in the final RAWP and Table 6-40. These species are:

Herbivores:

- Spruce grouse
- Tundra vole
- Beaver
- Green-winged teal

Invertivores

- Common snipe
- American robin
- Masked shrew

Carnivores

- Northern shrike
- Least weasel

Piscivores:

- Belted kingfisher
- Mink

For these species, chemical exposure from diet, incidental ingestion of soil and/or sediment, and drinking was estimated. Exposure parameters for these wildlife species were taken from the final RAWP and are presented in Table 6-55.

Exposure Point Concentrations

For most receptors, site-specific chemical concentrations in surface soil, sediment, surface water, and biota were used to calculate EPCs for these media (see Table 6-56). As described in Section 6.3.7.1, the UCL on the average concentration was used as the EPC, unless sample size was highly limited, in which case the maximum detected concentration was used as the EPC. Details are provided in Appendix O.

For terrestrial wildlife species that prey on soil invertebrates (e.g., earthworms) and small mammals, literature-based models were used to estimate chemical concentrations in prey. Surface soil EPCs were used as input to the models. EPCs for the 11 wildlife species evaluated in the BERA are presented in Tables 6-57 to 6-62. The models used to estimate chemical concentrations in earthworms and small mammals are provided in Tables 6-57 and 6-60.

Wildlife Exposure Calculations

Chemical exposure for wildlife was calculated as the sum of exposures from diet, incidental soil/sediment ingestion, and drinking. Dietary exposure was calculated using the following equation:

$$EE_{diet} = ([(C_1 \text{ x } F_1) + (C_2 \text{ x } F_2) + ... (C_n \text{ x } F_n)] \text{ x SUF x ED x IR})/BW$$

Where:

EE_{diet} = Estimated exposure from diet (mg/kg-day)
C_n = Chemical concentration in food item *n* (mg/kg, wet or dry weight)
F_n = Fraction of diet represented by food item *n*
SUF = Site use factor (unitless)
ED = Exposure duration (unitless)
IR = Ingestion rate of receptor (kg, wet or dry weight/day)
BW = Body weight of receptor (kg)

Food ingestion rates and body weights were taken from EPA (1993a), Dunning (1993), or other credible references (see Table 6-55). The diet of each receptor was assumed to consist exclusively of its preferred prey (see Table 6-55). For example, the diets of the American robin and marked shrew were assumed to consist entirely of soil invertebrates (e.g., earthworms). A wet food ingestion rate was used for the common snipe, kingfisher, and mink because chemical concentration data for benthic invertebrates and fish (sculpin) were provided on a wet weight basis. A dry food ingestion rate was used for all other receptors because site-specific data on chemical concentrations in their preferred food were provided on a dry weight basis (spruce needles, blueberry leaves, alder back, and pond vegetation) or because the models used to estimate chemical concentration in their preferred food yielded a dry weigh concentration (earthworms and small mammals). Of note, the EPA (2003d) uses a dry food ingestions rate and dry diet concentration when estimating the ingested dose of a chemical.

The SUF indicates the portion (fraction) of an animal's home range represented by the site. If the home range is larger than the site, the SUF equals the site area divided by the home range area. If the site area is greater than or equal to the home range, the SUF equals 1. For all wildlife receptors except the green-winged teal, an SUF of 1 was deemed applicable given the size of the site relative to the home range size (see Table 6-55). For the teal, the SUF was set equal to 0.004. This value was determined by dividing the settling pond surface area (1 ha assumed) by the teal home range size (243 ha).

ED is the fraction of the year spent in the site area by the receptor species. The robin, shrike, snipe, teal, and kingfisher are migratory and were assumed to be present at the site for four months. An ED value of 0.33 (4/12) was used for these receptors (see Table 6-55). The other receptors evaluated were assumed to be present at the site year-round (ED = 1).

Home-range size, IR, diet composition, and BW for the wildlife species being evaluated, were taken from the EPA (1993a), Dunning (1993), Kaufman (1996), or other credible references (see Table 6-55).

Wildlife exposure to chemicals through incidental soil/sediment ingestion was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{soil/sed} = (C_s \text{ x } IR_s \text{ x } SUF \text{ x } ED)/BW$$

Where:

$EE_{soil/sed}$ = Estimated exposure from incidental soil/sediment ingestion (mg/kg-day)

C_s = Chemical concentration in soil/sediment (mg/kg, dry weight)

IR_s = Soil/sediment ingestion rate of receptor (kg, dry weight/day)

SUF, ED, and BW are as defined above.

Soil/sediment ingestion rates were taken from the literature (Beyer et al. 1994, 2008; Sample et al. 1997; Sample and Suter 1994); or based on professional judgment (if a literature value could not be found) (see Table 6-55).

Wildlife exposure to chemicals through drinking was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{drinking} = (C_w \text{ x } IR_w \text{ x } SUF \text{ x } ED)/BW$$

Where:

$EE_{drinking}$= Estimated exposure from drinking surface water (mg/kg-day)

C_w = Chemical concentration in surface water (mg/L)

IR_s = Surface water ingestion rate (L/day)

SUF, ED, and BW are as defined above.

Surface water ingestion rates were taken from the literature or calculated using allometric relationships from Sample et al. (1996). The values are provided in Table 6-55.

The total exposure for a receptor was calculated as the sum of the exposure from diet, incidental soil/sediment ingestion, and drinking as represented by the following equation:

$$EE_{total} = EE_{diet} + EE_{soil/sed} + EE_{drinking}$$

Where:

EE_{total} = Total exposure (mg/kg-day)
EE_{diet} = Estimated exposure from diet (mg/kg-day)
$EE_{soil/sed}$ = Estimated exposure from incidental soil/sediment ingestion (mg/kg-day)
$EE_{drinking}$ = Estimated exposure from surface water consumption (mg/kg-day)

6.3.7.7.2 Wildlife Ecological Effects Assessment

Mammalian and avian NOAELs and LOAELs were taken from the peer-reviewed literature. The values and sources are provided in Table 6-63.

6.3.7.7.3 Wildlife Risk Characterization

Risk Calculation Methodology

The potential risks posed by site-related chemicals were determined by calculating an HQ for each contaminant for each wildlife endpoint species. The HQ was determined by dividing the total exposure (EE_{total}) by the NOAEL or LOAEL, as shown in the following equations:

$$\text{HQ-NOAEL} = EE_{total}/\text{NOAEL}$$

$$\text{HQ-LOAEL} = EE_{total}/\text{LOAEL}$$

For a given receptor and chemical, an HQ-NOAEL greater than 1 indicates that the estimated exposure exceeds the highest dose at which no adverse effect was observed. An HQ-LOAEL greater than 1 suggests that a chronic adverse effect to survival, growth, and/or reproduction is possible to an individual receptor, assuming that the estimated exposure for that receptor is accurate. Tables 6-64 to 6-74 present the estimated exposures and HQs for the 11 wildlife species evaluated.

Risk Results for Wildlife

The following results are noteworthy:

- For the northern shrike, least weasel, and green-winged teal, no contaminants were predicted to pose a risk; however, quantitative risk estimates could not be calculated for all site-related contaminants due to a lack of toxicity reference values (see Tables 6-68, 6-69, and 6-72).
- For the American robin, arsenic and lead were predicted to pose a potential risk (see Table 6-64). It should be noted, however, that the

potential lead risk is largely caused by a single surface soil sample (10MP48SS) with an unusually high total lead concentration (3,090 mg/kg). The next highest lead concentration in surface soil is 220 mg/kg (sample 10MP27SS), and most surface soil sample results for lead are less than 30 mg/kg. If the EPC for lead in surface soil is calculated without the 3,090 mg/kg value, the EPC is reduced by a factor of three, and no lead risks to the robin are predicted. Hence, potential risks to the robin from lead in soil at the RDM site are highly localized.

- For the masked shrew, nine contaminants were predicted to pose a potential risk (see Table 6-65). The greatest HQs were for antimony and arsenic. As discussed above for the robin, potential risks to the shrew from lead are driven by a hot spot and therefore are highly localized. Also, potential risks to the shrew from selenium and thallium are localized because both elements were detected in only two of 135 surface soil samples. For both contaminants, the maximum detected concentration was used to estimate exposure. This approach overestimates the true exposure.
- For the spruce grouse, arsenic, manganese, mercury, and vanadium were predicted to pose a risk (see Table 6-66). The greatest HQs were from arsenic and mercury.
- For the tundra vole, antimony, arsenic, and manganese were predicted to pose a risk (see Table 6-67). The greatest HQs were for antimony and arsenic. For these two contaminants, the estimated exposure from incidental soil ingestion accounts for greater than 99 percent of the total exposure. In contrast, for manganese, the estimated exposure from diet accounts for most of the total exposure.
- For the common snipe, arsenic, mercury, and selenium were predicted to pose a potential risk (see Table 6-70). The greatest HQ was for arsenic.
- For the beaver, only antimony was predicted to pose a risk (see Table 6-71). The estimated exposure from incidental soil ingestion accounted for 96 percent of the total exposure.
- For the belted-kingfisher, only arsenic was predicted to pose a potential risk (see Table 6-73). The estimated exposure from diet (sculpin from Red Devil Creek assumed) accounted for 99 percent of the total arsenic exposure.
- For the mink, antimony, arsenic, methylmercury, and selenium were predicted to pose a risk (see Table 6-74). The greatest HQ was for antimony. The estimated exposure from diet (sculpin from Red Devil Creek assumed) accounted for greater than 99 percent of the total antimony exposure.

6.3.8 Uncertainties

Significant sources of uncertainty in the BERA include the following:

6.3.8.1 Bioavailability

The bioavailability of chemicals in environmental media at the site is poorly understood. To be conservative, it was assumed that 100 percent of the chemicals in soil and sediment were bioavailable to all ecological receptors. If bioavailability is less than 100 percent, which seems likely, the potential risks to all categories of ecological receptors would be correspondingly lower. In general, uncertainties associated with bioavailability of metals in soil and sediment include: (1) lack of knowledge regarding how chemical, physical, and biological processes affect bioavailability; (2) lack of knowledge regarding how biota modify bioavailability of metals in soils and sediments in contact with external membranes (e.g., skin) or that are ingested; (3) lack of knowledge regarding whether bioavailability data for one species is applicable to bioavailability for other species; and (4) variability regarding chemical forms of metals in soil and sediment (e.g., redox state, mineralogy).

The mercury SSE and SPLP data collected for the RI both suggest that much of the total metals content in soil and sediment is not soluble under the conditions expected to exist in site soil and sediment. Mercury SSE data indicate that only a small fraction of total mercury in site soil and sediment is water soluble (F1) or stomach acid soluble (F2) and that the proportion of these soluble fractions relative to the total mercury decreases with increasing total mercury concentration (see Section 5.2.2, Table 5-1, Table 5-3, Tables 4-17 to 4-23, and Tables 4-32 to 4-33). Similarly, SPLP data suggest that only a small fraction of the total arsenic, antimony, and mercury concentration in site soil samples is soluble under simulated field conditions (see Table 6-75). Adsorption of metals by organisms involves mostly soluble metal species (McGeer et al. 2004). For plants, transfer takes place primarily from a water solution phase.

To further evaluate contaminant bioavailability in soil at the site, biota-soil accumulation factors (BSAFs) were calculated for arsenic, antimony, and mercury using data for co-located vegetation and surface soil samples. Site and background sample locations are shown in Figures 4-42 to 4-44 for blueberry stem/leaf composite samples, green alder bark composite samples, and white spruce needle composite samples. Soil-to-plant BSAFs for arsenic, antimony, and mercury were lower at the site than at nearby background locations for green alder bark (see Table 6-76), white spruce needles (see Table 6-77), and blueberry stems/leaves (Table 6-78), suggesting that contaminants in site soils are less bioavailable than in background soils.

Similarly, BSAFs were calculated from co-located samples of sediment and benthic macroinvertebrates from Red Devil Creek and six reference creeks in the middle Kuskokwim River region (see Figure 6-6). Sediment-to-benthic macroinvertebrate BSAFs for arsenic, antimony, mercury, and methylmercury were lower at Red Devil Creek than at the nearby reference creeks (see Table

6-79 and Appendix P), suggesting that contaminants in Red Devil Creek sediments are less bioavailable than in sediments from the reference creeks.

Finally, it should be noted that BSAFs (or BCFs if the exposure media is water) vary with contaminant concentrations in the environment. At higher contaminant concentrations in soil or sediment, the numeric value of the BSAF often is smaller than the BSAF at lower exposure concentrations, despite the tissue contaminant concentration being greater at greater exposure concentrations. This non-linear relationship between the soil or sediment and tissue concentration, particularly at higher exposure media concentrations, also may be a reason why lower BSAFs were observed in contaminated portions of the site compared with background.

6.3.8.2 Reliability of Soil Benchmarks

Many of the available soil screening benchmarks for plants and soil invertebrates (i.e., earthworms) were developed from laboratory studies in which chemical solutions were added to clean soil to arrive at a range of test concentrations. In such studies, the added chemicals are highly bioavailable. Comparing total chemical concentrations in field samples to solution-based soil benchmarks is conservative and likely results in an overestimation of risk. For aluminum, the EPA (2003f) has deemed that such a comparison is inappropriate.

6.3.8.3 Reliability of Sediment Screening Levels

The available sediment screening levels are based on total concentrations without consideration of chemical bioavailability. The sediment screening levels used in the BERA are expected to be conservative predictors of adverse effects for benthic organisms in Red Devil Creek, given that a large fraction of many site-related contaminants likely occur largely in a form that is less than 100 percent bioavailable. As noted in Section 6.3.7.4, a benthic macroinvertebrate survey for Red Devil Creek found no adverse impacts on abundance and diversity of benthic macroinvertebrates in Red Devil Creek compared with nearby reference creeks. These results suggest that the literature-based sediment screening levels used in the BERA are not reliable predictors of effects in Red Devil Creek.

6.3.8.4 Availability of Media Screening Levels and Wildlife Toxicity Reference Values

As indicated in Tables 6-44 and 6-63, screening levels are not available for all chemicals in all media. This situation leads to an underestimation of risk. For example, an avian TRV (i.e., NOAEL or LOAEL) is not available for antimony. Hence, potential risks to birds from antimony, which is one of the principal contaminants at the RDM site, could not be evaluated. Also, no soil screening level or wildlife TRV could be identified for benzoic acid; hence, potential risks from this chemical could not be evaluated (see Table 6-39). However, benzoic acid was detected at only one soil sampling location (11MP70SS) in the Main Processing Area, so any potential risks from this chemical are highly localized.

6.3.8.5 Chemicals in Wildlife Prey

Food-chain transfer of contaminants at the site is poorly understood for terrestrial predatory wildlife (e.g., American robin, masked shrew, northern shrike, and least weasel). The potential risks to these species are driven in part by estimated concentrations of chemicals in prey. For this assessment, prey concentrations were estimated from measured soil concentrations using bioaccumulation factors and models from the literature. Or, if a literature-based bioaccumulation factor was not available, it was assumed that the prey concentration was the same as the soil concentration. The uncertainty associated with this approach often is high because a number of site-specific factors affect food-chain transfer of chemicals. In general, the bioaccumulation factors and models used in this assessment are intended to provide a conservative estimate of chemicals in wildlife prey and are likely to result in an overestimation of risk.

6.3.8.6 Wildlife Diet

Uncertainty may result from the assumptions made about the diets of the wildlife receptors evaluated in this assessment. For the shrew and robin, the assumption of a diet consisting entirely of earthworms is conservative. In addition to earthworms, shrews consume other invertebrates (i.e. slugs, snails, centipedes, and various insects), fungi, plant materials, and small mammals (EPA 1993a). Similarly, robins also consume other invertebrates (i.e., spiders, sowbugs, and various insects) and plant materials (EPA 1993a). These foods are less intimately associated with the soil matrix than earthworms and thus accumulate lesser amounts of soil contamination. The diet assumed for the shrew and robin in this assessment likely overestimates exposure and risks from chemicals in soil.

6.3.8.7 Wildlife Use of the RDM Site

The wildlife evaluation assumed that all parts of the RDM site are equally attractive to wildlife, but this may not be the case. For example, wildlife may avoid the Main Processing Area because of its disturbed condition (i.e., compacted soils, sparse vegetation, etc.). Because the Main Processing Area is the most contaminated part of the site, wildlife exposure to site-related contaminants may have been overestimated if wildlife do not use the area, or do so only rarely.

6.3.8.8 Effect of Biased Sampling on Exposure Point Concentrations

As discussed in Section 6.2.6.1, many soil and sediment samples collected for the RI were purposely collected from areas of known contamination (Main Processing Area, spring, the “F” ore zone and the Dolly and Rice ore zone, etc.). Samples collected in this manner provide information about the nature of contamination in areas heavily used during mining and ore processing, but are not statistically representative of the average concentration across the site to which wildlife are exposed. Inclusion of results from biased sampling leads to higher EPCs than would be expected from random exposure. Conversely, it is possible that areas with elevated levels of surface soil contamination outside of the specific areas named above were inadvertently not sampled, which would lead to an underestimation of exposure and risk. However, this situation is considered unlikely given the large effort expended at site characterization (see Chapter 4).

6.3.8.9 Uncertainty Regarding Pre-Mining Background Concentrations

As discussed in Sections 6.2.6.1 and 4.1.7, it is likely that background contaminant levels in surface soil (see Table 4-2) have been underestimated at the RDM site. Consequently, the contribution of background to risk at the site likely has been underestimated.

6.3.8.10 Reliability of Surface Water Criteria and Screening Levels

In general, the EPA water quality criteria and State of Alaska water quality standards are considered to be among the most reliable screening levels because they are based on a large body of testing data and sound derivation methods. However, EPA and State of Alaska water quality criteria are not available for all chemicals. For chemicals without such criteria, surface water screening levels from other sources were used (see Table 6-48). These other surface water screening levels are based on fewer testing data than federal and state water quality criteria, and therefore the level of uncertainty associated with them is greater. For example, there is some uncertainty regarding the toxicity of barium to freshwater aquatic life. The EPA (1986b) states that “the soluble barium concentration in fresh or marine water generally would have to exceed 50 mg/L before toxicity to aquatic life would be expected.” In contrast, Suter and Tsao (1996) present a barium surface-water screening level of 4 µg/L. The difference between 4 µg/L and 50 mg/L is four orders of magnitude. Lastly, MacDonald et al. (1999) provide a hardness-dependent criterion equation for barium that yields a criterion value of 194 µg/L for the average hardness of Red Devil Creek surface water. The barium criterion from MacDonald et al. (1999) was used in this assessment because it is the most recent value and appears to be based on the best-available science.

6.3.8.11 Particulate versus Dissolved Contaminants in Red Devil Creek Surface Water

Risks to aquatic biota from contaminants in surface water were evaluated in the BERA using unfiltered surface water sample results, which include both dissolved and particulate contaminant forms. For most contaminants, the dissolved form is a better indicator of the bioavailable form and commonly is a small fraction of the total concentration. For example, for mercury in Red Devil Creek surface water, typically less than 10 percent of the total concentration was dissolved (see Table 4-31).

6.3.8.12 Mercury Surface Water Criteria Value

Two EPA water quality criteria for mercury that differ by more than an order of magnitude (0.77 and 0.012 µg/L) were used in the current assessment (see Table 6-48). Water quality guidelines developed by the Canadian Council of Ministers of the Environment (CCME 2003) suggest that the lower of the two EPA criteria is the more appropriate value for protection of freshwater aquatic life. Specifically, the CCME (2003) freshwater quality guidelines for inorganic mercury (0.026 µg/L) and methylmercury (0.004 µg/L) bracket the EPA 0.012 µg/L criterion. Hence, if only the EPA 0.77 µg/L criterion were used, potential risks to aquatic life from mercury in surface water at the RDM site may have been underestimated.

6.3.8.13 Temporal Variability in Surface Water Contaminant Levels

The BERA used Red Devil Creek surface water data collected during RI field activities in autumn 2010 and autumn 2011, a time when water flow in the creek typically is low. As part of the baseline monitoring effort, surface water samples were collected from the creek in May 2012, a time when water flow in the creek is elevated due to spring runoff (see Appendix A). Contaminant levels in creek surface water were greater in samples from May 2012 compared with those from autumn 2010 and autumn 2011. For example, antimony levels in unfiltered samples from May 2012 were on average three times greater (1.8 times greater excluding the seep [RD05] sample) than in unfiltered samples from autumn 2010 and 2011. Furthermore, arsenic and mercury levels in unfiltered samples from May 2012 were on average 40 percent greater than in unfiltered samples from autumn 2010 and 2011. Because no spring surface water data were used in the BERA, the BERA surface water EPCs likely are biased low. For aquatic organisms exposed directly to surface water in Red Devil Creek, potential risks (i.e., HQs) were estimated by dividing the surface water chemical concentration by a water quality criterion (see Table 6-48). The HQ values presented in Table 6-48 are directly proportional to the surface water chemical concentrations and, therefore, are biased low to the same degree that the surface water EPCs are biased low. For wildlife, underestimating chemical exposure from surface water is expected to have an inconsequential effect on the risk estimates because surface water exposure accounts for much less than 1 percent of the total exposure (see Tables 6-64 to 6-74). Appendix A includes additional information on seasonal variability of contaminant levels in surface water in Red Devil Creek.

6.3.9 Risk Summary

Table 6-80 provides a summary of the contaminants predicted to pose a potential risk to the assessment endpoints evaluated in the BERA. In general, the greatest HQ values were observed for antimony, arsenic, and mercury, as would be expected given the site history and local mineralogy. Additional observations to help interpret the significance of the risk results are presented below by assessment endpoint:

- For the terrestrial plant community, seven contaminants were predicted to be COCs (see Table 6-80). The greatest HQ values were for antimony, arsenic, and mercury. Confidence in the COC list and magnitude of the HQ values is considered low primarily because of the conservative nature of the soil screening levels for plants and because contaminant bioavailability in soil was not quantitatively considered. If the HQ values for plants were adjusted to account for solubility of site contaminants (e.g., using the SPLP and mercury SSE results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower. It should be noted that the Surface Mined Area has been successfully re-colonized by native plants since the end of mining at the site, suggesting that soil in this area is not phytotoxic. In contrast, the Main Processing Area has not been entirely re-colonized by native vegetation. While this could be the result of high levels of metals in soil, the highly compacted nature of the soil and/or absence of soil in some locations also are factors that may be limiting plant growth in the Main Processing Area. Lastly, as noted in Table 6-39, bis(2-ethylhexyl)phthalate and diethylphthalate may pose a localized risk to plants at one sample location each in the Main Processing Area.

- For the soil invertebrate community, seven contaminants were predicted to be COCs (see Table 6-80). The greatest HQ values were for antimony, arsenic, and mercury. Confidence in the COC list and magnitude of the HQ values is considered low primarily because of the conservative nature of the screening levels for soil invertebrates and because contaminant bioavailability in soil was not quantitatively considered. If the HQ values for soil invertebrates were adjusted to account for solubility of site contaminants (e.g., using the SPLP and mercury SSE results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower. In addition, thallium was identified as a COC for the soil invertebrate community because it was detected in site surface soil, but no screening level was available. However, thallium was detected in only two of 135 samples (see Table 6-44), so potential risks to the soil invertebrate community from thallium, if any, are localized in extent. Lastly, as noted in Table 6-39, bis(2-ethylhexyl)phthalate and diethylphthalate may pose a localized risk to soil fauna at one sample location each in the Main Processing Area.

- For fish, benthic macroinvertebrates, amphibians, periphyton, and other aquatic organisms exposed to surface water, five COCs were identified (see Table 6-80). The greatest HQ values were for antimony, arsenic, and mercury. Potential risk to aquatic life from arsenic, iron, and manganese in surface water in Red Devil Creek appear to be localized to an area near where a seep discharges to the creek in the Main Processing Area (see Section 6.3.7.5).

- For the fish community in Red Devil Creek, arsenic, antimony, mercury, and perhaps selenium were predicted to be COCs based on comparing chemical concentration in whole-body sculpin samples with tissue screening concentrations (see Table 6-80). Confidence in the risk estimates is considered moderate to low depending on the contaminant. For example, the selenium HQ value of 1.3 is based on a fish tissue criterion from Dyer et al. (2000). If the EPA draft selenium fish tissue criterion is used instead of the value from Dyer et al. (2000), an HQ < 1 results (see Table 6-40).

- For the benthic macroinvertebrate community, nine contaminants were predicted to be COCs based on comparing contaminant concentrations in sediment with sediment screening levels (see Table 6-80). Confidence in the COC list and HQ values based on this assessment method is considered low because site-specific bioavailability was not considered in the evaluation. Also, a benthic macroinvertebrate survey conducted in Red Devil Creek identified no adverse impacts to abundance and diversity of benthic macroinvertebrates in Red Devil Creek compared with nearby reference creeks (see Section 6.3.7.4). The site-specific survey is considered to be a more reliable assessment method and suggests no impacts to the benthic community from site-related contaminants. Lastly, potential risks to benthic macroinvertebrates also were assessed by comparing contaminant levels in benthic macroinvertebrate tissues with critical tissue concentrations (see Section 6.3.7.4). This assessment method identified only methylmercury as a COC for the benthic macroinvertebrate community (HQ 1.3, see Table 6-80).

- For the terrestrial avian invertivore assessment endpoint, represented by the American robin, up to seven contaminants (antimony, arsenic, beryllium, lead, thallium, benzoic acid, and diethylphthalate) were identified as COCs (see Table 6-80). Confidence in the arsenic and lead risk estimates is considered low for two reasons: (1) site-specific bioavailability of metals in soil was not quantitatively considered; and (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms). In addition, for lead, the risk is driven by a highly elevated lead concentration in surface soil at one location. Hence, potential risks to the robin from lead at the RDM site are highly localized. Thallium and benzoic acid were identified as COCs for the robin because they were detected in site surface soil, but no TRV was available. However, thallium was detected in only two of 135 surface soil samples (see Table 6-44), so potential risks to the robin from thallium, if any, are highly localized. Similarly, benzoic acid was detected at one surface-soil sample location, so potential risks from this chemical to the robin, if any, also are localized. Potential risks to the robin from diethylphthalate are restricted to one surface-soil sample location in the Main Processing Area (10MP20SS) where the concentration (140 µg/kg) exceeded a conservative soil screening value (100 µg/kg) from Buchman (2008). Potential risks to the robin from antimony cannot be ruled out given the nature of the site.
- For the terrestrial mammalian invertivore assessment endpoint, represented by the masked shrew, nine COCs were identified (see Table 6-80). The greatest HQ values were for antimony and arsenic. Confidence in the risk estimates is considered low for two reasons: (1) site-specific contaminant bioavailability in soil was not quantitatively considered and (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms). Also, for antimony, because a soil-to-earthworm uptake model was not available from the literature, a conservative bioaccumulation factor of 1 was assumed (i.e., worm and soil antimony concentrations are equal). This assumption is expected to lead to an overestimate of the risk from antimony given the limited bioavailability of contaminants in soil at the site (see Section 6.3.8.1). Lastly, as discussed above for the robin, any potential risks to the shrew from lead,

thallium, or benzoic acid in surface soil at the RDM site are highly localized.

- For the terrestrial avian herbivore assessment endpoint, represented by the spruce grouse, up to eight contaminants (antimony, arsenic, beryllium, mercury, thallium, vanadium, benzoic acid, and diethylphthalate) were predicted to be COCs (see Table 6-80). The greatest HQ values were for arsenic and mercury. Confidence in the arsenic and mercury risk estimates is considered low. Although metals levels in the primary food of the spruce grouse (spruce needles) were measured, site-specific bioavailability of metals in soil was not quantitatively considered, and incidental soil ingestion accounts for most arsenic and mercury exposure for the grouse (see Table 6-66). Potential risks from antimony cannot be ruled out, but could not be quantified because an avian TRV for antimony was not identified. As noted above, potential risks, if any, from thallium, benzoic acid, and diethylphthalate in soil are localized to one or two sample locations each in the Main Processing Area.
- For the terrestrial mammalian herbivore assessment endpoint, represented by the tundra vole, antimony, arsenic, manganese and benzoic acid were identified as COCs (see Table 6-80). The greatest HQ value was for antimony. Confidence in the risk estimates is considered low. Although metals concentrations in a representative forage plant (blueberry stems/leaves) were measured and used to quantify vole dietary exposure, site-specific bioavailability of metals in soil was not quantitatively considered, and nearly all of the vole’s exposure to antimony and arsenic comes from incidental soil ingestion (see Table 6-67). A potential risk to the vole from benzoic acid could not be ruled out due to the lack of a mammalian TRV for this chemical. However, any potential risks to the vole from benzoic acid are localized because this chemical was detected at only one sample location in the Main Processing Area (11MP70SS, see Table 6-39).
- For the terrestrial carnivorous bird assessment endpoint, represented by the northern shrike, only the HQ value for diethylphthalate was greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated (see Table 6-80). Potential risks to the shrike from diethylphthalate are restricted to one surface-soil sample location in the Main Processing Area (10MP20SS) where the detected concentration (140 µg/kg) exceeded a conservative soil screening value (100 µg/kg) from Buchman (2008).
- For the terrestrial carnivorous mammal assessment endpoint, represented by the least weasel, no metals were identified as COCs, but one SVOC (benzoic acid) could not be eliminated as a COC (see Table 6-80). However, because benzoic acid was detected at only one surface-soil sample location in the Main Processing Area (11MP70SS), any potential risks to the weasel from this chemical are highly localized.

- For the semi-aquatic avian invertivore assessment endpoint, represented by the common snipe, up to five COCs (antimony, arsenic, beryllium, selenium, and thallium) were identified (see Table 6-80). The greatest HQ was for arsenic. Confidence in the arsenic risk estimate for the snipe is considered moderate. Although the arsenic level in snipe prey (benthic macroinvertebrates from Red Devil Creek) was measured, site-specific arsenic bioavailability in sediment was not quantitatively considered. Potential risks to the snipe from antimony, beryllium, and thallium could not be quantitatively evaluated because avian TRVs for these elements were not identified.
- For the semi-aquatic mammalian herbivore assessment endpoint, represented by the beaver, arsenic was identified as a COC (see Table 6-80). Confidence in the arsenic risk estimate for the beaver is considered low. Although the arsenic level in a representative food of the beaver (alder bark) was measured, site-specific arsenic bioavailability in soil was not quantitatively considered and incidental soil ingestion accounts for 95 percent of arsenic exposure for this receptor (see Table 6-71).
- For the semi-aquatic avian herbivore assessment endpoint, represented by the green-winged teal, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated (see Table 6-80).
- For the avian piscivore assessment endpoint, represented by the belted kingfisher, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated (see Table 6-80).
- For the mammalian piscivore assessment endpoint, represented by the mink, antimony, arsenic and selenium were identified as COCs (see Table 6-80). Confidence in the risk estimates for the mink are considered moderate to high.

6.3.10 Ecological Risks Due to Background Chemical Concentrations

Several contaminants identified as COCs at the RDM site occur at concentrations in site media that are similar to background. Media-receptor pairs for which ecological risks appear to be the result of background contaminant concentrations are listed in Table 6-81. Beryllium, vanadium, and selenium may pose risks to some groups of ecological receptors at the RDM site, but their concentrations in site media lie within the range of background.

6.4 Development of Risk-Based Cleanup Levels

6.4.1 Preliminary Human Health Risk-Based Cleanup Levels

Preliminary alternative risk-based cleanup levels (RBCLs) are developed in the HHRA for COCs (COPCs that exceed risk-based standards). Developing RBCLs for each scenario provides a range of RBCLs based on future land use and will assist in risk management decisions at the site, including determination of remedial action objectives (RAOs).

Preliminary RBCLs were developed for each scenario and COC that exceeds a target cancer risk of 1 in 100,000 (10^{-5}) and an HI of 1.0. COCs by media are included in Table 6-82. No COCs were identified in surface water or berries and plants.

RBCLs were developed using the exposure equations and parameters identified in the HHRA and back-calculating a target concentration in each individual medium. Arsenic is the only carcinogen that was identified as a COC; RBCLs for arsenic were calculated based on a target cancer risk of 1 in 100,000. RBCLs for non-carcinogens were calculated based on child exposure for the resident and recreational/subsistence user since that represents the most highly potentially exposed receptor. Although arsenic presents noncarcinogenic hazards, the RBCL for carcinogenic risks is lower than that for noncarcinogenic hazards. Noncarcinogenic COC RBCLs were calculated based on a target HQ equal to 1.0. RBCLs are provided in Table 6-83, by medium and provided to two significant figures. Although RBCLs from groundwater ingestion were calculated for the mine worker exposure scenarios, ADEC guidance indicates that RBCLs for groundwater should not be based on such scenarios. These values are shown for comparison only. Federal (EPA 2009b) are also provided in Table 6-83 for comparison to groundwater RBCLs.

In the risk assessment, risk and hazards from exposure to air, large land mammals, small land mammals, and birds were calculated based on a calculated concentration in these exposure media and not direct measurements. For example, risks from inhalation of COPCs in air were calculated based on concentrations in groundwater (from volatilization of COPCs in groundwater) and soil (from volatilization of COPCs in soil or inhalation of particulates from soil). For these media, RBCLs were also calculated from the media for which COPC concentrations were used in the BRA (e.g., soil, groundwater, green alder bark, and white spruce needles). These RBCLs are provided in Table 6-84.

Final RAOs should be adjusted to ensure that the cumulative risk and hazard at the site do not exceed a target excess cancer risk of 1 in 100,000 (10^{-5}) or an HI of 1.0.

Lead was not determined to be a COC in soil at the site, so no RBCL is needed for lead.

Generally, cleanup levels are not set at concentrations below natural background levels. If RBCLs exceed background levels, preliminary cleanup levels should default to background concentrations. Background concentrations are included in Table 6-83 for comparison. The RBCL for arsenic in soil and groundwater and manganese in groundwater (for resident RBCL only) are less than the calculated background levels in these media. Difficulties associated with the development of soil background values for the RDM are discussed in Section 4.1.7.

6.4.2 Preliminary Ecological Risk-Based Cleanup Levels

In light of the importance of arsenic, antimony, and mercury in driving ecological (and human health) risks at the site, this section is focused on preliminary cleanup levels for arsenic, antimony, and mercury for protection of ecological receptors. Preliminary cleanup levels for surface soil, sediment, and surface water are presented in Tables 6-85 to 6-87 for arsenic, antimony, and mercury, respectively along with a discussion of the methods used to derive them and their reliability. These cleanup levels are not designed to account for the cumulative risk resulting from exposure to multiple contaminants simultaneously. As noted in Section 6.4.1, cleanup levels are not set at concentrations below natural background levels. If risk-based levels are less than background, the cleanup level should default to the background concentration.

Figures 6-8 to 6-17 provide ecological risk maps based on the risk-based cleanup levels presented in Tables 6-85 to 6-87. Collectively, the risk maps show that contaminated surface soil and sediment in the Main Processing Area poses the greatest ecological risks. In this area, much of the surface soil consists of tailings and waste rock materials, as shown on the figures. Confidence in the risk maps is the same as confidence in the risk-based cleanup levels, which is described in the last column of Table 6-85 to 6-87. For several receptors, confidence in the cleanup levels is considered low for the reasons provided in the tables.

Lastly, it should be noted that wildlife receptors integrate exposure over an area equal to the size of their home range. As a result, risk-based cleanup levels for protection of wildlife typically are not applied on a point-by-point basis. Instead, they usually are treated as surface weighted average concentration goals. When they are applied in this manner, it is not necessary that every sample location be remediated to less than the cleanup goal as long as the site-wide average concentration lies beneath the goal.

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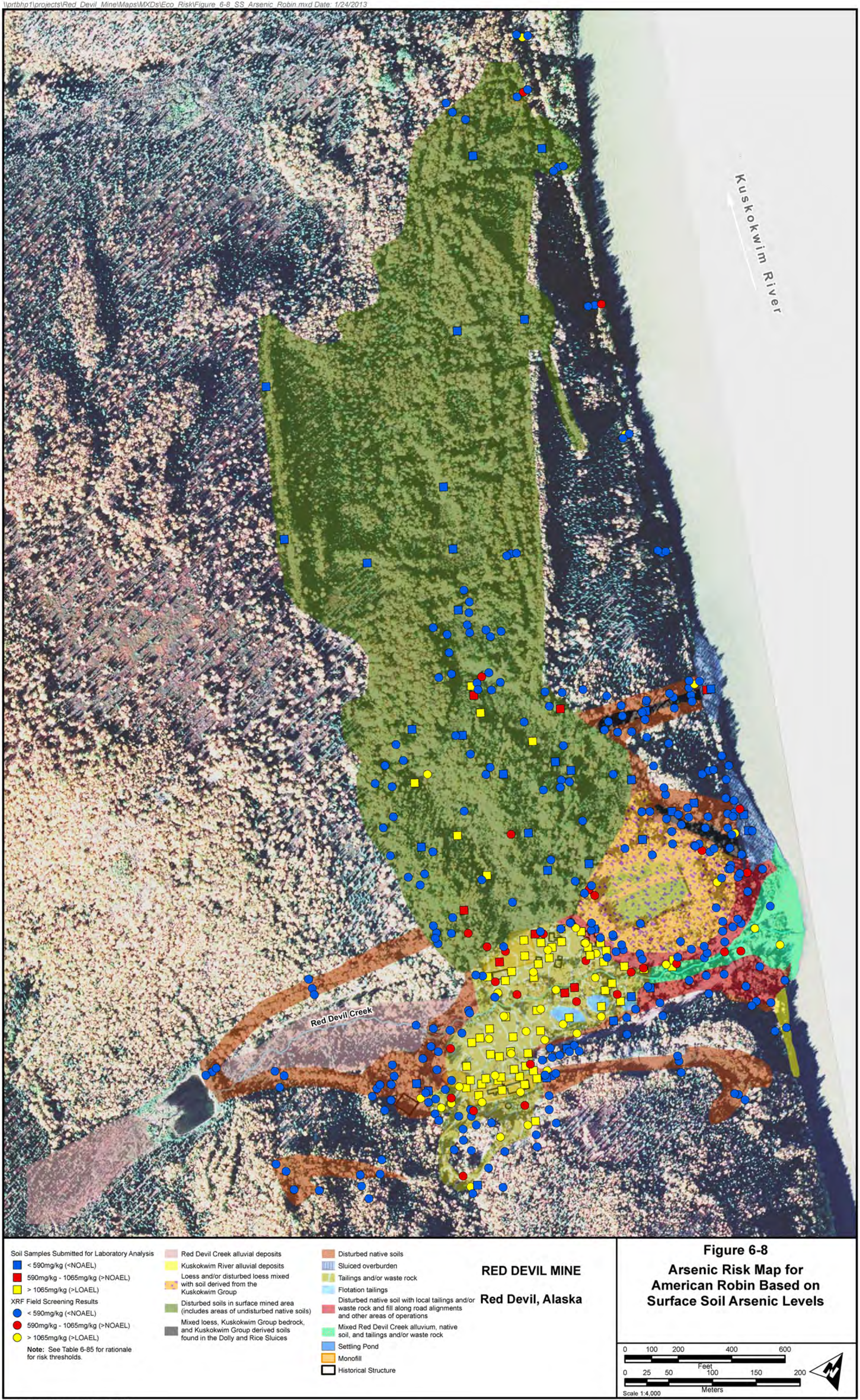
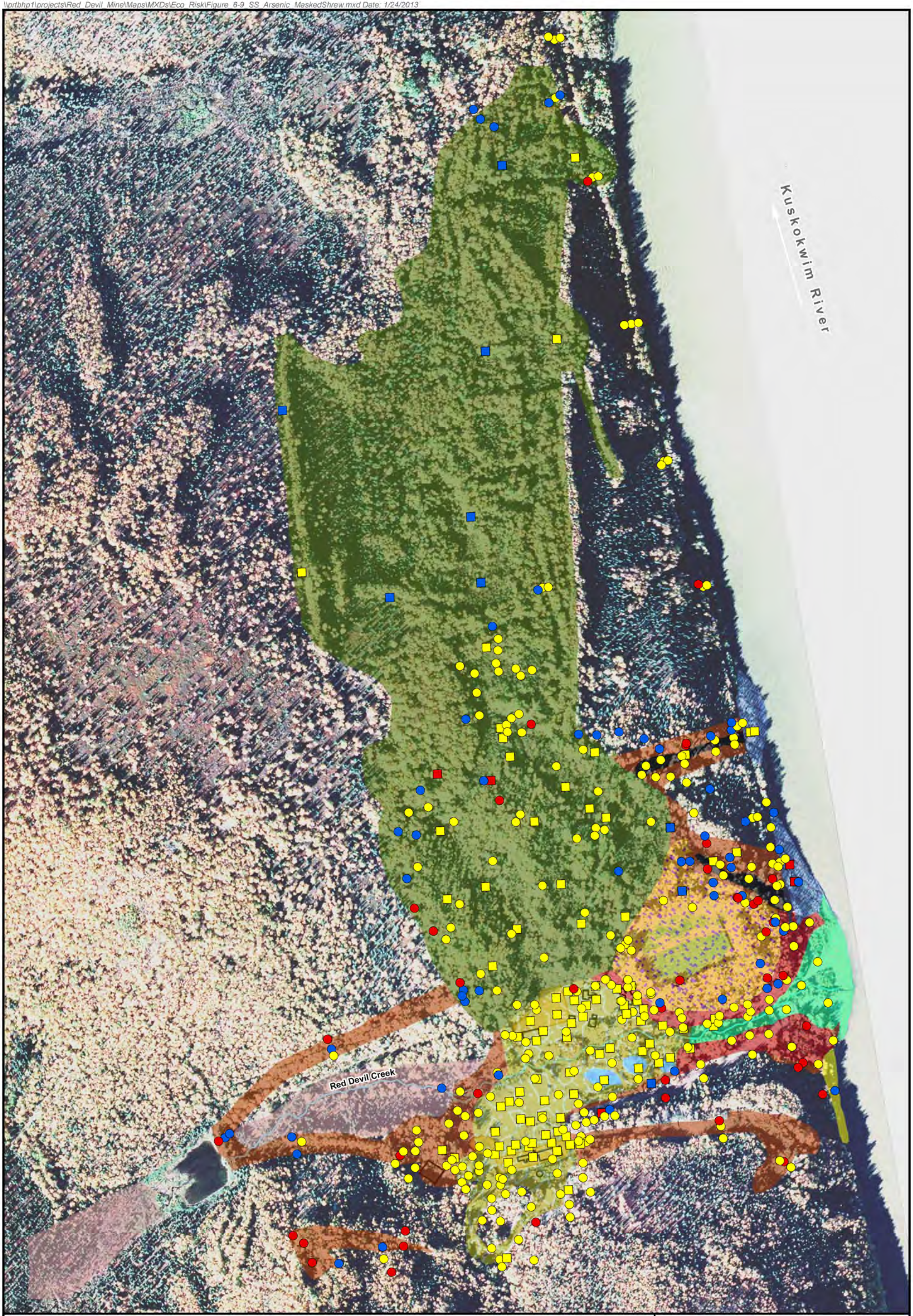


Figure 6-8
Arsenic Risk Map for American Robin Based on Surface Soil Arsenic Levels

Image Source: Aero-Metric, Inc. 2010a



Soil Samples Submitted for Laboratory Analysis
- 🟦 < 18mg/kg (<NOAEL)
- 🟥 18mg/kg - 35mg/kg (>NOAEL)
- 🟨 > 35mg/kg (>LOAEL)

XRF Field Screening Results
- ● < 18mg/kg (<NOAEL)
- ● 18mg/kg - 35mg/kg (>NOAEL)
- ● > 35mg/kg (>LOAEL)

Note: See Table 6-85 for rationale for risk thresholds

- Red Devil Creek alluvial deposits
- Kuskokwim River alluvial deposits
- Loess and/or disturbed loess mixed with soil derived from the Kuskokwim Group
- Disturbed soils in surface mined area (includes areas of undisturbed native soils)
- Mixed loess, Kuskokwim Group bedrock, and Kuskokwim Group derived soils found in the Dolly and Rice Sluices
- Disturbed native soils
- Sluiced overburden
- Tailings and/or waste rock
- Flotation tailings
- Disturbed native soil with local tailings and/or waste rock and fill along road alignments and other areas of operations
- Mixed Red Devil Creek alluvium, native soil, and tailings and/or waste rock
- Settling Pond
- Monofill
- ☐ Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 6-9

Arsenic Risk Map for Masked Shrew Based on Surface Soil Arsenic Levels

0 100 200 400 600
Feet
0 25 50 100 150 200
Meters
Scale 1:4,000

Image Source: Aero-Metric, Inc. 2010a

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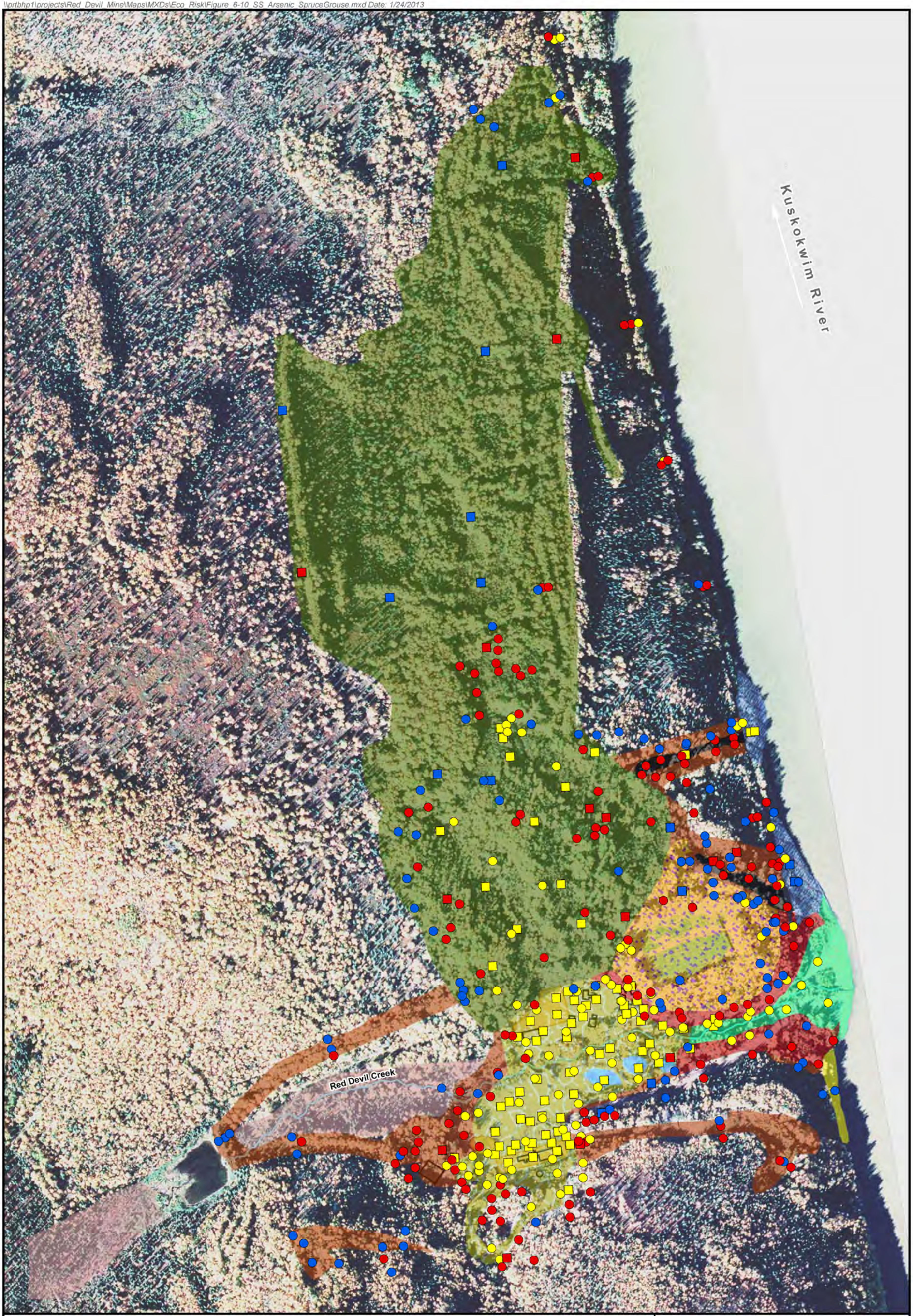

Soil Samples Submitted for Laboratory Analysis

- 🟦 < 208mg/kg (<NOAEL)
- 🟥 208mg/kg - 330mg/kg (>NOAEL)
- 🟨 > 330mg/kg (>LOAEL)

XRF Field Screening Results

- 🔵 < 208mg/kg (<NOAEL)
- 🔴 208mg/kg - 330mg/kg (>NOAEL)
- 🟡 > 330mg/kg (>LOAEL)

Notw: See Table 6-85 for rationale for risk thresholds.

- ▨ Red Devil Creek alluvial deposits
- 🟨 Kuskokwim River alluvial deposits
- ▨ Loess and/or disturbed loess mixed with soil derived from the Kuskokwim Group
- 🟩 Disturbed soils in surface mined area (includes areas of undisturbed native soils)
- ■ Mixed loess, Kuskokwim Group bedrock, and Kuskokwim Group derived soils found in the Dolly and Rice Sluices
- 🟫 Disturbed native soils
- ▥ Sluiced overburden
- ▨ Tailings and/or waste rock
- ▨ Flotation tailings
- 🟥 Disturbed native soil with local tailings and/or waste rock and fill along road alignments and other areas of operations
- ▨ Mixed Red Devil Creek alluvium, native soil, and tailings and/or waste rock
- 🟦 Settling Pond
- 🟧 Monofill
- ☐ Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 6-10
Arsenic Risk Map for Spruce Grouse Based on Surface Soil Arsenic Levels

0 100 200 400 600
Feet
0 25 50 100 150 200
Meters
Scale 1:4,000

Image Source: Aero-Metric, Inc. 2010a

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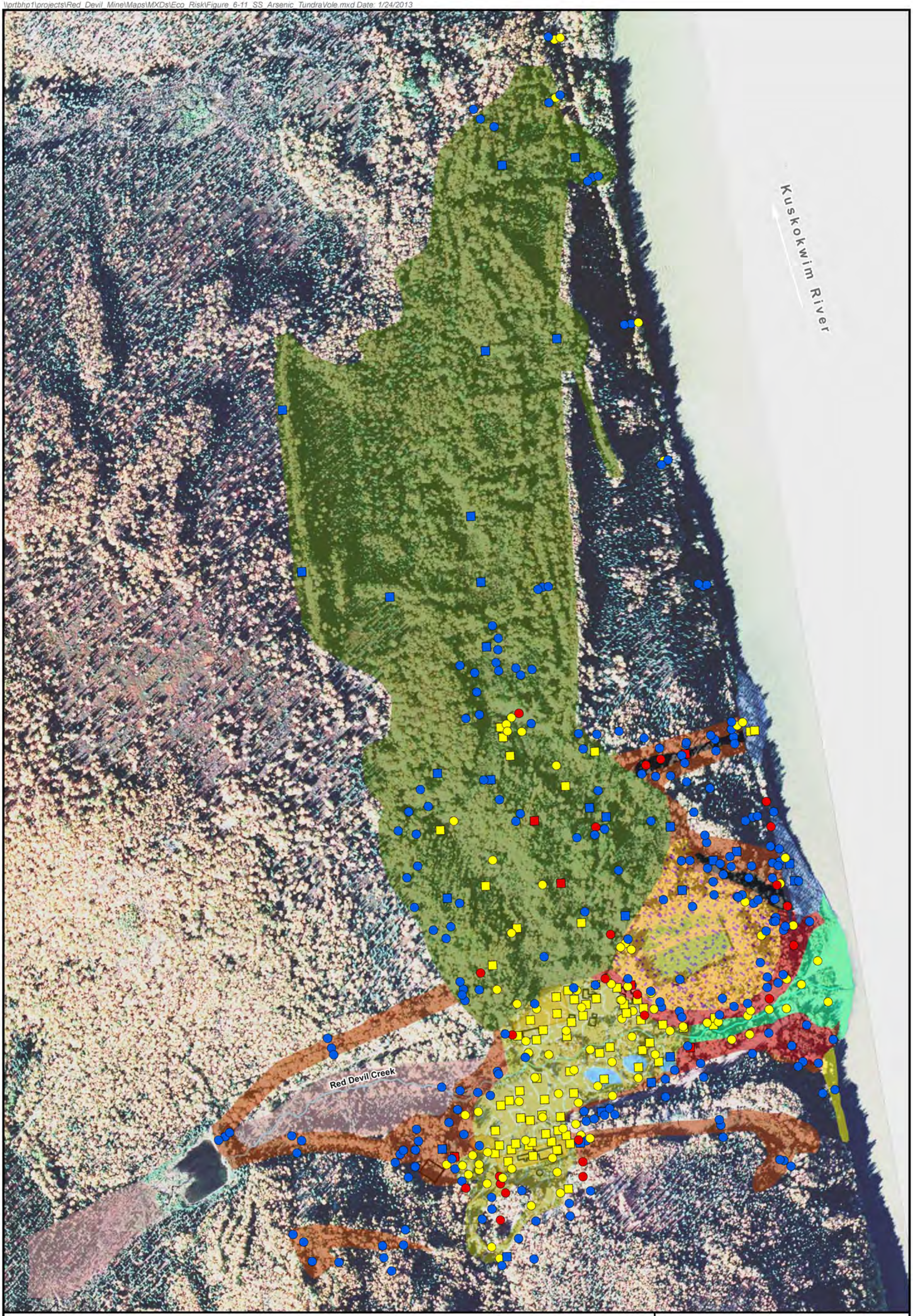

RED DEVIL MINE

Red Devil, Alaska

Figure 6-11
Arsenic Risk Map for Tundra Vole Based on Surface Soil Arsenic Levels

Image Source: Aero-Metric, Inc. 2010a

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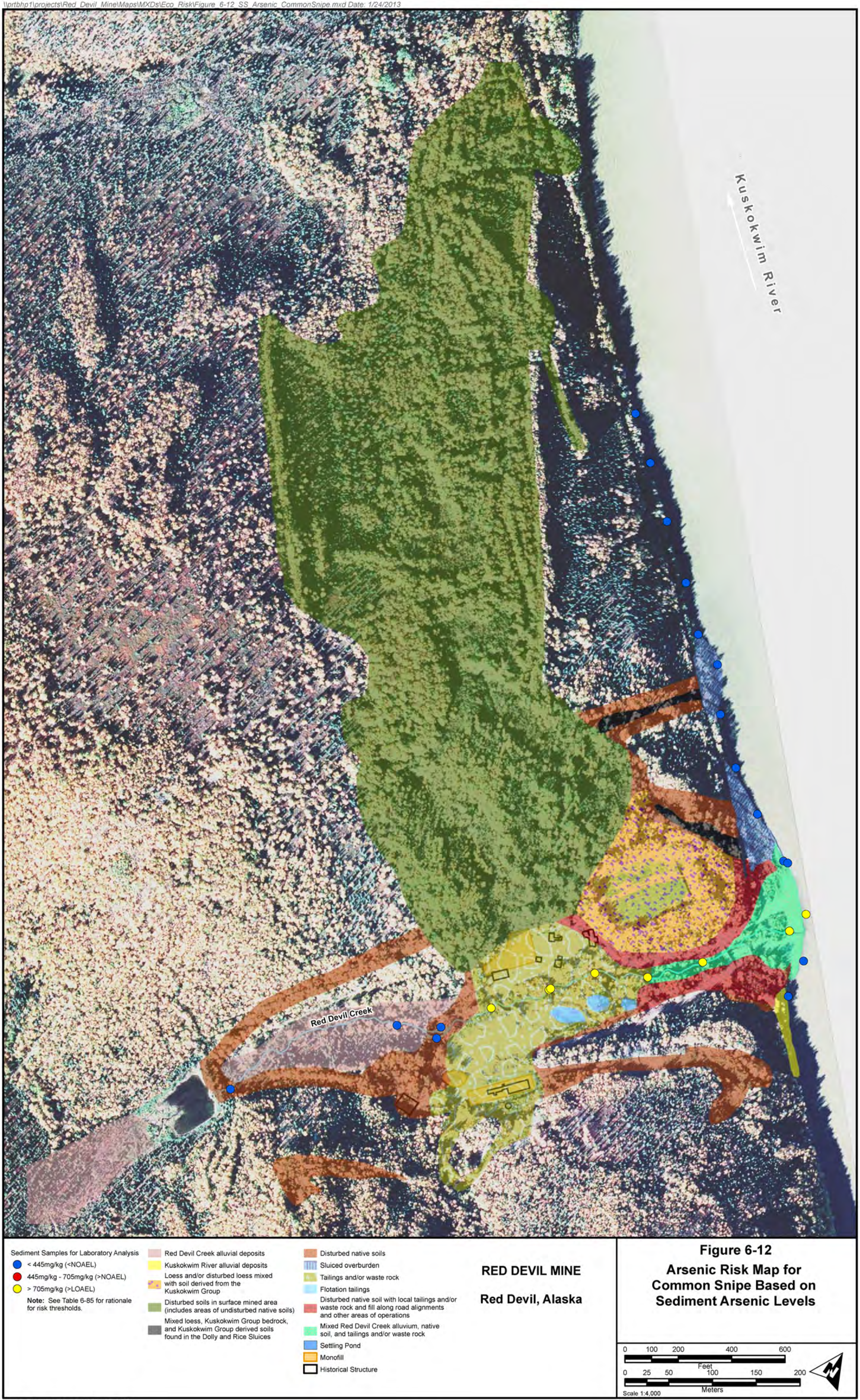


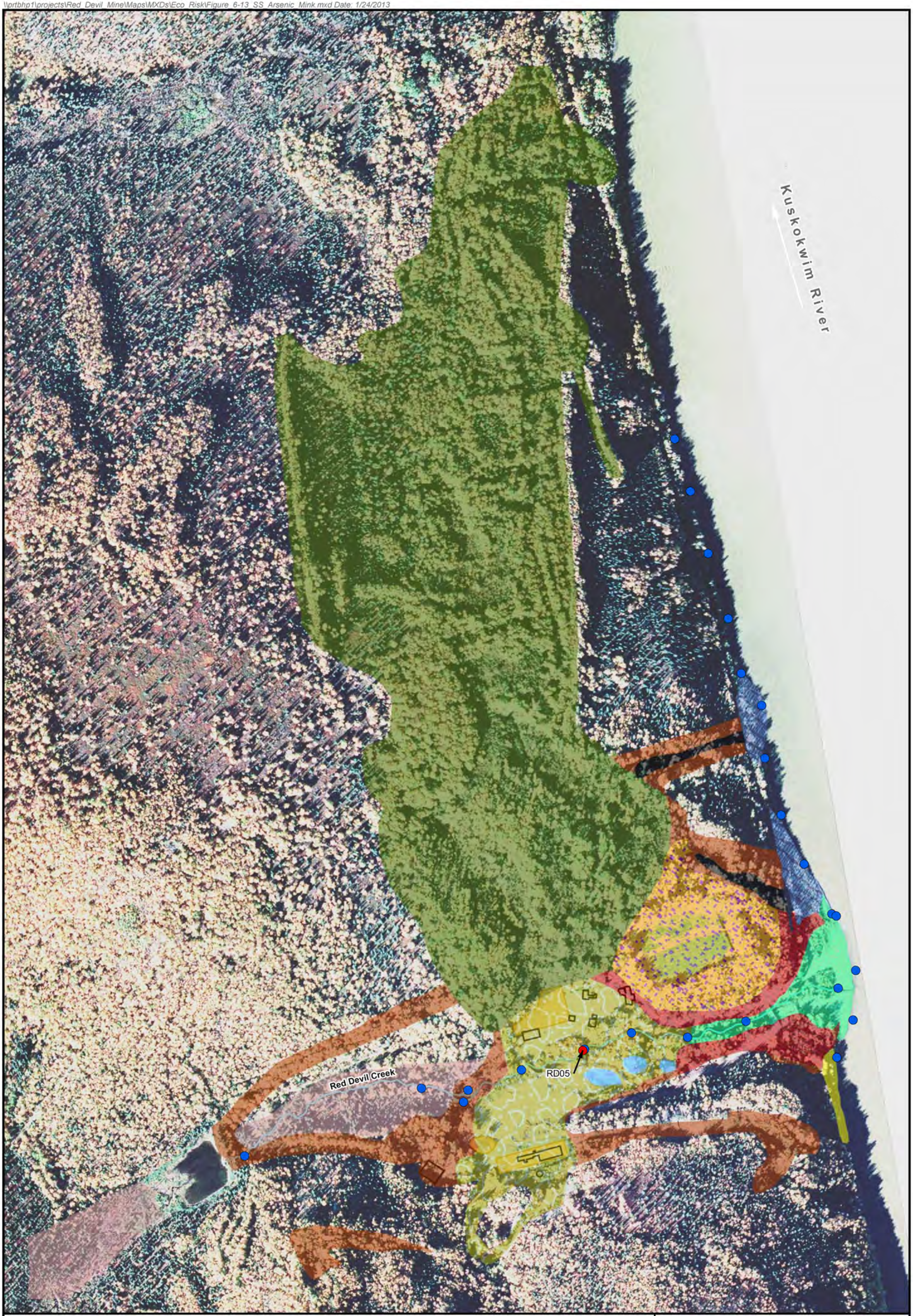
RED DEVIL MINE

Red Devil, Alaska

Figure 6-12

Arsenic Risk Map for Common Snipe Based on Sediment Arsenic Levels

Image Source: Aero-Metric, Inc. 2010a



RED DEVIL MINE

Red Devil, Alaska

Figure 6-13

Arsenic Risk Map for Mink Based on Sediment Arsenic Levels

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\Eco_Risk\Figure_6-14_SS_Antimony_TundraVole.mxd Date: 1/24/2013

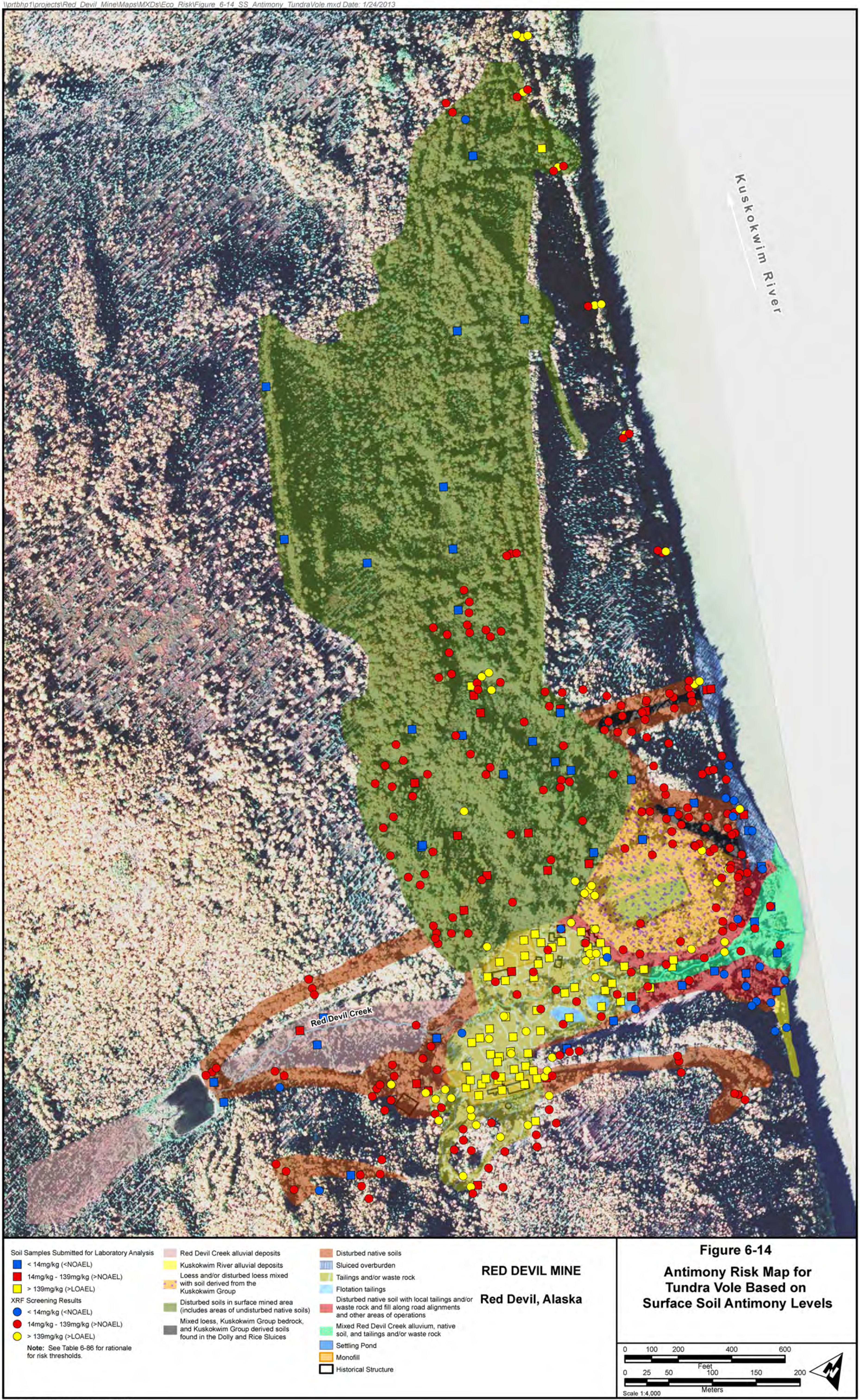


Figure 6-14
Antimony Risk Map for Tundra Vole Based on Surface Soil Antimony Levels

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project: \\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\Eco_Risk\Figure_6-15_SS_Antimony_Beaver.mxd Date: 1/24/2013

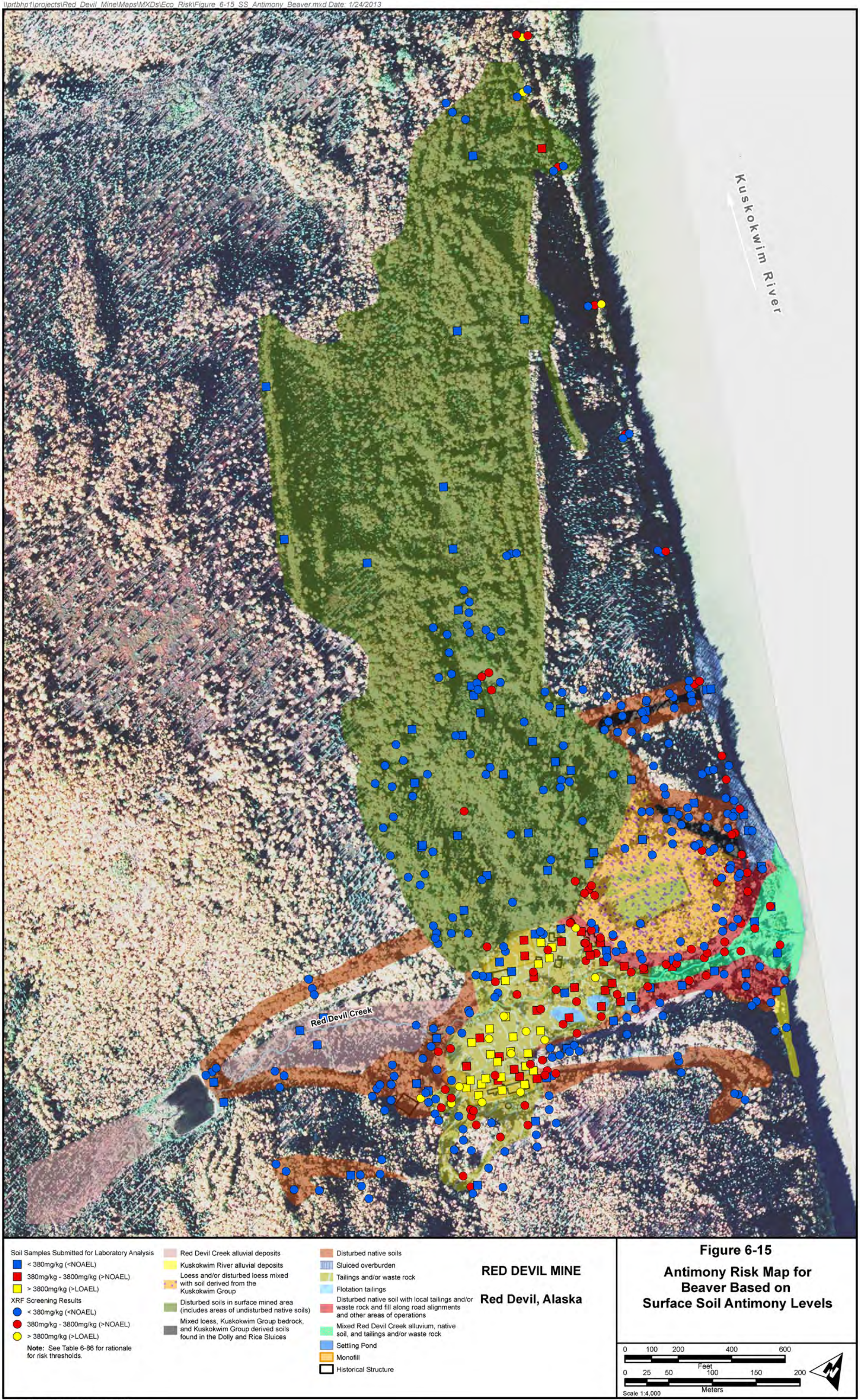
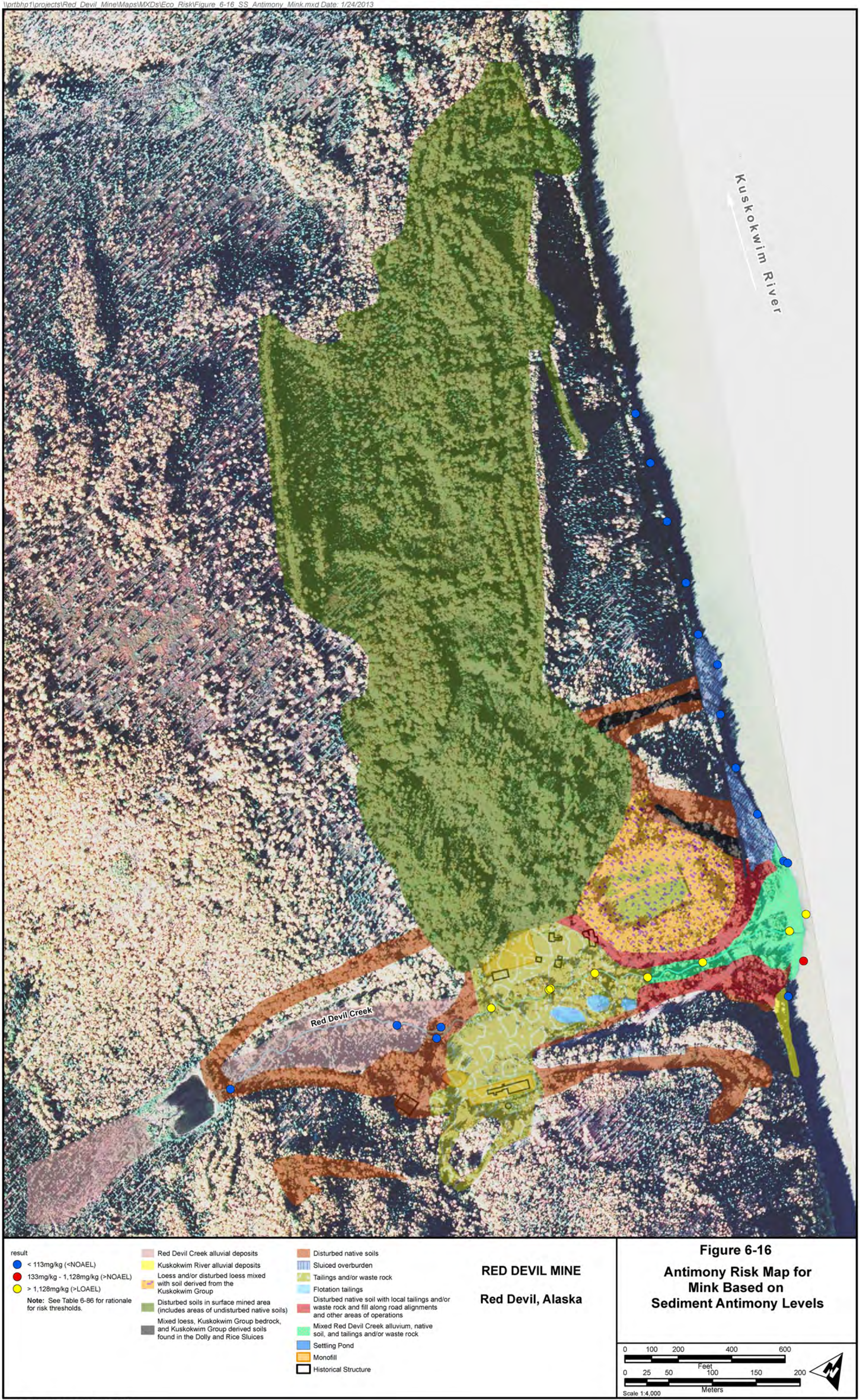


Figure 6-15

Antimony Risk Map for Beaver Based on Surface Soil Antimony Levels

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\Eco_Risk\Figure_6-16_SS_Antimony_Mink.mxd Date: 1/24/2013



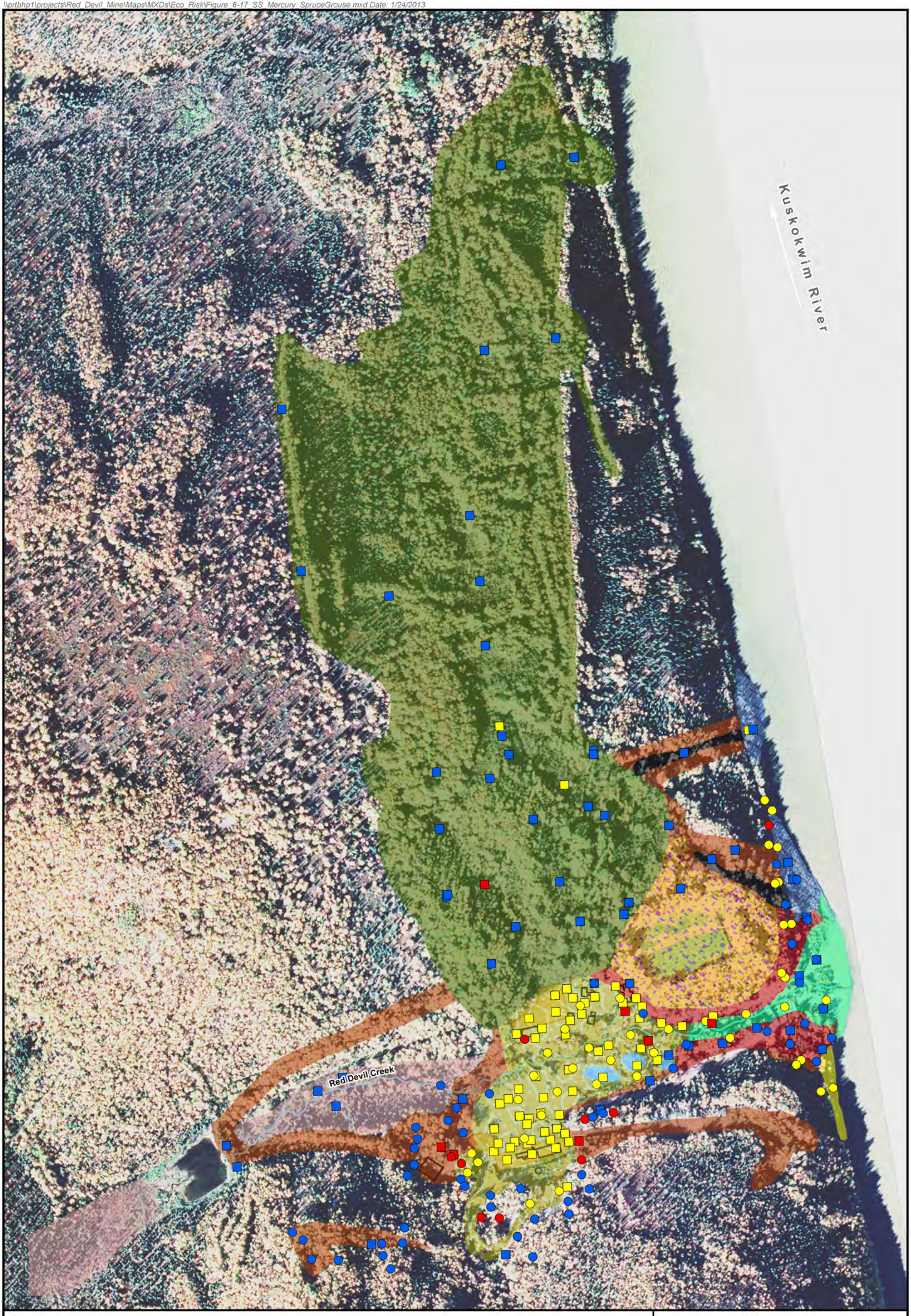
RED DEVIL MINE

Red Devil, Alaska

Figure 6-16

Antimony Risk Map for Mink Based on Sediment Antimony Levels

Image Source: Aero-Metric, Inc. 2010a



RED DEVIL MINE

Red Devil, Alaska

Figure 6-17

Mercury Risk Map for Spruce Grouse Based on Surface Soil Mercury Levels

Image Source: Aero-Metric, Inc. 2010a

Table 6-1 Surface Soil (0 to 2 feet) Human Health Screening Results, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Soil Human Health Screening Levels				
					EPA RSL - Residential	ADEC - Direct Contact	ADEC - Outdoor Inhalation	COPC	Rationale[c]
Metals (mg/kg)									
Aluminum	135	2410	21700	135/135	7.70E+03	--	--	YES	>SL
Antimony	135	0.708 J	23300 J	111/135	3.1	4.1	--	YES	>SL
Arsenic	136	9	9880	134/136	0.039	0.45	--	YES	>SL
Inorganic Arsenic	35	24.9 J	20100	35/35	0.039	0.45	--	YES	>SL
Barium	135	76.2	1710	135/135	1.50E+03	2030	--	YES	>SL
Beryllium	135	0.3	1.3	132/135	16	20	--	NO	<SLs
Cadmium	135	0.18	1.3	38/135	7	7.9	--	NO	<SLs
Calcium	135	390	10400 J	135/135	--	--	--	NO	NUT
Chromium[d]	135	6	101	135/135	2.90E-01	30	--	YES	>SL
Cobalt	135	5.9	38.8	135/135	2.3	--	--	YES	>SL
Copper	135	17	139	135/135	3.10E+02	410.0	--	NO	<SLs
Iron	135	16800	59100	135/135	5.50E+03	--	--	YES	>SL
Lead	135	5	3090	126/135	400	40	--	YES	>SL
Magnesium	135	390	11400	135/135	--	--	--	NO	NUT
Manganese	135	153	4230	135/135	1.80E+02	--	--	YES	>SL
Mercury[e]	135	0.05 J	1620	135/135	1	3	2	YES	>SL
Nickel[f]	135	18	97	135/135	1.50E+02	200	--	NO	<SLs
Potassium	135	600	4720	135/135	--	--	--	NO	NUT
Selenium	135	0.24	0.42	2/135	3.90E+01	51	--	NO	<SLs
Silver	135	0.068	0.123	2/135	3.90E+01	51	--	NO	<SLs
Sodium	135	42.3	430	75/135	--	--	--	NO	NUT
Thallium[f]	135	0.065	0.071	2/135	0.078	0.81	--	NO	<SLs
Vanadium	135	15.3	51.9	135/135	3.90E+01	71	--	YES	>SL
Zinc	135	38	386	135/135	2.30E+03	3040	--	NO	<SLs
Polychlorinated Biphenyls (PCBs) (mg/kg)									
Aroclor-1260	18	0.021 J	0.021 J	1/18	0.22	0.1	--	NO	<SLs
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)									
1-Methylnaphthalene	11	15 J	74	4/11	16,000	28000	76000	NO	<SLs
2-Methylnaphthalene	12	29	200	5/12	23,000	28000	75000	NO	<SLs
Acenaphthene	12	2.3 J	2.3 J	1/12	340,000	280000	--	NO	<SLs
Acenaphthylene	12	1.3 J	1.3 J	1/12	--	280000	--	NO	<SLs
Anthracene	12	2 J	2 J	1/12	1,700,000	2060000	--	NO	<SLs
Benzo(b)fluoranthene	12	10 J	10 J	1/12	150	490	--	NO	<SLs
Benzo(k)fluoranthene	12	10 J	10.0 J	1/12	1,500	4900	--	NO	<SLs
Fluorene	12	2.5 J	20	2/12	230,000	230000	--	NO	<SLs
Naphthalene	12	14 J	70	3/12	3,600	140000	2800	NO	<SLs
Phenanthrene	12	4.2 J	48	4/12	--	2060000	--	NO	<SLs
Pyrene	12	2.8 J	2.8 J	1/12	170,000	140000	--	NO	<SLs
Other Semivolatile Organic Compounds (SVOCs) (µg/kg)									
4-Bromophenyl Phenyl Ether	12	1.9 J	1.9 J	1/12	--	--	--	YES	NS

Table 6-1 Surface Soil (0 to 2 feet) Human Health Screening Results, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Soil Human Health Screening Levels				
					EPA RSL - Residential	ADEC - Direct Contact	ADEC - Outdoor Inhalation	COPC	Rationale[c]
4-Methylphenol	12	4.9 J	4.9 J	1/12	--	35000	--	NO	<SLs
Benzoic Acid	12	120 J	120 J	1/12	2.40E+07	31700000	--	NO	<SLs
Benzyl Alcohol	12	12 J	12 J	1/12	6.10E+05	--	--	NO	<SLs
Bis(2-Ethylhexyl)phthalate	12	11 J	220	8/12	35000	22000	--	NO	<SLs
Dibenzofuran	12	2.4 J	10 J	2/12	7800	20000	--	NO	<SLs
Diethylphthalate	12	8	140 B	2/12	4,900,000	6190000	--	NO	<SLs
Dimethylphthalate	12	160	160	1/12	--	77300000	--	NO	<SLs
Hexachlorobenzene	12	1.3 J	1.3 J	1/12	300	320	150	NO	<SLs
Pentachlorophenol	12	38 J	38 J	1/12	890	3900	--	NO	<SLs
Phenol	12	4.6 J	4.6 J	1/12	1,800,000	2320000	--	NO	<SLs

Key:
-- = not available or not applicable
µg/kg = micrograms per kilogram
COPC = contaminant of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
RSL = regional screening level
SVOCs = semivolatile organic compounds
Shading = Chemical is a selected as a COPC.

Notes:
a = Detected chemicals only are listed.
b = For metals, 127 original site samples and 8 field duplicate samples. For PCB, 16 original site samples and 2 field duplicates. For PAHs and SVOCs, 11 original site samples and 1 field duplicate.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = For conservative screening criteria, hexavalent chromium values for used.
e = RSL based on elemental mercury.

Table 6-2 Subsrface Soil (2 to 15 feet) Human Health Screening Results, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Soil Human Health Screening Levels				
					EPA RSL - Residential	ADEC - Direct Contact	ADEC - Outdoor Inhalation	COPC	Rationale[c]
Metals (mg/kg)									
Aluminum	192	1530	16800	192/192	7.70E+03	--	--	YES	>SL
Antimony	192	0.19 J	28900 J	192/192	3.1	4.1	--	YES	>SL
Arsenic	249	3.36 J	9530	249/249	0.039	0.45	--	YES	>SL
Inorganic Arsenic	12	10.7	7840	12/12	0.039	0.45	--	YES	>SL
Barium	192	61.1	1050	192/192	1.50E+03	2030	--	NO	<SLs
Beryllium	192	0.187	0.981	192/192	16	20	--	NO	<SLs
Cadmium	192	0.132 J	1.22 J	192/192	7	7.9	--	NO	<SLs
Calcium	192	768 J	117000 J	192/192	--	--	--	NO	NUT
Chromium[d]	192	8.18 J	59.6 J	192/192	2.90E-01	30	--	YES	>SL
Cobalt	192	5.5	34.4	192/192	2.3	--	--	YES	>SL
Copper	192	14.2 J	139 J	192/192	3.10E+02	410.0	--	NO	<SLs
Iron	192	14800	96500	192/192	5.50E+03	--	--	YES	>SL
Lead	192	0.027 J	396	192/192	400	40	--	YES	>SL
Magnesium	192	316 J	11300	192/192	--	--	--	NO	NUT
Manganese	192	102	2170	191/192	1.80E+02	--	--	YES	>SL
Mercury[e]	192	0.137	6110 J	192/192	1	3	2	YES	>SL
Nickel[f]	192	16.5	99.1	192/192	1.50E+02	200	--	NO	<SLs
Potassium	192	586	4580 J	192/192	--	--	--	NO	NUT
Selenium	192	0.04 J	6.07	192/192	3.90E+01	51	--	NO	<SLs
Silver	192	0.033	0.554 J	192/192	3.90E+01	51	--	NO	<SLs
Sodium	192	21.3	876 J	192/192	--	--	--	NO	NUT
Thallium[f]	192	0.051	1.54	192/192	0.078	0.81	--	YES	>SL
Vanadium	192	14.2	44.6 J	192/192	3.90E+01	71	--	YES	>SL
Zinc	192	39.8 J	461 J	192/192	2.30E+03	3040	--	NO	<SLs
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)									
2-Methylnaphthalene	13	12	1900	5/9	23,000	28000	75000	NO	<SLs
Acenaphthene	13	270 J	410	4/13	340,000	280000	--	NO	<SLs
Benzo(a)pyrene	13	9.4 J	9.4 J	1/13	15	490		NO	<SLs
Benzo(b)fluoranthene	13	1.3 J	7.2 J	3/13	150	4900	--	NO	<SLs
Benzo(g,h,i)perylene	13	10 J	10 J	1/13	--	1400000	--	NO	<SLs
Benzo(k)fluoranthene	13	3.7 J	3.7 J	1/13	1,500	4900	--	NO	<SLs
Chrysene	13	2.9 J	4.4 J	3/13	15,000	490000		NO	<SLs
Dibenz(a,h)anthracene	13	7.8 J	7.8 J	1/13	15	490	--	NO	<SLs
Fluorene	13	1.7 J	1400	9/13	230,000	230000	--	NO	<SLs
Indeno(1,2,3-cd)pyrene	13	11 J	11 J	1/13	150	4900	--	NO	<SLs
Naphthalene	13	8.3	3500	7/13	3,600	140000	2800	YES	>SL
Phenanthrene	13	1.9 J	1100	11/13	--	2060000	--	NO	<SLs

Table 6-2 Subsrface Soil (2 to 15 feet) Human Health Screening Results, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Soil Human Health Screening Levels				
					EPA RSL - Residential	ADEC - Direct Contact	ADEC - Outdoor Inhalation	COPC	Rationale[c]
Pyrene	13	1.7 J	1.8 J	2/13	170,000	140000	--	NO	<SLs
Other Semivolatile Organic Compounds (SVOCs) (µg/kg)									
4-Cholroaniline	13	8	8	1/13	2400	90000	--	NO	<SLs
Benzyl Alcohol	13	11 J	11 J	1/13	6.10E+05	--	--	NO	<SLs
Bis(2-Ethylhexyl)phthalate	13	10 J	10 J	1/13	35000	22000	--	NO	<SLs
Dibenzofuran	13	18 J	57 J	2/13	7800	20000	--	NO	<SLs
Diethylphthalate	13	1.7 J	1.7 J	1/13	4,900,000	6190000	--	NO	<SLs
N-Nitrosodiphenylamine	13	1.8 J	1.8 J	1/13	9,900	750000	--	NO	<SLs

Key:

-- = not available or not applicable
µg/kg = micrograms per kilogram
ADEC = Alaska Department of Environmental Conservation
COPC = contaminant of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
RSL = regional screening level
SVOCs = semivolatile organic compounds
Shading = Chemical is a selected as a COPC.

a = Detected chemicals only are listed.
b = For metals, 170 original site samples and 22 field duplicate samples. For PAHs and SVOCs, 11 original site samples and 2 field duplicates.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = For conservative screening criteria, hexavalent chromium values for used.
e = RSL based on elemental mercury.

Table 6-3 Sediment Human Health Screening Results for Red Devil Creek and Kuskokwim River Sediment, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Soil Human Health Screening Levels				
					EPA RSL - Residential	ADEC - Direct Contact	ADEC - Outdoor Inhalation	COPC	Rationale[c]
Metals (mg/kg)[g]									
Aluminum	45	710	18400	45/45	7.70E+03	--	--	YES	>SL
Antimony	45	0.237 J	6360 J	40/45	3.1	4.1	--	YES	>SL
Arsenic	50	0.57 J	130000	50/50	0.039	0.45	--	YES	>SL
Inorganic Arsenic	24	24.7 J	188000 J	24/24	0.039	0.45	--	YES	>SL
Barium	45	4.12	1990	45/45	1.50E+03	2030	--	YES	>SL
Beryllium	45	0.008 J	0.9	43/45	16	20	--	NO	<SLs
Cadmium	45	0.017 J	0.663 J	32/45	7	7.9	--	NO	<SLs
Calcium	45	1320	26300	45/45	--	--	--	NO	NUT
Chromium[d]	45	0.65 J	47.4 J	43/45	2.90E-01	30	--	YES	>SL
Cobalt	45	0.369	50	45/45	2.3	--	--	YES	>SL
Copper	45	0.68	87.5	45/45	3.10E+02	410.0	--	NO	<SLs
Iron	45	19600	344000	45/45	5.50E+03	--	--	YES	>SL
Lead	45	0.05	14.8	43/45	400	40	--	NO	<SLs
Magnesium	45	990	11400 J	45/45	--	--	--	NO	NUT
Manganese	45	404	5410	45/45	1.80E+02	--	--	YES	>SL
Mercury[e]	45	0.169 J	119 J	45/45	1	3	2	YES	>SL
Methylmercury	33	0.0001 J	0.0144	32/33	0.78	0.77	-	NO	<SLs
Nickel[f]	45	0.78	240 J	45/45	1.50E+02	200	--	YES	>SL
Potassium	45	510 J	2870 J	43/45	--	--	--	NO	NUT
Selenium	45	0.16 J	2.11	28/45	3.90E+01	51	--	NO	<SLs
Silver	45	0.04	0.41	29/45	3.90E+01	51	--	NO	<SLs
Sodium	45	21.1	270	39/45	--	--	--	NO	NUT
Thallium[f]	45	0.011 J	0.653	29/45	0.078	0.81	--	YES	>SL
Vanadium	45	1.72	48.5	43/45	3.90E+01	71	--	YES	>SL
Zinc	45	1.2 J	132 J	45/45	2.30E+03	3040	--	NO	<SLs
Polycyclic Aromatic Hydrocarbons (µg/kg)[g]									
Benzo(b)fluoranthene	2	1.5 J	1.5 J	1/2	1.50E+02	490	--	NO	<SLs
Phenanthrene	2	1.9 J	2.1 J	2/2	--	2060000	--	NO	<SLs
Other Semivolatile Organic Compounds (µg/kg)[g]									
Benzoic Acid	2	220	220	1/2	2.40E+07	31700000	--	NO	<SLs
Benzyl Alcohol	2	3.1 J	3.1 J	1/2	6.10E+02	--	--	NO	<SLs
Diethyl Phthalate	2	1.7 J	1.7 J	1/2	4.90E+06	6190	--	NO	<SLs
Di-n-butyl Phthalate	2	9 J	9 J	1/2	6.10E+06	7900000	--	NO	<SLs

Table 6-3 Sediment Human Health Screening Results for Red Devil Creek and Kuskokwim River Sediment, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Soil Human Health Screening Levels				
					EPA RSL - Residential	ADEC - Direct Contact	ADEC - Outdoor Inhalation	COPC	Rationale[c]
Pentachlorophenol	2	22 J	22 J	1/2	8.90E+02	3900	--	NO	<SLs
Phenol	2	4.1 J	4.1 J	1/2	1.80E+06	2320000	--	NO	<SLs

Key:
-- = not available or not applicable
µg/kg = micrograms per kilogram
ADEC = Alaska Department of Environmental Conservation
COPC = contaminant of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
SVOCs = semivolatile organic compounds
Shading = Chemical is a selected as a COPC.

Notes:
a = Detected chemicals only are listed.
b = For metals, 42 original site samples and 3 field duplicate samples. For PAHs and SVOCs, 2 original site samples.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = For conservative screening criteria, hexavalent chromium values for used.
e = RSL based on elemental mercury.
f = RSL based on soluble salt.
g = Units expressed on a dry weight basis.

Table 6-4 Groundwater Human Health Screening Results, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Groundwater Human Health Screening Levels			COPC	Rationale[c]
					EPA RSL - Tap Water	ADEC - Table C	EPA MCL		
Total Metals (µg/L)									
Aluminum	31	8.8 J	1460	26/31	1.60E+03	--	--	NO	<SLs
Antimony	31	0.6 J	13100	31/31	0.6	0.6	6	YES	>SL
Arsenic	31	1.3	6680	31/31	4.50E-02	1	10	YES	>SL
Inorganic Arsenic	22	0.17	4530	22/22	4.50E-02	1	10	YES	>SL
Barium	31	28.2	365	31/31	2.90E+02	200	2000	YES	>SL
Beryllium	31	0.006 J	0.11	18/31	1.6	0.4	4	NO	<SLs
Cadmium	31	0.008 J	0.224	28/31	0.69	0.5	5	NO	<SLs
Calcium	31	13200	96700	31/31	--	--	--	NO	NUT
Chromium[d]	31	0.05 J	10.6	26/31	3.10E-02	10	--	YES	>SL
Cobalt	31	0.045	40.5	30/31	0.47	--	--	YES	>SL
Copper	31	0.09 J	6.29	28/31	6.20E+01	100.0	1300	NO	<SLs
Iron	31	5.8 J	22400	28/31	1.10E+03	--	--	YES	>SL
Lead	31	0.019 J	2.02	26/31	--	1.5	15	YES	>SL
Magnesium	31	9800	71900	31/31	--	--	--	NO	NUT
Manganese	31	1.12	7370	30/31	3.20E+01	--	--	YES	>SL
Mercury[e]	31	0.00185	56.5	31/31	6.30E-02	0.2	2	YES	>SL
Methylmercury	31	0.00006 J	0.00171	27/31	0.16	0.37	--	NO	<SLs
Nickel[f]	31	0	35.9	31/31	3.00E+01	10	--	YES	>SL
Potassium	31	259 J	4930	30/31	--	--	--	NO	NUT
Selenium	31	0.3 J	5.4	11/31	7.80E+00	5	50	YES	>SL
Silver	31	0.004 J	0.049 J	21/31	7.10E+00	10	--	NO	<SLs
Sodium	31	1780	20000	31/31	--	--	--	NO	NUT
Thallium[f]	31	0.006 J	0.075	18/31	1.60E-02	0.20	2	YES	>SL
Vanadium	31	0.09 J	3.88	27/31	7.80E+00	26	--	NO	<SLs
Zinc	31	0.7	22	28/31	4.70E+02	500	--	NO	<SLs
Dissolved Metals (µg/L)									
Aluminum	32	2.1 J	140	22/32	1.60E+03	--	--	NO	<SLs
Antimony	32	0.317 J	13100	32/32	6.00E-01	1	6	YES	>SL
Arsenic	32	0.4	6660	32/32	4.50E-02	1	10	YES	>SL
Barium	32	23.3	348	32/32	2.90E+02	200	2000	YES	>SL
Beryllium	32	0.006 J	0.041	12/32	1.60E+00	0.4	4	NO	<SLs
Cadmium	32	0.006 J	0.3 J	26/32	6.90E-01	1	--	NO	<SLs
Calcium	32	7180	100000	32/32	--	--	--	NO	NUT
Chromium[d]	32	0.09 J	2.81	27/32	3.10E-02	10	--	YES	<SLs
Cobalt	32	0.037	41.5	31/32	4.70E-01	--	--	YES	>SL
Copper	32	0.08 J	1.8	29/32	6.20E+01	100	1300	NO	<SLs
Iron	32	3.4 J	19100	24/32	1.10E+03	--	--	YES	>SL
Lead	32	0.005 J	0.244	21/32	--	1.5	15	NO	<SLs
Magnesium	32	2900	73500	32/32	--	--	--	NO	NUT
Manganese	32	0.606	7050	31/32	3.20E+01	--	--	YES	>SL

Table 6-4 Groundwater Human Health Screening Results, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Groundwater Human Health Screening Levels			COPC	Rationale[c]
					EPA RSL - Tap Water	ADEC - Table C	EPA MCL		
Mercury[e]	32	0.00023 J	2.2	31/32	6.30E-02	0.2	2	YES	>SL
Nickel[f]	32	0.79	36.3	32/32	3.00E+01	10	--	YES	>SL
Potassium	32	211 J	4620	31/32	--	--	--	NO	NUT
Selenium	32	0.4 J	4.9	11/32	7.80E+00	5	50	NO	<SLs
Silver	32	0.004 J	0.013 J	3/32	7.10E+00	10	--	NO	<SLs
Sodium	32	1880	20000	32/32	--	--	--	NO	NUT
Thallium[f]	32	0.006 J	0.059	8/32	1.60E-02	0	2	YES	>SL
Vanadium	32	0.03 J	2.03	26/32	7.80E+00	26	--	NO	<SLs
Zinc	32	0.2 J	20.7	29/32	4.70E+02	500	--	NO	<SLs
Other Compounds (µg/L)									
Bis(2-ethylhexyl)phthalate	13	5.7 J	5.7 J	1/13	4.80E+00	0.6	--	YES	>SL
Toluene	5	0.09 J	1.8	3/15	8.60E+01	100	1000	NO	<SLs

Key:
-- = not available or not applicable
µg/L = micrograms per liter
ADEC = Alaska Department of Environmental Conservation
COPC = contaminant of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
MCL = maximum contaminant level
RSL = regional screening level
Shading = Chemical is a selected as a COPC.

Notes:
a = Detected chemicals only are listed.
b = For total metals, 31 original site samples and 2 field duplicate samples.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = RSL based on hexavalent chromium.
e = RSL based on elemental mercury.
f = RSL based on soluble salt.

Table 6-5 Surface Water Human Health Screening Results from Red Devil Creek, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Surface Water Human Health			COPC	Rationale[c]
					EPA RSL - Tap Water	ADEC - Table C	EPA MCL		
Total Metals (µg/L)									
Aluminum	22	6.5 J	30.9 J	13/22	1.60E+03	--	--	NO	<SLs
Antimony	22	1.3	184	22/22	0.6	0.6	6	YES	>SL
Arsenic	22	0.8	1030	22/22	4.50E-02	1	10	YES	>SL
Inorganic Arsenic	14	0.822	745	14/14	4.50E-02	1	--	YES	>SL
Barium	22	20.6	103	22/22	2.90E+02	200	2000	NO	<SLs
Beryllium	22	0.009 J	0.009 J	1/22	1.6	0.4	4	NO	<SLs
Cadmium	22	0.005 J	0.008 J	3/22	0.69	0.5	5	NO	<SLs
Calcium	22	8580	36000	22/22	--	--	--	NO	NUT
Chromium[d]	22	0.15 J	0.57	13/22	3.10E-02	10	--	YES	>SL
Cobalt	22	0.046	5.3	19/22	0.47	--	--	YES	>SL
Copper	22	0.28	0.71	14/22	6.20E+01	100.0	1300	NO	<SLs
Iron	22	118	2470	22/22	1.10E+03	--	--	YES	>SL
Lead	22	0.008 J	0.079	13/22	--	1.5	15	NO	<SLs
Magnesium	22	4460	37100	22/22	--	--	--	NO	NUT
Manganese	22	11.2	379	22/22	3.20E+01	--	--	YES	>SL
Mercury[e]	22	0.00192	0.385	22/22	6.30E-02	0.2	2	YES	>SL
Methylmercury	21	0.00008 J	0.00062	21/21	0.16	0.37	--	NO	>SL
Nickel[f]	22	0.39	19.2	19/22	3.00E+01	10	--	YES	>SL
Potassium	22	172	1210	13/22	--	--	--	NO	NUT
Selenium	22	0.3 J	0.5 J	9/22	7.80E+00	5	50	NO	<SLs
Silver	22	0.008 J	0.026	3/22	7.10E+00	10	--	NO	<SLs
Sodium	22	1440	12900	22/22	--	--	--	NO	NUT
Thallium[f]	22	0.007 J	0.01 J	2/22	1.60E-02	0.20	2	NO	<SLs
Vanadium	22	0.1 J	0.22 J	13/22	7.80E+00	26	--	NO	<SLs
Zinc	22	0.3 J	2.1	9/22	4.70E+02	500	--	NO	<SLs
Dissolved Metals (µg/L)									
Aluminum	21	3.5 J	19.7 J	12/21	1.60E+03	--	--	NO	<SLs
Antimony	21	1.2	185	21/21	6.00E-01	1	6	YES	>SL
Arsenic	21	0.8	857	21/21	4.50E-02	1	10	YES	>SL
Barium	21	20.7	99.5	21/21	2.90E+02	200	2000	NO	<SLs
Beryllium	21	0.012 J	0.012 J	1/21	1.60E+00	0.4	4	NO	<SLs
Calcium	21	16700	36000	21/21	--	--	--	NO	NUT
Chromium[d]	21	0.11 J	0.39	12/21	3.10E-02	10	--	YES	>SL
Cobalt	21	0.041	4.9	16/21	4.70E-01	--	--	YES	>SL
Copper	21	0.26	0.5	12/21	6.20E+01	100	1300	NO	<SLs
Iron	21	70	2180	21/21	1.10E+03	--	--	YES	>SL
Lead	21	0.005 J	0.037	7/21	--	1.5	15	NO	<SLs
Magnesium	21	8930	36400	21/21	--	--	--	NO	NUT
Manganese	21	8.2	380	21/21	3.20E+01	--	--	YES	>SL

Table 6-5 Surface Water Human Health Screening Results from Red Devil Creek, Red Devil Mine Site.

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Surface Water Human Health			COPC	Rationale[c]
					EPA RSL - Tap Water	ADEC - Table C	EPA MCL		
Mercury[e]	21	0.00213	0.0161	12/12	6.30E-02	0.2	2	NO	<SLs
Nickel[f]	21	0.32	17	18/21	3.00E+01	10	--	YES	>SL
Potassium	21	182 J	1170	13/21	--	--	--	NO	NUT
Selenium	21	0.3 J	0.6 J	8/21	7.80E+00	5	50	NO	<SLs
Silver	21	0.004 J	0.009 J	3/21	7.10E+00	10	--	NO	<SLs
Sodium	21	1430	13000	21/21	--	--	--	NO	NUT
Thallium[f]	21	0.006 J	0.006 J	1/21	1.60E-02	0	2	NO	<SLs
Vanadium	21	0.07 J	0.14 J	12/21	7.80E+00	26	--	NO	<SLs
Zinc	21	0.3 J	1	4/21	4.70E+02	500	--	NO	<SLs
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/L)									
1-Methylnaphthalene	8	1.5	1.5	1/8	9.70E-01	15	--	YES	>SL
2-Methylnapthalene	20	1.2 J	1.5	2/20	2.70E+00	15	--	NO	<SLs
Naphthalene	20	0.68 J	0.68 J	1/20	1.40E-01	73	--	YES	>SL

Key:

-- = not available or not applicable
µg/L = micrograms per liter
ADEC = Alaska Department of Environmental Conservation
COPC = contaminant of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
MCL = maximum contaminant level
PAHs = polycyclic aromatic hydrocarbons
RSL = Regional Screening Level
Shading = Chemical is a selected as a COPC.

Notes:

a = Detected chemicals only are listed.
b = For total metals, 21 original site samples and 2 field duplicate samples.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = RSL based on hexavalent chromium.
e = RSL based on elemental mercury.
f = RSL based on soluble salt.

Table 6-6 Final Compounds of Potentail Concern, Red Devil Mine Site

Analyte[a]	Surface Soils	Subsurface Soils	Sediment	Surface Water	Groundwater
Metals					
Aluminum	X	X	X	-	-
Antimony	X	X	X	X	X
Arsenic	X	X	X	X	X
Arsenic (Inorganic)	X	X	X	X	X
Barium	X	-	X		X
Cadmium	-	-	BIO	BIO	-
Chromium	X	X	X	X	X
Cobalt	X	X	X	X	X
Copper	-	-	BIO	BIO	-
Iron	X	X	X	X	X
Lead	X	X	BIO	BIO	X
Manganese	X	X	X	X	X
Mercury	X	X	X	X	X
Methylmercury	-	-	BIO	BIO	-
Nickel	-	-	X	X	X
Selenium	-	-	BIO	BIO	X
Silver	-	-	BIO	BIO	-
Thallium	-	X	X	-	X
Vanadium	X	X	X	-	-
Zinc	-	-	BIO	BIO	-
Other Semivolatile Organic Compounds (SVOCs)					
4-Bromophenyl phenyl ether	X	-	-	-	-
1-Methylnaphthalene	-	-	-	X	-
Naphthalene	-	X	-	X	-
Bis(2-ethylhexyl)phthalate	-	-	-	-	X

Key:

BIO	COPC based on bioaccumulative properties.
COPC	Contaminant of Potential Concern
SVOC	Semivolatile Organic Compound
X	COPC based on screening.

Table 6-7 Comparison of Exposure Unit Metal Concentrations in Soils

	Surface Mine Area (n=55)		Main Processing Area (n= 212)		Downstream Alluvial (n= 32)	
COPC	95% UCL	Maximum Concen-tration (mg/kg)	95% UCL	Maximum Concen-tration (mg/kg)	95% UCL	Maximum Concen-tration (mg/kg)
Aluminum	1.078E+04	2.03E+04	9.364E+03	2.170E+04	1.168E+04	1.730E+04
Antimony	5.009E+01	5.08E+02	4.516E+03	2.890E+04	7.986E+02	2.710E+03
Arsenic	2.090E+03	8.51E+03	2.978E+03	9.880E+03	1.408E+03	3.510E+03
Barium	1.910E+02	3.39E+02	3.790E+02	1.710E+03	2.027E+02	5.530E+02
Chromium	2.236E+01	3.20E+01	2.406E+01	1.010E+02	2.430E+01	3.110E+01
Cobalt	1.785E+01	3.88E+01	1.613E+01	3.500E+01	1.275E+01	1.900E+01
Iron	4.013E+04	6.64E+04	3.711E+04	6.610E+04	3.475E+04	9.650E+04
Lead	1.343E+01	3.20E+01	1.329E+02	3.090E+03	1.047E+01	2.150E+01
Manganese	8.959E+02	4.23E+03	7.279E+02	1.950E+03	4.689E+02	9.360E+02
Mercury	3.943E+01	3.26E+02	5.060E+02	6.110E+03	1.625E+02	4.710E+02
Thallium	2.000E-01	1.54E+00	1.740E-01	6.780E-01	1.920E-01	7.540E-01
Vanadium	3.559E+01	5.19E+01	2.980E+01	4.950E+01	3.547E+01	4.800E+01

Key:

COPC	contaminant of particular concern
mg/kg	milligrams per kilogram
UCL	Upper Confidence Limit

TABLE 6-8

SOIL EXPOSURE POINT CONCENTRATION SUMMARY - Resident (SMA)

RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Residential (SMA)

Contaminants of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Number	Reasonable Maximum Exposure			
					EPC Units	EPC Value	EPC Distribution	EPC Statistic
Aluminum	55	1.078E+04	2.03E+04	55	mg/kg	1.078E+04	Gamma	95% Approx. Gamma UCL
Antimony	55	5.009E+01	5.08E+02	36	mg/kg	5.009E+01	Gamma	95% KM (BCA) UCL
Arsenic	55	2.090E+03	8.51E+03	54	mg/kg	2.090E+03	Lognormal	97.5% KM (Chebyshev) UCL
Arsenic (inorganic)	17	5.659E+03	2.01E+04	17	mg/kg	5.659E+03	Gamma	95% Adjusted Gamma UCL
Barium	55	1.910E+02	3.39E+02	55	mg/kg	1.910E+02	Gamma	95% Approx. Gamma UCL
Chromium	55	2.236E+01	3.20E+01	55	mg/kg	2.236E+01	Normal	95% Student-t UCL
Cobalt	55	1.785E+01	3.88E+01	55	mg/kg	1.785E+01	Lognormal	95% Student-t UCL
Iron	55	4.013E+04	6.64E+04	55	mg/kg	4.013E+04	Gamma	95% Approx. Gamma UCL
Lead	55	1.343E+01	3.20E+01	55	mg/kg	1.343E+01	Gamma	95% Approx. Gamma UCL
Manganese	55	8.959E+02	4.23E+03	55	mg/kg	8.959E+02	Gamma	95% Approx. Gamma UCL
Mercury	55	3.943E+01	3.26E+02	55	mg/kg	3.943E+01	Gamma	95% Adjusted Gamma UCL
Thallium	55	2.000E-01	1.54E+00	19	mg/kg	2.000E-01	Non-Parametric	95% KM (t) UCL
Vanadium	55	3.559E+01	5.19E+01	55	mg/kg	3.559E+01	Normal	95% Student-t UCL

Key:

BCA = bias-corrected accelerated bootstrap method
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
mg/kg = milligrams per kilogram
SMA = Surface Mined Area
UCL = Upper Confidence Limit

TABLE 6-9
SOIL EXPOSURE POINT CONCENTRATION SUMMARY - Resident (MPA)
RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Residential (MPA)

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Number of Detections	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Aluminum	212	9.364E+03	2.170E+04	212	mg/kg	9.364E+03	Non-Parametric	95% Chebyshev UCL
Antimony	212	4.516E+03	2.890E+04	212	mg/kg	4.516E+03	Non-Parametric	95% Chebyshev UCL
Arsenic	212	2.978E+03	9.880E+03	212	mg/kg	2.978E+03	Non-Parametric	95% Chebyshev UCL
Arsenic (inorganic)	19	7.804E+03	1.330E+04	19	mg/kg	7.804E+03	Normal	95% Student-t UCL
Barium	212	3.790E+02	1.710E+03	212	mg/kg	3.790E+02	Non-Parametric	95% Chebyshev UCL
Chromium	212	2.406E+01	1.010E+02	212	mg/kg	2.406E+01	Non-Parametric	95% Student-t UCL
Cobalt	212	1.613E+01	3.500E+01	212	mg/kg	1.613E+01	Normal	95% Student-t UCL
Iron	212	3.711E+04	6.610E+04	212	mg/kg	3.711E+04	Normal	95% Student-t UCL
Lead	212	1.329E+02	3.090E+03	203	mg/kg	1.329E+02	Non-Parametric	97.5% KM (Chebyshev) UCL
Manganese	212	7.279E+02	1.950E+03	212	mg/kg	7.279E+02	Gamma	95% Approx. Gamma UCL
Mercury	212	5.060E+02	6.110E+03	212	mg/kg	5.060E+02	Non-Parametric	95% Chebyshev UCL
Thallium	212	1.740E-01	6.780E-01	133	mg/kg	1.740E-01	Non-Parametric	95% KM (BCA) UCL
Vanadium	212	2.980E+01	4.950E+01	212	mg/kg	2.980E+01	Non-Parametric	95% Student-t UCL
Naphthalene	22	5.047E+02	3.500E+03	9	µg/kg	5.047E+02	Gamma	95% KM (BCA) UCL

Key:

µg/kg = micrograms per kilogram
BCA = bias-corrected accelerated bootstrap method
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
mg/kg = milligrams per kilogram
MPA = Main Processing Area
NA = Not available
UCL = Upper Confidence Limit

TABLE 6-10
SOIL EXPOSURE POINT CONCENTRATION SUMMARY - Resident (DA)
RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Residential (DA)

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Number of Detections	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Aluminum	32	1.168E+04	1.730E+04	32	mg/kg	1.168E+04	Normal	95% Student-t UCL
Antimony	32	7.986E+02	2.710E+03	29	mg/kg	7.986E+02	Gamma	95% KM (Chebyshev) UCL
Arsenic	32	1.408E+03	3.510E+03	32	mg/kg	1.408E+03	Non-Parametric	97.5% Chebyshev UCL
Arsenic (inorganic)	6	3.405E+03	5.550E+03	6	mg/kg	3.405E+03	Normal	95% Student-t UCL
Barium	32	2.027E+02	5.530E+02	32	mg/kg	2.027E+02	Gamma	95% Approx. Gamma UCL
Chromium	32	2.430E+01	3.110E+01	32	mg/kg	2.430E+01	Normal	95% Student-t UCL
Cobalt	32	1.275E+01	1.900E+01	32	mg/kg	1.275E+01	Normal	95% Student-t UCL
Iron	32	3.475E+04	9.650E+04	32	mg/kg	3.475E+04	Non-Parametric	95% Student-t UCL
Lead	32	1.047E+01	2.150E+01	32	mg/kg	1.047E+01	Gamma	95% Approx. Gamma UCL
Manganese	32	4.689E+02	9.360E+02	31	mg/kg	4.689E+02	Gamma	95% KM (BCA) UCL
Mercury	32	1.625E+02	4.710E+02	32	mg/kg	1.625E+02	Lognormal	97.5% Chebyshev UCL
Thallium	32	1.920E-01	7.540E-01	22	mg/kg	1.920E-01	Non-Parametric	95% KM (BCA) UCL
Vanadium	32	3.547E+01	4.800E+01	32	mg/kg	3.547E+01	Normal	95% Student-t UCL

Key:

DA = Downstream Alluvial

EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
mg/kg = milligrams per kilogram
NA = Not available
UCL = Upper Confidence Limit

TABLE 6-11a

SOIL EXPOSURE POINT CONCENTRATION SUMMARY - Recreational/Subsistence User and Mine Worker

RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Recreationa/Subsistence and Mine Worker

						Reasonable Maximum Exposure		
Contaminant of Potential Concern	**Number of Samples**	**95% UCL**	**Maximum Detected Concen-tration**	**Number of Detections**	**EPC Units**	**EPC Value**	**EPC Distribution**	**EPC Statistics**
Aluminum	299	9.278E+03	2.170E+04	299	mg/kg	9.728E+03	Non-Parametric	95% Chebyshev UCL
Antimony	299	3.784E+03	2.890E+04	277	mg/kg	3.784E+03	Non-Parametric	97.5% KM (Chebyshev) UCL
Arsenic	299	2.615E+03	9.880E+03	298	mg/kg	2.615E+03	Non-Parametric	97.5% KM (Chebyshev) UCL
Arsenic (inorganic)	42	5.883E+03	2.010E+04	242	mg/kg	5.883E+03	Gamma	95% Approx. Gamma UCL
Barium	299	3.224E+02	1.710E+03	299	mg/kg	3.224E+02	Non-Parametric	95% Chebyshev UCL
Chromium	299	2.345E+01	1.010E+02	299	mg/kg	2.345E+01	Lognormal	95% Modified-t UCL
Cobalt	299	1.579E+01	3.880E+01	299	mg/kg	1.579E+01	Gamma	95% Approx. Gamma UCL
Iron	299	3.665E+04	9.650E+04	299	mg/kg	3.665E+04	Non-Parametric	95% Student-t UCL
Lead	299	7.761E+01	3.090E+03	290	mg/kg	7.761E+01	Non-Parametric	97.5% KM (Chebyshev) UCL
Manganese	299	7.186E+02	4.230E+03	298	mg/kg	7.186E+02	Gamma	95% KM (BCA) UCL
Mercury	299	3.728E+02	6.110E+03	299	mg/kg	3.728E+02	Non-Parametric	95% Chebyshev UCL
Thallium	299	1.710E-01	1.540E+00	174	mg/kg	1.710E-01	Non-Parametric	95% KM (t) UCL
Vanadium	299	3.110E+01	5.190E+01	299	mg/kg	3.110E+01	Non-Parametric	95% Student-t UCL
Naphthalene	22	5.047E+02	3.500E+03	9	µg/kg	5.047E+02	Gamma	95% KM (t) UCL

Key:

µg/kg = micrograms per kilogram
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
NA = Not available
UCL = Upper Confidence Limit

Table 6-11b Comparison of Exposure Point Concentrations for Surface and Subsurface Soil

Exposure Area	Sample Number	Antimony EPC (mg/kg)	Arsenic EPC (mg/kg)	Mercury EPC (mg/kg)
Main Processing Area				
Surface Soil	81	5221	4274	455.2
Subsurface Soil	131	4363	2591	1706
Combined	212	4516	2978	506
Surface Mined Area				
Surface Soil	36	126.6	1408	31.1
Subsurface Soil	19	37.2	3867	91
Combined	55	50.1	2090	39.4
Downstream Alluvial Area				
Surface Soil	10	552.3	2561	124.6
Subsurface Soil	22	1834	1653	303
Combined	32	798.6	1408	162.5
All Areas Combined				
Surface Soil	127	4234	3199	251.6
Subsurface Soil	172	3402	2140	1620
Combined	299	3784	2615	372.8

Key:
EPC = exposure point concentration
mg/kg = milligrams per kilogram

TABLE 6-12

SEDIMENT EXPOSURE POINT CONCENTRATION SUMMARY

RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Red Devil Creek and Near-Shore Kuskokwim River Sediments

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concentration	Number of Detections	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistics
Aluminum	25	1.082E+04	1.700E+04	25	mg/kg	1.082E+04	Normal	95% Student-t UCL
Antimony	25	4.455E+03	6.360E+03	20	mg/kg	4.455E+03	Non-Parametric	99% KM (Chebyshev) UCL
Arsenic	25	3.830E+04	1.300E+05	25	mg/kg	3.830E+04	Non-Parametric	97.5% KM (Chebyshev) UCL
Arsenic (Inorganic)	23	6.001E+04	1.880E+05	23	mg/kg	6.001E+04	Non-Parametric	97.5% KM (Chebyshev) UCL
Barium	25	6.806E+02	1.990E+03	25	mg/kg	6.806E+02	Non-Parametric	95% KM (Chebyshev) UCL
Cadmium	25	2.920E-01	6.000E-01	14	mg/kg	2.920E-01	Normal	95% KM (t) UCL
Chromium	25	2.574E+01	4.740E+01	24	mg/kg	2.574E+01	Normal	95% KM (t) UCL
Cobalt	25	1.711E+01	5.000E+01	25	mg/kg	1.711E+01	Gamma	95% Approx. Gamma UCL
Copper	25	3.716E+01	5.820E+01	25	mg/kg	3.716E+01	Gamma	95% Approx. Gamma UCL
Iron	25	9.919E+04	3.440E+05	25	mg/kg	9.919E+04	Non-Parametric	95% KM (Chebyshev) UCL
Lead	25	9.292E+00	1.400E+01	24	mg/kg	9.292E+00	Normal	95% KM (t) UCL
Manganese	25	2.015E+03	5.410E+03	25	mg/kg	2.015E+03	Non-Parametric	95% KM (Chebyshev) UCL
Mercury	25	6.659E+01	1.190E+02	25	mg/kg	6.659E+01	Non-Parametric	97.5% KM (Chebyshev) UCL
Methyl Mercury	25	5.228E-03	1.440E-02	24	mg/kg	5.228E-03	Lognormal	97.5% KM (Chebyshev) UCL
Nickel	25	5.697E+01	2.400E+02	25	mg/kg	5.697E+01	Gamma	95% Approx. Gamma UCL
Selenium	25	4.870E-01	6.200E-01	11	mg/kg	4.870E-01	Normal	95% KM (t) UCL
Silver	25	1.140E-01	2.290E-01	11	mg/kg	1.140E-01	Normal	95% KM (t) UCL
Thallium	25	1.490E-01	2.970E-01	11	mg/kg	1.490E-01	Gamma	95% KM (t) UCL
Vanadium	25	3.097E+01	4.850E+01	24	mg/kg	3.097E+01	Normal	95% KM (t) UCL
Zinc	25	9.161E+01	1.200E+02	25	mg/kg	9.161E+01	Normal	95% Student-t UCL

Key:

EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
mg/kg = milligrams per kilogram
NA = Not available
UCL = Upper Confidence Limit

TABLE 6-13

SURFACE WATER EXPOSURE POINT CONCENTRATION SUMMARY

RED DEVIL MINE

Scenario Timeframe: Current/Future

Medium: Red Devil Creek Surface Water (Total)

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Number of Detections	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Antimony	19	1.355E+02	1.840E+02	19	µg/L	1.355E+02	Gamma	95% Approx. Gamma UCL
Arsenic	19	8.113E+02	1.030E+03	17	µg/L	8.113E+02	Non-Parametric	99% KM (Chebyshev) UCL
Arsenic (Inorganic)	12	5.726E+02	7.450E+02	12	µg/L	5.726E+02	Gamma	95% Approx. Gamma UCL
Cadmium	19	--	8.000E-03	3	µg/L	8.000E-03	--	Maximum detection
Chromium	19	3.060E-01	5.700E-01	11	µg/L	3.060E-01	Normal	95% KM (t) UCL
Cobalt	19	3.039E+00	5.300E+00	16	µg/L	3.039E+00	Non-Parametric	97.5% KM (Chebyshev) UCL
Copper	19	4.310E-01	7.100E-01	12	µg/L	4.310E-01	Normal	95% KM (t) UCL
Iron	19	1.325E+03	2.470E+03	19	µg/L	1.325E+03	Non-Parametric	95% KM (Chebyshev) UCL
Lead	19	3.400E-02	7.900E-02	11	µg/L	3.400E-02	Gamma	95% KM (t) UCL
Manganese	19	1.706E+02	3.790E+02	19	µg/L	1.706E+02	Non-Parametric	95% KM (Chebyshev) UCL
Mercury	18	2.410E-01	3.850E-01	18	µg/L	2.410E-01	Gamma	95% Approx. Gamma UCL
Methyl Mercury	18	3.120E-04	6.200E-04	18	µg/L	3.120E-04	Non-Parametric	95% Chebyshev UCL
Nickel	19	1.054E+01	1.920E+01	16	µg/L	1.054E+01	Non-Parametric	97.5% KM (Chebyshev) UCL
Selenium	19	3.850E-01	5.000E-01	8	µg/L	3.850E-01	Normal	95% KM (t) UCL
Silver	19	--	2.600E-02	2	µg/L	2.600E-02	--	Maximum detection
Zinc	19	7.270E-01	2.100E+00	8	µg/L	7.270E-01	Non-Parametric	95% KM (t) UCL
1-Methylnaphthalene	7	--	1.500E+00	1	µg/L	1.500E+00	--	Maximum detection
Naphthalene	17	--	6.800E-01	1	µg/L	6.800E-01	--	Maximum detection

Key:

-- = Not calculated due to insufficient number of detected results.

µg/L = micrograms per liter

EPC= Exposure Point Concentration

KM = Kaplan-Meier (statistical evaluation)

NA = Not available

UCL = Upper Confidence Limit

TABLE 6-14
GROUNDWATER EXPOSURE POINT CONCENTRATION SUMMARY
RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Groundwater (Total)

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-trations	Number of Detections	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Antimony	29	5.609E+03	1.310E+04	29	µg/L	1.310E+04	Lognormal	Maximum detection
Arsenic	29	2.403E+03	6.680E+03	29	µg/L	6.680E+03	Normal	Maximum detection
Arsenic (Inorganic)	20	1.802E+03	4.530E+03	20	µg/L	4.530E+03	Lognormal	Maximum detection
Barium	29	1.006E+02	3.650E+02	29	µg/L	3.650E+02	Gamma	Maximum detection
Chromium	29	3.506E+00	1.060E+01	24	µg/L	1.060E+01	Gamma	Maximum detection
Cobalt	29	9.785E+00	4.050E+01	28	µg/L	4.050E+01	Gamma	Maximum detection
Iron	29	8.042E+03	2.240E+04	26	µg/L	2.240E+04	Gamma	Maximum detection
Lead	29	6.710E-01	2.020E+00	24	µg/L	2.020E+00	Gamma	Maximum detection
Manganese	29	2.243E+03	7.370E+03	28	µg/L	7.370E+03	Gamma	Maximum detection
Mercury	29	1.479E+01	5.650E+01	29	µg/L	5.650E+01	Lognormal	Maximum detection
Nickel	29	1.729E+01	3.590E+01	29	µg/L	3.590E+01	Gamma	Maximum detection
Selenium	29	9.170E-01	5.400E+00	10	µg/L	5.400E+00	Lognormal	Maximum detection
Thallium	29	1.710E-02	7.500E-02	18	µg/L	7.500E-02	Non-Parametric	Maximum detection
Bis(2-ethylhexyl)phthalate	11	--	5.700E+00	1	µg/L	5.700E+00	--	Maximum detection

Key:

-- = Not calculated due to insufficient number of detected results.
µg/L = microgram per liter
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
NA = Not available
UCL = Upper Confidence Limit

TABLE 6-15

SLIMY SCULPIN EXPOSURE POINT CONCENTRATION SUMMARY

RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Slimy Sculpin[1]

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Number of Detections	EPC	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Aluminum	45	2.670E+01	7.250E+01	45	mg/kg-wet	2.670E+01	Gamma	95% Approx. Gamma UCL
Antimony	21	1.706E+01	2.100E+01	21	mg/kg-wet	1.706E+01	Gamma	95% Approx. Gamma UCL
Arsenic (Inorganic)	12	1.923E+01	3.790E+01	12	mg/kg-wet	1.923E+01	Normal	95% Student-t UCL
Barium	45	6.060E+00	6.960E+00	44	mg/kg-wet	6.060E+00	Normal	95% Student-t UCL
Cadmium	45	4.200E-02	1.030E-01	29	mg/kg-wet	4.200E-02	Lognormal	95% KM (BCA) UCL
Chromium	45	1.990E-01	2.431E+00	21	mg/kg-wet	1.990E-01	Not Discernable	95% KM (t) UCL
Cobalt	--	--	--	--	--	--	--	--
Copper	45	1.238E+00	2.263E+00	45	mg/kg-wet	1.238E+00	Lognormal	95% Student-t UCL
Iron	45	1.203E+02	3.860E+02	45	mg/kg-wet	1.203E+02	Gamma	95% Approx. Gamma UCL
Lead	45	3.350E-02	7.900E-02	17	mg/kg-wet	3.350E-02	Gamma	95% KM UCL
Manganese	45	1.542E+01	4.070E+01	45	mg/kg-wet	1.542E+01	Lognormal	95% Student-t UCL
Methyl Mercury	7	2.070E-01	3.120E-01	7	mg/kg-wet	2.070E-01	Normal	95% Student-t UCL
Nickel	45	1.490E-01	5.030E-01	33	mg/kg-wet	1.490E-01	Gamma	95% Approx. Gamma UCL
Selenium	45	1.432E+00	2.975E+00	45	mg/kg-wet	1.432E+00	Gamma	95% Approx. Gamma UCL
Silver	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--
Vanadium	45	1.810E-01	4.330E-01	24	mg/kg-wet	1.810E-01	Normal	95% KM (t) UCL
Zinc	45	2.561E+01	3.537E+01	45	mg/kg-wet	2.561E+01	Normal	95% Student-t UCL

Key:

-- = Not calculated due to insufficient number of detected results.
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
mg/kg-wet = milligrams per kilogram wet weight

NA = Not available
UCL = Upper Confidence Limit

Notes:

1 - Whole fish samples.

TABLE 6-16

GREEN ALDER BARK EXPOSURE POINT CONCENTRATION SUMMARY

RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: Green Alder Bark

Contaminant of Particular Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Number of Detections	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Aluminum	8	1.587E+01	2.420E+01	8.000E+00	mg/kg	1.587E+01	Normal	95% Student-t UCL
Antimony	8	2.724E+00	3.350E+00	8.000E+00	mg/kg	2.724E+00	Gamma	95% Approx. Gamma UCL
Arsenic	8	5.320E-01	9.100E-01	8.000E+00	mg/kg	5.320E-01	Normal	95% Student-t UCL
Arsenic (inorganic)	--	--	--	--	--	--	NA	NA
Barium	8	1.552E+02	2.030E+02	8.000E+00	mg/kg	1.552E+02	Normal	95% Student-t UCL
Chromium	8	8.550E-01	1.400E+00	3.000E+00	mg/kg	8.550E-01	Normal	95% KM (t) UCL
Cobalt	8	3.350E-01	5.280E-01	8.000E+00	mg/kg	3.350E-01	Gamma	95% Approx. Gamma UCL
Iron	8	2.957E+01	3.490E+01	8.000E+00	mg/kg	2.957E+01	Normal	95% Student-t UCL
Lead	8	1.020E-01	1.130E-01	8.000E+00	mg/kg	1.020E-01	Normal	95% Student-t UCL
Manganese	8	7.149E+02	1.140E+03	8.000E+00	mg/kg	7.149E+02	Normal	95% Student-t UCL
Mercury	8	2.100E-01	2.890E-01	8.000E+00	mg/kg	2.100E-01	Normal	95% Student-t UCL
Thallium	8	1.620E-02	3.000E-02	4.000E+00	mg/kg	1.620E-02	Normal	95% Student-t UCL
Vanadium	8	6.450E-02	7.000E-02	8.000E+00	mg/kg	6.450E-02	Normal	95% KM (t) UCL

Key:

-- = Not calculated due to insufficient number of detected results.
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
NA = Not available
UCL = Upper Confidence Limit

TABLE 6-17

WHITE SPRUCE NEEDLES EXPOSURE POINT CONCENTRATION SUMMARY

RED DEVIL MINE

Scenario Timeframe: Current/Future
Medium: White Spruce Needles

Contaminant of Potential Concern	Number of Samples	95% UCL	Maximum Detected Concen-tration	Frequency of Detection	EPC Units	Reasonable Maximum Exposure		
						EPC Value	EPC Distribution	EPC Statistic
Aluminum	8	1.295E+02	1.720E+02	7	mg/kg	1.295E+02	Gamma	95% KM (Chebyshev) UCL
Antimony	8	1.032E+01	1.510E+01	8	mg/kg	1.032E+01	Lognormal	95% KM (Chebyshev) UCL
Arsenic	8	7.577E+00	1.110E+01	8	mg/kg	7.577E+00	Lognormal	95% KM (Chebyshev) UCL
Arsenic (inorganic)	--	NA	NA	--		NA	NA	NA
Barium	8	5.988E+01	8.530E+01	8	mg/kg	5.988E+01	Normal	95% Student-t UCL
Chromium	7	9.190E-01	1.300E+00	4	mg/kg	9.190E-01	Normal	95% KM (t) UCL
Cobalt	8	2.330E-01	3.030E-01	8	mg/kg	2.330E-01	Normal	95% Student-t UCL
Iron	8	1.972E+02	2.060E+02	8	mg/kg	1.972E+02	Non-Parametric	95% KM (Chebyshev) UCL
Lead	8	3.350E-01	4.660E-01	8	mg/kg	3.350E-01	Lognormal	95% KM (Chebyshev) UCL
Manganese	8	1.904E+03	2.990E+03	8	mg/kg	1.904E+03	Gamma	95% Approx. Gamma UCL
Mercury	8	5.694E+00	5.640E+00	8	mg/kg	5.640E+00	Gamma	Maximum, 95%UCL > Max
Thallium	8	--	2.100E-02	2	mg/kg	2.100E-02	Non-Parametric	Maximum, only 2 detections
Vanadium	8	9.920E-01	4.700E-01	5	mg/kg	4.700E-01	Non-Parametric	Maximum, 95%UCL > Max

Key:

-- = Not calculated due to insufficient number of detected results.
EPC= Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

Table 6-18 Dermal Chemical Specific Values

Compound of Potential Concern	ABSd Value	Kp (cm/hr)
Metals		
Aluminum	NA	1.00E-03
Antimony	NA	1.00E-03
Arsenic	0.03	1.00E-03
Arsenic (Inorganic)	0.03	1.00E-03
Barium	NA	1.00E-03
Cadmium	0.001	1.00E-03
Chromium (Hexavalent)	NA	2.00E-03
Cobalt	NA	4.00E-04
Copper	NA	1.00E-03
Iron	NA	1.00E-03
Manganese	NA	1.00E-03
Mercury	NA	1.00E-03
Nickel	NA	2.00E-04
Selenium	NA	1.00E-03
Silver	NA	6.00E-04
Thallium	NA	1.00E-03
Vanadium	NA	1.00E-03
Zinc	NA	6.00E-04
Organometals		
Methyl mercury	NA	1.00E-03
Polycyclic Aromatic Hydrocarbons (PAHs)		
1-Methylnaphthalene	0.13	--
Naphthalene	0.13	4.70E-02
Semivolatile Organic Compounds (SVOCs)		
Bis(2-Ethylhexyl)phthalate	0.1	--

Key:
ABSd = Dermal Absorption Fraction, from RAGS Part E (EPA 2004)
cm/hr = centimeters per hour
Kp = Dermal permeability coefficient of compound in water (cm/hr), from RAGS Part E (EPA 2004).
NA = Not available

Table 6-19a Calculation of COPC Intake from Soil Ingestion

A. Intake Equation[1]:

$$Intake(mg/kg/day) = \frac{C_s\ x\ IR\ x\ CF\ x\ EF\ x\ ED}{BW\ x\ AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_s	Chemical-specific			mg/kg	Concentration of COPC in soil calculated using the 95% UCL
IR_a	100	100	100	mg/day	Adult soil ingestion rate (ADEC 2010, EPA 2002b)
IR_c	200	200	–	mg/day	Child soil ingestion rate (ADEC 2010)
CF	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	kg/mg	Unit correction factor
EF_a	270	90	250	day/year	Adult residential user exposure frequency (ADEC 2010, EPA 2002b)
EF_c	270	90	–	day/year	Child residential exposure frequency (ADEC 2010)
ED_a	30/54[2]	30/54[2]	25	years	Adult exposure duration (ADEC 2010; EPA 1997a, 2002b; Kissinger 2013)
ED_c	6	6	–	years	Child exposure duration (ADEC 2010, EPA 2002b)
BW_a	70	70	70	kg	Adult body weight (ADEC 2010, EPA 1989, EPA 2002b)
BW_c	15	15	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key:

ADEC	Alaska Department of Environmental Conservation
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
kg	kilogram
kg/mg	kilograms to milligrams
mg/kg	milligrams per kilogram
UCL	upper confidence limit

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19b Calculation of COPC Intake from Dermal Soil Contact

A. Intake Equation[1]:

$$DAD\,(mg/kg/day) = \frac{C_s \; x \; SA \; x \; AF \; x \; ABS \; x \; CF \; x \; EF \; x \; ED \times EV}{BW \; x \; AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Citation	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_s	Chemical-specific			mg/kg	Concentration of COPC in soil calculated using the 95% UCL
SA_a	5,700	5,700	3,300	cm^2	Adult exposed body surface area (ADEC 2010, EPA 2004)
SA_c	2,800	2,800	–	cm^2	Child exposed body surface area (ADEC 2010)
CF	1 x 10^{-6}			kg/mg	Conversion factor
AF_a	0.07	0.07	0.2	mg/cm^2	Adult skin adherence factor (ADEC 2010, EPA 2004)
AF_c	0.2	0.2	–	mg/cm^2	Child skin adherence factor (ADEC 2010, EPA 2004)
ABS	Chemical-specific			Unitless	Dermal absorption fraction (Obtained from Table 6-18)
EF_a	270	90	250	day/year	Adult exposure frequency (ADEC 2010, EPA 2002b)
EF_c	270	90	–	day/year	Child exposure frequency (ADEC 2010, EPA 2002b)
ED_a	30/54[2]	30/54[2]	25	Years	Adult exposure duration (ADEC 2010, EPA 1997a, EPA 2002b, Kissinger 2013)
ED_c	6	6	–	Years	Child exposure duration (ADEC 2010, EPA 2002b)
EV	1	1	1	events/day	Events frequency
BW_a	70	70	70	Kg	Adult body weight (ADEC 2010, EPA 1989, EPA 2002b)
BW_c	15	15	–	Kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			Days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			Days	Averaging time – noncarcinogens (EPA 1989)

Key to Table 6-19b :

ADEC	Alaska Department of Environmental Conservation
cm^2	square centimeter
COPC	contaminant of potential concern
CT	average or central tendency case
DAD	Dermally Absorbed Dose
EPA	U.S. Environmental Protection Agency
kg	kilogram
kg/mg	kilograms to milligrams
mg/cm^2	milligrams per square centimeter
mg/kg	milligrams per kilogram
UCL	upper confidence limit

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19c Calculation of COPC Intake from Dermal Sediment Contact

A. Intake Equation[1]:

$$DAD(mg/kg/day) = \frac{C_s \ x\ SA\ x\ AF\ x\ ABS\ x\ CF\ x\ EF\ x\ ED \times EV}{BW\ x\ AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Citation	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_s	Chemical-specific			mg/kg	Concentration of COPC in sediment calculated using the 95% UCL
SA_a	5,700	5,700	3,300	cm^2	Adult exposed body surface area (ADEC 2010, EPA 2004)
SA_c	2,800	2,800	–	cm^2	Child exposed body surface area (ADEC 2010)
CF	1×10^{-6}			kg/mg	Conversion factor
AF_a	0.07	0.07	0.2	mg/cm^2	Adult skin adherence factor (ADEC 2010, EPA 2004)
AF_c	0.2	0.2	–	mg/cm^2	Child skin adherence factor (ADEC 2010, EPA 2004)
ABS	Chemical-specific			unitless	Dermal absorption fraction (Obtained from Table 6-18)
EF_a	90	90	90	day/year	Adult exposure frequency (ADEC 2010, EPA 2002b)
EF_c	90	90	–	day/year	Child exposure frequency (ADEC 2010, EPA 2002b)
ED_a	30/54[2]	30/54[2]	25	years	Adult exposure duration (ADEC 2010, EPA 1997a, EPA 2002b, Kissinger 2013)
ED_c	6	6	–	years	Child exposure duration (ADEC 2010, EPA 2002b)
EV	1	1	1	events/day	Event frequency
BW_a	70	70	70	kg	Adult body weight (ADEC 2010, EPA 1989, EPA 2002b)
BW_c	15	15	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key to Table 6-19c:

ADEC	Alaska Department of Environmental Conservation
cm^2	square centimeters
COPC	contaminant of potential concern
CT	average or central tendency case
DAD	Dermally Absorbed Dose
EPA	U.S. Environmental Protection Agency
kg	kilogram
kg/mg	kilograms to milligrams
mg/cm^2	milligrams per square centimeter
mg/kg	milligrams per kilogram
UCL	upper confidence limit

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19d Calculation of COPC Intake from Groundwater Ingestion

A. Intake Equation[1]**:**

$$Intake(mg/kg/day) = \frac{C_w \ x \ IR \ x \ EF \ x \ ED \times CF}{BW \ x \ AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_w	Chemical-specific			µg/L	Concentration of COPC in groundwater calculated using the maximum concentration or 95% UCL
IR_a	2	–	2	liters/day	Adult drinking water ingestion rate (ADEC 2010)
IR_c	1	–	–	liters/day	Child drinking water ingestion rate (EPA 2008c)
EF_a	350	–	250	day/year	Adult exposure frequency (ADEC 2010, EPA 2002b)
EF_c	350	–	–	day/year	Child exposure frequency (ADEC 2010)
ED_a	30/54[2]	–	25	years	Adult exposure duration (ADEC 2010, EPA 2002b, Kissinger 2013)
ED_c	6	–	–	years	Child exposure duration (ADEC 2010, EPA 1989, EPA 2002b)
CF	1×10^{-3}			mg/µg	Conversion factor
BW_a	70	–	70	kg	Adult body weight (ADEC 2010, EPA 2002b)
BW_c	15	–	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key:

ADEC	Alaska Department of Environmental Conservation
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
kg	kilogram
mg/µg	milligrams to micrograms
µg/L	micrograms per liter
UCL	upper confidence limit

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19e Calculation of COPC Intake from Dermal Groundwater Contact

A. Intake Equation[1]:

$$DAD(mg/kg/day) = \frac{DAevent\ x\ EV\ x\ ED\ x\ EF\ x\ SA}{BW\ x\ AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
DA_{event}	Chemical- and event-specific			mg/cm^2-event	Absorbed dose per event; calculated as described in Section 6.2.3.3.
SA_a	18,000	–	18,000	cm^2	Adult exposed body surface area (EPA 2004)
SA_c	6,600	–	–	cm^2	Child exposed body surface area (EPA 2004)
EV_a	1	–	1	events/day	Adult event frequency (EPA 2004)
EV_c	1	–	–	events/day	Child event frequency (EPA 2004)
EF_a	350	–	250	day/year	Adult exposure frequency (ADEC 2010, EPA 2002b)
EF_c	350	–	–	day/year	Child exposure frequency (ADEC 2010)
ED_a	30/54[2]	–	25	years	Adult exposure duration (ADEC 2010, EPA 2002b, Kissinger 2013)
ED_c	6	–	–	years	Child exposure duration (ADEC 2010, EPA 1989, EPA 2002b)
BW_a	70	–	70	kg	Adult body weight (ADEC 2010, EPA 2002b)
BW_c	15	–	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key:

ADEC	Alaska Department of Environmental Conservation
cm^2	square centimeter
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
DAD	Dermally Absorbed Dose
kg	kilogram
mg/cm^2-event	milligrams per square centimeter per event

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19f Calculation of COPC Intake from Surface Water Ingestion

A. Intake Equation[1]:

$$Intake(mg/kg/day) = \frac{C_w \; x \; IR \; x \; EF \; x \; ED}{BW \; x \; AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_w	Chemical-specific			mg/L	Concentration of COPC in sediment calculated using the 95% UCL
IR_a	–	2	–	L/day	Adult drinking water ingestion rate (ADEC 2010)
IR_c	–	1	–	L/day	Child drinking water ingestion rate (EPA 2008b)
EF_a	–	20	–	day/year	Adult exposure frequency
EF_c	–	20	–	day/year	Child exposure frequency
ED_a	–	30/54[2]	–	years	Adult exposure duration (ADEC 2010, EPA 2002b, Kissinger 2013)
ED_c	–	6	–	years	Child exposure duration (ADEC 2010, EPA 1989, EPA 2002b)
BW_a	–	70	–	kg	Adult body weight (ADEC 2010, EPA 2002b)
BW_c	–	15	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key:

ADEC	Alaska Department of Environmental Conservation
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
L/day	liters per day
mg/L	milligrams per liter
UCL	upper confidence limit

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19g Calculation of COPC Intake from Dermal Surface Water Contact

A. Intake Equation[1]:

$$DAD(mg/kg/day) = \frac{DAevent\ x\ EV\ x\ ED\ x\ EF\ x\ SA}{BW\ x\ AT}$$

B. Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
DA_{event}	Chemical- and event-specific			mg/cm^2-event	Absorbed dose per event calculated as described in Section 6.2.3.3.
SA_a	5,700	5,700	5,700	cm^2	Adult exposed body surface area (ADEC 2010, EPA 2004)
SA_c	2,800	2,800	–	cm^2	Child exposed body surface area (ADEC 2010)
EV_a	1	1	1	events/day	Adult event frequency (EPA 2004)
EV_c	1	1	–	events/day	Child event frequency (EPA 2004)
EF_a	60	20	40	day/year	Adult exposure frequency (site-specific)
EF_c	60	20	–	day/year	Child exposure frequency (site-specific)
ED_a	30/54[2]	30/54[2]	25	years	Adult exposure duration (ADEC 2010, EPA 2002b, Kissinger 2013)
ED_c	6	6	–	years	Child exposure duration (ADEC 2010; EPA 1989, 2002b)
BW_a	70	70	70	kg	Adult body weight (ADEC 2010, EPA 2002b)
BW_c	15	15	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key:

ADEC	Alaska Department of Environmental Conservation
cm^2	centimeter
COPC	contaminant of potential concern
DAD	Dermally Absorbed Dose
EPA	U.S. Environmental Protection Agency
kg	kilogram
mg/cm^2-event	milligrams per square centimeter per event

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.

2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19h Calculation of COPC Intake from Soil Inhalation Exposure

A. Intake Equation[1]:

$$EC\,(mg/m^3) = \frac{C_a \ x\ ET\ x\ EF\ x\ ED}{AT}$$

B. Variables and Assumptions:

Variable	Exposure Case			Units	Description/Citation
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_a	Chemical-specific			mg/m^3	Concentration of COPC in air; modeled concentration
ET_a	24	24	8	hours/day	Adult exposure time (EPA 2009c)
ET_c	24	24	-	hours/day	Child exposure time (EPA 2009c)
EF_a	270	90	250	day/year	Adult residential user exposure frequency (ADEC 2009, EPA 2002b)
EF_c	270	90	-	day/year	Child residential exposure frequency (ADEC 2010)
ED_a	30/54[2]	30/54[2]	25	years	Adult exposure duration (ADEC 2010; EPA 1997a, 2002b, Kissinger 2013)
ED_c	6	6	-	years	Child exposure duration (ADEC 2010, EPA 2002b)
AT_c	25,550 x 24			hours	Averaging time – carcinogens (EPA 2009c)
AT_{nc}	ED x 365 x 24			hours	Averaging time – noncarcinogens (EPA 2009c)

Key:

ADEC	Alaska Department of Environmental Conservation
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
mg/m^3	milligrams per cubic meter

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19i Calculation of COPC Intake from Groundwater Inhalation Exposure

A. Intake Equation[1]:

$$EC\,(mg/m^3) = \frac{C_a \; x \; ET \; x \, EF \; x \; ED}{AT}$$

B. Variables and Assumptions:

Variable	Exposure Case			Units	Description/Citation
	Future Residential	Recreational/ Subsistence User	Mine Worker		
C_a	Chemical-specific			mg/m^3	Concentration of COPC in air; modeled concentration
ET_a	0.75	-	-	hours/day	Adult exposure time (EPA 2009c)
ET_c	0.75	-	-	hours/day	Child exposure time (EPA 2009c)
EF_a	350	-	-	day/year	Adult exposure frequency (ADEC 2010, EPA 2002b)
EF_c	350	-	-	day/year	Child exposure frequency (ADEC 2010)
ED_a	30/54[2]	-	-	years	Adult exposure duration (ADEC 2010; EPA 1997a, 2002b, Kissinger 2013)
ED_c	6	-	-	years	Child exposure duration (ADEC 2010, EPA 2002b)
AT_c	25,550 x 24			hours	Averaging time – carcinogens (EPA 2009c)
AT_{nc}	ED x 365 x 24			hours	Averaging time – noncarcinogens (EPA 2009c)

Key:

ADEC	Alaska Department of Environmental Conservation
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
mg/m^3	milligrams per cubic meter

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.
2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-19j Calculation of COPC Intake from Subsistence Food Ingestion

A. Intake Equation[1]:

$$Intake(mg/kg/day) = \frac{Cfi\ x\ IR\ x\ FI\ x\ EF\ x\ ED}{BW\ x\ AT}$$

B: Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
Cf_i	Chemical-specific			mg/kg	Modeled concentration of COPC in subsistence foods (separate for whitefish, moose, beaver, grouse and blueberries)
$IR_{a\ (whitefish)}$	0.271	0.271	0.271	kg/day	Adult ingestion rate of non-salmon fish (whitefish) based on the 95th percentile use estimates from Red Devil (Brown et al. 2012)
$IR_{c\ (whitefish)}$	0.130	0.130	–	kg/day	Child ingestion rate of non-salmon fish (whitefish)
$FI_{(whitefish)}$	1	0.2	0.2	unitless	Fraction ingested from contaminated source at RDM site for non-salmon fish (whitefish)
$IR_{a\ (moose)}$	0.076	0.076	0.076	kg/day	Adult ingestion rate of large land mammals (moose) based on the mean harvest rate from Red Devil (ADF&G 2003)
$IR_{c\ (moose)}$	0.036	0.036	–	kg/day	Child ingestion rate of large land mammals (moose)
$FI_{(moose)}$	1	0.014	0.014	unitless	Fraction ingested from contaminated source at RDM site for large land mammals (moose)
$IR_{a\ (beaver)}$	0.037	0.037	0.037	kg/day	Adult ingestion rate of small land mammals (beaver) based on the 95th percentile use estimates from Red Devil (Brown et al. 2012)
$IR_{c\ (beaver)}$	0.018	0.018	–	kg/day	Child ingestion rate of small land mammals (beaver)
$FI_{(beaver)}$	1	0.02	0.02	unitless	Fraction ingested from contaminated source at RDM site for small land mammals (beaver)
$IR_{a\ (grouse)}$	0.011	0.011	0.011	kg/day	Adult ingestion rate of birds (grouse) based on the 95th percentile use estimates from Red Devil (Brown et al. 2012)
$IR_{c\ (grouse)}$	0.005	0.005	–	kg/day	Child ingestion rate of birds (grouse)
$FI_{(grouse)}$	1	0.33	0.33	unitless	Fraction ingested from contaminated source at RDM site for birds (grouse)
$IR_{a\ (blueberries)}$	0.014	0.014	0.014	kg/day	Adult ingestion rate of berries and plants (blueberries) based on the 95th percentile use estimates from Red Devil (Brown et al. 2012)

Table 6-19j Calculation of COPC Intake from Subsistence Food Ingestion

A. Intake Equation[1]:

$$Intake(mg/kg/day) = \frac{Cfi\ x\ IR\ x\ FI\ x\ EF\ x\ ED}{BW\ x\ AT}$$

B: Variables and Assumptions:

Variables	Exposure Case			Units	Description/Source
	Future Residential	Recreational/ Subsistence User	Mine Worker		
$IR_{c\ (blueberries)}$	0.007	0.007	–	kg/day	Child ingestion rate of berries and plants (blueberries)
$FI_{(blueberries)}$	1	0.10	0.10	unitless	Fraction ingested from contaminated source at RDM site for berries and plants (blueberries)
EF_a	365	365	250	day/year	Adult residential user exposure frequency (ADEC 2010, EPA 2002b)
EF_c	365	365	–	day/year	Child residential exposure frequency (ADEC 2010)
ED_a	30/54[2]	30/54[2]	25	years	Adult exposure duration (ADEC 2010; EPA 1997a, 2002b, Kissinger 2013)
ED_c	6	6	–	years	Child exposure duration (ADEC 2010, EPA 2002b)
BW_a	70	70	70	kg	Adult body weight (ADEC 2010; EPA 1989, 2002b)
BW_c	15	15	–	kg	Child body weight (ADEC 2010, EPA 2002b)
AT_c	25,550			days	Averaging time – carcinogens (EPA 1989)
AT_{nc}	ED x 365			days	Averaging time – noncarcinogens (EPA 1989)

Key:

ADEC	Alaska Department of Environmental Conservation
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
kg/day	kilograms per day
mg/kg	milligrams per kilogram

Notes:

1. For carcinogens, intake for the residential and recreational/subsistence user scenarios will be calculated as an aggregate of child and adult exposure, as described in Section 6.2.3.3.

2. An ED=30 years will be used to calculate the intake for non-carcinogens. An ED=54 years will be used to calculate the lifetime average daily intake (LADI) for carcinogens, as described in Section 6.2.3.4.3.

Table 6-20 Available Harvest Rates, Pre-2012

Food Source	Ballew et al. (2004) – Median (g/day)	IDM (1997) - 50th Percentile Harvest (g/day)	IDM (1997) - 95th Percentile Harvest (g/day)	EFH (2011) (g/day)
Salmon	68	76.8	967.9	NA
Non-Salmon Fish	16	27.8	149.6	NA
Large Land Mammal	47	76.1	199.5	NA
Berries	21	NA	NA	18.2
Birds	5	NA	NA	NA

Key:
EFH = Exposure Factors Handbook
g/day = grams per day
NA = Not available

Table 6-21 Native American Fish Ingestion Rates

	Ingestion Rates (g/day) [1]				
	Wolfe and Walker (1987)	Toy et al. (1996) – Tulalip	Toy et al. (1996) – Squaxin	Duncan (2000) – Suquamish	IDM (1997) – Subarctic Interior[2]
95th Percentile					
Adult	NA	203	210	700	1117.5
Child	NA	10.5	31.5	109.5	NA
Mean					
Adult	81[3]	63	63	189	104.6
Child	NA	3	12	22.5	NA

Notes:
1 – Body weight adjusted, if needed, at 70 kg for adult and 15 kg for child
2 – Sum of salmon and non-salmon harvest rate for 50th (mean) and 95th percentile
3 - Represents median value
Key:
NA = Not available

Table 6-22 Comparison of Harvest Rates for Alaska Department of Fish and Game Surveyed Communities

		Red Devil	Sleetmute	Stony River	Crooked Creek	Aniak	Chuathbaluk	Lower Kalskag	Upper Kalskag
Category	Type	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)	ADF&G 2012 - Use 95th percentile (grams/day)
Fish	Non-Salmon	271.81	118.06	230.28	86.68	36.63	48.35	84.69	111.15
Large Land Mammal		27.36	335.3	161.44	124.19	74.51	63.17	223.54	74.51
Small Land Mammal		37.26	60.29	91.28	15.97	21.75	29.18	7.76	9.31
Birds	Spruce Grouse	8.69	8.69	9.78	2.17	2.9	2.17	1.74	2.61
	Ruffed Grouse	2.17	4.89	4.35	1.74	2.53	2.61	1.79	1.74
	Ptarmigan	0	4.97	1.24	1.24	6.31	1.24	2.48	3.1
Plants	Blueberry	4.3	5.21	9.93	8.28	6.21	12.42	12.42	33.32
	Lowbush Cranberry	9.03	13.91	8.28	2.48	4.97	9.93	2.84	11.69
	Crowberry	12.42	8.94	16.56	14.9	3.73	16.73	14.9	24.84

Key:

Shading = highest of 95th percentile use values

ADF&G = Alaska Department of Fish and Game

Source:

Koster, David. 2012. E-mail from David Koster, Alaska Department of Fish and Game regarding Analysis of Kuskokwim Village Harvest Data. March 15, 2012.

Table 6-23 95th Percentile Use Estimates for Wild Food Ingestion Rates

Food Source Category	Indicator Species	Key Study, Community	Adult IR (kg/day)
Non-Salmon Fish	Whitefish	ADF&G 2012 Red Devil	0.271
Large Land Mammal	Moose	ADF&G 2003 Red Devil	0.076[1]
Small Land Mammals	Beaver	ADF&G 2012 Red Devil	0.037
Birds	Grouse	ADF&G 2012 Red Devil	0.011
Berries and Plants	Blueberry	ADF&G 2012 Red Devil	0.014

Key:

ADF&G	Alaska Department of Fish and Game
IR	Ingestion Rate
kg/day	kilograms per day

Table 6-24a Comparison of Modeled and Actual Game Fish Concentrations

COPC	Game Fish Modeled EPC			Reach C Northern Pike - Muscle					Reach C Northern Pike - Liver				
	n	95% UCL	Units	n	Min	Max	95% UCL	Units	n	Min	Max	95% UCL	Units
Antimony	21	17.06	mg/kg-wet	17	ND	ND	ND	mg/kg-wet	17	ND	ND	ND	mg/kg-wet
Arsenic	45	12.98	mg/kg-wet	17	0.059	1.025	0.626	mg/kg-wet	17	0.032	0.446	0.195	mg/kg-wet
Arsenic (Inorganic)	12	19.23	mg/kg-wet	NA	NA	NA	NA	mg/kg-wet	NA	NA	NA	NA	mg/kg-wet
Mercury	45	1.39	mg/kg-wet	17	0.060	0.609	0.371	mg/kg-wet	17	0.050	0.414	0.186	mg/kg-wet
Methyl-mercury	7	0.21	mg/kg-wet	NA	NA	NA	NA	mg/kg-wet	NA	NA	NA	NA	mg/kg-wet

Key:

95% UCL	95 percent upper confidence limit on the mean	Min	minimum detected concentration
COPC	contaminant of potential concern	N	number of samples
EPC	exposure point concentration	NA	Not Available
Max	maximum detected concentration	ND	not detected
mg/kg-wet	milligrams per kilograms wet weight	UCL	upper confidence limit

Table 6-24b Soil-to-Plant Concentration Factor

Compound of Potential Concern	Br
Metals	
Aluminum	6.5E-04
Antimony	3.0E-02
Arsenic (Inorganic)	6.0E-03
Barium	1.5E-02
Chromium	4.5E-03
Cobalt	7.0E-03
Iron	1.0E-03
Manganese	5.0E-02
Mercury	2.0E-01
Thallium	4.0E-04
Vanadium	3.0E-03

Source: Baes et al., 1984

Table 6-25 Non-Cancer Toxicity Date - Oral/Dermal

Compound of Potential Concern	Oral RfD Value	GI Absorption Factor(1)	Adjusted Dermal RfD(2)	Units	Primary Target Organ	Sources of RfD: Target Organ	Notes
Metals							
Aluminum	1.0E+00	1	1.0E+00	mg/kg-d	Nervous System	PPRTV	–
Antimony	4.0E-04	0.15	6.0E-05	mg/kg-d	Whole Body	IRIS	–
Arsenic	3.0E-04	1	3.0E-04	mg/kg-d	Cardiovascular, Skin	IRIS	Surrogate = Arsenic (Inorganic)
Arsenic (Inorganic)	3.0E-04	1	3.0E-04	mg/kg-d	Cardiovascular, Skin	IRIS	–
Barium	2.0E-01	0.07	1.4E-02	mg/kg-d	Kidney	IRIS	–
Cadmium (Diet)[4]	1.0E-03	0.025	2.5E-05	mg/kg-d	Kidney	IRIS	–
Cadmium (Water)	5.0E-04	0.05	2.5E-05	mg/kg-d	Kidney	IRIS	–
Chromium (trivalent)	1.5E+00	0.013	2.0E-02	mg/kg-d		IRIS	–
Chromium (hexavalent)	3.0E-03	0.025	7.5E-05	mg/kg-d	NA	IRIS	–
Cobalt	3.0E-04	1	3.0E-04	mg/kg-d	Hematologic System	PPRTV	–
Copper	4.0E-02	1	4.0E-02	mg/kg-d	GI Tract	HEAST	–
Iron	7.0E-01	1	7.0E-01	mg/kg-d		PPRTV	–
Manganese[5]	2.4E-02	0.04	9.6E-04	mg/kg-d	Nervous System	IRIS	Non-diet contribution
Manganese[5]	1.4E-01	1	1.4E-01	mg/kg-d	Nervous System	IRIS	Diet contribution
Mercury	3.0E-04	0.07	2.1E-05	mg/kg-d	Immune System, Nervous System, Kidney	IRIS	Mercuric Chloride (and other Mercury salts)
Nickel	2.0E-02	0.04	8.0E-04	mg/kg-d	–	IRIS	Soluble salts
Selenium	5.0E-03	1	5.0E-03	mg/kg-d	Skin	IRIS	–
Silver	5.0E-03	0.04	2.0E-04	mg/kg-d	Skin	IRIS	–
Thallium	1.0E-05	1	1.0E-05	mg/kg-d	Skin	PPRTV	Soluble salts
Vanadium[3]	5.0E-03	1	5.0E-03	mg/kg-d	Kidney	IRIS	Derived from vanadium pentoxide

Table 6-25 Non-Cancer Toxicity Date - Oral/Dermal

Compound of Potential Concern	Oral RfD Value	GI Absorption Factor(1)	Adjusted Dermal RfD(2)	Units	Primary Target Organ	Sources of RfD: Target Organ	Notes
Zinc	3.0E-01	1	3.0E-01	mg/kg-d	Hematologic System	IRIS	–
Organometals							
Methyl mercury	1.0E-04	1	1.0E-04	mg/kg-d	Nervous System, Developmental	IRIS	–
Polycyclic Aromatic Hydrocarbons (PAHs)							
1-Methylnaphthalene	7.0E-02	1	7.0E-02	mg/kg-d	Lung	ATSDR	–
Naphthalene	2.0E-02	1	2.0E-02	mg/kg-d	Nervous System	IRIS	–
Semivolatile Organic Compounds							
Bis(2-Ethylhexyl)phthalate	2.0E-02	1	2.0E-02	mg/kg-d	Reproductive System	IRIS	–

Key:

ATSDR = Agency of Toxic Substances and Disease Registry

GI = gastrointestinal

HEAST = Health Effects Assessment Summary Tables.

IRIS = Integrated Risk Information System.

mg/kg-d = milligrams per kilogram per day

NA = Not Applicable or Not Available.

PPRTV = Provisional Peer-Reviewed Toxicity Value

RfD = Reference Dose.

Notes:

(1) Refer to Risk Assessment Guidance for Superfund, Part E Exhibit 4-1 (EPA 2004).

(2) Dermal RfD = Oral RfD x GI Absorption Factor.

(3) Derived from vanadium pentoxide RfD based on molecular weight comparison, consistent with EPA's RSL User Guide.

(4) Diet value used for soil and biota. Water value used for surface water and groundwater exposure, consistent with EPA's RSL User Guide.

(5) Value for diet used for biota (fish, mammals, and plants). Value for non-diet used for soil, sediment and water, consistent with the EPA's RSL User Guide.

Table 6-26 Non-Cancer Toxicity Date - Inhalation

Compound of Potential Concern	Inh. RfC Value	Units	Primary Target Organ	Sources of RfC: Target Organ	Notes
Metals					
Aluminum	5.0E-03	mg/m^3	Respiratory	PPRTV	–
Arsenic	1.5E-05	mg/m^3	Skin, Nervous System, Cardiovascular	CalEPA	Surrogate = Arsenic (Inorganic)
Arsenic (Inorganic)	1.5E-05	mg/m^3	Skin, Nervous System, Cardiovascular	CalEPA	–
Barium	5.0E-04	mg/m^3	Cardiovascular, Reproductive and Developmental	HEAST	–
Cadmium	2.0E-05	mg/m^3	Kidney, Lungs	CalEPA	–
Chromium (hexavalent)	1.0E-04	mg/m^3	NA	IRIS	Hexavalent
Cobalt	6.0E-06	mg/m^3	NA	PPRTV	–
Manganese	5.0E-05	mg/m^3	Nervous System, Respiratory, Reproductive	IRIS	–
Mercury	3.0E-04	mg/m^3	Nervous System, Kidney	IRIS	Elemental mercury
Nickel	9.0E-05	mg/m^3	Respiratory, Immunological	ATSDR	Soluble salts
Selenium	2.0E-02	mg/m^3	Respiratory, Gastrointestinal, Nervous System	CalEPA	–
Polycyclic Aromatic Hydrocarbons (PAHs)					
Naphthalene	3.0E-03	mg/m^3	Blood, eyes, Gastrointestinal, Nervous System, Liver, Kidney	IRIS	–

Notes:

CalEPA = California Environmental Protection Agency

HEAST = Health Effects Assessment Summary Tables.

IRIS = Integrated Risk Information System.

mg/m^3 = milligrams per cubic meter

NA = Not Available

PPRTV = Provisional Peer-Reviewed Toxicity Value

Table 6-27 Cancer Toxicity Data - Oral/Dermal

Compound of Potential Concern	Oral Cancer Slope Factor	GI Absorption Factor[1]	Adjusted Dermal Cancer Slope Factor[2]	Units	Mutagen (Yes/No)	Source	Notes
Metals							
Arsenic	1.5	1	1.5	(mg/kg-d)-1	No	IRIS	Surrogate = Arsenic (Inorganic)
Arsenic (Inorganic)	1.5	1	1.5	(mg/kg-d)-1	No	IRIS	–
Polycyclic Aromatic Hydrocarbons (PAHs)							
1-Methylnaphthalene	0.029	1	0.029	(mg/kg-d)-1	No	PPRTV	Surrogate = 2-Methylnaphthalene
Semivolatile Organic Compounds (SVOCs)							
Bis(2-Ethylhexyl)phthalate	0.014	1	0.014	(mg/kg-d)-1	No	IRIS	–

GI = Gastrointestinal
IRIS = Integrated Risk Information System.
mg/kg-d = milligrams per kilograms per day
PPRTV = Provision Peer- Revised Toxicity Values
SF = Slope Factor

(1) Refer to Risk Assessment Guidance for Superfund, Part E (EPA 2004).
(2) Dermal SF = Oral SF/GI Absorption factor.

Table 6-28 Cancer Toxicity Data - Inhalation

Compound of Potential Concern	Inalation Unit Risk	Units	Mutagen (Yes/No)	Weight of Evidence/ Cancer Guideline Description	Source	Notes
Metals						
Arsenic	4.30E-03	(µg/m3)-1	No	A	IRIS	Surrogate = Arsenic (Inorganic)
Arsenic (Inorganic)	4.30E-03	(µg/m3)-1	No	A	IRIS	–
Chromium (hexavalent)	8.40E-02	(µg/m3)-1	Yes	–	RSL	–
Semivolatile Organic Compounds						
Bis(2-Ethylhexyl)phthalate	2.40E-06	(µg/m3)-1	No	–	CalEPA	–
Naphthalene	3.40E-05	(µg/m3)-1	No	–	CalEPA	–

IRIS = Integrated Risk Information System.
CalEPA = California Environmental Protection Agency
RSL = Regional Screening Level
µg/m3 = micrograms per cubic meter

Table 6-31 Summary of Excess Lifetime Cancer Risks for Background

Medium	Exposure Route	Future Resident	Recreational/ Subsistence User	Mine Worker
Soil	Ingestion	3E-05	1E-04	1E-05
	Dermal	5E-06	2E-06	2E-06
Sediment	Dermal	3E-06	9E-07	1E-06
Groundwater	Ingestion	3E-04	--	2E-04
	Dermal	7E-07	--	5E-07
Surface Water	Ingestion	--	1E-06	--
	Dermal	9E-09	3E-09	7E-09
Air	Inhalation of Fugitive Dust/Volatiles from Soil	3E-08	2E-09	3E-08
Fish	Ingestion	0E+00	0E+00	0E+00
Large Land Mammals	Ingestion	5E-06	7E-08	4E-08
Small Land Mammals	Ingestion	4E-05	8E-07	5E-07
Birds	Ingestion	1E-05	5E-06	2E-06
Berries and Plants	Ingestion	0E+00	0E+00	0E+00
Total Excess Lifetime Cancer Risk		**4E-04**	**2E-05**	**2E-04**

Note:
Shaded cell indicates excess lifetime cancer risk greater than 10^{-5}.

Table 6-32 Summary of Hazard Indices for Background

Medium	Exposure Route	Future Resident - Background	
		Adult	Child
Soil	Ingestion	0.3	2.4
	Dermal	0.01	0.08
Sediment	Dermal	0.006	0.04
Groundwater	Ingestion	9.3	21.6
	Dermal	0.2	0.5
Surface Water	Ingestion	--	--
	Dermal	0.004	0.004
Air	Inhalation of Fugitive Dust/Volatiles from Soil	0.2	0.2
	Inhalation of Volatiles from Groundwater	2.8	2.8
Fish	Ingestion	0.0	0.0
Large Land Mammals	Ingestion	1.7	3.7
Small Land Mammals	Ingestion	1.8	4.0
Birds	Ingestion	2.8	6.3
Berries and Plants	Ingestion	2.8	6.2
Total Hazard Index		19.0	45.0

Note:
Shaded cell indicates HI greater than 1.0.

Table 6-33 Human Health Risk Assessment Uncertainties

Area of Uncertainty	Potential Impact on Risk
Environmental Sampling and Analysis	
Targeted sampling	Overestimate
Background characterization	Over- or Underestimate
Detection limits in water above RBSC	Underestimate
Exposure Point Concentrations	
Inclusion of estimated results	Overestimate
Inclusion of non-detected chemicals in EPC calculation	Over- or Underestimate
Use of 95 UCL or maximum concentration	Overestimate
Exclusion of non-detected chemicals	Underestimate
Modeled COPC concentrations in tissue and berries	Overestimate
Use of total mercury results to estimate volatile, elemental mercury in soil and water	Overestimate
Assuming total chromium concentration are 100% in the hexavalent form	Overestimate
Use of total metal concentrations in groundwater	Overestimate
Exposure Assessment	
Change in chemical concentrations not considered	Over- or Underestimate
Use of high end and default values	Overestimate
Dermal exposure to some SVOCs in water	Underestimate
Dermal exposure to sediment	Over- or Underestimate
Wild food ingestion rates based on harvest data	Overestimate
Fraction of wild food ingested from site	Overestimate
Use of representative species	Over- or Underestimate
Bioaccessibility of arsenic and other metals	Overestimate
Toxicity Assessment	
Determination of toxicity values	Over- or Underestimate
Dermal toxicity values	Over- or Underestimate
Assumption of additive impacts	Overestimate
Not including synergistic effects	Underestimate
Use of surrogates	Over- or Underestimate
Use of lead models	Over- or Underestimate
Risk Characterization	
Not including preparation of food	Over- or Underestimate
Background risks and hazards not included	Overestimate
Exclusion of telemetry data for fish	Overestimate

Key:
EPC = exposure point concentration
RBSC = risk-based screening concentration
SVOC = semi-volatile organic compound
UCL = upper confidence limit

Table 6-34 Arsenic Bioaccessibility at Red Devil Mine

Exposure Unit	Sample ID	Arsenic Bioaccessibility (%)
		<250 µm Sieve
Background	11RD18SS	34.9
Background	11UP09SS	68.1
DA	11RD30SS	36.1
MPA	11MP34SS	2.7
MPA	11MP59SS	12.9
MPA	11MP32SS	15.2
MPA	11MP36SS	19.9
MPA	11MP52SS	39.1
MPA	11MP90SS	40.4
MPA	11MP17SS	40.9
MPA	11MP25SS	47.3
SMA	11SM18SS	4
SMA	11SM13SS	7.6
SMA	11SM28SS	43

Key:

DA	Downstream Alluvial Area
MPA	Main Processing Area
SMA	Surface Mined Area
µm	micrometer

Table 6-35 Impacts of Bioavailability Adjustments for Arsenic for Resident in Main Processing Area

Pathway	Arsenic RBA=100%		Arsenic RBA= 60%	
Excess Lifetime Cancer Risk[1]				
Soil Ingestion	2E-2		1E-2	
Air Inhalation of Particulates	3E-5		2E-5	
Total for All Pathways	3E-1		3E-1	
Hazards[1]	**Adult**	**Child**	**Adult**	**Child**
Soil Ingestion	28	260	17	150
Air Inhalation of Particulates	0.6	0.6	0.3	0.3
Total for All Pathways	2,120	5,070	2,107	5,063

Notes:
1 – All risks and hazards shown are for the most exposed potential receptor, a resident (adult and child) in the main processing area. Cancer risks are calculated based on an ED=54 years.

Kay:
RBA = relative bioavailability

Table 6-36 Uncommon or Rare Animal Species with Ranges that Overlap with the Red Devil Mine Site Location According to the AKNHP[a]

Species	Latin Name	Status	Summer Habitat and Diet (Kaufman 1996)	Likelihood of Occurring at RDM Site
Birds				
Gray-cheeked thrush	*Catharus minimus*	BLM Watchlist Species	Breeds in northern spruce forests, often rather open or stunted, and north of treeline in thickets of willow and alder on tundra. Eats mostly insects and berries.	Possible. Clusters of spruce trees are present on site.
Rusty blackbird	*Euphagus carolinus*	BLM Sensitive Species	Breeds in muskeg region, in wet northern coniferous forests with many lakes and bogs. Eats mostly seeds and insects, including many aquatic insects such as caddisflies, mayflies, dragonflies, and water beetles, plus terrestrial insects.	Low. Muskeg habitat not present on site.
Short-eared owl	*Asio flammeus*	BLM Sensitive Species	Found in open country that supports high numbers of small rodents (e.g., voles, lemmings). Nests most commonly on tundra, inland and coastal prairies, and extensive marshes. Nest site is on dry ground, often on raised hummock or ridge, especially in marshy country.	Low. Large expanses of tundra and marsh habitat not present at RDM site. Site is mainly tree-covered.
Golden eagle	*Aquila chrysaetos*	BLM Sensitive Species	Requires open terrain. In the north and west, found over tundra, prairie, rangeland, or desert. Very wide ranging in winter; in summer, more restricted to areas with good nest sites. Nest site is most often on a cliff ledge. Feeds mostly on small mammals, ranging in size from ground squirrels to marmots.	Low. The site includes little open terrain for hunting prey.
Blackpoll warbler	*Dendroica striata*	BLM Sensitive Species	Breeds in low northern spruce forests and in alder thickets north of the Arctic Circle and north of treeline. Eats mostly insects and berries.	Possible. The RDM site includes alder thickets and stands of spruce trees.
Olive-sided flycatcher	*Contopus borealis*	BLM Sensitive Species	Breeds mostly in coniferous forests of the north and the higher mountains, especially around the edges of open areas, including bogs, ponds, and clearings. Feeds almost entirely on flying insects.	Possible. Clusters of spruce trees are present on site.
Trumpeter swan	*Cygnus buccinator*	BLM Sensitive Species	Favors large but shallow freshwater ponds or lakes, or wide slow-flowing rivers, with much vegetation. Nest site is surrounded by water, as on a small island or beaver or muskrat house. Eats mainly stems, leaves, and roots of aquatic plants.	Possible. May use areas of the Kuskokwim River that provide the preferred habitat types.
Black-backed woodpecker	*Picoides arcticus*	Natural Heritage Program S3 Rank (uncommon or rare in Alaska)	Favors areas of dead or dying conifers, and may concentrate at burned or flooded areas with many standing dead trees.	Low. Stands of dead or dying conifers not present at RDM site.

Table 6-36 Uncommon or Rare Animal Species with Ranges that Overlap with the Red Devil Mine Site Location According to the AKNHP[a]

Species	Latin Name	Status	Summer Habitat and Diet (Kaufman 1996)	Likelihood of Occurring at RDM Site
Peregrine falcon	*Falco peregrinus*	Natural Heritage Program S3B Rank (uncommon or rare in Alaska; breeding status)	Found in wide variety of open habitats, from tundra to desert mountains, often near water. Limited by availability of nest sites and prey.	May occur near the RDM site along the Kuskokwim River. In a raptor survey conducted in July 2000, an active nest was found 7 miles down river of the RDM site, on rock cliffs on north side of river (BLM 2001c).
Mammals				
Alaska tiny shrew	*Sorex yukonicus*	Natural Heritage Program S3 Rank (uncommon or rare in Alaska)	Thought to be widespread, although uncommon, across Alaska (USFWS 2008). First described in 1997. Seven of 10 known specimens were collected in riparian habitats.	Possible, but distribution in Alaska is not well known. Cannot be ruled out as being present at RDM site.

Key:
AKNHP = Alaska Natural Heritage Program
BLM = Bureau of Land Management
RDM = Red Devil Mine
USFWS = United States Fish and Wildlife Service

Note:
a. See Appendix L for AKNHP correspondence.

Table 6-37 Uncommon or Rare Plants Likely to Occur at or Near the RDM Site According to AKNHP[a]

Species	Latin Name	Status	Remarks
Walpole's poppy	*Papaver walpolei*	State Rank: S3 (rare or uncommon).	Perennial forb/herb. Family Papaveraceae.
Siberian polypody	*Polypodium sibiricum*	State Rank: S3 (rare or uncommon).	Perennial forb/herb. Family Polypodiaceae.
Chukchi primrose	*Primula tschuktschorum*	State Rank: S3 (rare or uncommon).	Perennial forb/herb. Family Primulaceae.
Pear-shaped smeloskia	*Smelowskia pyriformis*	State Rank: S3 (rare or uncommon).	Perennial forb/herb. Family Brassicaceae.
Meadow-rue	*Thalictrum minus* subsp. *kemense*	State Rank: S3 (rare or uncommon).	Buttercup family (Ranunculaceae).

Key:
AKNHP = Alaska Natural Heritage Program
RDM = Red Devil Mine

Notes:
a. See Appendix L for AKNHP correspondence.

Table 6-38 Summary of COPCs Identified in the Screening Level Ecological Risk Assessment, Red Devil Mine Site

Analyte[b]	Assessment Endpoint and Maximum HQ from Revised SLERA[a]															
						Terrestrial Wildlife[h]						Aquatic-Dependent Wildlife[i]				
	Plants[c]	Soil Fauna[d]	Fish and Other Aquatic Biota[e]	Fish[f]	Benthos[g]	Robin	Shrew	Grouse	Vole	Shrike	Weasel	Snipe	Beaver	Teal	Kingfisher	Mink
Polychlorinated Biphenyls (PCBs)																
Sum of Aroclors (NDs = 0.5MDL)	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals																
Antimony	x	**299**	**6.1**	x	**2,193**	x	**136,370**	x	**1,681**	x	--	x	**60**	x	x	**89**
Arsenic	**549**	x	6.9	**14**	**13,265**	**28**	**214**	**47**	**41**	**1.5**	**1.9**	**823**	**1.5**	**37**	**5.5**	**3.3**
Barium	x	5.2	**26**	x	x	**2.0**	**1.6**	**1.3**	--	--	--	**1.4**	--	--	--	--
Beryllium	x	--	--	--	x	x	--	x	--	x	--	x	--	x	x	--
Cadmium	--	--	--	--	--	**1.7**	**4.4**	--	--	--	--	--	--	--	--	--
Chromium	1.3	x	--	3.5	1.1	**2.9**	**1.3**	--	--	--	--	--	--	--	--	--
Cobalt	**3.0**	x	--	--	1.0	--	--	--	--	--	--	--	--	--	**1.1**	--
Copper	2.0	1.7	--	--	2.8	**4.4**	**4.6**	--	--	--	--	**1.5**	--	--	--	--
Iron	--	--	2.5	--	**16**	--	--	--	--	--	--	--	--	--	--	--
Lead	26	1.8	--	--	--	**83**	**48**	**20**	**2.8**	**4.9**	**1.0**	--	--	--	--	--
Manganese	**19**	**9.4**	3.2	x	**12**	--	**2.3**	**2.1**	**6.1**	--	--	--	--	--	--	--
Mercury	**5,400**	**16,200**	**32**	**8**	**661**	**9.5**	**2.1**	**39**	--	--	--	**5.8**	--	**2.8**	**4.2**	--
Methylmercury			--	1	x	--	--	--	--	--	--	--	--	--	**2.3**	**1.3**
Nickel	**2.6**	--	--	--	**11**	**3.7**	**21**	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	**2.7**	--	--	**1.2**	--	--	--	--	**5.7**	--	--	**5.2**	**2.9**
Silver	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	x	--	--	x	x	**3.3**	x	--	x	--	x	--	x	x	**3.8**
Vanadium	**26**	x	--	x	x	**1.9**	--	**1.7**	--	--	--	**2.5**	--	--	--	--
Zinc	2.4	3.2	--	1.3	1.1	**2.2**	**2.7**	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																
HPAH sum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPAH sum	--	--	--	--	--	x	--	x	--	x	--	x	--	--	x	--
Other Semivolatile Organic Compounds (SVOCs)																
4-Bromophenyl phenyl ether	x	x	--	--	--	x	x	x	x	x	x	--	x	--	--	--
4-Methylphenol	x	x	--	--	--	x	--	x	--	x	--	--	--	--	--	--
Benzoic acid	x	x	--	--	--	x	x	x	x	x	x	--	x	--	--	--
Benzyl Alcohol	x	x	--	--	--	x	x	x	x	x	x	x	x	--	x	x
Bis(2-Ethylhexyl)phthalate	x	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	x	x	x	x	x	x	--	x	--	--	--
Diethylphthalate	--	x	--	--	--	x	--	x	--	x	--	x	--	--	x	--

Table 6-38 Summary of COPCs Identified in the Screening Level Ecological Risk Assessment, Red Devil Mine Site

Analyte[b]	Assessment Endpoint and Maximum HQ from Revised SLERA[a]															
						Terrestrial Wildlife[h]						Aquatic-Dependent Wildlife[i]				
	Plants[c]	Soil Fauna[d]	Fish and Other Aquatic Biota[e]	Fish[f]	Benthos[g]	Robin	Shrew	Grouse	Vole	Shrike	Weasel	Snipe	Beaver	Teal	Kingfisher	Mink
Dimethylphthalate	x	--	--	--	--	x	x	x	x	x	x	--	x	--	--	--
Di-n-butyl Phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key:
BERA = Baseline Ecological Risk Assessment
COPC = contaminant of potential concern
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
SLERA = screening level ecological risk assessment (Appendix G in draft RI report)
TRV = toxicity reference value
Value (with or without shading) = HQ equal to or greater than 1. Chemical and receptor combination will be evaluated quantitatively in the BERA.
x = chemical detected in site samples but no screening level or TRV is available. Chemical will be evaluated qualitatively in the BERA.

Notes:

a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):
Value = > 75%
Value = 50 - 75%
Value = 25 - 50%
Value = < 25%

For wildlife, the value of the maximum HQ (exposure estimate / TRV) is shown without shading because wildlife HQs were not calculated sample-by-sample.

b. Essential nutrients (calcium, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003a). Organic chemicals detected in surface soil, sediment, or surface water are listed.

c. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on plants (see SLERA Table 4-1).

d. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on earthworms (see SLERA Table 4-1).

e. Based on comparing maximum surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see SLERA Table 4-3).

f. Based on comparing maximum whole-body sculpin chemical concentrations with fish tissue screening concentrations (see SLERA Table 4-3b).

g. Based on comparing maximum sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see SLERA Table 4-2).

h. Based on screening-level exposure estimates and hazard quotients for the American robin (SLERA Table 4-15), masked shrew (SLERA Table 4-16), spruce grouse (SLERA Table 4-17), tundra vole (SLERA Table 4-18), northern shrike (SLERA Table 4-19), and least weasel (SLERA Table 4-20).

i. Based on screening-level exposure estimates and HQs for the common snipe (SLERA Table 4-21), beaver (SLERA Table 4-22), green-winged teal (SLERA Table 4-23), belted kingfisher (SLERA Table 4-24), and mink (SLERA Table 4-25).

Table 6-39 Supplemental Evaluation of Semivolatile Organic Contaminants Identified as COPCs in the SLERA

Chemical	Receptor for Which No TRV was Identified in the SLERA	Supplemental Evaluation and Result	COPC
Low Molecular Weight PAHs (LPAHs)	American robin, spruce grouse, northern shrike, common snipe, belted kingfisher	LPAHs were identified as a COPC for birds because no avian TRV for LPAHs was identified for the SLERA (see SLERA Table ES-1). However, the maximum LPAH soil concentration at the RDM site (0.42 mg/kg) is less than the LPAH soil benchmark for mammals (1.1 mg/kg) from Buchman (2008), which, if assumed to be applicable to birds as well, suggests that LPAHs are not a COPC for terrestrial birds at the RDM site. Likewise, the maximumn sediment LPAH concentration at the site (0.007 mg/kg) is less than the lowest LPAH sediment benchmark (0.076 mg/kg) from Buchman (2008), suggesting that LPAHs are not a COPC in sediment. These comparisons suggest that the levels of LPAHs detected in surface soil and sediment at the RDM site are not of ecological concern.	No
4-Bromophenyl phenyl ether	Plants, soil fauna, American robin, masked shrew, spruce grouse, tundra vole, northern shrike, least weasel, and beaver	This chemical was detected in 1 of 12 surface soil samples from the RDM site at a concentration of 1.9 µg/kg. A soil screening level for this chemical was not identified in the SLERA; hence, this chemical was identified as a COPC for all receptors exposed to soil (see SLERA Table ES-1). The EPA Region 5 sediment screening level for this chemical is 1500 µg/kg (EPA 2003e), which is three orders of magnitude greater than the concentration detected in soil at the RDM site. If the EPA Region 5 sediment screening level is used as a surrogate soil screening level, then 4-bromophenyl phenyl ether is not identified as a COPC at the RDM site.	No
4-Methylphenol	Plants, soil fauna, American robin, spruce grouse, and northern shrike	This chemical was detected in 1 of 12 surface soil samples from the RDM site at a concentration of 4.9 µg/kg. A soil screening level for this chemical for plants, soil fauna, and terrestrial birds was not identified in the SLERA; hence, this chemical was identified as a COPC for these receptors. However, 4-methylphenol is also known as p-cresol, which has a soil screening level of 163,000 µg/kg based on protection of mammalian wildlife (EPA 2003e). If this screening level is assumed to be applicable to other groups of ecological receptors, then 4-methylphenol can be screened out as a COPC for plants, soil fauna, and terrestrial birds.	No
Benzoic acid	Plants and soil fauna	Benzoic acid was detected in 1 of 12 surface soil samples from the RDM site at a concentration of 120 µg/kg (see SLERA Table 4-1). A soil screening level for this chemical was not identified in the SLERA; hence, this chemical was identified as a COPC for plants and soil fauna. During preparation of the BERA, no soil screening level was identified for benzoic acid.	Yes
	American robin, masked shrew, spruce grouse, tundra vole, northern shrike, least weasel, and beaver	This chemical was detected in 1 of 12 surface soil samples from the RDM site at a concentration of 120 µg/kg (see SLERA Table 4-1). No avian or mammalian TRV for this chemical was identified in the SLERA; hence, this chemical was identified as a COPC for terrestrial birds and mammals. During preparation of the BERA, no avian or mammalian TRVs were identified for benzoic acid.	Yes
Benzyl alcohol	Plants, soil fauna, American robin, masked shrew, spruce grouse, tundra vole, northern shrike, least weasel, and beaver	This chemical was detected in 1 of 12 surface soil samples from the RDM site at a concentration of 12 µg/kg (see SLERA Table 4-1). During the SLERA, no soil screening levels for plants, soil invertebrates, or terrestrial wildlife were identified; hence, this chemical was identified as a COPC for these receptor groups (see SLERA Table ES-1). However, EPA Region 5 developed a soil screening level for this chemical of 65,800 µg/kg (EPA 2003e), which is three orders of magnitude greater than the measured soil concentration at the RDM site. If the EPA Region 5 screening level is used to screen for potential effects on plants, soil fauna, and terrestrial birds and mammals, then benzyl alcohol is not identified as a COPC at the site.	No
	Belted kingfisher, mink, and common snipe	This chemical was detected in 1 of 2 sediment samples at 3.1 µg/kg (see SLERA Table 4-2). This concentration is four orders of magnitude less than the soil screening level (65,800 µg/kg) developed by EPA Region 5 for this chemical. If the EPA Region 5 soil screening level is applied to sediment, then benzyl alcohol is not identified as a COPC for aquatic-dependent wildlife at the site.	No
bis(2-Ethylhexyl) phthalate	Plants and soil fauna	This chemical was detected in 8 of 12 surface soil samples at concentrations ranging from 11 to 220 µg/kg (see SLERA Table 4-1). Buchman (2008) reports a soil screening level of 100 µg/kg. The maximum concentration (220 µg/kg in sample 10MP36SS from the Main Processing Area) exceeded the screening level, suggesting that a localized risk from bis(2-ethylhexyl)phthalate may exist at this location for plants and soil invertebrates. For wildlife, the SLERA showed that the maximum soil concentration of this chemcial did not pose a risk.	Yes

Table 6-39 Supplemental Evaluation of Semivolatile Organic Contaminants Identified as COPCs in the SLERA

Chemical	Receptor for Which No TRV was Identified in the SLERA	Supplemental Evaluation and Result	COPC
Dibenzofuran	American robin, masked shrew, spruce grouse, tundra vole, northern shrike, least weasel, and beaver	This chemical was detected in 2 of 12 surface soil samples at the RDM site at concentrations ranging from 2.4 to 10 µg/kg (see SLERA Table 4-1). No avian or mammalian TRVs were identified for this chemical during the SLERA; hence, this chemical was identified as a COPC for terrestrial wildlife (see SLERA Table ES-1). However, because dibenzofuran is structurally similar to fluorene, a PAH compound, is seems reasonable to evaluate its potential toxicity to wildlife using TRVs developed for PAHs. When the avian and mammalian NOAELs for HPAHs (2 and 0.62 mg/kg/day, respectively, see SLERA Table 3-2) are used for dibenzofuran, NOAEL-based HQs less than 1 can be calculated for the robin (0.001), shrew (0.01), grouse (0.001), vole (0.003), shrike (0.001), weasel (0.002), and beaver (0.0002) using the exposure equations and parameters in the SLERA.	No
Diethylphthalate	Soil fauna, American robin, spruce grouse, and northern shrike	This chemical was detected in 2 of 12 surface soil samples at the RDM site at concentrations ranging from 8 to 140 µg/kg (see SLERA Table 4-1). No soil screening level for soil fauna or TRV for avian wildlife was identified during the SLERA; hence, this chemical was identified as a COPC for soil fauna and terrestrial birds (see SLERA Table ES-1). Buchman (2008) provides a soil screeing level of 100 µg/kg for this chemical, which is less than the maximum detected concentration of 140 µg/kg, suggesting that diethylphthalate may represent a localized risk at the one sample location (10MP20SS) in the Main Processing Area where the surface soil concentration exceeded the soil screening level	Yes
	Common snipe and belted kingfisher	This chemical was detected in 1 of 2 sediment samples from RDC at a concentration of 1.7 µg/kg (see SLERA Table 4-2). This concentration is four orders of magnitude less than the soil screening level (24,800 µg/kg) developed by EPA Region 5 and two orders of magnitude less than the soil screeing level (140 µg/kg) from Buchman (2008) for this chemical. If these soil screening levels are applied to sediment, then diethylphthalate is not identified as a COPC for aquatic-dependent wildlife at the site.	No
Dimethylphthalate	Plants, American robin, masked shrew, spruce grouse, tundra vole, northern shrike, least weasel, and beaver	This chemical was detected in 1 of 12 surface soil samples at the RDM site at a concentration of 160 µg/kg (see SLERA Table 4-1). No soil screening level for soil fauna or TRVs for wildlife were identified during the SLERA; hence, this chemical was identified as a COPC for soil fauna and terrestrial wildlife (see SLERA Table ES-1). However, EPA Region 5 developed a soil screening level for this chemical of 734,000 µg/kg (EPA 2003e), which is three orders of magnitude greater than the maximum detected soil concentration at the RDM site. If the EPA Region 5 soil screening level is used to screen for potential effects on terrestrial plants and wildlife, then dimethylphthalate is not identified as a COPC at the site.	No
Hexachlorobenzene	Plants	This chemical was detected in 1 of 12 surface soil samples at the RDM site at a concentration of 1.3 µg/kg (see SLERA Table 4-1). No soil screening level for terrestrial plants was identified during the SLERA; hence, this chemical was identified as a COPC for terrestrial plants (see SLERA Table ES-1). However, Buchman (2008) presents two soil screening levels for this chemical -- 199 µg/kg for effects on wildlife and 1,000,000 ug/kg for effects on soil microbes -- both of which are several orders of magnitude greater than the maximum detected concentration in soil at the RDM site. If the soil screening levels from Buchman (2008) are used to screen for potential effects on terrestrial plants, then hexachlorobenzene is not identified as a COPC at the RDM site.	No

Key:

BERA = Baseline Ecological Risk Assessment
COPC = contaminant of potential concern
EPA = Environmental Protection Agency
HQ = hazard quotient
LPAHs = low molecular weight PAHs
HPAHs = high molecular weight PAHs
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
PAHs = polycyclic aromatic hydrocarbons
RDC = Red Devil Creek
RDM = Red Devil Mine
SLERA = screening level ecological risk assessment
TRV = toxicity reference value
µg/kg = micrograms per kilogram

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Primary Producers					
Terrestrial plant species abundance, diversity, and primary production.	Are levels of contaminants in surface soil from the site great enough to affect terrestrial plant survival, growth, or reproduction?	All plants that obtain nutrients primarily from soil.	Chemical concentrations in soils.	Compare soil chemical concentration with phytotoxicity benchmarks.	Yes
Aquatic plant species abundance, diversity, and primary production.	Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of periphyton and other aquatic primary producers?	All freshwater aquatic plants.	Chemical concentrations in surface water.	Compare surface water chemical concentration with chronic, freshwater quality criteria	Yes
Herbivores and Detritivores					
Freshwater aquatic invertebrate community abundance and diversity.	Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater aquatic invertebrates?	All freshwater aquatic invertebrates.	Chemical concentrations in surface water.	Compare surface water chemical concentration with chronic, freshwater quality criteria	Yes

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Freshwater benthic invertebrate community abundance and diversity.	Are levels of contaminants in sediment from Red Devil Creek great enough to affect survival, growth, or reproduction of benthic invertebrates?	All freshwater benthic invertebrates.	1. Chemical concentrations in sediment. 2. Results from benthic macroinvertebrate surveys in Red Devil Creek and nearby reference creeks. 3. Chemical concentrations in surface water. 4. Chemical concentrations in benthos from Red Devil Creek.	1. Compare sediment chemical concentration with sediment quality benchmark. 2. Compare Red Devil Creek benthic survey results with results from nearby reference creeks. 3. Compare surface water chemical concentration with chronic, freshwater quality criteria. 4. Compare chemical concentrations in benthos with tissue screening concentrations.	Yes
Soil invertebrate community abundance and diversity.	Are levels of contaminants in site soils great enough to affect survival, growth, or reproduction of soil invertebrates?	All terrestrial invertebrates.	Chemical concentrations in soil.	Compare soil chemical concentration with available toxicity benchmarks for earthworms or other soil invertebrates.	Yes
Freshwater fish detritivore abundance and diversity.	Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater fish?	All freshwater fish.	1. Chemical concentrations in surface water. 2. Chemical concentrations in slimy sculpin from Red Devil Creek.	1. Compare surface water chemical concentration with chronic, freshwater quality criteria. 2, Compare chemical concentrations in slimy sculpin with tissue screening concentrations.	Yes

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Freshwater semi-aquatic avian herbivore abundance and diversity.	Does the daily dose of chemicals received by herbivorous waterfowl from consumption of semi-aquatic plants and other media in the settling ponds at the RDM site exceed TRVs for survival, growth or reproduction of birds?	Green-winged teal[a]	1. Chemical concentrations in settling pond sediment (dry at time of sampling). 2. Chemical concentrations in settling pond surface water. 3. Chemical concentrations in semi-aquatic plants growing in the settling ponds.	Modeled chemical dose from ingestion of semi-aquatic plants, water, and sediment compared with TRV.	Yes. According to Alaska DEC, signs of waterfowl use of the settling ponds near the main processing area have been reported.
Terrestrial avian herbivore abundance and diversity.	Does the daily dose of chemicals received by herbivorous birds from consumption of terrestrial plants and other media at the site exceed TRVs for survival, growth or reproduction of birds?	Spruce grouse[a]	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water. 3. Chemical concentrations in conifer needles.	Modeled chemical dose from ingestion of terrestrial plants, water, and soil compared with TRV.	Yes. Spruce grouse are known to use the site and are hunted by residents of Red Devil Village.

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Freshwater mammalian semi-aquatic mammalian herbivore abundance and diversity.	Does the daily dose of chemicals received by herbivorous mammals from consumption of semi-aquatic and terrestrial plants and other media at the site exceed TRVs for survival, growth or reproduction of mammals?	Beaver[a]	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water. 3. Chemical concentrations in green alder bark.	Modeled chemical dose from ingestion of plants, water, and soil compared with TRV.	Yes. Historic use of Red Devil Creek by beavers is evident.
Terrestrial mammalian herbivore abundance and diversity.	Does the daily dose of chemicals received by herbivorous mammals from consumption of terrestrial plants and other media at the site exceed TRVs for survival, growth or reproduction of mammals?	Tundra vole.	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water. 3. Chemical concentrations in a representative herbaceous plant (blueberry stems and leaves).	Modeled chemical dose from ingestion of terrestrial plants, water, and soil compared with TRV.	Yes

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Secondary Consumers					
Semi-aquatic avian invertivore abundance and diversity.	Does the daily dose of chemicals received by semi-aquatic birds from consumption of benthic invertebrates and other media from Red Devil Creek exceed TRVs for survival, growth or reproduction of birds?	Common snipe.	1. Chemical concentrations in sediment. 2. Chemical concentrations in surface water. 3. Chemical concentrations in benthic invertebrates.	Modeled chemical dose from ingestion of benthic invertebrates, surface water, and sediment compared with TRV.	Yes
Terrestrial avian invertivore abundance and diversity.	Does the daily dose of chemicals received by invertivorous birds from consumption of terrestrial invertebrates and other media from the site exceed TRVs for survival, growth or reproduction of birds?	American robin.	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water.	Modeled chemical dose from ingestion of soil invertebrates, surface water, and soil compared with TRV.	Yes
Freshwater fish invertivore abundance and diversity.	Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater fish?	All freshwater fish.	1. Chemical concentrations in surface water. 2. Chemical concentrations in slimy sculpin from Red Devil Creek.	1. Compare surface water chemical concentration with chronic, freshwater quality criteria. 2, Compare chemical concentrations in slimy sculpin with tissue screening concentrations.	Yes

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Freshwater amphibian invertivore abundance and diversity.	Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of amphibians?	Wood frog.	Chemical concentrations in surface water.	Compare surface water chemical concentration with chronic, freshwater quality criteria.	Yes. Wood frogs have not been observed at the site, but their possible presence cannot be ruled out.
Terrestrial mammalian invertivore abundance and diversity.	Does the daily dose of chemicals received by invertivorous mammals from consumption of terrestrial invertebrates and other media from the site exceed TRVs for survival, growth, or reproduction of mammals?	Masked shrew.	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water.	Modeled chemical dose from ingestion of soil invertebrates, surface water, and soil compared with TRV.	Yes

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Tertiary Consumers					
Freshwater avian piscivore abundance and diversity	Does the daily dose of chemicals received by piscivorous birds from consumption of fish and other media from Red Devil Creek exceed TRVs for survival, growth, or reproduction of birds?	Belted kingfisher.	1. Chemical concentrations in surface water. 2. Chemical concentrations in fish.	Modeled chemical dose from ingestion of fish and water compared with TRV	Yes
Terrestrial avian carnivore abundance and diversity	Does the daily dose of chemicals received by carnivorous birds from consumption of small mammals and other media from the site exceed TRVs for survival, growth or reproduction of birds?	Northern shrike.	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water.	Modeled chemical dose from ingestion of prey compared with TRV	Yes
Terrestrial mammalian carnivore abundance and diversity	Does the daily dose of chemicals received by carnivorous mammals from consumption of prey and other media from the site exceed TRVs for survival, growth, or reproduction of mammals?	Least weasel.	1. Chemical concentrations in soil. 2. Chemical concentrations in surface water.	Modeled chemical dose from ingestion of prey, surface water, and soil compared with TRV.	Yes

Table 6-40 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.

Assessment Endpoint	Risk Question	Indicator Species	Measure for BERA	Assessment Method	Include in BERA?
Freshwater mammalian carnivore abundance and diversity	Does the daily dose of chemicals received by piscivorous mammals from consumption of fish and other media from Red Devil Creek exceed TRVs for survival, growth or reproduction of mammals?	Mink.	1. Chemical concentrations in surface water. 2. Chemical concentrations in fish.	Modeled chemical dose from ingestion of fish and sediment compared with TRV.	Yes
Freshwater fish piscivore abundance and diversity	Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater fish?	All freshwater fish.	1. Chemical concentrations in surface water. 2. Chemical concentrations in slimy sculpin from Red Devil Creek.	Compare surface water chemical concentration with chronic, freshwater quality criteria. 2, Compare chemical concentrations in slimy sculpin with tissue screening concentrations.	Yes

Key:
ADEC = Alaska Department of Environmental Conservation
BERA = Baseline ecological risk assessment
RDM = Red Devil Mine
TRV = Toxicity reference value

Note:
a = Differs from primary indicator species recommended by ADEC (1999) for site-specific reasons.

Table 6-41 Sources and Types of Toxicity Data Used in the Red Devil Mine Site Baseline Ecological Risk Assessment

Receptor Group	TRV Source	TRV Type	Contaminant
Soil			
Plants	EPA Eco-SSL Reports	Eco-SSL	As, Co, Cu, Pb, Mn, Ni, Ag, Zn
	Efroymson et al. 1997a	10%tile effects concentrations	Ba, Be, Hg, Tl, V
	Alloway 1990	Threshold concentration	Sb, Cr
Invertebrates	EPA Eco-SSL Reports	Eco-SSL, MATC (Cr)	Sb, Ba, Be, Cr, Cu, Pb, Mn, Ni, Zn
	Efroymson et al. 1997b	10%tile effects concentrations	As, Co, Hg, Ag, V
Sediment			
Benthos	Buchman 2008	PEL	As, Ba, Cr, Cu, Hg, Ni
	MacDonald et al. 1999	LEL, PAET, or AET	Sb, Be, Co, Fe, Mn, Tl
	EPA Region 5	ESL	Methyl Hg
Surface Water			
Fish, benthos, periphyton, etc.	EPA 2009a, ADEC 2008d	Chronic criteria	As, Fe, Hg
	Suter and Tsao 1996	Tier II SCV	Sb, Mn
	MacDonald et al. 1999	Chronic criterion (hardness-adjusted)	Ba
	EPA 1986b	Criterion	Hg
Tissue			
Fish	Dyer et al. 2000	5%tile effects residues	As, Cr, Hg, Zn
	Sandheinrich & Weiner 2011	Literature consensus	Methyl Hg
	EPA	Draft criterion	Se
	Site Specific	TSC = WQC x BCF(a)	Sb, Ba, Mn, V
Benthos	Site Specific	TSC = WQC x BCF(a)	Sb, As, Ba, Be, Cr, Co, Cu, Fe, Mn, Hg, Ni, Tl, V, Zn
Wildlife			
Birds	EPA Eco-SSL Reports	NOAEL, LOAEL	As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, V, Zn
	Sample et al. 1996	"	Ba, Hg
	CH2MHill 2000	"	Methyl Hg
Mammals	EPA Eco-SSL Reports	NOAEL, LOAEL	Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, V, Zn
	Sample et al. 1996	"	Hg, Tl
	CH2MHill 2000	"	Methyl Hg

Key:

AET = Apparent Effect Threshold
Ag = Silver
As = Arsenic
Ba = Barium
Be = Beryllium
BCF = Bioconcentration Factor
Cd = Cadmium
Co = Cobalt
Cr = Chromium
Cu = Copper
ESL = Ecological Screening Level
Hg = Mercury
LEL = Low Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum acceptable toxicant concentration
Mn = Manganese
Ni = Nickel
NOAEL = No Observed Adverse Effect Level
PAET = Probable Apparent Effect Threshold
Pb = Lead
PEL = Probable Effect Level
RDC = Red Devil Creek
Sb = Antimony
SCV = Secondary Chronic Value
Se = Selenium
Tl = Thallium
TSC = Tissue Screening Concentration
V = Vanadium
WQC = Water Quality Criterion
Zn = Zinc

Note: (a) = BCF calculated from geometric mean metals concentrations in whole-body sculpin or benthic macroinvertebrate samples and filtered water samples from RDC.

Table 6-42 Benthic Macroinvertebrate TSCs Developed from Water Quality Criteria and Site-Specific Bioconcentration Factors for Red Devil Creek Benthic Macroinvertebrates

Analyte	Geometric Mean Concentration		BCF (L/kg)	Chronic Water Quality Criterion		Benthic Macroinvertebrate TSC (mg/kg wet weight)[c]
	RDC Benthic Macroinvertebrate Composite Samples (mg/kg wet weight)[a]	RDC Filtered Surface Water (mg/L)		Value (mg/L)	Basis	
Antimony	20.23	0.018	1097	0.03	Suter and Tsao (1996), Tier II SCV	33
Arsenic	115.66	0.021	5489	0.15	EPA (2009a) WQC	823
Barium	6.29	0.029	219	0.194	MacDonald et al. (1999)	42
Beryllium	0.022	0.000006	3627	0.00066	Suter and Tsao (1996), Tier II SCV	2.4
Chromium	0.31	0.000086	3588	0.074	EPA (2009a) WQC	266
Cobalt	--	0.000063	--	0.023	Suter and Tsao (1996), Tier II SCV	--
Copper	8.44	0.000206	40917	0.009	EPA (2009a) WQC	368
Iron	985	0.155	6338	1	EPA (2009a) WQC	6,338
Manganese	40.11	0.025	1630	0.12	Suter and Tsao (1996), Tier II SCV	196
Mercury	0.92	0.000007	135202	0.000012	EPA (2009a) WQC	1.6
Methylmercury[b]	0.049	1.32E-07	374497	0.0000028	Suter and Tsao (1996), Tier II SCV	1.0
Nickel	1.101	0.000627	1756	0.052	EPA (2009a) WQC	91
Thallium	--	0.000002	--	0.012	Suter and Tsao (1996), Tier II SCV	--
Vanadium	0.360	0.000042	8555	0.02	Suter and Tsao (1996), Tier II SCV	171
Zinc	36.7	0.000246	149051	0.118	ADEC (2008d) WQC	17,588

Notes:

a. See Appendix N for listing of samples and metals data.

b. Unfiltered surface water concentration. No filtered samples were analyzed for methylmercury.

c. See Section 6.3.6 for method of derivation.

Key:

ADEC = Alaska Department of Environmental Conservation

BCF = Bioconcentration factor (benthic macroinvertebrate concentration / surface water concentration)

EPA = Environmental Protection Agency

L/kg = liters per kilogram

mg/kg = milligrams per kilgram

mg/L = milligrams per liter

RDC = Red Devil Creek

SCV = Secondary Chronic Value

TSC = Tissue Screening Concentration

WQC = Water Quality Criterion

Table 6-43 Fish TSCs Developed from Chronic Water Quality Criteria and Site-Specific Bioconcentration Factors for Red Devil Creek Fish

Parameter	Geometric Mean Concentration		BCF (L/Kg)	Chronic Water Quality Criterion		Fish TSC (mg/kg wet weight)[b]
	RDC Filtered Surface Water (mg/L)	RDC Sculpin (mg/kg wet weight)[a]		Value (mg/L)	Basis	
Antimony	0.0185	5.16	280	0.03	Suter and Tsao (1996). Tier II SCV.	8.4
Arsenic	0.0211	6.96	330	0.15	EPA (2009a) WQC.	50
Barium	0.0288	3.05	106	0.194	MacDonald et al. (1999).	20.6
Chromium	0.00009	0.045	518	0.074	EPA (2009a) WQC.	38
Manganese	0.0246	12.41	504	0.12	Suter and Tsao (1996). Tier II SCV.	61
Mercury	0.0000068	0.326	47923	0.000012	EPA (1986b).	0.58
Selenium	0.000148	1.17	7858	0.005	EPA (2009a) WQC.	39
Vanadium	0.000104	0.069	660	0.02	Suter and Tsao (1996). Tier II SCV.	13.2
Zinc	0.000246	24.13	98109	0.118	ADEC (2008d).	11,577

Notes:

a. See Appendix I for RDC sculpin metals data.

b. See Section 6.3.6 for method of derivation.

Key:

ADEC = Alaska Department of Environmental Conservation
BCF = Bioconcentration factor (sculpin concentration / surface water concentration)
EPA = United States Environmental Protection Agency
L/kg = liters per kilogram
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
RDC = Red Devil Creek
SCV = Secondary Chronic Value
TSC = Tissue Screening Concentration
WQC = Water Quality Criterion

Table 6-44 Exposure Assessment and Risk Characterization for Terrestrial Plants and Soil Invertebrates Based on Surface Soil (0 to 2 feet bgs) Data, Red Devil Mine Site BERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	EPC[c]	FoD	Soil Ecological Screening Levels and Hazard Quotients									
						Plants					Soil Invertebrates				
						Value[d]	FoE	HQ[f]	COC	Rationale[g]	Value[e]	FoE	HQ[f]	COC	Rationale[g]
Metals (mg/kg)															
Antimony	135	0.708 J	23300 J	4,234	111/135	5	109/111	847	Yes	>SL	78	86/111	54	Yes	>SL
Arsenic	135	9	9880	3,569	134/135	18	126/134	198	Yes	>SL	60	111/134	59	Yes	>SL
Barium	135	76.2	1710	438	135/135	500	26/135	0.88	No	<SL	330	41/135	1.3	Yes	>SL
Beryllium	135	0.3	1.3	0.73	132/135	10	0/132	0.07	No	<SL	40	0/1354	0.02	No	<SL
Chromium	135	6	101	29.1	135/135	75	1/135	0.39	No	<SL	57	2/135	0.51	No	<SL
Cobalt	135	5.9	38.8	18.1	135/135	13	103/135	1.4	Yes	>SL	1000	0/135	0.02	No	<SL
Copper	135	17	139	69.0	135/135	70	56/135	0.99	No	<SL	80	30/135	0.86	No	<SL
Lead	135	5	3090	96.6	126/135	120	6/126	0.80	No	<SL	1700	1/135	0.06	No	<SL
Manganese	135	153	4230	757	135/135	220	133/135	3.4	Yes	>SL	450	111/135	1.7	Yes	>SL
Mercury	135	0.05 J	1620	252	135/135	0.3	126/135	839	Yes	>SL	0.1	133/135	2516	Yes	>SL
Methylmercury	0	--	--	--	0/0	--	--	--	--	--	--	--	--	--	--
Nickel	135	18	97	52.4	135/135	38	101/135	1.4	Yes	>SL	280	0/135	0.35	No	<SL
Silver	135	0.068	0.123	0.12	2/135	560	0/2	0.0002	No	<SL	50	0/135	0.002	No	<SL
Thallium	135	0.065	0.071	0.071	2/135	1	0/135	0.07	No	<SL	--	--	--	Yes	NSL
Vanadium	135	15.3	51.9	34.8	135/135	2	135/135	17.4	Yes	>SL	20	132/135	1.7	Yes	>SL
Zinc	135	38	386	111	135/135	160	4/135	0.69	No	<SL	120	35/135	0.9	No	<SL

Key:

-- = not available or not applicable
BERA = Baseline ecological risk assessment
bgs = below ground surface
COC = contaminant of concern
COPC = contaminant of potential concern
Eco-SSL = Ecological Soil Screening Level
EPC = Exposure point concentration
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence (number of detects > screening level / number of detects)
HQ = hazard quotient
J = estimated value
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
SL = Screening level
SLERA = screening level ecological risk assessment
Shading = HQ equals or exceeds 1, or no SL available. Chemical is a COC.

Notes:

a = Only metals identified and COPCs in the SLERA are listed.
b = 127 original site samples and 8 field duplicate samples.
c = See Appendix O for method of calculation.
d = Eco-SSLs (www.epa.gov/ecotox/ecossl/) for arsenic, cobalt, copper, lead, manganese, nickel, silver, and zinc. Antimony and chromium plant screening levels are from Alloway (1990). Other plant screening levels are from Efroymson et al. (1997a).
e = Eco-SSLs (www.epa.gov/ecotox/ecossl/) except for arsenic, cobalt, silver, and vanadium, which are from Efroymson et al. (1997b) and chromium, which is from EPA (2008f).
f = Hazard quotient (EPC divided by screening level)
g = Rationale codes.
For Yes: >SL = EPC exceeds screening level
NSL = no screening level available.
For No: < SLs = EPC less than screening levels

Table 6-45 Exposure Assessment and Risk Characterization for Benthic Macroinvertebrates in Red Devil Creek and Kuskokwim River Based on Sediment Data, RDM Site BERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration		Maximum Detected Concentration		EPC[c]	FoD	Sediment Ecological Screening Levels		FoE	HQ[d]	COC	Rationale[e]
								Value	Basis				
Metals (mg/kg)													
Antimony	73	0.17	-	6360	J	1344	68/73	2.9	MacDonald et al. (1999). PAETA, WA	55/68	463	Yes	>SL
Arsenic	73	0.57	J	130000	-	10784	73/73	17	Buchman (2008). Freshwater PEL.	56/73	634	Yes	>SL
Barium	73	4.12	-	1990	-	338	73/73	48	Buchman (2008). Marine AET (amphipod).	71/73	7.0	Yes	>SL
Beryllium	73	0.008	J	0.9	-	0.46	71/73	0.36	MacDonald et al. (1999). Marine AET	39/71	1.3	Yes	>SL
Chromium	73	0.65	J	47.4	J	23	71/73	90	Buchman (2008). Freshwater PEL.	0/71	0.26	No	<SL
Cobalt	73	0.369	-	50	-	15	73/73	50	MacDonald et al. (1999). Criterion, Ontario.	1/73	0.31	No	<SL
Copper	73	0.68	-	87.5	-	33	73/73	197	Buchman (2008). Freshwater PEL.	0/73	0.17	No	<SL
Iron	73	4000	-	344000	-	55,022	73/73	21,200	MacDonald et al. (1999). LEL, B.C.	56/73	2.6	Yes	>SL
Manganese	73	53	-	5410	-	1104	73/73	460	MacDonald et al. (1999). LEL, B.C.	61/73	2.4	Yes	>SL
Mercury	73	0.011	-	29000	-	3154	72/73	0.49	Buchman (2008). Freshwater PEL.	56/72	6437	Yes	>SL
Methylmercury	40	0.0001	J	0.0144	J	0.0041	39/40	0.00001	EPA Region 5 ESL	28/39	408	Yes	>SL
Nickel	73	0.78	-	240	J	51	73/73	36	Buchman (2008). Freshwater PEL.	23/73	1.4	Yes	>SL
Thallium	73	0.011	J	0.653	-	0.14	31/73	0.24	MacDonald et al. (1999). Lowest marine AET.	4/31	0.57	No	<SL
Vanadium	73	1.72	-	48.5	-	27	71/73	57	Buchman (2008). Marine AET (*Neanthes*).	0/71	0.47	No	<SL
Zinc	73	1.2	J	270	-	84	73/73	315	Buchman (2008). Freshwater PEL.	0/73	0.27	No	<SL

Key:
-- = Not available or not applicable
AET = Apparent effect threshold
BERA = Baseline ecological risk assessment
B.C. = British Columbia, Canada
COC = contaminant of concern
COPC = contaminant of potential concern
EPC = Exposure point concentration
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
mg/kg = milligrams per kilogram
PAETA = Probable apparent effect threshold approach
PEL = Probable effect level
RDM = Red Devil Mine
SL = Screening level
PAHs = Polycyclic aromatic hydrocarbons
SLERA = Screening level ecological risk assessment
WA = Washington State
▨ = HQ equals or exceeds 1, or no SL available. Chemical is a COC.

Notes:
a = Only metals identified and COPCs in the SLERA are listed.
b = 67 original samples and 6 field duplicates
c = See Appendix O for method of calculation.
d = Hazard quotient (EPC / screening level)
e = Rationale codes.
For Yes: >SL = EPC exceeds screening level
NSL = no screening level available.
For No: <SL = EPC less than screening level

Table 6-46 Benthic Macroinvertebrate Metrics and Index Values for Red Devil Creek and Nearby Reference Streams

Metric or Index	Units	Description	Response to Disturbance	Red Devil Creek Value	Reference Creek Values[a]		
					Mean	Min.	Max.
Diversity Metrics							
Taxa Richness	Unitless	Richness is a component and estimate of community structure and stream health based on the number of distinct taxa.	Normally decreases with decreasing water quality. In some situations, organic enrichment can cause an increase in the number of pollution tolerant taxa.	22	23	18	30
# of Genera identified	Unitless	This is the number of genera identified in the sample. It can be less than total sample richness, because some individuals may have been identified to a level higher than genus but still represent at least one additional genus in the sample. Such individuals would add to the total richness, but not to the number of genera identified.	Normally decreases with decreasing water quality, however pollution may cause a shift toward more pollution-tolerant taxa.	10	11	9	13
# of Families identified	Unitless	Simply the number of invertebrate families identified in the sample.	Normally decreases with decreasing water quality, however pollution may cause a shift toward more pollution-tolerant taxa.	15	14	13	17
# of EPT Taxa	Unitless	A summary of the taxonomic richness and abundance within the insect Orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). These orders are commonly considered sensitive to pollution	Normally decreases with decreasing water quality.	9	11	8	14
Shannon's Diversity Index	Unitless	Ecological diversity is a measure of community structure defined by the relationship between the number of distinct taxa and their relative abundances. The Shannon diversity index was calculated for each sampling location for which there were a sufficient number of individuals and taxa collected to perform the calculations per Ludwig and Reynolds (1988) .	Normally decreases with decreasing water quality.	1.47	1.78	1.34	2.20
Evenness	Unitless	Evenness is a measure of the distribution of taxa within a community. The evenness index used in BLM (2012) was calculated following Ludwig and Reynolds (1988). Value ranges from 0-1 and approach zero as a single taxa becomes more dominant.	Normally will decrease as increases in pollution cause a shift toward dominance by fewer and more pollution tolerant taxa.	0.48	0.57	0.46	0.65
Biotic Indices							
Hilsenhoff Biotic Index	Unitless, varies from 0-10	Biotic indices use the indicator taxa concept. Taxa are assigned water quality tolerance values based on their tolerance to pollution. Scores are typically weighted by taxa relative abundance. The Hilsenhoff Biotic Index (HBI) summarizes the overall pollution tolerances of the taxa collected (family level in this report), and is best suited for detecting organic pollution.	Normally will increase with decreasing water quality. Regarding organic enrichment, HBI values of 0-2 are considered clean, 2-4 slightly enriched, 4-7 enriched, and 7-10 polluted.	5.28	4.53	3.84	5.25
USFS Community Tolerance Quotient	Unitless, varies from 20-100.	Taxa are assigned a tolerant quotient (TQ), and a dominance-weighted community quotient is calculated based on methods of Winget and Mangum (1979).	Normally will increase with decreasing water quality.	77.0	75.8	62.0	87.0
Abundance Metrics							
Abundance	Unitless	Abundance is simply the total number if organisms in the sample.	Although abundance may be expected to decline in extreme cases of pollution, other changes in community structure may occur before this happens.	5649	2156	705	2790
EPT Abundance	Unitless	The abundance of EPT organisms in the sample, regardless of the number of families or genera.	Normally will decrease with decreasing water quality; however, changes in dominance within EPT taxa, or other metrics, may be apparent before a decline in total EPT abundance.	1079	714	312	1511
Tolerance Metrics							
# of intolerant taxa	Unitless	The tolerance metrics used in this report are all based on HBI tolerance values. Intolerant taxa were defined as those families with HBI values from 0-2.	Because the tolerance metrics are all based on HBI scores, the number of intolerant taxa is expected to decrease with increasing levels of organic pollution, primarily.	5	6	4	8
Abundance of intolerant taxa	Unitless	Total number of invertebrates in intolerant families.	Normally will decrease with increased human impact - especially organic pollution.	477	125	28	338

Table 6-46 Benthic Macroinvertebrate Metrics and Index Values for Red Devil Creek and Nearby Reference Streams

Metric or Index	Units	Description	Response to Disturbance	Red Devil Creek Value	Reference Creek Values[a]		
					Mean	Min.	Max.
# of tolerant taxa	Unitless	Number of tolerant families (HBI scores from 8-10) identified in the sample.	Normally will increase with increased human impact - especially organic pollution.	0	0	0	0
Abundance of tolerant taxa	Unitless	Total number of invertebrates in tolerant families.	Normally will increase with increased human impact - especially organic pollution.	0	0	0	0
Human Induced Disturbance Metrics							
# of Ephemeroptera taxa	Unitless	The number of Ephemeroptera taxa identified in the sample.	Normally decreases with decreasing water quality, however pollution may cause a shift toward more pollution-tolerant taxa. The number will often vary based on diversity of habitat types and food sources, which often vary with stream size. Typically in the range of 3-6 families for small to medium-sized unimpacted streams (Strahler order of ~1-5).	3	4	3	5
# of Plecoptera taxa	Unitless	The number of Plecoptera taxa identified in the sample.	Normally decreases with decreasing water quality, however pollution may cause a shift toward more pollution-tolerant taxa. The number will often vary based on diversity of habitat types and food sources, which often vary with stream size. Typically in the range of 3-6 families for small to medium-sized unimpacted streams (Strahler order of ~1-5).	3	5	4	7
# of Trichoptera taxa	Unitless	The number of Trichoptera taxa identified in the sample.	Normally decreases with decreasing water quality, however pollution may cause a shift toward more pollution-tolerant taxa. The number will often vary based on diversity of habitat types and food sources, which often vary with stream size. Typically in the range of 3-6 families for small to medium-sized unimpacted streams (Strahler order of ~1-5).	3	1.5	0	3
% Contribution of Dominant taxa	Unitless	The percentage of total sample abundance comprised by individuals of the most common taxa.	Normally will increase as disturbance increases.	65	46	30	62
# of Clinger taxa	Unitless	The number of identified taxa with Clinger habits. Clingers typically cling to the tops of rocks.	Some research has indicated the number of clinger taxa may be reduced by sedimentation or abundant algal growth.	5	4.7	2	7
% Predators	Unitless	The percent composition of the total sample abundance comprised by predatory taxa. Predators feed on living animal tissue.	Predators typically make up about 25% of the assemblage in stream environments. A percentage composition of predators less than 25 may indicate some level of impairment.	3.3	3.9	1.3	6.6

[a] Average, minimum, and maximum for six nearby reference creeks (California, Downey, Fuller, Ice, No Name, and Vreeland Creeks) (see Figure 6-8).

Table 6-47 Exposure Assessment and Risk Characterization for Benthic Macroinvertebrates in Red Devil Creek Based on Comparing Metals Concentrations in Benthic Macroinvertebrates With Tissue Screening Concentrations

Analyte[a]	Maximum Concentration (mg/kg wet)[b]	Benthic Invertebrate TSC (mg/kg wet)[c]	Benthic Invertebrate EPC (mg/kg wet)[d]	FoE	HQ[e]	COPC	Rationale[f]
Antimony	21.4	33	21.4	0/3	0.6	No	<SL
Arsenic	277	823	206	0/7	0.2	No	<SL
Barium	14.6	42	10.1	0/7	0.24	No	<SL
Beryllium	--	2.4	--	--	--	No	ND
Chromium	0.67	266	0.54	0/7	0.002	No	<SL
Copper	12.4	368	10.2	0.7	0.03	No	<SL
Iron	2,570	6,338	1,725	0/7	0.41	No	<SL
Manganese	164	196	111	0/7	0.57	No	<SL
Mercury	2.41	1.6	2.1	3/7	1.3	Yes	>SL
Methylmercury	0.13	1	0.076	0/10	0.25	No	<SL
Nickel	2.96	91	1.88	0/7	0.03	No	<SL
Vanadium	1.09	171	0.75	0/7	0.004	No	<SL
Zinc	48.6	17588	45	0/7	0.003	No	<SL

Key:
-- not available or not applicable.
BCF = bioconcentration factor
COC = contaminant of concern
COPC = contaminant of potential concern
EPC = exposure point concentration
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HQ = hazard quotient
ND = not detected.
SL = screening level
SLERA = screening level ecological risk assessment
TSC = tissue screening concentration
HQ ≥ 1 (Chemical is a COC)

Notes:
a = Only metals identified as COPCs in the SLERA are listed.
b = See Appendix N.
c = TSCs developed from site-specific water-to-benthos BCFs and water quality criteria (see Section 6.3.6).
d = UCL for benthic macroinvertebrate composite samples from Red Devil Creek (see Appendix O for method of calculation).
e = Hazard quotient (EPC / screening level)
f = Rationale codes.
For Yes: >SL = EPC exceeds SL
NSL = no screening level available.
For No: <SL = EPC less than SL

Table 6-48 Exposure Assessment and Risk Characterization for Fish and other Aquatic Organisms in Red Devil Creek Based on Surface Water Data, Red Devil Mine Site BERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	EPC[c]	FoD	Surface Water Chronic Ecological Screening Levels		FoE	HQ[d]	COC	Rationale[e]
						Value	Basis				
Metals (µg/L)											
Antimony	22	1.3	184	135.5	22/22	30	Suter and Tsao (1996), Tier II SCV	12/22	4.5	Yes	>SL
Arsenic	22	0.8	1030	811.3	22/22	150	ADEC (2008d) and EPA (2009a)	2/22	5.4	Yes	>SL
Arsenic (without RD05)[f]	20	0.8	85.6	85.6	20/20	150	ADEC (2008d) and EPA (2009a)	0/22	0.57	No	<SL
Barium	22	20.6	103	43.71	22/22	194	MacDonald et al. (1999)	0/22	0.2	No	<SL
Iron	22	118	2470	1325	22/22	1,000	ADEC (2008d) and EPA(2009a)	3/22	1.3	Yes	>SL
Iron (without RD05)[f]	20	118	2470	892	20/20	1,000	ADEC (2008d) and EPA (2009a)	1/20	0.89	No	<SL
Manganese	22	11.2	379	170.6	22/22	120	Suter and Tsao (1996), Tier II SCV	2/22	1.4	Yes	>SL
Manganese (without RD05)[f]	20	11.2	86.4	33.2	20/20	120	Suter and Tsao (1996), Tier II SCV	0/22	0.28	No	<SL
Mercury	21	0.00192	0.385	0.243	21/21	0.77	ADEC (2008d) and EPA (2009a)	0/21	0.31	No	<SL
Mercury	21	0.00192	0.385	0.243	21/21	0.012	EPA (1986b)	15/21	20.2	Yes	>SL

Key:

-- = Not available or not applicable
ADEC = Alaska Department of Environmental Conservation
BERA = baseline ecological risk assessment
COC = contaminant of concern
COPC = contaminant of potential concern
EPA = United States Environmental Protection Agency
EPC = Exposure point concentration
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
SCV = secondary chronic value
SL = screening level
SLERA = screening level ecological risk assessment
▨ = HQ equals or exceeds 1. Chemical is a COC.

Notes:

a = Only metals identified and COPCs in the SLERA are listed.
b = 19 original samples and 3 field duplicates.
c = See Appendix O for method of calculation.
d = Hazard quotient (EPC / screening level).
e = Rationale codes.
For Yes: >SL = EPC exceeds screening level
NSL = no screening level available.
For No: <SL = EPC less than screening level.

Table 6-49 Exposure Assessment and Risk Characterization for Fish in Red Devil Creek Based on Comparing Metals in Whole-Body Sculpin Samples With Fish Tissue Sceening Concentrations

Analyte[a]	Maximum Detected Concentration (mg/kg wet weight)[b]	Fish TSC (mg/kg wet weight)	Fish TSC Source	EPC[c]	FoE	HQ[d]	COPC	Rationale[e]
Antimony	38.1	8.4	Table 6-36D	17.1	11/21	2.0	Yes	>SL
Arsenic	45.9	1.7	Dyer et al. 2000	13.0	41/45	7.6	Yes	>SL
Barium	7.0	20.6	Table 6-36D	3.6	0/45	0.18	No	<SL
Chromium	2.43	0.69	Dyer et al. 2000	0.20	1/45	0.29	No	<SL
Manganese	40.7	61	Table 6-36D	15.4	0/45	0.25	No	<SL
Mercury	3.70	0.46	Dyer et al. 2000	1.4	15/45	3.0	Yes	>SL
Methylmercury	0.312	0.3 - 0.7	S&W 2011	0.21	1/7	0.69	No	<SL
Selenium	2.98	1.1	Dyer et al. 2000	1.4	23/45	1.3	Yes	>SL
Selenium	2.98	1.58	EPA draft TSC	1.4	11/45	0.9	No	<SL
Vanadium	0.43	13.2	Table 6-36D	0.18	0/45	0.014	No	<SL
Zinc	35.4	27	Dyer et al. 2000	25.6	10/45	0.95	No	<SL

Key:
-- not available or not applicable.
BCF = bioconcentration factor
COC = contaminant of concern
COPC = contaminant of potential concern
EPC = exposure point concentration
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HQ = hazard quotient
SL = screening level
SLERA = screening level ecological risk assessment
S&W = Sandheinrich and Weiner (2011)
TSC = tissue screening concentration
UCL = Upper confidence limit (on average concentration).

Notes:
a = Only metals identified as COPCs in the SLERA are listed.
b = Maximum detected concentration for 45 samples (see Appendix H).
c = UCL for 45 slimy sculpin samples collected from Red Devil Creek (see Appendix O).
d = Hazard quotient (EPC / screening level)
e = Rationale codes.
For Yes: >SL = EPC exceeds SL
= SL = EPC equals SL
NSL = no screening level available.
For No: <SL = EPC less than SL

Table 6-50 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site

	Number of Samples[a]	Minimum Concentration (mg/kg dry weight)	Maximum Concentration (mg/kg dry weight)	Frequency of Detection
Green Alder Bark				
Aluminum	9	3.7	24.2	8/9
Antimony	9	0.165 J	3.35 J	8/9
Arsenic	9	0.06	0.91	7/9
Barium	9	2.35	203	8/9
Beryllium	9	0.005 J	0.015 J	4/9
Cadmium	9	0.014 J	0.129	6/9
Calcium	9	4560	10800	8/9
Chromium	9	0.3 J	1.4 J	3/9
Cobalt	9	0.064	0.528	8/9
Copper	9	4.33	6.64	8/9
Iron	9	17.6	34.9	8/9
Lead	9	0.06	0.113	8/9
Magnesium	9	529	967	8/9
Manganese	9	91.2	1140	8/9
Mercury	9	0.017 J	0.289 J	8/9
Methylmercury	5	0.0037 U	0.004 U	0/5
Nickel	9	0.72	4.15	8/9
Potassium	9	1530	2610	8/9
Selenium	9	0.22 J	0.22 J	1/9
Silver	9	0.016	0.193	2/9
Sodium	9	9.8	17	8/9
Thallium	9	0.006 J	0.03	4/9
Vanadium	9	0.03 J	0.07	8/9
Zinc	9	35.9 J	108 J	8/9
Blueberry Leaves and Stems				
Aluminum	2	59.7	64.6	2/2
Antimony	2	0.096 J	0.131 J	2/2
Arsenic	2	0.08 J	0.15 J	2/2
Barium	2	50.4	68	2/2
Beryllium	2	0.003 U	0.003 J	1/2
Cadmium	2	0.332	1.2	2/2
Calcium	2	2400	2430	2/2
Chromium	2	0.2 U	0.2 J	1/2
Cobalt	2	0.035	0.099	2/2
Copper	2	3.58	5.97	2/2
Iron	2	20.3	25.6	2/2
Lead	2	0.061	0.067	2/2
Magnesium	2	902	1120	2/2
Manganese	2	1430	1630	2/2
Mercury	2	0.023 J	0.034 J	2/2
Methylmercury	2	0.004 U	0.004 U	0/2
Nickel	2	1.89	6.68	2/2
Potassium	2	3930	4340	2/2
Selenium	2	0.15 U	0.15 U	2/2
Silver	2	0.008 U	0.008 U	2/2
Sodium	2	12.2 J	12.9 J	2/2
Thallium	2	0.005 J	0.006 J	2/2
Vanadium	2	0.03 J	0.03 J	2/2
Zinc	2	31.6 J	42.6 J	2/2
Spruce Needles				
Aluminum	9	5.1	172	8/9
Antimony	9	0.20 J	15.1 J	7/9
Arsenic	9	0.11 J	11.1	7/9
Barium	9	4.16	85.3	7/9
Beryllium	9	0.008 J	0.008 J	1/9
Cadmium	9	0.01 J	0.191	7/9

Table 6-50 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site

	Number of Samples[a]	Minimum Concentration (mg/kg dry weight)	Maximum Concentration (mg/kg dry weight)	Frequency of Detection
Calcium	9	3320	9920	8/9
Chromium	9	0.4 J	1.3 J	5/9
Cobalt	9	0.05	0.303	8/9
Copper	9	0.93	4.42	8/9
Iron	9	20.1	206	8/9
Lead	9	0.009	0.466	8/9
Magnesium	9	548	958	8/9
Manganese	9	130	2990	8/9
Mercury	9	0.03	5.64	8/9
Methylmercury	5	0.0037 U	0.004 U	0/5
Nickel	9	0.67	6.35	8/9
Potassium	9	3450	7740	8/9
Selenium	9	0.15 U	0.15 U	0/9
Silver	9	0.016 J	0.114	6/9
Sodium	9	4.1 J	24.8 J	8/9
Thallium	9	0.005 J	0.021 J	2/9
Vanadium	9	0.03 J	0.47	7/9
Zinc	9	13.9	53.2 J	8/9
Pond Vegetation				
Aluminum	5	8.3	94.2	4/5
Antimony	5	4.92 J	97.4 J	4/5
Arsenic	5	32.1	309	4/5
Barium	5	18.2	36.2	4/5
Beryllium	5	0.003 J	0.006 J	4/5
Cadmium	5	0.009 J	0.22	4/5
Calcium	5	13300	15700	4/5
Chromium	5	0.2 J	0.6 J	2/5
Cobalt	5	0.308	0.886	4/5
Copper	5	3.4	9.62	4/5
Iron	5	124	282	4/5
Lead	5	0.32	1.18	4/5
Magnesium	5	6340	13400	4/5
Manganese	5	46.8	199	4/5
Mercury	5	0.78 J	5.28 J	4/5
Methylmercury	5	0.0069 J	0.0069 J	1/1
Nickel	5	1.11	3.21	4/5
Potassium	5	15400	39500	4/5
Selenium	5	0.81	0.81	1/5
Silver	5	0.008 U	0.008 U	0/5
Sodium	5	52.5	377	4/5
Thallium	5	0.017 J	0.083	4/5
Vanadium	5	0.05 J	0.29	4/5
Zinc	5	36 J	55.7 J	4/5

Key:
-- = Not available or not applicable
J = estimated value
mg/kg = milligrams per kilogram
U = undetected (reported value is method detection limit)

Notes:
a = Number of original site samples and field duplicates.
Green alder bark: 8 original site samples and 1 field duplicate.
Blueberry leaves and stems: 2 original site samples and 0 field duplicates.
Blueberry fruit: 0 original site samples and 0 field duplicates.
Spruce needles: 8 original site samples and 1 field duplicate.
Pond vegetation: 4 original site samples and 1 field duplicate.

Table 6-51 Summary of 2010 Benthic Macroinvertebrate Composite Sample Data for Red Devil Creek, Red Devil Mine Site BERA

	August 2010 Samples[a]				June 2010 Samples[b]			
Analyte	**Number of Samples**	**Minimum Detected Concentration (mg/kg wet weight)**	**Maximum Detected Concentration (mg/kg wet weight)**	**Frequency of Detection**	**Number of Samples**	**Minimum Detected Concentration (mg/kg wet weight)**	**Maximum Detected Concentration (mg/kg wet weight)**	**Frequency of Detection**
Aluminum	--	--	--	--	3	118.4	125	3/3
Antimony	--	--	--	--	3	18.95	21.44	3/3
Arsenic	--	--	--	--	3	81.24	126.44	3/3
Barium	--	--	--	--	3	4.84	6.61	3/3
Beryllium	--	--	--	--	3	ND[c]	ND[c]	0/3
Boron	--	--	--	--	3	0.67 J+	1.011 J+	3/3
Cadmium	--	--	--	--	3	0.082	0.166	3/3
Calcium	--	--	--	--	3	--	--	--
Chromium	--	--	--	--	3	0.327	0.441	3/3
Cobalt	--	--	--	--	3	--	--	--
Copper	--	--	--	--	3	6.564	12.405	3/3
Iron	--	--	--	--	3	761.3 J-	974 J-	3/3
Lead	--	--	--	--	3	0.131	0.154	3/3
Magnesium	--	--	--	--	3	162	376	3/3
Manganese	--	--	--	--	3	27.84	50.8	3/3
Mercury	--	--	--	--	3	1.60	2.38	3/3
Methylmercury	3	0.0587	**0.131**	3/3	3	0.0238	0.0594	3/3
Molybdenum	--	--	--	--	3	0.1	0.19	3/3
Nickel	--	--	--	--	3	0.557	1.409	3/3
Potassium	--	--	--	--	3	--	--	--
Selenium	--	--	--	--	3	1.002	4.046	3/3
Silver	--	--	--	--	3	--	--	--
Sodium	--	--	--	--	3	--	--	--
Strontium	--	--	--	--	3	1.3 J+	2.2 J+	3/3
Thallium	--	--	--	--	3	--	--	--
Vanadium	--	--	--	--	3	0.40	0.47	3/3
Zinc	--	--	--	--	3	22.6 J-	44.9 J-	3/3

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK. See also Appendix I.

Key:
-- (double dash) = not analyzed.
BERA = Baseline Ecological Risk Assessment
BLM = Bureau of Land Management
J- = estimated value with low bias.
J+ = estimated value with high bias.
mg/kg = milligrams per kilogram
ND = not detected.

Notes:
a = Ephemeroptera, Heptageniidae, *Cinygmula* (mayfly) composite samples with 125 to 176 individuals per sample.
b = Ephemeroptera, Baetidae, *Baetis* (mayfly) composite samples with 270 to 425 individuals per sample.
c = Beryllium method detection limits = 0.025 mg/kg wet weight.

Table 6-52 Summary of 2011 Benthic Macroinvertebrate Composite Sample Data for Red Devil Creek, Red Devil Mine Site BERA

Analyte	September 2011 Sample[a]		June 2011 Samples[b]			
	Number of Samples	Reported Concentration (mg/kg wet weight)	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection
Antimony	1	--	3	--	--	--
Arsenic	1	277	3	29.1	235	3/3
Barium	1	14.6	3	2.08	8.82	3/3
Beryllium	1	0.065 U	3	0.064 U	0.076 U	0/3
Cadmium	1	0.025	3	0.003 U	0.085	2/3
Chromium	1	0.67	3	0.06 U	0.52	2/3
Cobalt	1	--	3	--	--	--
Copper	1	8.75	3	6.93	7.9	3/3
Iron	1	2570	3	305	1670	3/3
Lead	1	0.33	3	0.005 U	0.178	2/3
Manganese	1	164	3	9	51.1	3/3
Mercury	1	2.41	3	0.22	0.38	3/3
Methylmercury	1	0.0304	3	0.027	0.083	3/3
Nickel	1	2.96	3	0.538	1.25	3/3
Selenium	1	0.12 U	3	1.33	2.58	3/3
Silver	1	--	3	--	--	--
Thallium	1	--	3	--	--	--
Vanadium	1	1.09	3	0.05 U	0.63	2/3
Zinc	1	27.6	3	36.2	48.6	3/3

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK. See also Appendix I.

Key:
-- (double dash) = not analyzed.
BERA = Baseline Ecological Risk Assessment
BLM = Bureau of Land Management
mg/kg = milligrams per kilogram
U = not detected, reported value is method detection limit.

Notes:
a = Plecoptera, Nemouridae, *Zapata* (stonefly) composite sample with 937 individuals.
b = Ephemeroptera, Baetidae, *Baetis* (mayfly) and Plecoptera, Nemouridae, *Zapata* (stonefly) composite samples with 106 to 400 individuals per sample.

Table 6-53 Summary of 2010 Sculpin Data from Red Devil Creek, Red Devil Mine Site BERA

Analyte	August 2010 Samples				June 2010 Samples			
	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection
Aluminum	12	11.7	72.5	12/12	9	3.6	20.9	9/9
Antimony	12	6.51	38.1	12/12	9	0.40	4.04	9/9
Arsenic	12	6.86	24.1	12/12	9	1.10	4.49	9/9
Barium	12	2.83	5.40	12/12	9	2.01	4.35	9/9
Beryllium	12	ND[b]	ND[b]	0/12	9	ND[b]	ND[b]	0/9
Boron	12	0.031	0.088	5/12	9	0.142 J+	0.843 J	9/9
Cadmium	12	0.029	0.056	5/12	9	0.027	0.103	6/9
Calcium	--	--	--	--	9	--	--	--
Chromium	12	0.038	0.188	12/12	9	0.028	2.431	9/9
Cobalt	--	--	--	--	9	--	--	--
Copper	12	0.72	1.164	12/12	9	0.27 J-	2.263 J-	9/9
Iron	12	63.7	184	12/12	9	18.9 J-	61 J-	9/9
Lead	12	0.027	0.079	11/12	9	0.025 J	0.026	2/9
Magnesium	12	280	368	12/12	9	251	423	9/9
Manganese	12	6.65	21.3	12/12	9	8.44	16.0	9/9
Mercury	12	0.68	3.70	12/12	9	0.05	0.63	9/9
Methylmercury	1	0.16	0.16	1/1	1[a]	0.312	0.312	1/1
Molybdenum	12	0.028	0.038	7/12	9	0.03	0.03	1/9
Nickel	12	0.083	0.263	12/12	9	0.039	0.113	9/9
Potassium	--	--	--	--	9	--	--	--
Selenium	12	1.53	2.98	12/12	9	0.834	1.43	9/9
Silver	--	--	--	--	9	--	--	--
Sodium	--	--	--	--	9	--	--	--
Strontium	12	10.6	30.0	12/12	9	15.5 J+	32.8 J+	9/9
Thallium	--	--	--	--	9	--	--	--
Vanadium	12	0.15	0.32	12/12	9	0.10	0.40	9/9
Zinc	12	20.6	35.4	12/12	9	17.1 J-	30.2 J-	9/9

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK. See also Appendix I.

Key:
-- (double dash) = not analyzed.
BERA = Baseline Ecological Risk Assessment
BLM = Bureau of Land Management
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Composite sample. In June 2010, methylmercury was measured only in a composite sample of three sculpin.
b = Beryllium method dection limits = 0.025 mg/kg wet weight.

Table 6-54 Summary of 2011 Sculpin Data from Red Devil Creek, Red Devil Mine Site BERA

Analyte	September 2011 Samples				June 2011 Samples			
	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection
Antimony	12	--	--	--	12	--	--	--
Arsenic	12	3.66	45.9	12/12	12	1.62	9.11	12/12
Barium	12	0.99	6.96	12/12	12	1.93	4.83	12/12
Beryllium	12	0.058 U	0.067 U	0/12	12	0.057 U	0.066 U	0/12
Chromium	12	0.05 U	0.06 U	0/12	12	0.05 U	0.06 U	0/12
Cobalt	12	--	--	--	12	--	--	--
Manganese	12	3.49	30.3	12/12	12	7.46	40.7	12/12
Mercury	12	0.10	1.0	12/12	12	0.086	0.28	12/12
Methylmercury	2	0.0827	0.135	2/2	3	0.05	0.164	3/3
Selenium	12	0.58	1.48	12/12	12	0.59	1.05	12/12
Silver	12	--	--	--	12	--	--	--
Thallium	12	--	--	--	12	--	--	--
Vanadium	12	0.04 U	0.43	3/12	12	0.038 U	0.044 U	0/12
Zinc	12	15.9	26.9	12/12	12	20.3	33.5	12/12

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK. See also Appendix I.

Key:
-- (double dash) = not analyzed.
BERA = Baseline Ecological Risk Assessment
BLM = Bureau of Land Management
mg/kg = milligrams per kilogram
U = not detected, reported value is method detection limit.

Table 6-55 Exposure Parameters for Wildlife Receptors, Red Devil Mine Site BERA

Species	Assumed Diet	Soil or Sediment Ingestion (kg/d) dry	Surface Water Ingestion (L/day)	Home Range (ha or km)	Site Use Factor[i]	Exposure Duration[j]	Food Ingestion Rate (kg/d) wet	Percent Water in Diet	Food Ingestion Rate (kg/d) dry	Body Weight (kg)
Terrestrial Wildlife										
American Robin[a]	100% soil invertebrates	0.00019	0.011	0.42 ha	1.0	0.33	0.093	80%	0.0186	0.077
Masked Shrew[b]	100% soil invertebrates	0.00011	0.0011	0.22 ha	1.0	1.0	--	--	0.0021	0.0064
Spruce Grouse[c]	100% conifer foliage	0.0056	0.038	3.93 ha	1.0	1.0	--	--	0.06	0.53
Tundra Vole[b]	100% herbaceous plants	0.0002	0.0063	0.1087 ha	1.0	1.0	--	--	0.0085	0.047
Northern Shrike[d]	100% small mammals	0	0.0095	n.a.	1.0	0.33	--	--	0.0139	0.0656
Least Weasel[e]	100% small mammals	0	0.0053	n.a.	1.0	1.0	--	--	0.0048	0.039
Aquatic-Dependent Wildlife										
Common Snipe[b, h]	100% benthic invertebrates	0.0016	0.014	0.1 to 48 ha	1.0	0.33	0.047	68%	0.015	0.116
Beaver[f]	100% alder bark	0.0037	1.76	n.a.	1.0	1.0	--	--	0.186	24.5
Green Winged Teal[b]	100% pond vegetation	0.001	0.027	243 ha	0.004	0.33	--	--	0.053	0.32
Belted Kingfisher[g]	100% forage fish	0	0.016	2.2 km	1.0	0.33	0.075	68%	0.024	0.148
Mink[g]	100% forage fish	0	0.099	1.9 to 2.6 km	1.0	1.0	0.137	68%	0.044	1

Key:
-- = not applicable
BERA = baseline ecological risk assessment
ha = hectare
kg = kilogram
kg/d = kilograms per day
L/d = liters per day

Notes:
a. Sample and Suter (1994).
b. Exponent (2007).
c. Exponent (2007) for willow ptarmigan.
d. Dunning (1993) for body weight. Food ingestion rate calculated from body weight using allometric relationship for passerine birds from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
e. EPA (1993b) for body weight. Food ingestion rate calculated from body weight using allometric relationship for placental mammals from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
f. Body weight from www.Alaskan-Adventures.com (accessed 6-7-11). Food and water ingestion rates calculated from body weight using allometric relationships from Sample et al. (1996). Soil ingestion rate assumed to be 2% of food ingestion rate.
g. Sample and Suter (1994).
h. Food moisture content of 68% based on EPA (1999) for carnivores. Wet food Ingestion rate = dry food ingestion rate / (1- food moisture content).
i. Site use factor (SUF) of 1 assumed for all receptors except green-winged teal. For the teal, the SUF equals the settling pond surface area (1 ha) divided by the home range (243 ha).
j. Migratory birds (robin, shrike, snipe, teal, kingfisher) assumed to be present at site four months of the year (4/12 = 0.33). Other species assumed to be present year-round.

Table 6-56 Data Used to Estimate Exposure Point Concentrations for Calculating Exposure Estimates for Wildlife

Receptor	Exposure Point Concentration											
	Measured Chemical Concentration										Modeled Concentration[a]	
	RDC Surface Water	Surface Soil	Sediment		Spruce Needles[b]	Blueberry Stems and Leaves[b]	Green Alder Bark[b]	Settling Pond Plants[b]	Sculpin[b]	Mayfly[b]	Earthworm	Small Mammal
			RDC and KR	Settling Ponds								
Terrestrial Wildlife												
American Robin	X	X	--	--	--	--	--	--	--	--	X	--
Masked Shrew	X	X	--	--	--	--	--	--	--	--	X	--
Spruce Grouse	X	X	--	--	X	--	--	--	--	--	--	--
Tundra Vole	X	X	--	--	--	X	--	--	--	--	--	--
Northern Shrike	X	--	--	--	--	--	--	--	--	--	--	X
Least Weasel	X	--	--	--	--	--	--	--	--	--	--	X
Aquatic-Dependent Wildlife												
Common Snipe	X	--	X	--	--	--	--	--	--	X	--	--
Beaver	X	X	--	--	--	--	X	--	--	--	--	--
Green Winged Teal	X	--	--	X	--	--	--	X	--	--	--	--
Belted Kingfisher	X	--	--	--	--	--	--	--	X	--	--	--
Mink	X	--	--	--	--	--	--	--	X	--	--	--

Key:
EPC = Exposure Point Concentration
KR = Kuskokwim River
RDC = Red Devil Creek

Notes:
a = Based on surface soil EPC. For chemicals with no available model, the chemical concentration in earthworms and small mammals was set equal to the surface soil EPC.

b = If a chemical was detected in soil or sediment but not analyzed for in biota, the biota chemical concentration was assumed to be equal to the soil or sediment EPC.

Table 6-57 American Robin and Masked Shrew Exposure Point Concentrations, Red Devil Mine Site BERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Surface Soil EPC (mg/kg)[b]	Soil to-Earthworm Bioaccumulation Equation[c]	Earthworm EPC (mg/kg)
Metals				
Antimony	136	4234	$C_e = C_s$	4234
Arsenic	811	3596	$\ln(C_e) = 0.706 * \ln(C_s) – 1.421$	78
Barium	44	438.3	$C_e = 0.091 * C_s$	40
Beryllium	0.009	0.734	$C_e = 0.045 * C_s$	0.033
Cadmium	0.0059	0.321	$\ln(C_e) = 0.795 * \ln(C_s) + 2.114$	3.4
Chromium	0.31	29.1	$C_e = 0.306 * C_s$	8.9
Copper	0.43	69.03	$C_e = 0.5 15 * C_s$	35.6
Lead	0.034	96.56	$\ln(C_e) = 0.807 * \ln(C_s) – 0.218$	32
Manganese	171	756.6	$\ln(C_e) = 0.682 * \ln(C_s) – 0.809$	41
Mercury	0.2425	251.6	$\ln(C_e) = 0.118 * \ln(C_s) – 0.684$	0.97
Nickel	10.5	52.39	$C_e = 1.059 * C_s$	55
Selenium	0.39	0.42	$\ln(C_e) = 0.733 * \ln(C_s) – 0.075$	0.49
Thallium	0.0075	0.071	$C_e = C_s$	0.071
Vanadium	0.14	34.82	$C_e = 0.042 * C_s$	1.46
Zinc	0.73	110.6	$\ln(C_e) = 0.328 * \ln(C_s) + 4.449$	400

Key:
-- = not analyzed
BERA = baseline ecological risk assessment
C_e = chemical concentration in earthworm
C_s = chemical concentration in soil
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
UCL = upper confidence limit
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix O).
c. Soil-to-earthworm bioacumulation equations from EPA (2005a), except for nickel, which is from Sample et al. (1998a). For chemicals with no available model, the chemical concentration in earthworms was set equal to the surface soil EPC.

Table 6-58 Spruce Grouse, Tundra Vole, and Beaver Exposure Point Concentrations, Red Devil Mine Site BERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Surface Soil EPC (mg/kg)[b]	Spruce Needles (mg/kg)[b]	Blueberry Stems and Leaves (mg/kg)[c]	Alder Bark (mg/kg)[b]
Metals					
Antimony	136	4234	10.3	0.131	2.72
Arsenic	811	3596	7.6	0.15	0.53
Barium	44	438	59.9	--	--
Beryllium	0.009	0.73	0.008	--	--
Lead	0.034	97	0.34	0.067	--
Manganese	171	757	1904	1630	--
Mercury	0.24	252	5.6	--	--
Thallium	0.0075	0.071	0.021	--	--
Vanadium	0.14	35	0.47	--	--

Key:
-- = not available
BERA = baseline ecological risk assessment
EPC = Exposure Point Concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
SLERA = screening level ecological risk assessment
UCL = upper confidence limit
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix O).
c. Maximum detected concentration from Table 6-50.

Table 6-59 Green-Winged Teal Exposure Point Concentrations, Red Devil Mine Site BERA

Analyte[a]	Surface Water EPC (ug/L)[b]	Settling Pond "Sediment" EPC	Settling Pond Vegetation EPC	
			Value (mg/kg)	Basis
Metals				
Antimony	136	1430	97.4	Maximum measured concentration (Table 6-50)
Arsenic	811	9880	309	Maximum measured concentration (Table 6-50)
Beryllium	0.009	0.8	0.006	Maximum measured concentration (Table 6-50)
Mercury	0.24	127	5.28	Maximum measured concentration (Table 6-50)
Thallium	0.0075	0.75	0.083	Maximum measured concentration (Table 6-50)

Key:
-- = Not analyzed.
BERA = baseline ecological risk assessment
EPC = Exposure point concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix O).
c. Maximum concentration from three original surface soil samples (10MP32SS, 10MP34SS, and 10MP36SS) and one field duplicate surface soil sample (10MP84SS) collected from the settling ponds.

Table 6-60 Northern Shrike and Least Weasel Exposure Point Concentrations, Red Devil Mine Site BERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Surface Soil EPC (mg/kg)[b]	Soil- or Diet to Small Mammal Bioaccumulation Equation[c]	Small Mammal EPC (mg/kg)
Metals				
Antimony	136	4234	$C_m = 0.001 * 50 * C_d$	0.007
Arsenic	811	3596	$\ln(C_m) = 0.8188 * \ln(C_s) – 4.8471$	6.4
Beryllium	0.009	0.734	$C_m = 0.001 * 50 * C_d$	0.0002
Lead	0.034	96.6	$\ln(C_m) = 0.4422 * \ln(C_s)+0.0761$	8.1
Thallium	0.0075	0.071	$C_m = 0.1124 * C_s$	0.008

Key:
-- = not analyzed
BERA = baseline ecological risk assessment
C_d = chemical concentration in diet (maximum concentration in blueberry stems/leaves)
C_m = chemical concentration in small mammal tissue
C_s = chemical concentration in soil
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
NDs = non detects
SLERA = screening level ecological risk assessment
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix O).
c. EPA (2005a) except for thallium, which is from Sample et al. (1998b).

Table 6-61 Common Snipe Exposure Point Concentrations, Red Devil Mine Site BERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Sediment EPC (mg/kg)[c]	Benthic Macroinvertebrate EPC (mg/kg)	
			Value	Basis
Metals				
Antimony	136	4,455	21.44	Maximum measured concentration (see Appendix O)
Arsenic	811	38,302	206	95% UCL (see Appendix O)
Barium	44	681	10.1	95% UCL (see Appendix O)
Beryllium	0.009	1.32	0.013	One-half method detection limit (see Appendix N)
Copper	0.43	37	10.2	95% UCL (see Appendix O)
Mercury	0.24	67	2.1	95% UCL (see Appendix O)
Selenium	0.385	0.49	3.1	95% UCL (see Appendix O)
Thallium	0.0075	0.15	0.150	Not analyzed in benthic invertebrates. See note d.
Vanadium	0.14	31	0.75	95% UCL (see Appendix O)

Key:
BERA = baseline ecological risk assessment
EPC = Exposure Point Concentration
HHRA = human health risk assessment
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
UCL = upper confidence level
µg/L = micrograms per kilogram

Notes:

a. Only metals identified as COPCs in the SLERA are listed.

b. UCL on average concentration or maximum detected concentration (see Appendix O).

c. UCL on average concentration for Red Devil Creek and Kuskowkim River near-shore sediment samples (see HHRA EPC tables) except for beryllium, which is from Table 6-45.

d. Benthic macroinvertebrate EPC assumed to be equal to sediment EPC.

Table 6-62 Belted Kingfisher and Mink Exposure Point Concentrations, Red Devil Mine Site BERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Sediment EPC (mg/kg)[c]	Slimy Sculpin EPC Value (mg/kg)	Slimy Sculpin EPC Basis
Metals				
Antimony	136	4,455	17.06	UCL on average concentration (see Appendix O)
Arsenic	811	38,302	13.0	UCL on average concentration (see Appendix O)
Beryllium	0.009	1.32	0.0125	One-half method detection limit (see Appendix I)
Cobalt	3.04	17	17	Not analyzed in sculpin. See note d.
Mercury	0.24	67	1.4	UCL on average concentration (see Appendix O)
Methylmercury	0.0003	0.0052	0.21	UCL on average concentration (see Appendix O)
Selenium	0.39	0.49	1.4	UCL on average concentration (see Appendix O)
Thallium	0.0075	0.15	0.15	Not analyzed in sculpin. See note d.

Key:
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
µg/L = micrograms per kilogram

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix O).
c. UCL on average concentration for Red Devil Creek and Kuskowkim River near-shore sediment samples (see HHRA EPC tables) except for beryllium, which is from Table 6-45.
d. Sculpin EPC assumed equal to sediment EPC.

Table 6-63 Toxicity Reference Values for Birds and Mammals

Analyte	Wildlife Class	NOAEL (mg/kg-day)	Critical Effect	LOAEL (mg/kg-day)	Critical Effect	Reference and Comments
Metals						
Antimony	Birds	NA	NA	NA	NA	NA
	Mammals	0.059	Reproduction	0.59	Reproduction	EPA (2005h). Highest bounded NOAEL (0.059 mg/kg-d) for growth or reproduction below lowest bounded LOAEL (0.59 mg/kg-d) for growth or reproduction from 20 laboratory toxicity studies.
Arsenic	Birds	2.24	Reproduction	3.55	Growth	EPA(2005a). Lowest NOAEL for growth, reproduction, or survival from nine laboratory toxicity studies. Lowest LOAEL for growth, reproduction, or survival greater than selected NOAEL.
	Mammals	1.04	Growth	1.66	Growth	EPA (2005a). Highest bounded NOAEL for growth, reproduction, or survival less than lowest bounded LOAEL for growth, reproduction, or survival from 62 laboratory toxicity studies.
Barium	Birds	20.8	Survival	41.7	Survival	Sample et al. (1996).
	Mammals	51.8	Reproduction, growth, and survival	121	Growth and survival	EPA (2005b). Geometric mean NOAEL for growth, reproduction, and survival from 12 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL.
Beryllium	Birds	NA	NA	NA	NA	na
	Mammals	0.532	Survival	NA	NA	EPA (2005c). Lowest NOAEL for growth, reproduction, or survival from four laboratory toxicity studies.
Cadmium	Birds	1.47	Reproduction, growth, and survival	2.37	Reproduction	EPA (2005d). Geometric mean NOAEL for growth, reproduction, and survival from 49 laboratory toxicity studies. Lowest bounded LOAEL for growth, reproduction, or survival greater than geometric mean NOAEL.
	Mammals	0.77	Growth	1	Growth	EPA (2005d). Highest bounded NOAEL (0.77 mg/kg-d) for reproduction, growth, or survival less than the lowest bounded LOAEL (1.0 mg/kg-d) from 141 laboratory toxicity studies.
Chromium	Birds	2.66	Reproduction, growth, and survival	2.78	Survival	EPA (2008f). Geometric mean NOAEL for growth, reproduction, and survival from 17 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL.
	Mammals	9.24	Reproduction and growth	NA	NA	EPA (2008f). Geometric mean NOAEL for reproduction and growth from 10 studies with trivalent chromium.
Cobalt	Birds	7.61	Growth	7.8	Growth	EPA (2005e). Geometric mean NOAEL for growth from 10 toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL.
	Mammals	7.33	Reproduction and Growth	10.9	Reproduction	EPA (2005e). Geometric mean NOAEL for reproduction and growth based on 21 laboratory toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL.
Copper	Birds	4.05	Reproduction	4.68	Growth	EPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (4.05 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (4.68 mg/kg-day).
	Mammals	5.6	Reproduction	6.79	Growth	EPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (5.6 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (6.79 mg/kg-day).
Lead	Birds	1.63	Reproduction	1.94	Reproduction	EPA (2005f). Highest bounded NOAEL (1.63 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (1.94 mg/kg-d) for growth, reproduction, or survival based on 57 laboratory toxicity studies.
	Mammals	4.7	Growth	5	Growth	EPA (2005f). Highest bounded NOAEL (4.7 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (5 mg/kg-d) for growth, reproduction, or survival based on 220 laboratory toxicity studies.
Manganese	Birds	179	Reproduction and Growth	348	Growth	EPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
	Mammals	51.5	Reproduction and Growth	65	Growth	EPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.

Table 6-63 Toxicity Reference Values for Birds and Mammals

Analyte	Wildlife Class	NOAEL (mg/kg-day)	Critical Effect	LOAEL (mg/kg-day)	Critical Effect	Reference and Comments
Mercury	Birds	0.45	Reproduction	0.9	Reproduction	Sample et al. (1996).
	Mammals	13.2	Reproduction and survival	na	na	Sample et al. (1996).
Methylmercury	Birds	0.068	Reproduction	0.37	Reproduction	CH2MHILL (2000).
	Mammals	0.032	Reproduction	0.16	Reproduction	CH2MHILL (2000).
Nickel	Birds	6.71	Growth and survival	11.5	Growth	EPA (2007c). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
	Mammals	1.7	Reproduction	2.71	Reproduction	EPA (2007c). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival.
Selenium	Birds	0.291	Survival	0.368	Reproduction	EPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival.
	Mammals	0.143	Growth	0.145	Reproduction	EPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival.
Silver	Birds	2.02	Growth	20.2	Growth	EPA (2006a). Lowest LOAEL for reproduction or growth divided by 10.
	Mammals	6.02	Growth	60.2	Growth	EPA (2006a). Lowest LOAEL for reproduction or growth divided by 10.
Thallium	Birds	NA	NA	NA	NA	NA
	Mammals	0.0074	Reproduction	0.074	Reproduction	Sample et al. (1996).
Vanadium	Birds	0.344	Growth	0.413	Reproduction	EPA (2005g). Highest bounded NOAEL (0.344 mg/kg-d) for growth, reproduction, or survival less than lowest bounded LOAEL (0.413 mg/kg-d) for reproduction, growth, or survival based on 94 laboratory toxicity studies.
	Mammals	4.16	Reproduction and growth	5.11	Growth	EPA (2005g). Highest bounded NOAEL (4.16 mg/kg-d) for growth or reproduction less than lowest bounded LOAEL (5.11 mg/kg-d) for growth, reproduction, or survival based on 94 laboratory toxicity studies.
Zinc	Birds	66.1	Reproduction and Growth	66.5	Reproduction	EPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
	Mammals	75.4	Reproduction and Growth	75.9	Reproduction	EPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.

Key:
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NA = not available
NOAEL = no observed adverse effect level
TRV = toxicity reference value

Table 6-64 American Robin Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ NOAEL	HQ LOAEL
Metals								
Antimony	3.5E+00	6.5E-03	3.4E+02	3.4E+02	--	NA	--	--
Arsenic	3.0E+00	3.9E-02	6.3E+00	9.3E+00	2.24	3.55	4	3
Barium	3.6E-01	2.1E-03	3.2E+00	3.6E+00	20.8	41.7	0.2	0.1
Beryllium	6.0E-04	4.3E-07	2.7E-03	3.3E-03	--	NA	--	--
Cadmium	2.6E-04	2.8E-07	2.7E-01	2.7E-01	1.47	2.37	0.2	0.1
Chromium	2.4E-02	1.5E-05	7.2E-01	7.4E-01	2.66	2.78	0.3	0.3
Copper	5.7E-02	2.1E-05	2.9E+00	2.9E+00	4.05	4.68	0.7	0.6
Lead	7.9E-02	1.6E-06	2.6E+00	2.7E+00	1.63	1.94	1.6	1.4
Mercury	2.1E-01	1.2E-05	7.8E-02	2.8E-01	0.45	0.9	0.6	0.3
Nickel	4.3E-02	5.0E-04	4.5E+00	4.5E+00	6.71	11.5	0.7	0.4
Thallium	5.8E-05	3.6E-07	5.7E-03	5.8E-03	--	NA	--	--
Vanadium	2.9E-02	6.5E-06	1.2E-01	1.5E-01	0.344	0.413	0.4	0.4
Zinc	9.1E-02	3.5E-05	3.2E+01	3.2E+01	66.1	66.5	0.5	0.5

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quoti
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-65 Masked Shrew Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ NOAEL	HQ LOAEL
Metals								
Antimony	7.3E+01	2.3E-02	1.4E+03	1.5E+03	0.059	0.59	24781	2478
Arsenic	6.2E+01	1.4E-01	2.6E+01	8.8E+01	1.04	1.66	84	53
Barium	7.5E+00	7.5E-03	1.3E+01	2.1E+01	51.8	121	0.4	0.17
Cadmium	5.5E-03	1.0E-06	1.1E+00	1.1E+00	0.77	1	1.4	1.1
Chromium	5.0E-01	5.3E-05	2.9E+00	3.4E+00	9.24	--	0.37	--
Copper	1.2E+00	7.4E-05	1.2E+01	1.3E+01	5.6	6.79	2.3	1.9
Lead	1.7E+00	5.9E-06	1.1E+01	1.2E+01	4.7	5	3	2
Manganese	1.3E+01	2.9E-02	1.3E+01	2.6E+01	51.5	65	0.5	0.4
Mercury	4.3E+00	4.2E-05	3.2E-01	4.6E+00	13.2	--	0.4	--
Nickel	9.0E-01	1.8E-03	1.8E+01	1.9E+01	1.7	2.71	11	7
Selenium	7.2E-03	6.6E-05	1.6E-01	1.7E-01	0.143	0.145	1.2	1.2
Thallium	1.2E-03	1.3E-06	2.3E-02	2.5E-02	0.0074	0.074	3.3	0.33
Zinc	1.9E+00	1.2E-04	1.3E+02	1.3E+02	75.4	75.9	1.8	1.8

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-66 Spruce Grouse Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ NOAEL	HQ LOAEL
Metals								
Antimony	4.5E+01	9.7E-03	1.2E+00	4.6E+01	--	--	--	--
Arsenic	3.8E+01	5.8E-02	8.6E-01	3.9E+01	2.24	3.55	17	11
Barium	4.6E+00	3.1E-03	6.8E+00	1.1E+01	20.8	41.7	0.5	0.27
Beryllium	7.8E-03	6.5E-07	9.1E-04	8.7E-03	--	--	--	--
Lead	1.0E+00	2.5E-06	3.8E-02	1.1E+00	1.63	1.94	0.6	0.5
Manganese	8.0E+00	1.2E-02	2.2E+02	2.2E+02	179	348	1.2	0.6
Mercury	2.7E+00	1.7E-05	6.4E-01	3.3E+00	0.45	0.9	7.3	3.7
Thallium	7.5E-04	5.4E-07	2.4E-03	3.1E-03	--	--	--	--
Vanadium	3.7E-01	9.8E-06	5.3E-02	4.2E-01	0.344	0.413	1.2	1.0

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-67 Tundra Vole Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ-NOAEL	HQ-LOAEL
Metals								
Antimony	1.8E+01	1.8E-02	2.4E-02	1.8E+01	0.059	0.59	306	31
Arsenic	1.5E+01	1.1E-01	2.7E-02	1.5E+01	1.04	1.66	15	9.3
Lead	4.1E-01	4.6E-06	1.2E-02	4.2E-01	4.7	5	0.1	0.1
Manganese	3.2E+00	2.3E-02	2.9E+02	3.0E+02	51.5	65	5.8	4.6

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-68 Northern Shrike Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ-NOAEL	HQ-LOAEL
Metals								
Antimony	0.0E+00	6.5E-03	4.6E-04	7.0E-03	--	--	--	--
Arsenic	0.0E+00	3.9E-02	4.5E-01	4.9E-01	2.24	3.55	0.22	0.14
Beryllium	0.0E+00	4.3E-07	1.1E-05	1.1E-05	--	--	--	--
Lead	0.0E+00	1.7E-06	5.8E-01	5.8E-01	1.63	1.94	0.4	0.3
Thallium	0.0E+00	3.6E-07	5.6E-04	5.6E-04	--	--	--	--

Key:
-- = not available.
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HQ = hazard quotient
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
mg/kg = Milligrams per kilogram
mg/kg/day = Milligrams per kilogram per day
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-69 Least Weasel Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ NOAEL	HQ LOAEL
Metals								
Arsenic	0.0E+00	1.1E-01	7.9E-01	9.0E-01	1.04	1.66	0.9	0.5
Lead	0.0E+00	4.7E-06	1.0E+00	1.0E+00	4.7	5	0.2	0.2

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-70 Common Snipe Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ NOAEL	HQ LOAEL
Metals								
Antimony	2.0E+01	5.5E-03	2.9E+00	2.3E+01	--	--	--	--
Arsenic	1.8E+02	3.3E-02	2.8E+01	2.0E+02	2.24	3.55	91	57
Barium	3.1E+00	1.8E-03	1.4E+00	4.5E+00	20.8	41.7	0.2	0.11
Beryllium	6.1E-03	3.6E-07	1.7E-03	7.8E-03	--	NA	--	--
Copper	1.7E-01	1.7E-05	1.4E+00	1.5E+00	4.05	4.68	0.4	0.3
Mercury	3.1E-01	9.8E-06	2.8E-01	5.9E-01	0.45	0.9	1.3	0.7
Selenium	2.3E-03	1.5E-05	4.1E-01	4.2E-01	0.291	0.368	1.4	1.1
Thallium	6.9E-04	3.0E-07	2.0E-02	2.1E-02	--	--	--	--
Vanadium	1.4E-01	5.5E-06	1.0E-01	2.4E-01	0.344	0.413	0.71	0.59

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-71 Beaver Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ NOAEL	HQ LOAEL
Metals								
Antimony	6.4E-01	9.7E-03	2.1E-02	6.7E-01	0.059	0.59	11	1.1
Arsenic	5.4E-01	5.8E-02	4.0E-03	6.1E-01	1.04	1.66	0.6	0.4

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-72 Green Winged Teal Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ-NOAEL	HQ-LOAEL
Metals								
Antimony	6.1E-03	1.6E-05	2.2E-02	2.8E-02	--	--	--	--
Arsenic	4.2E-02	9.4E-05	7.0E-02	1.1E-01	2.24	3.55	0.05	0.03
Beryllium	3.4E-06	1.0E-09	1.4E-06	4.8E-06	--	--	--	--
Mercury	5.4E-04	2.8E-08	1.2E-03	1.7E-03	0.45	0.9	0.004	0.002
Thallium	3.2E-06	8.7E-10	1.9E-05	2.2E-05	--	--	--	--

Key:
-- = Not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated exposure from incidental sediment (i.e., dry surface soil) ingestion
EE-total = total chemical exposure
HQ = hazard quotient
NOAEL = no observed adverse effect level
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-73 Belted Kingfisher Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ-NOAEL	HQ-LOAEL
Metals								
Antimony	0.00	4.9E-03	2.88	2.89	--	--	--	--
Arsenic	0.00	2.9E-02	2.19	2.22	2.24	3.55	1.0	0.6
Beryllium	0.00	3.2E-07	0.00	0.00	--	--	--	--
Cobalt	0.00	1.1E-04	2.87	2.87	7.61	7.8	0.38	0.37
Mercury	0.00	8.7E-06	0.23	0.23	0.45	0.9	0.5	0.3
Methylmercury	0.00	1.1E-08	0.03	0.03	0.068	0.37	0.5	0.09
Selenium	0.00	1.4E-05	0.24	0.24	0.291	0.368	0.8	0.7
Thallium	0.00	2.7E-07	0.03	0.03	--	--	--	--

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-74 Mink Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	HQ-NOAEL	HQ-LOAEL
Metals								
Antimony	0.00	1.3E-02	2.34	2.35	0.059	0.59	40	4.0
Arsenic	0.00	8.0E-02	1.78	1.86	1.04	1.66	1.8	1.1
Methylmercury	0.00	3.1E-08	0.028	0.028	0.032	0.16	0.9	0.18
Selenium	0.00	3.8E-05	0.20	0.20	0.143	0.145	1.4	1.4
Thallium	0.00	7.5E-07	0.007	0.007	0.0074	0.74	0.9	0.01

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = contaminant of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient

mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Only metals identified as COPCs in the SLERA are listed.

Table 6-75 Percent of Total Concentration in Surface Soil Solubilized Via SPLP Extraction for Antimony, Arsenic, and Mercury

Sample ID	Antimony					Arsenic					Mercury				
	Total Antimony (mg/kg)		SPLP Antimony (µg/L)		Percent of Total Antimony Solubilized via SPLP	Total Arsenic (mg/kg)		SPLP Arsenic (µg/L)		Percent of Total Arsenic Solubilized via SPLP	Total Mercury (mg/kg)		SPLP Mercury (µg/L)		Percent of Total Mercury Solubilized via SPLP
10DS01SS	40	J	60	--	3.0%	1010	--	50	U	--	71	--	1.6	J	0.0%
10MP01SS	20	J	70	--	7.0%	100	--	50	U	--	2.6	--	0.1	--	0.1%
10MP02SS	210	J	90	--	0.9%	7310	--	440	--	0.1%	88	--	0.6	--	0.0%
10MP030405SS	5500	J	9250	--	3.4%	5580	--	3050	--	1.1%	680	--	30	--	0.1%
10MP06070809SS	4420	J	8190	--	3.7%	4520	--	2810	--	1.2%	750	--	8	--	0.0%
10MP16SS	1570	J	2790	--	3.6%	6950	--	3870	--	1.1%	290	--	5.7	--	0.0%
10MP17SS	6180	J	7740	--	2.5%	5540	--	4900	--	1.8%	460	--	14.7	--	0.1%
10MP25SS	14100	--	9240	--	1.3%	5400	--	3820	--	1.4%	1340	--	21	J	0.0%
10MP26SS	15100	--	11200	--	1.5%	6420	--	4890	--	1.5%	1620	--	12	J	0.0%
10MP27SS	8480	--	10700	--	2.5%	6100	--	3660	--	1.2%	250	--	1.5	J	0.0%
10MP29SS	16700	--	31300	--	3.7%	6170	--	6000	--	1.9%	440	--	7	J	0.0%
10MP32SS	1430	--	3660	--	5.1%	9880	--	2310	--	0.5%	127	--	3.3	J	0.1%
10MP34SS	780	--	480	--	1.2%	8510	--	700	J	0.2%	79	--	1.2	J	0.0%
10MP36SS	690	--	510	--	1.5%	7050	--	570	J	0.2%	75	--	1.4	J	0.0%
10MP41SS	39	--	50	U	--	516	--	50	U	--	8	--	0.9	J	0.2%
10MP424344SS	880	--	1580	--	3.6%	1840	--	590	J	0.6%	136	--	3.9	J	0.1%
10MP5051525354SS	10100	J	9140	--	1.8%	3610	--	2000	--	1.1%	144	--	174	--	2.4%
10MP55565758SS	764	J	960	--	2.5%	1100	--	920	--	1.7%	114	--	15	--	0.3%
10MP59SS	170	J	110	--	1.3%	1130	--	370	--	0.7%	115	--	0.2	--	0.0%
10OP01SS	3520	J	1950	--	1.1%	5340	--	4430	--	1.7%	170	--	4.8	J	0.1%
10RD04SS	381	J	620	--	3.3%	1210	--	540	--	0.9%	99	--	37	--	0.7%
10RD06SS	677	J	1290	--	3.8%	1250	--	660	--	1.1%	186	--	40	--	0.4%
10RD09SS	1.4	UJ	50	U	--	20	--	50	J	5.0%	2	--	0.1	UJ	--
10RD11SS	14	J	50	U	--	41	--	50	UJ	--	6.6	--	0.7	J	0.2%
10RD12SS	0.69	UJ	50	U	--	25	--	50	U	--	0.79	--	0.1	U	--
10RD18SS	0.8	UJ	50	U	--	40	--	50	U	--	1.57	--	0.1	U	--
10RD19SS	0.76	UJ	50	U	--	12	--	50	U	--	1.86	--	0.1	U	--
10RS01SS	34	J	50	U	--	29	--	50	U	--	1.25	--	0.1	U	--
10SM03SS	90	J	50	U	--	2290	--	170	--	0.1%	21	--	1.3	--	0.1%
10SM05SS	140	J	50	U	--	5120	--	560	--	0.2%	102	--	1.6	--	0.0%
10SM07SS	2.3	UJ	50	U	--	8510	--	300	--	0.1%	174	--	4.2	--	0.0%
10SM12SS	1.2	UJ	50	U	--	90	--	50	U	--	5.4	J	0.1	U	--
10SM13SS	40	J	110	--	5.5%	670	--	50	U	--	23	J	1.3	J	0.1%
10SM18SS	1.2	UJ	50	U	--	230	--	50	U	--	11	J	0.3	J	0.1%
10SM19SS	20	J	50	U	--	670	--	70	--	0.2%	14	J	2	J	0.3%
10SM21SS	0.47	UJ	50	U	--	39	--	50	U	--	2	J	0.1	U	--
10SM23SS	508	J	1430	--	5.6%	223	--	90	--	0.8%	8.2	J	1	J	0.2%
10SM27SS	1.2	UJ	50	U	--	20	--	50	U	--	1.9	J	0.2	J	0.2%
10SM28SS	109	J	380	--	7.0%	177	--	50	U	--	17	J	1.4	J	0.2%
10UP09SS	0.56	UJ	50	U	--	23	--	50	U	--	0.25	--	0.1	U	--
10UP10SS	0.59	UJ	50	U	--	16	--	50	U	--	0.22	--	0.1	U	--

Key:

J = Estimated value

mg/kg = milligrams per kilogram

SPLP = synthetic precipitation leaching procedure

U = Not detected; listed value is method detection limit.

µg/L = micrograms per liter

-- = Calculation not performed on nondetect results

Table 6-76 Arsenic, Antimony, and Mercury Concentrations in Co-located Samples of Green Alder Bark and Surface Soil and Biota-Soil Accumulation Factors

Green Alder Bark Composite Samples								Surface Soil Samples								Soil-to-Plant BSAF^{ab}		
Vegetation Sample No.	Local	Arsenic (mg/kg dry)		Antimony (mg/kg dry)		Mercury (mg/kg dry)		Surface Soil Sample No.	Local	Arsenic (mg/kg dry)		Antimony (mg/kg dry)		Mercury (mg/kg dry)		Arsenic	Antimony	Mercury
11RD11GA	Bkgd	0.1	-	0.009	U	0.056	-	10RD11SS	Bkgd	41	-	14	J	6.6	-	0.0024	0.0003	0.0085
11RD12GA	Bkgd	0.06	J	0.139	J	0.021	J	10RD12SS	Bkgd	25	-	0.69	UJ	0.79	-	0.0024	0.4029	0.0266
11RD14GA	Bkgd	0.06	U	0.009	U	0.014	-	10RD14SS	Bkgd	13	-	0.7	UJ	0.96	-	0.0023	0.0129	0.0146
11RD18GA	Bkgd	0.06	-	0.116	J	0.014	-	10RD18SS	Bkgd	40	-	0.8	UJ	1.57	-	0.0015	0.2900	0.0089
11MP20GA	Site	0.26	-	1.96	J	0.157	-	10MP20SS	Site	230	-	40	-	62	-	0.0011	0.0490	0.0025
11MP27GA	Site	0.43	-	3.35	J	0.243	-	10MP27SS	Site	6100	-	8480	-	250	-	0.0001	0.0004	0.0010
11MP34GA	Site	0.91	-	0.635	J	0.289	J	10MP34SS	Site	8510	-	780	-	79	-	0.0001	0.0008	0.0037
11MP38GA	Site	0.35	-	2.58	J	0.252	-	10MP38SS	Site	992	-	760	-	154	-	0.0004	0.0034	0.0016
11MP44GA	Site	0.23	J	0.435	J	0.027	J	10MP44SS	Site	860	-	340	-	86	-	0.0003	0.0013	0.0003
11SM07GA	Site	0.47	J	0.375	J	0.043	J	10SM07SS	Site	8510	-	2.3	UJ	174	-	0.0001	0.3261	0.0002
11SM11GA	Site	0.06	U	0.009	U	0.036	-	10SM11SS	Site	11	-	0.49	UJ	0.17	J	0.0027	0.0184	0.2118
11SM18GA	Site	0.13	J	0.165	J	0.017	J	10SM18SS	Site	230	-	1.2	UJ	11	J	0.0006	0.2750	0.0015

Geometric Mean Background BSAF	→	0.0021	0.0264	0.0131
Geometric Mean Site BSAF	→	0.0003	0.0102	0.0021
Background-to-Site BSAF Ratio	→	7.0	2.6	6.2

Key:

Bkgd = Background

BSAF = Biota-soil accumulation factor

J = Estimated value

mg/kg = milligrams per kilogram

U = Not detected; listed value is method detection limit.

Note:

a = (plant contaminant concentration) / (soil contaminant concentration)

b = One-half reported method detection limit used for U-qualified results

Table 6-77 Arsenic, Antimony, and Mercury Concentrations in Co-located Samples of White Spruce Needles and Surface Soil and Biota-Soil Accumulation Factors

White Spruce Needle Composite Samples								Surface Soil Samples								Soil-to-Plant BSAF[ab]		
Vegetation Sample No.	Local	Arsenic (mg/kg dry)		Antimony (mg/kg dry)		Mercury (mg/kg dry)		Surface Soil Sample No.	Local	Arsenic (mg/kg dry)		Antimony (mg/kg dry)		Mercury (mg/kg dry)		Arsenic	Antimony	Mercury
11RD11WS	Bkgd	0.11	J	0.205	J	0.056	J	10RD11SS	Bkgd	41	-	14	J	6.6	-	0.0027	0.0146	0.0085
11RD12WS	Bkgd	0.06	U	0.009	U	0.027	-	10RD12SS	Bkgd	25	-	0.69	UJ	0.79	-	0.0012	0.0130	0.0342
11RD14WS	Bkgd	0.09	-	0.009	U	0.039	-	10RD14SS	Bkgd	13	-	0.7	UJ	0.96	-	0.0069	0.0129	0.0406
11RD18WS	Bkgd	0.06	U	0.104	J	0.036	-	10RD18SS	Bkgd	40	-	0.8	UJ	1.57	-	0.0008	0.2600	0.0229
11UP01WS	Bkgd	0.06	J	0.096	J	0.034	J	10UP01SS	Bkgd	11	-	0.58	UJ	0.18	J	0.0055	0.3310	0.1889
11UP02WS	Bkgd	0.06	U	1.49	J	0.032	J	10UP02SS	Bkgd	10	-	0.8	U	0.23	-	0.0030	3.7250	0.1391
11UP07WS	Bkgd	0.06	U	0.101	J	0.021	J	10UP07SS	Bkgd	0.46	U	0.61	UJ	0.15	-	0.1304	0.3311	0.1400
11UP09WS	Bkgd	0.06	U	0.107	J	0.038	J	10UP09SS	Bkgd	23	-	0.56	UJ	0.25	-	0.0013	0.3821	0.1520
11SM07WS	Site	0.31	-	0.226	J	0.04	-	10SM07SS	Site	8510	-	2.3	UJ	174	-	0.0000	0.1965	0.0002
11SM11WS	Site	0.11	J	0.199	J	0.032	J	10SM11SS	Site	11	-	0.49	UJ	0.17	J	0.0100	0.8122	0.1882
11SM18WS	Site	0.13	-	0.573	J	0.05	-	10SM18SS	Site	230	-	1.2	UJ	11	J	0.0006	0.9550	0.0045
11MP20WS	Site	0.82	-	0.667	J	0.641	J	10MP20SS	Site	230	-	40	-	62	-	0.0036	0.0167	0.0103
11MP31WS	Site	0.71	-	1.22	J	0.965	-	10MP31SS	Site	19	-	7	-	0.28	-	0.0374	0.1743	3.4464
11MP34WS	Site	0.41	J	0.686	J	0.264	J	10MP34SS	Site	8510	-	780	-	79	-	0.0000	0.0009	0.0033
11MP38WS	Site	11.1	-	15.1	J	5.64	-	10MP38SS	Site	992	-	760	-	154	-	0.0112	0.0199	0.0366
11MP91WS	Site	0.23	J	0.343	J	0.036	J	10MP66SS	Site	2490	-	220	J	145	-	0.0001	0.0016	0.0002

Geometric Mean Background BSAF	→	0.0038	0.1333	0.0592
Geometric Mean Site BSAF	→	0.0010	0.0432	0.0110
Background-to-Site BSAF Ratio	→	3.7	3.1	5.4

Key:

Bkgd = Background

BSAF = Biota-soil accumulation factor

J = Estimated value

mg/kg = milligrams per kilogram

U = Not detected; listed value is method detection limit.

Note:

a = (plant contaminant concentration) / (soil contaminant concentration)

b = One-half reported method detection limit used for U-qualified results

Table 6-78 Arsenic, Antimony, and Mercury Concentrations in Co-located Samples of Blueberry Stems/Leaves and Surface Soil and Biota-Soil Accumulation Factors.

Blueberry Stem/Leaf Composite Samples								Surface Soil Samples								Soil-to-Plant BSAF[ab]		
Vegetation Sample ID	Local	Arsenic (mg/kg dry)		Antimony (mg/kg dry)		Mercury (mg/kg dry)		Surface Soil Sample ID	Local	Arsenic (mg/kg dry)		Antimony (mg/kg dry)		Mercury (mg/kg dry)		Arsenic	Antimony	Mercury
11RD12BL	Bkgd	0.1	J	0.146	J	0.016	J	10RD12SS	Bkgd	25	-	0.69	UJ	0.79		0.0040	0.4232	0.0203
11RD14BL	Bkgd	0.13	-	0.164	J	0.05	-	10RD14SS	Bkgd	13	-	0.7	UJ	0.96		0.0100	0.4686	0.0521
11RD18BL	Bkgd	0.15	-	0.214	J	0.039	J	10RD18SS	Bkgd	40	-	0.8	UJ	1.57		0.0038	0.5350	0.0248
11RD40BL	Bkgd	0.22	J	0.357	J	0.036	J	-	Bkgd	-	-	-	-	-	-	-	-	-
11UP02BL	Bkgd	0.06	U	0.225	J	0.023	-	10UP02SS	Bkgd	10	-	0.8	U	0.23		0.0030	0.5625	0.1000
11UP04BL	Bkgd	0.06	U	0.441	J	0.025	-	10UP04SS	Bkgd	0.58	U	0.76	UJ	0.2		0.1034	1.1605	0.1250
11UP07BL	Bkgd	0.11	-	0.009	U	0.03	-	10UP07SS	Bkgd	0.46	U	0.61	UJ	0.15		0.4783	0.0148	0.2000
11UP08BL	Bkgd	0.09	-	0.009	U	0.044	-	10UP08SS	Bkgd	20	-	1.3	UJ	0.32		0.0045	0.0069	0.1375
11UP09BL	Bkgd	0.16	J	0.126	J	0.034	J	10UP09SS	Bkgd	23	-	0.56	UJ	0.25		0.0070	0.4500	0.1360
11SM18BL	Site	0.15	J	0.096	J	0.034	J	10SM18SS	Site	230		1.2	UJ	11	J	0.0007	0.1600	0.0031
11SM24BL	Site	0.08	J	0.131	J	0.023	J	10SM24SS	Site	0.9	U	1.2	UJ	0.26	J	0.1778	0.2183	0.0885

	Arsenic	Antimony	Mercury
Geometric Mean Background BSAF	0.0127	0.2055	0.0769
Geometric Mean Site BSAF	0.0108	0.1869	0.0165
Background-to-Site BSAF Ratio	1.2	1.1	4.7

Key:

Bkdg = Background

BSAF = Biota-soil accumulation factor

J = Estimated value

mg/kg = milligrams per kilogram

U = Not detected; listed value is method detection limit.

Note:

a = (plant contaminant concentration) / (soil contaminant concentration)

b = One-half reported method detection limit used for U-qualified results

Table 6-79 Arsenic, Antimony, Mercury, and Methylmercury in Co-located Samples of Benthic Macroinvertebrates and Surface Sediment and Biota-Sediment Accumulation Factors.

Creek Name	Local	Sediment[a]				Benthic Macroinvertebrates[b]					BSAF[c]			
		Arsenic (mg/kg dry)	Antimony (mg/kg dry)	Mercury (µg/kg dry)	Methyl Hg (µg/kg dry)	Arsenic (mg/kg	Antimony (mg/kg wet)	Mercury (µg/kg	Methyl Hg (µg/kg wet)	% Methyl Hg	Arsenic	Antimony	Mercury	Methyl Hg
California Creek	Bkgd	12	4.9	113	0.64	0.48	0.13	10.0	6.3	63%	0.040	0.026	0.088	9.8
Downey Creek	Bkgd	11	2.8	229	1.2	0.92	0.03	26.2	16.9	64%	0.084	0.011	0.114	14.1
Fuller Creek	Bkgd	11	1.7	123	0.4	1.50	0.10	30.0	9.4	31%	0.136	0.057	0.244	23.4
Ice Creek	Bkgd	9.1	1.3	115	0.84	1.02	0.10	21.5	14.0	65%	0.113	0.078	0.187	16.7
No Name Creek	Bkgd	9.4	1.4	122	0.81	0.62	0.08	20.0	57.5	~100%	0.066	0.055	0.164	71.0
Vreeland Creek	Bkgd	9.5	1.1	200	1.7	0.69	0.11	37.2	14.1	38%	0.073	0.103	0.186	8.3
Red Devil Creek	Site	4000	10000	232000	51	100	20.2	1971	41.5	2%	0.025	0.002	0.008	0.8

	Arsenic	Antimony	Mercury	Methyl Hg
Geometric Mean BSAF for Reference Creeks	0.079	0.044	0.155	17.8
Red Devil Creek BSAF	0.025	0.002	0.008	0.8
Background-to-Site Ratio	3.2	22	18	22

Key:
Bkgd = background
BSAF = biota-sediment accumulation factor

a = Maximum of duplicate samples for Red Devil Creek and minimum of duplicate samples from reference creeks collected in June 2010 (see Appendix P).

b = Geometric Mean of up to four samples from each creek collected in June 2010 (see Appendix P).

c = (Benthic macroinvertebrate concentration [wet]) / (sediment concentration [dry]). Percent moisture data not available for benthic macroinvertebrate samples.

Table 6-80 Summary of COCs by Assessment Endpoint, Red Devil Mine Site BERA

	Assessment Endpoint and HQ[a]																
							Terrestrial Wildlife[i]						Aquatic-Dependent Wildlife[j]				
Analyte[b]	Plants[c]	Soil Fauna[d]	Fish and Other Aquatic Biota[e]	Fish[f]	Benthos[g]	Benthos[h]	Robin	Shrew	Grouse	Vole	Shrike	Weasel	Snipe	Beaver	Teal	Kingfisher	Mink
Metals																	
Antimony	**847**	**54**	**4.5**	**2.0**	**463**	--	x	**2,478**	x	**31**	x	--	x	**1.1**	x	x	**4.0**
Arsenic	**198**	**59**	5.4	**7.6**	**634**	--	**3**	**53**	**11**	**9.3**	--	--	**57**	--	--	--	**1.1**
Barium	--	1.3	--	--	**7**	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	**1.3**	--	x	--	x	--	x	--	x	--	x	x	--
Cadmium	--	--	--	--	--	--	--	**1.1**	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	**1.4**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	**1.9**	--	--	--	--	--	--	--	--	--
Iron	--	--	1.3	--	**2.6**	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	**1.4**	**2**	--	--	--	--	--	--	--	--	--
Manganese	**3.4**	**1.7**	1.4	--	**2.4**	--	--	--	--	**4.6**	--	--	--	--	--	--	--
Mercury	**839**	**2,516**	**20**	**3.0**	**6437**	1.3	--	--	**3.7**	--	--	--	--	--	--	--	--
Methylmercury			--	--	**408**	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	**1.4**	--	--	--	1.4	--	--	**7**	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	**1.3**	--	--	--	**1.2**	--	--	--	--	**1.1**	--	--	--	**1.4**
Silver	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	x	--	--	--	--	x	--	x	--	x	--	x	--	x	x	--
Vanadium	**17.4**	**1.7**	--	--	--	--	--	--	**1**	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	**1.8**	--	--	--	--	--	--	--	--	--
SVOCs																	
Benzoic acid	x	x	--	--	--	--	x	x	x	x	x	x	--	x	--	--	--
Bis(2-Ethylhexyl)phthalate	2.2	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethylphthalate	--	1.4	--	--	--	--	1.4	--	1.4	--	1.4	--	--	--	--	--	--

Key:
BERA = Baseline Ecological Risk Assessment
COC = contaminant of concern
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
SLERA = screening level ecological risk assessment
SVOCs = Semivolatile Organic Compounds
TRV = toxicity reference value
TSC = tissue screening concentration
Value (with or without shading) = HQ equal to or greater than 1.
x = chemical detected in site samples but no screening level or TRV is available.

Notes:

a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):

Value = > 75%
Value = 50 - 75%
Value = 25 - 50%
Value = < 25%

For wildlife, the value of the HQ (exposure estimate / LOAEL) is shown without shading because wildlife HQs were not calculated sample-by-sample.

b. Metals identified as COPCs in the SLERA for at least one assessment endpoint are listed. Also listed are three SVOCs identified as COPCs in Table 6-39.

c. For metals, based on comparing soil chemical concentrations with soil screening levels for effects on plants (see Table 6-44). For SVOCs, see Section 6.3.4.2 and Table 6-39 for rationale.

d. For metals, based on comparing soil chemical concentrations with soil screening levels for effects on earthworms (see Table 6-44). For SVOCs, see Section 6.3.4.2 and Table 6-39 for rationale.

e. Based on comparing surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see Table 6-48).

f. Based on comparing whole-body sculpin chemical concentrations with fish tissue screening concentrations (see Table 6-49).

g. Based on comparing sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see Table 6-45).

h. Based on comparing metals concentrations in benthic macroinvertebrate composite samples from Red Devil Creek with TSCs (see Table 6-47).

i. For metals, based on exposure estimates and hazard quotients for American robin (Table 6-64), masked shrew (Table 6-65), spruce grouse (Table 6-66), tundra vole (Table 6-67), northern shrike (Table 6-68), and least weasel (Table 6-69). For SVOCs, see Section 6.3.4.2 and Table 6-39 for rationale.

j. For metals, based on exposure estimates and HQs for common snipe (Table 6-70), beaver (Table 6-71), green-winged teal (Table 6-72), belted kingfisher (Table 6-62), and mink (Table 6-74). For SVOCs, see Section 6.3.4.2 and Table 6-39 for rationale.

Table 6-81 Media-Receptor Pairs and Contaminants for Which Site and Background Risks are Similar

Media / Receptor Pair	Contaminant	Remarks
Surface Soil and Terrestrial Plants	Vanadium (V)	Surface soil EPC for V (34.8 mg/kg) at the RDM site (see Table 6-37) lies within the background concentration range for V (31 to 63 mg/kg) in surface soil (see Table 4-2). This result suggests that any potential risk to terrestrial plants from V at the RDM site is not related to historical mining operations.
Surface Soil and Soil Invertebrates	Vanadium (V)	The surface soil EPC for V (34.8 mg/kg) at the RDM site (see Table 6-37) lies within the background concentration range for V in surface soil (31 to 63 mg/kg, see Table 4-2). This result suggests that any potential risks to soil invertebrates from V at the RDM site is not related to historical mining operations.
Slimy Sculpin from Red Devil Creek	Selenium (Se)	Se may pose a risk to fish in RDC (HQ 1.3, see Table 6-40). However, the whole-body sculpin EPC at the site (1.4 mg/kg wet weight, see Table 6-40) lies within the concentration range for Se in sculpin from nearby reference creeks. For example, in Vreeland Creek, for samples collected in June 2010, the observed range for Se in whole-body sculpin samples was 0.84 to 2.5 mg/kg wet weight (personal communication, M. Varner, BLM, AK State Office, Anchorage, AK, 4-13-11). Hence, potential Se risks to fish in RDC are similar to background.
Benthic Marco-invertebrates and Common Snipe	Selenium (Se)	Se may pose a risk to the common snipe feeding on benthos from RDC (HQ-LOAEL 1.1) and 98% of exposure is from diet (Table 6-59). However, the Se EPC for benthic macroinvertebrate composite samples collected from RDC (3.1 mg/kg wet weight, Table 6-50) is similar to the Se concentration in benthic macroinvertebrate composite samples from nearby reference creeks. For example, the observed range for three composite samples from Ice Creek was 3.3 to 3.7 mg/kg wet weight Se, and a composite sample from No Name Creek contained 3.3 mg/kg wet weight Se (personal communication, M. Varner, BLM, AK State Office, Anchorage, AK, 4-13-11). Also, the Se EPC for RDC sediment (0.49 mg/kg, Table 6-50) lies within the background concentration range for Se in sediment (0.04 to 1.03 mg/kg, Table 4-10). Hence, the snipe's exposure to Se at RDC and nearby reference creeks is similar.
Surface Soil and Spruce Grouse	Vanadium (V)	V may pose a risk to the spruce grouse at the RDM site (HQ-LOAEL 1) and 90% of the exposure is from incidental soil ingestion (see Table 6-55). However, the surface soil EPC for V at the RDM site (35 mg/kg, see Table 6-47) lies within the background concentration range for V in surface soil (31 to 63 mg/kg, see Table 4-2). Hence, potential risks to the spruce grouse from V at the RDM site are similar to background.
Slimy Sculpin from Red Devil Creek and Belted Kingfisher	Beryllium (Be)	Beryllium was retained as a COC for the kingfisher because no avian TRV was available to quantify potential risks (see Table 6-65). For the BERA, it was assumed that the kingfisher preys exclusively on sculpin. Be was not detected in sculpin from RDC or nearby reference creeks (method detection limit 0.025 mg/kg wet weight for all samples). Hence, potential risks to the kingfisher from Be at the RDM site appears to be no different than background.

Table 6-81 Media-Receptor Pairs and Contaminants for Which Site and Background Risks are Similar

Media / Receptor Pair	Contaminant	Remarks
Slimy Sculpin from Red Devil Creek and Mink	Selenium (Se)	Se may pose a risk to the mink at the RDM site (HQ-LOAEL 1.8) and nearly 100% of the exposure comes from diet (see Table 6-63). For the BERA, it was assumed that mink prey exclusively on sculpin. However, the whole-body sculpin EPC for Se at the site (1.9 mg/kg) lies with the concentration range for Se in sculpin from nearby reference creeks (California, Downey, Fuller, Ice, No-Name, and Vreeland Creeks; see Figure 6-6). For example, in Vreeland Creek, for samples collected in June 2010, the observed range for Se in whole-body sculpin samples was 0.84 to 2.5 mg/kg wet weight (personal communication, M. Varner, BLM, AK State Office, Anchorage, AK, 4-13-11). Hence, any potential risks to mink at the RDM site from Se are similar to background.

Key:
AK = Alaska
BLM = Bureau of Land Management
COC = Contaminant of Concern
EPC = Exposure point concentration
HQ = Hazard quotient
LOAEL = Lowest observed adverse effect level
RDC = Red Devil Creek
RDM = Red Devil Mine

Table 6-82 Human Health Compounds of Concern

Medium	Future Resident	Recreational/ Subsistence User	Mine Worker
Soil	Arsenic Antimony Mercury	Arsenic Antimony Mercury	Arsenic Antimony Mercury
Sediment	Arsenic	Arsenic	Arsenic
Groundwater	Arsenic Antimony (MPA and DA only) Cobalt Iron (MPA only) Manganese Mercury (MPA and DA only)	-	Arsenic Antimony Cobalt Manganese Mercury
Surface Water	-	Arsenic	-
Air	Arsenic (MPA and SMA only) Mercury	Mercury	Mercury
Fish	Arsenic Antimony Iron Methylmercury Selenium	Arsenic Antimony Methylmercury	Arsenic Antimony Methylmercury
Large Land Mammals	Arsenic Cobalt Mercury Thallium	-	-
Small Land Mammals	Arsenic Antimony Cobalt Manganese Thallium	-	-
Birds	Arsenic Antimony Manganese Mercury	Arsenic Antimony Manganese Mercury	Arsenic
Berries/Plants	Arsenic Antimony Mercury	Arsenic Antimony Mercury	Arsenic

Key:

DA	Downstream Alluvial Area
MPA	Main Processing Area
SMA	Surface Mined Area

Table 6-83 Risk-Based Cleanup Levels for Compounds of Concern

COC	Future Resident	Recreational/ Subsistence User	Mine Worker	Back-ground	Federal MCL[2]
Soil (mg/kg)					
Arsenic[1]	**6.1**	**18**	**22**	29	NA
Antimony	41	100	410	8	NA
Mercury	30	91	310	1.9	NA
Sediment (mg/kg)					
Arsenic[1]	130	130	270	13	NA
Groundwater (µg/L)					
Arsenic[1]	**0.27**	NA	**0.79**	14	10
Antimony	6.0	NA	20	0.51	6
Cobalt	4.7	NA	15	1.1	NA
Iron	11,000	NA	NA	9,000	300
Manganese	**320**	NA	1,200	1,100	50
Mercury	4.3	NA	14	0.058	2[3]
Surface Water (µg/L)					
Arsenic[1]	NA	4.8	NA	1.1	NA
Air (µg/m^3)					
Arsenic	0.0068	NA	NA	NA	NA
Mercury	0.4	1.2	1.3	NA	NA
Fish[4] (mg/kg – wet weight)					
Arsenic[1]	0.0020	0.0098	0.029	NA	NA
Antimony	0.046	0.23	0.75	NA	NA
Iron	81	NA	NA	NA	NA
Methyl mercury	0.012	0.057	0.19	NA	NA
Selenium	0.58	NA	NA	NA	NA
Large Land Mammals (mg/kg)					
Arsenic[1]	0.007	NA	NA	NA	NA
Cobalt	0.12	NA	NA	NA	NA
Mercury	0.12	NA	NA	NA	NA
Thallium	0.0041	NA	NA	NA	NA
Small Land Mammals (mg/kg)					
Arsenic[1]	0.014	NA	NA	NA	NA
Antimony	0.34	NA	NA	NA	NA
Cobalt	0.25	NA	NA	NA	NA
Manganese	120	NA	NA	NA	NA
Thallium	0.0084	NA	NA	NA	NA
Birds (mg/kg)					
Arsenic[1]	0.049	0.15	0.44	NA	NA
Antimony	1.2	3.5	NA	NA	NA
Manganese	400	1200	NA	NA	NA
Mercury	0.86	2.6	NA	NA	NA
Berries and Plants (mg/kg)					
Arsenic	0.037	3.7	11	NA	NA
Antimony	0.87	87	NA	NA	NA
Mercury	0.66	66	NA	NA	NA

Notes to Table 6-83:

1. Risk-based cleanup level set at carcinogenic risk of 10^{-5}, all other levels set based non-carcinogenic hazard index equal to 1.0.
2. Values represent federal Primary MCLs for all compounds except iron and manganese which represent Secondary MCLs (EPA 2009a).
3. Mercury MCL is specific for inorganic mercury (EPA 2009a).
4. Fish RBCs are based on game fish concentrations.

Key:

Bold = Risk-based Cleanup Level less than background concentration

µg/m^3	micrograms per meter cubed
COC	contaminant of concern
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
NA	Not applicable
RBCs	Risk-based cleanup
µg/L	micrograms per liter

Table 6-84 Risk-Based Cleanup Levels for Compounds of Concern in Air and Biota

COC	Future Resident	Recreational/ Subsistence User	Mine Worker	Exposure Media
Soil (mg/kg)				
Arsenic	4600	NA	NA	Air
Mercury	9.2	27	30	Air
Groundwater (µg/L)				
Mercury	20	NA	NA	Air
Green Alder Bark (mg/kg-wet weight)				
Arsenic	**0.13**	NA	NA	Large Land Mammals
Cobalt	0.23	NA	NA	Large Land Mammals
Mercury	**0.018**	NA	NA	Large Land Mammals
Thallium	0.0038	NA	NA	Large Land Mammals
Green Alder Bark (mg/kg-wet weight)				
Arsenic	**0.014**	NA	NA	Small Land Mammals
Antimony	0.34	NA	NA	Small Land Mammals
Cobalt	0.25	NA	NA	Small Land Mammals
Manganese	**120**	NA	NA	Small Land Mammals
Thallium	0.0084	NA	NA	Small Land Mammals
White Spruce Needles (mg/kg-wet weight)				
Arsenic	**0.049**	0.15	0.44	Birds
Antimony	**1.2**	3.5	NA	Birds
Manganese	**400**	**1200**	NA	Birds
Mercury	0.86	2.6	NA	Birds
Soil (mg/kg)				
Arsenic	**6.2**	620	1900	Berries and Plants
Antimony	29	2900	NA	Berries and Plants
Mercury	3.3	3300	NA	Berries and Plants

Key:

Bold	**Risk-based Cleanup Level less than background concentration**
µ/L	micrograms per liter
COC	contaminant of concern
mg/kg	milligrams per kilogram
NA	Not Applicable

Table 6-85 Preliminary Ecological Risk Based Cleanup Levels for Arsenic

Assessment Endpoint	Medium	Proposed Cleanup Level Value	Method of Derivation	Confidence
Terrestrial Plants	Surface Soil	None proposed. Methods are available that could be used to develop a site-specific no-effect level for arsenic in soil, but this was not undertaken for the BERA.	Not applicable.	Not applicable.
Soil Invertebrates	Surface Soil	None proposed. Methods are available that could be used to develop a site-specific no-effect level for arsenic in soil, but this was not undertaken for the BERA.	Not applicable.	Not applicable.
Aquatic Biota (excluding fish) Exposed to Surface Water	Surface Water	None required. No impacts to the benthic macroinvertebrate community in Red Devil Creek (RDC) are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of arsenic in surface water from RDC are not adversely affecting aquatic life.	Not applicable.	Not applicable.
Fish Community	Sediment and Surface Water	None proposed. Relationship between arsenic levels in sediment, surface water, and fish is not well understood at the site.	Not applicable.	Not applicable.
Benthic Macroinvertebrates	Sediment	None required. No impacts to the benthic macroinvertebrate community in RDC are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of arsenic in sediment from RDC are not adversely affecting benthic life.	Not applicable.	Not applicable.
Invertivorous bird (American robin)	Surface Soil	**590 mg/kg** (NOAEL) and **1065 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated with exposure equations and parameters from Section 6.3.7.7.	Low. Arsenic levels in the assumed prey of the robin (earthworms) were calculated with a soil-to-earthworm bioaccumulation model from the literature that has not been verified for use at the site. Also, it is not know if earthworms are a component of the soil invertebrate community at the site given the location and regional climate.
Invertivorous mammal (masked shrew)	Surface Soil	**18 mg/kg** (NOAEL) and **35 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated with exposure equations and parameters from Section 6.3.7.7.	Low. Arsenic levels in the assumed prey of the shrew (earthworms) were calculated with a soil-to-earthworm bioaccumulation model from the literature that has not been verified for use at the site. Also, it is not know if earthworms are a component of the soil invertebrate community at the site given the location and regional climate.
Herbivorous bird (spruce grouse)	Surface Soil	**208 mg/kg** (NOAEL) and **330 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7.	Low. Assumes 100% bioavailability of arsenic in soil incidentally ingested by herbivorous birds. True bioavailability may be less (see Section 6.3.8).

Table 6-85 Preliminary Ecological Risk Based Cleanup Levels for Arsenic

Assessment Endpoint	Medium	Proposed Cleanup Level Value	Method of Derivation	Confidence
Herbivorous mammal (tundra vole)	Surface Soil	**245 mg/kg** (NOAEL) and **390 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7.	Low. Assumes 100% bioavailability of arsenic in soil incidentally ingested by herbivorous mammals. True bioavailability may be less (see Section 6.3.8).
Carnivorous bird (northern shrike)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Carnivorous mammal (least weasel)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Semi-aquatic invertivorous bird (common snipe)	Sediment	**445 mg/kg** (NOAEL) and **705 mg/kg** (LOAEL)	Sediment concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7.	Low. Assumes 100% bioavailability of arsenic in sediment incidentally ingested by birds feeding on creek benthic organisms. True bioavailability may be less.
Semi-aquatic herbivorous mammal (beaver)	Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Semi-aquatic herbivorous bird (green-winged teal)	Pond Sediment	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Piscivorous bird (belted kingfisher)	Sediment	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Piscivorous mammal (mink)	Sediment	**22,980 mg/kg** (NOAEL) and **38,302 mg/kg** (LOAEL)	Sediment concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7. Arsenic levels in fish from RDC assumed to decrease proportionally with sediment arsenic levels.	Low. Relationship between arsenic levels in site sediment and fish is not well understood.

Key:
BERA = baseline ecological risk assessment
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NOAEL = no observed adverse effect level
RDC = Red Devil Creek
TRV = toxicity reference values

Table 6-86 Preliminary Ecological Risk Based Cleanup Levels for Antimony.

Assessment Endpoint	Medium	Proposed Cleanup Level Value	Method of Derivation	Confidence
Terrestrial Plants	Surface Soil	None proposed. Methods are available that could be used to develop a site-specific no-effect level for antimony in soil, but this was not undertaken for the BERA.	Not applicable.	Not applicable.
Soil Invertebrates	Surface Soil	None proposed. Methods are available that could be used to develop a site-specific no-effect level for antimony in soil, but this was not undertaken for the BERA.	Not applicable.	Not applicable.
Aquatic Biota (excluding fish) Exposed to Surface Water	Surface Water	None required. No adverse impacts to the benthic macroinvertebrate community in Red Devil Creek (RDC) are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of antimony in surface water from RDC are not adversely affecting aquatic life.	Not applicable.	Not applicable.
Fish Community	Sediment and Surface Water	None proposed. Relationship between antimony levels in sediment, surface water, and fish is not well understood at the site.	Not applicable.	Not applicable.
Benthic Macroinvertebrates	Sediment	None required. No impacts to the benthic macroinvertebrate community in RDC are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of antimony in sediment from RDC are not adversely affecting benthic life.	Not applicable.	Not applicable.
Invertivorous bird (American robin)	Surface Soil	None proposed. An avian toxicity reference value (TRV) for antimony is not available; hence, a risk-based soil cleanup level for protection of invertivorous birds cannot be calculated.	Not applicable.	Not applicable.
Invertivorous mammal (masked shrew)	Surface Soil	None proposed. A soil-to-earthworm bioaccumulation model is not available for antimony; hence, a risk-based soil cleanup level for protection of invertivorous mammals cannot be calculated.	Not applicable.	Not applicable.
Herbivorous bird (spruce grouse)	Surface Soil	None proposed. An avian TRV for antimony is not available; hence, a credible risk-based soil cleanup level for protection of herbivorous birds cannot be calculated.	Not applicable.	Not applicable.
Herbivorous mammal (tundra vole)	Surface Soil	**14 mg/kg** (NOAEL) and **139 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7.	Low. Assumes 100% bioavailability of antimony in soil incidentally ingested by herbivorous mammals. True bioavailability may be less (see Section 6.3.8).
Carnivorous bird (northern shrike)	Surface Soil	None proposed. An avian TRV for antimony is not available; hence, a risk-based soil cleanup level for protection of carnivorous birds cannot be calculated.	Not applicable.	Not applicable.
Carnivorous mammal (least weasel)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.

Table 6-86 Preliminary Ecological Risk Based Cleanup Levels for Antimony.

Assessment Endpoint	Medium	Proposed Cleanup Level Value	Method of Derivation	Confidence
Semi-aquatic invertivorous bird (common snipe)	Sediment	None proposed. An avian TRV for antimony is not available; hence, a risk-based sediment cleanup level for protection of invertivorous birds cannot be calculated.	Not applicable.	Not applicable.
Semi-aquatic herbivorous mammal (beaver)	Soil	**380 mg/kg** (NOAEL) and **3800 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7.	Low. Assumes 100% bioavailability of antimony in soil incidentally ingested by herbivorous mammals. True bioavailability may be less (see Section 6.3.8).
Semi-aquatic herbivorous bird (green-winged teal)	Pond Sediment	None proposed. An avian TRV for antimony is not available; hence, a risk-based sediment cleanup level for protection of herbivorous waterfowl cannot be calculated.	Not applicable.	Not applicable.
Piscivorous bird (belted kingfisher)	Sediment	None proposed. An avian TRV for antimony is not available; hence, a risk-based sediment cleanup level for protection of piscivorous birds cannot be calculated.	Not applicable.	Not applicable.
Piscivorous mammal (mink)	Sediment	**113 mg/kg** (NOAEL) and **1128 mg/kg** (LOAEL)	Sediment concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7. Antimony levels in fish from RDC assumed to decrease proportionally with sediment antimony levels.	Low. Relationship between antimony levels in site sediment and fish not well understood.

Key:
BERA = baseline ecological risk assessment
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NOAEL = no observed adverse effect level
RDC = Red Devil Creek
TRV = toxicity reference values

Table 6-87 Preliminary Ecological Risk Based Cleanup Levels for Mercury.

Assessment Endpoint	Medium	Proposed Cleanup Level Value	Method of Derivation	Confidence
Terrestrial Plants	Surface Soil	None proposed. Methods are available that could be used to develop a site-specific no-effect level for mercury in soil, but this was not undertaken for the BERA.	Not applicable.	Not applicable.
Soil Invertebrates	Surface Soil	None proposed. Methods are available that could be used to develop a site-specific no-effect level for mercury in soil, but this was not undertaken for the BERA.	Not applicable.	Not applicable.
Aquatic Biota (excluding fish) Exposed to Surface Water	Surface Water	None required. No adverse impacts to the benthic macroinvertebrate community in Red Devil Creek (RDC) are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of mercury in surface water from RDC are not adversely affecting aquatic life.	Not applicable.	Not applicable.
Fish Community	Sediment and Surface Water	None proposed. Relationship between mercury levels in sediment, surface water, and fish is not well understood at that site.	Not applicable.	Not applicable.
Benthic Macroinvertebrates	Sediment	None required. No impacts to the benthic macroinvertebrate community in RDC are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of mercury in sediment from RDC are not adversely affecting benthic life.	Not applicable.	Not applicable.
Invertivorous bird (American robin)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Invertivorous mammal (masked shrew)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Herbivorous bird (spruce grouse)	Surface Soil	**34.5 mg/kg** (NOAEL) and **69 mg/kg** (LOAEL)	Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.7.7.	Low. Assumes 100% bioavailability of mercury in soil incidentally ingested by herbivorous mammals. True bioavailability likely is less (see Sections 6.3.8 and 5.2.2).
Herbivorous mammal (tundra vole)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Carnivorous bird (northern shrike)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Carnivorous mammal (least weasel)	Surface Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Semi-aquatic invertivorous bird (common snipe)	Sediment	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Semi-aquatic herbivorous mammal (beaver)	Soil	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Semi-aquatic herbivorous bird (green-winged teal)	Pond Sediment	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Piscivorous bird (belted kingfisher)	Sediment	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.
Piscivorous mammal (mink)	Sediment	None required. HQ-NOAEL < 1 for this receptor.	Not applicable.	Not applicable.

Key:

BERA = baseline ecological risk assessment
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NOAEL = no observed adverse effect level
RDC = Red Devil Creek
TRV = toxicity reference values

7 Summary and Conclusions

This chapter presents a summary of the data collection activities performed at the RDM; the nature and extent of contamination, including comparisons of contaminants to relevant regulatory criteria; the fate and transport of the contaminants that were most widespread at the site and/or most significantly above background values; and the risks posed by contamination to human and ecological receptors.

This chapter also presents conclusions developed from the results of the RI studies. The conclusions are presented in the context of the key study questions developed through the DQO process outlined at the end of Chapter 1 of this document and presented in the Final RI/FS Work Plan (E & E 2011).

7.1 Summary

7.1.1 Data Collection Activities

Data collection activities to support the RDM RI/FS were conducted in 2010, 2011, and 2012. In 2010, the following data collection activities were conducted:

- Surface soil sampling for XRF field screening to delineate the surface extent of tailings/waste rock and impacted native surface soil.
- Surface soil sample collection for laboratory analyses.
- Surface water and sediment sample collection in Red Devil Creek and a seep on the left bank of the creek.
- Shoreline sediment sample collection along the Kuskokwim River.
- Groundwater sample collection from existing monitoring wells.

In addition, in 2010, the USGS conducted a geophysical survey of the site (Burton and Ball 2011), and the BLM collected fish tissue samples from Red Devil Creek and the Kuskokwim River. These two studies are used in the RI to support site characterization findings and conclusions.

In 2011, the following data collection activities were conducted:

- Additional surface soil sampling for XRF field screening to complete the delineation of the surface extent of tailings/waste rock and impacted native surface soil.
- Additional surface soil sample collection for laboratory analysis.
- Surface water sample collection at all 2010 sample stations and three new stations on Red Devil Creek.
- Sediment sample collection at three new sample stations on Red Devil Creek.
- Measurement of stream discharge (flow) at six stations along Red Devil Creek.
- Additional shoreline sampling along the Kuskokwim River.
- Off-shore sediment sampling in the Kuskokwim River.
- Drilling of 72 exploratory soil borings and collection of subsurface soil samples.
- Installation of 26 new monitoring wells and groundwater sample collection from the new and existing monitoring wells.
- Vegetation sample collection.
- Surveying elevation and lateral coordinates of all monitoring wells and the stream discharge measurement stations on Red Devil Creek.

In 2012, the following RI data collection activities were conducted:

- Blueberry fruit sampling.
- Additional off-shore sediment sampling in the Kuskokwim River.
- Additional soil characterization in the Surface Mined Area.

Additional work completed in 2012 consists of baseline groundwater and surface water monitoring. Baseline monitoring was performed during field events conducted in the spring (May 25 to May 31) and fall (September 7 to September 21). Groundwater samples were also collected from selected wells for PCBs in 2012.

Chapter 2 provides a detailed summary of these data collection activities.

7.1.2 Nature and Extent of Contamination

For the purposes of identifying contamination at the RDM, background concentrations of inorganic analytes are used to determine chemical concentrations representing "contamination" and the lateral and vertical extents of contamination. Inorganic element concentrations that exceed background values presented in Section 4.1 are considered "contamination." For organic analytes, all positive detections are considered to represent site-related "contamination" because there are no nearby offsite sources of organic contaminants that are expected to contribute to onsite contamination.

Many of the same inorganic elements that comprise contamination, notably including antimony, arsenic, and mercury, also occur naturally in native bedrock, soil, and sediment, and groundwater and surface water that flow through them. Such naturally occurring concentrations represent pre-mining "background" conditions. As noted in Section 4.1.7, it has not been possible with available RI data to determine the extent and concentrations of naturally mineralized soil at the RDM. As a result, the background levels presented in Section 4.1 likely underestimate pre-mining background concentrations of inorganic elements associated with natural mineralization. Distinguishing between naturally elevated concentrations of inorganics in various media and contamination resulting from mining-related activities is complicated by the superposition of mining-related impacts on natural bedrock and native soils and the physical hydrogeologic conditions within them.

Surface Soil

Thirteen inorganic elements were detected above background values in the surface soil samples. In addition, SVOCs, DRO, RRO, and PCBs were detected in surface soil samples. Table 7-1 provides a summary of the contaminants detected, detected concentration ranges, and applicable surface soil comparison criteria.

Inorganic elements were detected above background values in all general geographic areas of the site. Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. The highest concentrations of these inorganic elements were in the tailings and tailings/waste rock soil types in the Pre-1955 and Post-1955 portions of the Main Processing Area. These inorganic elements also were detected at concentrations well above background levels in the Surface Mined Area. At most locations in the Surface Mined Area, the elevated concentrations are likely attributable to naturally mineralized Kuskokwim group–derived soils, although at some locations along roads near the fringe of the Main Processing Area, elevated concentrations could be due to construction of the roads with tailings and/or waste rock.

Organic compounds were detected in the Pre-1955 and Post-1955 portions of the Main Processing Area. The extent of organic compounds in surface soil has not been determined.

Table 7-1 Surface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis
Total Inorganic Elements				
Antimony	0.708–23,300	mg/kg	3.6	18 AAC 75.340, Table B1, Migration to Groundwater
Arsenic	9–9,880	mg/kg	3.9	18 AAC 75.340, Table B1, Migration to Groundwater
Barium	76.2–1,710	mg/kg	1,100	18 AAC 75.340, Table B1, Migration to Groundwater
Beryllium	0.3–1.3	mg/kg	42	18 AAC 75.340, Table B1, Migration to Groundwater
Cadmium	0.18–1.1	mg/kg	5.0	18 AAC 75.340, Table B1, Migration to Groundwater
Chromium	8–101	mg/kg	25	18 AAC 75.340, Table B1, Migration to Groundwater
Cobalt	5.9–38.8	mg/kg	--	--
Copper	17–139	mg/kg	460	18 AAC 75.340, Table B1, Migration to Groundwater
Lead	5–3,090	mg/kg	400	18 AAC 75.340, Table B1, Under 40 inch Zone, Direct Contact
Manganese	153–4,230	mg/kg	--	--
Mercury	0.05–1,620	mg/kg	1.4	18 AAC 75.340, Table B1, Migration to Groundwater
Nickel	18–97	mg/kg	86	18 AAC 75.340, Table B1, Migration to Groundwater
Zinc	38–386	mg/kg	4,100	18 AAC 75.340, Table B1, Migration to Groundwater
Semi-Volatile Organic Compounds				
1-Methylnaphthalene	15 J–74	µg/kg	6,200	18 AAC 75.340, Table B1, Migration to Groundwater
2-Methylnaphthalene	29–200	µg/kg	6,100	18 AAC 75.340, Table B1, Migration to Groundwater
4-Bromophenyl Phenyl Ether	1.9 J	µg/kg	--	--
4-Methylphenol	4.9 J	µg/kg	1,500	18 AAC 75.340, Table B1, Migration to Groundwater
Acenaphthene	2.3 J	µg/kg	180,000	18 AAC 75.340, Table B1, Migration to Groundwater
Acenaphthylene	1.3 J	µg/kg	180,000	18 AAC 75.340, Table B1, Migration to Groundwater
Anthracene	2 J	µg/kg	3,000,000	18 AAC 75.340, Table B1, Migration to Groundwater
Benzoic Acid	120 J	µg/kg	410,000	18 AAC 75.340, Table B1, Migration to Groundwater
Benzyl Alcohol	12 J	µg/kg	--	--
bis(2-Ethylhexyl)phthalate	11 J–220	µg/kg	13,000	18 AAC 75.340, Table B1, Migration to Groundwater
Chrysene	2.6 J–42	µg/kg	360,000	18 AAC 75.340, Table B1, Migration to Groundwater

Table 7-1 Surface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis
Dibenzofuran	2.4 J–10 J	µg/kg	11,000	18 AAC 75.340, Table B1, Migration to Groundwater
Diethyl Phthalate	8–140	µg/kg	130,000	18 AAC 75.340, Table B1, Migration to Groundwater
Dimethyl Phthalate	160	µg/kg	1,100,000	18 AAC 75.340, Table B1, Migration to Groundwater
Docosanoic acid	1,300 J	µg/kg	--	--
Fluorene	2.5 J–20	µg/kg	220,000	18 AAC 75.340, Table B1, Migration to Groundwater
Hexachlorobenzene	1.3 J	µg/kg	47	18 AAC 75.340, Table B1, Migration to Groundwater
Naphthalene	14 J–70	µg/kg	20,000	18 AAC 75.340, Table B1, Migration to Groundwater
Pentachlorophenol	38 J	µg/kg	47	18 AAC 75.340, Table B1, Migration to Groundwater
Phenanthrene	4.2 J–48	µg/kg	3,000,000	18 AAC 75.340, Table B1, Migration to Groundwater
Phenol	4.6 J	µg/kg	68,000	18 AAC 75.340, Table B1, Migration to Groundwater
Pyrene	2.8 J	µg/kg	1,000,000	18 AAC 75.340, Table B1, Migration to Groundwater
Sulfur	190 J–1,300 J	µg/kg	--	--
Unknown	140 J–5,300 J	µg/kg	--	--
Unknown Alkane	4,000 J	µg/kg	--	--
Unknown Alkene	2,000 J	µg/kg	--	--
Unknown Aromatic	90–3,100 J	µg/kg	--	--
Unknown Branched Alkane	1,500 J	µg/kg	--	--
Unknown Hydrocarbon	96 J–980 J	µg/kg	--	--
Unknown Organic Acid	87 J–380 J	µg/kg	--	--
Unknown Sterol	78 J–5,000 J	µg/kg	--	--
Polychlorinated Biphenyls				
Aroclor 1260	0.021 J	mg/kg	0.3	18 AAC 75.340, Table B1, Migration to Groundwater
Diesel and Residual Range Organics				
C10–C25 DRO / Diesel Range Hydrocarbons	7.1 J–680 J	mg/kg	250	18 AAC 75.341, Table B2, Under 40 Inch Zone, Migration to Groundwater
C25–C36 RRO / Motor Oil	13–7,800	mg/kg	10,000	18 AAC 75.341, Table B2, Under 40 Inch Zone, Migration to Groundwater

Key

▨	concentration exceeds comparison criteria
--	Criterion not available
µg/kg	micrograms per kilogram
AAC	Alaska Administrative Code
DRO	diesel range organics
J	estimated quantity
mg/kg	milligrams per kilogram
RRO	residual range organics

Subsurface Soil

Seventeen inorganic elements were detected above background values in the subsurface soil samples. In addition, SVOCs, DRO, and RRO were detected in subsurface soil samples. Table 7-2 provides a summary of the contaminants detected, detected concentration ranges, and applicable subsurface soil comparison criteria.

Inorganic elements were detected above background values in all general geographic areas of the site. Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. The highest concentrations of these inorganic elements were in the tailings and tailings/waste rock soil types in the Pre-1955 and Post-1955 portions of the Main Processing Area. These inorganic elements were also detected at concentrations well above background levels in subsurface soil in parts of the Surface Mined Area. At many of those locations, the elevated concentrations are likely attributable to naturally mineralized Kuskokwim group–derived soils.

Organic compounds were detected throughout the Pre-1955 and Post-1955 portions of the Main Processing Area. Organic compounds were detected at depths ranging up to 30 feet bgs. Nearly every sample where organic compounds were analyzed had positive detections. The extent of organic compounds in surface soil has not been determined.

Table 7-2 Subsurface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis
Total Inorganic Elements				
Antimony	0.19 J–28,900 J	mg/kg	3.6	18 AAC 75.340, Table B1, Migration to Groundwater
Arsenic	3.36 J–9,530 J	mg/kg	3.9	18 AAC 75.340, Table B1, Migration to Groundwater
Barium	61.1–1,050 J	mg/kg	1,100	18 AAC 75.340, Table B1, Migration to Groundwater
Beryllium	0.187 J–0.981	mg/kg	42	18 AAC 75.340, Table B1, Migration to Groundwater
Cadmium	0.132 J–1.32 J	mg/kg	5.0	18 AAC 75.340, Table B1, Migration to Groundwater
Chromium	8.18 J–59.6 J	mg/kg	25	18 AAC 75.340, Table B1, Migration to Groundwater
Cobalt	5.5–34.4	mg/kg	--	--

Table 7-2 Subsurface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis
Copper	14.2 J–139 J	mg/kg	460	18 AAC 75.340, Table B1, Migration to Groundwater
Lead	0.027 J–396	mg/kg	400	18 AAC 75.340 Table B1, Under 40 Inch Zone, Direct Contact
Manganese	102–3,510	mg/kg	--	--
Mercury	0.032–6,110 J	mg/kg	1.4	18 AAC 75.340, Table B1, Migration to Groundwater
Nickel	16.5–99.1 J	mg/kg	86	18 AAC 75.340, Table B1, Migration to Groundwater
Selenium	0.04 J–6.07	mg/kg	3.4	18 AAC 75.340, Table B1, Migration to Groundwater
Silver	0.033–0.554 J	mg/kg	11.2	18 AAC 75.340, Table B1, Migration to Groundwater
Thallium	0.051–1.54	mg/kg	1.9	18 AAC 75.340, Table B1, Migration to Groundwater
Vanadium	14.2–44.6 J	mg/kg	3,400	18 AAC 75.340, Table B1, Migration to Groundwater
Zinc	39.8 J–461 J	mg/kg	4,100	18 AAC 75.340, Table B1, Migration to Groundwater
Semi-Volatile Organic Compounds				
.beta.-Sitosterol	160	µg/kg	--	--
.gamma.-Sitosterol	72	µg/kg	--	--
2-Methylnaphthalene	12–12,000	µg/kg	6,100	18 AAC 75.340, Table B1, Migration to Groundwater
4-Chloroaniline	8	µg/kg	--	--
9-Octadecenamide, (Z)-	650–2,600	µg/kg	--	--
Acenaphthene	66–410	µg/kg	180,000	18 AAC 75.340, Table B1, Migration to Groundwater
Benzo(a)pyrene	9.4	µg/kg	490	18 AAC 75.340. Table B1. Under 40 Inch Zone, Direct Contact
Benzo(b)fluoranthene	1.3–7.2	µg/kg	4,900	18 AAC 75.340. Table B1. Under 40 Inch Zone, Direct Contact

Table 7-2 Subsurface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis
Benzo(g,h,i)perylene	10	µg/kg	1,400,000	18 AAC 75.340. Table B1. Under 40 Inch Zone, Direct Contact
Benzo(k)fluoranthene	3.7	µg/kg	49,000	18 AAC 75.340. Table B1. Under 40 Inch Zone, Direct Contact
Benzyl Alcohol	11	µg/kg	--	--
Bis(2-ethylhexyl) Phthalate	10–310	µg/kg	13,000	18 AAC 75.340, Table B1, Migration to Groundwater
Chrysene	2.9–4.4	µg/kg	360,000	18 AAC 75.340, Table B1, Migration to Groundwater
Cyclopropane, 1-pentyl-2-propyl-	820	µg/kg	--	--
Decane, 4-methyl-	870	µg/kg	--	--
Dibenz(a,h)anthracene	7.8	µg/kg	--	--
Dibenzofuran	57–58	µg/kg	11,000	18 AAC 75.340, Table B1, Migration to Groundwater
Diethyl Phthalate	1.7	µg/kg	130,000	18 AAC 75.340, Table B1, Migration to Groundwater
Docosanoic acid	230	µg/kg	--	--
Dodecane	730	µg/kg	--	--
Dodecane, 2,6,11-trimethyl-	100 J	µg/kg	--	--
Fluorene	1.7–1,200	µg/kg	220,000	18 AAC 75.340, Table B1, Migration to Groundwater
Heptadecane	3,700–5,700	µg/kg	--	--
Heptadecane, 2,6,10,15-tetramethyl-	1,000	µg/kg	--	--
Heptadecane, 2,6-dimethyl-	3,300	µg/kg	--	--
Heptylcyclohexane	3,900	µg/kg	--	--
Hexadecane, 2,6,10,14-tetramethyl-	1,700	µg/kg	--	--
Hexadecanoic acid, butyl ester	66–110	µg/kg	--	--
Indeno(1,2,3-cd)pyrene	11	µg/kg	--	--
Naphthalene	8.3–3,500	µg/kg	20,000	18 AAC 75.340, Table B1, Migration to Groundwater
N-Nitrosodiphenylamine	1.8	µg/kg	15,000	18 AAC 75.340, Table B1, Migration to Groundwater
Nonadecane	1,400	µg/kg	--	--

Table 7-2 Subsurface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis
Octadecane	2,400–11,000	µg/kg	--	--
Octadecanoic acid, butyl ester	92	µg/kg	--	--
Octane, 3,6-dimethyl-	3,100	µg/kg	--	--
Oleic Acid	130	µg/kg	--	--
Pentadecane, 2,6,10,14-tetramethyl	1,300–56,000	µg/kg	--	--
Pentadecane, 2,6,10-trimethyl-	6,400	µg/kg	--	--
Phenanthrene	1.9–980	µg/kg	3,000,000	18 AAC 75.340, Table B1, Migration to Groundwater
Pyrene	1.7–1.8	µg/kg	1,000,000	18 AAC 75.340, Table B1, Migration to Groundwater
Tetradecane	1,500–83,000	µg/kg	--	--
Tricosane, 2-methyl-	60	µg/kg	--	--
Tridecane	60–73,000	µg/kg	--	--
Undecane	1,300–15,000	µg/kg	--	--
Undecane, 2,6-dimethyl-	540–7,900	µg/kg	--	--
Undecane, 2-methyl-	210	µg/kg	--	--
Unknown	68–16,000	µg/kg	--	--
Unknown Alkane	76–100,000	µg/kg	--	--
Unknown Branched Alkane	60–71,000	µg/kg	--	--
Unknown Branched Naphthalene	4,600	µg/kg	--	--
Unknown branched undecane	1,300	µg/kg	--	--
Unknown Carboxylic Acid	110	µg/kg	--	--
Unknown Cyclic Hydrocarbon	9,100	µg/kg	--	--
Unknown Substituted Aromatic	230	µg/kg	--	--
Z-1,6-Undecadiene	1,300	µg/kg	--	--
Diesel and Residual Range Organics				
C10–C25 DRO	2.7–7,300	mg/kg	250	18 AAC 75.341, Table B2, Under 40 Inch Zone, Migration to Groundwater
C25–C36 RRO	6.8–1,400	mg/kg	7500	18 AAC 75.341, Table B2, Under 40 Inch Zone, Migration to Groundwater

Key

concentration exceeds comparison criteria

Table 7-2 Subsurface Soil Summary

Contaminants	Range of Detected Concentrations	Units	Surface Soil Comparison Values	
			Value	Basis

--	Criterion not available
µg/kg	micrograms per kilograms
AAC	Alaska Administrative Code
DRO	Diesel range organics
J	estimated quantity
mg/kg	milligrams per kilograms
RRO	Residual range organics

Groundwater

Seventeen inorganic elements and methylmercury were detected above background values in the RDM groundwater samples. In addition, SVOCs, DRO, and RRO were detected in RDM groundwater samples. Table 7-3 provides a summary of the contaminants detected, detected concentration ranges, and applicable groundwater comparison criteria.

Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. Groundwater at the RDM is significantly impacted by leaching of contaminants from mine wastes, including tailings/waste rock, flotation tailings, and contaminated soils. The greatest impacts, particularly for antimony and arsenic, occur where tailings/waste rock materials within the Main Processing Area are within the saturated zone at least part of the time. Concentrations of total and dissolved antimony and arsenic are highest in the Post-1955 Main Processing Area. Mine waste materials also contribute to mercury groundwater contamination. It appears that much of the mercury in groundwater at the RDM is associated with flow through bedrock. Methylmercury was detected above the background value but not above the comparison criteria.

In 2010 and 2011, DRO were detected in almost all of the groundwater samples submitted for DRO analyses; however, the concentrations detected were below Alaska Method 2 cleanup levels. Other organic compounds also were detected in one or more samples below comparison criteria. In 2012, groundwater samples were collected from wells MW04 and MW27 for PCB analysis to assess possible impacts of PCBs associated with Monofill # 1. PCBs were not detected in either sample. The extent of organic compounds in groundwater has not been fully delineated. None of the organic compounds detected exceed comparison criteria in any of the groundwater samples.

Table 7-3 Red Devil Mine Groundwater Summary

Contaminants	Range of Detected Concentrations	Units	Groundwater Comparison Values	
			Value	Basis
Total Inorganic Elements				
Antimony	0.6 J–13,100	µg/L	6	Federal Drinking Water Maximum Contaminant Level
Arsenic	0.6–6,650	µg/L	10	Federal Drinking Water Maximum Contaminant Level
Barium	28.2–365	µg/L	2,000	Federal Drinking Water Maximum Contaminant Level
Beryllium	0.006 J–0.11	µg/L	4	Federal Drinking Water Maximum Contaminant Level
Cadmium	0.005 J–0.224	µg/L	5	Federal Drinking Water Maximum Contaminant Level
Chromium	0.05 J–10.6	µg/L	100	Federal Drinking Water Maximum Contaminant Level
Cobalt	0.045–40.5	µg/L	--	--
Copper	0.09 J–6.29	µg/L	1,300	Federal Drinking Water Maximum Contaminant Level
Lead	0.019 J–2.02	µg/L	15	Federal Drinking Water Maximum Contaminant Level
Manganese	1.12–7,370	µg/L	--	--
Nickel	0.9–35.9	µg/L	100	18 AAC 75.345 Table C
Selenium	0.3 J–5.4	µg/L	50	Federal Drinking Water Maximum Contaminant Level
Silver	0.004 J–0.049 J	µg/L	100	18 AAC 75.345 Table C
Thallium	0.006 J–0.075	µg/L	2	Federal Drinking Water Maximum Contaminant Level
Vanadium	0.09 J–3.88	µg/L	260	18 AAC 75.345 Table C
Zinc	0.8–22	µg/L	5,000	18 AAC 75.345 Table C
Total Low Level Mercury				
Mercury, Total	1.85–56,500	ng/L	2,000	Federal Drinking Water Maximum Contaminant Level
Dissolved Inorganic Elements				
Antimony, Dissolved	0.317 J–13,100	µg/L	6	Federal Drinking Water Maximum Contaminant Level
Arsenic, Dissolved	0.4–6,660	µg/L	10	Federal Drinking Water Maximum Contaminant Level
Barium, Dissolved	23.3–348	µg/L	2,000	Federal Drinking Water Maximum Contaminant Level
Beryllium, Dissolved	0.006 J–0.041	µg/L	4	Federal Drinking Water Maximum Contaminant Level
Cadmium, Dissolved	0.006 J–0.229	µg/L	5	Federal Drinking Water Maximum Contaminant Level
Chromium, Dissolved	0.09 J–2.81	µg/L	100	Federal Drinking Water Maximum Contaminant Level
Cobalt, Dissolved	0.027–41.5	µg/L	--	--
Copper, Dissolved	0.08 J–1.8	µg/L	1300	Federal Drinking Water Maximum Contaminant Level
Manganese, Dissolved	0.606–7,050	µg/L	--	--
Nickel, Dissolved	0.79–34.6	µg/L	100	18 AAC 75.345 Table C
Selenium, Dissolved	0.3 J–4.9	µg/L	50	Federal Drinking Water Maximum Contaminant Level

Table 7-3 Red Devil Mine Groundwater Summary

Contaminants	Range of Detected Concentrations	Units	Groundwater Comparison Values	
			Value	Basis
Silver, Dissolved	0.007 J–0.013 J	µg/L	100	18 AAC 75.345 Table C
Thallium, Dissolved	0.006 J–0.059	µg/L	2	Federal Drinking Water Maximum Contaminant Level
Vanadium, Dissolved	0.03 J–2.03	µg/L	260	18 AAC 75.345 Table C
Zinc, Dissolved	0.2 J–20.7	µg/L	5,000	18 AAC 75.345 Table C
Dissolved Low Level Mercury				
▨ Mercury, Dissolved	0.54 J–2,200	ng/L	2000	Federal Drinking Water Maximum Contaminant Level
Methlymercury				
Methylmercury	0.06 J–1.71	ng/L	3,700	18 AAC 75.345 Table C
Semi-Volatile Organic Compounds				
Toluene	0.09 J–1.8	µg/L	1000	Federal Drinking Water Maximum Contaminant Level
Bis(2-ethylhexyl) Phthalate	5.7 J	µg/L	--	--
Unknown Hydrocarbon	2 J	µg/L	--	--
Gasoline, Diesel and Residual Range Organics				
Diesel Range Organics	14 J–200 J	µg/L	1,500	18 AAC 75.345 Table C
Residual Range Organics	60 J–620 J	µg/L	1,100	18 AAC 75.345 Table C

Key

▨	concentration exceeds comparison criteria
--	Criterion not available
µg/L	micrograms per liter
AAC	Alaska Administrative Code
J	estimated quantity
ng/L	nanograms per liter

Red Devil Creek and Seep Surface Water

Fifteen inorganic elements and methylmercury were detected above background values in the surface water samples collected from Red Devil Creek and the seep (location RD05) located on the left bank of the creek in the Main Processing Area. In addition, several SVOCs were detected in several surface water samples. Table 7-4 provides a summary of the contaminants detected, detected concentration ranges, and applicable surface water comparison criteria.

Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. Starting at the upper end of the Main Processing Area, total and dissolved concentrations of antimony, arsenic, and mercury are significantly elevated above background down to the mouth of Red Devil Creek. The highest arsenic concentrations were detected in the seep samples. Methylmercury was detected at all sample stations on Red Devil Creek (including near the reservoir dam) and is significantly elevated above background in the Main Processing Area, particularly at the seep location; however, methylmercury concentrations are below comparison criteria.

All SVOCs in Red Devil Creek surface water were detected at low concentrations very near their respective method detection limits and below any applicable comparison criteria.

Table 7-4 Surface Water Summary

Contaminants	Range of Detected Concentrations	Units	Surface Water Chronic Water Quality Criteria for Aquatic Life	
			Value	Basis
Total Inorganic Elements				
Antimony	1.3–184	µg/L	--[1]	--
Arsenic	0.8–1,030	µg/L	--[1]	--
Barium	21.2–103	µg/L	--[1]	--
Beryllium	0.009 J	µg/L	--[1]	--
Cadmium	0.005 J–0.006 J	µg/L	--[1]	--
Chromium	0.15 J–0.57	µg/L	--[1]	--
Cobalt	0.046–5.3	µg/L	--[1]	--
Copper	0.28–0.71	µg/L	--[1]	--
Lead	0.008 J–0.079	µg/L	--[1]	--
Manganese	11.8–379	µg/L	--[1]	--
Nickel	0.36–19.2	µg/L	--[1]	--
Silver	0.008 J–0.012 J	µg/L	--[1]	--
Thallium	0.007 J	µg/L	--[1]	--
Zinc	0.3 J–2.1	µg/L	--[1]	--
Total Low Level Mercury				
Mercury, Total	2.33–385	ng/L	--[1]	--
Dissolved Inorganic Elements				
Antimony, Dissolved	1.2–184	µg/L	30	Suter and Tsao (1996), Tier II SCV
Arsenic, Dissolved	0.8–857	µg/L	150	ADEC (2008b) and EPA (2009a)
Barium, Dissolved	20.7–99.5	µg/L	4.0	Suter and Tsao (1996), Tier II SCV
Beryllium, Dissolved	0.012 J	µg/L	0.66	Suter and Tsao (1996), Tier II SCV
Chromium, Dissolved	0.11 J–0.39	µg/L	67[2]	ADEC (2008b) and EPA (2009a)
Cobalt, Dissolved	0.042–4.9	µg/L	23	Suter and Tsao (1996), Tier II SCV
Copper, Dissolved	0.15–0.5	µg/L	8.0[2]	ADEC (2008b)
Lead, Dissolved	0.005 J–0.037	µg/L	2.2[2]	ADEC (2008b) and EPA (2009a)
Manganese, Dissolved	8.2–380	µg/L	120	Suter and Tsao (1996), Tier II SCV
Nickel, Dissolved	0.32–17	µg/L	41[2]	ADEC (2008b) and EPA (2009a)

Table 7-4 Surface Water Summary

Contaminants	Range of Detected Concentrations	Units	Surface Water Chronic Water Quality Criteria for Aquatic Life	
			Value	Basis
Selenium, Dissolved	0.3 J–0.6 J	µg/L	4.6[3]	ADEC (2008b) and EPA (2009a)
Silver, Dissolved	0.009 J	µg/L	2.6[4]	ADEC (2008b) and EPA(2009a)
Vanadium, Dissolved	0.07 J–0.14 J	µg/L	20	Suter and Tsao (1996), Tier II SCV
Zinc, Dissolved	0.3 J–1	µg/L	18[2]	ADEC (2008b)
Dissolved Low Level Mercury				
Mercury, Dissolved	1.92–16.4	ng/L	770	ADEC (2008b) and EPA (2009a)
Methylmercury				
Methylmercury	0.08 J–0.62	ng/L	2.8	Suter and Tsao (1996), Tier II SCV
Semi-Volatile Organic Compounds				
1-Methylnaphthalene	1.5	µg/L	--	--
2-Methylnaphthalene	1.2 J–1.5	µg/L	--	--
Naphthalene	0.68 J	µg/L	12	Suter and Tsao (1996), Tier II SCV
Unknown Hydrocarbon	2 J–3 J	µg/L	--	--

Key

▨	concentration exceeds comparison criteria
--	Criterion not available
µg/L	micrograms per liter
J	estimated quantity
ng/L	nanograms per liter
SCV	secondary chronic value

Notes:

[1] Surface water comparison criterion is for dissolved fraction.

[2] Chronic hardness-adjusted criterion value was calculated using CCC = exp{mC [ln (hardness)]+ bC} (CF) and parameters specified in Appendix B - Appendix B-Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent (ADEC 2008b and EPA 2009a). A total hardness value of 87.7 mg/L as $CaCO_3$, based on the average value for Red Devil Creek surface water samples, is assumed.

[3] The recommended water quality criterion for selenium of 5 µg/L is expressed in terms of total recoverable metal in the water column. The conversion factor (0.922-CCC) was used to convert this to a value that is expressed in terms of dissolved selenium.

[4] No chronic criteria hardness adjustment parameters are available for silver. An acute hardness-adjusted criterion value calculated using CMC (dissolved) = exp{mA [ln(hardness)]+ bA} (CF) and parameters specified in Appendix B - Appendix B-Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent (ADEC 2008b and EPA 2009a). A total hardness value of 87.7 mg/L as $CaCO_3$, based on the average value for Red Devil Creek surface water samples, is assumed.

Red Devil Creek and Seep Sediment

Seventeen inorganic elements and methylmercury were detected above background values in the sediment samples collected from Red Devil Creek and the seep located along the left bank of the creek in the Main Processing Area (location RD05). In addition, SVOCs were detected in several sediment samples.

Table 7-5 provides a summary of the contaminants detected, detected concentration ranges, and applicable sediment comparison criteria.

Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. These three inorganic elements are significantly elevated above background in the Main Processing Area down to the mouth of Red Devil Creek. The seep in the Main Processing Area is the location of the highest concentrations of arsenic and several other inorganic elements detected in the Red Devil Creek drainage. Methylmercury was detected above the background value in all but one of the Red Devil Creek sediment samples, with the highest concentrations detected at the reservoir dam area and at the seep in the Main Processing Area. None of the methylmercury concentrations exceeded the comparison criteria. All of the SVOCs in Red Devil Creek sediments were detected at concentrations very near their respective method detection limits and below applicable comparison criteria.

Table 7-5 Red Devil Creek and Seep Sediment Summary

Contaminants	Range of Detected Concentrations	Units	Sediment Screening Levels	
			Value	Basis
Total Inorganic Elements				
Antimony	5.71 J–6,360 J	mg/kg	2.9	MacDonald et al. (1999). PAETA, WA
Arsenic	32.5–130,000	mg/kg	5.9	TEL. Buchman (2008).
Barium	119–1,990	mg/kg	--	--
Beryllium	0.311–0.9	mg/kg	--	--
Cadmium	0.163 J–0.317 J	mg/kg	0.6	TEL. Buchman (2008).
Chromium	11.8 J–47.4 J	mg/kg	37.3	TEL. Buchman (2008).
Cobalt	8.69–50	mg/kg	50	MacDonald et al. (1999). Criterion, Ontario.
Copper	13.2 J–58.2 J	mg/kg	35.7	TEL. Buchman (2008).
Lead	1.72 J–14	mg/kg	35	TEL. Buchman (2008).
Manganese	552–2,610	mg/kg	460	MacDonald et al. (1999). LEL, B.C.
Mercury	0.232–79 J	mg/kg	0.17	TEL. Buchman (2008).
Nickel	22 J–240	mg/kg	18	TEL. Buchman (2008).
Selenium	0.33–0.62	mg/kg	5	MacDonald et al. (1999). Criterion, B.C.
Silver	0.04–0.135 J	mg/kg	0.5	LEL. Buchman (2008)
Thallium	0.043–0.297	mg/kg	--	--
Vanadium	22.8–39.3	mg/kg	--	--
Zinc	51.1 J–120	mg/kg	123	TEL. Buchman (2008).
Methylmercury				
Methylmercury	0.1 J–12.7	ng/g	--	--
Semi-volatile Organic Compounds				
.gamma.-Sitosterol	230 J–390 J	µg/kg	--	--
Benzo(b)fluoranthene	1.5 J	µg/kg	27	MacDonald et al (1999). TEL *Hyalella* 28-day test.
Benzoic Acid	220	µg/kg	--	--

Table 7-5 Red Devil Creek and Seep Sediment Summary

Contaminants	Range of Detected Concentrations	Units	Sediment Screening Levels	
			Value	Basis
Benzyl Alcohol	3.1 J	µg/kg	52	Buchman (2008). AET, marine bivalve.
Diethyl Phthalate	1.7 J	µg/kg	320	MacDonald et al. (1999). Chronic EqP threshold.
Di-n-butyl Phthalate	9 J	µg/kg	42	MacDonald et al. (1999). PAETA, *Hyalella,* WA.
Docosanoic acid	190 J–710 J	µg/kg	--	--
Heptacosane	270 J	µg/kg	--	--
Pentachlorophenol (PCP)	22 J	µg/kg	40	MacDonald et al. (1999). Ecotoxicological value.
Phenanthrene	1.9 J–2.1 J	µg/kg	560	TEL. Buchman (2008).
Phenol	4.1 J	µg/kg	48	MacDonald et al. (1999). PAETA, *Hyalella* , WA
Unknown	180 J–700 J	µg/kg	--	--
Unknown Alkane	99 J	µg/kg	--	--
Unknown Alkene	240 J	µg/kg	--	--
Unknown Carboxylic Acid	130 J–370 J	µg/kg	--	--

Key

▨	concentration exceeds comparison criteria
--	Criterion not available
µg/kg	micrograms per kilogram
AET	apparent effects threshold
B.C.	British Columbia, Canada
J	estimated quantity
LEL	lowest effect level
mg/kg	milligrams per kilogram
ng/g	nanograms per gram
PAETA	Probable apparent effect threshold approach
TEL	Threshold effect level
WA	Washington State

Kuskokwim River Sediment

Seventeen inorganic elements and methylmercury were detected above background values in the Kuskokwim River sediment samples. Table 7-6 provides a summary of the contaminants detected, concentration ranges, and applicable sediment comparison criteria.

Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. Methylmercury was detected above the background value in approximately half of the samples analyzed for methylmercury. Concentrations of antimony, arsenic, mercury, and methylmercury generally decrease downriver from the mouth of Red Devil Creek, but not in a regular pattern. The samples collected from some of the most downriver and outboard sample locations exceed one or more of the background values. The extent of inorganic element contamination in river sediments has not been defined by RI sampling in either the downriver or cross-river direction.

Table 7-6 Kuskokwim River Sediment Summary

Contaminants	Range of Detected Concentrations	Units	Sediment Screening Levels	
			Value	Basis
Total Inorganic Elements				
Antimony	0.17–1,420 J	mg/kg	2.9	MacDonald et al. (1999). PAETA, WA
Arsenic	0.57 J–1,790	mg/kg	5.9	TEL. (Buchman 2008).
Barium	4.12–418	mg/kg	--	--
Beryllium	0.008 J–0.8	mg/kg	--	--
Cadmium	0.017 J–1.1	mg/kg	0.6	TEL. Buchman (2008).
Chromium	0.65 J–36	mg/kg	37.3	TEL. Buchman (2008).
Cobalt	0.369–27	mg/kg	50	MacDonald et al. (1999). Criterion, Ontario.
Copper	0.68 J–87.5 J	mg/kg	35.7	TEL. Buchman (2008).
Lead	0.05–18	mg/kg	35	TEL. Buchman (2008).
Manganese	53–5,410	mg/kg	460	MacDonald et al. (1999). LEL, B.C.
Mercury	0.011–29,000	mg/kg	0.174	TEL. Buchman (2008).
Nickel	0.78–67	mg/kg	18	TEL. Buchman (2008).
Selenium	0.075–2.5	mg/kg	5	MacDonald et al. (1999). Criterion, B.C.
Silver	0.0072–0.57	mg/kg	3.9	MacDonald et al. (1999). PAETA, WA.
Thallium	0.011 J–0.653	mg/kg	--	--
Vanadium	1,72–48.5	mg/kg	--	--
Zinc	1.2 J–270	mg/kg	123	TEL. Buchman (2008).
Methylmercury				
Methylmercury	0.15 J–3.73	ng/g	--	--

Key

▨	concentration exceeds comparison criteria
--	Criterion not available
AET	apparent effects threshold
B.C.	British Columbia, Canada
mg/kg	milligrams per kilogram
ng/g	nanograms per gram
PAETA	Probable apparent effect threshold approach
TEL	Threshold effect level
WA	Washington State

Vegetation

Fifteen inorganic elements and methylmercury were detected above background values in the vegetation samples. Methylmercury was detected in one sample—a horsetail pond vegetation sample (11MP84PV).

Of the inorganic elements detected, antimony, arsenic, barium, mercury, and nickel concentrations were the most highly elevated above background values. The horsetail pond vegetation samples contained the highest concentrations of antimony, arsenic, and mercury. The fewest number of contaminants detected above background values were in the blueberry stem and leaf samples.

7.1.3 Fate and Transport of Contaminants

The occurrence of contaminants at the RDM is chiefly dependent on the distribution of mine waste materials, consisting primarily of tailings, waste rock, and flotation tailings. Inorganics also are present in disturbed soils and sluiced overburden from the Surface Mined Area. The present distribution of these materials is explained by historical mining, ore processing, and subsequent modification by surface processes. The distribution of these materials at the RDM is discussed in Chapter 3.

Migration of contaminants associated with source materials is occurring, as described below. As noted above, many of the same inorganic elements that comprise contamination, notably including antimony, arsenic, and mercury, also occur naturally in native bedrock, soil, and sediment, and groundwater and surface water that flow through them. Such naturally occurring concentrations represent pre-mining “background” conditions.

Tailings/waste rock have historically been disposed of or eroded into Red Devil Creek within the Main Processing Area and downstream areas. In addition, naturally mineralized soils, particularly from the Surface Mined Area, have been eroded and transported into Red Devil Creek. Tailings/waste rock and natural materials that enter Red Devil Creek by erosion and mass wasting have been in the past, and presently are, subject to surface water transport downstream within Red Devil Creek. Tailings/waste rock and natural materials have been deposited within and transported down the channel of Red Devil Creek to the Kuskokwim River, where they accumulated in a delta. Sluicing of overburden from the Surface Mined Area created the Dolly and Rice Sluice deltas in the Kuskokwim River. Some of these materials also have migrated downriver to some extent in the Kuskokwim River. Materials deposited in the Red Devil Creek delta and sluice deltas may be subject to further erosion and transport.

Contaminants at the RDM presently are transported primarily by the groundwater and surface water pathways. Leaching of inorganics from contaminant sources is the primary source of contaminants to groundwater and surface water. Leached contaminants enter groundwater directly where/when groundwater immerses these source materials, and by leaching and downward transport toward groundwater where groundwater level is beneath the source materials. Leaching of inorganic elements from naturally mineralized bedrock and soil and migration via groundwater and surface water also is occurring at the RDM.

In general, the potential for leaching of inorganic elements is related to the solubility of the various forms of the elements, the amount of water percolating through the materials containing the elements, pH, redox potential, tendencies of various species of the elements to form complexes and adsorb to solids materials, and microbiological activity. The amounts of inorganic elements leached to groundwater are controlled primarily by the amounts of the elements present; rate of release; hydrologic factors including such as dispersion, advection, and dilution; and geochemical processes including such as interrelated processes of redox, adsorption-desorption, and precipitation/dissolution, and aqueous speciation. These general factors and processes, and conclusions that can be drawn from RI data regarding how these factors and processes affect mobility of inorganics at the RDM, are discussed in Section 5.3.

Antimony and arsenic are generally relatively more leachable than mercury at the RDM. This is supported by mercury SSE tests that indicate that the comparably less soluble SSE fractions, which include cinnabar, generally made up most of the mercury in samples with relatively higher concentrations of total mercury, including tailings/waste rock, waste rock, and flotation tailings. High proportions of the comparably less soluble SSE fractions also were observed in samples of other soil types, including weathered bedrock and a variety of disturbed and undisturbed native soil types and sluiced overburden. Elemental mercury was observed locally in subsurface soils within the pre-1955 and post-1955 Main Processing Areas. Mercury concentrations in groundwater may be locally impacted as a result of this elemental mercury.

Migration of inorganic elements in groundwater at the RDM is complicated and is affected by multiple complex groundwater migration pathways and varied geochemical conditions present at any given time at any given location along those pathways. Factors that control mobility and migration of inorganics in groundwater at the RDM are discussed in Sections 5.4.1 through 5.4.6. It appears likely that colloidal transport of mercury in fractured bedrock groundwater is a significant process at the RDM. It also appears likely that methylation of mercury occurs in groundwater within the Main Processing Area.

Contaminants are migrating via groundwater pathways into Red Devil Creek surface water along gaining reaches and are being transported downstream. Contaminants also are likely being dissolved or desorbed from stream bed sediments and being transported downstream. It also is possible that some contaminants in surface water may be adsorbed onto stream bed sediments. Particulates are being transported downstream as bed load (discussed above) and suspended phase transport within Red Devil Creek and the Kuskokwim River.

Concentrations of total and dissolved antimony, arsenic, and mercury, and contaminant loading, generally increase within and downstream of the Main Processing Area. Total concentrations of mercury were significantly higher (up to more than an order of magnitude) than the dissolved concentrations within and downstream of the Main Processing Area, indicating that mercury transport in surface water in Red Devil Creek is dominated by particulates, likely consisting predominantly of colloids. This is consistent with the conclusion that colloidal transport of mercury in groundwater is a significant process at the RDM. Methylmercury concentrations and loading in Red Devil Creek surface water generally increase downstream from the beginning of the Main Processing Area through about station RD06, and slightly decrease further downstream. This is consistent with the conclusion that methylation is occurring in soil and/or groundwater within the Main Processing Area.

7.1.4 Baseline Risk Assessment

7.1.4.1 Human Health Risk Assessment

An HHRA was conducted for the RDM site in accordance with Alaska State and EPA human health risk assessment guidance. The following potential receptors were evaluated in the HHRA: future onsite resident, current and future recreational or subsistence user, and future mine worker. The HHRA was conducted with contaminant data from surface and subsurface soil, near-shore sediment, groundwater, surface water, and biota data (fish and vegetation). The HHRA assessed potential exposure to COPCs in the environmental media from the following pathways:

- Dermal (skin) contact with surface water from Red Devil Creek.
- Dermal (skin) contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Ingestion of and dermal contact with groundwater or surface water.
- Incidental ingestion of and dermal contact with soil.
- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals from soil.
- Inhalation of volatile chemicals in groundwater.

Table 6-29 in Chapter 6 provides a summary of the predicted excess lifetime cancer risk to the potential receptors evaluated in the HHRA. Table 6-30 provides a summary of the predicted hazards to the potential receptors evaluated in the HHRA. The potential cancer risks at the site exceed both ADEC and EPA criteria for all receptors assessed. In general, exposure to arsenic in soil, groundwater, and fish posed greatest risk. Likewise, the potential hazards at the site exceed both ADEC and EPA criteria for all receptors evaluated in the HHRA. In general, exposure to antimony, arsenic, and mercury in soil, groundwater, and fish posed the greatest hazard. Risks and hazards were the highest for future residents potentially exposure to COPCs.

The HHRA included several areas of uncertainty. Significant and noteworthy sources of uncertainty in the HHRA and their potential effects on the risk and hazard results are summarized in Table 6-33. Specifically, the following areas provided sources of significant uncertainty in the HHRA:

- Modeled concentrations of COPCs in some wild food, including fish, birds, and berries.
- Estimation of consumption of wild food and assuming that residents harvest and consume wild food from the site.
- Characterization of true background levels in the mineralized area.

Potential RBCLs were proposed for the COCs and determined in the HHRA. RBCLs were developed for arsenic, antimony, and/or mercury in a number of media, including soil, groundwater, and biota. RBCLs also were developed for other COCs at the RDM site for media of concern. Several contaminants identified as COCs occur naturally at the RDM site. Generally, cleanup levels are not set at concentrations below natural background levels.

7.1.4.2 Ecological Risk Assessment

A BERA was conducted for the RDM site in accordance with Alaska State and EPA ecological risk assessment guidance. An assortment of ecologically relevant assessment endpoints was evaluated, including terrestrial plants, soil invertebrates, fish, benthic macroinvertebrates, and other aquatic biota, terrestrial wildlife, and aquatic-dependent wildlife. The assessment endpoints, risk questions, indicator species, and measures selected for the BERA are presented in Table 6-40. The BERA was conducted using contaminant data from two primary sources: (1) surface soil, sediment, surface water, and vegetation data collected for the RDM site RI; and (2) fish (slimy sculpin) and benthic macroinvertebrate contaminant data collected from Red Devil Creek by the BLM as part of a larger study examining contaminants in aquatic biota in the Middle Kuskokwim River.

A summary of the contaminants predicted to pose a risk to the assessment endpoints evaluated in the BERA is presented in Table 6-80. In general, the greatest HQ values were observed for antimony, arsenic, and mercury, as would be expected given the site history and local mineralogy. The BERA risk results are discussed below by assessment endpoint:

- For the **terrestrial plant community**, seven contaminants were predicted to be COCs. The greatest HQ values were for antimony, arsenic, and mercury. Confidence in the COC list and magnitude of the HQ values is considered low, primarily because of the conservative nature of the soil screening levels for plants and because contaminant bioavailability in soil was not considered. If the HQ values for plants were adjusted to account for solubility of site contaminants (e.g., using the SPLP and mercury SSE results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower. It should be noted that the Surface Mined Area has been successfully re-colonized by native plants since the end of mining at the site, suggesting that soil in this area is not phytotoxic. In contrast, the Main Processing Area has not been entirely re-colonized by native vegetation. While this situation could be the result of high levels of metals in soil, the highly compacted nature of the soil and/or absence of soil in some locations also are factors that may be limiting plant growth in the Main Processing Area. As noted in Table 6-39, bis(2-ethylhexyl)phthalate and diethylphthalate may pose a localized risk to plants at one sample location each in the Main Processing Area.
- For the **soil invertebrate community**, seven contaminants were predicted to be COCs. The greatest HQ values were for antimony, arsenic, and

mercury. Confidence in the COC list and magnitude of the HQ values is considered low, primarily because of the conservative nature of the soil screening levels for soil invertebrates and because contaminant bioavailability in soil was not considered. If the HQ values for soil invertebrates were adjusted to account for solubility of site contaminants (e.g., using the SPLP and mercury SSE results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower. In addition, thallium was identified as a COC for the soil invertebrate community because it was detected in site surface soil, but no screening level was available. However, thallium was detected in only two of 135 samples (see Table 6-44), so potential risks to the soil invertebrate community from thallium, if any, are localized in extent. As noted in Table 6-39, bis(2-ethylhexyl)phthalate and diethylphthalate may pose a localized risk to soil fauna at one sample location each in the Main Processing Area.

- For **aquatic biota** (periphyton, amphibians, benthic macroinvertebrates, fish, etc.) exposed to surface water, five COCs were identified based on comparing chemical concentrations in surface water with water quality criteria. The greatest HQ values were for antimony, arsenic, and mercury. Potential risk to aquatic life from arsenic, iron, and manganese in surface water in Red Devil Creek appears to be localized to an area near where a seep discharges to the creek in the Main Processing Area (see Section 6.3.7.5).
- For the **fish community** in Red Devil Creek, arsenic, antimony, mercury, and possibly selenium were predicted to be COCs based on comparing chemical concentration in whole-body sculpin samples with tissue screening concentrations. Confidence in the risk estimates is considered moderate to low depending on the contaminant. For example, the selenium HQ value of 1.3 is based on a fish tissue criterion from Dyer et al. (2000). If the EPA draft selenium tissue criterion is used instead of the value from Dyer et al. (2000), an HQ less than 1 is calculated (see Table 6-40).
- For the **benthic macroinvertebrate community**, nine contaminants were predicted to be COCs based on comparing contaminant concentrations in sediment with sediment screening levels. Confidence in the COC list and HQ values based on this assessment method is considered low because site-specific bioavailability was not considered in the evaluation. Also, a benthic macroinvertebrate survey conducted in Red Devil Creek identified no adverse impacts to abundance and diversity of benthic macroinvertebrates in Red Devil Creek compared with nearby reference creeks (see Section 6.3.7.4). The site-specific survey is considered to be a more reliable assessment method and suggests no impacts to the benthic community from site-related contaminants. Lastly, potential risks to benthic macroinvertebrates also were assessed by comparing contaminant levels in benthic macroinvertebrate tissues with critical tissue concentrations (see Section 6.3.7.4). This assessment method identified

only methylmercury as a COC for the benthic macroinvertebrate community (HQ 1.3).

- For the **terrestrial avian invertivore** assessment endpoint, represented by the **American robin**, up to seven contaminants (antimony, arsenic, beryllium, lead, thallium, benzoic acid, and diethylphthalate) were identified as COCs. Confidence in the arsenic and lead risk estimates is considered low for two reasons: (1) site-specific bioavailability of metals in soil was not quantitatively considered; and (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms). In addition, for lead, the risk is driven by a highly elevated lead concentration in surface soil at one location. Hence, potential risks to the robin from lead at the RDM site are highly localized. Thallium and benzoic acid were identified as COCs for the robin because they were detected in site surface soil, but no TRV was available. However, thallium was detected in only two of 135 surface soil samples (see Table 6-44), so potential risks to the robin from thallium, if any, are highly localized. Similarly, benzoic acid was detected at one surface-soil sample location, so potential risks from this chemical to the robin, if any, also are localized. Potential risks to the robin from diethylphthalate are restricted to one surface soil sample location in the Main Processing Area where the concentration exceeded a conservative soil screening value. Potential risks to the robin from antimony cannot be ruled out given the nature of the site.
- For the **terrestrial mammalian invertivore** assessment endpoint, represented by the **masked shrew**, nine COCs were identified. The greatest HQ values were for antimony and arsenic. Confidence in the risk estimates is considered low for two reasons: (1) site-specific bioavailability of metals in soil was not quantitatively considered; and (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms). Also, for antimony, because a soil-to-earthworm uptake model was not available from the literature, a conservative bioaccumulation factor of 1 was assumed (i.e., worm antimony concentration equals soil antimony concentration). This assumption is the primary reason why the antimony HQ for the shrew (2,478) is so high. It is expected that this assumption led to an overestimate of the risk from antimony, given the limited bioavailability of contaminants in soil at the site (see Section 6.3.8.1). Lastly, as discussed above for the robin, any potential risks to the shrew from lead, thallium, or benzoic acid in surface soil at the RDM site are highly localized.
- For the **terrestrial avian herbivore** assessment endpoint, represented by the **spruce grouse**, up to eight contaminants (antimony, arsenic, beryllium, mercury, thallium, vanadium, benzoic acid, and diethylphthalate) were predicted to be COCs. The greatest HQ values were for arsenic and mercury. Confidence in the arsenic and mercury risk estimates is considered low. Although metals levels in the primary food of the spruce grouse (spruce needles) were measured, site-specific bioavailability of metals in soil was not quantitatively considered, and

incidental soil ingestion accounts for over 80 percent of the grouse's exposure to arsenic and mercury (see Table 6-66). Potential risks from antimony cannot be ruled out, but they could not be quantified because an avian TRV for antimony was not identified. As noted above, potential risks, if any, from thallium, benzoic acid, and diethylphthalate in soil are localized to one or two sample locations each in the Main Processing Area.

- For the **terrestrial mammalian herbivore** assessment endpoint, represented by the **tundra vole**, antimony, arsenic, manganese, and benzoic acid were identified as COCs. The great HQ value was for antimony. Confidence in the risk estimates is considered low. Although metals concentrations in a representative forage plant (blueberry stems/leaves) were measured and used to quantify vole dietary exposure, site-specific bioavailability of metals in soil was not quantitatively considered, and nearly all of the vole's exposure to antimony and arsenic comes from incidental soil ingestion (see Table 6-67). A potential risk to the vole from benzoic acid could not be ruled out due to the lack of a mammalian TRV for this chemical. However, any potential risks to the vole from benzoic acid are localized because this chemical was detected at only one sample location in the Main Processing Area.

  For the **terrestrial carnivorous bird** assessment endpoint, represented by the **northern shrike**, only the HQ value for diethylphthalate was greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated. Potential risks to the shrike from diethylphthalate are restricted to one surface soil sample location in the Main Processing Area where the detected concentration exceeded a conservative soil screening value.

- For the **terrestrial carnivorous mammal** assessment endpoint, represented by the **least weasel**, no metals were identified as COCs, but one SVOC (benzoic acid) could not be eliminated as a COC (see Table 6-80). However, because benzoic acid was detected at only one surface-soil sample location in the Main Processing Area (11MP70SS), any potential risks to the weasel from this chemical are highly localized.
- For the **semi-aquatic avian invertivore** assessment endpoint, represented by the **common snipe**, up to five COCs (antimony, arsenic, beryllium, selenium, and thallium) were identified. The greatest HQ was for arsenic. Confidence in the arsenic risk estimate for the snipe is considered moderate. Although the arsenic level in snipe prey (benthic macroinvertebrates from Red Devil Creek) was measured, site-specific arsenic bioavailability in sediment was not quantitatively considered. Potential risks to the snipe from antimony, beryllium, and thallium could not be quantitatively evaluated because avian TRVs for these elements were not identified.
- For the **semi-aquatic mammalian herbivore** assessment endpoint, represented by the **beaver**, arsenic was identified as a COC. Confidence in

the arsenic risk estimate for the beaver is considered low. Although the arsenic level in a representative food of the beaver (alder bark) was measured, site-specific arsenic bioavailability in soil was not quantitatively considered, and incidental soil ingestion accounts for 95 percent of arsenic exposure for this receptor (see Table 6-71).

- For the **semi-aquatic avian herbivore** assessment endpoint, represented by the **green-winged teal**, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated.
- For the **avian piscivore** assessment endpoint, represented by the **belted kingfisher**, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated.
- For the **mammalian piscivore** assessment endpoint, represented by the mink, antimony, arsenic, and selenium were identified as COCs. Confidence in the risk estimates for the mink are considered moderate to high.

All risk assessments include elements of uncertainty and the BERA for the RDM site is no exception. Noteworthy sources of uncertainty in the BERA and their potential effect on the risk results are summarized in Section 6.3.8.

Several contaminants identified as COCs at the RDM site occur at concentrations in site media that are similar to background. Specifically, beryllium, vanadium, and selenium were predicted to pose a potential risk to one or more ecological receptors at the RDM site, but their concentrations in site media lie within the range of background (see Section 6.3.10).

Ecological risk-based remedial goals for arsenic, antimony, and mercury in surface soil and sediment were developed for the RDM site at the completion of the BERA (see Section 6.4.2). These cleanup levels are not designed to account for the cumulative risk resulting from exposure to multiple contaminants simultaneously. Based on the remedial goals, risk maps were developed to illustrate where soil and sediment contaminant levels exceeded risk thresholds. Collectively, the risk maps show that ecological risk are greatest in the Main Processing Area (see Section 6.4.2). In this area, much of the ground surface consists of tailings and other waste materials

7.2 Conclusions

7.2.1 Key Study Questions

This section provides responses, based on the RI's findings, to the key RI study questions developed through the Work Plan DQO process.

Nature and Extent of Contamination

1. **What COPCs, in addition to those identified in previous investigations, exist at and near the site?**
   The COPCs identified at the site include inorganic elements, methylmercury, SVOCs, and petroleum hydrocarbons. While PCBs were detected in one sample, PCBs are not considered a major site contaminant. The detailed list of COPCs is provided in the media-specific summary tables presented in Section 7.1.2.

2. **Do COPC concentrations differ in areas where different ore processing operations were conducted?**
   Yes. The characteristics of tailings, including contaminant concentrations, leachability of metals, texture, and appearance, are different in the Pre-1955 portion of the Main Processing Area, the Post-1955 portion of the Main Processing Area, and the flotation tailings in the settling ponds.

3. **Are COPC reporting limits sufficient to characterize human health and ecological risks?**
   Yes. For soil and sediment samples, all detection limits were below human health risk-based screening criteria and, with few exceptions, ecological risk-based screening criteria. For groundwater and surface water samples, detection limits were below human health and/or ecological risk-based screening criteria with several exceptions. Such exceptions are discussed in Section 6.1.4. It is concluded that elevated detection limits would not have an appreciable impact on overall assessment of risk at the site.

4. **Is mercury present in organic forms at the site?**
   Yes. Methylmercury was detected above background values in Red Devil Creek surface water and sediment, Kuskokwim River sediment, groundwater, and vegetation. See the summary tables in Section 7.1.2 for methylmercury concentration ranges in these media.

5. **What is the areal and vertical extent of tailings, flotation tailings, and waste rock?**
   Tailings and waste rock are typically comingled and are mixed with native alluvium and soil in some areas, most importantly in the channel and delta of Red Devil Creek. The areal extent of tailings/waste rock generally includes the Main Processing Area down to the mouth of Red Devil Creek. The maximum depth of tailing/waste rock encountered is approximately 24 feet bgs. The flotation tailings are mostly confined to the footprint of the settling ponds and extend to a maximum depth of approximately 8 feet bgs. Material that appears to be flotation tailings was encountered in a soil boring downgradient of Settling Pond #1.

6. **Are soils in the area of former surface exploration and mining a source of COPCs, and are metals in a mobile or bioavailable form?**
   Soils in the area of former surface exploration and mining contain contaminant concentrations above background values. Leaching tests indicate that these contaminants may be mobile. However, arsenic leachability appears to be lower in soils than in tailings/waste rock and flotation tailings based on leach test results. Three samples collected in the area of former surface exploration and mining had arsenic bioavailability results ranging from 3.9 to 43 percent. The method used to assess bioavailability has not been approved for the determination of arsenic bioavailability of arsenic in soil.

7. **Are roads at and to the site a source of COPCs?**
   Roads within the Main Processing Area are surfaced with tailings/waste rock that contains concentrations of inorganic elements above background values. XRF screening of roads outside the Main Processing Area, including the road along the Kuskokwim River, indicated elevated levels of arsenic, antimony, and mercury on the road surface and in soils down-slope of the road at most locations evaluated, suggesting that such roads are constructed of or otherwise affected by tailings/waste rock. Roads in the Surface Mined Area do not appear to be surfaced with tailings/waste rock, except in areas immediately adjacent to the Main Processing Area.

8. **Are the Dolly Sluice and possible Rice Sluice areas sources of COPCs?**
   Yes. Surface soils in the Dolly Sluice and the Rice Sluice contain concentrations of inorganic elements, particularly arsenic and mercury, above background values. There are no tailings in the Dolly Sluice and Rice Sluice areas. Surface and subsurface soil at the Dolly Sluice and Rice Sluice deltas on the Kuskokwim River also contain inorganic element concentrations above background values, particularly antimony, arsenic, and mercury.

9. **What is the nature and extent of contamination in native subsurface soil?**
   Native subsurface soils have been impacted locally by contaminants related to past mining activities and tailings/waste rock disposal. Native soils in some areas of the site contain concentrations of inorganics that are believed to be naturally elevated.

10. **What is the nature and extent of contamination in groundwater?** Groundwater is impacted locally by inorganic contaminants associated with tailings/waste rock, flotation tailings, and organic contaminants associated with petroleum hydrocarbons. Groundwater is also likely impacted by inorganic elements associated with bedrock and the underground mine workings. The extent of groundwater contamination includes the Main Processing Area, the Red Devil Creek downstream alluvial area, and the Surface Mined Area.

11. **What is the nature and extent of contamination in aquatic biota?** Benthic macroinvertebrate and slimy sculpin tissue samples, collected from Red Devil Creek by the BLM in 2010 and 2011, contained site-related inorganic elements and methylmercury. The risk assessment presented in Chapter 6 summarizes these data and integrates them into estimates of risk for the site.

12. **What are the background concentrations of COPCs in native soils and in groundwater, surface water, sediment, and biota in areas undisturbed by mining activities?** Background values for inorganic elements were developed through application of the EPA's ProUCL software for all media and are presented in Section 4.1. Background samples were collected from locations outside of and upgradient of the areas recognized as potentially impacted by mining, ore processing, and waste disposal operations. It should be noted that, although the ore zones that were mined are discrete, localized ore bodies, natural mineralization in the RDM area occurs outside of those areas that were mined, including areas not considered for background evaluation due to their location within the area of potential mine-related impacts. At several such locations, native soil that is apparently unaffected by mining impacts exhibits arsenic and mercury concentrations that are up to one or two orders of magnitude higher than the calculated background soil concentrations presented in Chapter 4. Detailed discussion of natural mineralization at the RDM is presented in Section 4.1.7. Therefore, the background levels presented Chapter 4, particularly soil background levels, are considered to be conservative, and likely underestimate actual background concentrations of inorganic elements associated with local bedrock mineralization.

13. **Are the previous locations of transformers a source of COPCs?** The locations where transformers were previously stored onsite were extensively researched through a review of historical photographs and previous waste removal and investigation reports. From this research, 16 soil samples were collected for PCB analysis. One sample (11MP82SS) had a positive detection of Aroclor1260 at a concentration of 0.021J mg/kg, which is less than the State of Alaska PCB soil cleanup level (18 AAC 75.340).

14. What physical and chemical characteristics can be used to define a difference between tailings, waste rock, and native soils at the site?

The following physical and chemical characteristics can be used to define the difference between tailings, waste rock, and native soils: contaminant concentrations, metals leachability, and lithologic characteristics, particularly the presence or absence of key minerals or red porous rock/red oxidation rind, which, in conjunction with supporting evidence (e.g., elevated concentrations of antimony, arsenic, and mercury), indicate the presence of calcines. These characteristics were used in conjunction with other lines of evidence to define material differences, including historical and recent aerial and land-based photographs, historical and recent topography, historical geologic maps, and historical information on historical mining and ore processing activities to identify and delineate the extent of these materials.

Fate and Transport of Contamination

15. Is contaminated groundwater impacting Red Devil Creek or the Kuskokwim River?

Contaminated groundwater is impacting Red Devil Creek surface water through baseflow and the seep in the Main Processing Area. Groundwater that emerges at the seep and via baseflow in the vicinity of the seep has resulted in the formation of iron oxyhydroxide (yellowboy) which has impacted sediments in Red Devil Creek.

The most impacted groundwater at the RDM emerges into Red Devil Creek and enters the Kuskokwim River as surface water rather than as groundwater. However, it is possible that some impacted groundwater discharges directly to the Kuskokwim River. Results of the RI suggest that contaminants detected in sediments in the Kuskokwim River are the result of the migration of solids from Red Devil Creek and the Dolly and Rice Sluice deltas into the river.

16. Have tailings, flotation tailings, waste rock, and/or other site sources impacted sediments, surface water, and aquatic biota in Red Devil Creek?

Yes. Tailings and waste rock are present in the bed and delta of Red Devil Creek. Concentrations of inorganic elements associated with tailings and waste rock, particularly antimony, arsenic, and mercury, were detected above background values in Red Devil Creek surface water, sediment, and aquatic biota. See the summary tables in Section 7.1.2 for contaminant concentration ranges in Red Devil Creek surface water and sediment. Contaminant concentration data for aquatic biota are presented in Chapter 6.

17. **Have tailings, flotation tailings, waste rock, and/or other site sources impacted sediments in the Kuskokwim River downriver of the mouth of Red Devil Creek?**
    Yes. Concentrations of inorganic elements associated with ore minerals, tailings, and waste rock were detected above background values in Kuskokwim River sediments. See the summary table in Section 7.1.2 for contaminant concentration ranges in Kuskokwim River sediment.

18. **Have tailings, flotation tailings, waste rock, and/or other site sources impacted native subsurface soils at the site?**
    Yes. See response to question 9.

19. **Has elemental mercury, previously documented in subsurface soil near Monofill #2, mobilized and/or entered groundwater?**
    Groundwater sampled in monitoring well MW-10, immediately downgradient of Monofill #2, contained total mercury at a concentration above the background value. Elemental mercury was observed adhering to clay/silt in a subsurface interval in the MW-10 soil boring. However, RI information does not indicate that mercury detected in monitoring well MW-10 is attributable to this elemental mercury or leaching from tailings/waste rock. Elemental mercury also was identified in subsurface soil from soil boring MP55. The total mercury concentration in the groundwater sample from downgradient well MW24 is significantly elevated above background. Despite extensive mercury ore processing that occurred on the site, only traces of elemental mercury in the two locations identified above were found. This suggests that elemental mercury is not widespread at the site and that its impact on groundwater concentrations is not significant.

20. **What is the leaching potential of COPCs in tailings and flotation tailings at the site?**
    Tailings/waste rock and flotation tailings exhibit varying degrees of metals leachability, based on the SPLP and TCLP leaching methods. Metals leaching potential is further evidenced by groundwater and surface water impacts that are attributable to leaching from tailings/waste rock and flotation tailings.

21. **What is the fraction of mercury in tailings, flotation tailings, waste rock, and contaminated soil that is available to chemically mobilize?**
    Mercury in waste materials exhibited varying degrees of susceptibility to mobilization. At locations where total mercury was at the highest concentrations, the dominant mercury form is likely cinnabar, which is minimally leachable in water.

22. **Are COPCs in waste rock and impacted soils leachable?**
    Yes. These materials exhibit varying degrees of metals leachability potential. See response to question 20.

23. **What is the fraction of arsenic in soil, sediment, surface water, and groundwater that is bioavailable to humans?**
    Based on *in vitro* arsenic bioavailability results for soil samples collected as part of the RI, the fraction of arsenic in soil that is bioavailable to humans ranges from 2.7 to 68.1 percent at the site and appears to be highly dependent on soil type. The bioavailability of arsenic is discussed in the Uncertainties section of the HHRA in Section 6.2.6.3. The bioavailability of arsenic in sediment, surface water, and groundwater was not measured in RI samples. The *in vitro* method used to assess bioavailability has not been approved for the determination of arsenic bioavailability of arsenic in soil.

24. **Are the underground mine workings influencing the nature, extent, and migration of COPCs in groundwater and surface water?**
    Probably. The exact manner in which the mine workings influence groundwater flow paths, and consequently groundwater and surface water contaminant levels and migration, is not known.

25. **Have site-related contaminants impacted onsite vegetation or wildlife?**
    Site-related contaminants, including inorganic elements and methylmercury, were detected above background values in onsite vegetation. RI field investigations did not include direct measurement of contaminants in tissues of wildlife; therefore, this study question remains unanswered.

Human Health and Ecological Risk

26. **What risks to human health under future residential, subsistence user, and industrial land use scenarios are posed by COPCs at and near the site?**
    The potential cancer risks at the site, under all future land use scenarios, exceed both ADEC and EPA criteria for all receptors assessed. In general, exposure to arsenic in soil, groundwater, and fish posed greatest risk. Likewise, the potential hazards at the site exceed both ADEC and EPA criteria for all receptors evaluated in the HHRA. In general, exposure to antimony, arsenic, and mercury in soil, groundwater, and fish posed the greatest hazard. Risks and hazards were the highest for future residents potentially exposed to COPCs.

27. **What risks to ecological receptors at various trophic levels are posed by COPCs at and near the site?**
    Potential risks to terrestrial plants, soil invertebrates, aquatic biota, invertivorous wildlife, herbivorous wildlife, carnivorous wildlife, and piscivorous wildlife were identified at the site. The greatest hazard quotients were for antimony, arsenic, and mercury, as would be expected

given the site history and local mineralogy. Risk maps show that ecological risks are greatest in the Main Processing Area. In this area, much of the ground surface consists of tailings and other waste materials containing high concentrations of antimony, arsenic, and mercury.

8

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