STREAMLINED HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

Rainy Mine and Millsite
Mt. Baker-Snoqualmie National Forest, Washington April 14, 2006

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ACRONYMS AND ABBREVIATIONS

cm^2	Square centimeter
cm/hr	Centimeter per hour
cyd	Cubic yard
kg	Kilogram
L/cm^3	Liter per cubic centimeter
m^3/day	Cubic meter per day
m^3/kg	Cubic meter per kilogram
mg/cm^2/day	Milligram per square centimeter per day
mg/day	Milligram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/L	Milligram per liter
μg/L	Microgram per liter
ABA	Acid base accounting
APA	Abbreviated Preliminary Assessment
ATSDR	Agency for Toxic Substance Disease Registry
BLM	United States Bureau of Land Management
CDI	Chronic daily intake
CERCLA	Comprehensive Emergency Response, Compensation & Liability Act
CES	Cascade Earth Sciences
CNS	Central nervous system
COI	Contaminant of interest
COPC	Contaminant of potential concern
COR	Contracting Officer's Representative
CPEC	Contaminant of potential ecological concern
CSEM	Conceptual site exposure model
CSM	Conceptual site model
CTE	Central tendency exposure
ECR	Excess cancer risk
EE/CA	Engineering Evaluation/Cost Analysis
EF	Exposure factor
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
HEAST	Health Effects Assessment Screening Tables
HHRA	Human health risk assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokentic
IRIS	Integrated Risk Information System
MCL	Maximum contaminant level

ACRONYMS AND ABBREVIATIONS (continued)

MDC	Maximum detected concentration
MDL	Method detection limit
MFSR	Middle Fork Snoqualmie River
MTCA	Model Toxics Control Act
NCEA	National Center for Environmental Risk Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFS	National Forest Service
NNP	Net neutralization potential
PPRTVS	Provisional Peer Reviewed Toxicity Values
PRG	Preliminary Remediation Goal
PQL	Practical quantitation limit
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference dose
RMC	Risk Management Criteria
RME	Reasonable maximum exposure
RTE	Rare, threatened, or endangered
SARA	Superfund Amendments and Reauthorization Act
SF	Slope factor
SI	Site Inspection
SLV	Screening level value
SOC	Species of concern
T&E	Threatened and endangered
UCL_{95}	95 percent upper confidence limit
USFS	United States Forest Service
WAC	Washington Administrative Code
WR	Waste rock
WSDH	Washington State Department of Health

EXECUTIVE SUMMARY

The Rainy Mine and Millsite is an inactive copper mine located about 12 miles northeast of North Bend, Washington, in the Mount Baker-Snoqualmie National Forest. Under contract to the USDA Forest Service (USFS), Millennium Science and Engineering, Inc. (MSE) completed streamlined human health and ecological risk assessments (RAs) to evaluate risks associated with exposure to mining-related contaminants at the site. Analytical data and other information presented in the Site Inspection (SI) Report by Cascade Earth Sciences (CES 2005) were used in the risk calculations. A hot spot assessment was completed and human health risk-based cleanup levels were developed for soil and sediment at the site. Physical hazards at the site were not addressed in this RA.

Streamlined human health and ecological RAs for the following pathways were completed to assess potential risks to human and ecological receptors at the site.

- **Groundwater Pathway:** The groundwater pathway is incomplete because there are no drinking water wells within a 4-mile radius of the site.
- **Surface Water Pathway:** The surface water ingestion pathway is complete and significant for both human and ecological receptors because of elevated metals concentrations in the surface water and sediment. The surface water dermal contact pathway is complete but insignificant because of low risk levels.
- **Soil Pathway:** The soil ingestion and dermal contact pathways are complete and significant for both human and ecological receptors because of elevated metals concentrations in the waste rock, soil around the mill foundation, and sediment.
- **Air Pathway:** The air pathway is complete for human receptors but insignificant because of extremely low risk levels.

Based on results of the streamlined RAs, there are significant human health risks from exposure to metals, particularly arsenic, in mine waste, soil, sediment, and surface water at the site. Non-carcinogenic Hazard Indices (HIs) ranged from 0.2 to 4 for the adult recreationalist, and from 3 to 100 for the child recreationalist. Carcinogenic risks ranged from 9.E-06 to 8.E-04 for the adult recreationalist, and from 1.E-04 to 5.E-03 for the child recreationalist. Six human health contaminants of potential concern (COPCs) were identified at the site: arsenic, cadmium, chromium, copper, iron, and manganese. The most significant exposure pathway is ingestion of and dermal contact with arsenic in with the mine waste.

There is also significant risk to ecological receptors at the site and several contaminants of potential ecological concern (CPECs) were identified, most notably aluminum, arsenic, copper and iron. The highest risk ratios are from exposure to the mine waste, and there is also risk to aquatic receptors from exposure to surface water, sediment, and pore water. However, with the possible exception of amphibian species, the risks appear to be limited to individual receptors rather than whole populations. This is because while individual receptors may be exposed to metals in mine wastes at the site, their populations are unlikely to be significantly impacted because it is improbable that entire populations of receptors reside strictly within the site boundaries. However, some sensitive species, such as the Oregon tailed frog or western toad, may have individual receptors that are at risk because they inhabit the seep areas and have home ranges that are limited to the site.

Several state or federal rare, threatened, or endangered (RTE) ecological species have potential habitat in vicinity of the site. In addition, the coastal cutthroat trout, a federal species of concern (SOC) has been documented in Quartz Creek and the Taylor River. There are also several RTE plant species that may be

present on the site. Therefore, a risk ratio for sensitive protected species (Q = 1) was used to evaluate potential ecological risks to birds, mammals, plants, and aquatic life; no RTE invertebrates were identified so a risk ratio of Q = 5 was used for invertebrates.

A hot spot assessment was completed and human health risk-based cleanup criteria were back calculated for soil and sediment using the human health exposure factors and risk equations. No sediment samples and only one soil sample exceeded a hot spot concentration. Arsenic was the only contaminant to exceed the soil hot spot concentration (330 milligram per kilogram [mg/kg]), and one area was identified as a hot spot: waste rock pile WR2. Arsenic was also the only contaminant to exceed soil and sediment cleanup levels (33 mg/kg and 132 mg/kg, respectively), and six areas exceeded the cleanup level: both waste rock piles, soil in two areas around the mill foundation, and sediment at both seeps.

Addressing or mitigating the human health risks through a removal action should also address the potential ecological risks. The areas containing the highest arsenic concentrations in soil and sediment also contain the highest concentrations of the other COPCs. Therefore, removal of waste rock, soil, and sediment from the areas with arsenic concentrations exceeding the cleanup levels should significantly reduce both the overall human health and potential ecological risk at the site. Removal of the waste rock should also significantly reduce metals concentrations in the two seeps, and metals migration to Quartz Creek from the seeps and unnamed drainage that flows across waste rock pile WR2. The total volume of waste rock in the two piles was estimated in the SI to be about 2,025 cubic yards (CES 2005).

Based on the results of the streamlined RAs, MSE recommends performing a streamlined Engineering Evaluation/Cost Analysis (EE/CA) to address metals concentrations in the mine waste, soil, and sediment at the site.

1.0 INTRODUCTION

This report presents streamlined human health and ecological risk assessments (RAs) for the Rainy Mine and Millsite, in the Mt. Baker-Snoqualmie National Forest, King County, Washington. The streamlined RAs were completed to evaluate risks associated with exposure to mining-related contaminants at the site using analytical data and other information presented in the Site Inspection (SI) Report by Cascade Earth Sciences (CES 2005). A hot spot assessment also was completed to identify highly contaminated areas, and human health risk-based cleanup levels were developed for soil and sediment at the site. Physical hazards at the site were not addressed in this RA.

This report describes the risk assessment methodology, assumptions, and potential risks to human and ecological receptors, and is organized into the following sections:

- Introduction
- Data Review
- Initial Risk Screening
- Streamlined Human Health Risk Assessment
- Streamlined Ecological Risk Assessment
- Conclusions
- References

A detailed description of the site location, background, field investigation, and physiography is presented in the SI report and will not be reiterated here. Summary tables are presented at the end of the report; human health and ecological risk calculation tables are presented in Appendices A and B, respectively. A supplemental list of threatened and endangered (T&E) wildlife and plant species, and species of concern (SOC) is provided in Appendix C.

1.1 Site Description

The Rainy Mine and Millsite is an inactive copper mine located about 12 miles northeast of North Bend, Washington, in the Mount Baker-Snoqualmie National Forest. Site features include:

- One open vertical shaft;
- One adit and several apparent collapsed features;
- Two waste rock piles; and
- Concrete mill foundation and miscellaneous debris.

The project site is located along a steep, heavily forested slope adjacent to a perennial stream at an elevation of about 1,800 feet. The stream, Quartz Creek, is a tributary to the Taylor River, which flows into the Middle Fork Snoqualmie River (MFSR). The site is divided into two zones, east and west. The east zone consists of an open vertical shaft, a concrete mill foundation, miscellaneous debris, and a large waste rock pile (WR1) containing approximately 2,000 cubic yards (cyd) of fine- to coarse-grained material. Water seeps from the toe of the waste rock pile in two locations and forms a marshy area that eventually drains into Quartz Creek. The west zone is about 900 feet upstream of the east zone and consists of an open adit and one small waste rock pile containing approximately 25 cyd of fine- to coarse-grained material.

1.2 Previous Investigations

An Abbreviated Preliminary Assessment (APA) was completed by the U.S. Forest Service (USFS) in September 2003. Metals concentrations at the site were assessed *in situ* using an x-ray fluorescence analyzer, and surface water pH and conductivity were measured using a portable field meter. Arsenic was detected at concentrations ranging from 63.3 to 145.2 milligrams per kilogram (mg/kg), and was the only detected compound that exceeded U.S. Environmental Protection Agency (EPA) Region IX Industrial Soil Preliminary Remediation Goals (PRGs) (2004a). Surface water pH ranged from 4.7 to 7.6. The APA concluded that there is a high potential for acid rock drainage at the site and that an SI was warranted.

An SI was completed in July 2005 by CES. SI activities included:

1) Researching and reviewing relevant background site information;
2) Conducting a field investigation and collecting samples for laboratory analysis;
3) Conducting aquatic, plant, and wildlife surveys of the site; and
4) Estimating mine waste volumes.

The site is currently inactive but there are four active claims on site. There are no known residences, drinking water wells, or wellhead protection areas within a 4-mile radius of the site. However, recreational use in vicinity of the site is high and likely includes hiking, fishing, camping, hunting, and minerals prospecting. In addition, a teacher reportedly regularly brings a class of children to the site to search for mineral crystals in the mine waste rock. No terrestrial sensitive or T&E species were observed on the site during the SI; however, several may inhabit the area. Cutthroat trout, a federal SOC have been documented in Quartz Creek and the Taylor River. However, the documented locations were not reported and no fish were observed in Quartz Creek during the SI field investigation. Rainbow trout, a state priority species, have been documented in the MFSR.

During the SI, the following media were sampled and submitted for laboratory analysis:

- Mine waste (waste rock from the two waste rock piles and soil from three locations around the mill foundation) – 9 samples;
- Background soil – 3 samples;
- Surface water – 10 samples, including 2 background;
- Pore water – 6 samples co-located with 6 surface water sample locations, including 1 background;
- Sediment – 8 samples co-located with 8 surface water sample locations, including 1 background;
- Plant tissue – 6 samples co-located with soil and mine waste samples, including 3 background; and
- Benthic Macroinvertebrates – samples collected from pool and riffle habitats along stream reaches at 6 locations.

Analytical results indicated concentrations of several metals were above screening levels in the background soil, mine waste, sediment, pore water, and surface water. The most notable exceedances included arsenic, copper, and silver. Acid base accounting (ABA) results indicate a high potential for acid generation in soil and mine waste at the site. Surface water, pore water, and sediment sample results indicate an impact to Quartz Creek, particularly from arsenic concentrations in the seeps.

The SI concluded there was evidence of a release of hazardous substances to soil and surface water at the site, and that an Engineering Evaluation/Cost Analysis (EE/CA) should be performed and should include human health and ecological RAs.

1.3 Purpose and Objectives

The streamlined RAs were prepared to assess potential hazards and risks to human and ecological receptors from exposure to mine waste and contaminated media at the Rainy Mine and Millsite. The primary objectives of the RA were to:

- Determine 95 percent Upper Confidence Level (UCL_{95}) concentrations;
- Assess potential risks to human and ecological receptors at the site;
- Identify hot spots, i.e. highly contaminated areas that contribute a large percentage of the overall site risk; and
- Establish appropriate risk-based, site-specific, cleanup levels.

2.0 DATA REVIEW

Analytical results presented in the SI were tabulated and reviewed to ensure suitability for use in the RA. Data used in the RA included results of background soil, mine waste (waste rock), surface water, pore water, sediment samples and vegetation samples collected during the SI. The analytical results are summarized by media type in Tables 1 through 5.

The method detection limit (MDL) for analytical results reported as below the MDL were compared to human health and ecological screening criteria to ensure the MDLs were below the applicable criteria. The only contaminants with MDLs consistently above at least one screening criteria were beryllium and selenium in surface water; the beryllium MDL was also above screening criteria in pore water. The MDLs for both contaminants were slightly above Oak Ridge National Laboratory (ORNL) Preliminary Remediation Goals for ecological endpoints (Efroymson *et al.* 1997). However, both MDLs were significantly below other screening criteria.

The surface water results were provided as total concentrations for all analytes; however, the screening criteria for some analytes are presented as dissolved concentrations. For those analytes, the screening criteria were converted to total concentrations using the conversion factors incorporated in the criterion equations (WDOE 2003a, Oregon Department of Environmental Quality [ODEQ] 2001). Similarly, for those analytes that are hardness dependent, the criteria were adjusted based on the average surface water and pore water hardnesses (WDOE 2003a, ODEQ 2001).

The maximum detected concentration (MDC), mean concentration, and UCL_{95} of the arithmetic mean concentration were determined for the contaminants of interest (COIs) in all media. For determining the average and UCL_{95} concentrations, samples with undetected concentrations were conservatively included at concentrations equal to ½ the laboratory reporting limit. Samples with concentrations detected above the MDL but below the practical quantitation limit (PQL) were included at the reported concentration. Because of the uncertainty associated with estimating true average concentrations, UCL_{95} concentrations were computed using EPA's PROUCL statistical program. The program computes UCL_{95} concentrations for each data set using several methods and recommends one based on the data distribution. A minimum of four data points are required; therefore, UCL_{95} concentrations were computed only for non-background samples because fewer than four background samples were collected from each media.

The two surface water and two co-located sediment samples collected from the Taylor River were not considered to be representative of the site or background conditions. Both locations are a considerable distance from the site and are subject to effects from other potential sources. In addition, a comparison of the surface water and sediment sample results from the two locations does not indicate any significant effects from the site. Therefore, analytical results of those samples were excluded from the site data set for calculating the minimum, maximum, or average contaminant concentrations.

3.0 INITIAL RISK SCREENING

The maximum detected COI concentrations were compared to U.S. Bureau of Land Management (BLM) Risk Management Criteria (RMCs) to provide a preliminary qualitative assessment of potential risk to human and ecological receptors at the site. The RMCs were developed as a screening tool for quickly assessing overall risks to humans and wildlife at abandoned mining sites and are based on the most problematic metals (Sb, As, Cd, Cu, Pb, Mn, Hg, Ni, Se, Ag, Zn) typically found at abandoned mine sites, on available toxicity data, and standard EPA exposure assumptions (Ford 1996). Comparing the maximum detected COI concentrations to the RMCs provides risk in logarithmic terms, with relative risk expressed in terms of the factor by which COI concentrations exceed the reference RMC. This initial risk screening process is intended to provide only a general level of risk and is, therefore, independent of the streamlined quantitative RAs. The results of the RMC screening are summarized in Table 6 and discussed in the following sections.

3.1 Human Health Risk Screening

Ford developed human health RMCs for soil, sediment, and surface water based on exposure scenarios that could potentially occur at abandoned mine sites, including camper, all-terrain vehicle driver, worker, surveyor, boater, swimmer, and resident. The RMCs correspond to either a target excess cancer risk level of 1.E-05, or a target non-carcinogenic Hazard Index (HI) of 1.0. For metals posing both carcinogenic and non-carcinogenic threats to health, the lower (more protective) concentration is used for the RMC. For a target Excess Cancer Risk (ECR) of 1.E-05, an individual exposed at the RMC under the BLM exposure conditions, would have a 1 in 100,000 chance to develop any type of cancer in a lifetime as a result of contact with the metal of concern. An HI of <1.0 is assigned when the dose of non-carcinogenic metals assumed to be received at the site by any of the receptors is lower than the dose that may result in adverse non-carcinogenic health effects. The RMCs are protective for exposures to multiple chemicals and media. Because of the limited available toxicological information regarding health risks associated with exposure to lead, the lead RMC was determined from the EPA Integrated Exposure Uptake Biokinetic (IEUBK) Model and other EPA regulations and guidance (Ford 1996). The RMCs apply to mine waste, sediment and surface water at the site.

The maximum detected COI concentrations in the mine waste, background soil, sediment, and surface water samples collected during the SI were compared to the RMCs for two receptor classifications: (1) camper, and (2) swimmer. Arsenic was the only COI that exceeded a human health RMC. The initial risk screening results, shown in Table 6, indicate an extremely high risk to human receptors from exposure to arsenic in the mine waste, and a moderate risk from exposure to arsenic in sediment and background soil at the site. Based on the BLM RMC, there does not appear to be a human health risk from exposure to arsenic in surface water.

3.2 Ecological Risk Screening

Ford developed ecological RMCs for soil from a survey of literature for toxicity data relevant to either wildlife receptors at BLM sites or to closely related species. For receptors without available toxicity data,

Ford selected data based on phylogenetic similarity between ecological receptors and the test species for which toxicity data were reported. He obtained soil ingestion data for each receptor from a study on dietary soil content of wildlife from the FWS. For receptors without available dietary soil content data, he assumed soil content was equal to that of an animal with similar diets and habits. The amount of soil ingested by each receptor was estimated as a proportion of their daily food intake. Ford then calculated the food intake in grams for each receptor as a function of body weight based on scaling factors specific to each type of species.

Ford calculated RMCs for metals in soil based upon assumed exposure factors for the specific receptors and species- and chemical-specific toxicity reference values (TRVs). The TRVs represent daily doses of the metals for each wildlife receptor that will not result in any adverse toxic effects. Ford computed the metals TRVs for each wildlife receptor/metal combination for which toxicity data were available. Phylogenetic and intraspecies differences between test species and ecological receptors were accounted for by applying uncertainty factors derived from critical toxicity values. These uncertainty factors were applied to protect wildlife receptors that might be more sensitive to the toxic effects of a metal than the test species. The uncertainty factors were applied to the test species toxicity data in accordance with a method developed by BLM. In accordance with this system, Ford applied a divisor of two to the toxicity reference dose for each level of phylogenetic difference between the test and wildlife species (in essence, individual, species, genus, and family).

The maximum detected COI concentrations in the mine waste and background soil were compared to ecological RMCs for six potential receptors: deer mouse, mule deer, elk, mallard, Canada goose, and robin. The initial mine waste screening results, shown in Table 6, indicate high to extremely high risk to all receptors from exposure to arsenic, and high to extremely high risk to all receptors except for the deer mouse from exposure to copper. There is moderate to high risk for the avian receptors from exposure to lead. There is also moderate risk to the most sensitive receptor (robin) from exposure to cadmium, mercury, and zinc. The background soil results, also shown in Table 6, indicate high risk to the robin from exposure to arsenic, copper, and lead, and moderate risk from exposure to zinc. There is also moderate to high risk to one or more ecological receptors from exposure to arsenic, copper, lead, and zinc in the background soil.

4.0 STREAMLINED HUMAN HEALTH RISK ASSESSMENT

The streamlined human health risk assessment (HHRA) was prepared to assess potential hazards and risks to human receptors from exposure to mine waste and contaminated media at the site. The HHRA used analytical data and other information gathered during the SI by CES in July 2005 and site-specific exposure factors (EFs) based on the anticipated receptors and future land uses. Both central tendency exposure (CTE) and reasonable maximum exposure (RME) scenarios were evaluated. The HHRA was prepared in general accordance with state and federal regulations and guidelines, including:

- Comprehensive Environmental Restoration and Compensation Liability Act (CERCLA);
- Superfund Amendments and Reauthorization Act (SARA);
- National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40CFR 300.415(b)(4)(i);
- EPA's *"Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual Part (A)",* 1991;
- Washington's Model Toxic Act (MTCA) (WDOE 2001a); and
- Washington Administrative Code (WAC) 173-340.

The streamlined HHRA process consisted of the six steps listed below:

Step 1 – Exposure Assessment
Step 2 – Toxicity Assessment
Step 3 – Risk Characterization
Step 4 – Uncertainty Analysis
Step 5 – Hot spot Assessment
Step 6 – Development of Risk-based Cleanup Levels

Each step is discussed in the following sections and summary tables are provided at the end of the report. Human health risk calculation tables are provided in Appendix A.

4.1 Exposure Assessment

The exposure assessment involved preparing a conceptual site model (CSM), identifying the potentially exposed populations at the site, determining the potentially complete exposure pathways at the site, identifying the contaminants of potential concern (COPCs), estimating EPCs, and developing a set of exposure factors and assumptions for use in the risk calculations. Each of these tasks is described in the following sections.

4.1.1 Human Health Conceptual Site Model

A human health CSM, shown in Figure 1, was prepared for the Rainy Mine and Millsite to provide a framework for assessing risk by identifying the following:

- The environmental setting and contaminants known or suspected to exist at the site
- Contaminant fate and transport mechanisms that might exist at the site
- Mechanisms of toxicity associated with contaminants and potential receptors
- Complete exposure pathways that might exist at the site
- Potential exposed populations

The Rainy Mine CSM was based on information provided in the SI and should be representative of current and likely future conditions at the site.

4.1.2 Potentially Exposed Populations

The Rainy Mine and Millsite is in a relatively remote location with no residences within a 4-mile radius of the site. Although there are no developed recreational areas in the area, recreational use of the site is likely high. Public exploration of the site is encouraged in *Discovering Washington's Historic Mines* (Northwest Underground Explorations 1997) and a claimant reportedly has brought his class of children to the site to search for mineral crystals in the waste rock piles. Additional recreational activities likely include hiking, fishing, camping, hunting, swimming, and minerals prospecting. Future uses of the site are expected to remain the same as current uses. Residential development of the site is believed to be unlikely. Therefore, the risk of long-term exposure to contaminants at the site is considered low.

The primary receptors evaluated in this streamlined HHRA and anticipated to visit the site include:

- Recreationalist – Adult Receptor
- Recreationalist – Child Receptor

4.1.3 Potentially Complete Exposure Routes

Based on the anticipated receptors, the following exposure pathways were evaluated:

- Incidental ingestion of mine waste (waste rock) and sediment;
- Ingestion of surface water as a drinking source;
- Dermal contact with mine waste, surface water, and sediment; and
- Inhalation of mine waste particulates.

Other potentially complete pathways, such as groundwater ingestion, plant ingestion, and fish tissue ingestion were qualitatively considered but not quantified. The groundwater pathway at the site is considered incomplete because there are no wells within a 4-mile radius of the site. Vegetation samples collected during the SI consisted of vine maple species, which is non-palatable; however, several palatable species, such as the salmonberry, elderberry, and thimbleberry were documented on site during the SI (CES 2005). Although these palatable plants likely contain elevated levels of metals, the fruit is relatively small and it is unlikely that a large quantity would be consumed. It's also unlikely that the site will be used for agricultural cultivation; therefore, plant ingestion was determined to be a potentially complete but insignificant pathway. No fish were observed in Quartz Creek during the SI; however, they likely inhabit the stream and their tissue may contain elevated levels of COIs. Although health risks resulting from ingestion of fish can be estimated based on COI concentrations in the surface water, Quartz Creek is a relatively small stream with a limited population of fish and would only be fished on a limited basis. Therefore, risks from ingestion of fish were not quantified because any fish caught from the stream would likely represent an insignificant fraction of any individual's diet.

4.1.4 Contaminants of Potential Concern

Analytical results of mine waste, sediment, and surface water samples collected during the SI were screened in accordance with EPA guidance (EPA 2001) to identify COPCs. The screening process consisted of three steps: (1) determining the frequency of detection, (2) comparing to background concentrations, and (3) comparing to established criteria for potential toxicity. The essential nutrients (calcium, iron, magnesium, potassium, and sodium) were not present at concentrations that would pose a threat to human health; therefore, they were removed from further analysis.

Frequency of Detection Screening – COIs detected in fewer than 5 percent of the samples site-wide for a given media were eliminated from further screening. Because of the small quantity of samples collected, a detected result in only a single sample would constitute a detection frequency of more than 5 percent. Therefore, only COIs that were not detected in any samples for each media were eliminated based on the frequency of detection screening. In mine waste and sediment, cyanide was the only COI that was analyzed for but not detected in any samples. In surface water, antimony, beryllium, chromium, cobalt, nickel, selenium, thallium, and vanadium were analyzed for but not detected in any samples.

Comparison with Background Concentration Screening – COIs with MDCs below the mean background concentrations were eliminated from further screening. Mean background concentrations were used because UCL_{95} concentrations could not be computed using the PROUCL program due to the small quantity of background samples. In mine waste, mercury was the only COI below background, and in sediment, barium was the only COI below background. In surface water, antimony, beryllium, chromium, cobalt, nickel, selenium, thallium, and vanadium were below background.

Concentration-risk Screening – The COI MDCs were compared to the lower of (1) EPA Region IX Industrial Soil PRGs (2004a), and (2) MCTA Method A Soil Cleanup Levels for industrial properties (WDOE 2001b). Industrial criteria were used for mine waste and sediment because there are no established criteria for a recreational use scenario and residential development of the site is believed to be unlikely. However, it should be noted that the industrial criteria are very conservative for this site because they are typically based on an occupational scenario with 250 days of exposure per year, which is much greater than would be expected for recreational use. For surface water, the MDCs were compared to the lower of (1) EPA Region IX Tap Water PRGs (2004a), and (2) State of Washington Drinking Water Criteria, WAC 246-290 (Washington State Department of Health [WSDH] 2006).

In addition to risk from individual COIs in each media, the concentration-risk screening also evaluated potential cumulative effects from exposure to multiple COIs across each media, as well as from exposure to COIs across multiple media. The risk from exposure to multiple COIs across a single medium is evaluated by dividing each single COI risk ratio by the sum of risk ratios for the medium. A result greater than 1 divided by the number of risk ratios indicates risk. The risk from exposure to a COI across multiple media is evaluated by summing the COI's risk ratio for each medium. A total risk ratio greater than or equal to 1, indicates risk.

Results of the screening process are summarized in Table 7; a total of six COPCs were identified: arsenic, cadmium, chromium, copper, iron, and manganese. Arsenic was identified as a COPC for mine waste, sediment, and surface water. Chromium was identified as a COPC for surface water. The remaining COPCs (cadmium, copper, iron, and manganese) were identified based on exposure to multiple COIs across multiple media.

4.1.5 Exposure Point Concentrations

The EPC is used in the risk calculations and is defined as the concentration that a receptor will potentially contact during the exposure period. EPCs were estimated for each COPC from the analytical results of samples collected during the SI. Because of the uncertainty associated with estimating the true average concentration at a site, UCL_{95} concentrations were used for the RME EPC. However, because of the relatively small data sets and non-parametric data distribution, the computed UCL_{95} concentration for some COPCs exceeded the MDC. In those instances, the MDC was used as the EPC. For the CTE scenario, the arithmetic mean concentration was used as the EPC for all media in accordance with EPA guidance (EPA 1991). The EPCs used in this HRHA are summarized in Table 8.

4.1.6 Exposure Factors and Assumptions

EFs are variables that are used with EPCs in the risk characterization equations to calculate contaminant exposures based on receptor body weight, exposure frequency and duration, averaging time, intake rates, chemical bioavailability, and other factors. The EFs used in the Rainy Mine HHRA were derived from a combination of site-specific conditions and standard default values presented in risk assessment guidance

documents (EPA 1997a) and are summarized in Table 9.

4.2 Toxicity Assessment

The toxicological properties of COPCs identified in the exposure assessment were evaluated to determine the types and severity of potential health hazards associated with each COPC. Toxicological values for use in the risk equations were obtained from EPA's Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), and Department of Energy's Risk Assessment Information System (RAIS). Although subchronic exposures may be most representative of actual exposure times at the site, toxicity values for chronic exposure, i.e., from 7 years to a lifetime, were used to be conservative. The non-carcinogenic and carcinogenic toxicity values are summarized in the human health risk calculation tables (Tables A.5 and A.6, respectively).

4.3 Risk Characterization

Potential non-carcinogenic hazards, carcinogenic risks, and lead risks to human receptors at the site were estimated using the EPA risk assessment methodology and equations presented in the following subsections (EPA 1991).

4.3.1 Chronic Daily Intake

The chronic daily intake (CDI) represents the estimated daily exposure in milligrams per kilogram per day (mg/kg-day) to a contaminant at the site based on site-specific exposure factors and other parameters. CDIs are calculated for each exposure pathway and media using the following equations:

Ingestion: $$CDI = \frac{CS \times IR \times EF \times ED \times CF}{BW \times AT}$$

Dermal Contact (soil): $$CDI = \frac{CS \times SA \times SSAF \times DAF \times EV \times EF \times ED \times CF}{BW \times AT}$$

Dermal Contact (water): $$CDI = \frac{CS \times SA \times Kp \times EV \times Tev \times EF \times ED \times CF}{BW \times AT}$$

Inhalation: $$CDI = \frac{CS \times IN \times EF \times ED}{BW \times AT \times PEF}$$

Where:

CS = Contaminant concentration (mg/kg or milligram per liter [mg/L])

IR = Ingestion rate (milligram per day [mg/day])

EF = Exposure frequency (day per year)

ED = Exposure duration (year)

EV = Events per day

Tev = Time per event (hour/event)

CF = Conversion factor (kg/mg or liter per cubic centimeter [L/cm^3])

BW = Body weight (kg)

AT = Averaging time (day)

DAF = Dermal absorption factor (unitless)

SA = Skin surface area (square centimeter [cm^2])

SSAF = Soil to skin adherence factor (milligram per square centimeter per day [$mg/cm^2/day$])

Kp = Dermal permeability coefficient (cm/hr)

IN = Inhalation rate (cubic meter per day [m^3/day])

PEF = Particulate emission factor (cubic meter per kilogram [m^3/kg])

4.3.2 Non-carcinogenic Hazards

Non-carcinogenic hazards are evaluated by comparing the CDIs for each exposure pathway and media with EPA-established reference doses (RfDs). RfDs are COPC-specific toxicological values developed by the EPA to represent route-specific estimates of the safe dosage for each COPC over a lifetime of exposure. Potentially adverse health affects can occur if the CDI exceeds the RfD. RfDs can be classified as chronic or subchronic depending on the length of exposure. Although subchronic RfDs may be more representative of actual site conditions, chronic RfDs represent the highest average daily exposure to a human receptor that will not cause adverse health effects during their lifetime; therefore, to be conservative chronic RfDs were used. A non-carcinogenic Hazard Quotient (HQ) is computed for each COPC and exposure pathway by dividing the CDI by the RfD:

$$Non-carcinogenic\ HQ = \frac{CDI}{RfD}$$

Where:

CDI = Chronic daily intake; the estimated exposure over a given time

RfD = Reference dose; the exposure level above which represents potential adverse health effects

Individual HQs are determined for all COPCs in each exposure pathway. Generally, if two or more COPCs have the same target organ or similar effects, their HQs are summed to determine a HI. For example, two COPCs that both have an effect on the liver would be summed into an HI. However, if one COPC affects the liver and the other COPC affects the central nervous system (CNS), their affects are not considered additive and their HQs are usually not summed into an HI. HQ or HI values greater than 1.E+00 indicate the potential for adverse health effects because the estimated intake exceeds the safe dosage. However, when there is a carcinogenic COPC at high concentrations, such as arsenic, carcinogenic risk will typically drive the human health risk and non-carcinogenic hazards will not be a factor. Therefore, because arsenic is present at such high concentrations at this site, the individual HQs were conservatively summed into an HI without regard for the target organ.

4.3.3 Carcinogenic Risks

The carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over their lifetime. Carcinogenic risks are estimated by multiplying the CDIs by COPC-specific slope factors (SFs) developed by the EPA:

$$Carcinogenic\ Risk = CDI \times SF$$

Where:

CDI = Chronic daily intake averaged over a lifetime; i.e., the estimated lifetime exposure at the site

SF = Slope factor; the upper-bound estimate of probability of cancer per unit of intake over a lifetime

The SF converts the contaminant intake to a risk of developing cancer from the exposure (i.e., ECR). SFs are chemical- and route-specific and represent an upper bound individual lifetime ECR. The ECR from each COPC in an exposure pathway are summed to determine the cumulative risk for each pathway and the cumulative risks from each pathway are summed to determine the overall site risk.

4.3.4 Lead Risks

Risks from exposure to lead cannot be quantified using standard risk assessment algorithms because lead RfDs and SFs have not been established by the EPA. The EPA currently recommends two models (IEUBK and ALM) for assessing lead risk based on the receptor age group; however, both models were developed to assess exposures under chronic, steady-state conditions such as a working environment, school, or residence (EPA 2002 and 2005a). The models are not intended to be used for acute, short-term exposures such as those associated with occasional recreational use of a remote site. Therefore, because exposures at the site are expected to be short-term and occasional, the lead exposure models were not used and lead risks were not quantitatively evaluated. However, lead risks were qualitatively evaluated by comparing the maximum detected lead concentrations at the site to EPA screening criteria and the BLM RMC for lead.

4.4 Uncertainty Analysis

The estimates of exposure, non-carcinogenic hazard, and carcinogenic risk presented in this HHRA are subject to varying degrees of uncertainty from a variety of sources, including site data, exposure assessment, and risk characterization. These uncertainties and their potential influence on results of this HHRA are discussed in the following sections.

4.4.1 Site Data

The size of the data set, sample locations, and sample analyses can all contribute uncertainty to the risk assessment. In general, smaller data sets lend more statistical variability to estimates of contaminant concentrations and may over or under estimate the true mean or maximum concentration. Also, background concentrations were based on very small data sets (three or fewer samples) and may not be representative of actual background conditions. Use of these background concentrations to screen COIs may result in screening out potential contaminants that could be above true background levels.

The intent of sampling during an SI is typically to determine metals concentrations in areas of suspected contamination, such as mine waste piles and seeps. Based on the methodology used for sample collection during the SI, the samples are expected to be biased to the highest concentrations present on the site and do not represent an average site concentration. Therefore, exposure doses based on the results of these non-random SI samples are expected to be biased to the upper end of the range of exposures at the site.

The analytical suite was limited to COIs identified in the SI; risks from exposure to organics at this site were not characterized in this HHRA. However, organics are not expected to be present at this site.

4.4.2 Exposure Assessment

Many of the factors used to estimate exposure rates at the site are standard assumptions based on EPA HHRA guidance values and may not accurately describe future site conditions or uses. The assumed receptors were limited to adult and child recreationalists. The recreational exposure frequencies are based on very limited use because of the absence of nearby developed recreational areas. However, the assumed duration of 30 years for the adult under the RME scenario may over estimate actual use since it is unlikely that a recreationalist will revisit the site for 30 consecutive years.

The anticipated recreational activities do not generally result in significant dermal contact or ingestion of sediment. Inclusion of these exposure pathways likely contributes additional conservatism to the HHRA. It is inherently assumed that future COPC concentrations will remain the same as current concentrations.

4.4.3 Toxicity Assessment

Uncertainties are inherent in toxicity factors because of several factors, including statistical extrapolation, population variability, and limited biological and epidemiological studies. These uncertainties may contribute to under or over estimation of potential risks and hazards.

4.4.4 Risk Characterization

The standard algorithms used to calculate the contaminant intakes and associated health risks and hazards add uncertainty to the risk assessment. The algorithms assume the additivity of toxic effects for multiple contaminants and do not account for synergistic or antagonistic effects. Concurrent exposure to multiple pathways by a single receptor and the associated cumulative risks and hazards also is assumed which likely over estimates actual exposures. The algorithms also do not account for factors such as absorption or matrix effects.

4.4.5 Lead Risk

Because of the lack of established quantitative reference data for lead, potential health risks from exposure to lead at the site were not quantified. However, the potential risks were qualitatively evaluated by comparing lead concentrations in mine waste and surface water samples to suggested screening values and may or may not be representative of actual risks. In addition, the EPA screening value (Region IX Industrial Soil PRG) is based on a worker scenario with 250 days of exposure. Therefore, application of this screening level should provide a very conservative estimate of lead risk at the Rainy Mine and Millsite where the adult recreationalist exposure is based on 14 days per year under the RME scenario.

4.5 Summary of Potential Human Health Risks

The estimated non-carcinogenic hazards and carcinogenic risks from exposure to COPCs at the Rainy Mine and Millsite are summarized in Table 10. The estimated non-carcinogenic hazards were compared to the EPA and Washington acceptable level of HI ≤ 1.E+00. The results indicate a low non-carcinogenic hazard to the child recreationalist under the CTE scenario, and a hazard to both the child and adult recreationalist under the RME scenario. The total cumulative HI to the child recreationalist was 3.E+00 under the CTE scenario, and 1.E+02 under the RME scenario. The total cumulative HI to the adult recreationalist was 2.E-01 under the CTE scenario, and 4.E+00 under the RME scenario. Incidental ingestion and dermal contact with arsenic in the mine waste appear to be the most significant exposure pathways.

The estimated carcinogenic risks from exposure to COPCs at the Rainy Mine and Millsite were compared with EPA's acceptable ECR range of 1.E-04 to 1.E-06. The results indicate carcinogenic risk to the child recreationalist under the CTE scenario, and risk to both the child and adult recreationalist under the RME scenario. The total cumulative ECR to the child recreationalist was 1.E-04 under the CTE scenario, and 5.E-03 under the RME scenario. The total cumulative ECR to the adult recreationalist was 9.E-06 under the CTE scenario, and 8.E-04 under the RME scenario.

Incidental ingestion of and dermal contact with arsenic in the mine waste are the most significant exposure pathways and contribute the majority of carcinogenic risk at the site. Inhalation of particulates from the mine waste, and dermal contact with sediment and surface water contributed minimally to the overall risk and, therefore, are not considered to be significant exposure pathways at the site.

Human health risks resulting from exposure to lead at the site were not quantified because (1) the EPA has not established quantitative reference data for lead, and (2) the current lead exposure models are based on chronic long-term exposures and are not intended for assessing risk from occasional short-term exposures. However, the potential risks were qualitatively evaluated by comparing lead concentrations in mine waste, sediment, and surface water samples to establish suggested screening levels for the protection of human health.

The EPA has not specified a hazardous waste threshold value for total lead in soil and they have not established a drinking water maximum contaminant level (MCL) for lead; however, they suggest lead screening levels of 800 mg/kg for industrial soils and 15 microgram per liter (µg/L) for drinking water. The maximum detected lead concentration in mine waste and sediment at the site was 79.6 mg/kg, well below the screening level. In surface water, lead was detected in only one sample at a concentration (0.5 µg/L) between the MDL and PQL, well below the MCL. Therefore, there does not appear to be a human health risk from exposure to lead at the Rainy Mine and Millsite.

4.6 Hot Spot Assessment

Results of the HHRA indicate potential significant human health risks at the site from exposure to arsenic in the mine waste and sediment; therefore, a hot spot assessment was conducted to identify specific areas contributing to a large percentage of the overall site risk. Hot spot concentrations for mine waste and sediment were back-calculated for each COPC using the HHRA risk equations based on an ECR of 1.E-04 and a non-cancer HI of 1.E+01 for the most sensitive receptor (child recreationalist). The hot spot concentrations are summarized in Table 11. Areas with COPC concentrations exceeding the hot spot concentrations are considered hot spots. A hot spot concentration was not calculated for lead because lead risks were qualitatively determined to be insignificant and not quantified.

Arsenic was the only COPC above the hot spot concentration of 330 mg/kg. One area was identified as a hot spot based on the arsenic concentration in one sample from waste rock pile WR2 (15,800 mg/kg). No sediment samples exceeded the hot spot concentrations.

4.7 Risk-based Cleanup Levels

Because results of the HHRA indicated potential significant human health risks at the site, risk-based cleanup criteria were developed for the site. Cleanup levels were established for soil (mine waste) and sediment using an acceptable non-carcinogenic HI of 1.E+00 and a carcinogenic ECR of 1.E-05 for the most sensitive receptor (child recreationalist) under the RME scenario. Because lead risks were not quantified, a risk-based cleanup level could not be established. However, as discussed in Section 4.5, there does not appear to be a risk from exposure to lead at the site. In addition, the maximum detected lead concentration (79.6 mg/kg) at the site is well below the WDOE MTCA Method A Industrial Soil Cleanup Level of 1,000 mg/kg.

Although there appears to be some risk from exposure to arsenic in surface water at the site, cleanup levels for surface water typically default to state or federal water quality criteria, such as EPA MCLs; therefore, risk-based cleanup levels were not established for surface water. The risk-based cleanup levels are summarized in Table 12.

Arsenic was the only COPC above the calculated cleanup levels. Of the nine mine waste samples, eight exceeded the cleanup level of 33 mg/kg. Areas above the arsenic cleanup level include both waste rock piles, soil adjacent to the shaft, and soil on the south side of the mill foundation. Arsenic was also the only COPC that exceeded the calculated sediment cleanup level of 132 mg/kg. Of the eight sediment samples, only two samples (both from the seep areas) exceeded the cleanup level.

5.0 STREAMLINED ECOLOGICAL RISK ASSESSMENT

A streamlined ecological risk assessment (ERA) was completed to assess potential risks to ecological receptors at the site from exposure to mine waste and contaminated media at the Rainy Mine and Millsite. The ERA was conducted in general accordance with state and federal regulations and guidelines, including:

- CERCLA;
- SARA;
- NCP 40CFR 300.415(b)(4)(i);
- EPA's *"Risk Assessment Guidance for Superfund Volume II – Environmental Evaluation Manual,"* 2001;
- EPA's *"Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund,"* 1997b;
- MTCA; and
- WAC 173-340.

The streamlined ERA consists of two levels:

Level 1 – Scoping ERA

- Identify the site ecological setting, sensitive environments, and T&E species
- Identify COIs
- Develop an ecological conceptual site exposure model (CSEM)

Level 2 – Screening ERA

- Identify potential ecological receptors and exposure pathways
- Identify assessment endpoints
- Estimate EPCs
- Screen CPECs
- Characterize ecological risks
- Evaluate uncertainties

The level 1 scoping ERA qualitatively determines whether there are potential ecological receptors or exposure pathways at the site and involves examining the ecological setting and identifying sensitive environments, T&E species, and ecological stressors. The level 2 screening ERA involves reviewing exposure pathways and receptors present at the site, determining assessment and measurement endpoints, identifying contaminants of potential ecological concern (CPECs), calculating EPCs, characterizing ecological risks, and evaluating uncertainties associated with the ERA.

The following sections describe the streamlined ERA processes and results. Summary tables are provided at the end of the report and ecological risk screening and calculation tables are provided in Appendix B.

5.1 Level 1 Scoping Ecological Risk Assessment

The objective of the Level 1 Scoping ERA is to qualitatively determine whether there are any potential ecological receptors or exposure pathways at the site. It requires an examination of the ecological setting of the site, presence of sensitive environments, presence of T&E species, ecological stressors (i.e., COIs), and development of a CSEM. The Level 1 Scoping ERA consisted of three steps:

Step 1 – Identify Ecological setting, sensitive environments, and T&E species

Step 2 – Identify COIs

Step 3 – Develop Conceptual Site Ecological Model

Each step is discussed below.

5.1.1 Ecological Setting, Sensitive Environments, and T&E Species

The SI report was reviewed to identify the ecological setting of the site and determine if any sensitive environments are present. The site is located in the Mount Baker-Snoqualmie National Forest within the Snoqualmie Ranger District in King County. Terrestrial habitats in vicinity of the site include steep woodland hillsides, meadows, riparian zones, and wetland areas. The dominant upland and riparian overstory vegetation types on the hillsides and disturbed mine area include are *Tsuga heterophylla* (western hemlock) and *Thuja plicata* (western red cedar) and *Alnus rubra* (red alder). Dominant understory vegetation is dominated by *Symphoricarpos albus* (snowberry). Riparian zone understory is dominated by *Acer circinatum* (vine maple) and *Rubus spectabilis* (salmonberry), with many species composing the groundcover. At least two edible plants occur on the site: salmonberry and thimbleberry.

A detailed description of the hydrologic setting of the site is presented in the SI report. The site is adjacent to Quartz Creek, which flows in Taylor River, a tributary of MFSR. An Aquatic Ecological Survey of the site was conducted by CES and is detailed in the SI report (2005).

Sensitive environments are defined in WAC 173-340-200, as "an area of particular environmental value, where a release could pose a greater threat than in other areas including: wetlands; critical habitat for endangered or threatened species; national or state wildlife refuge; critical habitat, breeding or feeding area for fish or shellfish; wild or scenic river; rookery; riparian area; big game winter range." Based on this definition, sensitive environments within 2 miles of the site include:

- Jurisdictional wetlands on Quartz Creek, as summarized in the SI report; and
- Threatened species and SOC that inhabit the Mt. Baker-Snoqualmie National Forest.

T&E species are those listed as threatened or endangered under the federal Endangered Species Act 16 U.S.C. Section 1533, or classified as threatened or endangered by the State Fish and Wildlife Commission under WAC 232-12-011(1) and 232-12-014. A list of T&E wildlife and plant species and species of concern (SOC) occurring in the Mt. Baker-Snoqualmie National Forest is provided in the SI report (CES 2005). For the purposes of this ERA, a supplemental list of T&E and sensitive species was compiled based on information gathered from other sources, including the Endangered Species Program website (U.S. Fish and Wildlife Service 2006), Washington Department of Fish and Wildlife (2006), Pacific Biodiversity Institute (2006), and Washington Native Plant Society (2006). The list is provided in Appendix C and is intended to supplement information provided in the SI report (CES 2005).

Although no threatened or endangered species were observed during the field investigation by CES, numerous federal and state rare, threatened, or endangered (RTE) mammals, birds, and herpetiles have potential habitat in vicinity of the site, including the Oregon spotted frog, western toad, spotted owl, pileated woodpecker, Townsend's big-eared bat, fisher, and others. In addition, the coastal cutthroat trout (a federal SOC) has been documented in Quartz Creek and the Taylor River. According to the ecological survey in the SI report (CES 2005), none of the identified plants were RTE species and no RTE invertebrate species are known to inhabit the site vicinity. However, according to the Washington Native Plant Society, there are several T&E species that may be present on the site, including the marsh sandwort, golden paintbrush, water howellia, Kincaid's lupine, Nelson's checker-mallow, and Bradhsaw's desert parsley.

5.1.2 Contaminants of Interest

Identification of COIs for ecological receptors requires a separate process than the one used for the HHRA because while some contaminants may not present a risk to human health, they may pose an ecological risk. A preliminary list of COIs was identified based on analytical results presented in the SI Report and a potential risk to ecological receptors: aluminum, arsenic (III, V, and total), barium, beryllium, cadmium, chromium (III, VI and total), mercury, manganese, nickel, copper, lead, antimony, selenium, thallium, vanadium, silver, calcium, magnesium, iron, sodium, potassium, zinc, and cyanide. During the level 2 screening discussed in Section 5.2, COIs are examined further to identify contaminants of CPECs posing risk to ecological receptors at the site.

5.1.3 Ecological Conceptual Site Exposure Model

A CSEM illustrates the general understanding of the sources of contamination, release and transport mechanisms, impacted exposure media, potential exposure routes, and ecological receptors at the site.

Like the human health CSM, the CSEM provides a framework for assessing risk by identifying the following:

- Environmental setting and contaminants known or suspected to exist at the site;
- Contaminant fate and transport mechanisms at the site;
- Mechanisms of toxicity associated with contaminants and potential receptors;
- Complete exposure pathways the site; and
- Potentially exposed populations.

The Rainy Mine CSEM, shown in Figure 2, was based on information provided in the SI and is intended to be representative of current and likely future conditions at the site. The primary source of CPECs is the waste rock piles. Precipitation could result in the following release/transport mechanisms from the waste rock piles: runoff, leaching, percolation, or infiltration into surface or subsurface soils, groundwater, or surface water. CPECs in the seeps and unnamed drainage can follow a similar pathway. Once in the surface water, CPECs can be deposited to sediment or transported downstream as a dissolved constituent, or attached to suspended sediment. Therefore, potential exposure media at the site includes waste rock, soil, sediment, pore water, and surface water.

Potential ecological receptors at the site include terrestrial wildlife (plants, birds, invertebrates, reptiles and amphibians, and mammals) and aquatic biota (fish and invertebrates). No RTE species were observed during the SI; however, coastal cutthroat (a federal SOC) has been documented in Quartz Creek. In addition, based on the available data, there are multiple RTE species potentially present on site, in addition to SOC and Washington's listed species, including: spotted owl, Oregon spotted frog, Olive-sided flycatcher, willow flycatcher, coastal cutthroat, northern goshawk, western toad, and two varieties of bats.

5.2 Level 2 Screening Ecological Risk Assessment

The level 2 screening ERA involves evaluating data collected during the SI and identifying those contaminants and media that pose potential risks to ecological receptors at the site. The level 2 screening consisted of six steps:

Step 1 – Summarizing the potential exposure pathways and receptors present on the site

Step 2 – Identifying assessment and measurement endpoints

Step 3 – Calculating EPCs

Step 4 – Identifying CPECs

Step 5 – Characterizing ecological risks

Step 6 – Evaluating uncertainties

Each of these steps is discussed on the following pages.

5.2.1 Potential Exposure Pathways and Receptors

Potential ecological exposure pathways at the site and evaluated in this ERA include:

- Incidental ingestion of soil (mine waste) and sediment;
- Direct contact with soil (mine waste), sediment, surface water, and pore water; and
- Ingestion of surface water.

Potential ecological receptors at the site are expected to include terrestrial wildlife (plants, birds, invertebrates, reptiles and amphibians, and mammals) and aquatic biota (invertebrates and fish).

5.2.2 Ecological Endpoints

Identification of ecological endpoints guides the completion of the risk characterization portion of the ERA. Assessment and measurement endpoints for this ERA were developed based on the CSEM for the site. Assessment endpoints are defined by the EPA as "formal expression of an actual environmental value to be protected… an environmental value which would indicate a need for remediation." The assessment endpoints for this ERA included:

- Survival and reproductive success of terrestrial receptors (invertebrates, birds, mammals, and vegetation) and;
- Survival and reproductive success of aquatic life (invertebrates and fish).

The measurement endpoint is defined by the EPA as a "quantitative expression of an observed or measured effects of a hazard; and, these measurable environmental characteristics are related to the valued characteristics chosen as assessment endpoints." Typically, the measurement endpoint will dictate the type of samples and/or data to be collected and assessed to address the affect of stressors on the ecological receptors. However, because the data has already been collected, the measurement endpoint for this ERA consisted of:

- Comparison of the measured concentrations of the COIs in soil, waste rock, surface water, and sediment to their respective ecological risk-based screening level values (SLVs).

5.2.3 Exposure Point Concentrations

Ecological receptors do not experience their environment on a "point" basis; therefore, it is necessary to convert measured data from single sample points into an estimate of concentration over their habitat to conduct an appropriate risk screening. For this ERA, EPCs were based on either the MDC or UCL_{95} concentration from the analytical results presented in the SI report, depending on the ecological receptor as suggested by ODEQ ecological risk assessment guidance (2001) and outlined below:

- For invertebrates (such as worms) and plants, the MDC was used as the EPC, and
- For birds, aquatic life, and mammals, the UCL_{95} was used as the EPC.

5.2.4 Contaminants of Potential Ecological Concern

The COIs identified in the level 1 scoping ERA were screened through four processes to identify CPECs:

- Preliminary screening
- Chemistry-toxicity screening
- Bioaccumulation screening
- SLV availability screening

Preliminary Screening:
In accordance with EPA guidance (1998), the COIs identified in the level 1 scoping ERA were screened and removed from further analysis if they exhibit the following characteristics:

- Qualify as an essential nutrient;
- Were detected in fewer than 5 percent of the samples by media type; or
- Are present in concentrations below background concentrations.

With the exception of iron, the essential nutrients (calcium, magnesium, potassium, and sodium) were not present at concentrations above the SLVs; therefore, they were removed from further analysis. Iron was present in mine waste at concentrations well above the plant and invertebrate SLVS, and above the aquatic life SLV in pore water; therefore, iron was retained as a CPEC in mine waste and pore water. COIs detected in fewer than 5 percent of the samples for each media type also were removed. Lastly, COIs with a MDC less than the average background concentration, were removed from the risk analysis. As discussed in Section 2.0, background UCL_{95} concentrations were not calculated because fewer than four background samples were collected for each media. The preliminary screening results are summarized in Tables 13 through 17.

Chemistry-toxicity Screening:
COIs remaining following the preliminary screening were subjected to chemistry-toxicity screening which involved assessing potential ecological risks by comparing the EPCs to ecological risk-based SLVs. When available, SLVs were obtained from WDOE MTCA (2001c, 2002, 2003a, 2003b); however, there were some instances where SLVs were not available in these documents. In such instances, SLVs were obtained from other sources such as the EPA, ODEQ, and ORNL.

A chemistry-toxicity screen was performed based on the following conditions:

- Exposure to a single COI in an exposure medium;
- Exposure to multiple COIs in an exposure medium; and
- Exposure to individual COIs in multiple exposure media.

Potential ecological risk from exposure to a single COI in an exposure medium was assessed by calculating contaminant-specific risk ratios (T_{ij}). Risk ratios for each COI were calculated using the following equation:

Single COI/single medium risk ratio: $$T_{ij} = \frac{C_{ij}}{SLV_{ij}}$$

Where:

T_{ij} = Risk ratio of COI *i* in medium *j*

C_{ij} = Contaminant concentration of COI *i* in medium *j* (milligram per kilogram [mg/kg] or milligram per liter [mg/L])

SLV_{ij} = Screening level value for COI *i* in medium *j* (mg/kg or mg/L)

The risk ratios were compared to receptor-specific risk ratios (*Q*-factors) to evaluate potential ecological risk. In general, higher risk ratios present a greater likelihood that a CPEC concentration will adversely affect ecological receptors. Risk ratios greater than 1 ($Q = 1$) indicate potential risk for protected (i.e., federally listed T&E species) while risk ratios greater than 5 ($Q = 5$) indicate potential risk to non-protected receptors. It is expected that multiple T&E species, as well as candidate and SOC are potentially present on site. Therefore, a Q-factor of 1 was used in this streamlined ERA for mammals, birds, plants, and aquatic life; a Q-Factor of 5 was used for invertebrates since no threatened or endangered species were identified as being potentially present on site:

If $T_{ij} \geq Q$ retain COI *i* as a CPEC in medium *j*

Where:

T_{ij} = Risk ratio of COI *i* in medium *j*

Q = Receptor-specific risk ratio, = 5 for non-protected species (invertebrates), = 1 for protected species (birds, mammals, and aquatic life)

For exposure to multiple COIs in a single exposure medium, the potential ecological risk was assessed by calculating the ratio of a contaminant-specific risk ratio to the overall risk (sum of all contaminant-specific risk ratios) presented in a medium:

If $\frac{T_{ij}}{T_i} \geq \left(\frac{Q}{N_{ij}} \right)$ retain COI *i* as a CPEC in medium *j*

Where:

T_{ij} = Risk ratio of COI *i* in medium *j*

T_j = Sum of risk ratios (T_{ij}) from all COIs to each receptor group

Q = Receptor-specific risk ratio, = 5 for non-protected species (invertebrates), = 1 for protected species (birds, mammals, and aquatic life)

N_{ij} = Number of COIs with risk ratios (T_{ij}) for each receptor group

If a COI was detected in multiple media, it was retained as a CPEC if the sum of risk ratios exceeded the receptor-specific risk ratio:

$$\text{If } \sum_{j=1}^{j} T_{ij} \geq Q \quad \text{retain COI } i \text{ as a CPEC}$$

Where:

T_{ij} = Risk ratio of COI i in medium j

Q = Receptor-specific risk ratio, = 5 for non-protected species (invertebrates), = 1 for protected species (birds, mammals, and aquatic life)

The results of the chemistry-toxicity screen are presented in the ecological risk calculation tables (Tables B.5 through B.8 in Appendix B), and summarized below according to exposure media. The screening results and identified CPECs are presented in Tables 13 through 17, and summarized in Table 18.

Mine Waste: Twelve CPECs were identified in mine waste from single COI risk ratios: silver, aluminum, arsenic (III and V), chromium III, copper, iron, mercury, lead, antimony, selenium, thallium, and vanadium. Of these, aluminum, arsenic V, iron, and selenium also showed risk from multiple COIs. Four additional CPECs were retained because of the lack of SLVs: arsenic total, chromium total, beryllium and cobalt.

Surface Water: Six CPECs were identified in surface water from single COI risk ratios: aluminum, barium, cadmium, copper, lead, and zinc. Of these, aluminum and cadmium also showed risk from multiple COIs. Four additional CPECs were retained because of the lack of SLVs: silver, arsenic (V and total), and beryllium.

Sediment: Seven CPECs were identified in sediment: silver, arsenic, cadmium, copper, antimony, selenium, and zinc. Seven additional CPECs were retained because of the lack of SLVs: aluminum, beryllium, cobalt, chromium, mercury, thallium, and vanadium.

Pore Water: Six CPECs were identified for pore water: aluminum, barium, cadmium, copper, iron, and zinc.

Bioaccumulation Screening:

COIs that are, or are suspected of being, persistent bioaccumulative toxins, such as mercury, require special attention. Bioaccumulative toxins can compromise food chains and induce adverse effects in higher trophic level species. COIs with bioaccumulative potential were retained as CPECs and include silver, cadmium, mercury, antimony, and iron. However, each of these COIs demonstrated risk to one or more ecological receptors in the chemistry-toxicity screening and, therefore, were already identified as CPECs.

SLV Availability Screening:

In some instances, SLVs were not available for a given COI-media-receptor combination. Because estimating the toxicity or bioaccumulative potential of the COI was not possible, the COI was retained as a potential CPEC. The COIs retained as CPECs because of the lack of SLVs are shown in Tables 13 through 18.

5.3 Ecological Risk Characterization

The results of the CPEC screening discussed above provide an approximate level of potential ecological risk at the site. Risk characterization is comprised of describing the risks to ecological receptors and the uncertainties in the ERA. The objective of the ecological risk description is to assess whether the predicted risks are likely to occur at the site. The objective of the uncertainties analysis is to examine the data gaps or sources of variability in the ERA process and whether these uncertainties under estimate or over estimate the ecological risks at the site. The uncertainty evaluation is described in Section 5.4 of this report.

The ecological risk ratio calculations are presented in Tables B.5 through B.9 in Appendix B, and the results are summarized in Table 19. The following sections discuss the ecological risk characterization for each media.

5.3.1 Mine Waste

Table B.5 in Appendix B presents the ecological risk calculations and results for mine waste. Aluminum, arsenic, and copper are the most significant CPECs because they pose a potential threat to all four ecological receptor groups (plants, invertebrates, birds, and mammals).

Five CPECs pose a risk to mammals based on an acceptable risk ratio of Q = 1 for protected species: aluminum, arsenic (III and V), copper, thallium, and vanadium. The most significant risk to mammals is from aluminum (Q = 245) and arsenic (Q = 119). Aluminum and arsenic also posed a multiple COI risk to mammals. The remaining risk ratios are all below 5. Four additional potential CPECs were identified for mammals because of the lack of SLVs: silver, arsenic total, chromium total, and iron.

Six CPECs pose a risk to birds based on an acceptable risk ratio of Q = 1 for protected species: aluminum, arsenic (III and V), chromium, copper, selenium, and vanadium. The highest risk to birds is from arsenic (Q = 119). There is also significant risk to birds from aluminum (Q = 58) and selenium (Q = 37). Aluminum, arsenic, and selenium also pose a multiple COI risk to birds. The remaining risk ratios were all below 10. Seven additional potential CPECs were identified for birds because of the lack of SLVs: arsenic total, silver, beryllium, cobalt, iron, antimony, and thallium.

Six CPECs pose a risk to invertebrates based on an acceptable risk ratio of Q = 5 for non-protected species: aluminum, arsenic V, chromium, copper, iron, and mercury. The highest risks to invertebrates are from iron (Q = 500) and arsenic V (Q = 263). There is also significant risk to invertebrates from exposure to aluminum (Q = 44), chromium III (Q = 28), and copper (Q = 39). Arsenic V and iron also pose a multiple COI risk to invertebrates. Five additional potential CPECs were identified for invertebrates because of the lack of SLVs: arsenic III, beryllium, antimony, thallium and vanadium.

Plants are the most sensitive receptor group with risk from 13 CPECs: silver, aluminum, arsenic (III and V), chromium, copper, iron, mercury, lead, nickel, antimony, selenium, thallium, and vanadium. The highest risk to plants is from iron (Q = 10,000), arsenic (Q = 1,577), and aluminum (Q = 524). There is also significant risk from silver (Q = 21), chromium (Q = 11), copper (Q = 20), and vanadium (Q = 34). Arsenic V and iron also pose a multiple COI risk to plants. The remaining risk ratios are all below 5. One additional potential CPEC was identified for invertebrates because of the lack of an SLV: arsenic V.

5.3.2 Surface Water

Table B.6 in Appendix B presents the ecological risk calculations and results for surface water. Six CPECs were identified as posing a risk to aquatic life based on an acceptable risk ratio of Q = 1 for protected species: aluminum, barium, cadmium, copper, lead, and zinc. The highest risk is from exposure to copper (Q = 1,084). There is also significant risk from exposure to aluminum (Q = 33). Copper also posed a multiple COI risk to aquatic life. Risk ratios from the remaining CPECs were all below than 5.

No CPECs were identified in surface water as posing a risk to birds or mammals from single COI risk ratios; however, under multiple COIs, aluminum poses a risk to both receptors and copper poses a risk to birds. Silver, arsenic (V and total), and beryllium were retained as potential bird CPECs because of the lack of SLVs; silver and arsenic (V and total) were retained as potential mammal CPECs because of the lack of SLVs.

5.3.3 Sediment

Table B.7 in Appendix B presents the ecological risk calculations and results for sediment. Seven CPECs were identified as posing a risk to aquatic life based on an acceptable risk ratio of Q = 1 for protected species: silver, arsenic, barium, cadmium, copper, antimony, selenium and zinc. The highest risk is from bioaccumulation of cadmium (Q = 320) and copper (Q = 335). There is also moderate risk from bioaccumulation of selenium (Q = 70) and zinc (Q = 27). Copper poses the highest freshwater sediment risk with a risk ratio of Q = 42. There is also moderate freshwater sediment risk from silver (Q = 17) and arsenic (Q = 10).

Aluminum, arsenic V, beryllium, cobalt, chromium (III and VI), mercury, thallium, vanadium were retained as potential aquatic life CPECs because of the lack of SLVs.

5.3.4 Pore Water

Table B.8 in Appendix B presents the ecological risk calculations and results for pore water. Six CPECs were identified as posing a risk to aquatic life based on an acceptable risk ratio of Q = 1 for protected species: aluminum, barium, cadmium, copper, iron, and zinc. The highest risks are from exposure to aluminum (Q = 11,000) and copper (Q = 220). Aluminum also poses a multiple COI risk to aquatic life. The remaining risk ratios are all below 10.

5.4 Uncertainty Evaluation

There are several sources of potential uncertainty associated with this ERA. These sources and their potential impact on the prediction of potential risks to ecological receptors at the site are discussed in the following sections.

5.4.1 Sample Data

The selection of sampling media, sample locations, quantity of samples, sampling procedures, and sample analysis introduce some uncertainties into this ERA. For example, time and monetary restraints limit the number of samples that can be collected; therefore, sample locations are selected based on knowledge of anticipated presence of particular contaminants. Overall, the data used in this ERA were generally collected from areas with expected elevated metals concentrations. As a result, this assessment likely over estimates the risk posed to ecological receptors at the site.

The lack of established SLVs for several COIs were another source of uncertainty in the ERA. COIs retained as CPECs because of the lack of SLVs rather than because of high-risk ratios may result in an over estimation of the overall potential for ecological risk at the site.

5.4.2 Screening Level Values

"NOAEL" is the acronym used for "No Observed Adverse Effect Level." It means the highest exposure level at which there are no statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered to be adverse, nor precursors to specific adverse effects (WAC 173-340-200).

"LOAEL" is the acronym used for "Lowest Observed Adverse Effect Level" which means the lowest concentration of a hazardous substance at which there is a statistically or biologically significant increase in the frequency or severity of an adverse effect between an exposed population and a control group (WAC 173-340-200).

The ecological risk-based SLVs used in this ERA are intended to be NOAELs, with the exception of sediment SLVs. Ecological effects occur at some concentration between the NOAELs and the LOAELs; therefore, concentrations exceeding the SLV do not necessarily constitute a "real" risk for ecological receptors. Thus, use of NOAEL-based SLVs results in an over estimation of actual ecological risks at the site.

5.4.3 CPEC Selection

The CPEC background concentration screening for pore water and sediment was based on only one background sample. Concentrations of COIs, particularly metals, are naturally variable; therefore, a single sample does not accurately reflect "natural" conditions. As a result, improper inclusion of contaminants during the background screening may result in over estimating actual risks, and improper exclusion of contaminants may result in under estimating actual risks. In addition, the use of the MDC or UCL_{95} as the EPC may inherently introduce conservatism and contribute to over estimation of risk at the site.

5.4.4 Home Range

The use of SLVs assumes that the receptor's habitat is restricted to the affected area represented by the EPC. However, these areas typically offer lower habitat quality compared to adjoining habitat and it is unlikely that a receptor would limit its habitat strictly to these areas. Also, the home range for most birds and mammals covers a fairly large area. Therefore, because of the relatively small area of the waste rock piles, the use of the SLVs likely over estimates the actual risk.

5.5 Summary of Potential Ecological Risks

Results of the streamlined ERA indicate potential risk to ecological receptors at the Rainy Mine and Millsite. However, these risks appear to be limited to individual receptors and there does not appear to be significant population-level risks. While individual receptors may be at risk from exposure to CPECs at the site, their populations are unlikely to be significantly impacted in the vicinity of the mine because it is unlikely that entire populations would reside entirely within the contaminated areas of the site. These areas typically offer lower habitat quality compared to adjoining habitat; therefore, it is unlikely that a receptor would limit its habitat strictly to these areas. However, there are some sensitive amphibian

species, such as the Oregon tailed frog and western toad, that have relatively small home ranges and my inhabit the seep areas.

Although there is no evidence of T&E species inhabiting the site and none were observed during the SI, available data from the USFS and FWS identify known and potential T&E habitats within the Mt. Baker-Snoqualmie National Forest. Therefore, these species may inhabit the area and occasionally traverse the site. Sensitive species such as the Oregon tailed frog (federal candidate species) and western toad (federal SOC) will be sensitive to metals in both the sediment and surface water. In addition, the range of these species is not as broad as other species potentially present. Non-migratory coastal cutthroat may also be sensitive to surface water quality in Quartz Creek where it is considered spawning and rearing habitat. Other species, such as the spotted owl (threatened) and the northern goshawk (federal SOC), may also be affected through surface water, and indirectly through soil consumption via predation.

6.0 CONCLUSIONS

Results of the streamlined RAs indicate significant potential risks to both human and ecological receptors at the site. The HHRA indicates non-carcinogenic hazard and carcinogenic risk from exposure to metals, particularly arsenic, in mine waste, sediment, and surface water at the site. Six human health COPCs were identified: arsenic, cadmium, chromium, copper, iron, and manganese. The most significant exposure pathway is ingestion of and dermal contact with the mine waste. Ingestion of sediment and surface water also poses a human health risk, particularly to the child receptor. Inhalation of particulates from the mine waste, and dermal contact with sediment and surface water contribute minimal risk and are insignificant pathways.

Results of the streamlined ERA indicate significant potential risk to ecological receptors at the site; however, the risks appear to be limited to individual receptors rather than whole populations. This is because (1) the home range for most receptors is significantly larger than the site and it is improbable that entire populations of receptors reside strictly within the site boundaries, and (2) the site likely represents suboptimal habitat compared to the surrounding area. However, for some individuals, particularly amphibians such as the Oregon tailed frog or western toad, the site may constitute their entire home range. This is critical because T&E species are to be protected to the individual level. Several CPECs were identified and the highest risk ratios for all terrestrial and avian receptors are from exposure to metals in the mine waste, particularly aluminum, arsenic, copper and iron. There is also potential risk to aquatic receptors from exposure to metals concentrations in surface water, sediment, and pore water at the site.

A hot spot assessment was completed and human health risk-based cleanup criteria were back calculated using the human health exposure factors and risk equations. Soil and sediment hot spot concentrations were calculated for all COPCs based on the most sensitive receptor (child recreationalist) under the RME scenario, a non-carcinogenic cumulative HQ of 10, and a hot spot carcinogenic risk level of 1.E-04 for total cumulative risk. Arsenic was the only COPC that exceeded the hot spot concentration of 330 mg/kg. One location was identified as a hot spot based on the arsenic concentration in a mine waste sample from waste rock pile WR2 (15,800 mg/kg).

Human health risk-based cleanup levels were also calculated for all COPCs in soil and sediment based on the most sensitive receptor (child recreationalist) under the RME scenario, an acceptable cumulative non-carcinogenic HQ of 1, and an acceptable carcinogenic risk level of 1.E-05 for total cumulative risk. While these cleanup levels are intended to be protective of human health, they will likely be protective of ecological receptors as well because the areas containing the highest arsenic concentrations in soil and sediment also contain the highest concentrations of the other COPCs and CPECs. Arsenic was the only

COPC to exceed the soil cleanup level of 33 mg/kg and sediment cleanup level of 132 mg/kg. Arsenic concentrations in samples from six areas exceeded the cleanup level: (1) waste rock pile WR1 (129 to 222 mg/kg), waste rock pile WR2 (15,800 mg/kg), (3) soil along the south side of the mill foundation (299 mg/kg), (4) soil along the northwest side of the mill foundation (225 mg/kg), (5) sediment at the west seep (179 mg/kg), and (6) sediment at the east seep (205 mg/kg).

Removal of waste rock, soil, and sediment from the areas with arsenic concentrations exceeding the cleanup levels should significantly reduce both the overall human health and potential ecological risk at the site. Removal of the waste rock should also improve surface water quality by significantly reducing metals concentrations in the two seeps, and metals migration to Quartz Creek from the seeps and unnamed drainage that flows across waste rock pile WR2. The total volume of waste rock in the two piles was estimated in the SI to be about 2,025 cyd.

Based on the results of the streamlined RAs, MSE recommends performing a streamlined Engineering Evaluation/Cost Analysis (EE/CA) to address metals concentrations in the mine waste, soil, and sediment at the site.

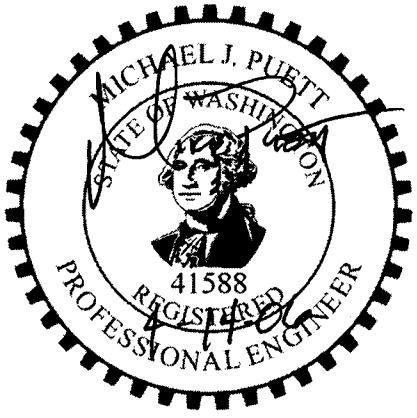
DISCLAIMER

This abandoned mine/mill site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the USFS. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 mining law. Therefore, USFS believes that this site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this site should be included on EPA' CERCLIS database Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Sited Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the EPA Regional Docket Coordinator consult with the USFS and EPA Headquarters before making a determination to include this site on the Federal Agency Hazardous Waste Compliance Docket.

Prepared by:

Millennium Science and Engineering, Inc.

Michael J. Puett, P.E.
Principal Author



EXPIRES 9/27/07

Millennium Science and Engineering, Inc.

Joe Davis
Technical Reviewer

R1670

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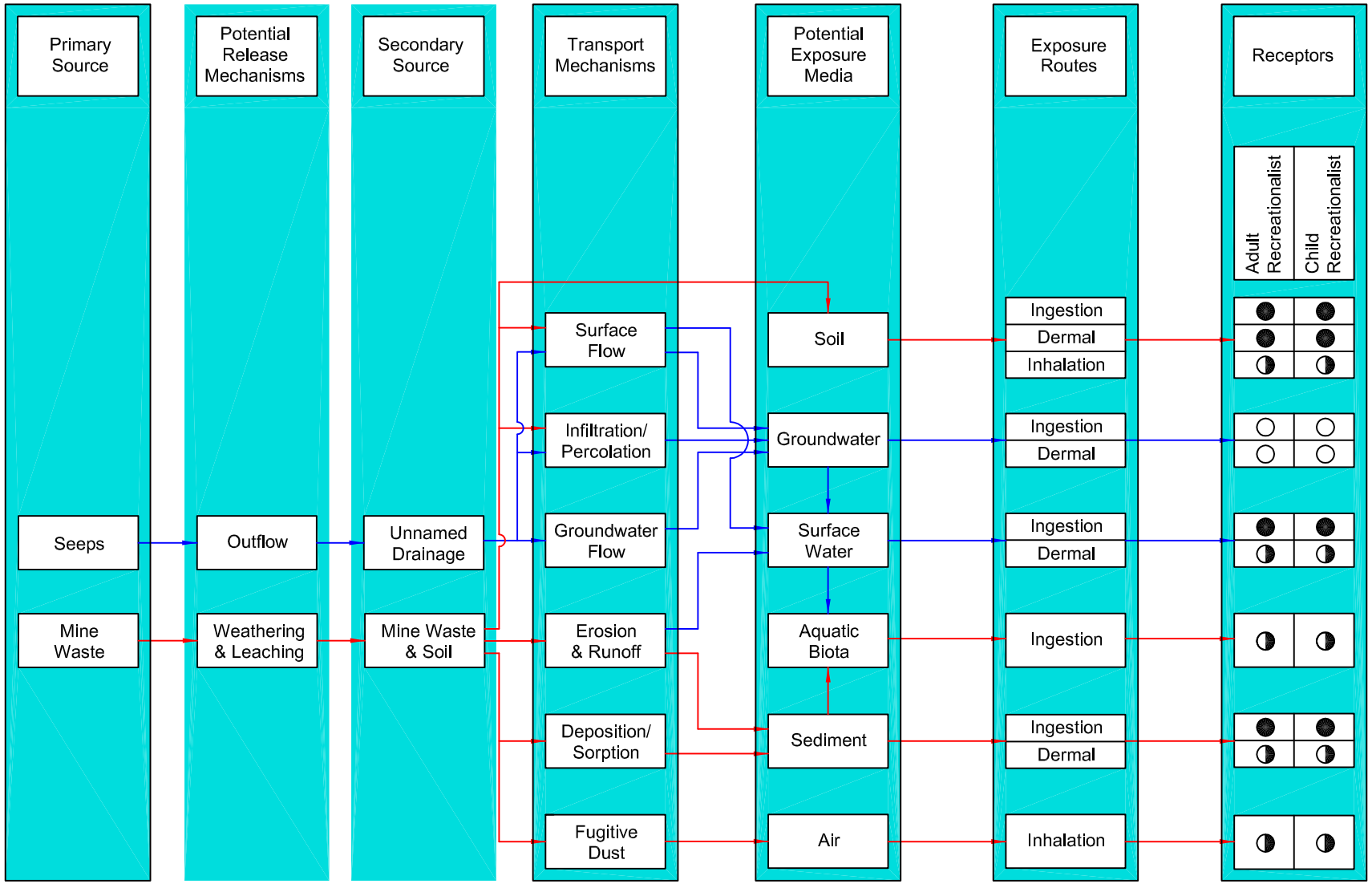
FIGURES



Legend

- ● Complete and potentially significant exposure pathway
- ◑ Potentially complete but insignificant exposure pathway
- ○ Incomplete exposure pathway

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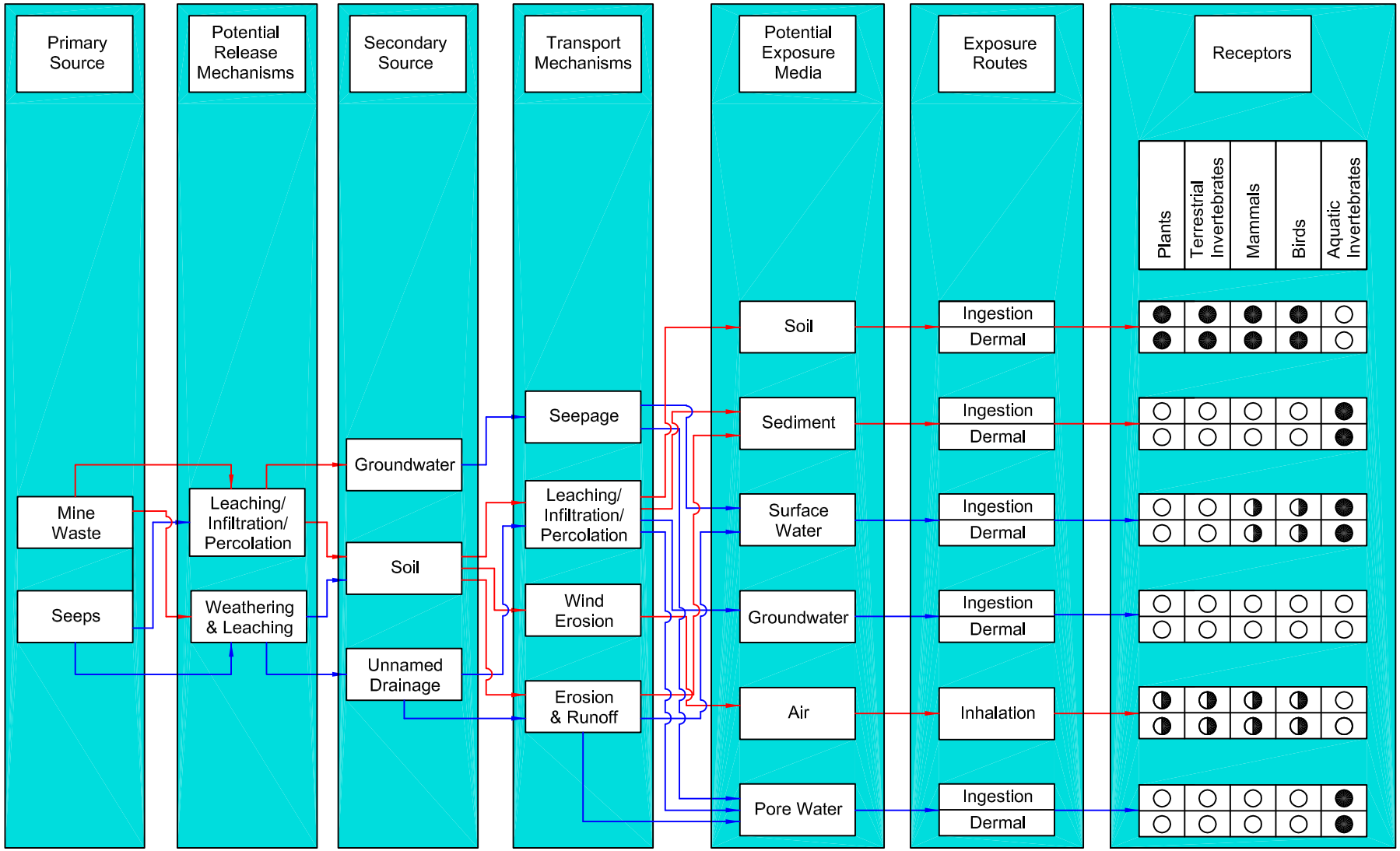
Human Health Conceptual Site Model

B2473C	2/02/06	HH CSM.dwg	FIGURE 1



Legend

- Complete and potentially significant exposure pathway
- Potentially complete but insignificant exposure pathway
- Incomplete exposure pathway

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Ecological Conceptual Site Exposure Model

B2473C	3-2-06	ERA CSM.dwg	FIGURE 2

TABLES

TABLE 1
Mine Waste Analytical Results Summary
Rainy Mine and Millsite

Sample ID	pH	Analyte Concentration (mg/kg)																										
		Ca	K	Mg	Na	CN	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_3	Cr_6	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
RM-WR1-1	3.1	1700	2150	4700	730	NA	29.5	8070	0.28	221.7	222	65	0.5	0.34	2.5	9	0.49	10	1260	70400	0.67	149	3.7	14.5	1.6	7.6	0.25	49	39
RM-WR1-2	3.4	3000	4160	9500	1860	NA	41.3	15500	0.02	48.7	48.7	70	0.5	0.27	2.5	11.2	0.40	12	1970	95300	0.1	363	4	8.31	1.7	11.1	0.2	67	69
RM-WR1-3	3.9	790	990	3270	290	0.3	12.5	13500	0.21	155.8	156	32.7	0.1	0.20	3	6.1	0.47	7	1140	40100	0.08	142	4	22	1.6	3	0.25	37.2	50
RM-WR1-4	3.8	660	1030	3600	290	NA	18	7660	0.19	128.8	129	37.9	0.1	0.22	2	5	0.98	6	1620	47900	0.09	158	7	13.7	1.3	4.8	0.08	26.7	50
RM-WR1-5	4.1	600	770	2410	160	NA	5.04	17500	0.25	137.7	138	35.9	0.1	0.23	3	6.1	0.46	7	1080	24100	0.06	112	5.6	7.2	0.4	1.6	0.11	28.6	35
RM-WR2-1	4.5	1500	470	1990	410	NA	15	7690	28.1	15772	15800	17.7	0.1	0.61	10	1.2	0.40	2	1310	47100	1.08	190	5	40	5	4.4	1.5	6.1	50
RM-S1	3.3	900	1390	3600	30	NA	41.1	6130	0.60	298.4	299	54.5	0.5	0.13	2.5	4.2	0.40	5	1380	100000	0.1	159	4	79.6	5.3	10.2	0.11	33	30
RM-S2	4.9	1170	710	2410	260	0.3	3.62	12800	0.08	21.9	22	24.3	0.1	0.23	4	6	0.50	7	986	28500	0.02	147	7.5	30.5	1.2	1	0.08	23	60
RM-S3	5.0	470	1180	2500	200	0.35	28	26200	0.43	224.6	225	38.4	0.3	0.38	3	4.7	0.64	6	1660	27500	0.11	129	12	12.6	0.9	5.3	0.11	22.3	50
minimum =	3.1	470	470	1990	30	0.3	3.62	6130	0.02	21.9	22	17.7	0.1	0.13	2.0	1.2	0.40	2	986	24100	0.02	112	3.7	7.2	0.4	1	0.08	6.1	30
MDC =	**5.0**	**3000**	**4160**	**9500**	**1860**	**0.35**	**41.3**	**26200**	**28.1**	**15772**	**15800**	**70**	**0.5**	**0.61**	**10**	**11.2**	**0.98**	**12**	**1970**	**100000**	**1.08**	**363**	**12**	**79.6**	**5.3**	**11.1**	**1.5**	**67**	**69**
average =	4.0	1199	1428	3776	470	0.32	21.6	12783	3.3	1890	1893	41.8	0.3	0.29	3.6	5.9	0.53	6.9	1378	53433	0.26	172	5.9	25.4	2.1	5.4	0.30	32.5	48
95% UCL =		**1690**	**2272**	**5334**	**976**		**30.4**	**16757**	**10.8**	**19158**	**19192**	**52.8**	**0.5**	**0.38**	**5.1**	**7.7**	**0.64**	**8.7**	**1575**	**71254**	**0.65**	**218**	**7.7**	**44.1**	**3.7**	**7.7**	**0.64**	**43.3**	**56**
Human Health Screening Criteria																												
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001b)			NS	NS	NS	NS	20	NS	NS	2	NS	2000	19	19	NS	NS	2	NS	NS	1000	NS	NS	NS	NS	NS			
EPA Region IX Industrial Soil PRGs (EPA 2004a)			5100	100000	NS	NS	1.6	67000	1900	450	1900	100000	30	450	41000	100000	310	19000	20000	800	410	5100	67	1000	100000			
Ecological Screening Criteria																												
WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals (WDOE 2001c)		2	50	7	10	NS	102	10	4	20	NS	NS	42	50	NS	0.1	1100	30	50	5	0.3	1	2	86				
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA		NS	NS	NS	NS	18	330	21	0.36	13	26	81	NS	NS	NS	NS	NS	NS	11	0.27	NS	NS	7.8	NS				
ORNL Soil PRGS for Ecological Endpoints (Efroymson et al. 1997)		2	NS	NS	NS	9.9	283	10	4	20	NS	NS	0.4	60	NS	0.00051	NS	30	40.5	5	0.21	1	2	8.5				

Notes:

Result below method detection limit, reported at 1/2 reporting limit

Result between method detection limit and practical quantitation limit, reported at detected concentration

Calculated value

Ecological screening criteria exceeded

Human health screening criteria exceeded

95 Percent upper confidence levels not computed because fewer than four samples.

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

MTCA = Model Toxics Control Act

NA = Not analyzed for

NS = No standard

ORNL = Oak Ridge National Laboratory

PRG = Preliminary remediation goal

WDOE = Washington Department of Ecology

U = Undetected, value = ½ reporting limit

mg/kg = Milligram per kilogram

TABLE 2
Background Soil Analytical Results Summary
Rainy Mine and Millsite

Sample ID	pH	Analyte Concentration (mg/kg)																								
		Ca	K	Mg	Na	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_3	Cr_6	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
RM-BGS-1	4.4	670	250	930	150	0.71	21900	0.534	58.3	58.8	21.3	0.3	0.15	2	4.0	0.52	5	38.6	13000	0.08	52.9	2.2	5.37	0.1	0.6	0.07	24.1	13
RM-BGS-2	5.1	1490	550	1620	160	0.43	23800	0.465	26.5	27	47.9	0.2	0.25	4	5.9	0.53	7	547	19500	0.08	196	7.1	82	0.8	0.5	0.1	29.5	166
RM-BGS-3	4.9	670	240	730	210	0.13	14300	0.235	7.5	7.7	14.1	0.1	0.14	3	NC	27.1	4	15	12600	0.11	161	1.9	6.71	0.2	0.25	0.08	25.5	12
minimum =	4.4	670	240	730	150	0.13	14300	0.24	7.5	7.7	14.1	0.1	0.14	2	4.0	0.52	4	15	12600	0.08	52.9	1.9	5.4	0.1	0.25	0.07	24.1	12
MDC =	**5.1**	**1490**	**550**	**1620**	**210**	**0.71**	**23800**	**0.53**	**58.3**	**58.8**	**47.9**	**0.3**	**0.25**	**4**	**5.9**	**27.1**	**7**	**547**	**19500**	**0.11**	**196**	**7.1**	**82**	**0.8**	**0.60**	**0.10**	**29.5**	**166**
average[a] =	4.8	943	347	1093	173	0.65	20000	0.41	30.8	31.2	27.8	0.2	0.18	3	5.0	9.4	5.3	200	15033	0.09	137	3.7	31.4	0.4	0.45	0.08	26.4	63.7
Human Health Screening Criteria																												
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001b)		NS	NS	NS	NS	20	NS	NS	2	NS	2000	19	19	NS	NS	2	NS	NS	1000	NS	NS	NS	NS	NS			
EPA Region IX Industrial Soil PRGs (EPA 2004a)		5100	100000	NS	NS	1.6	67000	1900	450	1900	100000	30	450	41000	100000	310	19000	20000	800	410	5100	67	1000	100000			
Ecological Screening Criteria																												
WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals (WDOE 2001c)		2	50	7	10	NS	102	10	4	20	NS	NS	42	50	NS	0.1	1100	30	50	5	0.3	1	2	86			
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005b)		NS	NS	NS	NS	18	330	21	0.36	13	26	81	NS	NS	NS	NS	NS	NS	11	0.27	NS	NS	7.8	NS			
ORNL Soil PRGS for Ecological Endpoints (Efroymson et al. 1997)		2	NS	NS	NS	9.9	283	10	4	20	NS	NS	0.4	60	NS	0.00051	NS	30	40.5	5	0.21	1	2	8.5			

Notes:

Result below method detection limit, reported at 1/2 reporting limit

Result between method detection limit and practical quantitation limit, reported at detected concentration

Calculated value

Ecological screening criteria exceeded

Human health screening criteria exceeded

[a]95 Percent upper confidence levels not computed because fewer than four samples.

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

MTCA = Model Toxics Control Act

NC = Not computed

NS = No standard

ORNL = Oak Ridge National Laboratory

PRG = Preliminary remediation goal

WDOE = Washington Department of Ecology

U = Undetected, value = ½ reporting limit

mg/kg = Milligram per kilogram

TABLE 3
Surface Water Analytical Results Summary
Rainy Mine and Millsite

Sample ID	Analyte Concentration (ug/L)[a]																						
	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_3	Cr_6	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
QC-SW1 - background	0.025	80	0.192	0.908	1.1	1.5	1	0.05	5	5	0.50	5	0.25	5	0.00089	2.5	5	0.05	0.1	1	0.025	2.5	5
RM-BG-SW4 - background	0.025	90	0.043	0.018	0.25	1.5	1	0.05	5	5	0.05	5	0.25	20	NA	2.5	5	0.05	0.1	1	0.025	2.5	5
minimum =	0.025	80	0.043	0.018	0.25	1.5	1	0.05	5	5	0.05	5	0.25	5	0.00089	2.5	5	0.05	0.1	1	0.025	2.5	5
MDC =	**0.025**	**90**	**0.192**	**0.908**	**1.1**	**1.5**	**1**	**0.05**	**5**	**5**	**0.5**	**5**	**0.25**	**20**	**0.00089**	**2.5**	**5**	**0.05**	**0.1**	**1**	**0.025**	**2.5**	**5**
average =	0.025	85	0.1175	0.463	0.675	1.5	1	0.05	5	5	0.275	5	0.25	12.5	0.00089	2.5	5	0.05	0.1	1	0.025	2.5	5
Taylor River[c]:																							
TR-SW1	0.025	50	0.069	0.216	0.25	1.5	1	0.05	5	5	0.5	5	0.25	5	0.00046	2.5	5	0.05	0.1	1	0.025	2.5	5
TR-SW2	0.025	50	0.115	0.193	0.25	1.5	1	0.05	5	5	0.5	5	0.25	5	0.00053	2.5	5	0.05	0.1	1	0.025	2.5	5
Site:																							
QC-SW2	0.025	70	0.131	1.269	1.4	1.5	1	0.05	5	5	0.5	5	0.25	20	0.00091	2.5	5	0.05	0.1	1	0.025	2.5	5
QC-SW3	0.025	100	0.117	1.283	1.4	1.5	1	0.05	5	5	0.5	5	1.1	10	0.00082	2.5	5	0.05	0.1	1	0.025	2.5	5
QC-SW4	0.025	70	0.163	0.937	1.1	1.5	1	0.05	5	5	0.5	5	0.8	5	0.00089	2.5	5	0.05	0.1	1	0.025	2.5	5
RM-SEEP-SW1	0.025	1260	0.044	14.1	14.1	8	1	0.2	5	5	0.5	5	687	580	0.00065	34	5	0.05	0.1	1	0.025	2.5	20
RM-SEEP-SW2	0.16	2890	0.0035	1.893	1.9	14	1	0.7	5	5	0.5	5	2020	150	0.00079	54	5	0.5	0.1	1	0.025	2.5	60
RM-AWR-SW3	0.025	110	5.43	52.3	57.7	4	1	0.05	5	5	0.5	5	2.1	30	0.00033	2.5	5	0.05	0.1	1	0.025	2.5	5
min (excluding BG) =	0.025	70	0.0035	0.937	1.1	1.5	1	0.05	5	5	0.5	5	0.25	5	0.00033	2.5	5	0.05	0.1	1	0.025	2.5	5
MDC (excluding BG) =	**0.16**	**2890**	**5.43**	**52.3**	**57.7**	**14**	**1**	**0.7**	**5**	**5**	**0.5**	**5**	**2020**	**580**	**0.00091**	**54**	**5**	**0.5**	**0.1**	**1**	**0.025**	**2.5**	**60**
avg (excluding BG) =	0.05	750	0.98	12.0	12.9	5.1	1	0.2	5	5	0.5	5	452	133	0.00073	16.3	5	0.13	0.1	1	0.025	2.5	16.7
95% UCL =	**0.03**	**5416**	**15.8**	**68.4**	**71.9**	**9.2**	**1**	**1.2**	**5**	**5**	**0.5**	**5**	**10076**	**1330**	**0.00091**	**107**	**5**	**0.45**	**0.1**	**1**	**0.025**	**2.5**	**106**
Human Health Screening Criteria																							
1a - Wash HH	NS	NS	NS	NS	0.018	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.14	NS	610	NS	14	170	1.7	NS	NS
1b - Wash HH	100	NS	NS	NS	10	2000	4	5	NS	NS	NS	100	1300	300	2	50	100	15	6	50	2	NS	5000
2- EPA HH	NS	NS	NS	NS	0.018	1000	NS	NS	NS	NS	NS	NS	1300	300	NS	50	610	NS	5.6	170	0.24	NS	7400
Ecological Screening Criteria																							
3- Wash Eco[b]	NS	NS	NS	NS	190	NS	NS	0.21	NS	30.3	10.4	NS	1.86	NS	0.012	NS	25.3	0.20	NS	5	NS	NS	17.0
4- EPA Eco[b]	0.36	NS	NS	3.1	150d	4	0.66	0.05	23	13	11d	NS	1	1000	0.77d	120	8	0.22	30	5	12	20	19
5 -ORNL Eco	0.36	87	0.19	0.0031	3.1	4	0.66	0.00015	23	NS	0.002	2	0.23	158	0.23	120	160	0.66	30	0.39	9	20	30

Sample ID	pH	Analyte Concentration (ug/L)[a]					
		Ca	Hard	K	Mg	Na	Sulfate
QC-SW1 - background	6.3	1200	3	300	100	900	20
RM-BG-SW4 - background	6.1	1300	NA	150	100	150	NA
minimum =	6.1	1200	3	150	100	150	20
maximum =	**6.3**	**1300**	**3**	**300**	**100**	**900**	**20**
average =	6.2	1250	3	225	100	525	20
Taylor River:							
TR-SW1	6.5	1200	3	150	100	600	5
TR-SW2	6.5	1200	3	150	100	700	10
Site:							
QC-SW2	6.6	1200	3	150	100	900	10
QC-SW3	6.5	1200	3	150	100	1000	5
QC-SW4	6.5	1000	3	150	100	900	5
RM-SEEP-SW1	6.7	7800	21	500	400	3200	20
RM-SEEP-SW2	4.3	6700	19	600	600	3500	50
RM-AWR-SW3	7.1	7600	20	500	300	3200	20
min (excluding BG) =	4.3	1000	3	150	100	900	5
MDC (excluding BG) =	**7.1**	**7800**	**21**	**600**	**600**	**3500**	**50**
avg (excluding BG) =	6.3	4250	11.5	342	267	2117	18.3
95% UCL =		**10840**		**721**	**437**	**4042**	**32.3**

Notes:

Result below method detection limit, reported at 1/2 reporting limit

Result between method detection limit and practical quantitation limit, reported at detected concentration

Calculated value

Ecological screening criteria exceeded

Human health screening criteria exceeded

[a]Total concentrations

[b]Screening criteria for hardness dependent metals are based on a average hardness of 11.5 and were converted to total concentrations where applicable.

[c]Samples from Taylor River were not included with samples from the site in determining minimum, maximum, and average concentrations.

BG = Background

d = Dissolved

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

ORNL = Oak Ridge National Laboratory

max = Maximum

min = Minimum

NS = No standard

ORNL = Oak Ridge National Laboratory

UCL = Upper confidence limit

WSDH = Washington State Department of Health

µg/L = Microgram per liter

1a-State of Washington ambient water quality criteria for protection of human health (WDOE 2001d)

1b-State of Washington drinking water standards, WAC 246-290-310 (WSDH 2006)

2-EPA recommended chronic ambient water quality criteria for human consumption of water and fish (EPA 2004c)

3-State of Washington ambient water quality criteria for protection of aquatic life, chronic criterion (WDOE 2003a)

4-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 2004c); if none existed then used Tier II secondary chronic values (NOAA

5-ORNL Ecological screening levels for freshwater, lowest chronic value (Suter & Tsao 1996)

TABLE 4
Sediment Analytical Results Summary
Rainy Mine and Millsite

Sample ID	TOC (%)	Analyte Concentration (mg/kg)																										
		Ca	K	Mg	Na	CN	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_3	Cr_6	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
QC-SS-1 - Background	0.5	960	1670	2770	130	0.3	0.04	6950	0.161	9.3	9.5	66.8	0.1	0.39	4	5	0.955	6	18	10600	0.02	181	2.7	4.78	0.1	0.25	0.11	23.9	31
Taylor River:																													
TR-SS-1	0.2	1690	1750	3270	190	NA	0.13	6490	0.086	3.5	3.6	53.1	0.1	0.14	4	2.2	0.786	3	19	12100	0.02	216	3.8	7.4	0.05	0.25	0.13	22.6	40
TR-SS-2	0.2	1920	1510	2990	280	NA	0.08	6790	0.068	5.3	5.4	44.1	0.1	0.12	3	3.2	0.823	4	16	10500	0.02	189	3.1	3.48	0.05	0.25	0.11	20.3	30
Site:																													
QC-SS-2	2.2	1490	1300	2540	230	NA	0.06	7550	0.098	12.2	12.3	61.6	0.1	0.22	4	3.1	0.936	4	27	9540	0.02	184	2.3	4.97	0.05	0.25	0.09	20.5	31
QC-SS-3	0.6	1180	1090	2390	190	0.25	0.28	6950	0.101	22.5	22.6	48.1	0.1	0.17	3	5.2	0.764	6	145	9700	0.02	135	2.4	3.6	0.05	0.25	0.07	17.7	30
QC-SS-4	0.2	1590	1350	2110	250	0.25	0.09	5750	0.137	15.2	15.3	36.8	0.1	0.14	3	2.2	0.765	3	30	8150	0.02	152	1.6	3.12	0.2	0.25	0.09	17	23
RM-SEEP-SS-1	8.8	3210	1420	3150	220	2	4.79	44200	1.025	178	179	66.3	0.6	1.27	8	8.4	2.573	11	4410	23300	0.025	167	7	27.2	0.5	0.8	0.23	39.9	82
RM-SEEP-SS-2	6.8	2360	1330	5100	320	0.5	33.9	19500	3.342	201.7	205	63.1	0.1	0.69	4	9.9	1.119	11	2620	49700	0.19	198	7	31.2	1	7	0.18	50.2	90
min (excluding BG) =	0.2	1180	1090	2110	190	0.25	0.06	5750	0.098	12.2	12.3	36.8	0.1	0.14	3	2.2	0.76	3	27	8150	0.02	135	1.6	3.12	0.05	0.25	0.07	17.0	23
MDC (excluding BG) =	**8.8**	**3210**	**1420**	**5100**	**320**	**2.0**	**33.9**	**44200**	**3.34**	**201.7**	**205**	**66.3**	**0.6**	**1.27**	**8**	**9.9**	**2.57**	**11**	**4410**	**49700**	**0.19**	**198**	**7**	**31.2**	**1.0**	**7.0**	**0.23**	**50.2**	**90**
avg (excluding BG) =	3.7	1966	1298	3058	242	0.8	7.8	16790	0.94	85.9	86.8	55.2	0.2	0.50	4	5.8	1.23	7	1446	20078	0.06	167	4.1	14.0	0.36	1.7	0.13	29.1	51
95% UCL =		**2748**	**1417**	**4205**	**288**	**4.1**	**207**	**32330**	**5.60**	**393**	**398**	**67.0**	**0.6**	**0.96**	**7**	**8.9**	**2.3**	**11**	**3346**	**36924**	**0.20**	**191**	**6.6**	**27.3**	**0.74**	**10.3**	**0.20**	**43.5**	**82**
Human Health Screening Criteria																													
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001b)		NS	NS	NS	NS	20	NS	NS	2	NS	2000	19	19	NS	NS	2	NS	NS	1000	NS	NS	NS	NS	NS				
EPA Region IX Industrial Soil PRGs (EPA 2004a)		5100	100000	NS	NS	1.6	67000	1900	450	1900	100000	30	450	41000	100000	310	19000	20000	800	410	5100	67	1000	100000				
Ecological Screening Criteria																													
State of Washington Development of Freshwater Sediment Quality Values (WDOE 2003b) - recommended only		2.0	NS	NS	NS	20.0	NS	NS	0.6	NS	NS	NS	95.0	80.0	NS	0.5	NS	60.0	335	0.4	NS	NS	NS	140				
State of Washington Development of Freshwater Sediment Quality Values (WDOE 2002) - in development		3.9	NS	NS	NS	5.9	NS	NS	0.6	NS	NS	NS	26.0	16.0	NS	0.17	NS	16.0	31.0	35.0	NS	NS	NS	110				
EPA Threshold Effects Level (NOAA 1999)		NS	NS	NS	NS	5.9	NS	NS	0.596	NS	NS	NS	37.3	35.7	NS	0.174	NS	18	35	NS	NS	NS	NS	123				
EPA Freshwater Probable Effects Level (NOAA 1999)		NS	NS	NS	NS	17	NS	NS	3.53	NS	NS	NS	90	197	NS	0.486	NS	35.9	91.3	NS	NS	NS	NS	315				
ORNL Preliminary Remediation Goals (PRGs) for Ecological Endpoints, Sediment (Efroymson et al. 1997)		1.8	NS	NS	NS	42	NS	NS	4.2	NS	NS	NS	159	77.7	NS	0.7	NS	38.5	110	NS	NS	NS	NS	270				

Notes:

Result below method detection limit, reported at 1/2 reporting limit

Result between method detection limit and practical quantitation limit, reported at detected concentration

Calculated value

Ecological screening criteria exceeded

Human health screening criteria exceeded

EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
MTCA = Model Toxics Control Act
NOAA = National Oceanic and Atmospheric Administration
NS = No standard
ORNL = Oak Ridge National Laboratory
PRG = Preliminary remediation goal
UCL = Upper confidence limit
WDOE = Washington Department of Ecology
mg/kg = Milligram per kilogram

TABLE 5
Pore Water Analytical Results Summary
Rainy Mine and Millsite

	Analyte Concentration (ug/L)[a]																					
	Ag	**Al**	**As_3**	**As_5**	**As_T**	**Ba**	**Be**	**Cd**	**Co**	**Cr_3**	**Cr_6**	**Cr_T**	**Cu**	**Fe**	**Hg**	**Mn**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**V**	**Zn**
RM-BG-SW4 - background	0.025	50	0.186	0.91	1.1	1.5	1	0.05	5	5	0.5	5	0.25	5	0.0008	2.5	5	0.05	0.1	0.05	0.2	2.5	5
QC-PW2	0.025	50	0.083	1.22	1.3	1.5	1	0.05	5	5	0.5	5	0.25	5	0.00088	2.5	5	0.05	0.1	0.05	0.18	2.5	5
QC-PW3	0.025	40	0.051	1.35	1.4	1.5	1	0.05	5	5	0.5	5	0.25	5	0.00177	2.5	5	0.05	0.1	0.05	0.08	2.5	5
QC-PW4	0.025	60	0.028	0.97	1	4	1	0.05	5	5	0.5	5	1.9	5	0.00286	2.5	5	0.05	0.1	0.05	0.05	2.5	5
RM-seep-PW1	0.025	1320	8.08	0.02	8.1	17	1	0.5	5	5	0.5	5	409	9360	0.0011	60	5	0.2	0.1	0.05	6.0	2.5	70
RM-seep-PW2	0.025	40	3.68	28.42	32.1	1.5	1	0.2	5	5	0.5	5	0.6	5	0.00013	2.5	5	0.05	0.1	0.05	0.05	2.5	5
min (excluding BG) =	0.025	40	0.028	0.02	1	1.5	1	0.05	5	5	0.5	5	0.25	5	0.00013	3	5	0.1	0.1	0.1	0.05	2.5	5
MDC (excluding BG) =	**0.025**	**1320**	**8.08**	**28.42**	**32.1**	**17**	**1**	**0.5**	**5**	**5**	**0.5**	**5**	**409**	**9360**	**0.0029**	**60**	**5**	**0.2**	**0.1**	**0.05**	**6.0**	**2.5**	**70**
avg (excluding BG) =	0.03	302			8.8	5.1	1	0.2	5	5	0.5	5	82	1876	0.0013	14.0	5	0.08	0.1	0	1.27	2.5	18
95% UCL =	0.025	2835	5.77	1539	49.7	20	1	0.47	5	5	0.5	5	438	10031	0.0023	128	5	0.21	0.1	0.05	6.42	2.5	147
Ecological Screening Criteria																							
1- Wash Eco[b]	NS	NS	NS	NS	190	NS	NS	0.21	NS	30.3	10.4	NS	1.86	NS	0.012	NS	25.3	0.20	NS	5	NS	NS	17.0
2- EPA Eco[b]	0.36	NS	NS	3.1	150d	4	0.66	0.05	23	12.6	11d	NS	1.41	1000	0.77d	120	8.3	0.22	30	5	12	20	18.9
3 -ORNL Eco	0.36	87	0.19	0.0031	3.1	4	0.66	0.00015	23	NS	0.002	2	0.23	158	0.23	120	160	0.66	30	0.39	9	20	30

		Analyte Concentration (ug/L)[a]						
Sample ID	**pH**	**Ca**	**Hard**	**K**	**Mg**	**Na**	**Sulfate**	**CN**
RM-BG-SW4 - background	6.5	1200	3	150	100	1000	5	0.005
QC-PW2	6.1	1200	3	150	100	1000	20	NA
QC-PW3	6.4	1200	3	150	100	1000	20	0.005
QC-PW4	6.2	1000	3	150	100	1000	10	0.005
RM-seep-PW1	5.6	6400	19	600	600	2600	40	NA
RM-seep-PW2	4.6	1200	3	150	100	1000	40	NA
min (excluding BG) =	4.6	1000	3	150	100	1000	10	0.005
MDC (excluding BG) =	**6.4**	**6400**	**19**	**600**	**600**	**2600**	**40**	**0.005**
avg (excluding BG) =	5.8	2200	6.2	240	200	1320	26	0.005
95% UCL =		6780		632	636	2002	39	

1-State of Washington ambient water quality criteria for protection of aquatic life, chronic criterion (WDOE 2003a)

2-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 2004c); if none existed, used Tier II secondary chronic values (NOAA 1999)

3-ORNL Ecological screening levels for freshwater, lowest chronic value (Suter & Tsao 1996)

Notes:

Result below method detection limit, reported at 1/2 reporting limit

Result between method detection limit and practical quantitation limit, reported at detected concentration

Calculated value

Ecological screening criteria exceeded

[a]Dissolved concentrations

[b]Screening criteria for hardness dependent metals are based on a average hardness of 6.2.

BG = Background

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

ORNL = Oak Ridge National Laboratory

max = Maximum

min = Minimum

NS = No standard

ORNL = Oak Ridge National Laboratory

UCL = Upper confidence limit

Wash = Washington

µg/L = Microgram per liter

TABLE 6
Preliminary Risk Screening Using BLM Risk Management Criteria
Rainy Mine and Millsite

Media and Receptor	Units	Contaminant of Interest										
		Sb	As	Cd	Cu	Pb	Mn	Hg	Ni	Se	Ag	Zn
HUMAN HEALTH RISK SCREENING												
Background Soil MDC	mg/kg	**0.8**	**59**	**0.25**	**547**	**82**	**196**	**0.11**	**7.1**	**0.60**	**0.71**	**166**
Camper RMC	mg/kg	50	20	70	5000	1000	19000	40	2700	700	700	40000
Mine Waste MDC	mg/kg	**5.3**	**15800**	**0.61**	**1970**	**79.6**	**363**	**1.08**	**12**	**11.1**	**41.3**	**69**
Camper RMC	mg/kg	50	20	70	5000	1000	19000	40	2700	700	700	40000
Sediment MDC	mg/kg	**1**	**205**	**1.27**	**4410**	**31.2**	**198**	**0.19**	**7.0**	**7.0**	**33.9**	**90**
Camper RMC	mg/kg	62	46	155	5745	1000	21679	46	3094	774	774	46455
Surface Water MDC	ug/L	**0.1**	**58**	**0.7**	**2020**	**0.5**	**54**	**0.001**	**5.0**	**1.0**	**0.16**	**60**
Swimmer RMC	ug/L	192	144	239	17768	50	2395	144	9578	2395	2395	143677
Camper RMC	ug/L	124	93	155	11490	50	1548	93	6194	1548	1548	92909
ECOLOGICAL RISK SCREENING												
Background Soil MDC	mg/kg		**59**	**0.25**	**547**	**82**		**0.11**				**166**
Deer Mouse RMC	mg/kg		230	7	640	142		2				419
Mule Deer RMC	mg/kg		200	3	102	106		9				222
Elk RMC	mg/kg		328	3	131	127		11				275
Mallard RMC	mg/kg		116	1	141	59		4				196
Canada Goose RMC	mg/kg		61	2	161	34		6				271
Robin RMC	mg/kg		4	0.3	7	6		1				43
Mine Waste MDC	mg/kg		**15800**	**0.61**	**1970**	**79.6**		**1.08**				**69**
Deer Mouse RMC	mg/kg		230	7	640	142		2				419
Mule Deer RMC	mg/kg		200	3	102	106		9				222
Elk RMC	mg/kg		328	3	131	127		11				275
Mallard RMC	mg/kg		116	1	141	59		4				196
Canada Goose RMC	mg/kg		61	2	161	34		6				271
Robin RMC	mg/kg		4	0.3	7	6		1				43

Notes:

< RMC = low risk

1 to 10X RMC = moderate risk

10 to 100X RMC = high risk

> 100X RMC = extremely high risk

BLM = U.S. Bureau of Land Management

MDC = Maximum detected concentration

RMC = Risk management criteria

mg/kg = Milligram per kilogram

µg/L = Microgram per liter

TABLE 7
Human Health COPC Summary
Rainy Mine and Millsite

COPC	Media			
	Mine Waste	Sediment	Surface Water	Multi-Media
Aluminum	<BG	<SC	<SC	
Antimony	<SC	<SC	<5%	
Arsenic	**X**	**X**	**X**	**X**
Barium	<SC	<BG	<SC	
Beryllium	<SC	<SC	<5%	
Cadmium	<SC	<SC	<SC	**X**
Chromium	<SC	<SC	**X**	**X**
Cobalt	<SC	<SC	<5%	
Copper	<SC	<SC	<SC	**X**
Iron	<SC	<SC	<SC	**X**
Lead	<SC	<SC	<SC	
Manganese	<SC	<SC	<SC	**X**
Mercury	<BG	<SC	<SC	
Nickel	<SC	<SC	<5%	
Selenium	<SC	<SC	<5%	
Silver	<SC	<SC	<SC	
Thallium	<SC	<SC	<5%	
Vanadium	<SC	<SC	<5%	
Zinc	<SC	<SC	<SC	
Cyanide	<5%	<5%	NA	

Notes:
COPC = Contaminant of potential concern
MDC = Maximum detected concentration
NA = Not analyzed for
X = Retained as a COPC
<BG = Screened out because MDC below background level
<SC = Screened out because MDC below screening criteria
<5% = Screened out because not detected in more than 5% of the samples

TABLE 8
Human Health Exposure Point Concentration Summary
Rainy Mine and Millsite

COPC	Exposure Point Concentration					
	RME			CTE		
	Mine Waste (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Mine Waste (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)
Arsenic	15800	0.058	205	1893	0.013	87
Cadmium	0.38	0.0007	0.96	0.29	0.0002	0.50
Chromium	8.7	0.005	10.6	6.9	0.005	7.0
Copper	1575	2.0	3346	1378	0.45	1446
Iron	71254	0.58	36924	53433	0.13	20078
Manganese	218	0.054	191	172	0.016	167

Notes:
Exposure point concentrations not calculated for lead because lead risks were not quantified
COPC = Contaminant of potential concern
CTE = Central tendency
RME = Reasonable maximum exposure
mg/kg = Milligram per kilogram
mg/L = Milligram per liter

TABLE 9
Human Health Exposure Factor Summary
Rainy Mine and Millsite

Medium	Exposure Route	Parameter Code	Parameter Definition	Units	Adult Recreationalist			Child Recreationalist		
					RME Value	CTE Value	Reference	RME Value	CTE Value	Reference
All	All	BW	Body Weight	kg	70	70	EPA 1997a	15	15	EPA 1997a
		AT-C	Averaging Time (Cancer)	day	25,550	25,550	EPA 1989	25,550	25,550	EPA 1997a
		AT-N	Averaging Time (Non-Cancer)	day	10,950	3,285	365 x ED	2,190	2,190	365 x ED
		CF1	Conversion Factor	1 kg/mg	1.0E-06	1.0E-06		1.0E-06	1.0E-06	
		CF2	Conversion Factor	L/cm^3	1.0E-03	1.0E-03		1.0E-03	1.0E-03	
Mine Waste	Ingestion	IR-S	Incidental Ingestion Rate of Soil	mg/day	100	50	EPA 1997a	600	200	EPA 1997a, (1)
		EF	Exposure Frequency	day/year	14	7	(1)	14	7	(1)
		ED	Exposure Duration	years	30	9	(1)	6	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	6,900	5,200	EPA 2004	5,000	4,500	EPA 2004
		DAF	Dermal Absorption Factor	--	CS	CS	EPA 2004	CS	CS	EPA 2004
		SSAF	Soil to Skin Adherence Factor	mg/cm^2-day	0	0	EPA 2004	1	0	EPA 2004
	Inhalation	IN	Inhalation Rate	m^3/day	15	15	EPA 1997a	8	8	EPA 1997a
		PEF	Particulate Emission Factor	m^3/kg	1.31.E+09	1.31.E+09	EPA 2000	1.31.E+09	1.31.E+09	EPA 2004
Sediment	Ingestion	IR-S	Incidental Ingestion Rate of Sediment	mg/day	50	25	EPA 1997a	200	50	EPA 1997a
		EF	Exposure Frequency	day/year	14	7	(1)	14	7	(1)
		ED	Exposure Duration	years	30	9	(1)	6	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	5,700	5,700	EPA 2004	2,800	2,800	EPA 2004
		DAF	Dermal Absorption Factor[a]	unitless	CS	CS	EPA 2004	CS	CS	EPA 2004
		SSAF	Soil to Skin Adherence Factor	mg/cm^2/day	0	0	EPA 2004	0	0	EPA 2004
Surface Water	Ingestion	IR-W	Ingestion Rate of Surface Water	L/day	2	1	EPA 1997a	1	1	EPA 1997a
		EF	Exposure Frequency	day/year	14	7	(1)	14	7	(1)
		ED	Exposure Duration	years	30	9	(1)	6	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	18,000	18,000	EPA 2004	6,000	6,000	EPA 2004
		KP	Permeability Coefficient	cm/hr	CS	CS	EPA 2004	CS	CS	EPA 2004
		EVF	Event Frequency	event/day	1	1	0	1	1	Site specific
		ET	Exposure Time	hr/day	2	2	EPA 1997a	2	2	EPA 1997a

Notes:

(1) Site-specific assumed value

EPA 1997a "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -Fb, -Fc. August.

EPA 2004a "Region 9 Preliminary Remediation Goals (PRGs) Table." November 2004. On-line address: http://www.epa.gov/region9/waste/sfund/prg/whatsnew.htm.

EPA 2004 "Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment." Volume I: Human Heath Evaluation Manual. Final. Office of Superfund Remediation and Technology Innovation. July.

CTE = Central tendency exposure

RME = Reasonable maximum exposure

cm/hr = Centimeter per hour

cm^2 = Square centimeter

hr/day = Hour per day

kg/gm = Kilogram per milligram

L/day = Liter per day

L/cm^3 = Liter per cubic centimeter

mg/cm^2-day = Milligram per square centimeter per day

mg/day = Milligram per day

m^3/day = Cubic meter per day

m^3/kg = Cubic meter per kilogram

TABLE 10
Human Health Hazard and Cancer Risk Summary
Rainy Mine and Millsite

Media	Exposure Pathway	CENTRAL TENDENCY EXPOSURE				REASONABLE MAXIMUM EXPOSURE			
		Adult Recreationalist		Child Recreationalist		Adult Recreationalist		Child Recreationalist	
		Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR
Mine Waste	Ingestion	9.E-02	5.E-06	**2.E+00**	**6.E-05**	**3.E+00**	**6.E-04**	**8.E+01**	**3.E-03**
	Dermal	5.E-02	3.E-06	8.E-01	**3.E-05**	1.E+00	**2.E-04**	**5.E+01**	**2.E-03**
	Inhalation	4.E-05	1.E-08	1.E-04	2.E-08	1.E-04	7.E-07	3.E-04	3.E-07
	Subtotal =	1.E-01	8.E-06	**2.E+00**	**9.E-05**	**4.E+00**	**8.E-04**	**1.E+02**	**5.E-03**
Surface Water	Ingestion	2.E-02	9.E-07	5.E-02	1.E-06	3.E-01	**5.E-05**	8.E-01	**2.E-05**
	Dermal	2.E-03	6.E-08	3.E-03	6.E-08	2.E-02	2.E-06	2.E-02	6.E-07
	Subtotal =	2.E-02	9.E-07	5.E-02	1.E-06	3.E-01	**5.E-05**	9.E-01	**3.E-05**
Sediment	Ingestion	3.E-03	1.E-07	3.E-02	7.E-07	2.E-02	4.E-06	5.E-01	**1.E-05**
	Dermal	3.E-04	2.E-08	3.E-03	1.E-07	1.E-02	2.E-06	7.E-02	3.E-06
	Subtotal =	3.E-03	1.E-07	3.E-02	8.E-07	4.E-02	6.E-06	5.E-01	**2.E-05**
TOTAL =		2.E-01	9.E-06	**3.E+00**	**1.E-04**	**4.E+00**	**8.E-04**	**1.E+02**	**5.E-03**

Notes:

ECR = Excess cancer risk

HI = Hazard index

Bold values exceed allowable risk levels

TABLE 11
Human Health Risk-based Hot Spot Concentrations
Rainy Mine and Millsite

Media	COPC	Calculated Hot Spot Concentration		Samples and Areas Exceeding Hot Spot Concentrations			
				Sample	Concentration		Area
Mine Waste/Soil	Arsenic	330	mg/kg	RM-WR2-1	15800	mg/kg	Waste rock pile WR2
	Cadmium	3730	mg/kg	None			
	Chromium	257180	mg/kg	None			
	Copper	246870	mg/kg	None			
	Iron	2053120	mg/kg	None			
	Manganese	285560	mg/kg	None			
Sediment	Arsenic	1320	mg/kg	None			
	Cadmium	16040	mg/kg	None			
	Chromium	30796800	mg/kg	None			
	Copper	753150	mg/kg	None			
	Iron	6159370	mg/kg	None			
	Manganese	923200	mg/kg	None			

Notes:
COPC = Contaminant of potential concern
mg/kg = Milligram per kilogram

TABLE 12
Human Health Risk-based Cleanup Levels
Rainy Mine and Millsite

Media	COPC	Calculated Cleanup Level		Samples and Areas Exceeding Cleanup Levels			
				Sample	Concentration		Area
Mine Waste/Soil	Arsenic	33	mg/kg	RM-WR1-1	222	mg/kg	Waste rock pile WR1
				RM-WR1-3	156	mg/kg	
				RM-WR1-4	129	mg/kg	
				RM-WR1-5	138	mg/kg	
				RM-WR2-1	15800	mg/kg	Waste rock pile WR2
				RM-WR2-1	49	mg/kg	
				RM-S1	299	mg/kg	Soil along south side of mill foundation
				RM-S3	225	mg/kg	Soil along northwest side of mill foundation
	Cadmium	373	mg/kg	None			
	Chromium	25718	mg/kg	None			
	Copper	24687	mg/kg	None			
	Iron	205312	mg/kg	None			
	Manganese	28556	mg/kg	None			
Sediment	Arsenic	132	mg/kg	RM-SEEP-SS-1	179	mg/kg	West seep at base of waste rock pile WR1
				RM-SEEP-SS-2	205	mg/kg	East seep at base of waste rock pile WR1
	Cadmium	1604	mg/kg	None			
	Chromium	3079687	mg/kg	None			
	Copper	75315	mg/kg	None			
	Iron	615937	mg/kg	None			
	Manganese	92320	mg/kg	None			

Notes:
COPC = Contaminant of potential concern
mg/kg = Milligram per kilogram

TABLE 13
Mine Waste Contaminants of Potential Ecological Concern
Rainy Mine and Millsite

CPEC	Risk from Single COI				Risk from Multiple COIs			
	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal
Silver	**X**	Q<5	No SLV[a]	No SLV[a]				
Aluminum	**X**	**X**	**X**	**X**			**X**	**X**
Arsenic III	**X**	Q<5	**X**	**X**				
Arsenic V	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Arsenic Total	No SLV[a]	No SLV[a]	No SLV[a]	No SLV[a]				
Barium	Q<1	Q<5	Q<1	Q<1				
Beryllium	Q<1	No SLV[a]	No SLV[a]	Q<1				
Cadmium	Q<1	Q<5	Q<1	Q<1				
Cobalt	Q<1	Q<5	No SLV[a]	Q<1				
Chromium III	**X**	**X**	**X**	Q<1				
Chromium VI	<BG	<BG	<BG	<BG				
Chromium Total	Q<1	Q<5	Q<1	No SLV[a]				
Copper	**X**	**X**	**X**	**X**				
Iron	**X**	**X**	No SLV[a]	No SLV[a]	**X**	**X**		
Mercury	**X**	**X**	Q<1	Q<1				
Manganese	Q<1	Q<5	Q<1	Q<1				
Nickel	Q<1	Q<5	Q<1	Q<1				
Lead	**X**	Q<5	Q<1	Q<1				
Antimony	**X**	No SLV[a]	No SLV[a]	Q<1				
Selenium	**X**	Q<5	**X**	Q<1			**X**	
Thallium	**X**	No SLV[a]	No SLV[a]	**X**				
Vanadium	**X**	No SLV[a]	**X**	**X**				
Zinc	Q<1	Q<5	Q<1	Q<1				
Cyanide	<5%	<5%	<5%	<5%				

Notes:

[a]Retained because of the lack of an SLV; may or may not present an ecological risk.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

Q<1, Q<5 = Screened out because risk ratio below acceptable level

SLV = Screening level value

X = Retained as CPEC

<BG = Screened out because MDC below background level

<5% = Screened out because not detected in more than 5% of the samples

TABLE 14
Surface Water Contaminants of Potential Ecological Concern
Rainy Mine and Millsite

CPEC	Risk from Single COI			Risk from Multiple COIs		
	Aquatic Life	Bird	Mammal	Aquatic Life	Bird	Mammal
Silver	Q<1	No SLV[a]	No SLV[a]			
Aluminum	**X**	Q<1	Q<1		**X**	**X**
Arsenic III	Q<1	Q<1	Q<1			
Arsenic V	Q<1	No SLV[a]	No SLV[a]			
Arsenic Total	Q<1	No SLV[a]	No SLV[a]			
Barium	**X**	Q<1	Q<1			
Beryllium	<5%	No SLV[a]	<5%			
Cadmium	**X**	Q<1	Q<1	**X**	**X**	
Cobalt	<5%	<5%	<5%			
Chromium III	<5%	<5%	<5%			
Chromium VI	<5%	<5%	<5%			
ChromiumTotal	<5%	<5%	<5%			
Copper	**X**	Q<1	Q<1			
Iron	Essential	Essential	Essential			
Mercury	Q<1	Q<1	Q<1			
Manganese	Q<1	Q<1	Q<1			
Nickel	<5%	<5%	<5%			
Lead	**X**	Q<1	Q<1			
Antimony	<5%	<5%	<5%			
Selenium	<5%	<5%	<5%			
Thallium	<5%	<5%	<5%			
Vanadium	<5%	<5%	<5%			
Zinc	**X**	Q<1	Q<1			

Notes:

[a]Retained because of the lack of an SLV; may or may not present an ecological risk.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

Essential = Screened out because essential nutrient

MDC = Maximum detected concentration

Q<1, Q<5 = Screened out because risk ratio below acceptable level

SLV = Screening level value

X = Retained as CPEC

<BG = Screened out because MDC below background level

<5% = Screened out because not detected in more than 5% of the samples

TABLE 15
Sediment Contaminants of Potential Ecological Concern
Rainy Mine and Millsite

CPEC	Freshwater Sediment Risk	Bioaccumulation Risk
Silver	**X**	No SLV[a]
Aluminum	No SLV[a]	No SLV[a]
Arsenic III	Q<1	Q<1
Arsenic V	No SLV[a]	No SLV[a]
Arsenic Total	**X**	No SLV[a]
Barium	<BG	<BG
Beryllium	No SLV[a]	Q<1
Cadmium	**X**	**X**
Cobalt	No SLV[a]	No SLV[a]
Chromium III	No SLV[a]	No SLV[a]
Chromium VI	No SLV[a]	No SLV[a]
Chromium Total	Q<1	Q<1
Copper	**X**	**X**
Iron	Essential	Essential
Mercury	Q<1	No SLV[a]
Manganese	No SLV[a]	Q<1
Nickel	Q<1	Q<1
Lead	Q<1	Q<1
Antimony	**X**	Q<1
Selenium	No SLV[a]	**X**
Thallium	No SLV[a]	Q<1
Vanadium	No SLV[a]	No SLV[a]
Zinc	Q<1	**X**
Cyanide	<5%	<5%

Notes:

[a]Retained because of the lack of an SLV; may or may not present an ecological risk.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

Essential = Screened out because essential nutrient

MDC = Maximum detected concentration

Q<1, Q<5 = Screened out because risk ratio below acceptable level

SLV = Screening level value

X = Retained as CPEC

<BG = Screened out because MDC below background level

<5% = Screened out because not detected in more than 5% of the samples

TABLE 16
Pore Water Contaminants of Potential Ecological Concern
Rainy Mine and Millsite

CPEC	Aquatic Life	
	Risk from Single COI	Risk from Multiple COIs
Silver	<5%	
Aluminum	**X**	**X**
Arsenic III	Q<1	
Arsenic V	Q<1	
Arsenic Total	Q<1	
Barium	**X**	
Beryllium	<5%	
Cadmium	**X**	
Cobalt	<5%	
Chromium III	<5%	
Chromium VI	<5%	
ChromiumTotal	<5%	
Copper	**X**	
Iron	**X**	
Mercury	Q<1	
Manganese	Q<1	
Nickel	<5%	
Lead	Q<1	
Antimony	<5%	
Selenium	<5%	
Thallium	Q<1	
Vanadium	<5%	
Zinc	**X**	
Cyanide	<5%	

Notes:

1. Retained because of the lack of an SLV; may or may not present an ecological risk.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

Q<1 = Screened out because risk ratio below acceptable level

SLV = Screening level value

X = Retained as CPEC

<5% = Screened out because not detected in more than 5% of the samples

TABLE 17
Multiple Media Contaminants of Potential Ecological Concern
Rainy Mine and Millsite

CPEC	Bird	Mammal
Aluminum	**X**	**X**
Arsenic III	**X**	**X**
Arsenic V	**X**	**X**
Chromium III	**X**	
Copper	**X**	**X**
Selenium	**X**	
Thallium		**X**
Vanadium	**X**	**X**

Notes:
CPEC = Contaminant of potential ecological concern

TABLE 18
Contaminants of Potential Ecological Concern Summary
Rainy Mine and Millsite

CPEC	Media				Mutiple Media
	Mine Waste	Surface Water	Sediment	Pore Water	
Silver	P	No SLV[a]	Fw	--	--
Aluminum	P, I, B, M	Aq, B, M	No SLV[a]	Aq	B, M
Arsenic III	P, B, M	--	--	--	B, M
Arsenic V	P, I, B, M	No SLV[a]	No SLV[a]	--	B, M
Arsenic Total	No SLV[a]	No SLV[a]	Fw	--	--
Barium	--	Aq	--	Aq	--
Beryllium	No SLV[a]	No SLV[a]	No SLV[a]		--
Cadmium	--	Aq	Fw, Bio	Aq	--
Cobalt	No SLV[a]	--	No SLV[a]	--	--
Chromium III	P, I, B	--	--	--	B
Chromium VI	--	--	No SLV[a]	--	--
Chromium Total	No SLV[a]	--	--	--	--
Copper	P, I, B, M	Aq, B	Fw, Bio	Aq	--
Iron	P, I	--	--	Aq	B, M
Mercury	P, I	--	No SLV[a]	--	--
Lead	P	Aq	--	Aq	--
Antimony	P	--	Fw	--	--
Selenium	P, B	--	Bio	--	B
Thallium	P, M	--	No SLV[a]	--	M
Vanadium	P, B, M	--	No SLV[a]	--	B, M
Zinc	--	Aq	Bio	Aq	--

Notes:

[a]Retained because of the lack of an SLV; may or may not present an ecological risk.

-- = Screened out

Aq = Aquatic life

B = Bird

Bio = Bioaccumulation risk

CPEC = Contaminant of potential ecological concern

Fw = Freshwater risk

I = Invertebrate

M = Mammal

P = Plant

SLV = Screening level value

TABLE 19
Ecological Risk Ratio Summary
Rainy Mine and Millsite

CPEC	Mine Waste				Surface Water			Sediment		Pore Water
	Plant	Invertebrate	Bird	Mammal	Bird	Mammal	Aquatic Life	Freshwater	Bio-accumulation	Aquatic Life
Silver	**21**	<5	NS	NS	NS	NS	<1	**17**	NS	-
Aluminum	**524**	**44**	**58**	**245**	<1	<1	**33**	NS	NS	**11000**
Arsenic III	**3**	<5	**3**	**4**	<1	<1	<1	<1	<1	<1
Arsenic V	**1577**	**263**	**119**	**119**	NS	NS	<1	NS	NS	<1
Arsenic Total	NS	NS	NS	NS	NS	NS	<1	**10**	NS	<1
Barium	<1	<5	<1	<1	<1	<1	**2**	-	-	**4**
Beryllium	<1	NS	NS	<1	NS	<1	<1	NS	NS	-
Cadmium	<1	<5	<1	<1	<1	<1	**3**	**2**	**320**	**2**
Cobalt	<1	<5	NS	<1	-	-	-	NS	NS	-
Chromium III	**11**	**28**	**3**	<1	-	-	-	NS	NS	-
Chromum VI	**-**	**-**	**-**	-	-	-	-	NS	NS	-
Chromium Total	<1	<5	<1	NS	-	-	-	<1	<1	-
Copper	**20**	**39**	**9**	**5**	<1	<1	**1084**	**42**	**335**	**220**
Iron	**10000**	**500**	NS	NS	-	-	-	-	-	**9**
Mercury	**4**	**11**	<1	<1	<1	<1	<1	<1	NS	<1
Manganese	<1	<5	<1	<1	<1	<1	<1	-	-	<1
Nickel	<1	<5	<1	<1	-	-	-	<1	<1	-
Lead	**2**	<5	<1	<1	<1	<1	**2**	<1	<1	<1
Antimony	**1**	NS	NS	<1	-	-	-	**2**	**<1**	-
Selenium	**11**	<5	**37**	<1	-	-	-	NS	**70**	-
Thallium	**2**	NS	NS	**2**	-	-	-	NS	<1	<1
Vanadium	**34**	NS	**1**	**3**	-	-	-	NS	NS	-
Zinc	<1	<5	<1	<1	<1	<1	**4**	<1	**27**	**4**

Notes:
CPEC = Contaminant of potential ecological concern
NS = No screening level value
- = Not calculated because not a CPEC for this media

APPENDIX A

HUMAN HEALTH RISK CALCULATION TABLES

TABLE A.1
Human Health Exposure Pathways and Receptors
Rainy Mine and Millsite

Scenario Timeframe	Media	Exposure Media	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-site/ Off-site	Type of Analysis	Rationale for Selection or Exlusion of Exposure Pathway
Current	Soil	Soil	Mine Waste	Recreationalist	Adult Child	Ingestion Dermal Inhalation	On-Site	Quantitative	Current (Baseline)
	Sediment	Sediment	Adit Discharge, seeps, and Quartz Creek	Recreationalist	Adult Child	Ingestion Dermal	On-Site	Quantitative	Current (Baseline)
	Surface Water	Surface Water	Adit Discharge, seeps, and Quartz Creek	Recreationalist	Adult Child	Ingestion Dermal	On-Site	Quantitative	Current (Baseline)

TABLE A.2
Human Health Contaminant of Potential Concern Screening
Rainy Mine and Millsite

		Mine Waste Screening											Surface Water Screening											Sediment Screening											Multimedia	
Metal	Essential Nutrient?	Detect Freq	Detect Freq > 5% Retain as COPC?	MDC (C_{ij})	Avg BG Conc	MDC>BG Retain as COPC?	Soil Screening Criteria[b] (PRG_{ij})	Units	R_{ij} (C_{ij}/PRG_j)	MDC>PRG Retain as COPC?	R_{ij}/R_j	Multi COI Retain as COPC?	Detect Freq	Detect Freq > 5% Retain as COPC?	MDC (C_{ij})	Avg BG Conc	MDC>BG Retain as COPC?	Drinking Water Screening Criteria[c] (PRG_{ij})	Units	R_{ij} (C_{ij}/PRG_j)	MDC>PRG Retain as COPC?	R_{ij}/R_j	Multi COI Retain as COPC?	Detect Freq	Detect Freq > 5% Retain as COPC?	MDC (C_{ij})	MDC BG Conc	MDC>BG Retain as COPC?	Soil Screening Criteria[b] (PRG_{ij})	Units	R_{ij} (C_{ij}/PRG_j)	MDC>PRG Retain as COPC?	R_{ij}/R_j	Multi COI Retain as COPC?	Sum R_{ij}	Multi media Retain as COPC?
Aluminum	No	100%	**Yes**	26200	12783	**Yes**	1.0E+05	mg/kg	2.62E-01	No	2.65E-05	No	100%	**Yes**	2890	85	**Yes**	36000	ug/L	8.03E-02	No	6.24E-05	No	100%	**Yes**	44200	6950	**Yes**	1.0E+05	mg/kg	4.42E-01	No	3.38E-03	No	7.84E-01	No
Antimony	No	89%	**Yes**	5.3	2.1	**Yes**	4.1E+02	mg/kg	1.29E-02	No	1.31E-06	No	0%	No	0.1	0.1	No	6	ug/L	1.67E-02	No	1.29E-05	No	38%	**Yes**	1.0	0.1	**Yes**	4.1E+02	mg/kg	2.44E-03	No	1.87E-05	No	3.20E-02	No
Arsenic$_3$	No	89%	**Yes**	28.1	3.3	**Yes**							90%	**Yes**	5.43	0.12	**Yes**							100%	**Yes**	3.342	0.161	**Yes**	0.0E+00							
Arsenic$_5$	No	100%	**Yes**	15772	1890	**Yes**							70%	**Yes**	52.3	0.46	**Yes**							100%	**Yes**	201.7	9.3	**Yes**	0.0E+00							
Arsenic$_{Tot}$	No	100%	**Yes**	15800	1893.3	**Yes**	1.6E+00	mg/kg	9.88E+03	**Yes**	1.00E+00	**Yes**	70%	**Yes**	57.7	0.7	**Yes**	0.045	ug/L	1.28E+03	**Yes**	9.96E-01	**Yes**	100%	**Yes**	205	9.5	**Yes**	1.6E+00	mg/kg	1.28E+02	**Yes**	9.80E-01	**Yes**	1.13E+04	**Yes**
Barium	No	100%	**Yes**	70	42	**Yes**	6.7E+04	mg/kg	1.04E-03	No	1.06E-07	No	30%	**Yes**	14	1.5	**Yes**	2000	ug/L	7.00E-03	No	5.44E-06	No	100%	**Yes**	66.3	66.8	No	6.7E+04	mg/kg	9.90E-04	No	7.57E-06	No	9.03E-03	No
Beryllium	No	11%	**Yes**	0.5	0.3	**Yes**	1.9E+03	mg/kg	2.63E-04	No	2.66E-08	No	0%	No	1	1	No	4	ug/L	2.50E-01	No	1.94E-04	No	13%	**Yes**	0.6	0.1	**Yes**	1.9E+03	mg/kg	3.16E-04	No	2.42E-06	No	2.51E-01	No
Cadmium	No	100%	**Yes**	0.61	0.29	**Yes**	2.0E+00	mg/kg	3.05E-01	No	3.09E-05	No	20%	**Yes**	0.7	0.05	**Yes**	5	ug/L	1.40E-01	No	1.09E-04	No	100%	**Yes**	1.27	0.39	**Yes**	2.0E+00	mg/kg	6.35E-01	No	4.86E-03	No	1.08E+00	**Yes**
Calcium	**Yes**	100%	**Yes**	3000	1199	**Yes**				No[b]		No	100%	**Yes**	7800	1250	**Yes**				No[a]			100%	**Yes**	3210	960	**Yes**	0.0E+00			No[a]			0.00	No[a]
Chromium$_3$	No	100%	**Yes**	11.2	6	**Yes**	2.0E+03	mg/kg	5.60E-03	No	5.67E-07	No	0%	No	5	5	No	55000	ug/L	9.09E-05	No	7.06E-08	No	100%	**Yes**	9.9	5	**Yes**	2.0E+03	mg/kg	4.95E-03	No	3.79E-05	No	1.06E-02	No
Chromium$_6$	No	11%	**Yes**	0.98	0.53	**Yes**	1.9E+01	mg/kg	5.17E-02	No	5.24E-06	No	0%	No	0.5	0.3	**Yes**	110	ug/L	4.55E-03	No	3.53E-06	No	100%	**Yes**	2.573	0.955	**Yes**	1.9E+01	mg/kg	1.35E-01	No	1.04E-03	No	1.92E-01	No
Chromium$_{tot}$	No	100%	**Yes**	12	6.9	**Yes**	1.9E+01	mg/kg	6.32E-01	No	6.39E-05	No	0%	No	5	5	No	100	ug/L	5.00E-02	No	3.88E-05	No	100%	**Yes**	11	6	**Yes**	1.9E+01	mg/kg	5.79E-01	No	4.43E-03	No	1.26E+00	**Yes**
Cobalt	No	67%	**Yes**	10	3.6	**Yes**	1.9E+03	mg/kg	5.26E-03	No	5.33E-07	No	0%	No	5	5	No	730	ug/L	6.85E-03	No	5.32E-06	No	100%	**Yes**	8	4	**Yes**	1.9E+03	mg/kg	4.21E-03	No	3.22E-05	No	1.63E-02	No
Copper	No	100%	**Yes**	1970	1378	**Yes**	4.1E+04	mg/kg	4.80E-02	No	4.86E-06	No	50%	**Yes**	2020	0.25	**Yes**	1300	ug/L	1.55E+00	**Yes**	1.21E-03	No	100%	**Yes**	4410	18	**Yes**	4.1E+04	mg/kg	1.08E-01	No	8.23E-04	No	1.71E+00	**Yes**
Iron	**Yes**	100%	**Yes**	100000	53433	**Yes**	1.0E+05	mg/kg	1.00E+00	No	1.01E-04	No	60%	**Yes**	580	13	**Yes**	300	ug/L	1.93E+00	No[d]	1.50E-03	No	100%	**Yes**	49700	10600	**Yes**	1.0E+05	mg/kg	4.97E-01	No	3.80E-03	No	3.43E+00	**Yes**
Lead	No	100%	**Yes**	79.6	25	**Yes**	8.0E+02	mg/kg	9.95E-02	No	1.01E-05	No	10%	**Yes**	0.5	0.05	**Yes**	15	ug/L	3.33E-02	No	2.59E-05	No	100%	**Yes**	31.2	4.78	**Yes**	8.0E+02	mg/kg	3.90E-02	No	2.98E-04	No	1.72E-01	No
Magnesium	**Yes**	100%	**Yes**	9500	3776	**Yes**				No[b]		No	30%	**Yes**	600	100	**Yes**				No[a]			100%	**Yes**	5100	2770	**Yes**	0.0E+00			No[a]			0.00E+00	No[a]
Manganese	No	100%	**Yes**	363	172	**Yes**	1.9E+04	mg/kg	1.91E-02	No	1.93E-06	No	20%	**Yes**	54	2.5	**Yes**	50	ug/L	1.08E+00	No[d]	8.39E-04	No	100%	**Yes**	198	181	**Yes**	1.9E+04	mg/kg	1.04E-02	No	7.97E-05	No	1.11E+00	**Yes**
Mercury	No	89%	**Yes**	1.08	5.87	No	2.0E+00	mg/kg	5.40E-01	No	5.47E-05	No	100%	**Yes**	0.00091	0.00089	**Yes**	2	ug/L	4.55E-04	No	3.53E-07	No	13%	**Yes**	0.19	0.02	**Yes**	2.0E+00	mg/kg	9.50E-02	No	7.27E-04	No	6.35E-01	No
Nickel	No	89%	**Yes**	12	5.9	**Yes**	2.0E+04	mg/kg	6.00E-04	No	6.07E-08	No	0%	No	5	5	No	100	ug/L	5.00E-02	No	3.88E-05	No	100%	**Yes**	7	2.7	**Yes**	2.0E+04	mg/kg	3.50E-04	No	2.68E-06	No	5.10E-02	No
Potassium	**Yes**	100%	**Yes**	4160	1428	**Yes**				No[b]		No	40%	**Yes**	600	225	**Yes**				No[a]			100%	**Yes**	1420	1670	No	0.0E+00			No[a]			0.00E+00	No[a]
Selenium	No	100%	**Yes**	11.1	5.4	**Yes**	5.1E+03	mg/kg	2.18E-03	No	2.20E-07	No	0%	No	1	1	No	180	ug/L	5.56E-03	No	4.31E-06	No	25%	**Yes**	7	0.3	**Yes**	5.1E+03	mg/kg	1.37E-03	No	1.05E-05	No	9.10E-03	No
Silver	No	100%	**Yes**	41.3	21.6	**Yes**	5.1E+03	mg/kg	8.10E-03	No	8.20E-07	No	10%	**Yes**	0.16	0.025	**Yes**	100	ug/L	1.60E-03	No	1.24E-06	No	100%	**Yes**	33.9	0.04	**Yes**	5.1E+03	mg/kg	6.65E-03	No	5.08E-05	No	1.63E-02	No
Sodium	**Yes**	100%	**Yes**	1860	470	**Yes**				No[b]		No	90%	**Yes**	3500	525	**Yes**				No[a]			100%	**Yes**	320	130	**Yes**	0.0E+00			No[a]			0.00E+00	No[a]
Thallium	No	78%	**Yes**	1.5	0.3	**Yes**	6.7E+01	mg/kg	2.24E-02	No	2.27E-06	No	0%	No	0.025	0.025	No	2	ug/L	1.25E-02	No	9.71E-06	No	100%	**Yes**	0.23	0.11	**Yes**	6.7E+01	mg/kg	3.43E-03	No	2.63E-05	No	3.83E-02	No
Vanadium	No	100%	**Yes**	67	32.5	**Yes**	1.0E+03	mg/kg	6.70E-02	No	6.78E-06	No	0%	No	2.5	2.5	No	36	ug/L	6.94E-02	No	5.39E-05	No	100%	**Yes**	50.2	23.9	**Yes**	1.0E+03	mg/kg	5.02E-02	No	3.84E-04	No	1.87E-01	No
Zinc	No	89%	**Yes**	69	48	**Yes**	1.0E+05	mg/kg	6.90E-04	No	6.99E-08	No	20%	**Yes**	60	5	**Yes**	11000	ug/L	5.45E-03	No	4.24E-06	No	100%	**Yes**	90	31	**Yes**	1.0E+05	mg/kg	9.00E-04	No	6.88E-06	No	7.04E-03	No
Cyanide	No	0%	No	0.35	0.32	**Yes**	1.2E+04	mg/kg	2.92E-05	No	2.95E-09	No										0.00E+00		0%	No	2.0	0.3	**Yes**	1.2E+04	mg/kg	1.67E-04	No	1.27E-06	No	1.96E-04	No
								R_j =	9878										**R_j =**	1288										**R_j =**	131					
								N_{ij} =	22										**N_{ij} =**	21										**N_{ij} =**	22					
								$1/N_{ij}$ =	0.05										**$1/N_{ij}$ =**	0.05										**$1/N_{ij}$ =**	0.045					

Notes:

[a]Lower of EPA Region 9 Industrial Soil PRGs (EPA 2004a) and Washington MTCA Method A Industrial Soil Cleanup Levels (WDOE 2001b).

[b]Essential nutrient

[c]Lower of EPA Region 9 Tapwater PRGs (EPA 2004a) and Washington Drinking Water Quality Criteria, WAC 246-290-310 (WSDH 2006).

[d]Secondary contaminant that is generally limited to cosmetic or aesthetic effects, such as taste, odor, color, skin discoloration.

BG = Background

COI = Contaminant of interest

Conc = Concentration

COPC = Contaminant of potential concern

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

PRG = Preliminary remedation goal

mg/kg = Milligram per kilogram

ug/L = Microgram per liter

Analyzed for but not detected; value = 1/2 reporting limit.

Detected at concentration between the method detection limit and practical quantitation limt; value = reported concentration.

TABLE A.3
Exposure Factors
Rainy Mine and Millsite

Medium	Exposure Route	Parameter Code	Parameter Definition	Units	Adult Recreationalist			Child Recreationalist		
					RME Value	CTE Value	Reference	RME Value	CTE Value	Reference
All	All	BW	Body Weight	kg	70	70	EPA 1997a	15	15	EPA 1997a
		AT-C	Averaging Time (Cancer)	day	25,550	25,550	EPA 1989	25,550	25,550	EPA 1997a
		AT-N	Averaging Time (Non-Cancer)	day	10,950	3,285	365 x ED	2,190	2,190	365 x ED
		CF1	Conversion Factor	1 kg/mg	1E-06	1E-06		1E-06	1E-06	
		CF2	Conversion Factor	L/cm^3	1E-03	1E-03		1E-03	1E-03	
Mine Waste	Ingestion	IR-S	Incidental Ingestion Rate of Soil	mg/day	100	50	EPA 1997a	600	200	EPA 1997a, (1)
		EF	Exposure Frequency	day/year	14	7	(1)	14	7	(1)
		ED	Exposure Duration	years	30	9	(1)	6	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	6,900	5,200	EPA 2004	5,000	4,500	EPA 2004
		DAF	Dermal Absorption Factor	--	CS	CS	EPA 2004	CS	CS	EPA 2004
		SSAF	Soil to Skin Adherence Factor	mg/cm^2-day	0.08	0.08	EPA 2004	1.00	0.3	EPA 2004
	Inhalation	IN	Inhalation Rate	m^3/day	15.2	15.2	EPA 1997a	8.3	8.3	EPA 1997a
		PEF	Particulate Emission Factor	m^3/kg	1.31E+09	1.31E+09	EPA 2000	1.31E+09	1.31E+09	EPA 2004
Sediment	Ingestion	IR-S	Incidental Ingestion Rate of Sediment	mg/day	50	25	EPA 1997a	200	50	EPA 1997a
		EF	Exposure Frequency	day/year	14	7	(1)	14	7	(1)
		ED	Exposure Duration	years	30	9	(1)	6	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	5,700	5,700	EPA 2004	2,800	2,800	EPA 2004
		DAF	Dermal Absorption Factor[a]	unitless	CS	CS	EPA 2004	CS	CS	EPA 2004
		SSAF	Soil to Skin Adherence Factor	mg/cm^2/day	0.07	0.01	EPA 2004	0.20	0.04	EPA 2004
Surface Water	Ingestion	IR-W	Ingestion Rate of Surface Water	L/day	2.3	1.3	EPA 1997a	1.3	0.66	EPA 1997a
		EF	Exposure Frequency	day/year	14	7	(1)	14	7	(1)
		ED	Exposure Duration	years	30	9	(1)	6	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	18,000	18,000	EPA 2004	6,000	6,000	EPA 2004
		KP	Permeability Coefficient	cm/hr	CS	CS	EPA 2004	CS	CS	EPA 2004
		EVF	Event Frequency	event/day	1	1		1	1	Site specific
		ET	Exposure Time	hr/day	2	2	EPA 1997a	2	2	EPA 1997a

Notes:

(1) Site-specific assumed value

EPA 1997a "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -Fb, -Fc. August.

EPA 2004a "Region 9 Preliminary Remediation Goals (PRGs) Table." November 2004. On-line address: http://www.epa.gov/region9/waste/sfund/prg/whatsnew.htm.

EPA 2004b "Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment." Volume I: Human Heath Evaluation Manual. Final. Office of Superfund Remediation and Technology Innovation. July.

CTE = Central tendency exposure
RME = Reasonable maximum exposure
cm/hr = Centimeter per hour
cm^2 = Square centimeter
hr/day = Hour per day
kg/gm = Kilogram per milligram
L/day = Liter per day
L/cm^3 = Liter per cubic centimeter
mg/cm^2-day = Milligram per square centimeter per day
mg/day = Milligram per day
m^3/day = Cubic meter per day
m^3/kg = Cubic meter per kilogram

TABLE A.4
Exposure Point Concentrations
Rainy Mine and Millsite

Contaminant of Potential Concern	Media	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Units	REASONABLE MAXIMUM EXPOSURE			CENTRAL TENDENCY EXPOSURE		
						Media EPC Value	Media EPC Statistic	Media EPC Rationale	Media EPC Value	Media EPC Statistic	Media EPC Rationale
$Arsenic_{Tot}$	Mine Waste	1,893	19,192	15,800	mg/kg	15,800	99% Chebyshev mean	UCL > MDC	1,893	Mean	RAGS
	Surface Water	0.013	0.072	0.058	mg/L	0.058	Student's t UCL	Normal distribution	0.013	Mean	RAGS
	Sediment	87	398	205	mg/kg	205	Appx. Gamma UCL	UCL > MDC	87	Mean	RAGS
Cadmium	Mine Waste	0.29	0.38	0.61	mg/kg	0.38	Student's t UCL	Normal distribution	0.29	Mean	RAGS
	Surface Water	0.0002	0.0012	0.0007	mg/L	0.0007	99% Chebyshev mean	UCL > MDC	0.0002	Mean	RAGS
	Sediment	0.50	0.96	1.27	mg/kg	0.96	Student's t UCL	Normal distribution	0.50	Mean	RAGS
$Chromium_{TOT}$	Mine Waste	6.9	8.7	12.0	mg/kg	8.70	Student's t UCL	Normal distribution	6.89	Mean	RAGS
	Surface Water	0.005	0.005	0.005	mg/L	0.005	No detected results	All results below detection limit	0.005	Mean	RAGS
	Sediment	7.0	10.6	11.0	mg/kg	10.6	Student's t UCL	Normal distribution	7.0	Mean	RAGS
Copper	Mine Waste	1,378	1,575	1,970	mg/kg	1,575	Student's t UCL	Normal distribution	1,378	Mean	RAGS
	Surface Water	0.5	10.1	2.0	mg/L	2.0	Appx. Gamma UCL	UCL > MDC	0.45	Mean	RAGS
	Sediment	1,446	3,346	4,410	mg/kg	3,346	Student's t UCL	Normal distribution	1,446	Mean	RAGS
Iron	Mine Waste	53,433	71,254	100,000	mg/kg	71,254	Student's t UCL	Normal distribution	53,433	Mean	RAGS
	Surface Water	0.13	1.33	0.58	mg/L	0.58	Appx. Gamma UCL	Gamma distribution	0.13	Mean	RAGS
	Sediment	20,078	36,924	49,700	mg/kg	36,924	Student's t UCL	Normal distribution	20,078	Mean	RAGS
Manganese	Mine Waste	172	218	363	mg/kg	218	Student's t UCL	Normal distribution	172	Mean	RAGS
	Surface Water	0.02	0.11	0.05	mg/L	0.05	99% Chebyshev mean	Non-parametric distribution	0.02	Mean	RAGS
	Sediment	167	191	198	mg/kg	191	Student's t UCL	Normal distribution	167	Mean	RAGS

Notes:

EPC = Exposure point concentration

RAGS = U.S. Environmental Protection Agency (EPA), 1991. "Risk Assessment Guidance for Superfund (RAGS): Volume 1, Human Health Evaluation Manual" (Part A), No. 9285.701A. Office of Solid Waste and Emergency Response, Washington, DC.

UCL = Upper confidence level

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

Analyzed for but not detected; value = 1/2 reporting limit.

Detected at concentration between the method detection limit and practical quantitation limt; value = reported concentration.

TABLE A.5
Non-carcinogenic COPC Toxicity Values
Rainy Mine and Millsite

Contaminant of Potential Concern	CAS Number	Chronic RfD (mg/kg-d)			Dermal Absorption Factor	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Data Source
		Oral	Dermal	Inhalation				
Arsenic	7440382	3.00E-04	1.23E-04	NA	0.03	Skin, Nervous System, Cardiovascular System	3/1	IRIS/RAIS
$Cadmium_{diet}$	7740439	1.00E-03	1.00E-05	NA	0.001	Kidneys	10/1	IRIS/RAIS
$Cadmium_{water}$	7740439	5.00E-04	5.00E-06	NA	0.001	Kidneys	10/1	IRIS/RAIS
Chromium	7440473	1.50E+00	NA	2.86E-05	0.001	GI Tract, Kidneys, Liver, Skin	100/10	IRIS/RAIS
Copper	7440508	3.70E-02	1.20E-02	NA	0.001	Central Nervous System	1/1	IRIS/RAIS
Iron	7439896	3.00E-01	NA	NA	0.001	Liver, Kidneys	--/--	RAIS
$Manganese_{diet}$	7439965	4.60E-02	5.60E-03	1.43E-05	0.001	Central Nervous System	1/3	IRIS/RAIS
$Manganese_{water}$	7439965	4.60E-02	1.84E-03	1.43E-05	0.001	Central Nervous System	1/3	IRIS/RAIS

Notes:
COPC = Contaminant of potential concern
IRIS = Integrated Risk Information System
NA = Not available
RAIS = Risk Assessment Information System
RfD = Reference dose
mg/kg-d = Milligram per kilogram per day

TABLE A.6
Carcinogenic COPC Toxicity Values
Rainy Mine and Millsite

Contaminant of Potential Concern	CAS Number	Slope Factor (mg/kg-day)$^{-1}$			Type of Cancer	Weight of Evidence/Cancer Guideline Description	Data Source
		Oral	Dermal	Inhalation			
Arsenic	7440382	1.50E+00	3.66E+00	1.51E+01	Skin, lung	A	IRIS
Cadmium	7440439			6.30E+00	Lung	B1	IRIS
Chromium	7440473			2.94E+02	Lung	A	IRIS

Notes:
A = Known human carcinogen
B1 = Probable human carcinogen
IRIS = Integrated Risk Information System
mg/kg-day = Milligram per kilogram per day

TABLE A.7a
Non-carcinogenic Hazards - Adult Recreationalist
Rainy Mine and Millsite

					CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
		Chronic Reference Dose (mg/kg-day)			CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			CTE Total Hazard	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			RME Total Hazard
Media	COPC	Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	3E-04	1E-04	NA	1893	3E-05	6E-06	6E-09	9E-02	5E-02		1.4E-01	15800	9E-04	1E-04	1E-07	3E+00	1E+00		4E+00
	Cd_d	1E-03	1E-05	NA	0.29	4E-09	3E-11	9E-13	4E-06	3E-06		7.3E-06	0.38	2E-08	1E-10	2E-12	2E-05	1E-05		3E-05
	Cr	2E+00	NA	3E-05	6.9	9E-08	8E-10	2E-11	6E-08		8E-07	8.3E-07	8.7	5E-07	3E-09	6E-11	3E-07		2E-06	2E-06
	Cu	4E-02	1E-02	NA	1378	2E-05	2E-07	4E-09	5E-04	1E-05		5.2E-04	1575	9E-05	5E-07	1E-08	2E-03	4E-05		2E-03
	Fe	3E-01	NA	NA	53433	7E-04	6E-06	2E-07	2E-03			2.4E-03	71254	4E-03	2E-05	5E-07	1E-02			1E-02
	Mn_d	5E-02	6E-03	1E-05	172	2E-06	2E-08	5E-10	5E-05	4E-06	4E-05	9.3E-05	218	1E-05	7E-08	1E-09	3E-04	1E-05	1E-04	4E-04
								Mine Waste CTE Subtotal =	**8.9E-02**	**5.3E-02**	**3.9E-05**	**1.4E-01**				**Mine Waste RME Subtotal =**	**3E+00**	**1E+00**	**1E-04**	**4E+00**
Sediment	As	3E-04	1E-04	NA	87	6E-07	4E-08		2E-03	3E-04		2E-03	205	6E-06	1E-06		2E-02	1E-02		3E-02
	Cd_d	1E-03	1E-05	NA	0.50	3E-09	8E-12		3E-06	8E-07		4E-06	0.96	3E-08	2E-10		3E-05	2E-05		5E-05
	Cr	2E+00	NA	3E-05	7.0	5E-08	1E-10		3E-08			3E-08	10.6	3E-07	2E-09		2E-07			2E-07
	Cu	4E-02	1E-02	NA	1446	1E-05	2E-08		3E-04	2E-06		3E-04	3346	9E-05	7E-07		2E-03	6E-05		3E-03
	Fe	3E-01	NA	NA	20078	1E-04	3E-07		5E-04			5E-04	36924	1E-03	8E-06		3E-03			3E-03
	Mn_d	5E-02	6E-03	1E-05	167	1E-06	3E-09		2E-05	5E-07		3E-05	191	5E-06	4E-08		1E-04	7E-06		1E-04
								Sediment CTE Subtotal =	**2.7E-03**	**3.3E-04**		**3.1E-03**				**Sediment RME Subtotal =**	**2E-02**	**1E-02**		**4E-02**
Surface Water	As	3E-04	1E-04	NA	0.013	5E-06	1E-07		2E-02	1E-03		2E-02	0.1	7E-05	1E-06		2E-01	9E-03		3E-01
	Cd_w	5E-04	5E-06	NA	0.0002	7E-08	2E-09		1E-04	4E-04		5E-04	0.001	9E-07	1E-08		2E-03	3E-03		5E-03
	Cr	2E+00	NA	3E-05	0.005	2E-06	1E-07		1E-06			1E-06	0.01	6E-06	2E-07		4E-06			4E-06
	Cu	4E-02	1E-02	NA	0.5	2E-04	4E-06		4E-03	4E-04		5E-03	2.0	3E-03	4E-05		7E-02	3E-03		7E-02
	Fe	3E-01	NA	NA	0.13	5E-05	1E-06		2E-04			2E-04	0.58	7E-04	1E-05		2E-03			2E-03
	Mn_w	5E-02	2E-03	1E-05	0.02	6E-06	2E-07		1E-04	9E-05		2E-04	0.05	7E-05	1E-06		1E-03	6E-04		2E-03
								Surface Water CTE Subtotal =	**2E-02**	**2E-03**		**2E-02**				**Surface Water RME Subtotal =**	**3E-01**	**2E-02**		**3E-01**
								Total CTE Non-carcinogenic Hazard =	**1E-01**	**5E-02**	**4E-05**	**2E-01**				**Total RME Non-carcinogenic Hazard =**	**3E+00**	**1E+00**	**1E-04**	**4E+00**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.7b
Non-carcinogenic Hazards - Child Recreationalist
Rainy Mine and Millsite

					CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
		Chronic Reference Dose (mg/kg-day)			CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			CTE Total Hazard	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			RME Total Hazard
Media	COPC	Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	3E-04	1E-04	NA	1893	5E-04	1E-04	2E-08	2E+00	8E-01		2E+00	15800	2E-02	6E-03	3E-07	8E+01	5E+01		1E+02
	Cd_d	1E-03	1E-05	NA	0.29	7E-08	5E-10	2E-12	7E-05	5E-05		1E-04	0.38	6E-07	5E-09	6E-12	6E-04	5E-04		1E-03
	Cr	2E+00	NA	3E-05	6.9	2E-06	1E-08	6E-11	1E-06		2E-06	3E-06	8.7	1E-05	1E-07	1E-10	9E-06		5E-06	1E-05
	Cu	4E-02	1E-02	NA	1378	4E-04	2E-06	1E-08	1E-02	2E-04		1E-02	1575	2E-03	2E-05	3E-08	7E-02	2E-03		7E-02
	Fe	3E-01	NA	NA	53433	1E-02	9E-05	4E-07	5E-02			5E-02	71254	1E-01	9E-04	1E-06	4E-01			4E-01
	Mn_d	5E-02	6E-03	1E-05	172	4E-05	3E-07	1E-09	1E-03	5E-05	1E-04	1E-03	218	3E-04	3E-06	4E-09	7E-03	5E-04	2E-04	8E-03
								Mine Waste CTE Subtotal =	**2E+00**	**8E-01**	**1E-04**	**2E+00**					**Mine Waste RME Subtotal =**	**8E+01**	**5E+01**	**3E-04**	**1E+02**
Sediment	As	3E-04	1E-04	NA	87	6E-06	4E-07		2E-02	3E-03		2E-02	205	1E-04	9E-06		3E-01	7E-02		4E-01
	Cd_d	1E-03	1E-05	NA	0.50	3E-08	7E-11		3E-05	7E-06		4E-05	0.96	5E-07	1E-09		5E-04	1E-04		6E-04
	Cr	2E+00	NA	3E-05	7.0	4E-07	1E-09		3E-07			3E-07	10.6	5E-06	2E-08		4E-06			4E-06
	Cu	4E-02	1E-02	NA	1446	9E-05	2E-07		2E-03	2E-05		3E-03	3346	2E-03	5E-06		5E-02	4E-04		5E-02
	Fe	3E-01	NA	NA	20078	1E-03	3E-06		4E-03			4E-03	36924	2E-02	5E-05		6E-02			6E-02
	Mn_d	5E-02	6E-03	1E-05	167	1E-05	2E-08		2E-04	4E-06		2E-04	191	1E-04	3E-07		2E-03	5E-05		2E-03
								Sediment CTE Subtotal =	**3E-02**	**3E-03**		**3E-02**					**Sediment RME Subtotal =**	**5E-01**	**7E-02**		**5E-01**
Surface Water	As	3E-04	1E-04	NA	0.01	1E-05	2E-07		4E-02	2E-03		4E-02	0.1	2E-04	2E-06		6E-01	1E-02		7E-01
	Cd_w	5E-04	5E-06	NA	0.0002	2E-07	3E-09		3E-04	6E-04		9E-04	0.001	2E-06	2E-08		5E-03	4E-03		9E-03
	Cr	2E+00	NA	3E-05	0.005	4E-06	2E-07		3E-06			3E-06	0.01	2E-05	3E-07		1E-05			1E-05
	Cu	4E-02	1E-02	NA	0.5	4E-04	7E-06		1E-02	6E-04		1E-02	2.0	7E-03	6E-05		2E-01	5E-03		2E-01
	Fe	3E-01	NA	NA	0.13	1E-04	2E-06		4E-04			4E-04	0.58	2E-03	2E-05		6E-03			6E-03
	Mn_w	5E-02	2E-03	1E-05	0.02	1E-05	3E-07		3E-04	1E-04		4E-04	0.05	2E-04	2E-06		4E-03	9E-04		5E-03
								Surface Water CTE Subtotal =	**5E-02**	**3E-03**		**5E-02**					**Surface Water RME Subtotal =**	**8E-01**	**2E-02**		**9E-01**
								Total CTE Non-carcinogenic Hazard =	**2E+00**	**8E-01**	**1E-04**	**3E+00**					**Total RME Non-carcinogenic Hazard =**	**8E+01**	**5E+01**	**3E-04**	**1E+02**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.8a
Carcinogenic Risks - Adult Recreationalist
Rainy Mine and Millsite

Media	COPC	Cancer Slope Factor (mg/kg-day)$^{-1}$			CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
					CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			CTE Total Risk	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			RME Total Risk
		Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	1.5E+00	3.7E+00	1.5E+01	1893	3E-06	8E-07	8E-10	5E-06	3E-06	1E-08	8E-06	15800	4E-04	6E-05	4E-08	6E-04	2E-04	7E-07	8E-04
	Cd_d			6.3E+00	0.29	5E-10	4E-12	1E-13			7E-13	7E-13	0.38	9E-09	5E-11	1E-12			7E-12	7E-12
	Cr_{VI}			2.9E+02	6.9	1E-08	1E-10	3E-12			8E-10	8E-10	8.7	2E-07	1E-09	2E-11			7E-09	7E-09
								Mine Waste CTE Subtotal =	**5E-06**	**3E-06**	**1E-08**	**8E-06**				**Mine Waste RME Subtotal =**	**6E-04**	**2E-04**	**7E-07**	**8E-04**
Sediment	As	1.5E+00	3.7E+00		87	8E-08	5E-09		1E-07	2E-08		1E-07	205	2E-06	6E-07		4E-06	2E-06		6E-06
	Cd_d				0.50	4E-10	1E-12						0.96	1E-08	9E-11					
	Cr_{VI}				7.0	6E-09	1E-11						10.6	1E-07	1E-09					
								Sediment CTE Subtotal =	**1E-07**	**2E-08**		**1E-07**				**Sediment RME Subtotal =**	**4E-06**	**2E-06**		**6E-06**
Surface Water	As	1.5E+00	3.7E+00		0.013	6E-07	2E-08		9E-07	6E-08		9E-07	0.058	3E-05	5E-07		5E-05	2E-06		5E-05
	Cd_w				0.0002	8E-09	2E-10						0.0007	4E-07	6E-09					
	Cr_{VI}				0.005	2E-07	1E-08						0.005	3E-06	8E-08					
								Surface Water CTE Subtotal =	**9E-07**	**6E-08**		**9E-07**				**Surface Water RME Subtotal =**	**5E-05**	**2E-06**		**5E-05**
								Total CTE Carcinogenic Risk =	**6E-06**	**3E-06**	**1E-08**	**9E-06**				**Total RME Carcinogenic Risk =**	**6E-04**	**2E-04**	**7E-07**	**8E-04**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.8b
Carcinogenic Risks - Child Recreationalist
Rainy Mine and Millsite

					CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
		Cancer Slope Factor (mg/kg-day)$^{-1}$			CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			CTE Total Risk	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			RME Total Risk
Media	COPC	Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	1.5E+00	3.7E+00	1.5E+01	1893	4E-05	8E-06	1E-09	6E-05	3E-05	2E-08	9E-05	15800	2E-03	5E-04	2E-08	3E-03	2E-03	3E-07	5E-03
	Cd_d			6.3E+00	0.29	6E-09	4E-11	2E-13			1E-12	1E-12	0.38	5E-08	4E-10	5E-13			3E-12	3E-12
	Cr_{VI}			2.9E+02	6.9	2E-07	1E-09	5E-12			1E-09	1E-09	8.7	1E-06	1E-08	1E-11			4E-09	4E-09
					Mine Waste CTE Subtotal =				**6E-05**	**3E-05**	**2E-08**	**9E-05**	**Mine Waste RME Subtotal =**				**3E-03**	**2E-03**	**3E-07**	**5E-03**
Sediment	As	1.5E+00	3.7E+00		87	5E-07	3E-08		7E-07	1E-07		8E-07	205	9E-06	8E-07		1E-05	3E-06		2E-05
	Cd_d				0.50	3E-09	6E-12						0.96	4E-08	1E-10					
	Cr_{VI}				7.0	4E-08	9E-11						10.6	5E-07	1E-09					
					Sediment CTE Subtotal =				**7E-07**	**1E-07**		**8E-07**	**Sediment RME Subtotal =**				**1E-05**	**3E-06**		**2E-05**
Surface Water	As	1.5E+00	3.7E+00		0.013	9E-07	2E-08		1E-06	6E-08		1E-06	0.058	2E-05	2E-07		2E-05	6E-07		3E-05
	Cd_w				0.0002	1E-08	2E-10						0.0007	2E-07	2E-09					
	Cr_{VI}				0.005	4E-07	1E-08						0.005	1E-06	3E-08					
					Surface Water CTE Subtotal =				**1E-06**	**6E-08**		**1E-06**	**Surface Water RME Subtotal =**				**2E-05**	**6E-07**		**3E-05**
					Total CTE Carcinogenic Risk =				**6E-05**	**3E-05**	**2E-08**	**1E-04**	**Total RME Carcinogenic Risk =**				**3E-03**	**2E-03**	**3E-07**	**5E-03**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.9

Summary of Human Health Non-carcinogenic Hazards and Carcinogenic Risks

Rainy Mine and Millsite

Media and Exposure Pathway	CENTRAL TENDENCY EXPOSURE				REASONABLE MAXIMUM EXPOSURE			
	NON-CARCINOGENIC HAZARD		CARCINOGENIC RISK		NON-CARCINOGENIC HAZARD		CARCINOGENIC RISK	
	Recreationalist Adult	Recreationalist Child	Recreationalist Adult	Recreationalist Child	Recreationalist Adult	Recreationalist Child	Recreationalist Adult	Recreationalist Child
Mine Waste:								
Ingestion	9.E-02	**2.E+00**	5.E-06	**6.E-05**	**3.E+00**	**8.E+01**	**6.E-04**	**3.E-03**
Dermal	5.E-02	8.E-01	3.E-06	**3.E-05**	1.E+00	**5.E+01**	**2.E-04**	**2.E-03**
Inhalation	4.E-05	1.E-04	1.E-08	2.E-08	1.E-04	3.E-04	7.E-07	3.E-07
Subtotal =	1.E-01	**2.E+00**	8.E-06	**9.E-05**	**4.E+00**	**1.E+02**	**8.E-04**	**5.E-03**
Sediment:								
Ingestion	3.E-03	3.E-02	1.E-07	7.E-07	2.E-02	5.E-01	4.E-06	**1.E-05**
Dermal	3.E-04	3.E-03	2.E-08	1.E-07	1.E-02	7.E-02	2.E-06	3.E-06
Subtotal =	3.E-03	3.E-02	1.E-07	8.E-07	4.E-02	5.E-01	6.E-06	**2.E-05**
Surface Water								
Ingestion	2.E-02	5.E-02	9.E-07	1.E-06	3.E-01	8.E-01	**5.E-05**	**2.E-05**
Dermal	2.E-03	3.E-03	6.E-08	6.E-08	2.E-02	2.E-02	2.E-06	6.E-07
Subtotal =	2.E-02	5.E-02	9.E-07	1.E-06	3.E-01	9.E-01	**5.E-05**	**3.E-05**
TOTAL =	2.E-01	**3.E+00**	9.E-06	**1.E-04**	**4.E+00**	**1.E+02**	**8.E-04**	**5.E-03**

Pathway Totals:

Ingestion	1.E-01	**2.E+00**	6.E-06	**6.E-05**	**3.E+00**	**8.E+01**	**6.E-04**	**3.E-03**
Dermal	5.E-02	8.E-01	3.E-06	**3.E-05**	1.E+00	**5.E+01**	**2.E-04**	**2.E-03**
Inhalation	4.E-05	1.E-04	1.E-08	2.E-08	1.E-04	3.E-04	7.E-07	3.E-07

APPENDIX B

ECOLOGICAL RISK CALCULATION TABLES

TABLE B.1
Preliminary Contaminant of Potential Ecological Concern Screening - Mine Waste
Rainy Mine and Millsite
(results reported in mg/kg)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	95% UCL[a]	Essential Nutrient?	Retain For Screening?	Detection Frequency	Retain for Screening?	Average Background Concentration[b]	Retain for Risk-based Screening?
Silver	3.62	41.3	30.4	No	**Yes**	100%	**Yes**	0.65	**Yes**
Aluminum	6130	26200	16757	No	**Yes**	100%	**Yes**	20000	**Yes**
Arsenic III	0.017	28.1	10.8	No	**Yes**	89%	**Yes**	0.41	**Yes**
Arsenic V	21.9	15772	15772	No	**Yes**	100%	**Yes**	30.8	**Yes**
Arsenic Total	22	15800	15800	No	**Yes**	100%	**Yes**	31.2	**Yes**
Barium	17.7	70.0	52.8	No	**Yes**	100%	**Yes**	27.8	**Yes**
Beryllium	0.10	0.50	0.5	No	**Yes**	11%	**Yes**	0.20	**Yes**
Cadmium	0.13	0.61	0.38	No	**Yes**	100%	**Yes**	0.18	**Yes**
Cobalt	2.0	10.0	5.14	No	**Yes**	67%	**Yes**	3.0	**Yes**
Chromium III	1.2	11.2	7.7	No	**Yes**	100%	**Yes**	5.0	**Yes**
Chromium VI	0.40	0.98	0.643	No	**Yes**	11%	**Yes**	9.4	No
Chromium Total	2.0	12.0	8.7	No	**Yes**	100%	**Yes**	5.3	**Yes**
Copper	986	1970	1575	No	**Yes**	100%	**Yes**	200	**Yes**
Iron	24100	100000	71254	Yes	**Yes**	100%	**Yes**	15033	**Yes**
Mercury	0.02	1.08	0.65	No	**Yes**	89%	**Yes**	0.09	**Yes**
Manganese	112	363	218	No	**Yes**	100%	**Yes**	137	**Yes**
Nickel	3.7	12.0	7.7	No	**Yes**	89%	**Yes**	3.7	**Yes**
Lead	7.2	79.6	44.1	No	**Yes**	100%	**Yes**	31.4	**Yes**
Antimony	0.4	5.3	3.7	No	**Yes**	89%	**Yes**	0.37	**Yes**
Selenium	1.0	11.1	7.7	No	**Yes**	100%	**Yes**	0.45	**Yes**
Thallium	0.08	1.50	0.64	No	**Yes**	78%	**Yes**	0.08	**Yes**
Vanadium	6.1	67.0	43.3	No	**Yes**	100%	**Yes**	26	**Yes**
Zinc	30	69	55.6	No	**Yes**	89%	**Yes**	64	**Yes**
Calcium	470	3000	1690	Yes	No	100%	No	943	No
Potassium	470	4160	2272	Yes	No	100%	No	347	No
Magnesium	1990	9500	5334	Yes	No	100%	No	1093	No
Sodium	30	1860	976	Yes	No	100%	No	173	No
Cyanide	0.3	0.35	0	No	**Yes**	0%	No	NA	No

Notes:

[a]If the calculated 95% upper confidence limit (UCL) was greater than the maximum detected concentration (MDC), the MDC was used.

[b]The average concentration was used because there were not enough background samples to calculate the 95% UCL.

NA = Not analyzed for

mg/kg = Milligram per kilogram

Analyzed for but not detected; value = 1/2 reporting limit.

Detected at concentration between the method detection limit and practical quantitation limt; value = reported concentration.

TABLE B.2
Preliminary Contaminant of Potential Ecological Concern Screening - Surface Water
Rainy Mine and Millsite
(results reported in mg/L)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	95% UCL[a]	Essential Nutrient?	Retain for Screening?	Detection Frequency	Retain for Screening?	Average Background Concentration[b]	Retain for Risk-based Screening?
Silver	0.000025	0.00016	0.000027	No	**Yes**	10%	**Yes**	0.000025	**Yes**
Aluminum	0.07	2.89	2.9	No	**Yes**	100%	**Yes**	0.085	**Yes**
Arsenic III	0.0000035	0.00543	0.005	No	**Yes**	90%	**Yes**	0.00012	**Yes**
Arsenic V	0.000937	0.0523	0.05	No	**Yes**	70%	**Yes**	0.00046	**Yes**
Arsenic Total	0.0011	0.0577	0.06	No	**Yes**	70%	**Yes**	0.00068	**Yes**
Barium	0.0015	0.014	0.009	No	**Yes**	30%	**Yes**	0.0015	**Yes**
Beryllium	0.001	0.001	0.001	No	**Yes**	0%	No	0.001	No
Cadmium	0.00005	0.0007	0.0007	No	**Yes**	20%	**Yes**	0.00005	**Yes**
Cobalt	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Chromium III	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Chromium VI	0.0005	0.0005	0.0005	No	**Yes**	0%	No	0.00028	No
Chromium Total	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Copper	0.00025	2.02	2.0	No	**Yes**	50%	**Yes**	0.00025	**Yes**
Iron	0.005	0.58	0.58	Yes	No	60%	No	0.0125	No
Mercury	0.00000033	0.00000091	0.000001	No	**Yes**	100%	**Yes**	0.00000089	**Yes**
Manganese	0.0025	0.054	0.05	No	**Yes**	20%	**Yes**	0.0025	**Yes**
Nickel	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Lead	0.00005	0.0005	0.0005	No	**Yes**	10%	**Yes**	0.00005	**Yes**
Antimony	0.0001	0.0001	0.0001	No	**Yes**	0%	No	0.0001	No
Selenium	0.001	0.001	0.00100	No	**Yes**	0%	No	0.001	No
Thallium	0.000025	0.000025	0.00003	No	**Yes**	0%	No	0.000025	No
Vanadium	0.0025	0.0025	0.003	No	**Yes**	0%	No	0.0025	No
Zinc	0.005	0.06	0.06	No	**Yes**	20%	**Yes**	0.005	**Yes**
Calcium	1.0	7.8	7.8	Yes	No	100%	No	1.25	No
Potassium	0.15	0.6	0.60	Yes	No	90%	No	0.23	No
Magnesium	0.1	0.6	0.44	Yes	No	30%	No	0.1	No
Sodium	0.9	3.5	3.5	Yes	No	90%	No	0.53	No
Sulfate	0.005	0.05	0.032	No	**Yes**	78%	**Yes**	0.02	**Yes**

Notes:

[a]If the calculated 95% upper confidence limit (UCL) was greater than the maximum detected concentration (MDC), the MDC was used.

[b]The average concentration was used because there were not enough background samples to calculate the 95% UCL.

mg/L = Milligram per liter

Analyzed for but not detected; value = 1/2 reporting limit.

Detected at concentration between the method detection limit and practical quantitation limt; value = reported concentration.

TABLE B.3
Preliminary Contaminant of Potential Ecological Concern Screening - Sediment
Rainy Mine and Millsite
(results reported in mg/kg)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	95% UCL[a]	Essential Nutrient?	Retain for Screening?	Detection Frequency	Retain for Screening?	Maximum Detected Background Concentration[b]	Retain for Risk-based Screening?
Silver	0.06	33.9	34	No	**Yes**	100%	**Yes**	0.04	**Yes**
Aluminum	5750	44200	32330	No	**Yes**	100%	**Yes**	6950	**Yes**
Arsenic III	0.098	3.342	3.3	No	**Yes**	100%	**Yes**	0.16	**Yes**
Arsenic IV	12.2	201.7	202	No	**Yes**	100%	**Yes**	9	**Yes**
Arsenic Total	12.3	205	205	No	**Yes**	100%	**Yes**	10	**Yes**
Barium	36.8	66.3	66	No	**Yes**	100%	**Yes**	66.8	No
Beryllium	0.1	0.6	0.6	No	**Yes**	13%	**Yes**	0.1	**Yes**
Cadmium	0.14	1.27	1.0	No	**Yes**	100%	**Yes**	0.39	**Yes**
Cobalt	3	8	7.1	No	**Yes**	100%	**Yes**	4	**Yes**
Chromium III	2.2	9.9	8.9	No	**Yes**	100%	**Yes**	5	**Yes**
Chromium VI	0.764	2.573	2.3	No	**Yes**	100%	**Yes**	0.96	**Yes**
Chromium Total	3	11	11	No	**Yes**	100%	**Yes**	6	**Yes**
Copper	27	4410	3346	No	**Yes**	100%	**Yes**	18	**Yes**
Iron	8150	49700	36924	Yes	No	100%	No	10600	No
Mercury	0.02	0.19	0.2	No	**Yes**	13%	**Yes**	0.02	**Yes**
Manganese	135	198	191	No	**Yes**	100%	**Yes**	181	**Yes**
Nickel	1.6	7	6.6	No	**Yes**	100%	**Yes**	2.7	**Yes**
Lead	3.12	31.2	27	No	**Yes**	100%	**Yes**	4.78	**Yes**
Antimony	0.05	1	0.7	No	**Yes**	38%	**Yes**	0.10	No[c]
Selenium	0.25	7	7.0	No	**Yes**	25%	**Yes**	0.25	**Yes**
Thallium	0.07	0.23	0.2	No	**Yes**	100%	**Yes**	0.11	**Yes**
Vanadium	17	50.2	44	No	**Yes**	100%	**Yes**	23.9	**Yes**
Zinc	23	90	82	No	**Yes**	100%	**Yes**	31	**Yes**
Calcium	1180	3210	2748	Yes	No	100%	No	960	No
Cyanide	0.25	2	2	No	**Yes**	0%	No	0.30	No
Potassium	1090	1420	1417	Yes	No	100%	No	1670	No
Magnesium	2110	5100	4205	Yes	No	100%	No	2770	No
Sodium	190	320	288	Yes	No	100%	No	130	No

Notes:

[a]If the calculated 95% upper confidence limit (UCL) was greater than the maximum detected concentration (MDC), the MDC was used.

[b]The maximum concentration was used because there was only a single background sample.

[c]Not retained because the MDC was below the method detection limit.

Analyzed for but not detected; value = 1/2 reporting limit.

Detected at concentration between the method detection limit and practical quantitation limt; value = reported concentration.

TABLE B.4
Preliminary Contaminant of Potential Ecological Concern Screening - Pore Water
Rainy Mine and Millsite
(results reported in mg/L)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	95% UCL[a]	Essential Nutrient?	Retain for Screening?	Detection Frequency	Retain for Screening?	Maximum Detected Background Concentration[b]	Retain for Risk-based Screening?
Silver	0.000025	0.000025	0.000025	No	**Yes**	0%	No	0.000025	No
Aluminum	0.04	1.32	1.32	No	**Yes**	100%	**Yes**	0.05	**Yes**
Arsenic III	0.000028	0.00808	0.00577	No	**Yes**	100%	**Yes**	0.000186	**Yes**
Arsenic V	0.00002	0.02842	0.02842	No	**Yes**	100%	**Yes**	0.00091	**Yes**
Arsenic Total	0.001	0.0321	0.0321	No	**Yes**	100%	**Yes**	0.0011	**Yes**
Barium	0.0015	0.017	0.017	No	**Yes**	33%	**Yes**	0.0015	**Yes**
Beryllium	0.001	0.001	0.001	No	**Yes**	0%	No	0.001	No
Cadmium	0.00005	0.0005	0.00047	No	**Yes**	33%	**Yes**	0.00005	**Yes**
Cobalt	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Chromium III	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Chromium VI	0.0005	0.0005	0.0005	No	**Yes**	0%	No	0.0005	No
Chromium Total	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Copper	0.00025	0.409	0.409	No	**Yes**	50%	**Yes**	0.00025	**Yes**
Iron	0.005	9.36	9.36	Yes	No	17%	No	0.005	No
Mercury	0.00000013	0.0000029	0.0000023	No	**Yes**	100%	**Yes**	0.0000008	**Yes**
Manganese	0.0025	0.06	0.06	No	**Yes**	17%	**Yes**	0.0025	**Yes**
Nickel	0.005	0.005	0.005	No	**Yes**	0%	No	0.005	No
Lead	0.00005	0.0002	0.0002	No	**Yes**	17%	**Yes**	0.00005	**Yes**
Antimony	0.0001	0.0001	0.0001	No	**Yes**	0%	No	0.0001	No
Selenium	0.00005	0.00005	0.00005	No	**Yes**	0%	No	0.00005	No
Thallium	0.00005	0.006	0.006	No	**Yes**	83%	**Yes**	0.0002	**Yes**
Vanadium	0.0025	0.0025	0.0025	No	**Yes**	0%	No	0.0025	No
Zinc	0.005	0.07	0.07	No	**Yes**	17%	**Yes**	0.005	**Yes**
Calcium	1.0	6.4	6.4	Yes	No	100%	No	1.2	No
Potassium	0.15	0.6	0.6	Yes	No	17%	No	0.15	No
Magnesium	0.1	0.6	0.6	Yes	No	17%	No	0.1	No
Sodium	0.01	0.04	0.039	Yes	No	83%	No	0.005	No
Cyanide	0.000005	0.000005	0.0	No	**Yes**	0%	No	0.000005	No

Notes:

[a]If the calculated 95% upper confidence limit (UCL) was greater than the maximum detected concentration (MDC), the MDC was used.

[b]The maximum concentration was used because there was only a single background sample.

mg/L = Milligram per liter

Analyzed for but not detected; value = 1/2 reporting limit.

Detected at concentration between the method detection limit and practical quantitation limt; value = reported concentration.

TABLE B.5
Chemistry Toxicity Screening - Mine Waste
Rainy Mine and Millsite
(results reported in mg/kg)

			SCREENING LEVEL VALUE[d]				SINGLE COI RISK RATIO (T_{ij} = EPC/SLV)				RISK TO RECEPTORS? (Tij >1)[f] OR (T_{ij} > 5)[g]				CPEC?	MULTIPLE COI RISK RATIO ($T_{mult} = T_{ij}/T_j$)				MULTIPLE COI RISK TO RECEPTORS? (T_{ij}/T_j) > ($1/N_{ij}$)[6] or > ($5/N_{ij}$)[7]				CPEC?	Bioaccumulator CPEC?[h]
Analyte[a]	EPC (MDC)[b]	EPC (95% UCL)[c]	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal	Plant[f]	Invertebrate[g]	Bird[f]	Mammal[f]		Plant	Invertebrate	Bird	Mammal	Plant[f]	Invertebrate[g]	Bird[f]	Mammal[f]		
Silver	41.3	30.4	2.0	50	NS	NS	21	0.83	-	-	**Yes**	No	No	No	**Yes**	0.00169	0.00093	-	-	No	No	No	No	**Yes**[e]	**Yes**
Aluminum	26200	16757	50	600	450	107	524	44	58	245	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	0.04291	0.04902	0.24985	0.64531	No	No	**Yes**	**Yes**	**Yes**	No
Arsenic III	28.1	10.8	10	60	10	7	2.8	0.47	2.8	4.0	**Yes**	No	**Yes**	**Yes**	**Yes**	0.00023	0.00053	0.01205	0.01057	No	No	No	No	No	No
Arsenic V	15772	15772	10	60	132	132	1577	263	119	119	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	0.12917	0.29511	0.51275	0.31489	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No
Arsenic Total	15800	15800	NS	NS	NS	NS	-	-	-	-	No	No	No	No	**Yes**[e]	-	-	-	-	No	No	No	No	**Yes**[e]	No
Barium	70	52.8	500	3000	85	102	0.14	0.02	0.82	0.69	No	No	No	No	No	0.00001	0.00003	0.00353	0.00181	No	No	No	No	No	No
Beryllium	0.5	0.5	10	NS	NS	83	0.05	-	-	0.01	No	No	No	No	**Yes**	0.00000	-	-	0.00002	No	No	No	No	**Yes**[e]	No
Cadmium	0.61	0.38	4	20	14	125	0.15	0.03	0.04	0.005	No	No	No	No	No	0.00001	0.00003	0.00019	0.00001	No	No	No	No	No	No
Cobalt	10.0	5.14	20	1000	NS	150	0.50	0.01	-	0.07	No	No	No	No	**Yes**[e]	0.00004	0.00001	-	0.00018	No	No	No	No	**Yes**[e]	No
Chromium III	11.2	7.7	1	0.4	4	340000	11	28	2.8	0.00003	**Yes**	**Yes**	**Yes**	No	**Yes**	0.00092	0.03143	0.01202	0.00000	No	No	No	No	No	No
Chromium Total	12	8.7	42	42	67	NS	0.29	0.29	0.18	-	No	No	No	No	**Yes**[e]	0.00002	0.00032	0.00077	-	No	No	No	No	**Yes**[e]	No
Copper	1970	1575	100	50	217	390	20	39	9	5.1	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	0.00161	0.04423	0.03896	0.01331	No	No	No	No	No	No
Iron	100000	71254	10	200	NS	NS	10000	500	-	-	**Yes**	**Yes**	No	No	**Yes**	0.81896	0.56134	-	-	**Yes**	**Yes**	No	No	**Yes**	**Yes**
Mercury	1.08	0.65	0.3	0.1	5.5	73	3.6	11	0.20	0.01	**Yes**	**Yes**	No	No	**Yes**	0.00029	0.01212	0.00084	0.00004	No	No	No	No	No	**Yes**
Manganese	363	218	1100	100	4125	1500	0.33	3.6	0.09	0.24	No	No	No	No	No	0.00003	0.00408	0.00038	0.00064	No	No	No	No	No	No
Nickel	12	7.7	30	200	980	625	0.40	0.06	0.01	0.02	No	No	No	No	No	0.00003	0.00007	0.00005	0.00005	No	No	No	No	No	No
Lead	79.6	44.1	50	500	118	4000	1.6	0.16	0.67	0.02	**Yes**	No	No	No	**Yes**	0.00013	0.00018	0.00289	0.00005	No	No	No	No	No	No
Antimony	5.3	3.7	5	NS	NS	15	1.1	-	-	0.35	**Yes**	No	No	No	**Yes**[e]	0.00009	-	-	0.00093	No	No	No	No	**Yes**[e]	**Yes**
Selenium	11.1	7.7	1	70	0.3	25	11	0.16	37	0.44	**Yes**	No	**Yes**	No	**Yes**	0.00091	0.00018	0.15878	0.00117	No	No	**Yes**	No	**Yes**	No
Thallium	1.50	0.64	1	NS	NS	1	1.5	-	-	1.5	**Yes**	No	No	**Yes**	**Yes**	0.00012	-	-	0.00395	No	No	No	No	**Yes**[e]	No
Vanadium	67	43.3	2	NS	47	25	34	-	1.4	2.7	**Yes**	No	**Yes**	**Yes**	**Yes**	0.00274	-	0.00612	0.00706	No	No	No	No	**Yes**[e]	No
Zinc	69	55.6	86	200	360	20000	0.8	0.3	0.2	0.003	No	No	No	No	No	0.00007	0.00039	0.00082	0.00001	No	No	No	No	No	No
					Sum of T_{ij} (T_j) =		12211	891	233	379															
					# of COIs (N_{ij}) =		21	17	15	18															
					$1/N_{ij}$ =		0.05	0.06	0.07	0.06															
					$5/N_{ij}$ =		0.24	0.29	0.33	0.28															

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).

[b]The EPC used for plant and invertebrate receptors is the maximum detected concentration.

[c]The EPC used for bird and mammal receptors is the 95% upper confidence limit.

[d]SLVs are from WDOE WAC-173-340, Table 749-3 (2001c), where available; otherwise taken from ODEQ Guidance for Ecological Risk Assessment, Level II Screening Level Values (2001).

[e]Retained because of the lack of an SLV.

[f]A screening risk ratio of 1 was used for protected species.

[g]A screening risk ratio of 5 was used for non-protected species.

[h]Bioaccumulator CPECs (silver, cadmium, mercury, antimony, and iron) were retained if they posed risk to single or multiple risk receptor groups, not retained due to lack of SLV.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

EPC = Exposure point concentration

MDC = Maximum detected concentration

NS = No SLV

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

WDOE = Washington Department of Ecology

mg/kg = Milligram per kilogram

TABLE B.6
Chemistry Toxicity Screening - Surface Water
Rainy Mine and Millsite
(results reported in mg/L)

		SCREENING LEVEL VALUE[b,d]			SINGLE COI RISK RATIO (T_{ij} = EPC/SLV)			RISK TO RECEPTORS? (T_{ij}>1)[c]			CPEC?	MULTIPLE COI RISK RATIO (T_{ij}/T_j)			MULTIPLE COI RISK TO RECEPTORS (T_{ij}/T_i) > ($1/N_{ij}$)			CPEC?
Analyte[a]	**EPC (95% UCL)**	**Aquatic Life**	**Bird**	**Mammal**	**Aquatic Life**	**Bird**	**Mammal**	**Aquatic Life**	**Birds**	**Mammals**		**Aquatic Life**	**Bird**	**Mammal**	**Aquatic Life**	**Bird**	**Mammal**	
Silver	0.00003	0.00012	NS	NS	0.23	-	-	No	No	No	**Yes[e]**	0.0002	-	-	No	No	No	**Yes[e]**
Aluminum	2.89	0.087	797	8	33.22	0.0036	0.36	**Yes**	No	No	**Yes**	0.03	0.34	0.90	No	**Yes**	**Yes**	**Yes**
Arsenic III	0.00543	0.15	18	6	0.04	0.0003	0.0009	No	No	No	No	0.00003	0.03	0.002	No	No	No	No
Arsenic V	0.0523	0.15	NS	NS	0.35	-	-	No	No	No	**Yes[e]**	0.0003	-	-	No	No	No	**Yes[e]**
Arsenic Total	0.0577	190	NS	NS	0.0003	-	-	No	No	No	**Yes[e]**	0.0000003	-	-	No	No	No	**Yes[e]**
Barium	0.0092	0.004	150	39	2.30	0.0001	0.0002	**Yes**	No	No	**Yes**	0.002	0.006	0.0006	No	No	No	No
Beryllium	0.001	5.3	NS	5000	0.0002	-	0.0000002	No	No	No	**Yes[e]**	0.0000002	-	0.0000005	No	No	No	**Yes[e]**
Cadmium	0.0007	0.00021	10	8	3.37	0.0001	0.0001	**Yes**	No	No	**Yes**	0.0030	0.0066	0.00022	No	No	No	No
Copper	2.02	0.002	341	53	1084	0.01	0.04	**Yes**	No	No	**Yes**	0.96	0.56	0.095	**Yes**	**Yes**	No	**Yes**
Mercury	0.00000091	0.000012	3	10	0.08	0.0000003	0.0000001	No	No	No	No	0.00007	0.00003	0.0000002	No	No	No	No
Manganese	0.054	0.12	7242	676	0.45	0.000007	0.00008	No	No	No	No	0.0004	0.0007	0.0002	No	No	No	No
Lead	0.00045	0.00020	28	323	2.22	0.00002	0.000001	**Yes**	No	No	**Yes**	0.002	0.002	0.000003	No	No	No	No
Zinc	0.06	0.017	105	1230	3.54	0.0006	0.00005	**Yes**	No	No	**Yes**	0.003	0.05	0.0001	No	No	No	No
				Sum of T_{ij} (T_j) =	1130	0.0106	0.401											
				# COIs (N_{ij}) =	13	9	10											
				$1/N_{ij}$ =	0.08	0.11	0.10											
				$5/N_{ij}$ =	0.38	0.56	0.50											

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).

[b]SLVs corrected for hardness and dissolved fraction where applicable.

[c]A screening risk ratio of 1 was used because of the coastal cutthroat, and threatened and endangered birds and mammals.

[d]SLVs are from WDOE Chronic AmbientFreshwater Criteria, WAC-173-201A (2003b), where available; otherwise taken from ODEQ Guidance for Ecological Risk Assessment, Level II Screening Level Values (2001).

[e]Retained because of the lack of an SLV.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

EPC = Exposure point concentration

NS = No SLV

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

UCL = Upper confidence limit

WDOE = Washington Department of Ecology

mg/L = Milligram per liter

TABLE B.7
Chemistry Toxicity Screening - Sediment
Rainy Mine and Millsite
(results reported in mg/kg)

		SCREENING LEVEL VALUE[d]		SINGLE COI RISK RATIO (T_{ij} = EPC/SLV)		RISK TO RECEPTORS (T_{ij}>1)[c]		
Analyte[a]	**EPC (95% UCL)**	**Freshwater Sediment**	**Bioaccumulation**	**Freshwater Sediment**	**Bioaccumulation**	**Freshwater Sediment**	**Bioaccumulation**	**CPEC?**
Silver	33.9	2	NS	17	-	**Yes**	No	**Yes**
Aluminum	32330	NS	NS	-	-	No	No	**Yes**[b]
Arsenic III	3.3	6	4	0.56	0.84	No	No	No
Arsenic V	202	NS	NS	-	-	No	No	**Yes**[b]
Arsenic Total	205	20	NS	10	-	**Yes**	No	**Yes**
Beryllium	0.60	NS	NS	-	-	No	No	**Yes**[b]
Cadmium	0.96	0.6	0.003	1.6	320	**Yes**	**Yes**	**Yes**
Cobalt	7.1	NS	NS	-	-	No	No	**Yes**[b]
Chromium III	8.9	NS	NS	-	-	No	No	No[e]
Chromium VI	2.3	NS	NS	-	-	No	No	No[e]
Chromium TOT	10.6	95	4200	0.11	0.0025	No	No	No
Copper	3346	80	10	42	335	**Yes**	**Yes**	**Yes**
Mercury	0.2	0.5	NS	0.38	-	No	No	**Yes**[b]
Manganese	191	NS	1100	-	0.17	No	No	No
Nickel	6.6	60	316	0.11	0.02	No	No	No
Lead	27.3	335	128	0.08	0.21	No	No	No
Antimony	0.7	0.4	10	1.9	0.07	**Yes**	No	**Yes**
Selenium	7.0	NS	0.1	-	70	No	**Yes**	**Yes**
Thallium	0.20	NS	0.7	-	0.29	No	No	**Yes**[b]
Vanadium	43.5	NS	NS	-	-	No	No	**Yes**[b]
Zinc	81.7	140	3	0.58	27	No	**Yes**	**Yes**

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).

[b]Retained because of the lack of an SLV.

[c]A screening risk ratio of 1 was used because of the coastal cutthroat trout.

[d]SLVs are from WDOE WAC-173-201A-230, Recommended Freshwater Sediment Quality Values (2004) where available; otherwise taken from ODEQ Guidance for Ecological Risk Assessment, Level II Screening (2001).

[e]Although no SLVs were available, not retained because the risks ratios from chromium (total) were below the SLVs.

CPEC = Contaminant of potential ecological concern

EPC = Exposure point concentration

NS = No SLV

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

UCL = Upper confidence limit

WDOE = Washington Department of Ecology

mg/kg = Milligram per kilogram

TABLE B.8
Chemistry Toxicity Screening - Pore Water
Rainy Mine and Millsite
(results reported in mg/L)

Analyte[a]	EPC (MDC)	AQUATIC LIFE						
		SCREENING LEVEL VALUE[b]	SINGLE COI RISK RATIO (T_{ij})	RISK TO RECEPTORS (T_{ij}>1)	CPEC?	MULTIPLE COI RISK RATIO (T_{ij}/T_i)	RISK TO RECEPTORS (T_{ij}/T_i) > ($1/N_{ij}$)	CPEC?
Aluminum	1.3	0.00012	11000	**Yes**	**Yes**	0.98	**Yes**	**Yes**
Arsenic III	0.008	0.15	0.05	No	No	0.000005	No	No
Arsenic V	0.03	0.15	0.19	No	No	0.00002	No	No
Arsenic Total	0.03	0.19	0.17	No	No	0.00002	No	No
Barium	0.017	0.004	4.3	**Yes**	**Yes**	0.0004	No	No
Cadmium	0.0005	0.0002	2.4	**Yes**	**Yes**	0.0002	No	No
Copper	0.41	0.002	220	**Yes**	**Yes**	0.02	No	No
Iron	9.4	1.0	9.4	**Yes**	**Yes**	0.0008	No	No
Mercury	0.000003	0.000012	0.24	No	No	0.00002	No	No
Manganese	0.06	0.12	0.50	No	No	0.00004	No	No
Lead	0.0002	0.0002	1.0	No	No	0.0001	No	No
Thallium	0.006	0.04	0.2	No	No	0.0000	No	No
Zinc	0.07	0.017	4.1	**Yes**	**Yes**	0.0004	No	No

Sum of T_{ij} (T_j) =	11242
# COIs (N_{ij}) =	13
$1/N_{ij}$ =	0.08

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).

[b]SLVs are from WDOE Chronic Ambient Freshwater Criteria, WAC-173-201A (2003b), where available; otherwise taken from ODEQ Guidance for Ecological Risk Assessment, Level II Screening Level Values (2001).

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

EPC= Exposure point concentration

MDC = Maximum detected concentration

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

WDOE = Washington Department of Ecology

mg/L = Milligram per liter

TABLE B.9
Chemistry Toxicity Screening - Multiple Media
Rainy Mine and Millsite

	Single COI Risk Ratio (T_{ij})				Multiple Media Risk Ratio (T_{ij}-mine waste + T_{ij}-surface water)		Risk to Receptor ($T_{ij\text{-combined}}$>1)		CPEC?
	Mine Waste		Surface Water						
Analyte[a]	**Bird**	**Mammal**	**Bird**	**Mammal**	**Bird**	**Mammal**	**Bird**	**Mammal**	
Silver	-	-	-	-	-	-	No	No	No
Aluminum	58	244.9	0.00363	0.36	58	245	**Yes**	**Yes**	**Yes**
Arsenic III	2.8	4.0	0.00030	0.0009	2.8	4.0	**Yes**	**Yes**	**Yes**
Arsenic V	119	119	-	-	119	119	**Yes**	**Yes**	**Yes**
Arsenic Total	-	-	-	-	-	-	No	No	No
Barium	0.82	0.69	0.00006	0.0002	0.82	0.69	No	No	No
Beryllium	-	0.01	-	0.0000002	-	0.01	No	No	No
Cadmium	0.04	0.005	0.00007	0.0001	0.04	0.00	No	No	No
Cobalt	-	0.1			-	0.07	No	No	No
Chromium III	2.8	0.00003			2.8	0.00	**Yes**	No	**Yes**
Chromium Total	0.18	-			0.18	-	No	No	No
Copper	9.1	5.1	0.006	0.04	9	5	**Yes**	**Yes**	**Yes**
Iron	-	-			-	-	No	No	No
Lead			0.0000003	0.0000001	0.0000003	0.0000001	No	No	No
Mercury	0.20	0.015			0.20	0.01	No	No	No
Manganese	0.09	0.24			0.09	0.24	No	No	No
Nickel	0.01	0.02			0.01	0.02	No	No	No
Antimony	-	0.35			-	0.35	No	No	No
Selenium	37	0.44			37	0.44	**Yes**	No	**Yes**
Thallium	-	1.5			-	1.5	No	**Yes**	**Yes**
Vanadium	1.4	2.7			1.4	2.7	**Yes**	**Yes**	**Yes**
Zinc			0.00001	0.0001	0.00001	0.0001	No	No	No

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

APPENDIX C

SUPPLEMENTAL LIST OF SENSITIVE PLANT AND ANIMAL SPECIES

Species of Concern
Mt. Baker Snoqualmie National Forest

Federal Threatened Species

Animals
***Brachyramphus marmoratus* (Marbled Murrelet)**: Occurs seasonally in the western Cascade Mountains and Puget Sound, nesting in trees in the forested portion of the coast roughly 2km from the shoreline. Not on Site (US Fish and Wildlife Service 1997)
***Lynx Canadenis* (Canada Lynx)**: Occurs only in the northern Cascade Mountains Not on Site (US Fish and Wildlife Service 2006)
***Strix occidentalis* (Spotted Owl)**: Occurs in higher elevations of old growth forest, documented on the Mt. Baker Snoqualmie National Forest. Present (US Fish and Wildlife Service 1992)

Federal Threatened and Endangered Plants
Western Washington
(Washington Native Plant Society 2006)

Arenaria paludicola (Marsh sandwort)
Castilleja levisecta (Golden Paintbrush)
Howellia aquatilis (Water howellia)
Lupinus sulphureus ssp.kincaidii *(*Kincaid's lupine)
Sidalcea nelsoniana (Nelson's checker-mallow)
Lomatium bradshawii (Bradshaw's desert parsley)

Federal Candidate Species

***Rana pretiosa* (Oregon Spotted Frog):** Occur in wetland habitats in forested landscapes within the western Cascade Mountains at elevations ranging from sea level to 5000 feet. Washington Endangered Species, Federal Candidate Species. Potentially Present (US Fish and Wildlife Service 2004b)

Federal Species of Concern

***Contopus borealis* (Olive sided flycatcher)**: Western Washington is a core habitat. Present (US Fish and Wildlife Service 2001) Washington GAP Analysis
***Empidonax traillii* (Willow Flycatcher)**: Occurs throughout Washington, Oregon, and Idaho Present (Pacific Biodiversity Institute 2006b)
***Oncorhynchus clarki clarki* (Coastal Cutthroat)**: Occurs in small streams and headwater

habitat where spawning and rearing occurs with small-scale migrations. Populations above Snoqualmie Falls are considered non-migratory. Present (US Fish and Wildlife Service 2006)
***Martes oennanti* (Fisher)**: Washington has scattered individuals and are considered extirpated. Not on Site (US Fish and Wildlife Service 2004a)
***Accipiter gentiles* (Northern Goshawk)**: Occurs in most forested regions of Washington, about 27% of the breeding population within the state occurs in the Western Cascade Mountains. Present (The Center for Biological Diversity 2006)
***Bufo boreas* (Western Toad):** Occurs at lower elevations west of the Cascades, and at higher elevations in the Cascades Present (Pacific Biodiversity Institute 2006a)
***Myotis yumanensis* (Yuma myotis):** Occurs regular large concentrations in naturally occurring breeding areas and other communal roosts within western Washington. Potentially Present (Washington Department of Fish and Wildlife 2006)
***Coryhorhinus townsendii townsendii* (Pacific Townsend's big-eared bat):** Occurs within western Washington. Potentially Present (Washington Department of Fish and Wildlife 2006)

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