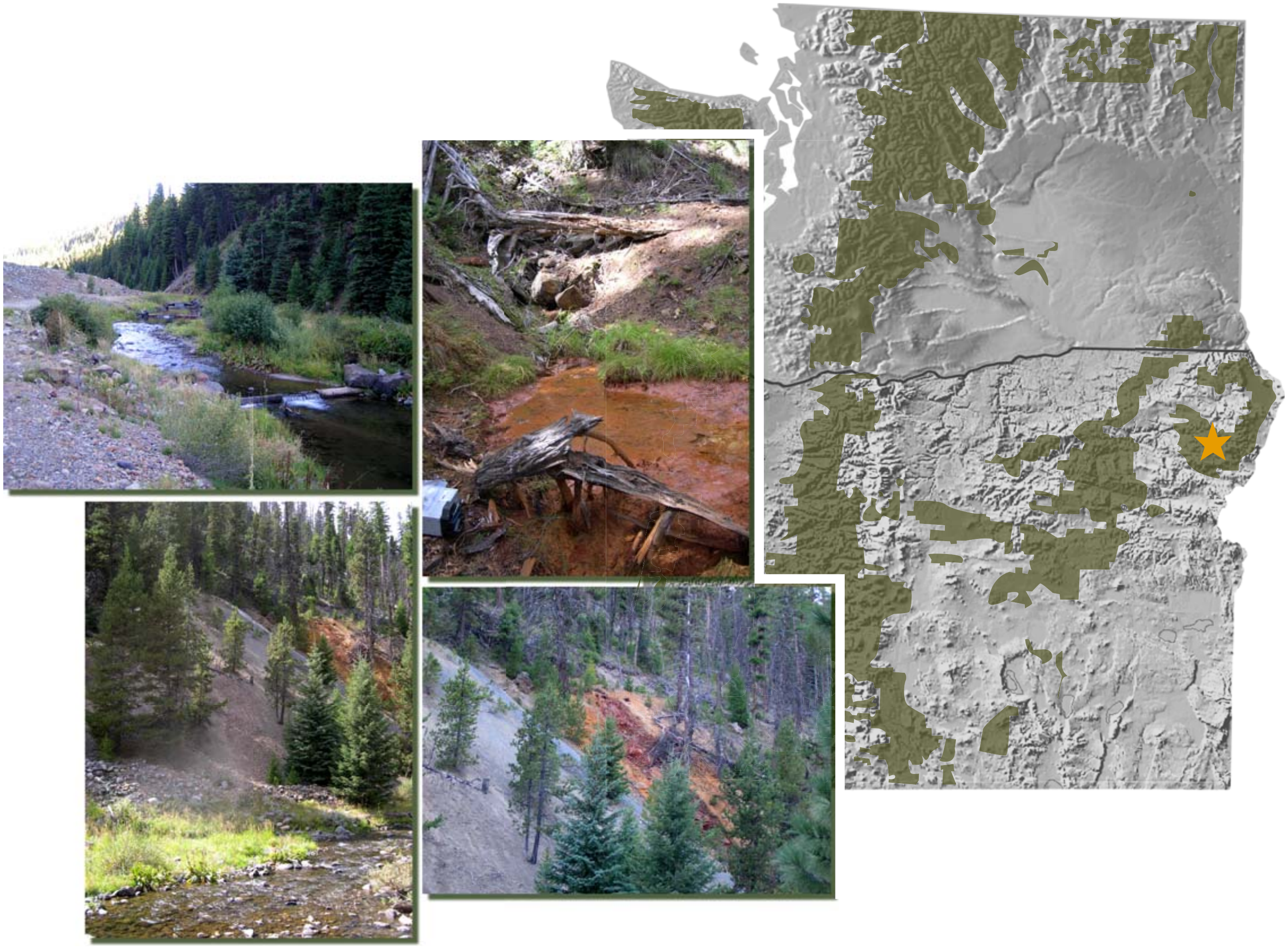
FINAL

ENGINEERING EVALUATION/COST ANALYSIS
BLACKJACK MINE SITE
GRANITE, OREGON



Submitted to:

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February 2005

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EXECUTIVE SUMMARY

Science Applications International Corporation (SAIC) has prepared the following Engineering Evaluation/Cost Analysis (EE/CA) for completing a non-time-critical removal action related to releases of hazardous substances to the environment from the abandoned Blackjack Mine Site located near the town of Granite in Grant County, Oregon. The site is about 2 acres and consists of an adit that is sealed off with a bulkhead with a pipeline that drains mine water from the adit to a settling pond channel away from Clear Creek for the purpose of protecting threatened salmonids. An uncontrolled release of mine water is occurring from a lower adit and entering the Clear Creek floodplain. There is a small former settling pond that was breached and there are approximately 1,400 cubic yards of waste rock on top of native soils, most of which is on a steep slope that has the potential to erode.

This EE/CA is being prepared under the Comprehensive Environmental Response and Liability Act cleanup authorities [42 USC 9604(a) and 7 CFR 2.60(m)] and associated regulations in 40 CFR 300.415(b). The purpose of this EE/CA is to select a preferred alternative to minimize or eliminate any release or threat of release of a hazardous substance into the environment or impact on public health and welfare.

The scope of the removal action is to prevent or reduce the potential of mining-related materials to cause unacceptable levels of risk to humans and the environment, while attaining applicable or relevant and appropriate requirements (ARARs) to the extent practicable.

Based on the results of the streamlined human health and ecological risk assessments, unacceptable hazards and risks to human health are not expected based on the current site configuration, and terrestrial ecological receptors are not adversely affected. Therefore, preliminary remedial goals were not developed. Furthermore, the USFS is in the process of designing and installing a new pipeline system to control mine drainage from both the upper and lower adits. This system is expected to provide additional protection for aquatic resources in Clear Creek. In accordance with 40 CFR 300.410(e)(2)(f)(5), this EE/CA process is determined complete because the amount, quantity, or concentrations released do not warrant further response at this time. The existing USFS long-term monitoring and maintenance plan for the pipeline system will further assure that the ecological values of Clear Creek are protected.

1.0 INTRODUCTION

This report presents the results of an Engineering Evaluation/Cost Analysis (EE/CA) for the Blackjack Mine Site (Site) located in the Umatilla National Forest near Granite, Oregon. The report was prepared for the U.S. Department of Agriculture, U.S. Forest Service (USFS) Region 6 under Contract Number 53-05K3-4-0021, Task Order SAIC-4-001 pursuant to 42 USC 9604(a), 7 CFR 2.60(m), and Federal Executive Order 12580. The report complies with the provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300.415(b)(4)(i), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The purpose of this EE/CA is to select an alternative that would minimize or eliminate the risk of a release from the mine that could adversely affect the environment or public health and welfare as stipulated in 40 CFR 300.415(b)(2)(i)-(viii). This EE/CA has been prepared utilizing the U.S. Environmental Protection Agency (USEPA) "Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA" (USEPA 1993).

2.0 SITE CHARACTERIZATION

2.1 Site Description and Background

The following sections present information on site location and status, previous removal actions, physiography, climate, geology/soils, hydrogeology, hydrology, surrounding land use, and sensitive ecosystems. Additional descriptions of the Blackjack site are contained in the Site Inspection (SI) report (EA Engineering 2003).

2.1.1 Site Location and Status

The abandoned Site is located off USFS Road 13, approximately 4.5 miles southwest of the town of Granite, in Grant County, Oregon. The Site is located on the west side of Clear Creek within the Granite Mining District (Figure 1) at latitude 44° 47' 09' North, longitude 118° 27' 59" West, in Section 14, Township 9 South, Range 35 East, Willamette Meridian.

Mining in this area began in the 1860s with the discovery of placer deposits in the gravels of Granite Creek, and in tributaries including Clear Creek. Placer mining was followed by lode mining as the gold was traced back to its sources. Limited information exists regarding the historical workings of the Blackjack Mine or production estimates. Mining claims at the Site have dated back to 1898, proof of labor was filed with the County in 1902, and a tunnel was first mentioned in 1915. The historical records suggest that the mine had approximately 3,000 feet of underground workings and had been intermittently worked up to 1950 (EA Engineering 2003). Additional historical details about the Blackjack Mine are provided in the SI report.

The Site covers approximately 2 acres and contains an upper and lower adit or entrance. The upper adit is located approximately 90 vertical feet above Clear Creek and is plugged with concrete. A four-inch diameter PVC pipe protrudes from the plug and is connected to a short length of four-inch pipe that discharges into a larger six-inch diameter pipe. This mine water drainpipe continues out of the portal and is buried below a trail leading to the north. The drainpipe then crosses the valley bottom and a county road for a distance slightly over 1,000 feet north of the portal. Just before the county road, it travels through an 18-inch diameter corrugated HDPE pipe to the settling pond east of the road. During the September 2004 supplementary sampling event, some leakage was occurring at one of the downstream cleanouts located on the east side of Clear Creek.

The lower adit has a collapsed portal and is located approximately 30 vertical feet above Clear Creek. This adit drains into the west floodplain adjacent to Clear Creek.

A total of 1,400 cy of waste rock was found to be located at the upper south adit. EA Engineering (2003) reported that 12 cy of waste rock was located at the lower north adit. Based on the appearance of the north adit, it is likely that the volume of waste rock located in that area is somewhat larger. An inactive settling pond (dry at the time of sampling in 2003 and 2004) is located on the south portion of the Site, west of Clear Creek. This pond was used to collect the upper adit water prior to installation of the current drainage pipe.

The primary focus of investigations has been on potential impacts of drainage from the underground mine workings at the Site and associated sediment ponds/waste piles. Sulfide minerals present in the deposits can react with groundwater, producing a low pH solution (known as acid mine drainage, or AMD) which can transport metals from the deposit to local surface water. The acidic water tends to mobilize heavy metals into solution. Metals found in the waste piles may also pose a threat to human health and the environment. In 1996, the USEPA collected and analyzed surface water and sediment samples from the Site and reported that several metals in each medium exceeded preliminary risk-based screening guidelines (USEPA 1997a). In the summer of 2003, a site investigation was conducted by a USFS contractor, and a Site Inspection (SI) report was completed in December 2003 (EA Engineering 2003). The data presented in the SI report, and supplemental information collected by SAIC in September 2004, form the basis of this EE/CA. The Site physiography, climate, geology, hydrogeology, and hydrology are described in the SI and not repeated here.

In 2003, discharge from the lower adit was measured at 2.33 gallons per minute. However no flow measurements from the upper adit were obtained in 2003. In September 2004, discharge from the main upper adit was measured at approximately 80 gallons per minute and discharge from the lower adit was measured at 4 gallons per minute.

2.1.2 Previous Removal Actions

USFS efforts to prevent AMD from the upper adit from entering Clear Creek began in the 1960s. This work included the installation of a 4-inch PVC pipe that routed the adit drainage to the old south settling pond. Over time, this pipe was broken and the drainage entered Clear Creek directly from the adit.

In the 1980s, a concrete plug was installed in the mine portal with a 6-inch drain pipe to divert the AMD into a channel in the dredge tailings. Periodic maintenance of this drainpipe has continued. The volume of contaminated water diverted by this drainpipe is unknown. Implementation and maintenance costs over the years have not been tabulated.

2.1.3 Surrounding Land Use

The Blackjack Mine is on lands administered by the Umatilla National Forest. The nearest private lands occur approximately 0.5 mile north and about one mile south of Blackjack. Mining is the predominant land use on private property in the watershed. Numerous claims are active, especially upstream of the Site and there are several private land parcels in the area such as the “Red Boy Mine” located north of the Site. Recreation is common in the area, consisting of hunting, hiking, and camping at scattered locations. The hunting season typically begins in October and extends through November. Other than tribal ceremonial fishing, fishing is not allowed in Clear Creek due to the salmon restoration program. USFS Road 13 is used as a groomed snowmobile trail between December and March. The small town of Granite, approximately four miles from the Site, provides limited goods and services.

2.1.4 Sensitive Ecosystems

Clear Creek is a sensitive environment that functions as a migratory pathway and spawning area critical to the maintenance of anadromous fish species.

Threatened, Endangered, and Sensitive Species. Two federal-listed threatened species have been reported in the reach of Clear Creek found within the project area: bull trout (*Salvelinus confluents*) and steelhead (*Oncorhynchus mykiss*). These species are designated by the State of Oregon as sensitive-critical species (bulltrout) and sensitive-vulnerable species (steelhead).

The westslope cutthroat trout (*Oncorhynchus clarki lewisi*), reported within 2 miles of the Site, is designated as a federal species of concern and a state-sensitive species. The interior redband trout (*Oncorhynchus mykiss gairdneri*), a state-sensitive species, is also common in Clear Creek. The Columbia spotted frog (*Rana luteiventris*), a state-sensitive species, has been observed in a side channel of Clear Creek.

Wetlands and Wildlife Breeding Areas. The portion of Clear Creek, found within the Site vicinity, is characterized as *riverine, upper perennial, unconsolidated bottom, permanently flooded*. There are several small wetland ponds across from the Blackjack Mine Site on the east side of USFS Road 13. These ponds currently receive mine drainage water from Blackjack and have variable classifications according to the National Wetlands Inventory. There are no known designated wildlife breeding areas located in the Site vicinity. A designated Wild and Scenic River, the North Fork John Day River, is approximately 15 miles north of the Site.

2.2 Source, Nature, and Extent of Contamination

This section describes the nature and extent of environmental contamination at the Blackjack Mine Site. The primary source of information and data for the Site is provided in the SI report (EA Engineering 2003). In September 2004, SAIC conducted a supplemental investigation to assess current conditions and to fulfill potential data gaps. Photographs from this investigation are provided in Appendix B.

The 2004 investigation also included the collection of water samples from both the upper and lower adits. These samples were analyzed for total and dissolved metals. A composite soil sample, blended from three locations from the main waste rock pile, was also collected and analyzed for total metals, paste pH, acid-base accounting parameters, and TCLP/SPLP leach procedures. The analytical results from these samples are summarized in Appendix C, and all of the laboratory data sheets are located in the USFS work file.

2.2.1 Surface Water

This section provides a brief summary of the SI surface water data supplemented by data collected in 2004. Detailed analytical results are provided in the SI. Specifically, surface water sample results for filtered (dissolved) constituents are presented in Table G-1 of the SI report and unfiltered (totals) data are presented on page 148 of the SI report. The 2004 Blackjack Mine Site water sample results are provided in the summary table in Appendix C. Sample locations are shown on Figures 1 and 2 of the SI report.

Clear Creek. Eleven surface water samples were collected in Clear Creek downstream of the Site, and 2 samples were collected upstream of the Site. Concentrations of barium and lead exceeded initial risk-screening values in the SI; however, these concentrations were within the upstream background values. Hardness values in the Creek ranged between 84 and 172 mg/L $CaCO_3$ with a mean of 114 mg/L. The field pH values for Clear Creek indicated slightly alkaline conditions with values ranging from 7.8 to 8.4 standard units.

Settling Pond. Three pond water samples were collected from the settling pond adjacent to, and downstream of the Site discharge pipe. Aluminum, barium, cadmium, cobalt, iron, manganese, nickel, selenium, and zinc were identified in the SI as exceeding one or more conservative risk-screening values. The water chemistry data for total constituents (including suspended solids), indicate that aluminum, iron, and manganese are precipitating out in the ponds as the water oxidizes. Hardness of the pond water averaged 150 mg/L $CaCO_3$ and field pH ranged from 5.94 to 6.26. Dissolved oxygen in the pond water was slightly less than in Clear Creek.

Adits. Two water samples were collected from the main (upper) adit (one in 2003 and one in September 2004). Another water sample was collected in 2004 at the lower iron seep. The concentrations of barium, iron, manganese, mercury, and nickel exceeded SI ecological screening values in both upper adit samples (2003 and 2004 sampling events). The pH of the mine water was 5.49 in 2004 and 6.03 in 2003. The lower adit seep water pH was 5.82. The main adit discharges approximately 14 pounds of iron per day (lbs/day) into the settling pond and about 2 lbs/day of manganese. Loading from the lower adit seep is about 1 lb/day of iron.

2.2.2 Sediment

Eleven sediment samples were collected (and co-located with the surface water samples) in Clear Creek downstream of the Site for the SI. Three sediment samples were collected upstream of the Site. No additional sediment samples were collected in 2004. The sediment samples are representative of only the fine fraction of the substrate habitat. Most of the substrate of Clear Creek is comprised of gravels, cobbles, and boulder-sized materials. Most of the streambed has been substantially altered as part of the recent salmon restoration program.

Arsenic, total chromium, copper, manganese, nickel, and silver were noted in the SI as exceeding conservative sediment benchmark levels; however, none of these metals was notably above concentrations detected in the reference upstream samples. Detailed analytical results are provided in the SI, Table G-3.

The highest concentration of several metals in the Creek sediments was from samples collected from a side channel pool (Station BLAC-42) (see Figure 1). It appears this location may have been an old remnant of a receiving pond near the Red Boy mine and may not have been disturbed during the Creek restoration program.

Three sediment samples were also collected in the settling pond channel that receives the Blackjack Mine water. Antimony, arsenic, cadmium, total chromium, copper, manganese, mercury, nickel, and zinc were found in concentrations above preliminary screening values in these pond sediments. This is due to the precipitation of iron oxide and oxyhydroxide metal complexes from the mine water.

2.2.3 Groundwater and Pore Water

Groundwater in the immediate vicinity of the Site is not used as drinking water source. Thus the groundwater exposure pathway is considered to be incomplete. Additional investigation and characterization of deep groundwater is not warranted.

Due to the potential that chemicals from the settling pond water might migrate through the substrate and enter Clear Creek, eight pore water samples were collected from the creek downstream of the Site, but upstream of Congo Gulch. Two pore water samples were collected upstream of Blackjack. Barium and one sample of mercury (BLAC-02 [see Figure 1]) exceeded SI ecological screening values. An extremely high concentration of aluminum (431 µg/L) was detected at station BLAC-42. No other metals in this sample were significantly elevated relative to other samples; therefore, this value is considered an outlier. Hardness and pH of the creek pore waters were similar to the co-located surface water samples. Pore water sample data are presented in SI Table G-2

2.2.4 Air

The most likely source of air emissions related to the Site would be particulate matter blowing from the waste piles. However, most of the waste rocks are too large to be mobilized by wind, so data on particulate matter emissions from the waste piles were not collected. Remediation of the Site should address dust concerns that may affect remedial workers.

2.2.5 Soil/Waste Material

Six soil/waste samples were collected from the Site as part of the SI, along with two background soil samples. One additional sample, a composite from three locations on the largest mine waste pile, was collected in September 2004. Aluminum, antimony, arsenic, cadmium, total chromium, copper, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc were reported above the preliminary screening values in the SI. Detailed analytical results are provided in Table G-4 of the SI, and the 2004 data are provided in the summary tables of Appendix C. In general, the highest metal concentrations were found in the former south settling pond. This is due to the precipitated iron-metal complexes that formed when the adit mine water was diverted into the pond during the 1970s and 1980s. The average arsenic concentration in Blackjack soils/wastes (25.2 mg/kg) is about three times that of background soils (8.1 mg/kg).

The SI Report (EA Engineering 2003) estimated a total of 77 cubic yards of waste rock located at the Blackjack upper adit and an additional 12 cubic yards located near the lower caved adit. SAIC estimated the total volume to be approximately 1,400 cubic yards. This volume was calculated by using the two-foot contour interval survey map provided by the USFS. The original ground surface below the waste rock pile was estimated and the volume was calculated using this estimate. This estimate of waste rock volume for the Site resulted in a significantly higher total volume than that estimated in the SI Report. The accuracy of the volume estimate is plus or minus 30 percent. This level of accuracy is due to the difficulty of projecting ground surface below the pile given the steep topography of this location.

Additional precision in measurement of the waste rock volume could be determined by measuring the actual contact of the waste rock pile with the original steep underlying ground surface. This could be accomplished either by drilling, trenching, or using appropriate geophysical methods. The total volume of 1,400 cubic yards was used for all calculations in this EE/CA.

2.2.6 Plant Tissue

Two plant tissue samples of wild strawberry were collected from the Site; one near the main upper adit and one near the lower adit. Iron, manganese, zinc, and cyanide were elevated in the sample from the lower adit relative to two background tissue samples. Cyanide has never been detected in any soil/waste or sediment samples. There was no known processing of material at the Site. It is likely that the cyanide detection is an anomaly. The tissue sample near the upper adit was notably higher in zinc than background tissues samples. Tissue data are presented in Table G-5 of the SI report.

3.0 STREAMLINED RISK EVALUATION AND ASSESSMENT

3.1 Streamlined Human Health Risk Evaluation

A human health risk evaluation (HHRE) is a streamlined analysis of the potential adverse health effects that could result from current or future exposures to hazardous substances released from a site, in the absence of any action to control or mitigate these releases. The HHRE incorporates analytical data and information on potential exposure pathways gathered during preparation of the SI and EE/CA, and uses default exposure assumptions where applicable to develop risk estimates for this Site. The HHRE was conducted in accordance with ODEQ guidance (ODEQ 2000) and relevant EPA guidance (USEPA 1989), and is provided in Appendix A, Part 1.

The following are primary elements of the HHRE:

- **Identification of contaminants of potential concern:** Evaluation of site data and identification of elevated concentrations of contaminants in site media.

- **Exposure assessment:** Development of a conceptual site model and identification of potential exposure pathways under current and future land uses, and development of a quantitative estimate of exposure.

- **Toxicity assessment:** Identification of toxicity values for use in quantifying carcinogenic and non carcinogenic risks associated with exposure to site-related chemicals.

- **Risk characterization:** Development of quantitative risk estimates using potential exposure and toxicity information previously developed for the contaminants of potential concern (COPCs).

3.1.1 Contaminants of Potential Concern

All data collected during the SI and 2004 supplemental sampling were screened using the Oregon Department of Environmental Quality (ODEQ) screening protocol (ODEQ 2000). The screening results are presented in Appendix A. Twenty four inorganic chemicals were identified as Chemicals of Interest (COIs) for the Site: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, cyanide, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

As allowed by ODEQ guidance, COIs were eliminated if the frequency of detection was less than 5 percent or if they were detected at concentrations less than background.

Maximum concentrations of the remaining COIs were screened against EPA Region IX Preliminary Remediation Goals (PRGs; USEPA 2004b). In addition to individual screening, ODEQ requires consideration of multiple chemical COPCs and, where more than one medium is contaminated, multiple media COPCs. Industrial PRGs were selected as the most appropriate screening criteria for soils and sediment. Because there are no industrial PRGs for water, tap water PRGs were used to represent a very conservative screen for surface water.

Based on this screening process, the following human health COPCs were identified for the Blackjack Mine Site:

- Soils/wastes: arsenic, iron

- Surface water: arsenic
- Sediment: aluminum, arsenic
- Multiple media: aluminum, arsenic, iron

3.1.2 Exposure Assessment

A recreational visitor hiking in the vicinity of the Site was identified as the most conservative (i.e., health protective) scenario. Exposure to COPCs was evaluated for incidental ingestion of and dermal contact with surface soil, waste rock and sediment, and inhalation of airborne particulates. In addition, it was conservatively assumed that a hiker may swim in the salmon pond downstream of the Site. Incidental ingestion of surface water while swimming was evaluated. In addition, USFS or contract maintenance workers may be involved in maintenance of culverts or discharge pipes at the Site for two days per year (quarterly, for 4 hours each visit); potential exposure to COPCs by a maintenance worker was evaluated in this HHRE.

Exposure assumptions include factors such as body weight, averaging time, exposure frequency, and exposure duration. For purposes of this streamlined HHRE, calculations were performed using reasonable maximum exposure (RME) default assumptions based on EPA and ODEQ guidance.

Because the RME scenario is evaluated in this streamlined HHRE, statistical analysis and calculation of the 90 percent upper confidence limit (UCL90) on the mean was used to estimate the EPC. If the UCL90 was greater than the maximum detected concentration, then the maximum detected concentration was used as the EPC. The EPCs used to calculate risks are presented in Appendix A-1.

3.1.3 Toxicity Assessment

The objectives of the toxicity assessment were to evaluate the inherent toxicity of the COPCs, and to identify and select toxicity values for use in calculating human health risk. Toxicity values are used to quantify the relationship between the level of exposure to a COPC and the potential increased likelihood and/or severity of adverse health effects. The sources used to obtain toxicity information and methods for deriving toxicity criteria are presented in Appendix A-1.

Both cancer and non cancer health effects were evaluated quantitatively. Dose-response estimates are presented as reference doses (RfDs) for non-carcinogenic effects (those not related to cancer) and cancer slope factors (SFs) for carcinogenic effects.

3.1.4 Risk and Hazard Estimates for the Recreational Receptor

The HHRE results for a recreational visitor are summarized below.

COPC	Excess Cancer Risk	Hazard Index
Aluminum	NA	0.0006
Arsenic	7E-7	0.01
Iron	NA	0.03
Total	7E-7	0.04

Cancer risks and non cancer hazards to the recreational visitor do not exceed levels of concern for any of the exposure pathways evaluated.

3.1.5 Risk and Hazard Estimates for the Maintenance Worker

Risk results for the maintenance worker are summarized below.

COPC	Excess Cancer Risk	Hazard Index
Aluminum	NA	0.00009
Arsenic	1E-7	0.0009
Iron	NA	0.004
Total	1E-7	0.005

Cancer risks and non cancer hazards to maintenance workers do not exceed levels of concern for any of the exposure pathways evaluated.

3.1.6 Determination of Hot Spots

An assessment of hot spots is performed by comparing the concentration of a site contaminant to its "highly concentrated" hot spot level, defined as the concentration corresponding to a lifetime cancer risk of 1E-4 for carcinogens and a hazard quotient of 10 for non carcinogens.

No contaminants were present at levels above their "highly concentrated" hot spot level.

3.1.7 Human Health Risk Evaluation Summary

The human health conceptual site model is presented in Figure 1 of Appendix A, Part 1. Of the 23 COIs detected at the Site, only aluminum, arsenic, and iron were identified as COPCs. Exposure to these three chemicals was evaluated quantitatively in this HHRE. Based on current and projected future land use, individuals who may come in contact with site-related contaminants during recreational activities such as hiking or swimming, and USFS employees or contract workers involved in maintenance of culverts and discharge pipes were identified as potential receptors. Results of the HHRE indicate that the potential for carcinogenic and noncarcinogenic human health impacts resulting from exposure to site contaminants is low. Concentrations of constituents in soils, waste rock, surface water, and sediment did not exceed the regulatory standards, and therefore risk-based cleanup goals were not calculated.

3.2 Streamlined Ecological Risk Assessment

This section summarizes the Streamlined Ecological Risk Assessment (ERA) that is presented in Appendix A, Part 2. The ERA was conducted in accordance with ODEQ guidance (ODEQ, 2001) and consistent with EPA guidance (USEPA 1997, 1998). The purpose of the streamlined ERA is to provide an understanding of the potential for ecological risks due to mine-related contamination and to determine whether there is a need for more detailed ecological risk assessment. The ERA provided a discussion of the following components:

- A problem formulation that includes identification of contaminants of interest (COIs) based on site uses and existing data
- A description of the ecology of the site and potential ecological receptors (including rare, threatened, and endangered species) at or near the site
- A conceptual site model that provides a summary of potential exposure media and pathways
- Assessment and measurement endpoints
- Risk screening of the COIs in each media to identify contaminants of potential ecological concern (CPECs)

- Risk characterization to assess the potential for significant ecological effects due to site-related contaminants

Ecological conditions were documented in the SI report and during supplemental Site visits on September 8-10 and on October 5, 2004. An ODEQ ecological scoping checklist was also completed and is provided with the ERA in Appendix A, Part 2.

The conceptual site model presented in Figure 1 in the Ecological Risk Assessment in Appendix A, Part 2 outlines the sources of contamination, contaminant release and transport mechanisms, impacted exposure media, and exposure routes for ecological receptor types at the Site. Threatened salmonids, other fish, and macroinvertebrate communities of Clear Creek may be exposed to contaminants from failures of the existing discharge pipes or of the side sediment ponds where mine water could directly enter the creek. Organisms in Clear Creek may also be exposed to potential discharge of contaminated groundwater from the side channel ponds and from the small adit seep.

Plants growing on contaminated soils or waste materials may uptake and bioaccumulate chemicals that may become toxic or could be transferred through the food web. Local small mammals and ground birds (e.g., grouse) may be exposed to contaminants in waste rock piles and from the lower adit seep, via direct contact and/or incidential ingestion. Larger mammals and birds with greater home ranges may occasionally be exposed to the mine waste materials.

3.2.1 Summary of Risks to the Aquatic Ecosystem

There were no contaminants of interest identified in Clear Creek surface waters and pore waters. Copper, iron, and mercury were identified as Chemicals of Potential Ecological Concern (CPECs) in Clear Creek sediments; however, their risk ratio (the exposure concentration divided by the sediment screening value) ranged from 0.2 for mercury to 1.3 for arsenic. These low risk ratios suggest that the fine sediment fraction in the Creek does not pose an adverse risk or threat to aquatic resources. Fish population data, macroinvertebrate community data, and aquatic habitat assessment data were also evaluated. Using the weight-of-evidence approach, it was concluded that Clear Creek currently is not being adversely affected by the Site. However, the uncontrolled release of mine water and associated iron precipitates from the lower adit directly into Clear Creek should be prevented. The USFS is currently planning to install a new pipeline system that will prevent this.

3.2.2 Summary of Risks to the Terrestrial Ecosystem

The ODEQ risk-screening methodology for terrestrial receptors was used in the streamlined ERA. Concentrations of chemicals of interest in the soil/waste materials were compared with soil screening values for four terrestrial receptor groups (plants, invertebrates, birds, and mammals). Risk ratios were determined for two primary source areas, the former old south settling pond and the large waste rock pile near the upper Blackjack portal. The main waste rock pile had risk ratios > 1 for several contaminants. Mercury had the highest ratios (>5) for plants and invertebrates. The remaining CPECs have ratios ranging from <0.1 to 5, suggesting a low risk potential from individual contaminants; however, the presence of multiple contaminants suggests that some low-level or chronic risks primarily to invertebrates and plant receptors may occur. The waste rock and iron precipitate in the old settling pond lack soil horizons and nutrients. Consequently, the material does not provide quality habitat for soil organisms or vertebrates. The plant tissue data from the Site did not show unusual levels of metals uptake, with most metals being within background tissue concentrations. Leach testing of the waste pile indicates that contaminant release potential is negligible, is not of regulatory concern and this low release potential suggests a minimal potential for bioavailability of these metals to terrestrial receptors. Given these conditions, the relatively low risk ratios, and small extent of the waste material (< 0.5 acre), risks to terrestrial receptors are considered low for localized receptors to negligible for wildlife populations of the area.

4.0 SITE CLEANUP CRITERIA

4.1 Applicable or Relevant and Appropriate Requirements

Applicable or Relevant and Appropriate Requirements" (ARARS) are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) site. CERCLA requires that remedial actions attain ARARs to the extent practicable, considering the urgency of the situation and the scope of the action. ARARs are either applicable or relevant and appropriate.

Applicable: A requirement is applicable if the jurisdictional prerequisites of a standard correspond to conditions at the site. Most hazardous waste and material regulations were developed to address active industrial operations and industrial waste disposal activities and, for the most part, were not intended to address remediation after mismanagement had occurred. Therefore, many regulations and statutes are not directly applicable to CERCLA activities, but do contain language that addresses CERCLA site conditions, contaminants, and/or actions that are similar to the intent of the original regulations.

Relevant and Appropriate: Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, are not applicable, but address situations similar to the proposed response action and site conditions. Only those state promulgated requirements that have been identified in a timely manner, consistently applied, and are more stringent than federal requirements would be considered relevant and appropriate.

Although non-promulgated advisories or guidance issued by federal or state government are not legally binding and do not have the status of ARARs, such requirements may be useful and may be considered. "To be considered" (TBC) requirements complement ARARs but do not override them. They are useful for guiding decisions on cleanup levels or methodologies for which regulatory standards are not available. TBCs are included in this analysis in the form of ecological and human health risk benchmark values.

ARARs are chemical, location, or action-specific:

Chemical Specific. Chemical specific ARARs include laws and regulations that regulate the release of hazardous chemicals to the environment. These requirements generally set health or risk based concentration limits or discharge limitations for specific compounds. Many chemicals, particularly in soils, wastes, and sediments, do not have regulatory action levels (i.e., levels above which remediation is required) specifically addressed by ARARs. Therefore, a risk assessment may be performed to identify an action level for a contaminant based on a level of "acceptable" risk defined for the site. The results of a risk assessment can be used as an enforceable standard for remediation of a site.

Location Specific. Location specific ARARs are requirements related to the geographical location of the site (e.g., state regulations) or physical condition of the site (e.g., if the site is in a coastal area, then coastal regulations may apply), and may limit the type of remedial actions that can be implemented.

Action Specific. For the most part, these ARARs are technology- or activity-based requirements, or limitations on actions taken to remediate hazardous waste sites. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. These action-specific requirements do not identify the remedial alternative; rather, they indicate how a selected alternative should be achieved.

Table 1 (following the text) summarizes ARARs by chemical-specific, location-specific, or action-specific regulation.

4.2 ARAR-Based Preliminary Removal Goals (PRGs)

The primary ARAR guiding the removal actions at the Site is the National Recommended Water Quality Criteria: 2002 (USEPA 2002). Actions to date at the Site have piped the adit drainage to a settling pond and away from Clear Creek. ESA-listed Chinook salmon utilize Clear Creek for spawning and rearing. The Endangered Species Act is considered a primary ARAR as well.

4.3 Risk-Based PRGs

According to OAR 340-122-040, removal actions shall be implemented to achieve 1) acceptable risk levels as demonstrated through site-specific risk assessment for both human and ecological receptors; 2) background concentrations for naturally occurring substances; or 3) numeric soil cleanup levels specified in OAR 340-122-045 and the EPA Region 9 PRGs. Because the streamlined human health risk evaluation did not indicate that there were unacceptable risks to humans, a risk-based PRG for humans was not developed. Furthermore, the soil cleanup levels and EPA Region 9 PRGs are screening levels that were used in the risk assessment and are not considered appropriate cleanup levels.

As outlined in the streamlined ecological risk assessment, State of Oregon soil ERBSC's would be highly overprotective of ecological receptors. In addition, population-level effects could only occur for ecological species if the receptors were to forage predominantly at the Site. Considering the localized and small exposure areas, this is unlikely. Furthermore, the habitat lost due to any effects on plants is also unlikely to result in significant effects to upper trophic level species due to the large amount of relatively undisturbed habitats available surrounding the Site. Therefore, risk-based PRGs for ecological receptors were not developed.

5.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

5.1 Scope, Goals and Objectives of the Removal Action

The scope of the removal action is to achieve closure of the Site while attaining ARARs to the extent practicable.

The goal of the removal action for the Site is to achieve final cleanup of mining-related materials to acceptable levels of risk to humans and the environment. As described in the human health risk evaluation, there are no adverse hazards or risks to humans. The ecological risk assessment described the potential threat to Clear Creek (and its threatened salmonids) in the event of uncontrolled discharge of mine water.

Since the evaluation in this EECA indicates that the scope and goal of the removal action are met, no objectives for the removal action were developed and a detailed analysis of removal action alternatives was not performed.

6.0 CONCLUSION AND RECOMMENDATION

Because unacceptable hazards and risks to human health are not expected, and terrestrial ecological receptors are not adversely affected, no further environmental action is warranted for waste rock. The USFS is in the process of designing and installing a new pipeline system to control mine drainage from both the upper and lower adits. This system is expected to protect aquatic resources in Clear Creek. In accordance with 40 CFR 300.410(e)(2)(f)(5), this EE/CA process is completed because the amount, quantity, or concentrations released do not warrant further response at this time.

The existing USFS long-term monitoring and maintenance plan for the pipeline system will further assure that the ecological values of Clear Creek are protected.

USFS 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 USDA Forest Service. The Forest Service has conducted a PRP search relating to this site and has been unable to identify any current claimants or viable PRPs at this time. 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, USDA Forest Service 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’s CERCLIS database. Consistent with the June 24, 2003 OECA/FFEO “Policy on Listing Mixed Ownership Mine or Mill Sites 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 Forest Service and EPA Headquarters before making a determination to include this site on the Federal Agency Hazardous Waste Compliance Docket.

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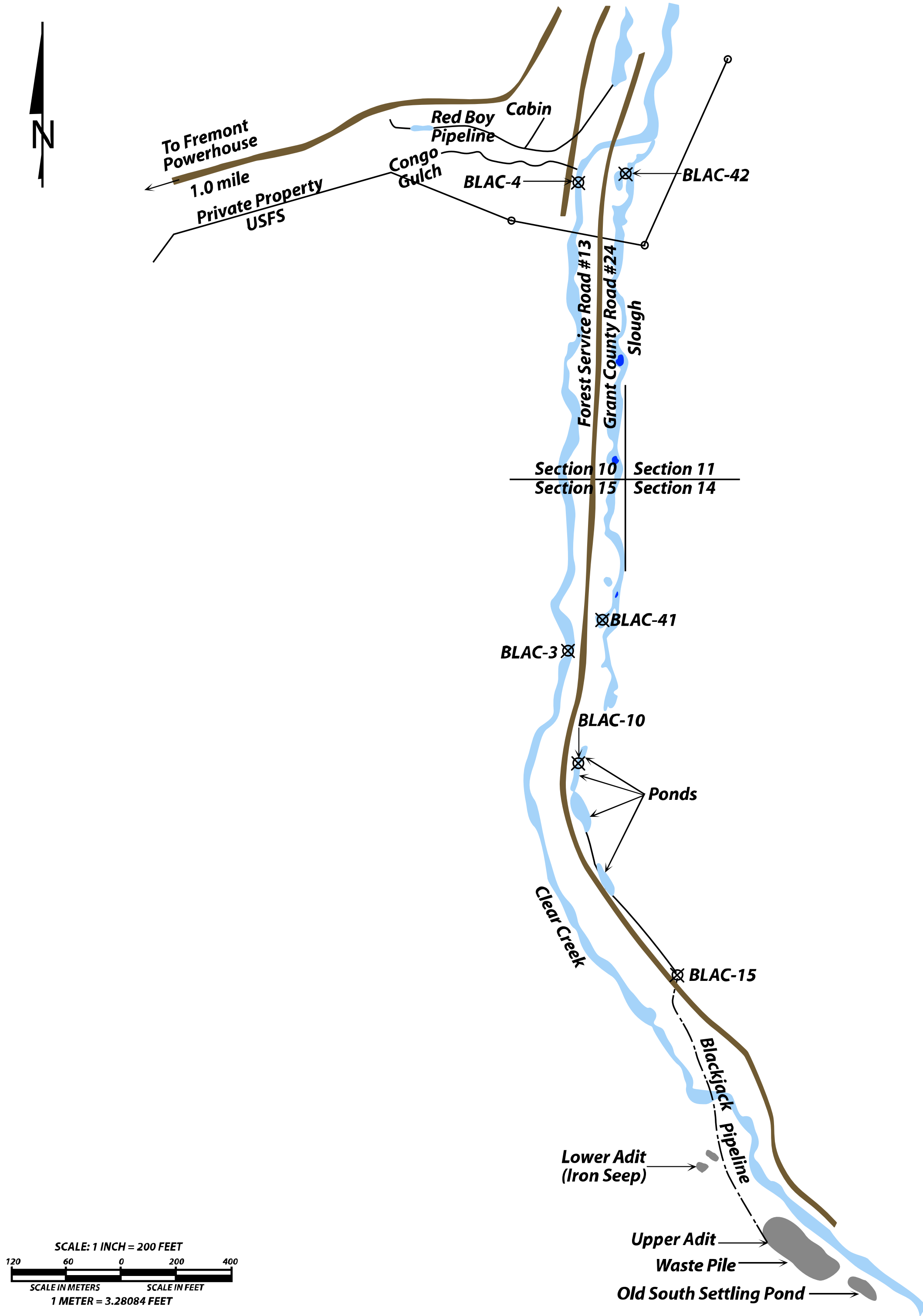

LEGEND

- SAMPLING STATION
- PROPERTY BOUNDARY
- UNDERGROUND PIPE

Figure 1
Blackjack Site Area

SOURCE:
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
UMATILLA NATIONAL FOREST
PACIFIC NORTHWEST REGION

October 1999

TABLES

Table 1: Potential ARARs for Blackjack Mine

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
Chemical Specific ARARs			
FEDERAL			
Safe Drinking Water Act	40 USC § 300		
National Primary Drinking Water Regulations	40 CFR Part 141	Establishes health-based standards, maximum contaminant levels (MCLs), for public water systems.	Not an ARAR, groundwater has been eliminated from the removal action.
National Secondary Drinking Water Regulations	40 CFR Part 143	Establishes aesthetic standards (secondary MCLs) for public water systems.	Not an ARAR, these are not enforceable standards and are outside scope of removal action.
Clean Water Act	33 USC §§ 1251 - 1387		
National Ambient Water Quality Criteria	40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	Not an ARAR since the State of Oregon has been delegated this program.
Clean Air Act	40 USC § 7409		
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes air quality levels that protect public health.	Not an ARAR – only “major” sources are subject to requirements related to NAAQS, defer to state regulation of fugitive dust emissions.
Resource Conservation and Recovery Act	40 USC § 7601		
Lists of Hazardous Wastes	40 CFR Part 261, Subpart D and C	Defines those solids wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271.	Not an ARAR – mine waste is not a listed hazardous waste, Bevill exempt. Even if TCLP testing confirmed a characteristic waste (Subpart C), it is still

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
			exempt. Parts of the RCRA regulations may be relevant and appropriate, however, and are discussed under action-specific requirements.
STATE OF OREGON			
Hazardous Substance Remedial Action Rules	OAR 340-122-84 and 1-115	Establishes DEQ Guidelines for assessing human health and ecological risk assessments on potential adverse affects from contamination according to DEQ risk guidelines and levels.	Relevant and Appropriate Requirement
Preliminary Remediation Goals (PRGs) for soil and water	US Environmental Protection Agency (EPA) Region 9	Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements. The PRGs contained in the Region 9 PRG Table are generic; they are calculated without site specific information. However, they may be re-calculated using site specific data. PRGs should be viewed as Agency guidelines, not legally enforceable standards. They are used for site "screening" and as initial cleanup goals if applicable.	Relevant and Appropriate Requirement
Hazardous Substance Occupational Exposure	OAR 437	Establishes OR-OSHA Permissible Exposure Limits (PELs). OR-OSHA exposure limits mirror the federal chemical specific limits (refer to NIOSH Pocket Guide to Chemical Hazards for details on individual chemicals)	Relevant and Appropriate Requirement
Numeric Soil Cleanup Levels for Motor Fuel and Heating Oil	OAR 340-122-305 through 360	Establish cleanup standards for contamination of soil by motor fuel and heating oil.	Not an ARAR

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
Oregon Soil Cleanup Rules for Simple Sites	OAR 340-122-045 and 046	Establishes DEQ rules for streamlined cleanup processes and numerical cleanup standards at simple sites.	To Be Considered
State of Oregon is authorized by the USEPA to implement the Clean Water Act in Oregon	Clean Water Act – FWQC 40 CFR	Establishes acceptable contaminant levels for ingestion of aquatic organisms and for intake by aquatic organisms in surface water.	Applicable Requirement
Asbestos Removal	OAR 340-32-5620 through 5650	Establish DEQ requirements for licensing and certification for asbestos workers. All workers who handle asbestos-containing materials must meet certain training, licensing and certification requirements.	Not an ARAR
		Location-Specific ARARs	
		FEDERAL	
Resource Conservation and Recovery Act	40 USC § 7601		
Hazardous and Solid Waste Regulations	40 CFR Part 264.18	Location standards and restrictions for hazardous waste treatment, storage, and disposal (TSD) facilities.	Not an ARAR, no materials are being disposed.
	40 CFR §§ 257.3-1 through 257.3-4	Location standards and restrictions for municipal solid waste (MSW) facilities.	Not an ARAR, no materials are being disposed.
National Historic Preservation Act	16 USC § 470; 36 CFR Part 800; 40 CFR 6.301(b)	Requires Federal Agencies to take into account the effect of any Federally assisted undertaking or licensing on any property with historic, architectural, archeological, or cultural value that is included in or eligible for inclusion in the National Register of Historic Places.	Applicable Requirement
Archeological and Historic Preservation Act	16 USC § 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of significant scientific, prehistoric, historic, and archeological data that might be destroyed through	Applicable Requirement

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
		alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	
Protection of Wetlands Executive Order No. 11990	40 CFR Part 6; Appendix A, 40 CFR 6.302(a)	Avoid adverse impacts associated with the destruction or loss of wetlands and avoid support of new construction in wetlands if a practicable alternative exists.	Applicable Requirement
Dredge and Fill Regulations	33 USC § 1344, 33 CFR 323.1 et. seq.	Prohibits discharge of dredged or fill material into waters of the United States without a permit	Relevant and Appropriate Requirement
Fish and Wildlife Coordination Act	16 USC Chapter 49, §§ 2901-2912; 40 CFR 6.302(g)	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body to assure adequate protection of fish and wildlife resources.	Not an ARAR – no stream modification is contemplated for this removal action.
Floodplain Management Executive Order No. 11988	40 CFR Part 6, Appendix A; 40 CFR 6.302(b)	Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain to the extent possible.	Applicable Requirement
Endangered Species Act	16 USC §§ 1531-1543; 40 CFR 6.302 (h); 50 CFR Part 402	Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat.	Applicable Requirement
Bald Eagle Protection Act	16 USC §§ 668 et seq.	Requires continued consultation with the USFWS during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald or golden eagle.	Applicable Requirement
Migratory Bird Treaty Act	16 USC §§ 703 et seq.	Establishes federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	Applicable Requirement

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
		Action-Specific ARARs	
		FEDERAL	
Clean Water Act	33 USC § 1342		
National Pollutant Discharge Elimination System	40 CFR Part 122.26	In general, Part 122 provides permit requirements for the discharge of pollutants from any point source into waters of the United States. Part 122.26 requires permits for storm-water discharges.	Applicable Requirement
Surface Mining Control and Reclamation Act	30 USC §§ 1201-1328	Performance standards for surface mining activities.	Relevant and Appropriate Requirement
Hazardous Materials Transportation Act	49 USC §§ 1801-1813 49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials.	Not an ARAR, no materials are being hauled.
Resource Conservation and Recovery Act	46 USC § 7601		
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities	40 CFR Part 264.13.14	Requirements for proper handling, treatment, storage, and disposal of hazardous wastes.	Not an ARAR, no hazardous materials are being treated, stored, or disposed.
Land Disposal Restrictions (LDRs)	40 CFR Part 268	LDRs place specific restrictions (conc. or trmt) on RCRA hazardous wastes prior to their placement in a land disposal unit. Relevant and appropriate LDR requirements will be met if any material accumulations are treated ex situ.	Not an ARAR, no materials are being disposed.
Disposal of Solid Waste	RCRA 42 U.S.C. § 6901 et seq; 40 CFR 257	Facility or practices in floodplains will not restrict flow of basic flood, reduce the temporary water storage capacity of the floodplain or otherwise result in a wash-out of solid waste.	Not an ARAR, no materials are being disposed.

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
Closure Requirements	RCRA/HWMA 40 CFR & 264, Subpart G	Closure of hazardous waste repositories must meet protective standards. Regulations to minimize contaminant migration, provide leachate collection and prevent contaminant exposure will be met.	Not an ARAR.
Landfill Design and Construction	RCRA/HWMA 40 CFR & 264, Subpart N	Hazardous waste landfills must meet minimum design standards. Protectiveness will be achieved through capping and institutional controls.	Not an ARAR.
Ground Water Monitoring	RCRA/HWMA 40 CFR & 264, Subpart F 40 CFR & 264, Subpart X	Establishes standards for detection and compliance monitoring. Site wide monitoring will accommodate specific ground water monitoring requirements.	Not an ARAR, groundwater is not an impacted media.
Occupational Exposure to Asbestos	29 CFR Parts 1910 and 1926.	Establishes OSHA requirements for asbestos-related work in the construction and demolition industry. Requirements on exposure limits, work practices and engineering controls to provide worker safety in handling, removal, disposal, or other workplace exposure to asbestos.	Not an ARAR.
STATE OF OREGON			
Fugitive Dust Emissions	40 CFR Section 50.6	Establishes standards for PM-10	Applicable Requirement
Asbestos Removal	OAR 340-32-5620 through 5650	Establish DEQ requirements for licensing and certification for asbestos workers. All workers who handle asbestos-containing materials must meet certain training, licensing and certification requirements.	Not an ARAR
	OAR 340-33-010 through 100	Establish DEQ requirements for handling asbestos-containing materials. Handling, removing, transporting and disposing of asbestos material in a manner that prevents it from becoming friable and releasing asbestos fibers.	Not an ARAR.

Appendix A: Risk Assessments

Blackjack Mine Site

Appendix A-1: Streamlined Human Health Risk Evaluation

Blackjack Mine Site

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1.0 INTRODUCTION

A human health risk evaluation (HHRE) was conducted at the Blackjack Mine, located in Umatilla National Forest. The objective of this HHRE was to determine the potential for adverse health effects to human receptors that may be exposed to site-related contaminants in soil and waste rock, sediment, and surface water. The HHRE was conducted in accordance with Oregon Department of Environmental Quality (ODEQ 2000) and U.S. Environmental Protection Agency (USEPA) risk assessment guidance (USEPA 1989, USEPA 2004c).

The HHRE is a streamlined analysis of the potential adverse health effects that could result from current or future exposures to hazardous substances released from the site, in the absence of any action to control or mitigate these releases. The HHRE incorporates analytical data and information on potential exposure pathways gathered during the Site Inspection (SI) and Engineering Evaluation/Cost Analysis (EE/CA), and uses default exposure assumptions where applicable to develop risk estimates for this site.

The following are primary elements of the HHRE:

- **Identification of contaminants of potential concern:** Evaluation of site data and identification of elevated concentrations of contaminants in site media.

- **Exposure assessment:** Development of a conceptual site model and identification of potential exposure pathways under current and future land uses, and development of a quantitative estimate of exposure.

- **Toxicity assessment:** Identification of toxicity values for use in quantifying carcinogenic and noncarcinogenic risks associated with exposure to site-related chemicals.

- **Risk characterization:** Development of quantitative risk estimates using potential exposure and toxicity information previously developed for the contaminants of potential concern (COPCs).

2.0 HAZARD IDENTIFICATION AND SELECTION OF COPCS

This section presents the rationale for the selection of the contaminants of potential concern (COPCs). All data collected during the site investigations were screened using the Oregon Department of Environmental Quality (ODEQ) screening protocol (Guidance for Conduct of Deterministic Human Health Risk Assessments, ODEQ 2000). The screening results are presented in Attachment A. Twenty four metals were identified as Chemicals of Interest (COIs) for the Blackjack Mine site: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, cyanide, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

As allowed by ODEQ guidance, COIs were prescreened based on the following criteria:

- Frequency of Detection – COIs that were detected in less than 5 percent of the samples site-wide were not selected as COPCs. A number of chemicals in soil, sediment and groundwater were deleted on the basis of this criterion.

- Background – Naturally occurring chemicals detected at concentrations less than background were not selected as COPCs.

Several chemicals were eliminated from further consideration based on this prescreening. Tables A-1 through A-3 present the results of the prescreening.

Maximum concentrations of the remaining COIs were screened against En USEPA Region IX Preliminary Remediation Goals (PRGs). In addition to individual screening, ODEQ requires consideration of multiple chemical COPCs and, where more than one medium is contaminated, multiple-media COPCs. Industrial PRGs were selected as the most appropriate screening criteria for soils and sediment. Since there are no industrial PRGs for water, tap water PRGs were used to represent a very conservative screen for surface water.

In addition, essential nutrients (calcium, magnesium, potassium, and sodium) were eliminated as COPCs, as recommended by USEPA guidance (USEPA 1989).

Tables A-4 through A-7 present the chemical screening; Table A-8 summarizes the results of the screening process. The following COPCs were identified for the Blackjack Mine site:

- Soils/Wastes: arsenic, iron

- Surface water: arsenic

- Sediment: aluminum, arsenic

- Multiple media: aluminum, arsenic, iron

3.0 EXPOSURE ASSESSMENT

Assessing the exposure at a given site includes the identification of potentially exposed populations, development of exposure pathways, and calculation of exposure point concentrations and chronic daily intakes.

3.1 Potentially Exposed Populations

The Blackjack Mine site is currently inactive and covers an area of approximately 2 acres on steep hillsides along the west side of Clear Creek within Umatilla National Forest. It is not currently occupied, nor is it expected to be occupied or developed in the near future. The town of Granite, with a reported population of 24, is located about 3 miles from the site (EA Engineering, Science, and Technology, 2003). There are no on-site workers and no people who live within 200 feet of areas of suspected site-related contamination. The nearest private land is approximately 0.6 mile from the site.

Public use of the mine and vicinity is most likely minimal, although public access records are not maintained. Visitors to the site would need to park at a pull-off area along Forest Service Road 13 near the site, and would then need to cross the creek in order to access the site. The creek is generally 1 to 3 feet deep in summer, with greater flows in the spring. Visiting the blocked mine portal would require climbing a steep slope.

There are no designated campsites near the site but dispersed and/or primitive campsites may be located in the general site area. A deep pool is located about 350 feet downstream of the site; recreational visitors may occasionally enter the pool to cool off or view salmon.

There are no attractive ruins or structures on the site that would attract visitors, and the creek serves as an additional deterrent. In addition, the site is a poor location for hunting due to its proximity to the road. Access is currently not restricted by fencing nor were any “No Trespassing” signs noted during the site investigation. Impacts to ecological receptors are addressed in the ecological risk assessment.

To protect Chinook salmon, recreational fishing is prohibited in Granite Creek and its tributaries (including Clear Creek) by the Oregon Department of Fish and Wildlife (ODFW). Local Native American populations may engage in subsistence fishing in this area, however no information on the frequency of this activity was available and no fish tissue data were collected as part of this EE/CA or the earlier SI.

In general, land use in this area is limited to occasional recreational use (hiking, salmon-watching), limited mining, maintenance of culverts and discharge pipes, and potentially subsistence fishing.

3.2 Current and Potential Future Receptors

The Blackjack Mine site is located within the Umatilla National Forest; it is not currently occupied, nor is it expected to be occupied or developed in the near future. The likely current and potential future receptors identified for the site are recreational visitors and U.S. Forest Service or contract maintenance workers. It is assumed that recreational visitors may include both adults and children; maintenance workers are assumed to be adult only. While subsistence fishing may occur in this area, no fish tissue data were collected and therefore potential exposures to this receptor were not quantified as part of this HHRE.

3.3 Identification of Potential Exposure Pathways

This section identifies potential pathways for human exposures to the COPCs. In general, an exposure pathway consists of four elements: a source of chemical release into the environment, an environmental medium for transport of the chemical (e.g., air, groundwater or soil), a point of potential human exposure (the exposure point), and a route of exposure of the chemical into the body (e.g., breathing, eating, drinking or skin contact). The conceptual site model is presented as Figure 3-1.

Although the risk of long-term exposure to contaminants at the site is considered low, the ingestion, dermal contact and air exposure pathways are considered complete, because recreational visitors and maintenance workers have the potential to access contaminated soil or waste, sediment, or surface water.

3.4 Exposure Scenarios

At the Blackjack Mine site, a recreational visitor hiking in the vicinity of the site was identified as the most conservative (i.e., health protective) scenario. Because of its steep slopes, camping was not believed to be a relevant exposure scenario. Exposure to COPCs was evaluated for incidental ingestion of and dermal contact with surface soil, waste rock and sediment, inhalation of airborne particulates, and incidental ingestion of surface water while swimming. In addition, maintenance workers may be involved in maintenance at the site for two days per year (quarterly, 4 hours per visit); therefore, potential exposure to COPCs by a maintenance worker was also evaluated in this HHRE.

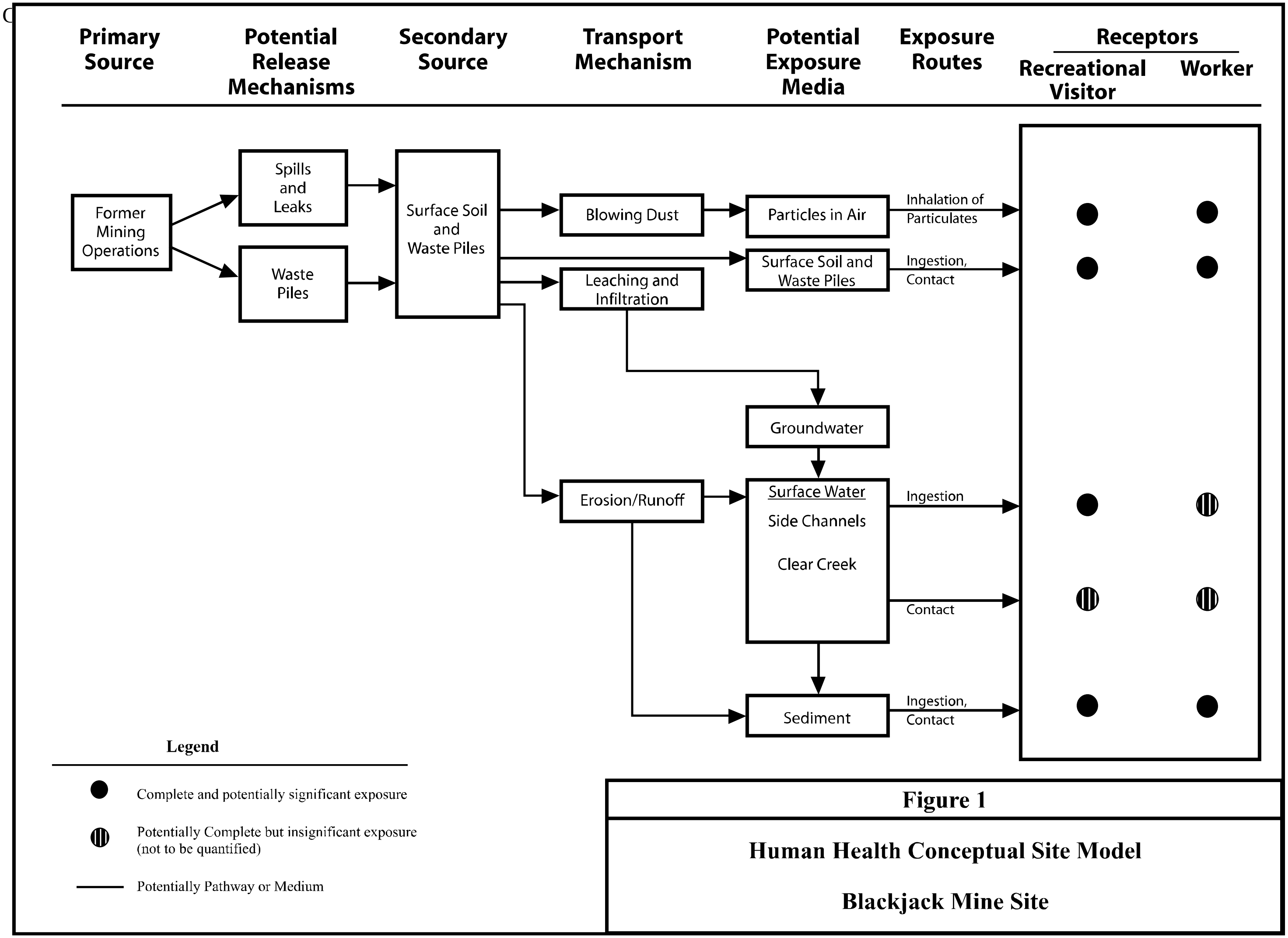

Figure 1

Human Health Conceptual Site Model

Blackjack Mine Site

3.5 Exposure Assumptions

Exposure assumptions include factors such as body weight, averaging time, exposure frequency, and exposure duration. For purposes of this HHRE, initial calculations were performed using reasonable maximum exposure (RME) assumptions, which are discussed below. If the RME assumptions result in a determination that potential risks are above levels of concern, central tendency exposure (CTE) assumptions will be used to develop estimates of risk for average exposures.

Default exposure assumptions, based on USEPA and ODEQ guidance, were used when available. These include body weight, exposure duration, averaging time, soil adherence factor, skin surface area, inhalation rate, and water ingestion rate. Assumptions that do not have default values are discussed below. All exposure assumptions are presented in Attachment B, Tables B-1 through B-2.

Exposure Frequency: Exposure frequency is the number of days per year that an individual participates in a particular activity. A recreational visitor was assumed to hike at the site once per month during the warmer months of May through October, or a total of 6 times each year. For the maintenance worker, exposures were assumed to take place two days per year, once in the spring and once in the fall.

Exposure Time for Incidental Soil/Sediment Ingestion: Based on the areal extent of contamination, it was assumed that a recreational visitor would be in contact with contaminated soil or waste rock for 2 hours each day. It was assumed that contact with sediment would occur for 1 hour each day. A maintenance worker was assumed to be in contact with soil and sediment for a standard 8-hour work day.

Sediment ingestion rate and sediment adherence factor were assumed to be the same as for soil. The soil ingestion rate is the default ingestion rate for a residential receptor.

3.6 Exposure Point Concentrations

Exposure point concentrations (EPCs) represent the chemical concentrations in soil, surface water, and sediment that a receptor will potentially contact during the exposure period. The EPC is used to calculate the Intake, or Average Daily Dose (ADD) of a contaminant. Generally, the EPC is not the maximum concentration detected at the site because, in most situations, it is not reasonable to assume long-term contact with the maximum concentration. Average concentrations are used because toxicity criteria are based on lifetime average exposures, and an average concentration is most representative of the concentration contacted over time, based on the assumption that an exposed individual moves randomly across an exposure area.

Exposure to a chemical can be calculated using the EPC in units of mg/L for water, mg/kg for soils/wastes and sediment, or mg/m^3 for air. EPCs are combined with the exposure parameters identified in Section 3.5 above to calculate the intake, or average daily dose of a contaminant. Equations for calculating intake are presented in ODEQ 2000; intakes are presented in Attachment B.

The data for some media at the Blackjack Mine site are limited. Risk calculations were based on 7 soil/waste samples, 11 surface water samples, and 17 sediment samples.

When data sets are small, the maximum detected concentration is used as the EPC. Average concentrations represent more realistic EPCs as they assume equal access to all portions of the site. Because the RME scenario is evaluated in this streamlined HHRE, statistical analysis and calculation of the 90 percent upper confidence level (UCL90) on the mean was used to estimate the EPC. If the UCL90 was greater than the maximum detected concentration, then the maximum detected concentration was used as the EPC.

The UCL90 is a conservative estimate of the mean concentration, and is specified in Oregon's Revised Clean Up Rules, OAR 340-122-084. It is appropriate for use when the data are normally distributed.

ODEQ's spreadsheet for calculation of a one-sided 90 percent upper confidence limit of the mean was used (http://www.deq.state.or.us/wmc/tank/ucls.htm). The EPCs used to calculate risks are presented in Table 1.

Table 1: Exposure Point Concentrations

COPC	No. of Samples	Maximum Concentration	EPC	Comments
Soils/Wastes (mg/kg)				
Aluminum	7	19,300	19,300	MaxDetect[a]
Arsenic	7	82.3	50.9	Lognormal UCL90
Iron	7	459,000	441,000	Lognormal UCL90
Surface Water (mg/L)				
Aluminum	11	0.134	0.068	Normal UCL90
Arsenic[b]	11	0.0028	0.0024	Normal UCL90
Iron	11	0.175	0.083	Lognormal UCL90
Sediment (mg/kg)				
Aluminum	17	42,700	15,200	Lognormal UCL90
Arsenic	17	55.7	40.4	Lognormal UCL90
Iron	17	61,100	35,400	Lognormal UCL90

EPC = Exposure Point Concentration
UCL90 = 90 percent confidence limit on the mean
a The UCL90 of 29,200 exceeded the maximum detected concentration, therefore the maximum detected concentrations was selected as EPC.
b Only one of 11 samples contained arsenic above the detection limit. The normal UCL90 was used to represent the exposure point concentration; however this value likely significantly overestimates the average concentration of arsenic in surface water.

4.0 TOXICITY ASSESSMENT

The objectives of the toxicity assessment were to evaluate the inherent toxicity of the COPCs and to identify and select toxicity values for use in calculating human health risk. The purpose of the toxicity assessment is as follows:

- To identify the cancer and noncancer health effects that may arise from direct or indirect exposure of humans to the COPCs; and
- To provide an estimate of the quantitative relationship between the magnitude and duration of exposure, and the probability or severity of adverse effects.

4.1 Toxicity Values

Toxicity values are used to quantify the relationship between the level of exposure to a COPC and the potential increased likelihood or severity of adverse health effects. The sources used to obtain toxicity information and methods for deriving toxicity criteria are presented below.

Both cancer and noncancer health effects were evaluated quantitatively. Dose-response estimates are presented as reference doses (RfDs) for non-carcinogenic effects (those not related to cancer) and cancer slope factors (SFs) for carcinogenic effects. Some chemicals (e.g., arsenic) may exhibit both types of effects.

The following USEPA sources of toxicity values were used:

- Arsenic: Integrated Risk Information System (IRIS) (USEPA 2004a)
- Iron: National Center for Environmental Assessment, Risk Assessment Issue Paper for Derivation of a Provisional RfD for Iron (USEPA 1999a)
- Aluminum: National Center for Environmental Assessment, as cited in USEPA Region 9's PRG tables (USEPA 2004b).

4.2 Noncancer Health Effects

Noncancer health effects, by definition, include all adverse health impacts other than cancer. For most noncancer effects, protective mechanisms within an individual are assumed to exist that must be overcome before an adverse effect is elicited. The level above which effects may occur is referred to as a threshold level or reference dose (RfD). Examples of noncancer health effects include central nervous system disorders (e.g., neurological damage or impairment), blood disorders (e.g., anemia), organ toxicity (e.g., kidney, liver, and heart effects), reproductive toxicity (e.g., infertility), and developmental effects (e.g., birth defects, miscarriage).

Methods used by USEPA to develop toxicity values for noncancer health effects (RfDs) are described in *Risk Assessment Guidance for Superfund* (USEPA 1989).

The toxicity values for the non-carcinogenic COPCs are listed in Table 2. RfD values for the oral ingestion pathway were available for all COPCs; an RfD value for the inhalation pathway was available only for aluminum.

Table 2: Toxicity Values for Noncarcinogenic COPCs

COPC	*Chronic RfD (mg/kg per day)*		*Uncertainty Factor*		*Critical Effect*
	Oral	*Inhalation*	*Oral*	*Inhalation*	
Aluminum	1.0	0.0014	NA	NA	NA
Arsenic	0.0003	NA	3	NA	Hyperpigmentation, keratosis, and possible vascular complications
Iron	0.3	NA	1	NA	Chronic iron overload

4.3 Carcinogenic Effects

In *Guidelines for Carcinogen Risk Assessment* (USEPA 1986), USEPA described the general framework to be followed in developing an analysis of carcinogenic risk. The Guidelines also identified principles to be used in evaluating the quality of data and in formulating judgments concerning the nature and magnitude of the cancer hazard from suspect carcinogens. The general theory behind cancer development and the process used by USEPA to classify chemicals as carcinogens are described in *Risk Assessment Guidance for Superfund* (USEPA 1989). The derivation of a dose-response relationship for potential and known carcinogens (called a slope factor) is described in USEPA 1989 and the *Proposed Guidelines for Carcinogen Risk Assessment* (USEPA 1996) and *Guidelines for Carcinogen Risk Assessment* (Review Draft; USEPA 1999b).

Arsenic is the only carcinogenic COPC at the Blackjack Mine site. Slope factors for arsenic, in units of $(mg/kg\text{-}day)^{-1}$, are presented in Table 3.

Table 3: Toxicity Values for Carcinogenic COPCs

COPC	Oral SF $(mg/kg\text{-}day)^{-1}$	Type of Cancer	Weight of Evidence	Source	Inhalation SF $(mg/kg\text{-}day)^{-1}$	Type of Cancer	Weight of Evidence	Source
Arsenic	1.5E+00	Skin	A	IRIS	15	Lung	A	IRIS

4.4 Toxicity Summaries

The toxic effects of the COPCs are briefly summarized in the following subsections.

4.4.1 Arsenic

Arsenic is a COPC in soils/wastes, surface water, and sediments at the Blackjack Mine site. Arsenic occurs in soil and rock along with other minerals such as copper, lead, iron, and nickel. It is typically found in soil in the form of an insoluble sulfide. Naturally occurring arsenic concentrations in soil range from 1 to 40 mg/kg, with a mean concentration of approximately 5 mg/kg. The maximum concentration limit (MCL) for arsenic in drinking water is 10 µg/L.

Inorganic arsenic (the form typically found in soil or water) is often in a form that is readily absorbed by ingestion. Following absorption, it is distributed throughout the body. Studies with laboratory animals suggest that the bioavailability of arsenic in soil may be lower than that of arsenic ingested in solution. The issue of arsenic bioavailability is especially important at mining, milling, and smelting sites because the arsenic at these sites often exists, at least in part, as a poorly soluble sulfide and may also occur in particles of inert or insoluble material. These factors all tend to reduce the bioavailability of arsenic.

The distinguishing adverse effects associated with chronic ingestion of arsenic are skin lesions (hyperkeratoses and hyperpigmentation) and skin cancer. Other adverse effects due to ingestion exposure include cancer of the internal organs (prostate, liver, bladder, and kidney). USEPA has given arsenic a carcinogenicity weight-of-evidence classification of Group A (human carcinogen) based on sufficient evidence of cancer mortality from both ingestion and inhalation exposures in human populations. The International Agency for Research on Cancer classifies arsenic as a proven human carcinogen.

The oral reference dose (RfD) is based on the occurrence of hyperpigmentation and hyperkeratosis, and vascular complications observed in a human population ingesting elevated levels of arsenic in drinking water. The oral RfD for arsenic is 0.0003 mg/kg per day (used in this risk evaluation), although strong scientific arguments can be made to adjust this RfD between 0.0001 to 0.0008 mg/kg per day (USEPA 2004c). The oral unit risk factor for estimating excess lifetime cancer risks is based on the incidence of skin cancer observed in a human population ingesting elevated levels of arsenic in drinking water.

The oral unit risk factor for estimating excess lifetime cancer risks is based on the incidence of skin cancer observed in a human population ingesting elevated levels of arsenic in drinking water. Using the assumptions of 2 L/day drinking water consumption and 70-kg body weight, this unit risk factor converts to an oral slope factor of 1.5 (mg/kg per day)-1. It should be noted that USEPA's assessment is based on prevalence of skin cancer rather than mortality, because the types of skin cancer produced by arsenic are not normally fatal (USEPA 2004c).

4.4.2 Iron

Iron is a COPC in soils/wastes at the Blackjack Mine site. Iron is a major constituent in rocks and soil generally at concentrations averaging about 2 percent (20,000 mg/kg). Iron is an essential element in human nutrition; however, there is the potential for adverse health effects from excessive ingestion.

Iron bioavailability is important when considering sediment or soil exposure pathways because iron in sediment can exist, at least in part, as poorly soluble salts and may also occur in particles of inert or insoluble material. These factors all tend to reduce the bioavailability of iron.

Chronic overexposure (also known as iron overload) may occur as a result of excessive dietary consumption of iron with accumulation in the liver, spleen, pancreas, endocrine organs, and the heart. Adverse effects may include disturbance of liver function, diabetes mellitus, disturbance of endocrine function, and cardiovascular effects. On a cellular level, increased lipid peroxidation occurs, resulting in damage to the membranes of cell organelles. Elevated exposure to iron is not considered to be associated with reproductive or developmental toxicity.

USEPA's IRIS database does not currently provide a reference dose, cancer slope factor, or other toxicological information for iron (USEPA 2004c). The USEPA Superfund Technical Support Center has developed a provisional oral RfD for iron. USEPA notes that iron is an essential element and that deriving a risk assessment value for it poses special problems in that the dose-response curve is "U-shaped" (i.e., there is a range of doses necessary to maintain health; doses both above and below that range can result in adverse effects). Thus, the provisional RfD must be protective against deficiency as well as toxicity.

The provisional chronic oral RfD is 0.3 mg/kg per day. An uncertainty factor of 1 is supported by the fact that iron is an essential element. This RfD may not be protective of individuals with inherited disorders of iron metabolism and could be conservative if applied to exposure scenarios involving forms of iron with low bioavailability.

4.4.3 Aluminum

Aluminum is a COPC in sediment at the Blackjack Mine site. Aluminum is a silver-white flexible metal with a vast number of uses. It makes up about 8 percent of the earth's crust. Until recently, aluminum has existed in forms not available to humans and most other species. However, acid rain has increased the availability of aluminum to biological systems and has resulted in destructive effects on fish and plant species. It is unknown if humans are susceptible to this increased bioavailability. It is poorly absorbed and efficiently eliminated; however, when absorption does occur, aluminum is distributed mainly in bone, liver, testes, kidneys, and brain. Aluminum may be involved in Alzheimer's disease (dialysis dementia) and in Amyotrophic Lateral Sclerosis and Parkinsonism-Dementia Syndromes of Guam.

The respiratory system appears to be the primary target following inhalation exposure to aluminum. Aluminum has been placed in the USEPA weight-of-evidence classification D, not classifiable as to human carcinogenicity. The National Center for Environmental Assessment (NCEA) has established a provisional oral RfD of 1.0 mg/kg per day, and an inhalation RfD of 1.4E-3 mg/kg per day.

5.0 RISK CHARACTERIZATION

Risk characterization integrates the results of the exposure and toxicity assessments by combining estimates of chemical intake (Section 3.0) with toxicity data (Section 4.0) to determine the likelihood of adverse effects to potentially exposed populations. Risk characterization also serves as the bridge between risk assessment and risk management and is a key step in the ultimate decision-making process (USEPA 1989). Because of the fundamental differences in the mechanisms through which carcinogenic and noncarcinogenic processes occur, risks are characterized separately for these two types of heath effects. This section presents risks for each complete exposure pathway identified during the exposure assessment.

5.1 Noncancer Hazard Quotients

The potential for noncancer health effects was evaluated by comparing the intake of a chemical with the reference dose. The resulting ratio is the hazard quotient (HQ), which is calculated using the following equation:

$$HQ = \frac{Intake}{RfD}$$

Where:

Intake	=	Average daily intake of a chemical (mg/kg per day)
RfD	=	Reference dose (mg/kg per day)

An HQ is not a mathematical prediction of the incidence or severity of effects (i.e., probability), but is instead a numerical index (i.e., a ratio) that can be used to determine if the estimated exposure may present a potential health threat (USEPA 1989). When the daily intake of a chemical exceeds the reference dose (i.e., HQ greater than 1) there is a potential for noncancer health effects.

Noncancer hazards resulting from exposure to multiple chemicals are estimated through the calculation of a hazard index (HI). An HI is a summation of relevant HQ values and is used to determine if an exposed individual is at risk of developing adverse health effects resulting from simultaneous exposure to all selected chemicals by all complete exposure pathways. Risks from exposure to multiple chemicals are assumed to be additive; this does not address potential synergistic or antagonistic interactions.

An HI greater than 1 suggests that simultaneous exposure to all chemicals may present a potential health threat. The level of concern increases as the HI approaches and exceeds a value of 1. HI results greater than 1 should be interpreted cautiously because (1) slopes of chemical-specific dose-response curves may differ substantially, and the respective HQs may not be directly comparable among different chemicals; and (2) the RfDs have varying degrees of confidence associated with them because of the relative strength of the toxicity database for each chemical and the range of uncertainty and modifying factors used in developing the RfD. Under these circumstances (HI greater than 1), USEPA recommends segregating the compounds into groups of like or common toxicological effects and reevaluating the potential for manifestation of the various adverse health effects identified (USEPA 1989).

5.2 Cancer Risks

Potential health risk associated with carcinogens was estimated by calculating the increased probability of an individual developing cancer during his or her lifetime as a result of exposure to a carcinogenic compound. These excess lifetime cancer risks were computed using the estimated chemical intakes calculated in the exposure assessment (Section 3.0) and the cancer slope factors (SFs) identified in the toxicity assessment (Section 4.0). Arsenic is the only carcinogenic COPC that was identified for the Blackbird Mine site.

$$\textit{Cancer Risk} = \textit{Intake} \times \textit{CSF}$$

When calculating cancer risk it can be assumed that the dose-response relationship will be in the linear portion of the dose-response curve according to the following equation:

Where:

Cancer risk	=	A unitless probability of an individual developing cancer
Intake	=	Chemical intake (mg/kg per day)
CSF	=	Cancer slope factor (mg/kg per day)-1

Resulting cancer risks represent the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. Because the SFs are typically the 95th percentile of the probability of a carcinogenic response, the resulting carcinogenic risk estimate is also an upper bound determination. In other words, the true risk is not likely to exceed the estimated risk and is in fact likely to be less. Because 95 percentiles are not truly additive, the total cancer risk may become artificially more conservative as risks from a number of different carcinogens are combined. Thus the total cancer risk may be overestimated because of the combination of conservative estimates of cancer potency used to calculate risk.

5.3 Risk and Hazard Estimates for the Recreational Visitor

Table 4 summarizes the quantitative risk results for the recreational visitor. Calculations, assumptions, and inputs are presented in Attachment B.

Table 4: Risk Results: Recreational Visitor (RME Scenario)

COPC	Excess Cancer Risk	Hazard Index
Aluminum	NA	0.0006
Arsenic	7E-7	0.01
Iron	NA	0.03
Total	7E-7	0.04

Cancer risks to a recreational visitor from arsenic in soils, waste materials, sediment, and surface water are below 1E-6. Noncancer hazards are all less than 1.

5.4 Risk and Hazard Estimates for the Maintenance Worker

Table 5 summarizes the quantitative risk results for the maintenance worker. Calculations, assumptions, and inputs are presented in Attachment B.

Table 5: Risk Results: Maintenance Worker (RME Scenario)

COPC	Excess Cancer Risk	Hazard Index
Aluminum	NA	0.00009
Arsenic	1E-7	0.0009
Iron	NA	0.004
Total	1E-7	0.005

Cancer risks and noncancer hazards to maintenance workers do not exceed levels of concern for any of the exposure pathways evaluated.

6.0 DETERMINATION OF POTENTIAL HOT SPOTS

An assessment of hot spots is performed by comparing the concentration of a site contaminant to its “highly concentrated” hot spot level, defined as the concentration corresponding to a lifetime cancer risk of 1E-4 for carcinogens and a hazard quotient of 10 for noncarcinogens.

No contaminants were present at levels above their “highly concentrated” hot spot level.

7.0 SUMMARY OF RISKS

Of the 23 COIs detected at the Blackjack Mine site, only aluminum, arsenic, and iron were identified as COPCs. Exposure to these three chemicals was evaluated quantitatively in this HHRE. Based on current and projected future land use, individuals who may come in contact with site-related contaminants during recreational activities such as hiking and U.S. Forest Service employees or contract workers involved in maintenance of culverts and discharge pipes were identified as potential receptors. Results of the HHRE indicate that the potential for carcinogenic and non-carcinogenic human health impacts resulting from exposure to site contaminants is low. Concentrations of constituents in soils, waste materials, surface water, and sediment did not exceed the regulatory standards, and therefore risk-based cleanup goals were not calculated.

8.0 REFERENCES

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Attachment A: COPC Screening
Streamlined Human Health Risk Evaluation
Blackjack Mine Site

Table A-1: Blackjack Mine -- Soils/Wastes Prescreening

Chemical	Minimum Detected Conc'n	Maximum Detected Conc'n	Units	Detection Frequency (%)	Retained for Screening?	Background Conc'n	Retained for Screening?
Aluminum	1,300	19,300	mg/kg	100%	**yes**	27,500	no
Antimony	0.96	7.8	mg/kg	100%	**yes**	1.2	**yes**
Arsenic	7.9	82.3	mg/kg	100%	**yes**	8.1	**yes**
Barium	12.2	131	mg/kg	100%	**yes**	430	no
Beryllium	<0.019	0.45	mg/kg	71%	**yes**	0.94	no
Cadmium	<0.1	1.1	mg/kg	86%	**yes**	0.16	**yes**
Calcium	<25.5	5,290	mg/kg	71%	**yes**	1,880	**yes**
Chromium (total)	3	147	mg/kg	100%	**yes**	12.5	**yes**
Chromium (VI)	<3.5	0.59	mg/kg	14%	**yes**	<2.1	no
Cobalt	9.6	30.5	mg/kg	100%	**yes**	12.9	**yes**
Copper	20.9	1,440	mg/kg	100%	**yes**	52.6	**yes**
Iron	21,800	459,000	mg/kg	100%	**yes**	35,300	**yes**
Lead	7.3	221	mg/kg	100%	**yes**	8.2	**yes**
Magnesium	<50	13,200	mg/kg	86%	**yes**	1,910	**yes**
Manganese	15.8	1,020	mg/kg	100%	**yes**	1,502	no
Mercury (total)	0.096	3.7	mg/kg	100%	**yes**	0.068	**yes**
Nickel	16.8	146	mg/kg	100%	**yes**	39.5	**yes**
Potassium	214	1,430	mg/kg	100%	**yes**	1,450	no
Selenium	0.31	29.7	mg/kg	100%	**yes**	1.9	**yes**
Silver	0.11	1.3	mg/kg	100%	**yes**	0.53	**yes**
Sodium	<46.2	1,150	mg/kg	57%	**yes**	358	**yes**
Thallium	<0.1	17.4	mg/kg	86%	**yes**	1.5	**yes**
Vanadium	19.1	64.8	mg/kg	100%	**yes**	38.5	**yes**
Zinc	27.4	78.4	mg/kg	100%	**yes**	102	no

mg/kg = milligrams of chemical per kilogram of soil

Table A-2: Blackjack Mine -- Surface Water Prescreening

Chemical	Minimum Detected Conc'n	Maximum Detected Conc'n	Units	Detection Frequency (%)	Retained for Screening?	Background Conc'n	Retained for Screening?
Aluminum	<23.6	34	ug/L	82%	**yes**	<23.6	**yes**
Antimony	<4.7	6	ug/L	36%	**yes**	<4.7	**yes**
Arsenic	<2.4	2.8	ug/L	9%	**yes**	<4.8	**yes**
Barium	14	17.9	ug/L	100%	**yes**	15.4	**yes**
Beryllium	0.2	0.32	ug/L	27%	**yes**	<0.2	**yes**
Cadmium	<0.6	<0.6	ug/L	0%	no	--	
Calcium	11,900	13,400	ug/L	100%	**yes**	12,60	**yes**
Chromium (total)	<1.4	1.9	ug/L	27%	**yes**	2.7	no
Cobalt	<1.8	<2	ug/L	0%	no	--	
Copper	<2.4	<2.4	ug/L	0%	no	--	
Cyanide	<0.01	<10	ug/L	0%	no	--	
Iron	<33.3	175	ug/L	91%	**yes**	69	**yes**
Lead	<1.3	<1.5	ug/L	0%	no	--	
Magnesium	6,500	7,720	ug/L	100%	**yes**	7,620	**yes**
Manganese	4.2J	13.8	ug/L	100%	**yes**	5	**yes**
Mercury (total)	<0.1	0.11	ug/L	9%	**yes**	<0.1	**yes**
Nickel	<2	<2.1	ug/L	0%	no	--	
Potassium	1,100	1,360	ug/L	100%	**yes**	1,210	**yes**
Selenium	<1.7	4.5	ug/L	9%	**yes**	<3.4	**yes**
Silver	<0.9	<2.2	ug/L	0%	no	--	
Sodium	2,490	3,040	ug/L	100%	**yes**	2,680	**yes**
Thallium	<2.8	<5.7	ug/L	0%	no	--	
Vanadium	<2	2.5	ug/L	27%	**yes**	<2	**yes**
Zinc	2.4 J	<5.7	ug/L	64%	**yes**	4.2	no

ug/L = micrograms of chemical per liter of water

Table A-3: Blackjack Mine -- Sediment Prescreening

Chemical	Minimum Detected Conc'n	Maximum Detected Conc'n	Units	Detection Frequency (%)	Retained for Screening?	Background Conc'n	Retained for Screening?
Aluminum	6,680	42,700	mg/kg	100%	yes	15,870	**yes**
Antimony	<0.47	5.9	mg/kg	88%	yes	2.9	**yes**
Arsenic	3.9	55.7	mg/kg	100%	yes	35.3	**yes**
Barium	40.5	405	mg/kg	100%	yes	74.4	**yes**
Beryllium	0.11	1.2	mg/kg	100%	yes	0.35	**yes**
Cadmium	<0.059	4.2	mg/kg	59%	yes	0.49	**yes**
Calcium	1,070	6,750	mg/kg	100%	yes	3,120	**yes**
Chromium (total)	10.7	191	mg/kg	100%	yes	116	**yes**
Cobalt	9.5	85.5	mg/kg	100%	yes	24.6	**yes**
Copper	17.7	323	mg/kg	100%	yes	30.8	**yes**
Cyanide	<0.61	<0.61	mg/kg	0%	no	--	
Iron	14,000	61,100	mg/kg	100%	yes	34,400	**yes**
Lead	1.3	11.6	mg/kg	100%	yes	3.5	**yes**
Magnesium	2,690	21,500	mg/kg	100%	yes	11,120	**yes**
Manganese	409	3,090	mg/kg	100%	yes	797	**yes**
Mercury (total)	<0.019	0.38	mg/kg	53%	yes	0.026	**yes**
Nickel	51.9	503	mg/kg	100%	yes	158	**yes**
Potassium	350	2,650	mg/kg	100%	yes	1,070	**yes**
Selenium	<0.17	2.9	mg/kg	76%	yes	0.66	**yes**
Silver	<0.22	2.6	mg/kg	12%	yes	<0.27	**yes**
Sodium	62.3	1,040	mg/kg	100%	yes	319	**yes**
Thallium	<0.58	2.4	mg/kg	53%	yes	1.62	**yes**
Vanadium	10.6	106	mg/kg	100%	yes	64	**yes**
Zinc	28.8	556	mg/kg	100%	yes	72.3	**yes**

mg/kg = milligrams of chemical per kilogram of sediment

Table A-4: Blackjack Mine -- PRG Screening, Soils/Wastes

Chemical	Cancer/ Noncancer	Maximum Detected Concentration (mg/kg)	USEPA Region 9 PRG Indust. Soil (mg/kg)	Individual COI Risk Ratio, Ri	Individual COPC - Soils/Wastes?	Multiple COIs Ri/Rtotal	1/N	Multiple COPC - Soils/Wastes?
Antimony	nc	7.8	410	0.019	no	0.00033	0.071	no
Arsenic	ca/nc	82.3	1.6	51.44	**yes**	0.90	0.071	**yes**
Cadmium	nc	1.1	450	0.0024	no	0.000043	0.071	no
Calcium(a)	NA	5,290	NA	NA	no	NA		no
Chromium (total)	ca	147	450	0.33	no	0.0057	0.071	no
Cobalt	ca	30.5	1,900	0.016	no	0.00028	0.071	no
Copper	nc	1,440	41,000	0.035	no	0.00062	0.071	no
Iron	nc	459,000	100,000	4.59	**yes**	0.080	0.071	**yes**
Lead	nc	221	800	0.28	no	0.0048	0.071	no
Magnesium(a)	NA	13,200	NA	NA	no	NA		no
Mercury (total)	nc	3.7	310	0.012	no	0.00021	0.071	no
Nickel	nc	146	20,000	0.0073	no	0.00013	0.071	no
Selenium	nc	29.7	5,100	0.0058	no	0.00010	0.071	no
Silver	nc	1.3	5,100	0.00025	no	0.0000045	0.071	no
Sodium(a)	NA	1,150	NA	NA	no	NA		no
Thallium	nc	17.4	67	0.26	no	0.0046	0.071	no
Vanadium	nc	64.8	1,000	0.065	no	0.0011	0.071	no

Sum of Risk Ratios (Rtotal)	**57.05**
Number of COIs (N)	**14**
1/N	**0.071**

(a) Essential nutrients (calcium, magnesium, potassium, sodium) were not retained as COPCs per EPA guidance (USEPA 1989)

NA = Not applicable
COI = Chemical of interest
ca = carcinogen
nc = noncarcinogen
PRG = Preliminary Remediation Goal

Table A-5: Blackjack Mine -- PRG Screening, Surface Water

Chemical	Cancer/ Noncancer	Maximum Detected Concentration (ug/L)	USEPA Region 9 PRG Tap Water (ug/L)	Individual COI Risk Ratio, Rsw	Individual COPC - Surface Water?	Multiple COIs Rsw/Rtotal	1/N	Multiple COPC - Surface Water?
Aluminum	nc	34	36,000	0.00094	no	0.000015	0.10	no
Antimony	nc	6	15	0.40	no	0.0064	0.10	no
Arsenic	ca/nc	2.8	0.045	62	**yes**	0.99	0.10	**yes**
Barium	nc	17.9	2,600	0.0069	no	0.00011	0.10	no
Beryllium	nc	0.32	73	0.0044	no	0.000070	0.10	no
Calcium(a)	NA	13,400	NA	NA	no	NA		no
Iron	nc	175	1,100	0.16	no	0.0025	0.10	no
Magnesium(a)	NA	7,720	NA	NA	no	NA		no
Manganese	nc	13.8	880	0.016	no	0.00025	0.10	no
Mercury (total)	nc	0.11	11	0.010	no	0.00016	0.10	no
Potassium(a)	NA	1,360	NA	NA	no	NA		no
Selenium	nc	4.5	180	0.025	no	0.00040	0.10	no
Sodium(a)	NA	3,040	NA	NA	no	NA		no
Vanadium	nc	2.5	36	0.069	no	0.0011	0.10	no

Sum of Risk Ratios (Rwtotal)	**62.91**
Number of COIs (N)	**10**
1/N	**0.10**

(a) Essential nutrients (calcium, magnesium, potassium, sodium) were not retained as COPCs per EPA guidance (USEPA 1989)

NA = Not applicable
COI = Chemical of interest
ca = carcinogen
nc = noncarcinogen
PRG = Preliminary Remediation Goal

Table A-6: Blackjack Mine -- PRG Screening, Sediment

Chemical	Cancer/ Noncancer	Maximum Detected Concentration (mg/kg)	USEPA Region 9 PRG Industrial Soil (mg/kg)	Individual COI Risk Ratio, Rsed	Individual COPC - Sediment?	Multiple COIs Rsed/Rtotal	1/N	Multiple COPC - Sediment?
Aluminum	nc	42,700	10,000	4.27	**yes**	0.11	0.053	**yes**
Antimony	nc	5.9	410	0.014	no	0.00035	0.053	no
Arsenic	ca/nc	55.7	1.6	34.81	**yes**	0.86	0.053	**yes**
Barium	nc	405	67,000	0.0060	no	0.00015	0.053	no
Beryllium	ca/nc	1.2	1,900	0.00063	no	0.000016	0.053	no
Cadmium	nc	4.2	450	0.0093	no	0.00023	0.053	no
Calcium(a)	NA	6,750	NA	NA	no	NA		no
Chromium (total)	ca	191	450	0.42	no	0.010	0.053	no
Cobalt	ca	85.5	1900	0.045	no	0.0011	0.053	no
Copper	nc	323	41,000	0.0079	no	0.00019	0.053	no
Iron	nc	61,100	100,000	0.61	no	0.015	0.053	no
Lead	nc	11.6	800	0.015	no	0.00036	0.053	no
Magnesium(a)	NA	21,500	NA	NA	no	NA		no
Manganese	nc	3,090	19,000	0.16	no	0.0040	0.053	no
Mercury (total)	nc	0.38	310	0.0012	no	0.000030	0.053	no
Nickel	nc	503	20,000	0.025	no	0.00062	0.053	no
Potassium(a)	NA	2,650	NA	NA	no	NA		no
Selenium	nc	2.9	5,100	0.00057	no	0.000014	0.053	no
Silver	nc	2.6	5,100	0.00051	no	0.000013	0.053	no
Sodium(a)	NA	1,040	NA	NA	no	NA	0.053	no
Thallium	nc	2.4	67	0.036	no	0.00088		no
Vanadium	nc	106	1,000	0.11	no	0.0026	0.053	no
Zinc	nc	556	100,000	0.0056	no	0.00014	0.053	no

Sum of Risk Ratios (Rtotal)	**40.55**
Number of COIs (N)	**19**
1/N	**0.053**

(a) Essential nutrients (calcium, magnesium, potassium, sodium) were not retained as COPCs per EPA guidance (USEPA 1989)

NA = Not applicable
COI = Chemical of interest
ca = carcinogen
nc = noncarcinogen
PRG = Preliminary Remediation Goal

Table A-7: Blackjack Mine -- PRG Screening, Sum of All Media

Chemical	Ri (soils/wastes)	Rsw (surface water)	Rsed (sediment)	Rall (sum of all media)	Mulitple Medium COPC?
Aluminum	NA	0.0016	4.27	4.27	**yes**
Antimony	0.019	0.40	0.014	0.43	no
Arsenic	51.44	62	34.8	148	**yes**
Barium	NA	0.0069	0.0060	0.013	no
Beryllium	NA	0.0044	0.00063	0.0050	no
Cadmium	0.0024	NA	0.0093	0.012	no
Calcium	NA	NA	NA	NA	no
Chromium (total)	0.33	NA	0.42	0.75	no
Cobalt	0.016	NA	0.045	0.061	no
Copper	0.035	NA	0.0079	0.043	no
Iron	4.59	0.16	0.61	5.4	**yes**
Lead	0.28	NA	0.015	0.29	no
Magnesium	NA	NA	NA	NA	no
Manganese	NA	0.016	0.16	0.18	no
Mercury (total)	0.012	0.010	0.0012	0.023	no
Nickel	0.0073	NA	0.025	0.033	no
Potassium	NA	NA	NA	NA	no
Selenium	0.0058	0.025	0.00057	0.031	no
Silver	0.00025	NA	0.00051	0.00076	no
Sodium	NA	NA	NA	NA	no
Thallium	0.26	NA	0.036	0.30	no
Vanadium	0.065	0.069	0.11	0.24	no
Zinc	NA	NA	0.0056	0.0056	no

Table A-8: Blackjack Mine -- Chemicals of Potential Concern (COPCs)

Chemical	Soils/Wastes		Surface Water		Sediment		Multiple Medium
	Individual	Multi-Chemical	Individual	Multi-Chemical	Individual	Multi-Chemical	
Aluminum					●	●	●
Antimony							
Arsenic	●	●	●	●	●	●	●
Barium							
Beryllium							
Cadmium							
Calcium							
Chromium (total)							
Cobalt							
Copper							
Iron	●						●
Lead							
Magnesium							
Manganese							
Mercury (total)							
Nickel							
Potassium							
Selenium							
Silver							
Sodium							
Thallium							
Vanadium							
Zinc							

Note: Iron is identified as a multiple medium COPC because it was detected in several media (soil/waste, surface water, and sediment), and its Rall value (see Table 7) exceeds 1. This is consistent with Oregon guidance (ODEQ 2000).

Attachment B: Risk Calculations
Streamlined Human Health Risk Evaluation
Blackjack Mine Site

Table B-1. RME Exposure Factors for Recreational Visitor (Hiker)

Exposure Parameter	Units	Adult	Child	Source
General Parameters				
Body Weight (BW)	kg	70	15	ODEQ 2000; default value
Exposure Duration (ED)	years	24	6	ODEQ 2000; default values for residential exposure. Total exposure duration (adult + child) = 30 years.
Exposure Frequency (EF)	days/year	6	6	Professional judgement; assumes one visit per month during June through October.
Conversion Factor 1 (CF1)	kg/mg	1.00E-06	1.00E-06	
Conversion Factor 2 (CF2)	hrs/day	24	24	
Averaging Time -- Cancer (ATc)	days	25550	25550	ODEQ 2000; default value
Averaging Time -- Noncancer	days	365*ED	365*ED	ODEQ 2000; default value
Exposures to Soil				
Soil Ingestion Rate (IRs)	mg/day	100	200	USEPA 1991; default residential values
Exposure Time for Soil (ETs)	hrs/day	2	2	Professional judgement; based on areal extent of contamination
Soil Adherence Factor (AF)	mg/cm2-day	0.07	0.2	USEPA 2004c; default value
Skin Surface Area for Soil Exposure	cm2	5,700	2,800	USEPA 2004c; default value
Inhalation Rate of Air (IRA)	m3/day	15.2	8.3	ODEQ 2000; default value
Particulate Emission Factor (PEF)	m3/kg	1.32E+09	1.32E+09	ODEQ 2000; default value
Exposures to Sediment				
Sediment Ingestion Rate (IRsed)	mg/day	100	200	USEPA 1991; default soil ingestion rate
Exposure Time for Sediment (ETsed)	hrs/day	1	1	Assumes one hour spent in contact with Clear Creek water/sediments each day of camping.
Sediment Adherence Factor (AFsed)	mg/cm2-day	0.07	0.2	USEPA 2004c; default value
Skin Surface Area for Sediment Exposure	cm2	5,700	2,800	USEPA 2004c; default value
Exposures to Surface Water				
Exposure Time (ET)	hrs/day	2	2	Assumes maximum time of swimming is 2 hours per visit.
Water Ingestion Rate (IRw)	L/hr	0.05	0.05	USEPA 1989; default value for incidental ingestion of water while swimming.

Table B-2. RME Exposure Factors for Maintenance Worker

Exposure Parameter	Units	Adult	Source
General Parameters			
Body Weight (BW)	kg	70	ODEQ 2000; default value
Exposure Duration (ED)	years	25	ODEQ 2000; default value for occupational exposure.
Exposure Frequency (EF)	days/year	2	Assumes 1 day each in spring and fall for maintenance of culverts and drainpipes.
Conversion Factor 1 (CF1)	kg/mg	1.00E-06	
Conversion Factor 2 (CF2)	hrs/day	24	
Averaging Time -- Cancer (ATc)	days	25550	ODEQ 2000; default value
Averaging Time -- Noncancer	days	365*ED	ODEQ 2000; default value
Exposures to Soil			
Soil Ingestion Rate (IRs)	mg/day	100	ODEQ 2000; default value for occupational exposure.
Exposure Time for Soil (ETs)	hrs/day	8	Assumes standard work day.
Soil Adherence Factor (AF)	mg/cm2-day	0.08	ODEQ 2000; default value for occupational exposure
Skin Surface Area for Soil Exposure	cm2	2,300	50th percentile surface area for hands and forearms, male; USEPA 1997
Inhalation Rate of Air (IRA)	m3/day	15.2	ODEQ 2000; default value for occupational exposure
Particulate Emission Factor (PEF)	m3/kg	1.32E+09	ODEQ 2000; default value
Exposures to Sediment			
Sediment Ingestion Rate (IRsed)	mg/day	100	ODEQ 2000; default value for occupational exposure.
Exposure Time for Sediment (ETsed)	hrs/day	8	Assumes standard work day.
Sediment Adherence Factor (AFsed)	mg/cm2-day	0.08	ODEQ 2000; default value for occupational exposure
Skin Surface Area for Sediment Exposure	cm2	3,300	95th percentile surface area for hands and forearms, male; USEPA 1997

Table B-3. Exposure Point Concentrations

COPC	No. of Samples	Maximum Conc'n	UCL90 (a)	Mean	Distribution
Soils/Wastes (mg/kg) (b)					
Aluminum (c)	7	19,300	29,200	8,840	Lognormal
Arsenic	7	82.3	50.9	25.2	Lognormal
Iron	7	459,000	441,000	129,000	Lognormal
Surface Water (mg/L) (d)					
Aluminum	11	0.134	0.068	0.054	Normal
Arsenic (e)	11	0.0028	0.0024	0.0024	Normal
Iron	11	0.175	0.083	0.06	Lognormal
Sediment (mg/kg) (f)					
Aluminum	17	42,700	15,200	12,900	Lognormal
Arsenic	17	55.7	40.4	28.2	Lognormal
Iron	17	61,100	35,400	29,400	Lognormal

UCL90 = 90 percent confidence limit on the mean

(a) Note: The UCL90 was used to represent the exposure point concentration for the RME scenarios.

(b) Soil/waste data are from Table G-4 of the 2003 SI report and 2004 data collected by SAIC.

(c) Because the UCL90 for aluminum was greater than the maximum detected concentration, the maximum detected concentration was used to represent the exposure point concentration.

(d) Surface water data are for total metals as presented on page 148 of the 2003 SI report.

(e) Only one of 11 samples contained arsenic above the detection limit. The normal UCL90 was used to represent the exposure point concentration, however this value likely significantly overestimates the average concentration of arsenic in surface water.

(f) Sediment data are from Table G-3 of the 2003 SI report.

Table B-4. Noncarcinogenic Toxicity Factors

COPC	Oral Rfd (mg/kg-day)	Critical Effect	Uncertainty Factor	Source	Inhalation RfD (mg/kg-day)	Critical Effect	Uncertainty Factor	Source
Aluminum	1.0E+00	--	--	NCEA	1.40E-03	--	--	NCEA
Arsenic	3.0E-04	hyperpigmentation, keratosis, and possible vascular complications	3	IRIS	--	--	--	--
Iron	3.0E-01	chronic iron overload	1	NCEA	--	--	--	--

NCEA -- National Center for Environmental Assessment
IRIS -- Integrated Risk Information System (2004)

Table B-5. Carcinogenic Toxicity Factors

COPC	Oral SF 1/(mg/kg-day)	Type of Cancer	Weight of Evidence	Source	Inhalation SF 1/(mg/kg-day)	Type of Cancer	Weight of Evidence	Source
Arsenic	1.5E+00	Skin	A	IRIS	15	Lung	A	IRIS

IRIS -- Integrated Risk Information System (2004)
SF -- cancer slope factor

Table B-6. Chemical Intakes: Recreational Visitor

Exposure Route	Chemical	EPC	Dermal Absorption Factor (ABS)	Intake Factor (Cancer)	Intake Factor (Noncancer)	Intake (Cancer)	Intake (Noncancer)
Incidental Ingestion of Soil/Waste	Aluminum	19300	NA	2.2E-09	1.8E-08	4.3E-05	3.5E-04
	Arsenic	50.9	NA	2.2E-09	1.8E-08	1.1E-07	9.3E-07
	Iron	459000	NA	2.2E-09	1.8E-08	1.0E-03	8.4E-03
Dermal Contact with Soil/Waste	Aluminum	19300	NA	8.5E-08	6.1E-07	NA	NA
	Arsenic	50.9	0.03	8.5E-08	6.1E-07	1.3E-07	9.4E-07
	Iron	459000	NA	8.5E-08	6.1E-07	NA	NA
Inhalation of Particulates	Aluminum	19300	NA	1.5E-12	6.9E-12	2.9E-08	1.3E-07
	Arsenic	50.9	NA	1.5E-12	6.9E-12	7.7E-11	3.5E-10
	Iron	459000	NA	1.5E-12	6.9E-12	7.0E-07	3.2E-06
Incidental Ingestion of Surface Water While Swimming	Aluminum	0.068	NA	2.0E-05	1.3E-04	1.4E-06	8.7E-06
	Arsenic	0.0024	NA	2.0E-05	1.3E-04	4.9E-08	3.1E-07
	Iron	0.083	NA	2.0E-05	1.3E-04	1.7E-06	1.1E-05
Incidental Ingestion of Sediment	Aluminum	15200	NA	1.1E-09	9.1E-09	1.7E-05	1.4E-04
	Arsenic	40.4	NA	1.1E-09	9.1E-09	4.5E-08	3.7E-07
	Iron	35400	NA	1.1E-09	9.1E-09	4.0E-05	3.2E-04
Dermal Contact with Sediment	Aluminum	15200	NA	8.5E-08	6.1E-07	NA	NA
	Arsenic	40.4	0.03	8.5E-08	6.1E-07	1.0E-07	7.4E-07
	Iron	35400	NA	8.5E-08	6.1E-07	NA	NA

Table B-7. Chemical Intakes: Maintenance Worker

Exposure Route	Chemical	EPC	Dermal Absorption Factor (ABS)	Intake Factor (Cancer)	Intake Factor (Noncancer)	Intake (Cancer)	Intake (Noncancer)
Incidental Ingestion of Soil/Waste	Aluminum	19300	NA	9.3E-10	2.6E-09	1.8E-05	5.0E-05
	Arsenic	50.9	NA	9.3E-10	2.6E-09	4.7E-08	1.3E-07
	Iron	459000	NA	9.3E-10	2.6E-09	4.3E-04	1.2E-03
Dermal Contact with Soil/Waste	Aluminum	19300	NA	5.1E-09	1.4E-08	NA	NA
	Arsenic	50.9	0.03	5.1E-09	1.4E-08	7.9E-09	2.2E-08
	Iron	459000	NA	5.1E-09	1.4E-08	NA	NA
Inhalation of Particulates	Aluminum	19300	NA	1.1E-13	3.0E-13	2.1E-09	5.8E-09
	Arsenic	50.9	NA	1.1E-13	3.0E-13	5.5E-12	1.5E-11
	Iron	459000	NA	1.1E-13	3.0E-13	4.9E-08	1.4E-07
Incidental Ingestion of Sediment	Aluminum	15200	NA	9.3E-10	2.6E-09	1.4E-05	4.0E-05
	Arsenic	40.4	NA	9.3E-10	2.6E-09	3.8E-08	1.1E-07
	Iron	35400	NA	9.3E-10	2.6E-09	3.3E-05	9.2E-05
Dermal Contact with Sediment	Aluminum	15200	NA	5.1E-09	1.4E-08	NA	NA
	Arsenic	40.4	0.03	5.1E-09	1.4E-08	6.2E-09	1.7E-08
	Iron	35400	NA	5.1E-09	1.4E-08	NA	NA

Table B-8. Risk Characterization Summary

Exposure Scenario	COPC	Noncancer Hazard						
		Ingestion (Soil)	Dermal (Soil)	Inhalation of Particulates	Ingestion (surface water)	Ingestion (Sediment)	Dermal (Sediment)	Total
Recreational Visitor (Hiker)	Aluminum	4.E-04	NA	9.E-05	9.E-06	1.E-04	NA	6.E-04
	Arsenic	3.E-03	3.E-03	NA	1.E-03	1.E-03	2.E-03	1.E-02
	Iron	3.E-02	NA	NA	4.E-05	1.E-03	NA	3.E-02
	TOTAL	**3.E-02**	**3.E-03**	**9.E-05**	**1.E-03**	**2.E-03**	**2.E-03**	**4.E-02**
Maintenance Worker	Aluminum	5.E-05	NA	4.E-06	NA	4.E-05	NA	9.E-05
	Arsenic	4.E-04	7.E-05	NA	NA	4.E-04	6.E-05	9.E-04
	Iron	4.E-03	NA	NA	NA	3.E-04	NA	4.E-03
	TOTAL	**4.E-03**	**7.E-05**	**4.E-06**	**NA**	**7.E-04**	**6.E-05**	**5.E-03**

Exposure Scenario	COPC	Cancer Risk						
		Ingestion (Soil)	Dermal (Soil)	Inhalation of Particulates	Ingestion (surface water)	Ingestion (Sediment)	Dermal (Sediment)	Total
Recreational Visitor (Camper)	Aluminum	NA	NA	NA	NA	NA	NA	NA
	Arsenic	2.E-07	2.E-07	1.E-09	7E-08	7.E-08	2.E-07	7.E-07
	Iron	NA	NA	NA	NA	NA	NA	NA
	TOTAL	**2.E-07**	**2.E-07**	**1.E-09**	**7.E-08**	**7.E-08**	**2.E-07**	**7.E-07**
Maintenance Worker	Aluminum	NA	NA	NA	NA	NA	NA	NA
	Arsenic	7.E-08	1.E-08	1.E-10	NA	6.E-08	9.E-09	1.E-07
	Iron	NA	NA	NA	NA	NA	NA	NA
	TOTAL	**7.E-08**	**1.E-08**	**1.E-10**	**NA**	**6.E-08**	**9.E-09**	**1.E-07**

Appendix A-2: Streamlined Ecological Risk Assessment

Blackjack Mine Site

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1.0 INTRODUCTION

In accordance with Oregon Department of Environmental Quality (ODEQ) guidance (ODEQ, 2001), Science Applications International Corporation (SAIC) conducted a Screening Level Ecological Risk Assessment (ERA) for the Blackjack Mine Site (Site) as part of the Engineering Evaluation/Cost Analysis (EE/CA). This ERA is consistent with national and regional guidance (USEPA 1997, 1998). The purpose of the streamlined ERA is to provide an understanding of the potential for ecological risks due to mine-related contamination and to determine whether there is a need for more detailed ecological risk assessment. This report consists of the following:

- A problem formulation that includes identification of contaminants of interest (COIs) based on site uses and existing data
- A description of the ecology of the site and potential ecological receptors (including rare, threatened, and endangered species) at or near the site
- A conceptual site model that provides a summary of potential exposure media and pathways
- Assessment and measurement endpoints
- Risk screening of the COIs in each media to identify contaminants of potential ecological concern (CPECs)
- Risk characterization to assess the potential for significant ecological effects due to site-related contaminants

SAIC visited the site on September 8-10 and on October 5, 2004 to document current ecological conditions at and near the site. An ODEQ ecological scoping checklist was completed and is provided as Attachment A.

2.0 PROBLEM FORMULATION

The scope of an ERA is defined through the "Problem Formulation" step that identifies COIs, describes physical and chemical characteristics of the site, and describes aquatic and terrestrial resources. This information is utilized to identify ecological receptors of concern and to develop a conceptual site model (CSM) that depicts the expected fate and transport of chemicals at the site, the potential exposure media, and likely exposure pathways for ecological receptors of concern. Ecological assessment and measurement endpoints are selected to focus the ERA on issues of most concern. Where possible, references to relevant EE/CA chapters and previous documents, such as the Site Investigation report (EA Engineering, 2003) are provided as supporting information rather than repeated here.

2.1 Contaminants of Interest

This section identifies COIs for surface water, pore water, sediments, and soil/waste materials. Depending on the number of samples in each media, the procedure compares either the maximum media concentration or the 90th upper confidence percentile limit (90UCL) concentration relative to conservative Risk-Based Screening Concentrations (RBSCs) that are considered protective of ecological receptors. Attachment B provides a list and references for each RBSC used in this assessment. In those cases where a published RBSC was below local background reference concentrations, then the background value was used.

2.1.1 COIs in Clear Creek Water

Thirteen water samples in Clear Creek were collected in the summer of 2003 between Stations BLAC 1 through BLUE 8 (see Figure 1 in EE/CA report and Figures 1 and 2 in the SI report). Table 1 compares the range of chemical concentrations with their respective RBSC. Barium exceeded the upstream background concentration (15.8 µg/L) at three site locations; however, the 90UCL concentration is 15.7 µg/L. Barium is not a COI in pore water, sediments, or waste piles and therefore will not be evaluated further.

2.1.2 COIs in Clear Creek Pore Water

Nineteen pore water samples were collected from Clear Creek between Stations BLAC 1 through BLUE 8. Table 2 compares the range of chemical concentrations with their respective RBSC. No contaminants of interest were identified in Clear Creek pore water.

2.1.3 COIs in Clear Creek Sediments

Twenty sediment samples were collected from Clear Creek between Stations BLAC 1 through BLUE 8. Table 3 compares the range and 90UCL concentrations with the RBSCs. Arsenic, chromium (total), cobalt, copper, iron, manganese, mercury (total), and nickel are identified as COIs in the sediments and will be evaluated further. Three samples from Blackjack sediment ponds (not within Clear Creek) also contain these COIs as well as antimony, cadmium, and zinc.

2.1.4 COIs in Soils/Wastes

Seven solid samples were collected at the Site from a few potential source locations ranging from mine waste rock to material in a former settling pond. Table 4 compares the range and 90UCL concentrations with the soil RBSCs. Arsenic, chromium (total), cobalt, copper, iron, lead, mercury (total), nickel, selenium, thallium, and vanadium are identified as COIs that may be associated with former mining operations. These COIs will be evaluated further in Section 3.

2.1.5 Bioaccumulation Screen

Because mercury in sediments and soils/wastes and selenium in wastes are bioaccumulators, their potential to compromise the food chain will be discussed in Section 4.0. The ODEQ (2001) bioaccumulation screening values for cadmium, selenium, and thallium are within background levels, and are therefore not considered contaminants of interest.

Table 1: Identification of Contaminants of Interest in Clear Creek Waters

Chemical	Range	RBSC	Freq > RBSC	COI ?
Aluminum	< 23.6 - 56.9	87	0/13	No
Antimony	< 4.7	1,000	0/13	No
Arsenic	< 2.4 - 4.9	150	0/13	No
Barium	13.5 - 17.4 (a)	15.8 (b)	3/13	No
Cadmium	< 0.6	2.2	0/13	No
Calcium	11,400 - 13,600	116,000	0/13	No
Chromium	< 0.6 - 1.5	11	0/13	No
Cobalt	< 2	23	0/13	No
Copper	< 2.4	9	0/13	No
Iron (total)	< 16.8 - 58.9	1,000	0/13	No
Lead	< 1.3 - 1.6	2.5	0/13	No
Magnesium	6,520 - 7,860	82,000	0/13	No
Manganese	1.9 - 17.3	120	0/13	No
Mercury (total)	< 0.1	0.77	0/13	No
Nickel	< 2.1	52	0/13	No
Potassium	991 - 1,370	53,000	0/13	No
Selenium (total)	< 3.4	5	0/13	No
Sodium	2,290 - 2,960	680,000	0/13	No
Vanadium	< 2 - 2.5	20	0/13	No
Zinc	1.4 - 8.6	120	0/13	No

Concentrations in µg/L dissolved unless otherwise noted.
total - Total recoverable concentrations.
(a) - 90th percentile UCL for barium is 15.7 µg/L
(b) - RBSC is based on mean + 2 standard deviations of background concentrations in Clear Creek upstream of Blackjack.

Table 2: Identification of Contaminants of Interest in Pore Waters of Clear Creek

Chemical	Range	RBSC	Freq > RBSC	COI ?
Aluminum	< 23.6 – 431	87	1/19	No (a)
Antimony	< 4.7 - 6.4	1,000	0/19	No
Arsenic	< 4.8	150	0/19	No
Barium	13 - 30.6	23.3 (b)	1/19	No (c)
Cadmium	< 0.6	2.2	0/19	No
Calcium	11,300 - 26,700	116,000	0/19	No
Chromium	< 0.6 - 1.4	11	0/19	No
Cobalt	< 2	23	0/19	No
Copper	< 1.4 - 2.4	9	0/19	No
Iron (total)	< 16.8 – 399	1,000	0/19	No
Lead	< 1.5	2.5	0/19	No
Magnesium	6,510 - 14,900	82,000	0/19	No
Manganese	< 0.7 - 61.1	120	0/19	No
Mercury (total)	< 0.1 - 0.17	0.77	0/19	No
Nickel	< 2 - 8.5	52	0/19	No
Potassium	1,090 - 2,320	53,000	0/19	No
Selenium (total)	< 3.4	5	0/19	No
Sodium	2,710 - 6,570	680,000	0/19	No
Vanadium	< 2 - 3.1	20	0/19	No
Zinc	< 1 - 17.6	120	0/19	No

Concentrations in µg/L dissolved unless otherwise noted.
total - Total recoverable concentrations.
(a) - The maximum appears to be an outlier, the next highest value was 53 µg/L. Aluminum is not a CPEC in any other media at Blackjack or Bluebird.
(b) - RBSC is based on background concentration in Clear Creek upstream of Blackjack.
(c) - Barium 90th percentile UCL = 17.9 µg/L, which is less than RBSC.

Table 3: Identification of Contaminants of Interest in Clear Creek Sediments

Chemical	Range	90th UCL *	RBSC	Freq > RBSC	COI ?
Aluminum	6,680 - 42,700	15,090	58,000	0/20	No
Antimony	< 0.47 - 5.9	2.0	3	1/20	No
Arsenic	3.9 - 55.7	33.7	35.3 (a)	4/20	Yes (b)
Barium	40.5 - 405	126.5	165	1/20	No
Beryllium	0.11 - 1.2	0.44	2	0/20	No
Cadmium	< 0.059 - 4.2	0.41	0.6	1/20	No
Calcium	1,070 - 6,750	3,790	NA	NA	No
Chromium	10.7 - 193	107	116 (a)	6/20	Yes
Cobalt	9.5 - 85.5	28.9	27	4/20	Yes
Copper	17.7 - 323	37.2	36	9/20	Yes
Cyanide	< 0.61	< 0.61	NA	NA	No
Iron	14,000 - 61,100	33,680	34,400 (a)	6/20	Yes
Lead	1.3 - 11.6	4.4	35	0/20	No
Magnesium	2,690 - 21,500	13,300	NA	NA	No
Manganese	409 - 3,090	1,100	1,100	2/20	Yes
Mercury	< 0.019 - 0.38	0.26	0.2	2/20	Yes
Nickel	51.9 - 503	181	158 (a)	8/20	Yes
Potassium	350 - 2,650	1,019	NA	NA	No
Selenium	< 0.17 - 2.9	0.86	4	0/20	No
Silver	< 0.22 - 2.6	0.87	4.5	0/20	No
Sodium	62.3 - 1,040	382	NA	NA	No
Thallium	< 0.58 - 2.4	1.6	8	0/20	No
Vanadium	10.6 - 106	53.3	64 (a)	NA	No
Zinc	28.8 - 556	83.8	123	1/20	No

Concentrations in mg/kg.
* - Does not include background samples (n=18)
(a) - RBSC is based on the mean + 2 standard deviations of background sediment concentrations in pool upstream of Blackjack.
(b) - Although the 90th UCL is < the RBSC, 20% of samples exceed RBSC.

For pond sediments, antimony, cadmium, cobalt, and zinc are included to the list of CPECs.

Table 4: Identification of Contaminants of Interest in Blackjack Soils/Wastes

Chemical	Range (n=7)	90th UCL	RBSC	Background	COI ?
Aluminum	1,300 - 19,300	13,040	50 *	27,500	No
Antimony	0.96 - 7.8	4.3	5	1.2	No
Arsenic	7.9 - 82.3	44.4	10	8.1	Yes
Barium	12.2 - 131	93.5	85 *	430	No
Beryllium	< 0.019 - 0.45	0.30	10	0.94	No
Cadmium	< 0.1 - 1.1	0.65	4	0.16	No
Calcium	< 25.5 - 5,290	5,290	NA	1,880	No
Chromium (total)	3 - 147	82	0.4 *	12.5	Yes
Chromium (VI)	< 3.5	< 3.5	410	< 2.1	No
Cobalt	9.6 - 30.5	21.1	20	12.9	Yes
Copper	20.9 - 1,440	1,010	50 *	52.6	Yes
Iron	21,800 - 459,000	268,400	10 *	35,300	Yes
Lead	7.3 - 221	133	16	8.2	Yes
Magnesium	< 50 - 13,200	6,350	NA	1,910	No
Manganese	15.8 - 1,020	576	100 *	1,502	No
Mercury (total)	0.096 - 3.7	1.95	0.1	0.068	Yes
Nickel	16.8 - 146	86.1	30 *	39.5	Yes
Potassium	214 - 1,430	1,120	NA	1,450	No
Selenium	0.31 - 29.7	17.4	1 *	1.9	Yes
Silver	0.11 - 1.3	0.78	2	0.53	No
Sodium	< 46.2 - 1,150	725	NA	358	No
Thallium	< 0.1 - 17.4	11.6	1 *	1.5	Yes
Vanadium	19.1 - 64.8	47.3	2 *	38.5	Yes
Zinc	27.4 - 78.4	56.3	50 *	102	No

Concentrations in mg/kg.
* - Minimum RBSC is below local background soil concentration.

2.2 Ecosystem Potentially at Risk

The local and site-specific ecology are briefly described in this section to provide an understanding of the ecosystem that is potentially at risk. Detailed information on habitat characterizations, plant and animal species, and biological survey methods may be found in EA Engineering (2003).

2.2.1 Aquatic Environment

Clear Creek provides habitat for wild Mid-Columbia spring chinook salmon (*Oncorhynchus tshawytscha*), a species of special concern, wild Mid-Columbia summer steelhead (*Oncorhynchus mykiss*), listed as threatened under the Endangered Species Act (ESA), and Columbia Basin bull trout (*Salvelinus confluentus*) which is also listed as threatened under ESA. Other salmonid species include redband trout (*O. mykiss gairdneri*) and westslope cutthroat trout (*O. clarki lewisi*).

Within the project vicinity, Clear Creek has undergone extensive stream restoration activities for improving salmon habitat, largely as part of the North Fork John Day Dredge Tailings Restoration Project (BPA 2002). The restoration project largely occurred between 2000 and 2003 with riparian revegetation enhancements continuing into 2003.

Prior to the 1980s, mine drainage from the Site discharged directly into Clear Creek, affecting water quality and resulting in iron precipitate coatings on the stream substrate. Since the 1980s, the USFS piped the adit water into side channel ponds to reduce the flow entering the creek. The current channel pond that receives Blackjack mine water is in the Clear Creek floodplain, separated from the creek by roadbed and dredge piles, and is well vegetated. Iron and associated heavy metals precipitate in the channel, and the remaining mine water filters through the floodplain materials (e.g., gravels, cobbles, and boulders) partially reentering the stream through shallow groundwater flow. A small adit seep west of the creek has formed a small cascading pool of iron precipitate (approximately 500 square feet) and the water flows overland into the floodplain.

The fish and macroinvertebrate communities of Clear Creek may be exposed to contaminants in mine water from potential failures of the existing discharge pipes or of the side sediment pond that receives the mine water. Aquatic organisms in the creek may also be exposed to discharge of contaminated shallow groundwater reentering from the settling pond area and from the small adit seep.

2.2.2 Terrestrial Environment

The Site is located on a steep hillside with an eastern aspect and moderately forested with coniferous trees. A large waste rock pile located adjacent and below the mine portal is sparsely vegetated with trees. The understory is also sparse with grasses and forbs. The riparian vegetation in the Clear Creek flood plain is generally a scrub-shrub environment with a distinct lack of mature stands of trees such as cottonwood, alder, or willow. A small spring seep area occurs at the base of the hillside within the floodplain, resulting in a wetland of sedges and grasses.

Plants growing on contaminated soils or waste materials may uptake and bioaccumulate chemicals that may become toxic or could be transferred through the food web. Local small mammals and ground birds (e.g., grouse) are potentially at risk from contaminants in waste rock piles and from the iron seep. Larger mammals and birds with greater home ranges may occasionally be exposed to the mine-waste materials.

2.3 Conceptual Site Model

In this section, a site conceptual model is developed to depict sources of contamination, potential contaminant release and transport mechanisms, impacted exposure media, and exposure routes for ecological receptor types at the site. The primary sources of the COIs are the mine adit discharges and mining-related waste piles. The waste piles are subject to erosion and potential leaching of contaminants into the shallow groundwater that could enter Clear Creek.

Much of the eroded material or iron precipitate that historically entered the creek and deposited into the sediments was disturbed, relocated, or dispersed by the recent stream restoration activities. The outfall of the Blackjack mine water discharges into a pond channel located east of USFS Road-10 and continues to flow downstream for approximately 0.3 mile before it is no longer noticeable. This water may provide some exposure to wildlife and potentially some seepage back into Clear Creek.

The COIs may bioaccumulate in plant or animal tissues and be transported through the food chain (especially mercury). Figure 1 provides a graphic representation of the conceptual site model for the Blackjack site.

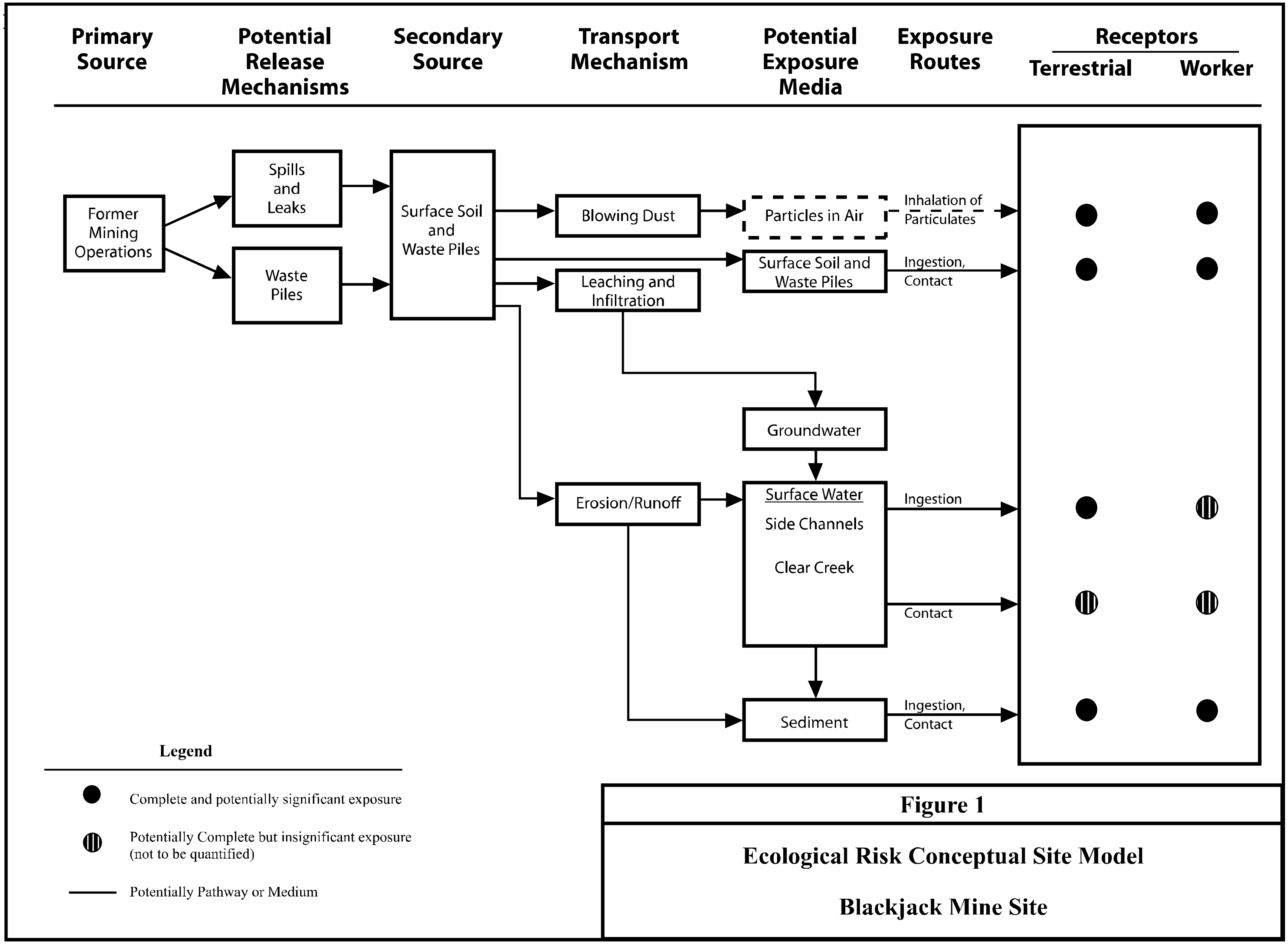

Figure 1

Ecological Risk Conceptual Site Model

Blackjack Mine Site

2.4 Assessment and Measurement Endpoints

Assessment endpoints, listed below, are qualitative or quantitative expressions of the environmental values to be protected and are used to link the ERA and risk management processes by highlighting ecological aspects that are of concern to risk managers. Measurement endpoints, also listed below, are characteristics of the site, receptors, or ecological data that are measured through sampling or monitoring, and then related qualitatively or quantitatively to the selected assessment endpoints.

2.4.1 Assessment Endpoints

- Protect salmonid species of concern and their associated aquatic habitat (including macroinvertebrates) from adverse effects due to contaminants in Clear Creek.
- Protect small mammals and ground birds from adverse effects of contaminants in soils and wastes.
- Protect vegetation from adverse effects from contaminants in soils and water.

2.4.2 Measurement Endpoints

- Measured concentrations of chemicals in soil, waste piles, surface water, pore water, and sediment and plant tissue.
- Other chemistry data such as soil leach tests results, acid generation potential, pH, and redox potential.
- Benthic macroinvertebrate surveys and fish population data.
- Readily available ecological risk-based screening concentrations (RBSCs) available from ODEQ guidance or other readily available published literature.

2.5 Data Usability

Standard field and laboratory quality control procedures were used and analytical results were quality assured by the laboratory. The analytical data are considered good quality and useable for the ERA.

The Blackjack soil/waste data were collected from two primary sources:

- The main waste rock pile adjacent to the adit portal, represented by four discrete samples and one composite sample from 3 locations,
- The old south settling pond and breached area, represented by 2 samples.

3.0 ECOLOGICAL RISK-BASED SCREENING

This section identifies contaminants of potential ecological concern (CPECs) by comparing the media concentrations of the COIs identified in Section 2.1 with RBSCs specific to aquatic life; or to plants, invertebrates, birds, and mammals in the terrestrial ecosystem. The exposure point concentrations are represented by either the 90UCL or maximum concentration, depending on sample size for the source area. One-half the analytical reporting limit was used in these calculations when a particular result was listed as not detected.

Generally, the RBSCs used in the risk-based screening were the screening level values cited in ODEQ (2001). Exceptions to this are referenced in Attachment B. The ratio of the media exposure concentration to the RBSCs results in a risk ratio or hazard quotient, and defines a CPEC. Risk ratios greater than 1 indicates a potential risk for protected (i.e., federally threatened or endangered) species, while a risk ratio of 5 or greater indicates a potential risk for non-protected receptors (ODEQ 2001). The predicted risks for the CPECs are discussed further in the risk characterization section.

3.1 Risk Screening of Sediments in Clear Creek

Table 5 compares the 90UCL concentration of the COIs from both pool and riffle habitats to their respective sediment conservative screening values. The risk ratios ranged from 0.1 for mercury to 1.3 for arsenic. Mercury is not a CPEC in sediments related to the Blackjack Mine. The low ratios for the remaining CPECs suggest that the site sediment concentrations have low potential for risks. For chromium, iron, and nickel, the ratios suggest variability near reference background levels.

The sediment concentrations reflect only the fine sediment particles that are collected for analysis. These fine sediments represent a small fraction of the exposure medium in mountain streams. Most benthic macroinvertebrates in mountain streams are not fine sediment dwellers but rather utilize boulders, cobbles, gravels, and woody debris. Therefore, the risk ratios are considered over-conservative for potential effects to aquatic invertebrates in Clear Creek.

3.2 Risk Screening of Blackjack Soil/Waste Areas

For this risk screening, the available site data generally represent two contaminated source areas; the main waste rock pile located adjacent and downslope of the upper adit portal, and the old south settling pond and breached area. This pond historically received mine drainage water piped from the portal, but has since been abandoned and was dry during field visits. ODEQ (2001) risk-based screening levels for terrestrial receptors (plants, soil invertebrates, birds, and mammals) were used to compare to the concentrations of COIs in these two source areas. Table 6 presents the terrestrial screening results. Because only two samples represent the old south settling pond, the maximum concentration was used for comparisons.

At the main waste rock pile, mammals generally have the lowest risk ratios to the contaminants. Mercury has the highest ratios (>5) for plants and invertebrates. The remaining CPECs have ratios ranging from <0.1 to 5, suggesting low potential for risks from individual contaminants. However, the multiple contaminants suggest that some low-level or chronic risks to terrestrial receptors may occur.

Table 5: Risk-Based Screening of Sediments in Clear Creek Potentially Influenced by Blackjack Mine

COI	Habitat	90UCL Concentration	Sediment Screening Value	Ratio
Arsenic	pool	44.7	35.3	1.3
	riffle	42.6		1.2
Chromium	pool	147	116	1.3
	riffle	124		1.1
Cobalt	pool	27.7	27	1.0
	riffle	28.4		1.1
Copper	pool	36.2	36	1.0
	riffle	46.0		1.3
Iron	pool	30,930	34,400	0.9
	riffle	34,930		1.0
Manganese	pool	1,224	1,100	1.1
	riffle	866		0.8
Mercury	pool	0.043	0.2	0.2
	riffle	0.010		0.1
Nickel	pool	189	158	1.2
	riffle	154		1.0
All concentrations in mg/kg				

At the old south settling pond, resident birds may be more susceptible to hazards from arsenic, copper, and selenium where risk ratios were greater than 5. Plants appear to be at elevated risk from the multiple CPECs. The south settling pond material is comprised mainly of precipitated iron oxide and oxyhydroxide metal complexes that overlie a bed of dredged cobbles and gravels. No plants were observed growing in the dry pond.

Table 6: Risk-Based Screening of Blackjack Mine Soil/Waste Materials

	Arsenic	*Chromium*	*Cobalt*	*Copper*	*Iron*	*Lead*	*Mercury*	*Nickel*	*Selenium*	*Thallium*	*Vanadium*
RBSC											
Plants	10	12.5 *	13	100	35300 *	50	0.3	39.5 *	1.9 *	1.5 *	38.5 *
Invertebrates	60	12.5 *	1000	52.6 *	35300 *	500	0.1	200	70		
Birds	10	12.5 *	190	190		16	1.5	320	2		47
Mammals	29	410	240	390		4000	73	625	25	1.5	38.5
Main Waste Rock Pile (n=5)											
UCL90	**19.8**	**62.6**	**22.4**	**461**	**103800**	**99.5**	**1.8**	**53.3**	**5.8**	**4.0**	**43.1**
Risk Ratio[1]											
Plants	2.0	5.0	1.7	4.6	2.9	2.0	6.0	1.3	3.1	2.7	1.1
Invertebrates	0.3	5.0	0.0	8.8	2.9	0.2	18.0	0.3	0.1		
Birds	2.0	5.0	0.1	2.4		6.2	1.2	0.2	2.9		0.9
Mammals	0.7	0.2	0.1	1.2		0.0	0.0	0.1	0.2	2.7	1.1
Old South Settling Pond and Breached Area											
Concentrations	21.2	39.6	18.3	1440	459000	32	0.49	23.9	29.7	17.4	35.7
	82.3	147	20	126	106000	10.3	0.75	146	4	3	64.8
Risk Ratio[1]											
Plants	8.2	11.8	1.5	14.4	13.0	0.6	2.5	3.7	15.6	11.6	1.7
Invertebrates	1.4	11.8	0.0	27.4	13.0	0.1	7.5	0.7	0.4		
Birds	8.2	11.8		7.6		2.0	0.5	0.5	14.9		1.4
Mammals	2.8	0.4	0.1	3.7		0.0	0.0	0.2	1.2	11.6	1.7

* - Based on maximum background soil RBSC.

1. Risk ratios <1.0 indicate no risk.
   Risk ratios >1.0 and <5.0 suggest potential risks to threatened and endangered species.
   Risk ratios >5.0 suggest potential risk to non-T&E species.
   (There are no terrestrial T&E species known to utilize the site.

4.0 RISK CHARACTERIZATION

This section provides a description of risks that involves evaluating the risk ratio estimates presented in Section 3 relative to other site information and uncertainties to characterize the potential for ecological risks at the site.

The primary assessment endpoint related to the Site is protecting threatened and endangered species that reside in Clear Creek and their habitat. The protection of local and transient terrestrial receptors from hazardous substances is also important.

4.1 Risks to Aquatic Resources in Clear Creek

There were no contaminants of interest identified in Clear Creek surface waters and pore waters. This suggests that fish populations and macroinvertebrate communities are not impacted by hazardous substances release from the Site. To determine if this is the case, an examination of the available fish and macroinvertebrate data is needed.

EA Engineering (2003) collected benthic macroinvertebrate data from seven stations in Clear Creek, one station in a side channel, and one upstream reference background station (see Figures 1 and 2 in the SI for sample locations). EA Engineering developed macroinvertebrate metric scores using ODEQ's Biotic Index methodology that provides a measure of the relative condition or health of the benthic community. The higher the score, the more diverse and productive the community is. Table 7 summarizes the metric scores for both pool and riffle habitats. The data indicate no significant differences between the reference station and any of the downstream stations, even after a known release of approximately 70,000 gallons of Blackjack mine water discharged directly into the creek. From Table 7, the BLAC-2 pool station after the spill was slightly lower, but not distinguishable with natural variability, even though visible iron flocculent precipitate was noted in the pool (EA Engineering 2003). Station BLAC-42 in the side channel had the highest macroinvertebrate score, even though it had the highest metal sediment concentrations.

Fish population data was also collected by EA Engineering before and after the Blackjack spill. Table 8 shows the number of fish species collected at each station. The data indicate no apparent effects on fish populations or diversity in Clear Creek from the mine or the spill. For example, at BLAC-2, there were more Chinook salmon, redband trout, and torrent sculpin in the pool after the spill than before the spill. BLAC-42 is a side channel where dace and sculpins (species that are more associated with benthic substrate and lower flows) typically frequent. The higher sediment metal concentrations at this station do not appear to influence their use at this location.

Habitat assessment scores were also developed by EA Engineering (2003) and are summarized in Table 9. The data indicate that physical habitat conditions are not a limiting factor for supporting healthy macroinvertebrate and fish communities.

In summary, the weight-of-evidence of water quality, sediment quality, habitat conditions, fish population, and macroinvertebrate community data indicate that Clear Creek is not currently being impacted by the Site. However, the uncontrolled release of mine water, along with its associated precipitated iron-metal complexes, from the small north adit (approximately 5 gal/min) should be prevented from discharging into Clear Creek. The USFS is currently planning to install a new pipeline system to convey the mine discharge (including the north adit) into the settling pond east of USFS Road-10.

Table 7: Clear Creek Macroinvertebrate Metric Scores [a]

Station	Before Spill b		11 Days After Spill	
	Pool Habitat	Riffle Habitat	Pool Habitat	Riffle Habitat
BLAC-1 - Upstream	30	40	24	36
BLAC-2	34	40	20	42
BLAC-3	30	38	26	36
BLAC-4	34	34	NC	NC
BLAC-42	NC	42	NC	NC
BLUE-5	34	38	32	40
BLUE-6	28	42	NC	NC
BLUE-7	30	40	NC	NC
BLUE-8 - Downstream	30	38	NC	NC

a - Source: EA Engineering (2003) using ODEQ Biotic Index level 3 methods.
b - Spill occurred on July 29, 2003 of approx. 70,000 gal from the upper Blackjack adit with visible iron plume about one mile downstream. Macroinvertebrate community re-evaluated on August 9.
NC - Data not collected.

Table 8: Fish Population Data in Clear Creek [a]

Station	Chinook Salmon	Redband Trout	Speckled Dace	Torrent Sculpin	Paiute Sculpin
BLAC-1	~ 100 / 3	2 / 5	2 / 0	3 / 0	0 / 0
BLAC-2	10 / 100	0 / 10	0 / 0	0 / 2	0 / 0
BLAC-3	75 / 0	0 / 5	1 / 0	3 / 2	0 / 1
BLAC-4	60	1	20	2	0
BLAC-41	0	4	0	3	0
BLAC-42	0	0	51	3	0
BLUE-5	60 / 5	0 / 10	30 / 2	1 / 6	0 / 0
BLUE-6	0	1	10	1	0
BLUE-7	10	0	50	3	0
BLUE-8	20	0	75	2	0

a - Source: EA Engineering (2003).
First number in cell indicates population prior to spill; second number is population after spill.

Table 9: Clear Creek Aquatic Habitat Assessment Scores

Station	Score
BLAC-1 - Upstream	176
BLAC-2	169
BLAC-3	171
BLAC-4	183
BLAC-42	147
BLUE-5	151
BLUE-6	167
BLUE-7	180
BLUE-8 - Downstream	182

Source: EA Engineering (2003).
Potential maximum score is 200.
Highest siltation occurred at BLUE-5 and BLAC-42 (side channel) - resulted in lower scores for embedded ness.

4.2 Risk Characterization of Terrestrial Receptors

4.2.1 Settling Ponds

Old South Settling Pond. Terrestrial receptors are exposed to hazardous substances that primarily occur in waste piles, settling ponds, and the lower iron seep area. As described in section 3.2, the precipitate material in the former south settling pond (See Figure 1 of the EE/CA report) may pose a localized threat to terrestrial receptors. Although the pond size is small (approximately 80 feet by 35 feet), deer, bird, and small mammal tracks were observed in the orange-colored material. Due to the lack of habitat and cover, wildlife use is negligible. The toxicological risk posed to local populations of wildlife from this source area is not significant. The breach at the north end of this pond suggests that future erosion of the pond walls could result in the release of pond material into Clear Creek, during a major storm/runoff event. This south pond is also contemplated by the USFS as a potential emergency backup pond during construction of the new pipeline drainage system or during unforeseen maintenance problems where mine water may have to be diverted into it rather than into Clear Creek.

Current Settling Pond. The iron-metal precipitate in the ponds, at and downstream of the Blackjack mine water discharge point is likely to result in some risks to macroinvertebrates that may attempt to colonize the pond bottom. The concentrations of arsenic, copper, iron, manganese, nickel, and zinc are notably high relative to sediment screening values. However, the pond is considered necessary for containing the mine water and precipitating the heavy metals that would otherwise enter Clear Creek. Vegetation in the current settling pond varies depending on water depth and extent of settled precipitate. In general, the thicker the precipitate, the less emergent vegetation is observed. The cattails and sedges appear most tolerant. Birds, mammals, reptiles and amphibians may drink from the pond water but most of the metals have been precipitated with the iron and manganese out of the water column, and is not expected to pose an adverse threat.

Some of the mine water in the current settling pond may eventually filter through the substrate and seep into Clear Creek. Since the 1970s when these ponds have been in operation, there is no evidence of significant seepage to the creek based on available surface water, pore water, and sediment data.

Maintaining the physical integrity of the ponds is important to prevent a release of the precipitated material into Clear Creek.

4.2.2 Waste Piles

As mentioned in Section 3.2, several contaminants collectively may pose a threat to local terrestrial receptors. Vegetation on the main waste rock pile is limited to scattered fir trees. Very few grasses and forbs are growing, largely due to the physical characteristics of the rock material (e.g., no soil horizons) and lack of nutrients. Consequently the material does not provide quality habitat for soil organisms or vertebrates to utilize the waste pile area. The plant tissue data from the site did not show unusual levels of metals uptake, with most metals being within background tissue concentrations. Most of the material is also on a very steep slope and could potentially erode into the creek. However, given the growth of trees and other vegetation at the base of the rock pile, and no evidence of prior mass wasting, the likelihood of the coarse waste rock entering the creek is very low.

Leach testing of the waste pile further indicates that contaminant release potential is low and not of regulatory concern and indicate that the elevated metal concentrations in the rock material has low potential for bioavailability to terrestrial receptors. Given these conditions, the relatively low risk ratios, and small size of the waste material (< 0.5 acre), risks to localized terrestrial receptors is considered low. Adverse risks to wildlife populations of the area are not expected.

4.3 Uncertainty Analysis

Overall, the data used in this assessment conservatively represent exposure and toxicity. Thus, the estimated risks using the screening-level approach likely overestimate actual risks at the site. The use of maximum detected concentrations or 90UCL as the exposure concentrations is a conservative approach purposefully designed to result in some overestimation of the potential for ecological risks. The screening-level values are also based on very conservative toxicity information to sensitive organisms that may or may not be relevant at the Site.

5.0 CONCLUSIONS AND RECOMMENDATIONS

There was sufficient information to characterize potential contamination and ecological risks at the site. Although it is likely that individual terrestrial receptors may be at risk within a localized area, receptor populations in the vicinity of the Site are unlikely to be significantly impacted by the localized and small exposure areas to source materials. Any habitat loss from waste rock piles is also unlikely to result in adverse effects to species due to the large amount of relatively undisturbed habitats available in the immediately surrounding area. The uncontrolled discharge of approximately 5 gal/min from the lower adit should be contained or diverted from directly entering Clear Creek. The USFS is currently planning a pipeline to control this discharge.

Because significant risks are not predicted for terrestrial ecological receptors, use of the soil RBSCs as preliminary remediation goals (PRGs) would be too conservative and no site-specific numerical PRG concentrations for the CPECs in waste rock are necessary. Although actions could be taken to reduce the already low wildlife exposures and risks (i.e., from the former south settling pond and waste rock pile); such low risk reductions would be virtually impossible to quantify at the individual or population level.

6.0 REFERENCES

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Attachment A: ODEQ Ecological Scoping Checklist
Streamlined Ecological Risk Assessment
Blackjack Mine Site

Ecological Scoping Checklist

Site Name	Blackjack Abandoned Mine Site
Date of Site Visit	Sept 8, 9, 10 2004
Site Location	Umatilla National Forest (Near Granite)
Site Visit Conducted by	Jim Eldridge, Tom Moyer, Art Braun, Mike Johnsen

Part ❶

CONTAMINANTS OF INTEREST **Types, Classes, Or Specific Hazardous Substances**‡ **Known Or Suspected**	**Onsite**	**Adjacent to or in locality of the facility**†
Mining-related wastes		
heavy metals	X	X
mercury	X	X

‡ As defined by OAR 340-122-115(30) † As defined by OAR 340-122-115(34)

Part ❷

OBSERVED IMPACTS ASSOCIATED WITH THE SITE	**Finding**
Onsite vegetation (**N**one, **L**imited, **E**xtensive)	L
Vegetation in the locality of the site (**N**one, **L**imited, **E**xtensive)	E
Onsite wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other (**N**one, **L**imited, **E**xtensive)	L
Wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other in the locality of the site (**N**one, **L**imited, **E**xtensive)	E
Other readily observable impacts (**N**one, **D**iscuss below)	D

Discussion:

one large waste rock pile on hillside,

one former settling pond for AMD discharge

one uncontrolled discharge from collapsed adit on north end

Blackjack

Ecological Scoping Checklist (cont'd)

Part ❸

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Terrestrial - Wooded	
Percentage of site that is wooded	60 %
Dominant vegetation type (**E**vergreen, **D**eciduous, **M**ixed)	P *
Prominent tree size at breast height, i.e., four feet (<6", 6" to 12", >12")	6-12
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Mac, B, M
Terrestrial - Scrub/Shrub/Grasses	
Percentage of site that is scrub/shrub	30 %
Dominant vegetation type (**Sc**rub, **Sh**rub, **G**rasses, **O**ther)	h P
Prominent height of vegetation (<2', 2' to 5', >5')	2-5
Density of vegetation (**D**ense, **P**atchy, **S**parse)	D P
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Mac, B, M
Terrestrial - Ruderal	
Percentage of site that is ruderal	10 %
Dominant vegetation type (**L**andscaped, **A**griculture, **B**are ground)	B ~~10%~~ P
Prominent height of vegetation (0', >0' to <2', 2' to 5', >5')	0-2
Density of vegetation (**D**ense, **P**atchy, **S**parse)	S P
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Mac, B, M
Aquatic - Non-flowing (lentic)	
Percentage of site that is covered by lakes or ponds	
Type of water bodies (**L**akes, **P**onds, **V**ernal pools, **I**mpoundments, **La**goon, **R**eservoir, **C**anal)	Pond
Size (acres), average depth (feet), trophic status of water bodies	0.1 acre
Source water (**R**iver, **S**tream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff)	Stream
Water discharge point (**N**one, **R**iver, **S**tream, **G**roundwater, **W**etlands impoundment)	
Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther)	Rocky P
Vegetation present (**S**ubmerged, **E**mergent, **F**loating)	E P
Obvious wetlands present (**Y**es / **N**o)	Yes
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Mac, A, B, M
Aquatic - Flowing (lotic)	
Percentage of site that is covered by rivers, streams (brooks, creeks), intermittent streams, dry wash, arroyo, ditches, or channel waterway	5 %
Type of water bodies (**R**ivers, **S**treams, **I**ntermittent Streams, **Dr**y wash, **A**rroyo, **D**itches, **C**hannel waterway)	Stream
Size (acres), average depth (feet), approximate flow rate (cfs) of water bodies	2' - P
Bank environment (cover: **V**egetated, **Ba**re / slope: **S**teep, **G**radual / height (in feet))	V, G
Source water (**R**iver, **S**tream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff)	S
Tidal influence (**Y**es / **N**o)	No

Blackjack

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Water discharge point (**N**one, **R**iver, **St**ream, **G**roundwater, **W**etlands impoundment)	S
Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther)	R
Vegetation present (**S**ubmerged, **E**mergent, **F**loating)	E **P**
Obvious wetlands present (**Y**es / **N**o)	Yes
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds,	Mac, B, M
Mammals, **O**ther)	
Aquatic - Wetlands	
Obvious or designated wetlands present (**Y**es / **N**o)	Yes
Wetlands suspected as site is/has (**A**djacent to water body, in **F**loodplain, **S**tanding water, **D**ark wet soils, **Mu**d cracks, **De**bris line, **W**ater marks)	F
Vegetation present (**S**ubmerged, **E**mergent, **S**crub/**s**hrub, **W**ooded)	SS **P**
Size (acres) and depth (feet) of suspected wetlands	< 2
Source water (**R**iver, **St**ream, **G**roundwater, **I**ndustrial discharge, **Sur**face water runoff)	S, G
Water discharge point (**N**one, **R**iver, **St**ream, **G**roundwater, **I**mpoundment)	S
Tidal influence (**Y**es / **N**o)	No
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Mac, B, M.

* **P**: Photographic documentation of these features is highly recommended.

Part ❹

ECOLOGICALLY IMPORTANT SPECIES/HABITATS OBSERVED
Clear Creek riparian / wetland floodplain.
chinook salmon
other salmonids

Blackjack

Evaluation of Receptor-Pathway Interactions

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in surface waters? **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via surface water?**	X X		X
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in surface waters. • Ability of hazardous substances to migrate to surface waters. • Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters. Aquatic receptors may be exposed through osmotic exchange, respiration or ventilation of surface waters. • Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters. • Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.			
Are hazardous substances present or potentially present in groundwater? AMD **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via groundwater?** Seepage	X X X		
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in groundwater. AMD • Ability of hazardous substances to migrate to groundwater. • Potential for hazardous substances to migrate via groundwater and discharge into habitats and/or surface waters. • Contaminants may be taken-up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1m depth). • Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

Blackjack

Evaluation of Receptor-Pathway Interactions (cont'd)

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in sediments? **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via contact with sediments?**	 X X		X
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in sediment. • Ability of hazardous substances to leach or erode from surface soils and be carried into sediment via surface runoff. • Potential for contaminated groundwater to upwell through, and deposit contaminants in, sediments. • If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods. Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration or ventilation of sediment pore waters. • Terrestrial plants may be exposed to sediment in an area that is only periodically inundated with water. • If sediments are present in an area that is only periodically inundated with water, terrestrial species may have direct access to sediments for the purposes of incidental ingestion. Aquatic receptors may regularly or incidentally ingest sediment while foraging.			
Are hazardous substances present or potentially present in prey or food items of ecologically important receptors? Mercury ? **AND** **Are ecologically important species or habitats present?** salmonids **AND** **Could hazardous substances reach these receptors via consumption of food items?**	 X		X X
When answering the above questions, consider the following: • Higher trophic level terrestrial and aquatic consumers and predators may be exposed through consumption of contaminated food sources. • In general, organic contaminants with log $K_{ow} > 3.5$ may accumulate in terrestrial mammals and those with a log $K_{ow} > 5$ may accumulate in aquatic vertebrates.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

Blackjack

Evaluation of Receptor-Pathway Interactions (cont'd)

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in surficial soils?	X		
AND			
Are ecologically important species or habitats present?		X	
AND			
Could hazardous substances reach these receptors via incidental ingestion of or dermal contact with surficial soils?	X		
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in surficial (~1m depth) soils. • Ability of hazardous substances to migrate to surficial soils. • Significant exposure via dermal contact would generally be limited to organic contaminants which are lipophilic and can cross epidermal barriers. • Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash). • Contaminants in bulk soil may partition into soil solution, making them available to roots. • Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.			
Are hazardous substances present or potentially present in soils?	X		
AND			
Are ecologically important species or habitats present?		X	
AND			
Could hazardous substances reach these receptors via vapors or fugitive dust carried in surface air or confined in burrows?	X		
When answering the above questions, consider the following: • Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant > 10-5 atm-m3/mol and molecular weight < 200 g/mol). • Exposure via inhalation is most important to organisms that burrow in contaminated soils, given the limited amounts of air present to dilute vapors and an absence of air movement to disperse gases. • Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that could be exposed to dust disturbed by their foraging or burrowing activities or by wind movement. • Foliar uptake of organic vapors would be limited to those contaminants with relatively high vapor pressures. • Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

Attachment B: Risk Based Screening Concentrations
Streamlined Ecological Risk Assessment
Blackjack Mine Site

Table B-1. Ecological Risk Based Screening Concentrations for Surface Water and Sediment at the Blackjack Mine

Chemical	*Surface Water RBSC (µg/L)* [a]	*Sediment RBSC (mg/kg)*	*Source*
Aluminum	87	58,000	c
Antimony	1,000	3	a
Arsenic III	150	35.3	b
Barium	23.3 (b)	165	c
Beryllium	5.3	2	d
Cadmium	2.2	0.6	a
Calcium	116,000	NA	NA
Chromium	11	37	a
Cobalt	23	27	e
Copper	9	36	a
Iron	1,000	34,400	b
Lead	2.5	35	a
Magnesium	82,000	NA	NA
Manganese	120	1,100	a
Mercury	0.77	0.2	a
Nickel	52	18	a
Potassium	53,000	NA	NA
Selenium	5	4	f
Silver	0.12	4.5	a
Sodium	680,000	NA	NA
Thallium	40	8	d
Vanadium	20	64	b
Zinc	120	123	a

a - ODEQ Level II Ecological Screening Level Values except for barium.
b - Based on mean + 2 standard deviations of background concentrations in Clear Creek upstream of Blackjack.
c - Ingersoll, et al. (1996)
d - Efroymson, et al. (1997)
e - Friday (1998)
f - Van Derver and Canton (1997), Lemley and Smith (1987)
NA - Not Applicable.

Table B-2. Ecological Risk Based Screening Concentrations for Soils/Wastes at the Blackjack Mine (mg/kg) [a]				
Chemical	*Plants*	*Invertebrates*	*Birds*	*Mammals*
Aluminum	50	600	450	107
Antimony	5	78 (b)	NA	15
Arsenic III	10	60	10	29
Barium	500	3,000	85	638
Beryllium	10	NA	NA	83
Cadmium	4	20	6	125
Chromium	12.5 (c)	12.5 (c)	12.5 (c)	340,000
Cobalt	20	1,000	190 (b)	150
Copper	100	52.6 (c)	190	390
Iron	35,300 (c)	35,300 (c)	NA	NA
Lead	50	500	16	4,000
Manganese	1,502 (c)	1,502 (c)	4,125	11,000
Mercury	0.3	0.1	1.5	73
Nickel	39.5 (c)	200	320	625
Selenium	1.9 (c)	70	2	25
Silver	2	50	NA	NA
Thallium	1.5 (c)	NA	NA	1.5 (c)
Vanadium	38.5 (c)	NA	47	38.5 (c)
Zinc	50	200	60	20,000
a - ODEQ Level II Ecological Screening Level Values b - USEPA (2003) c - Based on maximum of 2 local soil background samples.				

References:

Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2. Prepared for the U.S. Department of Energy, Officeof Environmental Management.

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Ingersol, C.G., Haverland, P.S., Brunson, E.L., Canfield, T.J., Dwyer, F.J., Henke, C.E., Kemble, N.E., Mount, D.R., and Fox, R.G. 1996. Calculation and Evaluation of Sediment Effect Concentrations for the Amphipod *Hyalella azteca* and the Midge *Chironomus riparius*. National Biological Service Final Report for the USEPA Great Lakes National Program Office (GLNPO) Assessment and Remediation of Contaminated Sediment (ARCS) Project. EPA 905-R96-008. USEPA, Chicago.

Lemley, A.D., and Smith, G.J. 1987. Aquatic Cycling of Selenium: Implications for Fish and Wildlife. Fish and Wildlife Leaflet 12. U.S. Fish and Wildlife Service, Washington D.C.

U.S. Environmental Protection Agency. 2003. Guidance for Developing Ecological Soils Screening Levels. OSWER Directive 9285.7-55, Office of Solid Waste and Emergency Response.

Van Derveer, W.D., and Canton., S.P. 1997. Selenium Sediment Toxicity Thresholds and Derivation of Water Quality Criteria for Freshwater Biota of Western Streams. Environmental Toxicology and Chemistry. 16:1260-1268.

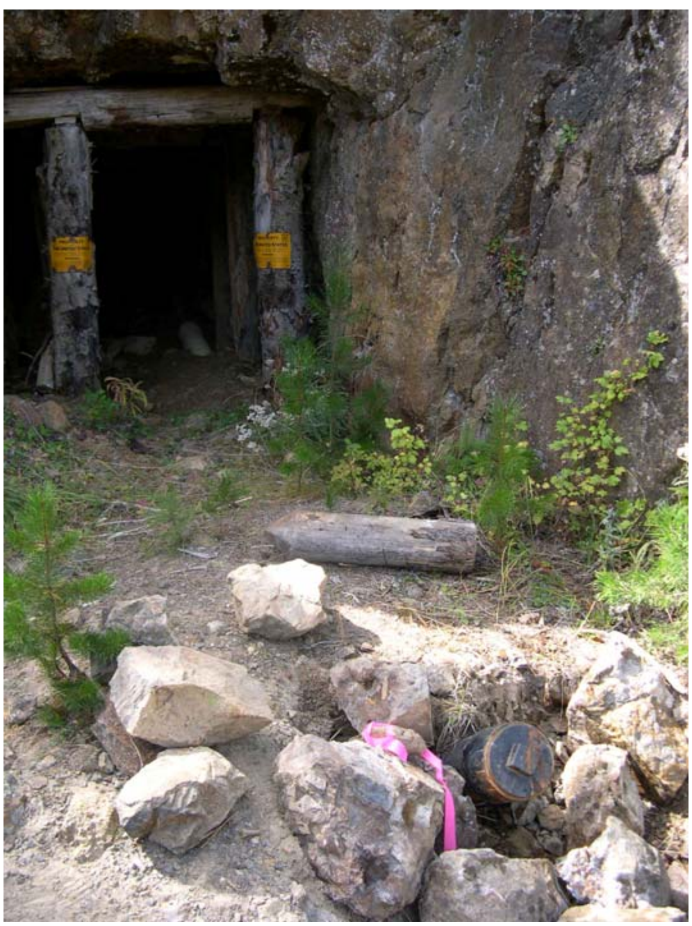
Appendix B: Site Photos

Blackjack Mine Site

Near base of Blackjack waste rock area.

Close-up of leaking AMD.

Leaking AMD from Blackjack pipe eastside of Clear Creek.



Blackjack mine portal.


Blackjack waste rock layer looking southeast.

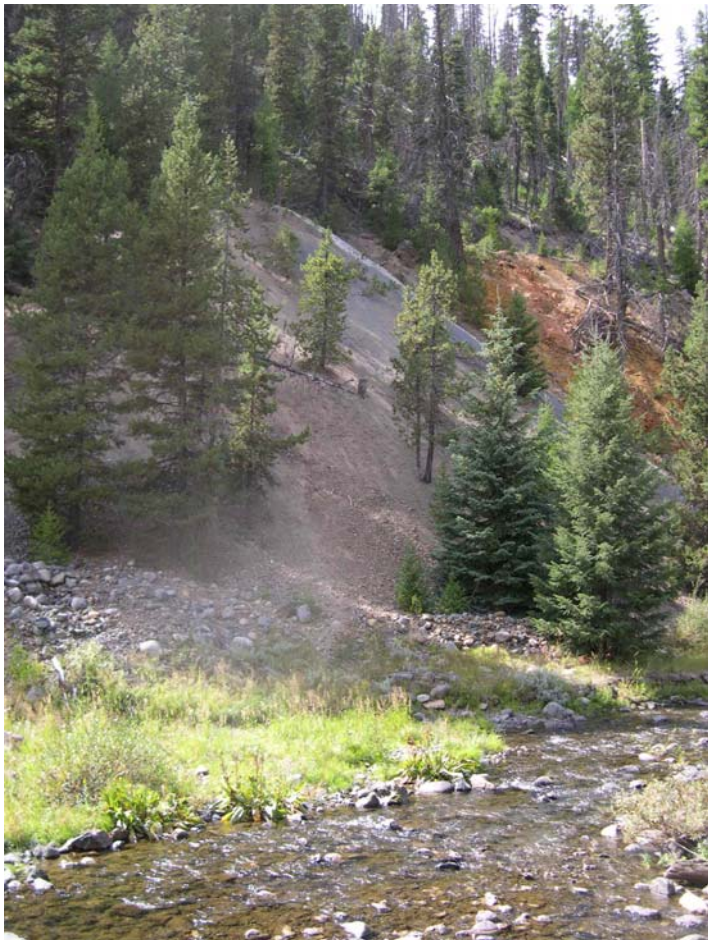

Blackjack iron seep.

Iron seep developed for flow measurements.

Small waste rock pile near iron seep.

Seep near Clear Creek floodplain – some iron stain.

Developing flume for flow measurements.



View of Blackjack waste rock area.

Former area of uncontrolled AMD discharge.

Series of log weirs upstream of Blackjack.

Artificially constructed fish pool.

Appendix C: Summary Data Tables From 2004 Sampling Blackjack Mine Site

Blackjack Waste Supplemental Data

	BLK-WA-001	Qual	Ecological Risk Screening Criteria								Human Health Risk Screening Criteria
			ODEQ Level II Screening Values for Surface Soil				EPA Ecological Soil Screening Levels				EPA Region 9 PRGs
			Plants	Inverts	Birds	Mammals	Plants	Inverts	Birds	Mammals	
Aluminum	4080		50	600	450	107					100000
Antimony	0.3	U	5			15		78		0.29	410
Arsenic III	10.6		10	60	10	29					1.6
Barium	116		500	3000	85	638		330		1000	
Beryllium	0.23		10			83		40		36	1900
Cadmium	0.2	U	4	20	120	3500	32	140	1	0.38	450
Calcium	330										
Chromium	76.8		1	0.4	4	340000					64
Cobalt	5.58		20	1000		150	13		190	240	1900
Copper	82.7		100	50	190	390					41000
Iron	28000		10	200							100000
Lead	221		50	500	16	4000	110	1700	16	59	800
Magnesium	1010										
Manganese	366		500	100	4125	11000					19000
Mercury	0.587		0.3	0.1	1.5	73					310
Nickel	20.8		30	200	320	625					20000
Potassium	1430										
Selenium	0.31		1	70	2	25					5100
Silver	0.5	U	2	50							5100
Sodium	50	U									
Thallium	0.1	U	1			1					67
Vanadium	22.4		2		47	25					1000
Zinc	54		50	200	60	20000					100000

All values in mg/kg

Blackjack Waste Supplemental Data

General Chemistry

Parameter	Units	Value
Acid-Base Potential	TCaCO3/1000T	1.70
Acid Generating	TCaCO3/1000T	0.94
Acid Neutralizing	TCaCO3/1000T	2.64
Non-Ext Sulfur	%	<0.010
Pyritic Sulfur	%	0.030
Sulfate Sulfur	%	0.020
Total Sulfur	%	0.050
pH-paste	s.u.	5.63

Blackjack Water Supplemental Data

					Ecological Risk Screening Criteria							Human Health Risk Screening Criteria			
	BLK-SW-001	Qual	BLK-SW-002	Qual	ODEQ Water Quality Criteria, Protection of Aquatic Life, Fresh chronic	ODEQ Level II Screening Values for Surface Water			EPA Ambient WCC Freshwater Aquatic Organisms, Chronic	EPA Ambient WCC Freshwater Aquatic Organisms, Chronic, Tier II	ORNL PRGs	ODEQ Consumption of Water and Fish	ODEQ Consumption of Fish Only	EPA WCC Consumption of Water and Organism	EPA WCC Consumption of Organism only
						Aquatic	Birds	Mammals							
Aluminum	466		9.6		87	87	797000	8000		87	87				
Antimony	0.1		0.06		1600	1600		1000			30	146	45000	5.6	640
Arsenic III	3.9		0.3		150	150	18000	6000	150		0.31	0.018	0.14	0.018	0.14
Barium	32.7		28.5			4	150000	39000			4	1000			
Beryllium	0.051		0.034		5.3	5.3		5000			0.66	0.0000068	0.000117		
Cadmium	1.24		0.02	U		2.2	10000	8000	0.25		1.1	10			
Calcium	5750		7660			116000									
Chromium	3	U	3	U	11	11	7200	25000	11		11	50	3433000		
Cobalt	33.1		12.3			23		9000			23				
Copper	92.3		0.56		12	9	341000	53000	9		12	1300		1300	
Iron	14400		18500		1000	1000				1000	1000	300			
Lead	0.054		0.016		3.2	2.5	28000	323000	2.5		3.2				
Magnesium	7610		12700			82000									
Manganese	2380		2440			120	7242000	676000			120	50	100		
Mercury	0.04	U	0.04	U	0.012	0.77	3300	1000	0.77		1.3	0.000144	0.000146		0.3
Nickel	81.2		47.7		160	52	562000	38000	52		160	13.4	100	610	4600
Potassium	1120		1250			53000									
Selenium	0.2		0.2		5	5	3600	1500	5		0.39	170	4200	170	4200
Silver	0.017		0.009	U	0.1	0.12					0.36	10			
Sodium	2810		2580			680000									
Thallium	0.604		0.248		40	40		60			9	13	48	1.7	6.3
Vanadium	5	U	5	U		20	82000	1600			20				
Zinc	110		85.2		110	120	105000	1230000	120		110	7400	26000		

All values in µg/L

Blackjack Water Supplemental Data Additional Parameters

Sample ID		**BLK-SW-001**	**BLK-SW-002**
Date Collected		9/10/2004	9/10/2004
Parameter	Units	Value	Value
General Chemistry			
Acidity	mg/L	46	70
Alkalinity	mg/L	14	36
Chloride	mg/L	0.5	0.5
Sulfate	mg/L	45.3	58.9
Total Dissolved Solids	mg/L	95	131
Total Suspended Solids	mg/L	17	6
Field Measurements			
Temperature	°C	10.6	8.9
pH	s.u.	5.49	5.82
Conductivity	µS/cm	137	184
Total Dissolved Solids	ppm	68.5	92
Oxidation-Reduction Potential	mV	91	40

Blackjack 2004 Data Summary - TCLP Extractions

Sample ID		BLK-WA-001		EPA Reg.	OR Reg.
Date Collected		9/8/2004		Limit	Limit
Parameter	Units		Qual		
Metals					
Aluminum	mg/L	0.136			
Antimony	mg/L	0.0030	U		
Arsenic	mg/L	0.0030	U	5	0.004
Barium	mg/L	0.374		100	100
Beryllium	mg/L	0.0020	U		0.002
Cadmium	mg/L	0.0020	U	1	0.5
Calcium	mg/L	3.61			
Chromium	mg/L	0.0060	U	5	10
Cobalt	mg/L	0.0310			
Copper	mg/L	0.0279			100
Iron	mg/L	0.039			
Lead	mg/L	2.54		5	2
Magnesium	mg/L	6.92			
Manganese	mg/L	2.45			400
Nickel	mg/L	0.025			
Potassium	mg/L	3.8			
Selenium	mg/L	0.0030	U	1	
Silver	mg/L	0.0050	U	5	5
Thallium	mg/L	0.0020	U		
Total Mercury	mg/L	0.00020	U	0.2	0.2
Vanadium	mg/L	0.0050	U		
Zinc	mg/L	0.103			

U - Detection Limit

Blackjack 2004 Data Summary - SPLP Extractions

Sample ID		**BLK-WA-001**		**EPA Reg.**	**OR Reg.**
Date Collected		9/8/2004		**Limit**	**Limit**
Parameter	Units		Qual		
Metals					
Aluminum	mg/L	0.020	U		
Antimony	mg/L	0.0030	U		
Arsenic	mg/L	0.0030	U	5	0.004
Barium	mg/L	0.0235		100	100
Beryllium	mg/L	0.0020	U		0.002
Cadmium	mg/L	0.0020	U	1	0.5
Calcium	mg/L	1.33			
Chromium	mg/L	0.0060	U	5	10
Cobalt	mg/L	0.0060	U		
Copper	mg/L	0.0030	U		100
Iron	mg/L	0.020	U		
Lead	mg/L	0.0030	U	5	2
Magnesium	mg/L	1.57			
Manganese	mg/L	0.350			400
Nickel	mg/L	0.010	U		
Potassium	mg/L	1.7			
Selenium	mg/L	0.0030	U	1	
Silver	mg/L	0.0050	U	5	5
Sodium	mg/L	2.90			
Thallium	mg/L	0.0020	U	0.2	0.2
Total Mercury	mg/L	0.00020	U		
Vanadium	mg/L	0.0050	U		
Zinc	mg/L	0.0050	U		
pH	s.u.	6.67			

U - Detection Limit