Non-Time-Critical Removal Action Engineering Evaluation /Cost Analysis Upper Granite Creek, Grant County, Oregon Wallowa-Whitman National Forest

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Engineering Evaluation / Cost Analysis
Upper Granite Creek, Grant County, Oregon
Wallowa-Whitman National Forest

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Cover Photograph: Former Stamp Mill Foundation, Monumental Mine.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response and Liability Act
CES	Cascade Earth Sciences
COPC	Contaminants of Potential Concern
COPEC	Contaminants of Potential Ecological Concern
cy	cubic yards
DGI	Data Gap Investigation
EE/CA	Engineering Evaluation / Cost Analysis
ERA	Ecological Risk Assessment
HHRA	Human Health Risk Assessment
mg/kg	milligrams per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ODEQ	Oregon Department of Environmental Quality
SI	Site Inspection
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

Cascade Earth Sciences (CES) has prepared this Engineering Evaluation / Cost Analysis (EE/CA) for completing a Non-Time-Critical Removal Action related to hazardous substances in the Upper Granite Creek Watershed (Site) near Granite, Oregon. A total of nine separate localities comprise the Site: Monumental Mine, Cap Martin Mine, Tillicum Mine, Sheridan Mine, Golden Fraction Mine, Central Mine, and Granite Creek (GC) -5 Mine, GC-6 Mine, and GC-7 Mine.

The purpose of the EE/CA is to develop alternatives, make comparative analysis between the alternatives, and recommend a preferred alternative based upon the comparative analysis of the alternatives. The goal is 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 proposed Removal Action is to achieve cleanup of Site related hazardous substances to acceptable levels of risk to humans and the environment.

The following four alternatives were evaluated and compared as potential Removal Actions and were evaluated individually and collectively against three criteria: effectiveness, implementability, and cost.

- Alternative 1: No Action ($0)
- Alternative 2: Onsite Containment ($499,00)
- Alternative 3: Excavation and Onsite Containment/Disposal in Repository ($903,000)
- Alternative 4: Excavation and Offsite Disposal ($6,155,000)

A mixture of Alternative 1 - No Action; Alternative 2 – Onsite Containment; and Alternative 3 – Excavation and Onsite Containment in a Repository are recommended as the most appropriate and cost-effective alternatives. The total cost to implement this Recommended Blended Alternative is $691,000. A brief discussion of the areas selected for onsite containment and no action are discussed below:

Monumental Mine

- The Monumental Mine is the most significant of the mines within the watershed, with wastes totaling 39,000 cubic yards (cy). Waste samples contained arsenic concentrations of up to 11,400 mg/kg, which is well in excess of the arsenic cleanup level of 143 mg/kg calculated for the Site.
- Impacts to surface water in the unnamed tributary were measured and appear to be the result of contaminated waste rock and tailings deposited in the headwaters of the stream.
- The recommended alternatives for the Monumental Mine include the following:
  - Upper Shaft Area – Placement of arsenic-contaminated waste rock in the partially open shaft to reduce physical hazards. The remainder of the material will be contoured to the surrounding terrain and covered/revegetated, or placed in an onsite repository.
  - Upper Monumental Mine, millsite, and settling ponds - Removal of arsenic-contaminated waste rock, tailings, and concentrates and placement in an onsite repository. The settling ponds (wetland) may need to be mitigated in accordance with federal guidance. The Upper Adit discharge will be diverted along the access road and infiltrated into surrounding native material using buried perforated sewer pipe.
  - Lower Monumental Mine – The main waste rock pile and the crusher fines will be graded and consolidated onsite. The graded pile will be sloped to allow stormwater runoff and covered/revegetated. Water from the adit/lower settling pond will be diverted around the reclaimed waste rock pile into the uncontaminated hummocky area and ultimately into the unnamed tributary. This area will be evaluated further during the Removal Action design for potential wetland mitigation.

Golden Fraction (Middle)/Central Mines and Upper Granite Creek Near Station GC-03 – Onsite Waste Rock Contouring

- The Middle Golden Fraction Mine contains small waste rock piles with elevated concentrations of arsenic. The waste rock piles are located upslope from Granite Creek, with no evidence of erosion into the stream.
- The Central Mine has several small waste rock piles with concentrations of arsenic near the cleanup level of 143 mg/kg. The piles are located near Forest Service Road 73 and are easily accessible to the public.
- The small waste rock pile located near Granite Creek background station GC-03 was identified with an arsenic concentration in excess of the cleanup level. The pile is located along a closed Forest Service road, but is accessible to the public.
- These locations will be re-contoured to blend in with the surrounding terrain. The areas will be covered with soil that can be scavenged from around the area and revegetated.

Golden Fraction (Upper and Lower), Cap Martin, Sheridan, Tillicum, GC-5, GC-06, and GC-7 Mines – No Action

- These mines were identified with concentrations of arsenic in waste rock piles at or well below the cleanup level.
- The mines are located in remote sections of the Upper Granite Creek watershed, with limited access to the public.
- Based on this and the remote nature of these mines, CES recommends that no action be taken.

1.0 INTRODUCTION

On behalf of the United States Department of Agriculture, Forest Service (Forest Service), Cascade Earth Sciences (CES) has prepared an Engineering Evaluation / Cost Analysis (EE/CA) for completing a Non-Time-Critical Removal Action at nine abandoned mines and associated millsites (Site) in the Upper Granite Creek Watershed of the Wallowa-Whitman National Forest and in accordance with:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup authorities [42 USC 9604(a) and 7 CFR 2.60(a)(39)] and Federal Executive Order 12580;
- The provisions of National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300.415(b)(4)(i);
- U.S. Environmental Protection Agency (USEPA) "Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA" (USEPA, 1993).

Nine separate localities comprise the Site: Monumental Mine, Cap Martin Mine, Tillicum Mine, Sheridan Mine, Golden Fraction Mine, Central Mine, Granite Creek #5 (GC-5) Mine, GC-6 Mine, and GC-7 Mine. The locations of the mines are shown on Figure 1. Photographs of the mines are included in Appendix A.

The reader is referred to the "*Site Inspection, Granite Creek Mines, Wallowa-Whitman National Forest, Oregon"* (EA, 2003); and the "*Human Health and Ecological Risk Assessment, Granite Creek Mines, Wallowa Whitman National Forest"* (CES, 2006) for additional information. The purpose of the EE/CA is to develop alternatives, make comparative analysis between the alternatives, and recommend a preferred alternative based upon the comparative analysis of the alternatives. The goal of the preferred alternative is to minimize or eliminate any release or threat of release of a hazardous substance into the environment or impact on public health and welfare.

2.0 SITE CHARACTERIZATION

2.1 Previous Investigations/Studies

- 2003 – Site Inspection (SI) conducted by EA Engineering, Sciences, and Technology, Inc.
- 2006 – Risk Assessment conducted by CES.
- 2007 – EE/CA Data Gap Investigation (DGI) conducted by CES.
- 2008 – Draft EE/CA Report submitted by CES.
- 2009 – Supplemental DGI at the Monumental Mine conducted by CES.

2.2 Site Description and Background

The Site is located in the Wallowa-Whitman National Forest, along a maintained scenic byway and Forest Service roads where the Monumental, Golden Fraction, and Central Mines can be easily accessed. However, access to the other mines is very difficult due to the unmaintained roads and downed timber. The following sections provide a brief overview of the key features of the nine mines included in this EE/CA. All waste rock/tailings volumes and distances are considered approximate, and are based on measurements completed in the field.

2.2.1 Monumental Mine

The Monumental Mine is situated on moderate to steep hillsides near the headwaters of an unnamed tributary to Granite Creek; vehicle access to the mine is easy via County Road 73 (Blue Mountain Scenic Highway) by

driving east 3.8 miles on Forest Service Road (FR) 7345. The mine is the largest of the nine mines that comprise the Site, and is split into three areas (the upper shaft area, upper mine/mill area, and lower mine/mill area), see Figures 2 and 3.

Upper Shaft Area

The upper shaft area consists of a partially open shaft, multiple trenches and cuts, excavation pits, and several waste rock piles. The waste rock pile adjacent to the shaft (200 cubic yards [cy]) is shown on Figure 2; however, 3,000 cy of waste material is scattered in numerous piles throughout the area. The partially open shaft presents a possible physical hazard to humans and terrestrial wildlife.

Upper Mine/Mill Area

The upper mine/mill area has an open adit (Upper Adit) and associated waste rock pile (15,000 cy). The adit was observed with minimal flow in 2009, which infiltrated into the eastern section of the waste rock pile. The remains of a 20-stamp dry crushing mill, flotation table (referred to as "floater" in the EA, 2003 report), chlorination plant, and stone conduit (chlorination flue) are located at the former millsite. A layer ranging in depth from 6-inches to 4-feet deep of pink-colored concentrations/tailings from the former floatation table is spread along the surface to the northwest of the former mill (400 cy).

Water flows from a spring northeast of the former mill into a series of settling ponds, all of which are connected by surface water flow. The upper and middle settling ponds have developed into a small (0.08-acre) wetland system. The settling ponds contain 1,000 cy of tailings from the former mill. Tailings are exposed on the southern section of the wetland, and are situated under the root system of hydrophytic vegetation within the wetland.

Lower Mine/Mill Area

The lower mine/mill area contains one open adit (Lower Adit) and associated waste rock pile (18,500 cy). A former crusher and associated waste material (1,200 cy) are located adjacent to the north of the large waste rock pile. The lowest settling pond is located south of the adit. Water seeps from the open adit through a constructed ditch to the lower settling pond. No apparent tailings were observed in the lowest settling pond, although no sediment samples were collected during the field activities. No outlet for the lowest settling pond was observed during field activities, but seeps located at the base of the lowest waste rock pile suggest water is seeping through the pile.

A "hummocky area" is located adjacent to the south of the lower waste rock pile (EA, 2003). This area consists of parallel cuts in the hillslope, and may be associated with former exploratory cuts in the hillside. Based on Niton x-ray fluorescence (XRF) readings, the material does not appear to be contaminated from hardrock mining activities. Wet areas were observed at the bottom of the cuts in 2009. As such, the hummocky area may provide suitable hydrology for wetland mitigation activities during the Removal Action, if needed. In addition, a cabin, collapsed adit (Adit #3), and small waste rock pile (100 cy) are located north and upslope of the crusher. No water was observed emanating from the adit during field activities.

2.2.2 Golden Fraction Mine

Golden Fraction Mine is located 0.4 mile downstream of Tillicum Mine, and is access from County Road 73, then hiking 0.2 miles east along FS 680. The mine has three areas: the upper area located near FS 7345, the middle area located midway between FS 7345 and Granite Creek, and the lower area located along Granite Creek. The upper area consists of one collapsed adit, 2,000 cy of associated waste rock, a collapsed shaft, and ruins of a cabin (Figure 10). The middle area consists of four small waste rock piles totaling 120 cy, and several dredge spoils/retaining walls (Figure 10). The lower area consists of a collapsed adit and 380 cy of

waste rock located along FR 680 and Granite Creek. Evidence of erosion of the lower section of the waste rock pile was noted in Granite Creek. A seep was observed emanating from the adit, which creates a small marshy area (Figure 11). There was no evidence that the seep discharged into Granite Creek.

2.2.3 Central Mine

The Central Mine is located 0.6 miles downstream of the Tillicum Mine on a moderately steep slope on the north side of Granite Creek, which is accessed from FR 73 and either FR 7345 (upper area) or FS 680 (lower area). The mine contains four possible collapsed adits, five waste rock piles, and other mine features (Figure 12). During field activities, water was not observed emanating from the adits.

Of the five waste rock piles at the mine, the following is a summary of the volumes:

- 50 cy of waste rock located below the lower adit (Adit 1) on a bench above Granite Creek;
- 300 cy of waste rock below Adit 1 with the toe of the pile located adjacent to Granite Creek;
- 40 cy of waste rock is situated in two piles below the upper adit;
- 200 cy of waste rock associated with the adit northeast of the upper adit; and
- 60 cy of waste rock associated with the adit north of the upper adit.

A waste rock berm, likely created as a result of hydraulic mining activities, runs the east-west direction 75 to 100 feet upslope of Granite Creek.

2.2.4 Cap Martin Mine

The Cap Martin Mine is located 1.4 miles downstream from the headwaters of Granite Creek (which bisects the mine); Figure 4 shows the site layout. The mine is accessible from County Road 73 by driving east 2.45 miles on FR 7345 and hiking down through heavy brush and blow- down 0.2 miles to the mine.

Two collapsed cabins and one standing cabin are located on the north side of Granite Creek. Four collapsed adits are located at the mine: Adits 1 and 2 on the south side of Granite Creek, and Adits 3 and 4 on the north side of Granite Creek. Three waste rock piles (300 cy) and a thin outwash fan are associated with Adits 1 and 2. Two waste rock piles (1,200 cy) are associated with Adits 3 and 4. Two springs/seeps are located on the south side of Granite Creek. There was no evidence that the seeps discharged into Granite Creek.

2.2.5 Unnamed (GC-7) Mine

The mine is located adjacent to an unnamed tributary on the north side of Granite Creek, 0.25 miles below the Cap Martin Mine. The mine is accessed from County Road 73, then hiking east 1.06 miles up an abandoned road (FR 680) adjacent to Granite Creek, then bushwhacking north on an unnamed tributary to the mine. Figure 5 shows the site layout, which consists of one collapsed adit and associated waste rock (300 cy) in two piles above and adjacent to Granite Creek.

2.2.6 Unnamed (GC-6) Mine

The mine is located adjacent to an unnamed tributary on the north side of Granite Creek, 400 feet downstream of GC-7 Mine. Access is from County Road 73, then hiking 0.95 miles up FR 680 along Granite Creek. The mine consists of one partially collapsed adit and two waste rock piles (100 cy; Figure 6). No water was observed emanating from the adit or surrounding piles.

2.2.7 Sheridan Mine

The Sheridan Mine is located 0.25 miles downstream of the Cap Martin Mine on moderately steep slopes on the south side of Granite Creek. The mine is accessed from County Road 73, then hiking 1.07 miles up Granite Creek along FS 680 to an unnamed tributary discharging from the south. The mine includes one collapsed adit, a possible adit or prospect, and 125 cy of waste rock associated with the collapsed adit (Figure 7). A seep discharges from the collapsed adit into a marshy area. There was no evidence during field activities that the seep discharged into Granite Creek.

2.2.8 Tillicum Mine

The Tillicum Mine is located 0.25 miles downstream of the Sheridan Mine on moderately steep slopes along the north bank of Granite Creek. The mine is accessed by hiking down the slope from FR 7345 or hiking 0.6 miles up Granite Creek along FS 680. The mine consists of two collapsed adits (upper and lower), 700 cy of waste rock, and 600 cy of possible dredge spoil piles/waste material, which are situated in five piles east and west of the collapsed lower adit (Figure 8). No water emanated from the adits during field activities.

2.2.9 Unnamed (GC-5) Mine

The Unnamed (GC-5) Mine is located 0.3 miles downstream of Tillicum Mine, and is accessed from County Road 73, then hiking 0.3 miles up Granite Creek along abandoned FR 680. The mine consists of one collapsed adit (with no signs of water discharge) and 400 cy of waste rock, located below the adit, adjacent to Granite Creek (see Figure 9). Evidence of erosion of the lower section of the waste rock pile was noted in Granite Creek. A seep was observed 150 feet west of the adit, which infiltrates into the soil upslope from the Granite Creek floodplain. It does not appear the seep is related to the adit at the mine.

2.2.10 Upper Granite Creek Station GC-03

A small waste rock pile (20 cy) is located adjacent to Granite Creek background aquatic station GC-03. The waste rock pile can be accessed by foot from closed FR 720 from FR 7345.

2.3 Summary of 2006 Human and Ecological Risk Assessment

Based on the results of the SI (EA, 2003), CES prepared a Human and Ecological Risk Assessment in 2006 (Risk Assessment; CES, 2006) for five of the mines (Monumental, Cap Martin, Tillicum, Sheridan, and the Central Mines). The following provides a brief summary of potential risk associated with these mines.

- Human Health Risk Assessment
  - Current and future potential receptors were identified as hunters, hikers, and campers.
  - Arsenic and lead were identified as the soil/waste rock, sediment, and surface water non-carcinogenic contaminants of potential concern (COPCs).
  - No unacceptable non-carcinogenic health effects are anticipated under both the central tendency exposure (CTE) and reasonable maximum exposure (RME) conditions.
  - Arsenic was the only carcinogenic COPC identified at the mines.
  - Carcinogenic risks were predicted from exposure to arsenic-impacted surface water and soil/waste rock under both the CTE and the RME exposure conditions at each of the mines.
  - The Monumental Mine had the highest arsenic concentrations and therefore represents the highest level of human risk.
  - No carcinogenic risks were predicted from exposure to sediment.

- Human health "hot spots" are areas of unacceptable risk, where the concentrations are high enough that there is a preference for treatment (ODEQ, 1998). Hot spots are present if chemicals are present in concentrations exceeding risk-based concentrations corresponding to:
  - 100 times the acceptable risk level for human exposure to each individual carcinogen;
  - 10 times the acceptable risk level for human exposure to each individual noncarcinogen; or
  - 10 times the acceptable risk level for exposure of individual ecological receptors or populations of ecological receptors to each individual hazardous substance.
- No hot spots were identified at the mines.

- Ecological Risk Assessment
  - Ecological impacts were predicted for immobile species, primarily plants and terrestrial invertebrates, due to contaminants of potential ecological concern (COPECs) in soil and waste rock (list of COPECs provided in Appendix C). Local and regional populations of these and other terrestrial species are unlikely to be significantly impacted.
  - Ecological impacts were also predicted for aquatic life and wildlife exposed to COPECs in surface water and pore water. However, the lack of background data in 2006 made it more difficult to predict the potential for impacts.
  - Benthic invertebrates and wildlife appear to have the potential to be impacted by total arsenic, cadmium, and zinc, which are present at elevated concentrations at nearly all sediment sample locations. The lack of background sediment samples likely results in an overestimation of these potential impacts.
  - The Monumental and Tillicum Mines have more locations with elevated COPEC concentrations in soil/waste rock than the other mines and therefore represent the highest level of ecological risk.
  - Ecological "hot spots" are generally defined as concentrations greater than 10 times the ecological risk-based screening concentration (ERBSC). Multiple ecological hot spots were identified at every mine.

Based on the Risk Assessment, CES recommended that an EE/CA be prepared and that a DGI be conducted to quantify the data gaps associated with the SI and Risk Assessment. Subsequently, the Forest Service added four additional mines to the investigation (GC-5, GC-6, GC-7, and the Golden Fraction Mine).

2.4 Data Gap Investigation (2007)

In June 2007, CES conducted a DGI at the Site to collect information and samples to fill in data gaps presented in the Risk Assessment (CES, 2006). The scope of the DGI was to:

- Verify previously identified hazardous substances, mining features, and volumes at the Central, Sheridan, Tillicum, Cap Martin, and Monumental Mines;
- Inspect the new mines (GC-5, GC-6, GC-7, and the Golden Fraction Mines) and collect waste rock, soil, and water samples;
- Collect three background sediment, surface water, and pore water samples from Granite Creek, and also collect four streambank/floodplain sediment samples (Figure 13);
- Collect background soil samples within the upper Granite Creek watershed (Note: these samples were collected as part of the New York Mine Complex SI [locations are shown on Figure 14];

- Assess each mine for alternatives for the EE/CA (i.e., access, repository locations, etc.); and
- Develop human health and ecological risk assessment updates based on the new data collected. Results of the updated risk assessment identified a cleanup concentration of 143 mg/kg for arsenic.

The DGI was successfully implemented and the data collected were combined with information obtained during the SI and Risk Assessment and are summarized in Section 2.5. For additional information regarding the scope of the DGI, refer to "*Field Operation Plan, Data Gap Investigation of the Upper Granite Creek Watershed, Grant County, Oregon"* (CES, 2007).

2.5 Data Gap Assessment (2009)

In September 2009, CES completed a DGI at the Monumental Mine, which included:

- Adit and spring sampling to characterize the quality and flow rate for potential water diversion during and after the Removal Action;
- Additional topographic survey of waste rock piles, tailings, and pertinent features for accurate volume estimation;
- Detailed field screening of waste rock and tailings with an XRF to guide additional sampling and analysis activities;
- Collection of waste rock and tailings samples for laboratory analysis for total metals and toxicity characteristic leaching procedure (TCLP) metals; and
- Wetland delineation of the upper and middle settling ponds for possible mitigation activities (Appendix B).

The DGI was successfully implemented and the data collected were combined with information obtained during previous events and are summarized in Section 2.5. For additional information regarding the scope of the 2009 DGI, refer to "*Scope of Work and Cost Estimate – Data Gap Assessment: Monumental Mine"* (CES, 2009).

2.6 Source, Nature, and Extent of Contamination

This section gives a brief overview of the source, nature, and extent of contamination of the Site, which is specifically focused on the hazardous substances of concern identified in the SI, Risk Assessment, and DGIs. Information from the SI conducted by EA in 2003 has been incorporated with the DGIs performed by CES. Laboratory analytical data from each investigation is presented in Tables 1 through 7. Table 8 includes a summary of the extent of contamination at the Monumental Mine, with XRF and analytical data collected as part of the 2009 DGI. As shown in the tables, XRF data provided uncertain correlation with laboratory data. However, the XRF was useful as a screening tool to assess lateral and vertical extent of arsenic concentrations at the Site, and provided pertinent data for submittal of samples to the laboratory for analysis.

2.6.1 Surface Water Pathway

Surface Water – Granite Creek

A total of 13 surface water samples were collected in Granite Creek during the SI and DGIs; 3 were collected from background locations, 8 were collected near the mines to assess the impact on the aquatic environment, and 2 were collected downstream of the Site above and below the confluence of Granite Creek and Lucas Gulch, 0.5 miles downstream of the Central Mine (Lower Granite Creek). These two downstream samples are not included in the following discussion because they appear to be impacted by other sources (i.e., Boston Mine, East Eddie Group and the Ajax-Magnolia Mine Complex).

No human health screening criteria were exceeded in any of the surface water samples. However, during the SI, laboratory method detection limits (MDLs) on arsenic and thallium were higher than the screening criteria (EA, 2003). Arsenic, concentrations estimated at 0.6 micrograms per liter (µg/L) were detected in two of the background samples, which exceeded the human health screening criterion of 0.018 µg/L. Barium was the only contaminant detected that exceeded an ecological/aquatic screening criteria (4 µg/L), with concentrations ranging from 34.9 to 52.9 µg/L in all the downstream samples. Barium was not analyzed in DGI background samples because it was not identified in the Risk Assessment as a COPC.

The MDLs as reported in the SI for four contaminants (cadmium, mercury, selenium, and silver) were higher than the respective ecological/aquatic screening criteria (EA, 2003). Therefore, it is unknown if concentrations of these contaminants are higher than the screening criteria. However, the contaminant loading from the mines within the Upper Granite Creek Watershed on Granite Creek appears to be negligible.

2.6.2 Surface Water – Springs/Seeps

A total of 13 surface water samples were collected from seeps and springs at or near the mines (Table 1).

Monumental Mine - two samples were collected from the adit seeps emanating from the Upper and Lower Adits; two samples were collected from the spring at the headwaters of the unnamed tributary; two samples were collected below the lower waste rock pile in the unnamed tributary; and three samples were collected from the upper and lower settling ponds.

Other Mines - two samples were collected from springs at the Cap Martin Mine; one sample was collected from the adit seep at the lower Golden Fraction Mine; and one sample was collected from a seep near the GC-5 Mine.

Below is a summary by constituent.

- Arsenic was detected above the human health screening criteria of 0.018 µg/L in 11 of the samples with concentrations ranging from 1.3 to 105 µg/L; arsenic was not detected above the MDL in two of the samples, but the MDL was above the human health screening criterion (EA, 2003).
  - The highest concentrations of arsenic were exhibited from the samples collected from the Monumental Mine upper settling pond (81.8 and 105 µg/L).
  - Arsenic concentrations from the Monumental Mine adit seeps ranged from 21.8 to 27.2 µg/L.
  - Elevated concentrations of arsenic (21.4 and 24.2 µg/L) were also identified in the samples collected from the unnamed tributary below the lowest waste rock pile at the Monumental Mine.
  - An elevated concentration of arsenic (51 µg/L) was also identified in the sample collected from the headwaters during the 2009 DGI. However, the 2003 sample was not detected above the MDL of 6.0 µg/L. The 2009 result may be indicative of high total suspended solids (TSS) for the sample (142 mg/L). Conversely, the sample collected in 2003 contained a TSS concentration of 30.6 mg/L.
  - None of the samples exceeded the ecological/aquatic screening criteria of 150 µg/L for arsenic.
- Cadmium (0.70 µg/L) exceeded the aquatic life criteria (0.232 µg/L) in the sample collected from a seep near the GC-5 Mine. However, three of the samples collected during the SI had MDLs (1.2 µg/L) that were slightly higher than the screening criteria (EA, 2003); therefore, it is unknown if concentrations are higher than the criteria.
- Iron (ranging from 650 to 5,610 µg/L) was detected above the human health and aquatic screening criteria (300 and 1,000 µg/L, respectively) in six samples, two from the Monumental Mine, two from the Cap Martin Mine, one each from the Golden Fraction Mine and the GC-5 Mine.

- Lead (ranging from 9 to 29.4 µg/L) was detected above the lowest aquatic criteria (2.3 µg) at the GC-5 Mine seep, and two samples from the Monumental Mine.
- Magnesium (ranging from 55.4 to 374 µg/L) was detected above the human health and aquatic screening criteria (50 and 120 µg/L, respectively) in two samples (Golden Fraction seep and unnamed drainage near the Monumental Mine).
- Mercury (0.141 µg/L) was only detected in one sample (GC-5 seep) above the aquatic criteria of 0.012 µg/L.
- Method detection limits as reported in the SI for three contaminants (selenium, silver, and thallium) were all greater than the respective ecological/aquatic screening criteria (EA, 2003). Therefore, it is unknown if concentrations of these contaminants are higher than the screening criteria.

Overall, several of the seeps/springs are elevated with hazardous substances, mainly arsenic. Considering arsenic concentrations were below laboratory MDLs within Granite Creek downstream from the adit seeps, they do not appear to be significantly contributing contaminants to the stream. However, arsenic concentrations of 21.4 and 24.2 µg/L in the unnamed tributary downslope from the lowest Monumental Mine waste rock pile indicate mining related impacts in this tributary, which discharges to Granite Creek. The tributary supports a native population of redband trout, which are a species of concern (SOC). In addition, summer steelhead spawning and rearing habitat is located up Granite Creek to the confluence with the unnamed tributary (StreamNet, 2010). Middle Columbia River Steelhead are listed by the National Oceanic Atmospheric Administration Fisheries Service as "threatened" under the Endangered Species Act (ESA). As outlined in the SI, bull trout were also observed within Granite Creek upstream to the Cap Martin Mine (EA, 2003). Bull trout are also listed as "threatened" under the ESA.

2.6.3 Pore Water – Granite Creek

A total of 14 pore water samples were collected in Granite Creek during the SI and DGIs; 3 were collected from background locations, 9 were collected near each mine to assess the impact on the aquatic environment, and 2 were collected downstream of the Site above and below the confluence of Granite Creek and Lucas Gulch, 0.5 miles downstream of the Central Mine. These two downstream samples are not included in the following discussion because they appear to be impacted by other sources (i.e., Boston Mine, East Eddie Group, and the Ajax-Magnolia Mine Complex). Below is a summary by constituent (see Table 2).

- Arsenic was not detected above the aquatic life screening criteria of 150 µg/L in any sample.
- Barium exceeded the ecological/aquatic screening criteria (4 µg/L) in every downstream sample with concentrations ranging from 31.0 µg/L upstream of the Cap Martin Mine to 60.8 µg/L downstream of the Central Mine. Barium was not analyzed in DGI background samples because it was not identified in the Risk Assessment as a COPC.
- Iron was detected (5,560 µg/L) above the ecological/aquatic screening criteria of 1,000 µg/L in one background sample (GC-PW-02), but all other samples did not exceed the criteria.
- Lead was detected above the lowest aquatic criteria (2.05 µg/L) in two pore water samples near the Central Mine (2.4 µg/L at ST-PWP-09 and ST-PWR-10).
- Magnesium was detected (259 µg/L) above the ecological/aquatic screening criteria of 120 µg/L in one background sample (GC-PW-02), but all other samples did not exceed the criteria.
- As reported in the SI, the MDLs for three contaminants (cadmium, mercury, and silver) were all greater than the respective ecological/aquatic screening criteria (EA, 2003). Therefore, it is unknown if concentrations of these contaminants are higher than the screening criteria.

2.6.4 Stream Sediment – Granite Creek

A total of 23 sediment samples were collected from Granite Creek during the SI and DGIs; 3 were collected from background locations, 16 were collected near the mines to assess the impact on the aquatic environment, and 4 were collected downstream of the Site above and below the confluence of Granite Creek and Lucas Gulch, 0.5 miles downstream of the Central Mine. These four downstream samples are not included in the following discussion because they appear to be impacted by other sources (i.e., East Eddie Group and the Ajax-Magnolia Mine Complex). A total of four bank samples were also collected from the streambank along Granite Creek in the floodplain during the 2007 DGI. Below is a summary by constituent (Table 3).

- Arsenic was detected above the lowest aquatic life screening criteria of 5.9 milligrams per kilogram (mg/kg) in every sediment and streambank sample, with concentrations ranging from 9.3 mg/kg (downstream of the Sheridan Mine) to 127 mg/kg (streambank upstream of the Central Mine).
- Cadmium was detected above the lowest aquatic screening criteria of 0.6 mg/kg in one sediment sample (upstream of the Central Mine at 0.62 mg/kg), and three streambank samples (0.85 – 1.5 mg/kg).
- Chromium was detected above the lowest aquatic screening criteria (37 mg/kg) in one sediment sample (upstream of the Cap Martin Mine at 45.6 mg/kg) and one streambank sample (near the Central Mine at 42 mg/kg).
- Lead was detected above the lowest aquatic screening criteria (35 mg/kg) in one sediment sample (upstream of the Central Mine at 52.4 mg/kg) and in two streambank samples (45.3 and 45.8 mg/kg both near the Central Mine).
- Mercury was not detected above the lowest aquatic screening criteria (0.174 mg/kg) in any sediment sample, and only one streambank sample (upstream of the Central Mine at 0.23 mg/kg) was detected above the criteria.
- Silver was only detected slightly above the lowest screening criteria of 1.8 mg/kg in one sediment sample (1.9 mg/kg upstream of the Tillicum Mine); two streambank samples were also slightly above the criteria near the Central Mine (2.4 mg/kg and 3.27 mg/kg).

2.6.5 Soil Pathway

A total of 65 waste rock, tailings, and soil samples were collected as part of the SI, and DGIs. Of these, 24 samples were collected during the SI conducted by EA in 2003, 21 samples were collected by CES during the DGI in 2007, and 20 samples were collected by CES during the DGI in 2009.

A total of 46 test pits were advanced with an excavator or hand auger during the 2009 DGI. Each test pit was screened at selected vertical intervals with an XRF for arsenic concentrations. From these, 20 samples were submitted to the laboratory for analysis. Table 8 includes a summary of the locations and arsenic concentrations, while Figures C-1 and C-2 identify the locations of the test pits.

Overall, arsenic is the main contaminant of concern at all nine mines that comprise the Site. Arsenic concentrations in waste rock and tailings are highest at the Monumental Mine. Concentrations ranged from 1.7 mg/kg (GC-6 Mine) to 11,400 mg/kg (Monumental Mine), which were all greater than the EPA Regional Screening Level of 1.6 mg/kg (industrial soil) and most were above the ecological screening criteria of 9.9 and 37 mg/kg. Several other constituents (antimony, lead, mercury, and zinc) were elevated when compared to background and regulatory screening criteria.

Acid Base Accounting (ABA) was analyzed on 28 waste rock, tailings, and soil samples.

- The acid base potential (ABP) is the result of the acid neutralizing potential (ANP) minus the acid generating potential (AGP). A negative ABP indicates that the AGP is greater than the ANP, and thus the material has the potential to produce acid rock drainage (ARD).
- Waste rock ABP's ranged from -20 (Monumental Mine Crusher) to 98 (Upper Monumental Mine Waste rock Pile) t $CaCO_3$/Kt (ABP units are presented as tons of calcium carbonate needed to neutralize a kiloton of waste [$CaCO_3$/Kt]).
- Generally ABP values below -20 indicate a strong potential for ARD and values above +20 indicates that material is unlikely to form ARD. Based on these results, waste material near the Monumental Mine Crusher has the potential to produce ARD.

Thirty waste rock, tailings, and soil samples were submitted for the TCLP and the synthetic precipitation leaching procedure (SPLP) for the eight Resource Conservation Recovery Act (RCRA) constituents (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver).

- There are no applicable standards for SPLP; however, the results can be compared to RCRA TCLP disposal limits.
- Most of the samples did not contain concentrations of constituents in the TCLP or SPLP extracts in excess of the TCLP limits. However, samples collected from the Monumental Mine floatation table and former chlorination plant contained TCLP and SPLP arsenic at concentrations of 15.6 and 9.4 mg/L, respectively. In addition, the sample collected from the Monumental Mine upper settling pond contained TCLP arsenic at a concentration of 8.5 mg/L (Table 6). The USEPA TCLP regulatory threshold for arsenic is 5.0 mg/L.
- Under the Bevill Exclusion (40 CFR 261.4(b)(7)), waste derived from the extraction (gangue and waste rock), beneficiation (milling, floatation), and some processing are exempt from hazardous waste designation under Subtitle C of RCRA. As such, tailings material derived from the ore processing at the Site may be exempt from RCRA hazardous waste designation. Furthermore, the TCLP analysis uses a weak organic acetic acid solvent commonly found in municipal landfills. However, organic acids are not typically present in waste material found at mines and other field sites, and the TCLP usually overestimate the concentration of leachable metals in mine wastes.

2.6.6 Groundwater

Groundwater samples were not collected as part of the SI or DGI field activities. Groundwater that discharges from adits, seeps, and springs is addressed under the surface water pathway. As outlined in the SI (EA, 2003), shallow groundwater at the Site does not likely form a laterally continuous aquifer due to the presence of igneous intrusions and shallow bedrock. Localized shear zones may also influence groundwater flow. The closest drinking water well is 4 miles from the Site near the Town of Granite and is several hundred feet deep. Therefore, impacts to the well are not expected from the Site sources and activities, and the groundwater pathway appears to be incomplete.

2.6.7 Air

Air samples were not collected as part of the SI or DGI field activities. Arsenic and other contaminants were likely released to the air during the mining and milling processes as dust and particulate matter. Chlorine gas was also probably discharged from the chlorination flue at the mill during milling activities.

The air pathway is complete because contaminant-impacted soil, waste rock, and tailings is concentrated at the surface where human and ecological receptors could be exposed to particulate matter by inhalation.

However, further assessment of the air pathway is not recommended because addressing and/or eliminating the soil exposure pathway will render the air exposure pathway incomplete.

2.7 Human Health Risk Assessment Update Summary

An update to the human health risk assessment (HHRA) developed in 2006 was prepared as part of this EE/CA and is included as Appendix C. A brief summary of the conclusions is presented below. Arsenic and lead were identified as the soil/waste rock, sediment, and surface water COPCs. Quantitative risk assessment determined that no unacceptable non-carcinogenic health effects are anticipated for exposure to COPCs in all media.

Arsenic was the only carcinogenic COPC identified in soil, waste rock, sediment, and surface water.

- Unacceptable carcinogenic risks from exposure to arsenic in waste rock under the RME recreational exposure scenarios were predicted at four of the nine mines: Monumental Mine, Cap Martin Mine, Tillicum Mine, and Central Mine.
- The Monumental Mine had the highest arsenic concentrations and therefore represents the highest level of human risk.
- No unacceptable human health risks were identified from exposure to arsenic under the CTE.
- No carcinogenic risks were predicted from exposure to sediment or surface water.
- Carcinogenic risks from ingestion and dermal contact with arsenic-impacted soil and waste rock under the RME, worst-case conservative estimate of exposure, exceed the Oregon Department of Environmental Quality's (ODEQ) regulatory standard of 1×10^{-6} excess cancer risk at the Site.
- Based on analytical results for Sheridan, GC-05, GC-06, and GC-07 Mines, no unacceptable carcinogenic risks are anticipated under both the CTE and RME exposure conditions.
- No hot spots were identified at the Site.

Per OAR 340-122-0040(2)(a) and OAR 340-122-0084, risk-based cleanup concentrations can be calculated to mitigate a hazardous substance release. A risk-based cleanup concentration for soil and waste rock was calculated to be 143 mg/kg total arsenic, which is well above the average background arsenic concentration of 10.7 mg/kg.

Following completion of the 2009 DGI, CES reviewed the updated data with our risk assessors to determine the overall impact of the new data on the existing risk assessment and cleanup level. Since all arsenic concentrations exhibited during the 2009 DGI were within the range of those previously identified at the Site, risk appears to remain consistent. As such, the cleanup concentration for the Site was confirmed at 143 mg/kg (Appendix C).

2.8 Ecological Risk Assessment Update Summary

An update to the Screening Level Ecological Risk Assessment (ERA) developed in 2006 was prepared as part of this EE/CA in accordance with ODEQ guidance (ODEQ, 2001) and presented in Appendix C of this report. A brief summary of conclusions is presented below.

- Elevated concentrations of several COPECs (aluminum, antimony, arsenic, barium, cadmium, cobalt, iron, lead, manganese, mercury, selenium, silver, thallium, vanadium, and zinc) are present in soil, waste rock, surface water, pore water, and sediment at the Site.

- Immobile receptors (i.e., plants and invertebrates) are likely to be adversely impacted within the boundaries of the Site; especially at the Monumental Mine; where the highest concentrations of arsenic were identified in waste rock.
- Several ecological hot spots were identified, including antimony, arsenic, lead, mercury, and silver in waste rock at the Monumental, Tillicum, Golden Fraction, Cap Martin, and Central Mines; as well as samples collected from waste rock along Granite Creek.
- Individual birds and small mammals are likely to be exposed to COPECs in the waste rock piles and may be adversely impacted. However, population level impacts are not expected because of the relatively limited distribution of the COPECs compared to the home ranges of these more wide-ranging terrestrial species.
- Elevated risk ratios for barium and zinc were observed in surface water and pore water and an elevated risk ratio was observed for silver in pore water. The farthest upstream and farthest downstream stations have the highest concentrations of several COPECs in surface water and pore water. This suggests Monumental and Tillicum Mines (or other downstream source) may be contributing a majority of the COPECs to Granite Creek.
- Elevated risk ratios were observed for total arsenic, cadmium, and zinc in sediment.
    - These contaminants appear likely to have the potential to impact immobile aquatic receptors or those that are frequently exposed to COPECs in sediment (i.e., benthic macroinvertebrate), especially in the lower reaches of the Upper Granite Creek watershed.
    - Cadmium was the only COPEC that had a hot spot that exceeded both the ERBSC and background concentrations by a factor of more than ten. However, this was a pore water sample collected in Granite Creek downstream of Lucas Gulch. As stated above, Granite Creek in this area appears to be impacted by other sources (i.e., Boston Mine, East Eddie Group and the Ajax-Magnolia Mine Complex).
- The total arsenic cleanup concentration of 143 mg/kg recommended to reduce human health risks is expected to reduce the ecological impacts that were predicted for the Site. Ecological risk-based cleanup concentrations cannot be calculated unless a more detailed species specific ERA is performed.

2.9 Human and Ecological Hot Spots

A hot spot is generally defined as an area that presents an unacceptable risk and the contamination is highly concentrated, highly mobile, or cannot be reliably contained (ODEQ, 1998). No human health hot spots were identified because the areas that indicated human health risk were not deemed to be highly concentrated and/or highly mobile, and they could be reliably contained with proper engineering controls.

Numerous ecological hot spots were identified in all media at the Site because the areas that indicated ecological risk were deemed to be highly concentrated (i.e., > 10 times the ERBSC). OAR 340-122 (Hazardous Substance Remedial Action Rules), require that certain actions be taken for "hot spots" of contamination, which includes the "treatment" of hot spots, to the extent feasible, as part of a remedial action selected or approved by the director of ODEQ.

3.0 SITE CLEANUP CRITERIA

3.1 Potential Applicable or Relevant and Appropriate Requirements

ARARs are "*applicable*" and/or "*relevant and appropriate*" federal and state environmental requirements. The *applicable* requirements include cleanup standards and other important requirements, criteria, or

limitations promulgated from federal or state laws that apply to hazardous substances and Removal Actions. *Relevant and appropriate* requirements are not necessarily applicable, but may be suitable for use because they address issues or problems sufficiently similar to those that exist at a site. In addition to ARARs, federal and state environmental and public health guidance and proposed standards that may not be legally binding but could prove useful are standards "*to be considered*" (TBC).

Federal, state, and local potential ARARs are used to 1) evaluate the extent of site cleanup needed; 2) scope and develop Removal Action alternatives; and 3) guide the implementation and operation of the preferred alternative.

The NCP (40 CFR 300.415(j)) establishes that Removal Actions shall "to the extent practicable, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental facility siting laws."

- To determine whether compliance with potential ARARs is practicable, two factors are specified in 40 CFR 300.415(j): (1) urgency and (2) scope of the Removal Action.
- The scope of the Removal Action is often directed at minimizing and mitigating potential hazard rather than eliminating the hazard. Therefore, even though a particular standard may be an ARAR for a particular medium, it may be outside of the scope of the immediate problem. For example, removal of a hazardous substance source may improve groundwater or surface water quality without meeting water quality criteria, thus not meeting the potential ARAR, can be an acceptable Removal Action.

The potential ARARs are grouped as federal or State of Oregon potential ARARs; no specific local potential ARARs were identified (Appendix D). Potential ARARs are identified by a statutory or regulatory citation, followed by a brief explanation of the potential ARAR, and whether the potential ARAR is (1) "potentially applicable", (2) "potentially relevant and appropriate", or (3) "to be considered". In accordance with Section 121(e) of CERCLA, no permits are required for an on-site Removal Action. However, as discussed above, substantive requirements, which a permit might otherwise address, must be met to the extent practicable.

Potential ARARs are either: chemical-, location-, or action-specific.

- Chemical-specific requirements address chemical or physical characteristics of chemicals or hazardous substances. These values establish acceptable amounts or concentrations of chemicals that may be found in or discharged to the ambient environment.
- Location-specific requirements are restrictions placed on the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographical or physical positions of a site rather than to the nature of hazardous substances at sites.
- Action-specific requirements are usually technology based or activity based requirements or limitations on actions taken with respect to chemicals or hazardous substances. A given cleanup activity could trigger an action-specific requirement. Such requirements do not themselves determine the cleanup alternative but define how to perform chosen cleanup methods.

The following sections outline the key potential ARARs for the Site.

3.1.1 Key Chemical-Specific ARARs

Soil, Sediment, and Water Quality Standards

As allowed by ODEQ regulations, risk-based cleanup concentrations were calculated for human exposure to soil/waste rock, surface water, and sediment at the Site (see Section 4.2). Ecological risk-based cleanup concentrations were not calculated for ecological receptors. Additional site-specific ecological risk evaluation would be needed before ecological risk-based cleanup concentrations can be calculated. Therefore, the following potential ARARs are considered key for the Site.

- National Recommended Water Quality Criteria (Section 304(a) of the CWA)
- Oregon Water Quality Standards (OAR Chapter 340 Division 41, Table 20)
- Federal Freshwater Sediment Standards, Threshold Effects Level and Probably Effects Level, as outlined in the National Oceanic and Atmospheric Administration Screening Quick Reference Tables (NOAA, 2008)

3.1.2 Key Action-Specific ARARs-

Solid Waste Disposal Requirements

The Solid Waste disposal ARARs establish the performance standards for proper handling and disposal of solid waste; outline responsibilities of various entities and stakeholders; and outline requirements for solid waste handling facility location, design, construction, operation, and closure. All substantive requirements for closure and post-closure of non-municipal landfills (OAR 340 Div 95) are potential ARARs.

3.1.3 Key Location-Specific ARARs

Forest Plan Standards and Guidelines

Portions of the Pacific Northwest Forest Plan (NWFP) are potentially ARARs for assessing Site removal action alternatives. The NWFP include standards and guidelines that are potentially relevant and appropriate to actions at the Site, including activities within, or that affect Riparian Management Areas. These standards and guidelines control the design, construction, and use of temporary and permanent roads and other modifications within Riparian Reserves. In addition, the standards control solid waste and mine waste facilities within Riparian Reserves.

Ecologically Sensitive Areas

Possible ecologically sensitive location-specific ARARs at the Site will be considered during the design phase of the removal. These include the following key ARARs:

- Endangered Species Act (USC 1531(h) - 1543)
- Section 404 CWA (33 CFR 330) and Executive Order Number 11990 – Protection of Wetlands (40 CFR 6.302(a) and Appendix A)
- Executive order Number 119988 – Floodplain Management (40 CFR 6.302(g) and Appendix A)
- Oregon Wildlife Diversity Program and Plant Protection (OAR 635, Division 100)

Historic and Cultural Requirements

In regards to historic and cultural requirements, there are several potential location-specific and some potential action-specific ARARs that will be considered during the design phase of the removal, after the removal decision identifies the selected alternative and removal activities. Key potential historic and cultural ARARs are outlined below:

- National Historic Preservation Act (16 USC § 470)
- Historic Site, Buildings, Objects, and Antiquities Act (16 USC § 461-467)
- Archeological and Historic Preservation Act (16 USC § 469)

3.2 Risk-Based Cleanup Concentrations

The human health risk-based cleanup concentration for soil and waste rock was calculated at 143 mg/kg total arsenic. Ecological risk-based cleanup concentrations cannot be calculated unless a more detailed species specific ecological risk assessment is performed. Removal or containment of waste rock and soil to the cleanup concentration of 143 mg/kg should control migration of contaminants and exposure routes and will be considered protective of ecological receptors.

4.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

4.1 Removal Action Objectives

Removal Action objectives are specific goals for protection of human health and the environment that identify response actions to adequately address human health and ecological risks. The objectives for the Removal Action include:

- Protection of human health by minimizing exposure and hazards to onsite receptors.
- Reduction of possible mobilization of hazardous substances by removal of waste material or capping in-place with appropriate restoration.
- To the extent practicable, compliance with ARARs.

4.2 Removal Action Justification

The NCP states that an appropriate Removal Action may be conducted at a site when a threat to human health or welfare or the environment is identified. The Removal Action is undertaken to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or the threat of a release at a site. Section 300.415(b)(2) of the

NCP outlines eight factors to be considered when determining the appropriateness of a Removal Action; these factors are assessed against the preferred alternative in Section 7.0, outlined below:

Removal Action Justification Table

Factor	Site Summary	Justification
(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants	Complete exposure pathways to human and ecological receptors were documented from exposure to contaminant-impacted waste rock, soil, tailings, and stream sediment. Arsenic was detected up to 11,400 mg/kg in waste rock, which exceeds the USEPA Regional Screening Level of 1.6 mg/kg for industrial workers. Leachable arsenic concentrations of 15.6 and 8.5 mg/L were exhibited in samples collected near the floatation table and upper settling pond, which were above the hazardous waste disposal limit.	**Yes**

Factor	Site Summary	Justification
(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems	Impacts to the unnamed tributary to Granite Creek were documented during field activities. The primary sources of the impacts appear to be via erosion of waste rock and tailings. Sensitive ecosystems, including an onsite wetland (Appendix B); wildlife breeding areas; and wild and scenic rivers are located near the Site and the 15-mile downstream target distance. The unnamed tributary, which emanates from the lower waste rock pile at the Monumental Mine, supports a native population of redband trout (SOC). Listed "threatened" Middle Columbia River Evolutionarily Significant Unit (ESU) Steelhead and bull trout have also been documented in Granite Creek upstream to the confluence with the unnamed tributary.	**Yes**
(3) "Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release"	No drums, barrels, tanks, or other bulk storage containers were observed at the Site.	**No**
(4) High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate	Surficial waste rock, soil, and tailings are contaminated with arsenic. This hazardous substance is susceptible to chemical mobilization and transport by snow melt and possible acid mine drainage percolating through the contaminated materials.	**Yes**
(5) Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released	High runoff conditions, particularly in the spring and during summer thunderstorms, may erode and transport contaminated waste rock and tailings that are located within the floodplains.	**Yes**
(6) Threat of fire or explosion	No known fire of explosion threats is present at the Site.	**No**
(7) The availability of other appropriate federal or state mechanisms to respond to the release	The Site is on land administered by the Forest Service and is not currently listed or proposed for listing on the National Priorities List. Thus, the Forest Service is the agency with CERCLA authority over the National Forest System land.	**No**
(8) Other situations or factors that may pose threats to public health or welfare of the United States or the environment.	The Site is located in the Wallowa-Whitman National Forest, along a maintained scenic byway and Forest Service roads where the Monumental, Golden Fraction, and Central Mines can be easily accessed. However, access to the other mines is very difficult due to the unmaintained roads and downed timber.	**Yes**

4.3 Scope of the Removal Action

The scope of the Removal Action for the Site is to achieve cleanup of site-related hazardous substances to acceptable levels of risk to humans and the environment. The scope includes the following:

- A combination of removal and capping of arsenic-contaminated waste rock, tailings, and concentrates in excess of the Site-specific human health cleanup goal of 143 mg/kg.
- Mitigation of physical hazards.
- Site restoration following implementation of the Removal Action.

4.4 Removal Action Schedule

The Removal Action process should be completed in a period of 18 to 24 months, not including the post monitoring, which should be conducted for at least 3 to 6 years following the Removal Action. Time period

includes allotment for assessing data gaps, design of the recommended Removal Action; review by the client and appropriate regulatory bodies; public comment; preparation of bid documents; completion of the Removal Action; and completion of the final Removal Action Report.

5.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section describes the selection of a Removal Action using a four step process:

1. Identify technologies and processes potentially applicable to the Site.
2. Screen technologies and processes to eliminate ineffective or unfeasible technologies.
3. Develop alternatives using combinations of technologies that pass the screening process.
4. Evaluate the alternatives according to criteria described in Section 6.3.

5.1 Identification and Screening of Removal Action Options and Alternatives

The purpose of identifying and screening technology types and processes is to eliminate those technologies and process options that are unfeasible and/or do not meet potential ARARs. General Removal Actions are refined into technology types and process options. Multiple treatment technologies and process options have been evaluated for mine/mill solid waste. Most of these are not considered feasible because they would require extensive treatability studies, which are cost prohibitive, and not considered appropriate. Table 9 summarizes the results of the screening process for developing alternatives.

5.2 Identification and Description Alternatives For Further Evaluation

Conceptual alternatives were developed from the technologies that passed the screening process. Key design features are estimates only and provided for comparison purposes. Using the retained process options, the following alternatives were selected for detailed analysis:

- Alternative 1 – No Action
- Alternative 2 – Onsite Containment
- Alternative 3 – Excavation and Onsite Containment in Repository
- Alternative 4 – Excavation and Offsite Disposal

Because waste rock samples collected at the GC-6, Sheridan, and Upper Golden Fraction Mines were below the risk-based cleanup concentration, Removal Actions at these mines were not considered. The Monumental Mine, GC-5, Cap Martin, Lower and Middle Golden Fraction, and Central Mines were considered for further evaluation.

5.2.1 Alternative 1: No Action

No Removal Action would be completed to control migration of hazardous substances, or reduce the toxicity or volume. This alternative would require no further investigation or monitoring action and would be used as baseline against which other removal options can be compared as suggested by the NCP.

5.2.2 Common Items for Alternatives 2, 3, and 4

Several items are common to Alternatives 2, 3, and 4, and will be discussed and outlined in this section. Evaluation of these common items against the evaluation criteria is included in the overall evaluation of each of the alternatives. A summary of the common items is outlined in the following:

Building Material, Equipment, and Debris Demolition / Disposal

The SI identified a six-inch transit pipe at the Central Mine area (EA, 2003). Transit pipes traditionally consisted of cement mixed with asbestos fibers to increase strength and durability.

- Asbestos is regulated under the Clean Air Act, Toxic Substances Control Act, and by OSHA due to unique and significant health risks associated with disturbance, handling, and disposal. As such, workers without requisite asbestos-related training will not be allowed to conduct abatement activities at the Site.
- Based on this, the pipe should be handled and treated as suspect asbestos-containing material (ACM). The suspect ACM will be kept in non-friable condition and removed under the supervision of an ODEQ licensed asbestos contractor.
- Handling, transport, and disposal will require treatment of suspect ACM that prevents it from becoming friable. The material will be transported to a landfill permitted to accept asbestos waste (e.g., Baker County Landfill). The landfill will be notified in advance the material is considered suspect ACM.

All metal, wood, equipment, and other miscellaneous nuisance debris that pose a potential physical or chemical hazard to Site users will be removed from the Site. CES estimates that 3 truck loads (10 cy each) of building materials will be disposed in the onsite repository.

Historic Preservation

To the extent possible and practicable, the Monumental Mill and crusher foundations will be left intact; tailings and concentrations above the cleanup concentration will be removed using hand tools, vacuum trucks, or small equipment.

Cover Soil Borrow Area

Cover material will be obtained from surface material in the former clearcut in the Upper Granite Creek Saddle, a one-mile (one way) haul route on FR 7453 east of the Monumental Mine. Test pits completed during the 2009 DGI in this area showed the following general shallow lithology:

- 0 – 1 feet: soft ash/organics
- 1 - 2.5 feet: loamy material/cobbles
- 2.5 – 4 feet: weathered granite

Volcanic ash soils in the Blue Mountains of Northeastern Oregon support productive conifer forests, although displacement may negatively affect juvenile tree growth (USFS, 2008). Nonetheless, various grass species produce high forage yields on cleared volcanic ash soils, which also reduce erosion, and allows for succession to shrubs and trees (Pumphrey, 1970).

The proposed borrow area is currently vegetated with root intrusions into the ash/loam layers, indicating the material has the capability to support forest vegetation. A blend of the ash, loam, and upper one foot of the weathered granite should provide a suitable mix as cover soil for revegetation of excavated or contoured waste rock piles. The lateral extent of the borrow areas will be dependent upon the depth to which material may be excavated, the area of disturbance could vary between 0.25 acres to 2 acres. Additional cover soil may be scavenged from the hummocky area south of the lower waste rock pile at the Monumental Mine. Re-graded areas will be covered with a 1-foot soil cover (6-inch equipment compacted lift and 6-inch loose lift). This is considered sufficient because most of the waste rock, tailings, and concentrates have a low AGP as discussed in Section 2.6.5.

Repository

The proposed repository in the Upper Granite Creek saddle will be excavated from the cover soil borrow area. As discussed, the lateral extent of the borrow area and repository will be dependent upon the depth to which material may be excavated (between 0.25 and 2 acres). Excavated borrow soil will be used to cap disturbed areas at the Monumental Mine and will be stockpiled to be used as the cap for the repository. The repository will be constructed with 3H: 1V slopes or flatter, depending upon the extent of the borrow area footprint. The repository will be graded to prevent erosion and ponding, and runon channels will be constructed around the base of the repository, as necessary.

Waste material generated from the Monumental Mine will be compacted in one-foot lifts in the repository to obtain the desired slope. The cover will consist of a two-foot soil cover (one-foot equipment compacted lift and one-foot loose lift) from borrowed cover material. Cleared materials, including slash, trees, and boulders would be stockpiled to be used for erosion control on the repository cap and to regulate access from public roads.

The Removal Action design will include additional details regarding the proposed repository. As discussed in Section 2.6.5, tailings from the former flotation table and settling pond failed the TCLP regulatory threshold for arsenic. Therefore, the need for an impermeable liner and/or additional RCRA municipal landfill requirements will be assessed further during the Removal Action design.

Revegetation and Erosion Control

All disturbed areas, excavation areas, covered waste material, and the repository (Alternative 3) will be revegetated with the application of seed, fertilizer, and mulch. The seed mix will be selected following consultation with the Forest Service. Fertilizer will consist of 16% total nitrogen, 16% available phosphoric acid, 16% total water soluble potash, and 5% sulfur applied at the rate of 400 pounds per acre. Certified weed-free WoodStraw™ mulch would be applied at 70% coverage to control erosion during plant establishment.

Stormwater and snowmelt run-on would be controlled on the upgradient side by constructing run-on control berms; these will be incorporate into the grading activities so separate run-on ditches will not be required.

Monumental Mine Spring

The Monumental Mine spring, located downslope from the Upper Monumental Mine adit, currently discharges to the upper settling ponds. The settling ponds contain tailings and elevated concentrations of hazardous substances; therefore, during the Removal Action, water will be diverted around the wetland and discharged downslope from the lower waste rock pile into the unnamed tributary.

The size and type of the pipe will be determined during the Removal Action design, but a 12-inch corrugated plastic pipe would be more than sufficient based on the flows observed. Following tailings removal activities and revegetation of the ponds and wetlands, water will be diverted back to the upper settling pond.

Monumental Mine Adit Seeps

The Monumental Mine Upper and Lower Adit have minimal flow and relatively low arsenic concentrations, and currently infiltrates into the adjacent waste rock (Upper Adit) or into the lower settling pond (Lower Adit). The Upper Adit discharge will be diverted away from the waste rock pile in a pipeline and infiltrated into surrounding native material using buried perforated sewer pipe. The Lower Adit discharge will continue to be diverted to the settling pond, which will be diverted around the lower waste rock pile using flexible pipe. Following the Removal Action activities, the lower settling pond will be permanently diverted around

the hummocky area on the south side of the lower waste rock pile using an open rock-lined channel. Details regarding the design of the channel and possible use of the hummocky area for wetland mitigation will be included in the Removal Action design.

Surface Water Management

Water emanating from the Monumental Mine Lower Adit currently discharges to the lower settling pond. There is no evidence of a surface water outlet from the lower settling pond to the unnamed tributary. However, there is evidence of surface water flow over the access road into the settling pond area during high flow events. A 12-inch HDPE culvert will be installed under the access road to convey water during high flow events.

Road Maintenance and Decommissioning

During the Removal Action, select access roads will be minimally improved and closed to traffic. Currently, the undulating topography of FR 7453 precludes access for haul equipment. Therefore, filling in select areas will be necessary to upgrade the road for haul access. The old road bed to the Monumental Mine Upper Adit will require repairs, widening, and upgrades to allow access for machinery and trucks. The access road to the Monumental Mine Lower Adit will need minor upgrades for access. FR 680 will require upgrades, including widening and filling to provide access for machinery to the Central Mine.

Water will also be applied, as needed, to control fugitive dust emissions. CES will obtain permission from local Forest Service staff to withdraw water from Granite Creek and/or the unnamed tributary and lower settling pond, with appropriate cautions taken to withdraw water from designated fire water withdraw points and fish screens on intake hoses.

Upon completion of the Removal Action activities, old mining roads within the limits of the Site and temporary access Forest Service roads will be decommissioned and revegetated in coordination with local Forest Service staff. Decommissioning will consist of re-contouring the road for proper drainage, ripping to 12-inches, seeding, and mulching. Following decommissioning, large boulders, trees, or appropriate Wallowa-Whitman National Forest road closure methods will be employed to limit unauthorized vehicle access. The length of roads to be decommissioned will vary based on the alternative selected. All other Forest Service and county roads will be left open using signs/flagging. Oregon Department of Transportation approved signs will be used on Forest Service and county roads.

5.2.3 Alternative 2: Onsite Containment

Under this alternative, all waste material at the Site that exceeds the cleanup concentration of 143 mg/kg total arsenic would be contained onsite and cover soil applied to assist with the establishment of vegetation. The volumes of material to be contained are summarized below:

- Monumental Mine – 39,200 cy of waste rock, tailings, and concentrates
- Cap Martin Mine – 1,500 cy of waste rock
- GC-7 Mine – 300 cy of waste rock
- Tillicum Mine – 1,300 cy of waste rock
- GC-5 Mine – 400 cy of waste rock
- Golden Fraction Mine – Middle (120 cy of waste rock) / Lower (380 cy of waste rock)
- Central Mine Lower Adit – 650 cy of waste rock
- Granite Creek aquatic station GC-03 – 20 cy of waste rock

All disturbed areas and re-graded areas will be re-contoured and revegetated as outlined in the Common Items (Section 5.2.2). Details regarding the onsite excavation/containment at each mine are provided below.

Monumental Mine - Upper Shaft Area

The piles will be pushed into the partially open shaft, to the extent practicable, to reduce physical hazards. The remaining material will be re-contoured and blended into the surrounding terrain. The estimated volume of cover material needed is 50 cy.

Monumental Mine - Upper Waste Rock Pile

Under this alternative, the northern and southern edges of the waste rock pile would be pulled out to provide a gentler slope. However, the overall slopes will likely be steeper than desired for onsite containment. Timber would likely need to be logged north of the existing pile to provide area for waste rock material placement. Trees currently growing on the waste rock pile will logged and stockpiled and later utilized on the re-graded pile for erosion control. The estimated volume of cover material is 1,600 cy. Equipment planned for this alternative will be several large dozers and excavators, and standard haul trucks.

Monumental Mine - Millsite and Settling Ponds

Under this alternative, no action would occur in the settling ponds since they are currently covered with an organic layer and hydrophytic vegetation. The millsite areas exceeding the arsenic cleanup goal will be covered. The estimated volume of cover material needed is 100 cy. Equipment planned for this alternative will be a small excavator and standard haul trucks.

Monumental Mine - Lower Waste Rock Pile and Crusher

Under this alternative, the northern and southern edges of the large, flat waste rock pile would be pulled toward the center, to provide a gentle slope (e.g., 3H:1V). In addition, the small waste rock pile associated with the collapsed adit and the crusher area will be consolidated with the re-graded pile. The graded pile will be covered as described above with clean material in the hummocky area adjacent to the south end of the pile, and from the main borrow area. The hummocky area was observed to support vegetation during the DGI field activities and should provide suitable organic cover material. The estimated volume of cover material needed is 1,700 cy.

Trees currently growing on the waste rock pile will be stockpiled and later utilized on the re-graded pile for erosion control. Equipment planned for this alternative will be several large dozers and excavators, and standard haul trucks.

Cap Martin Mine

Under this alternative, the waste rock (1,200 cy on the north side and 300 cy on the south side) would be re-contoured on each side of Granite Creek to blend into the surrounding terrain. The estimated volume of cover material needed is 1,500 cy. Equipment planned for this alternative will be a small excavator and small dozer. Access to the mine will be via FR 7345. About 1,000 feet of primitive road would need to be constructed through the heavy brush/blow-down.

GC-7 Mine

Under this alternative, the waste rock at each mine (300 cy) would be re-contoured to blend into the surrounding terrain. The GC-7 Mine has a collapsed adit portal that is currently a concave topographic feature along the hillside. This area would be used to the extent practical to place waste rock. The estimated volume of cover material needed is 75 cy. Equipment planned for this alternative will be a small excavator

and small dozer. Access will be via FR 680 (along Granite Creek) with a primitive spur road used to assess the mine.

Tillicum Mine

The Tillicum Mine has two collapsed adits, providing concave topography on the hillslope. As part of the alternative, waste rock at the Tillicum Mine Upper and Lower Adits (1,300 cy) will be excavated and placed into the existing collapsed adit portal and re-contoured to blend into the surrounding terrain. Excess waste material would be blended into the surrounding terrain. The estimated volume of cover material needed is 300 cy. Equipment planned for this alternative will be a small excavator and small dozer. Access to the Tillicum Mine will be accomplished using FR 680, along Granite Creek.

GC-5 Mine

The GC-5 Mine has a collapsed adit, providing concave topography on the hillslope. Waste rock at the GC-5 Mine (400 cy) will be excavated and pulled back into the existing collapsed adit portal and re-contoured to blend into the surrounding terrain. Excess waste material would be blended into the surrounding terrain. The estimated volume of cover material needed is 50 cy. Equipment planned for this alternative will be a small excavator and small dozer. Access to the GC-5 Mine will be accomplished using FR 680, along Granite Creek.

Golden Fraction Mine – Middle Area

Under this alternative, the four small separate piles (120 cy) will be re-contoured to blend into the surrounding terrain. The estimated volume of cover material needed is 30 cy. Equipment planned for this alternative will be a small excavator with a blade. Access will be from FR 7345, located upslope of the waste rock piles.

Golden Fraction Mine –Lower Area

The Lower Golden Fraction Mine has a collapsed adit, providing concave topography on the hillslope. As part of this alternative, waste rock (380 cy) from the Lower Area will be re-contoured to blend into the collapsed portal and surrounding terrain. Excess waste material would be blended into the surrounding terrain. The estimated volume of cover material needed is 60 cy. Equipment planned for this alternative will be a small excavator and a small dozer. Access will be accomplished using FR 680, along Granite Creek.

Central Mine

The Central Mine has two collapsed adits, providing concave topography on the hillslope. Waste rock at the Central Mine (650 cy) will be excavated and pulled back into the existing collapsed adit portals and surrounding terrain. Excess waste material would be blended into the surrounding terrain. The estimated volume of cover material needed is 100 cy. Equipment planned for this alternative will be a small excavator and a small dozer. Access will be accomplished using FR 680, along Granite Creek.

GC-03 Waste Rock Pile

Under this alternative, the waste rock pile adjacent to Granite Creek aquatic station GC-03 will be pulled away from the Granite Creek floodplain and re-contoured using a small excavator with access from the west on the spur road (FR 740) originating from FR 7345. The re-contoured waste rock will be covered with soil that can be scavenged from around the immediate area and revegetated in the same manner as the other areas.

5.2.4 Alternative 3: Excavation and Onsite Containment

Under this alternative, all waste material at the Monumental Mine that exceeds the cleanup concentration of 143 mg/kg total arsenic would be excavated disposed in an onsite repository, all other waste material would be contained onsite as outlined in Alternative 2. The volumes of material to be removed/contained are summarized below:

- Monumental Mine – 39,200 cy of waste rock, tailings, and concentrates – Onsite Repository
- Cap Martin Mine – 1,500 cy of waste rock – Onsite Containment
- GC-7 Mine – 300 cy of waste rock – Onsite Containment
- Tillicum Mine – 1,300 cy of waste rock – Onsite Containment
- GC-5 Mine – 400 cy of waste rock – Onsite Containment
- Golden Fraction Mine – Middle (120 cy) / Lower (380 cy) – Onsite Containment
- Central Mine Lower Adit– 650 cy of waste rock – Onsite Containment

Visual observations and an XRF will be used to delineate the extent of the excavations and confirmation samples will be collected and sent to the laboratory to document the removal. The preferred repository location is the former clearcut in the Upper Granite Creek Saddle, east of the Monumental Mine. The round-trip haul route is 2 miles on FR 7345 from the Monumental Mine. The clearcut provides relatively flat terrain to contain the material, and access to the public can be minimized with road decommissioning following the Removal Action. Large boulders may also be obtained from the clearcut, which can be used at the Site to limit public access.

All disturbed areas, excavated areas, re-graded areas, and the repository will be revegetated as outlined in the Common Items (Section 5.2.2). Details regarding the onsite excavation/containment at each mine are provided below.

Monumental Mine - Upper Shaft Area

The waste rock piles will be pushed into the partially open shaft, to the extent practicable, to reduce physical hazards. The remaining material will be placed in the repository.

Monumental Mine - Upper Waste Rock Pile

Waste rock that exceeds the cleanup goal will be pushed downslope with a dozer to FR 7345, where it can be loaded and hauled to the repository via traditional dump trucks. Trees will need to be removed near the haul road to provide access for equipment to load dump trucks. The trees will be used for erosion control on the excavated areas or the repository.

Monumental Mine - Millsite and Settling Ponds

Tailings and concentrates from the millsite and settling ponds that exceed the cleanup goal will be removed using an excavator and transported and placed in the repository using standard dump trucks. The wetland area in the settling ponds (0.08 acres) will be mitigated in accordance with USEPA CERCLA guidance. Options for wetland creation near the upper repository adit drainage and in the hummocky area adjacent to the lower waste rock pile will be considered as part of the Removal Action design.

Monumental Mine - Lower Waste Rock Pile and Crusher

Under this alternative, all waste rock and crusher fines that exceed the cleanup goal will be excavated and placed in the repository. As part of wetland mitigation, a channel will be constructed from the lower settling pond to the unnamed tributary around the wet hummocky area. A rip-rap lined V-shaped channel with

2H:1V slopes will be constructed from the outlet of the settling pond to the wetland. The settling pond outlet will be armored with geo-textile and rip-rap to prevent erosion. The estimated volume of cover material needed is 1,700 cy. The estimated volume of clean organic media for the wetland is 100 cy. A 12-inch HDPE culvert will be installed under the access road to convey water during high flow events. No action would occur at the collapsed adit and small waste rock pile (100 cy) located north and upslope of the Crusher.

Cap Martin Mine, GC-7 Mine, Tillicum Mine, GC-5 Mine, Golden Fraction Mine, Central Mine, and GC-03 Waste Rock Pile

Under this alternative, waste rock at the Cap Martin, GC-5, GC-7, Tillicum, Golden Fraction, and Central Mines and GC-03 waste rock pile would be managed as discussed under Alternative 2.

5.2.5 Alternative 4: Excavation and Offsite Disposal

Under this alternative, all waste material at the Site that exceeds the cleanup concentration of 143 mg/kg total arsenic would be excavated and transported offsite for disposal. The volumes of material to be removed are summarized below:

- Monumental Mine – 39,200 cy of waste rock, tailings, and concentrates.
- Cap Martin Mine – 1,500 cy of waste rock.
- GC-7 Mine – 300 cy of waste rock.
- Tillicum Mine – 1,300 cy of waste rock.
- GC-5 Mine – 400 cy of waste rock.
- Golden Fraction Mine – Middle (120 cy of waste rock) / Lower (380 cy of waste rock).
- Central Mine Lower Adit– 650 cy of waste rock.

Access to the mines would be the same as outlined in Alternative 2. Articulated haul trucks would be used to transport the waste material from the mines to a staging area (located to be determined) where the material would be transferred into highway approved haul trucks for transport. Visual observations and an XRF will be used to delineate the extent of the excavations and confirmation samples will be collected and sent to the laboratory to document the removal. Since the tailings and concentrates from the Monumental Mine exceeded the RCRA disposal limit, CES assumes the material would have to be disposed at the Arlington, Oregon Subtitle C facility (round trip haul of 430 miles) as Subtitle D facilities are not likely to accept the material. The excavated areas will be re-contoured to blend into the surrounding terrain. All disturbed areas and excavated areas will be re-contoured and revegetated as outlined in the Common Items (Section 5.2.2).

5.3 Analysis of Selected Removal Action Alternatives

As required by the CERCLA guidance (USEPA, 1993) and the NCP (40 CFR 300.415), Removal Action alternatives that were retained after the initial evaluation and screening have been evaluated individually against the following three criteria (effectiveness, implementability, and cost), and listed subcriteria.

- **Effectiveness**
  - Compliance with Removal Action goals and objectives
  - Overall protection of human health and the environment
  - Compliance with Potential ARARs
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness

- **Implementability**
  - Administrative feasibility
  - Technical feasibility
  - Availability of services and materials
  - State and community acceptance
- **Cost**
  - Direct capital costs
  - Indirect capital costs
  - Annual maintenance and inspection costs

Table 10 outlines the comparative analysis of the retained alternatives against the listed criteria.

5.4 Cost Estimates

Evaluation of costs consists of developing conservative, order-of-magnitude estimates based on the description of work items developed for each Removal Action alternative. A similar set of assumptions is used for all the alternatives, so that the *relative* difference in cost between alternatives is represented. Appendix E provides cost estimates with the capital, indirect, operation and maintenance costs, as well as the 20 year Net Present Value (NPV) of each of the alternatives. Costs are presented below:

Alternative	Estimated Cost (NPV)
Alternative 1 – No Action	$0
Alternative 2 – Onsite Containment	$499,000
Alternative 3 – Excavation and Onsite Containment in Repository	$903,000
Alternative 4 – Excavation and Offsite Disposal	$6,155,000

6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The effectiveness of the retained alternatives was evaluated based on advantages in each of the evaluation criteria outlined in Section 5.2, as well as the removal action goals and objectives. Table 11 contains a summary of the advantages of each of the retained alternatives. Based on the information presented in Table 11, excavation and onsite containment/disposal was retained due to the following:

- Reduces risk to human health and the environment to an acceptable level;
- Provides a reduction in the mobility of contaminants;
- Removes possible acid-generating waste material from the headwaters of the unnamed tributary;
- Improvement of wetland functions and values;
- Most technically feasible to construct;
- Complies with potential ARARs; and
- Reduces physical hazards at the upper shaft.

7.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the conclusions of the detailed analysis and comparative analysis of alternatives above, CES recommends a combination of Alternative 1 - No Action; Alternative 2 - Onsite Containment, and Alternative 3 - Excavation with Onsite Containment in a Repository, with justification for recommendations. The

Common Items listed in 5.2.2 will also be incorporated into the Removal Action plan, but are not repeated below.

7.1 Upper Granite Creek Waste Rock (Near GC-03)

A soil sample collected from the pile adjacent to Granite Creek (near aquatic station GC-03) exhibited arsenic concentrations of 337 mg/kg, which exceed the risk-based cleanup concentration of 143 mg/kg. Removal of material from the area offsite or into a repository would be cumbersome for a relatively small amount of material (20 cy). Additionally, road upgrades would be necessary to allow haul trucks to access the pile.

Based on this, CES recommends that the pile be pulled away from the Granite Creek floodplain and re-contoured using a small excavator with access from the west on a spur road originating from FR 7345. The re-contoured waste rock will be covered with soil that can be scavenged from around the immediate area and revegetated in the same manner as the other areas.

7.2 Monumental Mine

7.2.1 Upper Shaft Area

The waste rock piles scattered around the Upper Shaft Area (3,000 cy) were identified with an arsenic concentration of 860 mg/kg, which exceeds the cleanup level of 143 mg/kg. The piles will be pushed into the partially open shaft, to the extent practicable. Filling the open portion of the shaft will reduce the physical hazards associated with this portion of the Site. The remaining material will be re-contoured and blended into the surrounding terrain. Remaining exposed waste rock will be covered with cover soil as described in the alternatives.

7.2.2 Upper Waste Rock Pile

The Upper Monumental Mine waste rock pile contains concentrations of arsenic as high as 2,920 mg/kg, which is well above the cleanup level of 143 mg/kg. The steep slope of the waste rock pile will not likely allow re-contouring of the material, without significant mobilization and/or erosion downslope toward the unnamed tributary and wetland. Moreover, stabilization of cover material over the existing pile will be difficult, considering the steep slope of the pile. Equipment access on the steep slopes is likely impractical, but the possibility of re-grading the waste rock within the existing terrain will be further assessed in the Removal Action design.

Based on this, CES recommends excavation and disposal of the material in the repository at the Upper Granite Creek Saddle (see Section 5.2.2). The waste material will be pushed downslope from the Upper Adit with a dozer to FR 7345, loaded, and hauled to the repository for placement. This option removes contamination upgradient from the headwaters of the unnamed tributary, and thus, a potential source of contamination to the spring and wetlands at the Site. Trees removed near the loading area along FR 7345 will be stockpiled and re-used for erosion control following removal and cover soil placement.

7.2.3 Monumental Mine Millsite and Settling Ponds

The millsite and settling ponds contain concentrations of arsenic as high as 11,400 mg/kg, and leachable arsenic which would typically be considered in excess of the federal hazardous waste toxicity criterion. However, the Bevill Exclusion exempts this material from hazardous waste classification. Floatation concentrates should be excavated and removed from the millsite to protect human health and safety. If necessary, a vacuum truck will be utilized to remove concentrates from around the floatation table and within the mill area.

Following removal of the concentrates, the area will be re-graded and revegetated in the same manner as the other areas. If it is not possible to remove all of the concentrates to the cleanup goal, then cover soil may be placed over the remaining areas to provide an exposure barrier. Tailings from the middle and upper settling ponds will also be excavated and removed for protection of water quality and ecological function of the wetland system. Tailings and concentrates will be transported and placed in the repository.

The wetland will be restored following the removal of hazardous substances in accordance with the USEPA guidance document *Considering Wetlands at CERCLA Sites* (USEPA, 1994). If needed, clean organic fill may be imported from offsite for placement in the new wetland system. Wetland plants will be obtained either offsite, or from a local borrow area, pending Forest Service approval.

7.2.4 Lower Waste Rock Pile and Crusher

The lower waste rock pile contains arsenic concentrations as high as 4,610 mg/kg. Waste material around the crusher was identified with concentrations of arsenic as high as 9,360 mg/kg. Both concentrations are well above the cleanup level of 143 mg/kg. Due to the relatively flat nature of this portion of the Lower Monumental Mine, onsite containment and capping of the main waste rock pile and crusher fines provides the most cost-effective alternative. Waste rock from the northern and southern edges of the main pile will be pulled toward the center, to provide a gentle slope (e.g., 3H:1V). The re-contoured waste rock will be covered with soil from the repository or material that can be scavenged from around the immediate area (i.e., hummocky area) and revegetated in the same manner as the other areas.

Sediment samples have not been collected from the lower settling pond, but it is likely that a small amount of tailings are present. If determined to be present during additional sampling, these tailings will be removed and placed on the re-graded waste rock pile, prior to placement of cover soil. A channel will be constructed from the lower settling pond to the unnamed tributary through the wet hummocky area. A rip-rap lined V-shaped channel with 2H:1V slopes will be constructed from the outlet of the settling pond to the wetland. The settling pond outlet will be armored with geo-textile and rip-rap to control erosion. This will allow the surface water to bypass waste rock pile left in place. A 12-inch HDPE culvert will be installed under the access road to convey water during high flow events.

7.3 Cap Martin Mine

The two springs at the Cap Martin Mine were not observed discharging into Granite Creek; furthermore, water sampling activities conducted in Granite Creek did not identify total or dissolved arsenic at concentrations exceeding laboratory MDLs. As such, there is no evidence of water quality impacts from the mine. Total arsenic concentrations, ranging from 6.3 to 131 mg/kg in samples collected from waste rock near Adits 1, 2, and 4, the outwash fan, and placer spoils along Granite Creek, are below the risk-based cleanup concentration of 143 mg/kg. Arsenic, detected at concentrations of 198 and 257 mg/kg, in waste rock from Adit 3, slightly exceeds the cleanup concentration of 143 mg/kg.

The mine is located in a remote area of the Upper Granite Creek watershed, with difficult access via foot travel. As such, exposure to contaminants at this mine are likely minimal. Onsite containment or removal of waste rock from the Cap Martin Mine is not practical without constructing a new road which would disturb a significant amount of the hillside. Based on this and the remote nature of the mine, CES recommends that no action be taken at the Cap Martin Mine.

7.4 GC-7 Mine

Waste rock samples collected at the GC-7 Mine indicated total arsenic ranging from 22.9 to 220 mg/kg was either below or slightly above the cleanup concentration of 143 mg/kg. No signs of water discharge were

observed from the adit at the mine. Equipment access would require rehabilitation of FR 680 along Granite Creek, or crossing Granite Creek from the Sheridan Mine to the southwest.

The mine is located in a remote area of the Upper Granite Creek watershed, with difficult access via foot travel. As such, exposure to contaminants at this mine are likely minimal. Furthermore, waste rock from the mine does not appear to be significantly impacting water quality in Granite Creek. Based on the above, the relatively small amount of waste rock (300 cy), and the remote nature of the mine, CES recommends no action at the GC-7 Mine.

7.5 Tillicum Mine

Waste rock samples collected at the Tillicum Mine indicated total arsenic ranging from 35.7 to 371 mg/kg (average of 148.7 mg/kg) was either below or slightly above the cleanup concentration of 143 mg/kg. No signs of water discharge were observed from the adit at the mine. Equipment access would require significant rehabilitation of FR 680 along Granite Creek. Furthermore, water sampling activities conducted in Granite Creek did not identify total or dissolved arsenic at concentrations exceeding laboratory MDLs. As such, there is no evidence of water quality impacts from the mine. Exposure to contaminants at this mine are likely minimal. Based on the above and the remote nature of the mine, CES recommends no action at the Tillicum Mine.

7.6 GC-5 Mine

The GC-5 Mine is collapsed with no apparent signs of discharge. Waste rock (400 cy) is located below the adit and adjacent to Granite Creek. Total arsenic concentrations ranging from 155 to 179 mg/kg in the waste rock, which slightly exceeded the risk-based cleanup concentration of 143 mg/kg. A seep is located 100 feet west of the adit and infiltrates into soil near the Granite Creek floodplain. Total arsenic was detected at 4.6 μg/L in the sample collected from the seep, which is above the human screening criteria but below the ecological screening criteria. Furthermore, based on sampling results from downstream stations, it does not appear to have adversely impacted surface water in Granite Creek. Therefore, based on the above and the remote nature of the mine, CES recommends no action be taken at the GC-5 Mine.

7.7 Golden Fraction Mine - Middle Area

A sample collected during the 2007 DGI from one of the four piles in the middle area near a possible dredge retaining wall identified an arsenic concentration (1,340 mg/kg). This concentration exceeds the cleanup concentration of 143 mg/kg. Removal of the material would require construction of a new access road and significant disturbance to the hillside. Based on this and the small amount of impacted material (30 cy), the piles and retaining wall will be re-contoured to blend in with the surrounding terrain. The area will be covered with soil that can be scavenged from around the area and revegetated in the same manner as the other areas. Access will be from FR 7345, located upslope of the piles.

7.8 Golden Fraction Mine – Lower Area

Water seeping from the adit currently infiltrates into the soils near FR 680. There is no evidence that the seep reaches Granite Creek, though it may be possible during times of high rainfall and rain on snow events. Total arsenic was detected at 11.9 μg/L in the sample collected from the seep, which is above the human screening criteria but below the ecological screening criteria.

Furthermore, based on sampling results from downstream stations, it does not appear to have adversely impacted surface water in Granite Creek. A sample collected from the lower waste rock pile (350 cy) indicated the arsenic concentration (89 mg/kg) is below the cleanup concentration of 143 mg/kg. Therefore,

based on this and the remote nature of the mine, CES recommends no action be taken at the Lower Golden Fraction Mine.

7.9 Central Mine

The Central Mine is easily accessed and visible from FR 73 and either FR 7345 (Upper Area) and FS 680 (Lower Area). Waste rock samples collected at the Central Mine indicated total arsenic ranging from 27.4 to 295 mg/kg (with an average of 144.6 mg/kg) was either below or slightly above the cleanup concentration of 143 mg/kg.

Due to the high visibility, easy access, and elevated concentrations of waste rock in several of the samples, CES recommends the waste rock material at the mine will be re-contoured onsite in the portal excavations and the surrounding terrain. The re-contoured waste rock will be covered with non-impacted soil that can be scavenged from around the immediate area and revegetated in the same manner as the other areas.

7.10 Summary of Recommended Removal Action Alternative

The follow table provides a summary of the recommended Removal Action alternative, by mine/feature.

Mine/Feature	Recommended Removal Action
Upper Granite Creek Waste Rock Pile	Onsite Containment
Monumental Mine – Shaft Area	Onsite Containment
Monumental Mine – Upper Waste Rock Pile	Excavation/Containment in Onsite Repository
Monumental Mine – Millsite and Settling Ponds	Excavation/Containment in Onsite Repository
Monumental Mine – Lower Waste Rock Pile/Crusher	Onsite Containment
Cap Martin Mine	No Action
GC-07 Mine	No Action
GC-06 Mine	No Action
Sheridan Mine	No Action
Tillicum Mine	No Action
GC-05 Mine	No Action
Golden Fraction Mine – Upper Area	No Action
Golden Fraction Mine – Middle Area	Onsite Containment
Golden Fraction Mine – Lower Area	No Action
Central Mine	Onsite Containment

7.11 Recommended Removal Action Cost

The recommended Removal Action includes a combination of Alternative 1 - No Action; Alternative 2 – Onsite Containment; and Alternative 3 – Excavation and Containment in onsite Repository. The total estimated cost to implement the recommended Removal Action is $691,000, as outlined in Appendix E.

Forest Service 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 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, 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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TABLES

Table 1. **Surface Water Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample I.D.	Sample Date	Sampling Entity	Aluminum, TR	Antimony, TR	Arsenic, TR	Barium, TR	Beryllium, TR	Cadmium, TR	Calcium, TR	Chromium, TR	Cobalt, TR	Copper, TR	Iron, TR	Lead, TR	Magnesium, TR	Manganese, TR	Mercury, TR	Nickel, TR	Potassium, TR	Selenium, TR	Silver, TR	Sodium, TR	Thallium, TR	Vanadium, TR	Zinc, TR
			Results in µg/L																						
Granite Creek Background																									
GC-SW-01	6/25/2007	CES	NA	< 0.4	0.6 B	NA	< 0.10	< 0.10	4,500	< 10	NA	< 0.5	30 B	0.1 B	700 B	< 5.0	< 0.0001	< 10	NA	< 0.1	< 0.05	NA	NA	NA	< 10.0
GC-SW-02	6/25/2007	CES	NA	< 0.4	< 0.5	NA	< 0.10	< 0.10	4,500	< 10	NA	< 0.5	40 B	< 0.1	800 B	< 5.0	0.00048	< 10	NA	< 0.1	< 0.05	NA	NA	NA	10.0 B
GC-SW-03	6/5/2007	CES	NA	< 0.4	0.6 B	NA	< 0.10	< 0.10	4,700	< 10	NA	< 0.5	100	0.1 B	900 B	< 5.0	0.00048	< 10	NA	< 0.1	< 0.05	NA	NA	NA	10.0 B
Granite Creek																									
ST-SFW-03	7/15/2003	EA	< 23.6	< 4.7	< *4.8*	34.9 B	< 0.20	< *0.60*	5,560	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	998 B	< 0.70	< 0.10 U	< 2.1	1,210 B	< *3.4*	< *2.2*	2,810 B	< *5.7*	< 2.0	2.0 B
ST-SFW-04	7/15/2003	EA	126 B	< 4.7	< *4.8*	41.5 B	< 0.20	< *0.60*	7,060	< 1.4	< 2.0	< 2.4	94.1 B	< 1.3	1,320 B	5.7 B	< 0.10 U	< 2.1	1,750 B	< *3.4*	< *2.2*	3,160 B	< *5.7*	< 2.0	2.6 B
ST-SFW-05	7/13/2003	EA	< 23.6	< 4.7	< *4.8*	38.5 B	< 0.20	< *0.60*	7,130	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,330 B	0.88 B	< 0.10 U	< 2.1	2,340 B	< *3.4*	< *2.2*	3,260 B	< *5.7*	< 2.0	2.5 B
ST-SFW-06	7/13/2003	EA	< 23.6	< 4.7	< *4.8*	45.6 B	< 0.20	< *0.60*	8,450	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,720 B	0.72 B	< 0.10 U	< 2.1	1,990 B	< *3.4*	< *2.2*	3,220 B	< *5.7*	< 2.0	2.3 B
ST-SFW-07	7/12/2003	EA	< 63.1 U	< 5.0	< *6.0*	45.5 B	< 0.40	< 1.2	8,700	< 1.9	< 3.7	< 3.3	< 66.7	1.7 B	1,760 B	< 1.9	< 0.10 U	< 4.4	1,590 B	< *1.7*	< *2.9*	3,160 B	< *2.8*	< 3.6	2.9 B
ST-SFW-08	7/12/2003	EA	< 23.6 U	< 4.7	< *4.8*	48.5 B	< 0.20	< *0.60*	9,010	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,820 B	1.1 B	< 0.10 U	< 2.1	2,670 B	< *3.4*	< *2.2*	3,420 B	< *5.7*	< 2.0	3.0 B
ST-SFW-09	7/11/2003	EA	< 63.1 U	< 5.0	< *6.0*	50.9 B	< 0.40	< 1.2	9,690	< 1.9	< 3.7	< 3.3	< 66.7	< 1.5	2,010 B	< 1.9	< 0.10 U	< 4.4	1,620 B	< *1.7*	< *2.9*	3,240 B	< *2.8*	< 3.6	3.3 B
ST-SFW-10	7/10/2003	EA	< 63.1 U	< 5.0	< *6.0*	52.9 B	< 0.40	< 1.2	9,910	< 1.9	< 3.7	< 3.3	< 66.7	< 1.5	2,070 B	< 1.9	< 0.10 U	< 4.4	1,630 B	< *1.7*	< *2.9*	3,140 B	< *2.8*	< 3.6	3.5 B
ST-SFW-53	7/17/2003	EA	79.3 B	< 4.7	13.1	55.0 B	< 0.20	< *0.60*	15,300	< 1.4	< 2.0	< 2.4	< 16.8	< 1.3	3,540 B	10.3 B	0.20 B	< 2.1	1,870 B	< *1.7*	< *2.2*	3,380 B	< *2.8*	< 2.0	3.1 B
ST-SFW-54	7/17/2003	EA	26.4 B	< 3.8	9.6 B	51.0 B	< 0.20	< *0.30*	15,900	0.74 B	< 1.8	< 1.4	32.3 B	< 1.3	4,040 B	6.7 B	0.10 B	< 2.0	2,490 B	< *1.7*	< *0.90*	3,650 B	< *2.8*	< 2.2	< 5.7
Monumental Mine																									
Spring																									
SP-SFW-51	7/10/2003	EA	< 63.1	< 5.0	< *6.0*	75.6 B	< 0.40	< 1.2	17,800	< 1.9	< 3.7	< 3.3	< 66.7	2.1 B	4,530 B	55.4	< 0.0001 U	< 4.4	1,610 B	< *1.7*	< *2.9*	2,630 B	< *2.8*	< 3.6	5.0 B
MMDGA-SW-01	9/28/2009	CES			51.0								4,220.0	11.8											28.0
Ponds																									
SP-SFW-18	7/9/2003	EA	< 63.1 U	< 5.0	81.8	67.7 B	< 0.40	< 1.2	17,400	< 1.9	< 3.7	< 3.3	< 66.7	< 1.5	4,660 B	2.9 B	< 0.0001 U	< 4.4	2,440 B	< *1.7*	< *2.9*	2,940 B	< *2.8*	< 3.6	27.6
MMDGA-SP-01	9/28/2009	CES			105.0								5,610	29.4											120
MMDGA-SP-02	9/28/2009	CES			19.9								60	< 0.1											4 B
Unnamed Tributary																									
SP-SFW-19	7/19/2003	EA	< 63.1 U	< 5.0 U	21.4	99.5 B	< 0.40 U	< 1.2 U	22,600	< 1.9 U	< 3.7 U	< 3.3 U	< 66.7 U	2.3 B	7,150	6.7 B	< 0.10 U	< 4.4 U	2,720 B	2.6 B	< *2.9* U	3,310 B	< *2.8* U	< 3.6 U	15.6 B
MMDGA-SW-02	9/28/2009	CES			24.2								< 20	0.3 B											9.0 B
Adit Seeps																									
MMDGA-AS-01	9/28/2009	CES			21.8								130	< 0.1											4.0 B
MMDGA-AS-02	9/28/2009	CES			27.2								330	0.4 B											14.0
Cap Martin Mine (Springs)																									
CM-AS-01	6/21/2007	CES	NA	< 0.4	< 0.5	NA	< 0.10	< 0.10 U	9,800	< 10	NA	< 0.5	650	0.1 B	2,000	21 B	0.00095	< 10	NA	< 0.1	< 0.05	NA	NA	NA	1,310
CM-AS-02	6/21/2007	CES	NA	< 0.4	1.3	NA	< 0.10	0.10 B	9,900	< 10	NA	< 0.5	2,030	< 0.1 B	2,100	26 B	0.00574	< 10	NA	< 0.1	< 0.05	NA	NA	NA	< 10
Golden Fraction (Seep)																									
GF-AS-01	6/25/2007	CES	NA	0.7 B	11.9	NA	< 0.10	< 0.10	28,200	< 10	NA	0.7 B	1870	0.2 B	6,700	374	0.00194	< 10	NA	< 0.1	< 0.05	NA	NA	NA	< 10
Granite Creek Mine #5 (Seep)																									
GC5-AS-01	6/24/2007	CES	NA	0.9 B	4.6	NA	< 0.10	0.70	22,700	< 10	NA	3.8	1740	9	4,900	10 B	0.141	< 10	NA	0.5 B	0.09 B	NA	NA	NA	20 B
Standards, corrected for hardness where applicable (used 98 mg/L background for surface water samples																									
Oregon - Aquatic Life [1]			87	NS	*150*	NS	NS	*0.27*	NS	NS	NS	*9.2*	1,000	*3.10*	NS	NS	0.012	*51*	NS	5	0.12	NS	NS	NS	118
Oregon - Ecological Screening Level Values [2]			87	1,600	NS	4	5.3	2.2	116,000	NS	23	9	1,000	2.5	82,000	120	0.77	52	53,000	5	0.12	680,000	40	20	120
Oregon - Human Health [3]			NS	5.6	0.018	1,000	NS	NS	NS	NS	NS	NS	1,300	300	NS	NS	50	NS	610	NS	170	NS	NS	0.24	NS	7,400
EPA - Aquatic Life (CCC) [4]			87	NS	*150*	NS	NS	0.243	NS	100	NS	8.8	1,000	2.46	NS	NS	0.77	51.1	NS	5	NS	NS	NS	NS	118
EPA - Human Health (Water+Organism) [5]			NS	5.6	0.018	1,000	NS	NS	NS	NS	NS	1,300	300	NS	NS	50	NS	610	NS	170	NS	NS	1.7	NS	7,400
ORNL - Surface Water PRGs [6]			87	30	NS	4	0.66	1.10	NS	NS	23	12	1,000	3.20	NS	120	1.3	160	NS	0.39	0.36	NS	9	20	118

Table 1. **Surface Water Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample I.D.	Sample Date	Sampling Entity	Flow Rate	Temperature (Field)	pH (Field)*	pH (Lab)*	Turbidity*	Conductivity (Lab)	Conductivity (Field)	Dissolved Oxygen (Field)*	Oxygen Reduction Potential (Field)	Hardness as $CaCO_3$, TR*	Residue, Filterable (TDS) @180*	Residue, Non-Filterable (TSS) @105° C*	Sulfate+
			cfs	°C	s.u.		NTU	µS/cm		mg/L	mV	mg/L			
Granite Creek Background															
GC-SW-01	6/25/2007	CES	2	6.12	6.47	7.6 H	NM	45	38	12	225	14	40	< 5 U	< 10 U
GC-SW-02	6/25/2007	CES	145	4.85	6.24	7.8 H	NM	47	42	13.53	343	15	50	< 5 U	< 10 U
GC-SW-03	6/5/2007	CES	161	4.47	5.45	7.8 H	NM	52	50	13.19	375	15	50	< 5 U	< 10 U
Granite Creek															
ST-SFW-03	7/15/2003	EA	NM	9.58	7.96	7.3	0.44	46.7	48	11.29	NM	112	39.0	2.7	5.0
ST-SFW-04	7/15/2003	EA	NM	10.7	7.87	7.2	0.71	55.0	57	10.7	NM	128	40.0	5.4	5.2
ST-SFW-05	7/13/2003	EA	0.34	10.72	8.27	7.6	0.37	57.0	60	10.7	NM	160	51.0	2.4	5.1
ST-SFW-06	7/13/2003	EA	0.23	11.14	8.28	7.6	0.41	69.3	70	10.73	NM	88.0	64.0	1.3	5.9
ST-SFW-07	7/12/2003	EA	0.21	12.43	8.08	7.6	0.27	73.1	73	10.62	NM	96.0	64.0	1.8	5.9
ST-SFW-08	7/12/2003	EA	0.10	12.31	8.08	7.7	0.48	73.0	75	10.24	NM	100	65.0	9.2	6.2
ST-SFW-09	7/11/2003	EA	NM	10.49	8.1	7.6	0.57	78.0	80	10.78	NM	108	61.0	1.6	6.0
ST-SFW-10	7/10/2003	EA	NM	13.02	8.09	7.6	0.4	78.9	80	10.37	NM	100	70.0	1.8	6.1
ST-SFW-53	7/17/2003	EA	0.03	14.96	7.87	7.6	0.58	108	122	10.2	NM	80.0	100.0	7.2	14.8
ST-SFW-54	7/17/2003	EA	0.08	14.04	8.49	7.7	5	112	133	10.58	NM	104	116	5.0	15.3
Monumental Mine															
Spring															
SP-SFW-51	7/10/2003	EA	NM	8.36	7.76	7.0	2.34	139	142	7.35	NM	64.0	107	30.6	26.0
MMDGA-SW-01	9/28/2009	CES	NM	9.38	7.33	8 H		59	138	9.29	140	65	100	142	20
Ponds															
SP-SFW-18	7/9/2003	EA	NM	7.01	7.65	6.9	4.68	141	148	7.8	NM	104	116	36.1	24.6
MMDGA-SP-01	9/28/2009	CES	NM	9.66	6.75	8.1 H		197	134	8.59	172.6	91	140	57	47
MMDGA-SP-02	9/28/2009	CES	NM	7	6.86	8.4 H		317	212	12.87	123	175	210	< 5	48
Unnamed Tributary															
SP-SFW-19	7/19/2003	EA	0.14	10.64	7.9	7.5	0.72	182	185	10.21	NM	132	123	50.7	23.5
MMDGA-SW-02	9/28/2009	CES	0.0076	8.62	6.47	8.2 H		218	143	11.59	142.2	105	140	10 B	30
Adit Seeps															
MMDGA-AS-01	9/28/2009	CES	NM	6.06	7.23	8.4 H		322	208	12.31	136	179	210	7	51
MMDGA-AS-02	9/28/2009	CES	NM	6.34	7.43	8.5 H		529	319	11	150.2	273.0	340	76	98.0
Cap Martin Mine (Springs)															
CM-AS-01	6/21/2007	CES	NM	10.49	NM	7.9 H	0.57	84	NM	NM	NM	33	60	16 B	< 10.0 U
CM-AS-02	6/21/2007	CES	NM	13.02	NM	7.9 H	0.4	104	NM	NM	NM	33	70	16 B	< 10.0 U
Golden Fraction (Seep)															
GF-AS-01	6/25/2007	CES	NM	NM	8.1	7.9 H	NM	256	80	10.78	NM	98	180	40	20 B
Granite Creek Mine #5 (Seep)															
GC5-AS-01	6/24/2007	CES	NM	8	6.35	7.8 H	NM	221	210	7.1	220	77	150	158	10 B
Standards															
Oregon - Aquatic Life [1]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oregon - Ecological Screening Level Values [2]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oregon - Human Health [3]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA - Aquatic Life [4]			NS	9-19	6.5-9	6.5-9	NS	NS	NS	9.5	NS	NS	NS	NS	NS
EPA - Human Health [5]			NS	NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	NS	NS
ORNL - Surface Water PRGs [6]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NOTES:

Analyses were performed by Severn Trent Laboratories, Inc. (EA - Site Inspection Samples) and by ACZ (CES - Data Gap Investigation Samples).

Abbreviations: < value = analyte not detected above method detection limit (MDL), µg/L = micrograms per liter, µS/cm = micro siemans per centimeter, B = analyte was detected above the MDL but below the practical quantitation limit (PQL), C = calculated, cfs = cubic feet per second, H = storage and preservation times were not met, mg/L = milligrams per liter, NA = not analyzed, NC = not calculated, NM = not measured, NTU = nephelometric turbidity units , s.u. = standard units, TDS = total dissolved solids, TR = total recoverable metals.

Italic values indicate that the MDL exceeds the lowest standard

Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded

STANDARD NOTES:

1 - State of Oregon proposed Aquatic Life criteria (Toxic Compounds Criteria, May 2004), underline - corrected for hardness, *italics* - expressed as dissolved

2 - State of Oregon Level II Ecological Screening criteria (ODEQ, December 2001), *italics* - expressed as dissolved

3 - State of Oregon proposed Human Health criteria, water+organism (Toxic Compounds Criteria, May 2004), underline - corrected for hardness, *italics* - expressed as dissolved

4 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002), underline - corrected for hardness, *italics* - expressed as dissolved

5 - EPA recommended ambient water quality criteria for protection of human consumption of water and fish (EPA, 2002 NTR), *italics* - expressed as dissolved

6 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)

NS = No Standard

Table 2. **Pore Water Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample I.D.	Sample Date	Sampling Entity	Pool (P) or Riffle (R)	Aluminum, Diss.	Antimony, Diss.	Arsenic, Diss.	Barium, Diss.	Beryllium, Diss.	Cadmium, Diss.	Calcium, Diss.	Chromium, Diss.	Cobalt, Diss.	Copper, Diss.	Iron, Diss.	Lead, Diss.	Magnesium, Diss.	Manganese, Diss.	Mercury, Diss.	Nickel, Diss.	Potassium, Diss.	Selenium, Diss.	Silver, Diss.	Sodium, Diss.	Thallium, Diss.	Vanadium, Diss.	Zinc, Diss.
				Results in µg/L																						
Granite Creek Background																										
GC-PW-01	6/25/2007	CES	P	NA	< 0.4	0.8 B	NA	< 2	< 0.1	5,800	10 B	NA	< 10	< 20	0.3 B	900 B	< 5	< 0.0001	< 10	NA	< 0.1	< 0.05	NA	NA	NA	< 10
GC-PW-02	6/25/2007	CES	P	NA	< 0.4	3.4	NA	< 2	< 0.1	4,200	10 B	NA	< 10	5,560	0.2 B	800 B	259	0.00024	< 10	NA	< 0.1	< 0.05	NA	NA	NA	< 10
GC-PW-03	6/25/2007	CES	P	NA	< 0.4	1.6	NA	< 2	< 0.1	5,900	10 B	NA	< 10	< 20	0.2 B	1,100	< 5	0.00066	< 10	NA	< 0.1	< 0.05	NA	NA	NA	< 10
Granite Creek																										
ST-PWP-03	7/15/2003	EA	P	< 23.6	< 4.7	< 4.8	31.0 B	< 0.20	< *0.60*	5,520	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,010 B	1.1 B	< *0.10*	< 2.1	514 B	< 3.4	< *2.2*	2,840 B	< 5.7	< 2.0	2.4 B
ST-PWP-04	7/15/2003	EA	P	< 23.6	< 4.7	< 4.8	36.2 B	< 0.20	< *0.60*	6,730	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,240 B	2.3 B	< *0.10*	< 2.1	< 393	< 3.4	< *2.2*	3,060 B	< 5.7	< 2.0	1.7 B
ST-PWP-05	7/14/2003	EA	P	< 23.6	< 4.7	< 4.8	36.0 B	< 0.20	< *0.60*	6,910	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,290 B	0.70 B	< *0.10*	< 2.1	415 B	< 3.4	< *2.2*	2,980 B	< 5.7	< 2.0	2.8 B
ST-PWP-06	7/14/2003	EA	P	< 23.6	< 4.7	6.1 B	38.4 B	< 0.20	< *0.60*	13,200	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	2,460 B	1.1 B	< *0.10*	< 2.1	1,060 B	< 3.4	< *2.2*	4,550 B	< 5.7	< 2.0	2.7 B
ST-PWP-07	7/12/2003	EA	P	< 23.6	< 4.7	6.1 B	49.4 B	< 0.20	< *0.60*	8,780	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,800 B	4.0 B	< *0.10*	< 2.1	1,890 B	3.5 B	< *2.2*	3,600 B	< 5.7	< 2.0	4.1 B
ST-PWP-08	7/12/2003	EA	P	< 23.6	< 4.7	< 4.8	44.3 B	< 0.20	< *0.60*	8,320	< 1.4	< 2.0	< 2.4	< 33.3	< 1.3	1,700 B	1.5 B	< *0.10*	< 2.1	1,640 B	< 3.4	< *2.2*	3,540 B	< 5.7	< 2.0	2.5 B
ST-PWP-09	7/11/2003	EA	P	< 63.1	< 5.0	< 6.0	49.6 B	< 0.40	< *1.2*	9,940	< 1.9	< 3.7	< 3.3	< 66.7	2.4 B	2,110 B	4.9 B	< *0.10*	< 4.4	1,650 B	< 1.7	< *2.9*	3,280 B	< 2.8	< 3.6	3.1 B
ST-PWP-10	7/10/2003	EA	P	< 63.1	< 5.0	< 6.0	53.4 B	< 0.40	< *1.2*	11,200	< 1.9	< 3.7	< 3.3	< 66.7	1.9 B	2,280 B	< 1.9	< *0.10*	< 4.4	1,820 B	< 1.7	< *2.9*	3,550 B	< 2.8	< 3.6	4.8 B
ST-PWR-10	7/10/2003	EA	R	< 63.1	< 5.0	< 6.0	60.8 B	< 0.40	< *1.2*	9,890	< 1.9	< 3.7	< 3.3	< 66.7	2.4 B	2,080 B	5.1 B	< *0.10*	< 4.4	2,390 B	< 1.7	< *2.9*	4,070 B	< 2.8	< 3.6	5.5 B
ST-PWP-53	7/19/2003	EA	P	60.5 B	< 4.7	16.7	47.6 B	< 0.20	< *0.60*	15,500	< 1.4	< 2.0	< 2.4	23.3 B	< 1.3	3,580	4.0 B	< *0.10*	< 2.1	2,000 B	< 1.7	< *2.2*	3,420 B	4.1 B	< 2.0	5.9 B
ST-PWP-54	7/18/2003	EA	P	45.7 B	< 4.7	13.2	45.9 B	< 0.20	< *0.60*	16,700	< 1.4	< 2.0	< 2.4	< 16.8	< 1.3	4,440	4.4 B	0.12 B	< 2.1	1,830 B	< 1.7	< *2.2*	3,540 B	< 2.8	< 2.0	5.4 B
Standards, corrected for hardness where applicable (used 98 mg/L as average in surface water samples, since hardness was not measured during the SI in 2005)																										
Oregon - Aquatic Life [1]				87	NS	*150*	NS	NS	*0.27*	NS	NS	NS	*9.2*	1,000	*3.10*	NS	NS	0.012	*51.3*	NS	5	*0.12*	NS	NS	NS	*118*
Oregon - Ecological Screening Level Values [2]				87	1,600	NS	4	5.3	2.2	116,000	NS	23	9	1,000	2.5	82,000	120	0.77	52	53,000	5	0.12	680,000	40	20	120
Oregon - Human Health [3]				NS	5.6	0.018	1,000	NS	NS	NS	NS	NS	1,300	300	NS	NS	50	NS	610	NS	170	NS	NS	0.24	NS	7,400
EPA - Aquatic Life (CCC) [4]				87	NS	*150*	NS	NS	*0.243*	NS	NS	NS	8.8	1,000	*2.46*	NS	NS	0.77	51.1	NS	5	NS	NS	NS	NS	118
EPA - Human Health (Water+Organism) [5]				NS	5.6	0.018	1,000	NS	NS	NS	NS	NS	1,300	300	NS	NS	50	NS	610	NS	170	NS	NS	1.7	NS	7,400
ORNL - Pore Water PRGs [6]				87	30	NS	4	0.66	1.10	NS	NS	23	12	1,000	3.20	NS	120	1.3	160	NS	5	0.36	NS	12	20	118

Sample I.D.	Sample Date	Sampling Entity	Pool (P) or Riffle (R)	Temperature (Field)	pH (Field)*	pH (Lab)*	Conductivity (Field)	Conductivity @ 25C (Lab)	Dissolved Oxygen (Field)*	Oxygen Reduction Potential (Field)	Hardness as $CaCO_3$, TR*	Residue, Filterable (TDS) @180*	Residue, Non-Filterable (TSS) @105° C*	Cyanide, Diss.	$Sulfate^+$
				°C	s.u.		µS/cm		mg/L	mV	mg/L				
Granite Creek Background															
GC-PW-01	6/25/2007	CES	P	5.42	6	7.5 H	50	50	9.14	350	18	30	NM	NA	< 10 U
GC-PW-02	6/25/2007	CES	P	6.11	5.82	7.2 H	53	50	1.77	38.1	14	60	NM	NA	< 10 U
GC-PW-03	6/25/2007	CES	P	6.04	7.35	7.7 H	43	52	10.25	201	19	50	NM	NA	< 10 U
Granite Creek															
ST-PWP-03	7/15/2003	EA	P	11.29	7.94	NM	49	NM	10.7	21.4	NM	NM	NM	< 0.01 U	NA
ST-PWP-04	7/15/2003	EA	P	12.51	8.09	NM	57	NM	9.57	19.2	NM	NM	NM	< 0.01 U	NA
ST-PWP-05	7/14/2003	EA	P	10.83	8.24	NM	59	NM	10.02	9.6	NM	NM	NM	< 0.01 U	NA
ST-PWP-06	7/14/2003	EA	P	10.48	8.24	NM	75	NM	9.64	5.7	NM	NM	NM	< 0.01 U	NA
ST-PWP-07	7/12/2003	EA	P	12.65	8.14	NM	81	NM	10.4	20.8	NM	NM	NM	< 0.01 U	NA
ST-PWP-08	7/12/2003	EA	P	14.56	8.32	NM	70	NM	9.53	22.9	NM	NM	NM	< 0.01 U	NA
ST-PWP-09	7/11/2003	EA	P	10.9	8.16	NM	80	NM	10.4	8.3	NM	NM	NM	< 0.01 U	NA
ST-PWP-10	7/10/2003	EA	P	12.88	7.86	NM	90	NM	8.02	32.2	NM	NM	NM	< 0.01 U	NA
ST-PWR-10	7/10/2003	EA	R	12.9	8.00	NM	87	NM	7.9	50.9	NM	NM	NM	< 0.01 U	NA
ST-PWP-53	7/19/2003	EA	P	15.9	8.20	NM	124	NM	9.35	83.9	NM	NM	NM	< 0.01 U	NA
ST-PWP-54	7/18/2003	EA	P	12.08	8.45	NM	138	NM	10.79	10.2	NM	NM	NM	< 0.01 U	NA
Standards															
Oregon - Aquatic Life [1]				NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	NS
Oregon - Ecological Screening Level Values [2]				NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	NS
Oregon - Human Health [3]				NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.14	NS
EPA - Aquatic Life [4]				9-19	6.5-9	6.5-9	NS	NS	9.5	NS	NS	NS	NS	0.005	NS
EPA - Human Health [5]				NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	0.7	NS
ORNL - Pore-water PRGs [6]				NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	NS

NOTES:

Analyses were performed by Severn Trent Laboratories, Inc. (EA - Site Inspection Samples) and by ACZ (CES - Data Gap Investigation Samples).

Abbreviations: < value U = analyte not detected above method detection limit (MDL), µg/L = micrograms per liter, µS/cm = micro siemans per centimeter,

B = analyte was detected above the MDL but below the practical quantitation limit (PQL), H = holding time exceeded, mg/L = milligrams per liter,

mV = millivolts, NA = not analyzed or sample not obtained, NC = not calculated, NM = not measured, s.u. = standard units, TDS = total dissolved solids.

Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded

Italic values indicate that the MDL exceeds the lowest standard

STANDARD NOTES:

1 - State of Oregon proposed Aquatic Life criteria (Toxic Compounds Criteria, May 2004), underline - corrected for hardness, *italics* - expressed as dissolved

2 - State of Oregon Level II Ecological Screening criteria (ODEQ, December 2001), *italics* - expressed as dissolved

3 - State of Oregon proposed Human Health criteria, water+organism (Toxic Compounds Criteria, May 2004), underline - corrected for hardness, *italics* - expressed as dissolved

4 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002), underline - corrected for hardness, *italics* - expressed as dissolved

5 - EPA recommended ambient water quality criteria for protection of human consumption of water and fish (EPA, 2002 NTR), *italics* - expressed as dissolved

6 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)

NS = No Standard

Table 3. **Sediment Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample ID	Sample Date	Sampling Entity	Pool (P), Riffle (R), Bank (B)	Aluminum, Total	Antimony, Total	Arsenic - Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total
				Results in mg/kg																					
Granite Creek Background																									
GC-SS-01	6/25/2007	CES	P	NA	< 0.2	7.5	NA	0.3 B	0.22 B	NA	9	NA	3 B	9,320	1.89	NA	165	0.07 B	1 B	NA	0.31	0.12	NA	NA	NA	25
GC-SS-02	6/25/2007	CES	P	NA	0.3 B	6.3	NA	0.6 B	0.12 B	NA	9	NA	2 B	13,700	2.04	NA	213	< 0.04	< 1	NA	0.09 B	0.05 B	NA	NA	NA	36
GC-SS-03	6/25/2007	CES	P	NA	0.3 B	36.5	NA	0.8 B	0.17 B	NA	10	NA	3 B	16,600	2.63	NA	298	0.10 BH	< 1	NA	0.15 B	0.13	NA	NA	NA	36
Granite Creek																									
ST-PSD-03	7/15/2003	EA	P	4,360	1.20 B	13.8	76.3	0.32 B	< 0.053	2,050	45.6	6.4	2.5	40,000	4.4	1,520	162	< 0.019	5.5	950	0.88	0.22 B	< 41.6	1.80	154.0	23.0
ST-RSD-03	7/15/2003	EA	R	3,820	< 0.40	17.4	68.2	0.20 B	< 0.062	1,430	12.9	3.7 B	1.3 B	15,400	4.1	1,600	171	< 0.019	2.2 B	1,070	0.43 B	< 0.094	96.8 B	< 0.29	50.2	21.8
ST-PSD-04	7/15/2003	EA	P	6,260	1.50 B	19.5	127.0	0.38 B	< 0.053	1,650	5.2	6.3	3.1	11,600	4.9	3,330	159	< 0.020	4.3	2,020	0.34 B	0.58 B	< 41.9	< 0.25	28.5	43.7
ST-RSD-04	7/15/2003	EA	R	5,940	< 0.41	44.2	92.5	0.23 B	0.074 B	2,070	6.1	4.7 B	2.1 B	12,400	6.3	3,390	203	< 0.021	2.7 B	1,320	0.35 B	0.86 B	120 B	< 0.31	29.5	34.0
ST-PSD-05	7/14/2003	EA	P	6,670	< 0.39	18.7	126	0.27 B	< 0.062	1,820	7.0	5.7	2.4 B	14,500	6.4	3,530	187	< 0.021	3.2 B	2,190	0.50 B	0.64 B	< 48.9	< 0.29	36.6	41.9
ST-RSD-05	7/14/2003	EA	R	6,030	< 0.40	23.0	105	0.24 B	< 0.063	1,950	9.7	4.6 B	2.9	15,200	3.8	2,600	169	< 0.023	3.1 B	1,630	0.41 B	< 0.094	76.0 B	< 0.29	45.9	38.7
ST-PSD-06	7/14/2003	EA	P	9,210	< 0.41	18.6	170	0.36 B	< 0.065	2,130	8.1	8.2	3.0	18,800	4.9	5,550	343	0.027 B	4.4	3,000	0.57	0.54 B	< 50.9	0.50 B	45.3	63.3
ST-RSD-06	7/14/2003	EA	R	4,640	0.92 B	9.3	92.1	0.32 B	< 0.059	1,900	24.9	6.0	2.4 B	29,900	4.4	2,220	156	0.037 B	4.3	1,420	0.63	0.24 B	< 46.8	1.1	113.0	35.6
ST-PSD-07	7/12/2003	EA	P	6,980	< 0.36	21.9	127	0.30 B	< 0.057	2,040	11.5	5.7	10.6	19,100	5.3	3,080	202	0.087	3.6 B	2,100	0.40 B	0.83 B	< 44.8	0.30 B	57.5	62.6
ST-RSD-07	7/12/2003	EA	R	9,650	< 0.42	19.3	174	0.39 B	< 0.066	2,330	10.1	8.0	3.5	22,000	4.3	5,160	277	0.050	4.4	3,500	0.37 B	1.9	< 52.2	0.59 B	58.5	57.7
ST-PSD-08	7/12/2003	EA	P	11,700	< 0.55	25.9	217	0.47 B	< 0.086	2,990	10.7	9.6	7.8	24,600	6.7	6,100	342	0.12	5.7 B	3,870	0.73	0.63 B	< 68.0	0.44 B	61.9	94.2
ST-RSD-08	7/12/2003	EA	R	8,350	< 0.40	14.8	158	0.39 B	< 0.063	2,310	15.3	8.2	7.7	25,300	5.7	5,210	283	0.058	4.8	3,330	0.34 B	0.73 B	< 49.8	0.69 B	76.2	58.1
ST-PSD-09	7/11/2003	EA	P	3,990	< 0.42	9.6	52.3	0.11 B	0.069 B	1,240	2.3	1.9 B	1.5 B	5,650	2.2	1,370	100	< 0.019	1.1 B	762	0.29 B	< 0.10	230 B	< 0.31	13.0	20.7
ST-RSD-09	7/11/2003	EA	R	6,190	0.56 B	57.9	101	0.27 B	0.62	1,820	10.0	5.2	7.7	16,900	52.4	3,130	177	0.031 B	3.2 B	1,920	0.40 B	1.0	< 44.1	0.51 B	51.2	75.1
ST-PSD-10	7/10/2003	EA	P	6,680	0.74 B	22.5	109	0.29 B	0.12 B	1,710	9.0	5.1 B	12.2	16,100	8.0	2,840	177	0.070	3.2 B	2,000	0.63	0.49 B	79.7 B	< 0.33	46.0	50.2
ST-RSD-10	7/10/2003	EA	R	6,850	1.0 B	29.0	116	0.36 B	< 0.068	2,300	24.3	7.9	8.9	33,700	9.5	3,490	193	0.034 B	5.2	2,410	0.58	0.92 B	< 53.2	1.4	117	64.9
GC-ABS-01	6/26/2007	CES	B	NA	1.2	27.9	NA	0.20 B	0.44	NA	25	NA	4 B	36,000	12.50	NA	243	0.23	3 B	NA	0.28 B	1.15	NA	NA	NA	77
GC-ABS-02	6/26/2007	CES	B	NA	1.2	127	NA	< 0.20	0.90	NA	12	NA	7	26,600	45.30	NA	376	0.12 B	4 B	NA	0.28 B	3.27	NA	NA	NA	99
GC-ABS-03	6/26/2007	CES	B	NA	0.7 B	25	NA	< 0.20	0.85	NA	42	NA	3 B	54,600	15.10	NA	320	0.09 B	3 B	NA	0.38	0.68	NA	NA	NA	84
GC-ABS-04	6/27/2007	CES	B	NA	1.7	67	NA	0.30 B	1.5	NA	18	NA	10	29,400	45.80	NA	414	< 0.05	5	NA	0.64	2.40	NA	NA	NA	120
ST-PSD-53	7/19/2003	EA	P	10,200	2.0 B	130	139	0.24 B	0.96	2,180	10.4	6.9	18.1	21,600	38.2	4,790	364	0.11	6.2	2,840	0.44 B	1.8	< 45.2	0.69 B	52.1	150
ST-RSD-53	7/19/2003	EA	R	9,670	2.3 B	126	127	0.25 B	1.2	2,230	9.9	6.2	18.6	19,000	44.3	4,030	360	0.12	6.5	2,550	0.42 B	4.9	45.9	0.73 B	45.9	148
ST-PSD-54	7/17/2003	EA	P	8,910	5.1 B	303	144	0.26 B	2.8	2,740	10.9	6.5	28.0	18,900	148	3,460	611	0.32	7.6	2,400	0.80	7.9	70.2 B	< 0.67	43.0	186
ST-RSD-54	7/17/2003	EA	R	7,770	5.1 B	246	126	0.21 B	1.8	1,750	8.3	6.4	30.0	18,300	121	3,380	560	0.12	7.3	2,340	0.63	6.3	79.5 B	0.76 B	38.3	151
Standards																									
OR - Freshwater [1]				NS	3	NS	NS	NS	0.6	NS	37	NS	36	NS	35	NS	1,100	0.2	18	NS	NS	4.5	NS	NS	NS	123
EPA - Freshwater TEL [2]				NS	NS	5.9	NS	NS	0.596	NS	NS	NS	35.7	NS	35	NS	NS	0.174	18	NS	NS	NS	NS	NS	NS	123.1
EPA - Freshwater PEL [3]				NS	NS	17	NS	NS	3.53	NS	NS	NS	197	NS	91.3	NS	NS	0.486	35.9	NS	NS	NS	NS	NS	NS	315
ORNL - Freshwater [4]				NS	NS	42	NS	NS	4.2	NS	159	NS	77.7	NS	110	NS	NS	0.7	38.5	NS	NS	1.8	NS	NS	NS	270

Sample ID	Sample Date	Sampling Entity	Pool (P), Riffle (R), Bank (B)	Total Organic Carbon	Size Fraction by Hydrometer				Total Cyanide
					Clay	Gravel	Sand	Silt	
				mg/kg	%				
Granite Creek Background									
GC-SS-01	6/25/2007	CES	P	3,000	3.8	NA	90.0	6.3	NA
GC-SS-02	6/25/2007	CES	P	900	<0.1	NA	96.3	3.7	NA
GC-SS-03	6/25/2007	CES	P	1,000	1.3	NA	96.3	2.5	NA
Granite Creek									
ST-PSD-03	7/15/2003	EA	P	2,100	1.1	20.3	77.7	0.8	< 0.55
ST-PSD-04	7/15/2003	EA	P	2,550	0.6	0.0	97.3	2.0	< 0.60
ST-RSD-03	7/15/2003	EA	R	133	1.0	16.2	81.4	1.3	< 0.60
ST-RSD-04	7/15/2003	EA	R	< 130	0.5	10.5	86.7	2.3	< 0.66
ST-PSD-05	7/14/2003	EA	P	< 132	0.6	6.8	91.7	0.9	< 0.63
ST-RSD-05	7/14/2003	EA	R	2,490	1.2	5.4	91.6	1.9	< 0.70
ST-PSD-06	7/14/2003	EA	P	< 137	0.5	0.0	96.7	2.7	< 0.63
ST-RSD-06	7/14/2003	EA	R	< 114	0.7	33.2	64.7	1.5	< 0.54
ST-PSD-07	7/12/2003	EA	P	10,500	2.1	3.5	91.0	3.3	< 0.47
ST-RSD-07	7/12/2003	EA	R	496	2.6	12.3	82.9	2.3	< 0.54
ST-PSD-08	7/12/2003	EA	P	3,180	4.1	0.8	90.3	4.8	< 0.78
ST-RSD-08	7/12/2003	EA	R	3,240	0.3	19.2	73.6	6.9	< 0.57
ST-PSD-09	7/11/2003	EA	P	381	0.9	6.7	87.9	4.5	< 0.63
ST-RSD-09	7/11/2003	EA	R	4,200	0.6	8.2	90.0	1.1	< 0.59
ST-PSD-10	7/10/2003	EA	P	941	0.6	6.1	92.4	0.9	< 0.65
ST-RSD-10	7/10/2003	EA	R	1,000	0.5	5.5	91.8	2.2	< 0.65
ST-PSD-53	7/19/2003	EA	P	2,670	3.5	8.8	82.6	5.1	< 0.57
ST-RSD-53	7/19/2003	EA	R	6,750	2.2	14.7	79.1	3.8	< 0.60
ST-PSD-54	7/17/2003	EA	P	27,700	4.6	1.1	90.1	4.3	< 0.59
ST-RSD-54	7/17/2003	EA	R	< 121	2.4	7.4	88.2	2.0	< 0.57

NOTES:

Analyses were performed by Severn Trent Laboratories, Inc. (EA - Site Inspection Samples) and by ACZ (CES - Data Gap Investigation Samples).

Abbreviations: < value = analyte not detected above Method Detection Limit (MDL, shown), % = percent,

B = analyte detected between MDL and practical quantification limit (PQL), H = storage and preservation times were not met, mg/kg = milligrams per kilogram, NA = not analyzed.

Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded

STANDARD NOTES:

1 - State of Oregon, Level II Screening Level Values for Freshwater Sediment (ODEQ, 2001)

2 - EPA Threshold Effects Level (NOAA, 1999)

3 - EPA Probable Effects Level (NOAA, 1999)

4 - ORNL ecological screening level values for freshwater, lowest chronic value used (ORNL, 1997)

NS = No Standard

Table 4. **Background Soil Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample ID	Sample Date	Sampling Entity	Sample Depth (feet)	Paste pH	Aluminum, Total	Antimony, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total
				s.u.	Results in mg/kg																						
Background Soil Samples - Upper Granite Creek and Lucas Gulch																											
BGS-01	6/26/2007	CES	0.5 - 1.0	6.5	NA	< 0.2	6.2	NA	0.6 B	1.1	NA	12	NA	8	22,900	8.04	NA	716	0.06 B	7	NA	0.37	0.29	NA	NA	NA	71
BGS-02	6/26/2007	CES	0.5 - 1.0	6.5	NA	< 0.2	7.8	NA	0.6 B	1.45	NA	7	NA	10	13,600	5.98	NA	668	< 0.04	6	NA	0.28 B	0.51	NA	NA	NA	61
BGS-03	6/26/2007	CES	0.5 - 1.0	5.1	NA	0.2 B	5.4	NA	0.4 B	0.39	NA	11.0	NA	8	20,300	4.58	NA	644	< 0.05 B	8	NA	0.15 B	0.20	NA	NA	NA	71
BGS-04	6/26/2007	CES	0.5 - 1.0	5.8	NA	< 0.2	9.0	NA	0.8 B	2.03	NA	15	NA	24	16,800	7.62	NA	848	0.06 B	23	NA	0.36	0.63	NA	NA	NA	126
BGS-05	6/26/2007	CES	0.5 - 1.0	6.0	NA	0.3 B	11.8	NA	0.9 B	1.85	NA	7	NA	31	13,400	7.92	NA	319	0.06 B	10	NA	0.77	0.58	NA	NA	NA	44
BGS-06	6/27/2007	CES	0.5 - 1.0	6.3	NA	0.2 B	15.3	NA	0.4 B	0.51	NA	15	NA	5	29,800	4.86	NA	644	< 0.04	7	NA	0.24 B	0.32	NA	NA	NA	88
BGS-07	6/27/2007	CES	0.5 - 1.0	5.8	NA	< 0.2	5.0	NA	0.6 B	1.01	NA	12	NA	30	13,600	5.93	NA	606	0.07 B	13	NA	0.39	0.23	NA	NA	NA	60
BGS-08	6/27/2007	CES	0.5 - 1.0	6.2	NA	0.3 B	43.5	NA	0.4 B	1.11	NA	70	NA	67	35,300	7.30	NA	1,060	0.08 B	70	NA	0.38	0.53	NA	NA	NA	145
BG-SSS-19	7/19/2003	EA	0.5	5.9	24,400	0.84 B	4.5	288	1.2	0.43 B	1,830	31.3	11.3	30.7	24,600	8.4	2,630	837	0.14	23.4	1,570	0.76	0.26 B	806	0.97	47.8	105
BG-SSS-34	7/15/2003	EA	0.5	6.4	26,400	< 0.38 U	3.4	187	0.72	0.35 B	1,130	5.7	5.5	8.9	10,800	3.8	880	429	0.032 B	5.2	848	0.61	0.28 B	1,220	< 0.28 U	24.9	50.2
BG-SSS-35	7/15/2003	EA	0.5	6.7	31,200	< 0.40 U	5.5	268	1.0	0.54	2,110	6.2	6.7	15.4	12,400	5.9	1,560	156	0.035 B	5.6	1,140	0.42 B	0.62 B	1,450	< 0.29 U	26.5	43.2
BG-SSS-36	7/15/2003	EA	0.5	6.6	19,400	< 0.33 U	11.4	319	0.55	< 0.026 U	2,080	27.4	10.2	11.0	17,700	6.3	4,930	610	0.027 B	23.4	3,920	0.24 B	0.48 B	1,180	< 0.24 U	47.2	61.3
Mean				**6.2**	**25,350**	**0.3**	**10.7**	**266**	**0.7**	**0.9**	**1,788**	**18.3**	**8.4**	**20.8**	**19,267**	**6.4**	**2,500**	**628.1**	**0.1**	**16.8**	**1,870**	**0.4**	**0.4**	**1,164**	**0.4**	**36.6**	**77.1**
90% UCL(Mean)				**6.4**	**28,831**	**0.4**	**15.7**	**306**	**0.8**	**1.2**	**2,112**	**26.6**	**10.4**	**28.7**	**22,726**	**7.1**	**3,763**	**738.4**	**0.1**	**25.1**	**2,866**	**0.5**	**0.5**	**1,354**	**0.7**	**45.6**	**92.0**
Standards																											
OR - Ecological Receptors (p=plant, i=invertebrate, b =birds, m = mammals)[1]					50 p	5 p	NS	85 b	10 p	4 p	NS	NS	20 p	50 i	NS	16 b	NS	100 i	0.1 i	30 p	NS	1 p	2 p	NS	1 p	2 p	50 p
EPA Regional Screening Levels - Industrial[2]					990,000	410	1.6	190,000	2,000	800	NS	NS	300	41,000	720,000	800	NS	3,100	310	20,000	NS	5,100	5,100	NS	NS	5,200	310,000
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate, p=plant)[3]					NS	21 m	37 p	NS	NS	29 p	NS	5 p	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i
ORNL - Ecological Receptors[4]					NS	5	9.9	283	10	4	NS	0.4	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5

NOTES:

Analyses were performed by Severn Trent Laboratories, Inc. (EA - Site Inspection Samples) and by ACZ (CES - Data Gap Investigation Samples).
BGS-7 is MM-BGS-04 on the laboratory reports
BGS-8 is MM-BGS-08 on the laboratory reports
BGS-1 - BGS-6 corresponds to BG-1 - BG-6 in the laboratory reports
Abbreviations: < value = analyte not detected above Method Detection Limit (MDL, shown), B = analyte detected between MDL and practical quantification limit (PQL), mg/kg = milligrams per kilogram, NA = not analyzed, NC = not calculated, s.u. = standeard units.
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded

STANDARD NOTES:

1 - State of Oregon, Level II Ecological Screening Level Values for Soil (ODEQ, 2001); dominantly based on soluble salts
2 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2008).
3 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000)
4 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 1997
NS = Not standard

Table 5. **Soil and Waste Material Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample ID	Sample Date	Sampling Entity	Sample Depth (feet)	Solids (Lab)	Paste pH	Aluminum, Total	Antimony, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total	Sulfur Forms: Total Sulfur	Sulfur Forms: Pyritic Sulfur	Sulfur Forms: Sulfate Sulfur	ABAs: Acid Generation Potential	ABAs: Acid Neutralization Potential	ABAs: Acid-Base Potential
				%	s.u.	Results in mg/kg																						%			t $CaCO_3$/Kt		
Upper Granite Creek (Waste rock pile near GC-03)																																	
GC3-WR-01	6/24/2007	CES	0.5	94.0	7.4	NA	7.2	337	NA	0.3 B	7.97	NA	7	NA	57	29,900	152	NA	1,070	0.29 H	4 B	NA	0.27 B	19.10	NA	NA	NA	377	NA	NA	NA	NA	NA	NA
Monumental Mine																																	
ML-SSS-12	7/9/2003	EA	0.7	72.0	6.4	13,300	4.0 B	73.0	322	0.32 B	0.65	3,050	8.4	10.4	14.2	32,000	27.5	5,730	730	56.0	7.3	4,270	1.1	1.8	1,080	2.5	66.2	211	< 0.02	< 0.02	< 0.01	< 0.6	3.7	3.7
ML-SSS-16	7/10/2003	EA	0.5	83.1	4.6	6,180	368	7,500	129	0.25 B	8.1	1,610	7.7	1.6 B	80.0	16,300	1,350	678	100	3.1	2.5 B	2,550	1.6	156	370 B	1.1 B	15.6	432	0.35	0.07	0.28	2.2	-4.5	-6.7
ML-SSS-38	7/9/2003	EA	0.5	58.7	3.5	1,110	78.3	4,470	51.7	0.033 B	0.22 B	308 B	2.3	0.60 B	26.6	16,500	856	212 B	30.9	0.37	2.2 B	836	0.86	48	193 B	< 0.46	5.1 B	65.0	0.4	0.16	0.24	5.0	-6.0	-11.0
WP-SSS-13	7/9/2003	EA	1.0	92.6	4.0	4,220	11.6	860	189	0.087 B	< 0.064	523 B	3.6	3.6 B	12.5	21,500	31.3	2,270	115	0.50	2.6 B	2,950	0.83	21.2	557	0.57 B	26.1	55.0	0.13	0.06	0.07	1.9	-0.5	-2.4
WP-SSS-14	7/10/2003	EA	0.7	85.1	8.4	3,190	2.5 B	616	69.8	0.26 B	8.5	5,980	2.3	5.0 B	7.4	13,600	15.0	2,450	691	0.51	4.7	1,650	0.70	1.5	< 23.6	1.2	15.0	857	NA	NA	NA	NA	NA	NA
WP-SSS-15	7/9/2003	EA	0.5	80.1	7.8	3,740	5.0 B	573	149	0.25 B	1.4	5,570	3.5	6.4	14.6	18,900	12.4	3,690	757	0.14	4.8	2,010	0.90	7.1	385 B	1.5	24.7	107	NA	NA	NA	NA	NA	NA
WP-SSS-17	7/9/2003	EA	1.0	69.0	6.8	10,600	241	11,400	73.2	0.30 B	23.4	3,610	2.1	2.7 B	698	16,300	2,120	3,200	321	784	3.2 B	3,480	0.75	319	3,240	1.60	14.9	2,410	0.14	0.12	0.02	3.8	3.5	-0.3
WP-SUS-14	7/10/2003	EA	3.5	90.8	8.6	4,680	5.8 B	355	166	0.23 B	0.52	10,100	3.3	6.4	8.0	18,800	36.9	4,100	511	0.61	4.6	2,920	0.61	11.6	516	1.7	25.4	107	0.46	0.46	< 0.01	14.4	31.7	17.3
WP-SUS-15	7/9/2003	EA	4.0	91.6	8.5	4,800	5.3 B	544	176	0.25 B	1.1	7,180	4.4	6.6	18.2	20,900	25.0	4,940	776	0.33	6.0	2,730	0.99	6.4	478	1.8	30.3	130	0.56	0.56	< 0.01	17.5	18.2	0.7
MMDGA-WR-2-4	9/28/2009	CES	4.0	95.3	7.7			164							15.2		11.3		1,200	0.88				0.8				116	0.6			19	117	98.0
MMDGA-WR-3-4	9/28/2009	CES	4.0	94.5	6.3			2,240							70.6		479.0		865	1.09				48.1				844						
MMDGA-WR-5-1	9/28/2009	CES	1.0	94.3	5.6			2,920							51.1		231.0		313	0.40				39.8				248						
MMDGA-WR-18-3.5	9/29/2009	CES	3.5	89.0	5.8			2,700							45.0		589.0		51	0.42				48.8				152						
MMDGA-WR-19-3	9/29/2009	CES	3.0	88.5	3.8			223							9.4		16.1		277	0.17 B				1.1				63						
MMDGA-WR-20-3	9/29/2009	CES	3.0	87.5	6.5			4,610							220		3,210.0		185	1.28				343.0				1,140						
MMDGA-WR-21-1	9/29/2009	CES	1.0	92.3	7.8			258							13.9		12.0		784	0.36				2.6				132						
MMDGA-WR-24-0.5	9/29/2009	CES	0.5	95.2	3.1			8,150							48.0		712.0		342	2.99				21.9				78	0.63			20	0	-20.0
MMDGA-WR-25-0.5	9/29/2009	CES	0.5	79.1	3.2			9,360							60.5		453.0		207	0.53				9.5				69						
MMDGA-WR-26-0.5	9/29/2009	CES	0.5	96.6	7.1			5,690							135		578.0		713	0.84				40.0				2,030						
MMDGA-WR-28-0.5	9/29/2009	CES	0.5	91.2	4.6			740							8.1		10.4		197	0.15 B				2.6				52						
MMDGA-T-9-1	9/29/2009	CES	1.0	92.4	5.9			2,440							75.3		549		246	12				80.1				294						
MMDGA-T-13-1	9/29/2009	CES	1.0	95.2	6.8			10,200							58.4		1200		381	8				35				674	0.07 B			2 B	15	13.0
MMDGA-T-34-0.25	9/30/2009	CES	0.3	98.6	6.1			1,900							119		478		398	190				85				816						
MMDGA-T-34-2	9/30/2009	CES	2.0	67.4	5.9			9,610							440		2340		400	770				229				3,490	0.11			3 B	6	3.0
MMDGA-T-35-1	9/30/2009	CES	1.0	92.6	6.2			4,770							247		1240		281	270				144				1,760						
MMDGA-T-37-0.25	9/30/2009	CES	0.3	96.7	6.1			1,360							128		334		781	101				51.1				764						
MMDGA-T-40-2	9/30/2009	CES	2.0	60.1	6.7			6,310							460		1140		565	254				214				3,030	0.03 B			0	10	10.0
MMDGA-T-41-2	9/30/2009	CES	2.0	60.3	6.2			8,750							700		1680		575	222				303				4,900	0.09 B			3 B	9	6.0
MMDGA-T-46-3.5	9/30/2009	CES	3.5	57.3	6.6			3,340							152		627		208	95				54.9				1,500						
Cap Martin Mine																																	
CM-WR1-1-0.5'	6/21/2007	CES	0.5	98.7	5.5	NA	0.30 B	19.6	NA	< 0.20	0.17 B	NA	11	NA	4 B	20,500	5.71	NA	312	0.06 B	3 B	NA	0.30	0.14	NA	NA	NA	39	NA	NA	NA	NA	NA	NA
CM-WR2-1-0.5'	6/21/2007	CES	0.5	96.5	5.6	NA	< 0.20	9.7	NA	< 0.20	0.33	NA	9	NA	3 B	15,500	4.26	NA	234	< 0.04	3 B	NA	0.23 B	0.08 B	NA	NA	NA	34	NA	NA	NA	NA	NA	NA
CM-WR2-2-0.5'	6/21/2007	CES	0.5	96.3	5.9	NA	< 0.20	26.5	NA	< 0.20	0.20 B	NA	11	NA	4 B	12,400	4.68	NA	198	0.07 B	4 B	NA	0.23 B	0.19	NA	NA	NA	25	NA	NA	NA	NA	NA	NA
CM-WR3-1-0.5'	6/21/2007	CES	0.5	93.4	6.0	NA	0.90 B	131	NA	0.70 B	0.27 B	NA	3 B	NA	3	16,800	12.9	NA	69.4	0.09 B	2 B	NA	0.58	0.92	NA	NA	NA	50	< 0.01	< 0.01	< 0.01	< 0.6	2	2.0
CM-WR4-1-0.5'	6/21/2007	CES	0.5	93.7	6.6	NA	< 1.00	257	NA	0.30 B	8.48	NA	6.0	NA	12	28,800	105	NA	657	0.06 B	5 B	NA	0.46	1.42	NA	NA	NA	330	0.02 B	< 0.01	< 0.01	< 0.6	7	7.0
TA-SUS-22	7/15/2003	EA	1.5	86.5	7.1	12,500	0.68 B	6.3	155	0.38 B	< 0.030	1,940	5.2	8.0	3.3	16,300	2.8	5,180	408	0.058	3.8 B	3,720	0.24 B	0.28 B	982	< 0.28	40.6	41.8	NA	NA	NA	NA	NA	NA
WP-SUS-20	7/15/2003	EA	4.0	91.2	7.4	15,600	0.38 B	10.1	180	0.48	< 0.027	2,850	8.4	9.1	5.5	19,700	3.6	5,320	270	0.026 B	4.3	4,080	< 0.31	0.63 B	1,100	< 0.25	52.2	48.6	< 0.02	< 0.02	< 0.01	< 0.6	3.3	3.3
WP-SUS-21	7/15/2003	EA	2.5	92.8	8.0	10,400	2.0 B	198	177	0.50	14.1	6,320	5.5	7.4	43.5	20,700	44.1	2,980	504	0.30	4.1	3,240	0.40 B	4.2	122 B	0.45 B	33.9	495	0.25	0.25	< 0.01	7.8	11	3.2
WP-SUS-39	7/15/2003	EA	2.0	91.4	4.9	14,900	0.61 B	17.5	167	0.44	< 0.025	905	9.7	9.6	11.0	19,600	4.2	4,560	321	0.064	4.8	3,560	0.40 B	0.79 B	1,060	< 0.23	52.2	50.5	< 0.02	< 0.02	< 0.01	< 0.6	-1.3	-1.3
Granite Creek Mine #7																																	
GC7-WR-01	6/24/2007	CES	0.5	92.6	7.4	NA	19	185	NA	0.4 B	1.84	NA	6	NA	120	22,600	81.70	NA	661	0.24 H	5 B	NA	0.35	20.40	NA	NA	NA	134	0.19	0.12	0.01 B	6	26	20
GC7-WR-02	6/24/2007	CES	0.5	92.0	7.6	NA	2.5	142	NA	0.6 B	0.50	NA	7	NA	17	28,500	19.00	NA	593	0.24	5	NA	0.40	1.79	NA	NA	NA	84	NA	NA	NA	NA	NA	NA
GC7-WR-03	6/24/2007	CES	0.5	92.8	7.6	NA	7.6	220	NA	0.6 B	0.76	NA	3	NA	66	25,100	17.10	NA	608	0.42	0	NA	0.45	4.08	NA	NA	NA	83	NA	NA	NA	NA	NA	NA
GC7-WR-04	6/24/2007	CES	0.5	91.3	6.3	NA	0.4 B	22.9	NA	0.3 B	0.27 B	NA	9	NA	9	22,500	4.94	NA	443	< 0.04 H	4 B	NA	0.26	0.34	NA	NA	NA	61	< 0.01	< 0.01	< 0.01	< 0.6	12	12
Granite Creek Mine #6																																	
GC6-WR-01	6/24/2007	CES	0.5	95.0	7.1	NA	< 0.2	9.3	NA	< 0.2	0.21	NA	9	NA	14	20,700	1.49	NA	497	1.21 H	4 B	NA	0.25 B	0.08 B	NA	NA	NA	59	NA	NA	NA	NA	NA	NA
GC6-WR-02	6/24/2007	CES	0.5	95.1	5.2	NA	< 0.2	6.6	NA	0.3 B	0.24	NA	10	NA	6	21,400	3.37	NA	367	0.09 BH	4 B	NA	0.26 B	0.09 B	NA	NA	NA	62	NA	NA	NA	NA	NA	NA
GC6-WR-03	6/24/2007	CES	0.5	70.8	6.1	NA	< 0.2	1.7	NA	< 0.2	0.29 B	NA	< 1	NA	4 B	2,650	0.85	NA	25	< 0.05 H	< 1	NA	0.17 B	0.08 B	NA	NA	NA	4 B	NA	NA	NA	NA	NA	NA
Sheridan Mine																																	
SM-WR2-1-0.5'	6/21/2007	CES	0.5	98.7	5.5	NA	< 0.20	16.8	NA	< 0.20	0.230 B	NA	9	NA	7	20,700	11.1	NA	278	0.150 B	5 B	NA	0.25 B	0.16	NA	NA	NA	67	NA	NA	NA	NA	NA	NA
TA-SUS-25	7/14/2003	EA	1.5	9.3	6.8	17,500	0.94 B	26.0	269	0.55	< 0.027	1,930	8.6	10.5	10.2	20,600	10.4	6,310	444	0.048	5.3	4,900	0.24 B	1.4	1,330	< 0.26	58.5	66.9	NA	NA	NA	NA	NA	NA
WP-SUS-23	7/14/2003	EA	3.5	93.0	7.0	11,900	6.0	81.8	188	0.48	0.63	2,920	6.7	8.6	30.5	20,100	15.6	5,200	782	0.36	5.2	3,320	0.48	32.5	676	0.76 B	50.8	87.8	< 0.02	< 0.02	< 0.01	< 0.6	4.8	4.8
Tillicum Mine																																	
TILL-WR-01	6/26/2007	CES		95.4	7.7	NA	5.5	371	NA	0.7 B	15.60	NA	2 B	NA	27	24,600	184	NA	1,020	0.46 H	4 B	NA	0.84	3.34	NA	NA	NA	525	2.26	1.80	0.13	71	86	0.0
TA-SSS-30	7/12/2003	EA	0.4	78.6	6.9	11,600	1.6 B	58.6	201	0.20 B	6.2	3,480	8.8	8.8	10.4	22,900	40.9	6,290	579	0.12	5.7	3,490	0.45 B	0.29 B	927	0.98 B	51.6	297	NA	NA	NA	NA	NA	NA
WP-SSS-27	7/12/2003	EA	0.8	94.3	6.6	9,660	2.4 B	88.0	177	0.20 B	3.4	2,600	5.9	8.2	27.5	20,000	375	4,330	556	0.38	4.3	2,610	0.84	1.8	590	1.8	36.5	322	NA	NA	NA	NA	NA	NA
WP-SSS-28	7/12/2003	EA	0.8	95.8	8.6	3,550	1.3 B	183	32.8	0.43 B	2.8	26,500	1.4	4.7	14.4	19,300	52.2	1,740	890	0.21	4.0	1,410	0.78	1.2	38.5 B	2.0	11.7	183	0.74	0.74	< 0.01	23.1	86.4	63.3
WP-SUS-26	7/12/2003	EA	3.0	88.9	6.6	8,350	1.7 B	156	138	0.29 B	7.5	3,120	4.3	6.7	32.3	23,800	120	3,220	660	0.10	3.9 B	1,980	1.1	2.2	271 B	2.3	34.5	356	0.18	0.17	0.01	5.3	8.7	3.4
WP-SUS-27	7/12/2003	EA	4.5	89.6	7.4	11,700	1.8 B	35.7	206	0.21 B	1.9	1,830	6.8	8.2	15.2	21,300	27.8	5,880	603	0.029 B	5.2	3,820	0.95	< 0.24	947	1.6	51.8	157	< 0.02	< 0.02	< 0.01	< 0.6	2.2	2.2
Granite Creek Mine #5																																	
GC5-WR-01	6/26/2007	CES	0.5	96.0	6.5	NA	1.4	155	NA	0.3 B	3.35	NA	13	NA	34	27,300	35.80	NA	821	0.08 BH	8	NA	0.40	1.20	NA	NA	NA	221	NA	NA	NA	NA	NA	NA
GC5-WR-02	6/26/2007	CES	0.5	96.5	6.9	NA	2.4	170	NA	0.4 B	4.77	NA	18	NA	61	30,600	88.50	NA	929	0.07 BH	8	NA	0.55	5.05	NA	NA	NA	250	NA	NA	NA	NA	NA	NA
Golden Fraction																																	
GF-WR-01	6/25/2007	CES	1.0	96.2	6.6	NA	0.6 B	28.7	NA	0.3 B	1.00	NA	20	NA	12	26,300	14.80	NA	692	< 0.04 H	6	NA	0.23 B	0.58	NA	NA	NA	191	NA	NA	NA	NA	NA	NA
GF-WR-2	6/25/2007	CES	0.5	92.8	3.4	NA	30 B	1,340	NA	< 0.2	1.36	NA	6	NA	114	97,300	2,430	NA	97.5	2.61	1	NA	3.26	52	NA	NA	NA	305	0.32	0.03 B	0.19	10	0	-10
GF-WR-3	6/25/2007	CES	0.5	92.2	6.2	NA	1.5	89.0	NA	0.3 B	0.85	NA	18	NA	15	35,600	4.89	NA	544	< 0.04 H	8	NA	0.34	0.64	NA	NA	NA	94	NA	NA	NA	NA	NA	NA
GF-WR2-1-0.5'	6/21/2007	CES	0.5	91.1	6.2	NA	3.10	141	NA	0.3 B	4.07	NA	12	NA	22	30,500	143	NA	718	0.19 B	7	NA	0.39	7.95	NA	NA	NA	201	NA	NA	NA	NA	NA	NA
Central Mine																																	
TA-SUS-33	7/10/2003	EA	1.5	92.3	7	11,100	1.3 B	27.4	124	0.20 B	0.36 B	1,380	9.8	7.2	12.6	16,900	9.9	4,650	378	0.12	6.9	2,750	0.52	< 0.21	805	0.34 B	44.2	63.2	NA	NA	NA	NA	NA	NA
WP-SSS-31	7/10/2003	EA	0.5	97.1	6.5	11,100	5.9 B	295	223	0.28 B	3.4	2,110	10.4	8.5	56.2	31,400	358	4,860	1,260	0.27	9.6	2,840	1.6	2.7	787	3.3	96.1	203	NA	NA	NA	NA	NA	NA
WP-SUS-31	7/10/2003	EA	4.5	93.5	7.2	10,900	2.3 B	150	179	0.29 B	2.2	2,270	8.4	8.1	30.6	26,500	53.0	3,450	833	0.19	8.0	1,770	1.0	1.9	425 B	2.5	59.4	137	< 0.02	< 0.02	< 0.01	< 0.6	2.5	2.5
WP-SUS-32	7/10/2003	EA	4.0	71.5	6.7	17,600	1.8 B	106	225	0.30 B	1.1	1,900	13.3	9.9	16.3	28,200	22.9	6,300	697	0.12	9.7	4,030	1.0	0.28 B	1,040	1.3	73.7	96.2	< 0.02	< 0.02	< 0.01	< 0.6	2.2	2.2
Standards																																	
OR - Ecological Receptors (p=plant, i=invertebrate, b =birds,m = mammals) [1]						50 p	5 p	NS	85 b	10 p	4 p	NS	NS	NS	20 p	50 i	NS	16 b	NS	100 i	0.1 i	30 p	NS	1 p	2 p	NS	1 p	2 p	50 p	NS	NS	NS	NS	NS	NS
EPA Regional Screening Levels - Industrial[2]						990,000	410	1.6	190,000	2,000	800	NS	NS	300	41,000	720,000	800	NS	3,100	310	20,000	NS	5,100	5,100	NS	NS	5,200	310,000	NS	NS	NS	NS	NS	NS
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate, p=plant)[3]						NS	21 m	37 p	NS	NS	29 p	NS	5 p	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i	NS	NS	NS	NS	NS	NS
ORNL - Ecological Receptors[4]						NS	5	9.9	283	10	4	NS	0.4	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5	NS	NS	NS	NS	NS	NS

NOTES:
Analyses were performed by Severn Trent Laboratories, Inc. (EA - Site Inspection Samples) and by ACZ (CES - Data Gap Investigation Samples).
Abbreviations: % = percent, < value = analyte not detected above Method Detection Limit (MDL, shown), ABA = Acid Base Accounting,
B = analyte detected between MDL and practical quantification limit (PQL), mg/kg = milligrams per kilogram, NA = not analyzed, R = rejected value due to matrix interference and sample concentrations below MDL, s.u. = standard units, t CaCO3/Kt = tons of calcium carbonate needed to neutralize a kiloton of waste.
Italic values indicate that the MDL exceeds the lowest standard
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded

STANDARD NOTES:
1 - State of Oregon, Level II Ecological Screening Level Values for Soil (ODEQ, 2001); dominantly based on soluble salts
2 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2008).
3 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000)
4 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 1997
NS = Not standard

Table 6. **Synthetic Precipitation Leaching Procedure and Toxicity Characteristic Leaching Procedure Results for Soil and Waste Material Samples**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample ID	Sample Date	Sampling Entity	Sample Depth (feet)	SPLP Arsenic	TCLP Arsenic	SPLP Barium	TCLP Barium	SPLP Cadmium	TCLP Cadmium	SPLP Chromium	TCLP Chromium	SPLP Lead	TCLP Lead	SPLP Mercury	TCLP Mercury	SPLP Selenium	TCLP Selenium	SPLP Silver	TCLP Silver
				Results in mg/L															
Monumental Mine																			
ML-SSS-12	7/9/2003	EA	0.7	0.0085 B	NA	< 0.0073	NA	< 0.0003	NA	< 0.0006	NA	0.0029 B	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
ML-SSS-16	7/10/2003	EA	0.5	0.719	NA	0.0516 B	NA	0.0005 B	NA	< 0.0006	NA	0.0034	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
ML-SSS-38	7/9/2003	EA	0.5	0.0072 B	NA	0.114 B	NA	0.002 B	NA	< 0.0006	NA	0.004	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
WP-SSS-13	7/9/2003	EA	1.0	0.004 B	NA	0.0185 B	NA	< 0.0003	NA	< 0.0006	NA	< 0.0015	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
SWP-SSS-17	7/9/2003	EA	1.0	0.716	NA	< 0.0073	NA	0.0013 B	NA	< 0.0006	NA	0.101	NA	0.036	NA	< 0.0017	NA	0.0051 B	NA
WP-SUS-14	7/10/2003	EA	3.5	0.0362	NA	0.0145 B	NA	< 0.0003	NA	< 0.0006	NA	0.0018 B	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
WP-SUS-15	7/9/2003	EA	4.0	0.0000	NA	0.0000 B	NA	< 0.0000	NA	< 0.0000	NA	0.0000 B	NA	< 0.00	NA	< 0.0000	NA	< 0.0000	NA
MMDGA-WR-2-4	9/28/2009	CES	4.0	< 0.06	< 0.10	< 0.0030	0.5500	< 0.0050	0.020 B	NA	NA	< 0.0400	< 0.080	< 0.0002	< 0.0002	< 0.0600	< 0.10	< 0.0100	< 0.02
MMDGA-WR-24-0.5	9/29/2009	CES	0.5	< 0.06	< 0.10	0.0840	0.0990	< 0.0050	< 0.010	NA	NA	< 0.0400	< 0.080	0.0005 B	< 0.0002	< 0.0600	< 0.10	< 0.0100	< 0.02
MMDGA-T-13-1	9/29/2009	CES	1.0	**9.04**	**15.60**	< 0.0030	0.0190 B	< 0.0050	0.070	NA	NA	< 0.0400	0.120 B	< 0.0002	< 0.0002	< 0.0600	< 0.10	< 0.0100	< 0.02
MMDGA-T-34-2	9/30/2009	CES	2.0	1.18	1.50	< 0.0030	0.2030	< 0.0050	0.160	NA	NA	0.1100 B	0.730	0.0270	0.0040	< 0.0600	< 0.10	< 0.0100	< 0.02
MMDGA-T-40-2	9/30/2009	CES	2.0	2.21	**8.50**	0.0150 B	0.6830	< 0.0050	0.030 B	NA	NA	0.2000	0.650	0.0330	0.0110	< 0.0600	< 0.10	< 0.0100	< 0.02
MMDGA-T-41-2	9/30/2009	CES	2.0	1.52	3.40	0.0140 B	0.76	< 0.0050	0.300	NA	NA	0.1000 B	0.810	0.0210	0.0014	< 0.0600	< 0.10	0.0200 B	< 0.02
Cap Martin Mine																			
WP-SUS-20	7/15/2003	EA	4.0	0.0047 B	NA	0.0531 B	NA	< 0.0003	NA	0.0027 B	NA	0.0022 B	NA	0.0165 B	NA	< 0.0017	NA	< 0.0009	NA
WP-SUS-21	7/15/2003	EA	2.5	0.0212	NA	0.0161 B	NA	< 0.0003	NA	0.001 B	NA	0.002 B	NA	0.02	NA	0.0033 B	NA	< 0.0009	NA
WP-SUS-39	7/15/2003	EA	2.0	0.0027 B	NA	0.032 B	NA	< 0.0003	NA	0.0019 B	NA	0.0021 B	NA	0.0171 B	NA	< 0.0017	NA	< 0.0009	NA
Sheridan Mine																			
WP-SUS-23	7/14/2003	EA	3.5	< 0.0024	NA	0.0079 B	NA	< 0.0003	NA	0.0013 B	NA	0.0192	NA	0.0112 B	NA	< 0.0017	NA	0.0012 B	NA
Tillicum Mine																			
TILL-WR-01	6/26/2007	CES	0.5	< 0.04	< 0.04	< 0.003	0.413	< 0.005	0.202	< 0.01	< 0.01	< 0.04	< 0.04	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.01	< 0.01
WP-SSS-28	7/12/2003	EA	0.8	< 0.0024	NA	0.012 B	NA	< 0.0003	NA	< 0.0006	NA	< 0.0015	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
WP-SUS-26	7/12/2003	EA	3.0	0.0185	NA	0.053 B	NA	0.0005 B	NA	< 0.0006	NA	0.0152	NA	< 0.01	NA	< 0.0017	NA	0.0013 B	NA
WP-SUS-27	7/12/2003	EA	4.5	0.0096 B	NA	0.048 B	NA	< 0.0003	NA	< 0.0006	NA	0.0081	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
Golden Fraction																			
GF-WR-2	6/25/2007	CES	0.5	< 0.04	< 0.04	0.224	0.046	< 0.005	0.024	< 0.01	< 0.01	0.11 B	0.04 B	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.01	< 0.01
Central Mine																			
WP-SUS-31	7/10/2003	EA	4.5	0.0554	NA	0.0451 B	NA	< 0.0006	NA	0.0048 B	NA	0.0148	NA	< 0.01	NA	< 0.0034	NA	0.0023 B	NA
WP-SUS-32	7/10/2003	EA	4.0	0.0232	NA	0.0328 B	NA	< 0.0003	NA	< 0.0006	NA	0.0054	NA	< 0.01	NA	< 0.0017	NA	< 0.0009	NA
Granite Creek																			
GC7-WR-01	6/24/2007	CES	0.5	0.04 B	< 0.04	0.015 B	1.41	< 0.005	0.016 B	< 0.01	< 0.01	< 0.04	< 0.04	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.01	< 0.01
GC7-WR-04	6/24/2007	CES	0.5	< 0.04	< 0.04	0.012 B	1.06	< 0.005	< 0.005	< 0.01	< 0.01	< 0.04	< 0.04	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.01	< 0.01
Background																			
BG-SSS-19	7/19/2003	EA	0.5	< 0.0024	NA	0.0099 B	NA	0.00033 B	NA	0.0011 B	NA	0.0017 B	NA	< 0.01	NA	0.002 B	NA	< 0.0009	NA
BG-SSS-34	7/15/2003	EA	0.5	< 0.0024	NA	0.0115 B	NA	< 0.0003	NA	0.001 B	NA	0.003 B	NA	0.02	NA	0.003 B	NA	< 0.001	NA
BG-SSS-35	7/15/2003	EA	0.5	< 0.0024	NA	0.0133 B	NA	< 0.0003	NA	0.0011 B	NA	< 0.0015	NA	0.0144 B	NA	0.0023 B	NA	< 0.0009	NA
BG-SSS-36	7/15/2003	EA	0.5	0.0065 B	NA	0.165 B	NA	< 0.0003	NA	0.0049 B	NA	0.0033	NA	0.021	NA	0.0037 B	NA	< 0.0009	NA
Applicable Standards																			
RCRA TCLP Disposal Limits				**5**	**5**	100	100	1	1	5	5	5	5	0.2	0.2	1	1	5	5

NOTES:

Analyses were performed by Severn Trent Laboratories, Inc. (EA - Site Inspection Samples) and by ACZ (CES - Data Gap Investigation Samples) per EPA Method 6000 series.

Abbreviations: < value = analyte not detected above Method Detection Limit (MDL, shown), B = analyte detected between MDL and Practical Quantification Limit (PQL, not shown), mg/L = milligrams per liter, NA = not analyzed, RCRA = Resource Conservation Recovery Act, SPLP = synthetic precipitation leaching procedure, TCLP = toxicity characteristic leaching procedure.

Bold and Shaded cell indicate that the value exceeds criteria; corresponding criteria also bolded and shaded.

Table 7. **Vegetation Analytical Results**
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Sample ID	Sample Date	Sample Entity	Onsite or Background	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
				Results in mg/kg																						
Lucas Gulch																										
BG-PLT-19	07/19/03	EA	Background	72.7	< 1.2	< 1.3	252	0.12 B	< 0.16	12,400	< 0.37	< 0.52	5.7 B	132	1.1	4,330	238	< 0.051	< 0.6	16,500	1.4	< 0.57	330 B	< 1.5	< 0.52	21.4
Granite Creek																									<	
BG-PLT-34	07/15/03	EA	Background	143	< 1.2	< 1.2	341	0.071 B	0.37 B	13,300	< 0.36	< 0.51	4.3 B	181	1.1	4,280	262	< 0.045	< 0.5	16,800	< 0.86	< 0.56	311 B	< 1.4	< 0.51	18.1
BG-PLT-35	07/15/03	EA	Background	312	< 1.3	< 1.3	368	0.12 B	< 0.16	10,400	< 0.37	< 0.53	4.6 B	315	0.91	4,290	202	< 0.052	< 0.6	19,600	1.2 B	< 0.59	340 B	< 1.5	0.94 B	14.2
BG-PLT-36	07/15/03	EA	Background	213	< 1.0	< 1.1	505	0.054 B	< 0.13	17,300	< 0.31	< 0.44	4.8 B	247	0.38 B	4,570	324	< 0.045	< 0.5	16,200	0.95 B	< 0.48	285 B	< 1.3	0.60 B	13.4
Monumental Mine																										
WP-PLT-14	07/10/03	EA	Onsite	220	< 1.3	10.6	86.3	0.16 B	1.0 B	12,000	< 0.38	< 0.54	5.0 B	642	2.7	4,640	118	< 0.052	< 0.6	15,900	< 0.92	< 0.60	381 B	< 1.5	1.2 B	53.6
WP-PLT-15	07/09/03	EA	Onsite	206	< 1.3	6.1	51.9 B	0.13 B	0.78 B	9,750	< 0.38	< 0.55	5.1 B	535	1.2	4,500	169	< 0.046	< 0.6	14,900	< 0.93	< 0.60	428 B	< 1.6	0.95 B	35.9
Cap Martin Mine																					<					
WP-PLT-20	07/15/03	EA	Onsite	257	< 1.2	< 1.2	231	0.096 B	< 0.15	12,700	< 0.36	< 0.51	4.6 B	262	0.50 B	4,030	162	0.063 B	< 0.5	15,900	< 0.87	< 0.56	289 B	< 1.5	0.76 B	16.7
Sheridan Mine																										
WP-PLT-23	07/14/03	EA	Onsite	153	< 1.2	< 1.3	247	0.11 B	0.50 B	12,200	< 0.37	< 0.53	4.6 B	197	1.3	4,690	291	0.050 B	< 0.6	16,700	0.91 B	< 0.58	370 B	< 1.5	0.81 B	27.2
Tillicum Mine																										
WP-PLT-27	07/12/03	EA	Onsite	284	< 0.9	1.0 B	272	0.087 B	2.6	20,000	0.48 B	< 0.40	5.0	427	2.7	4,120	158	0.070 B	< 0.4	13,700	0.70 B	< 0.44	262 B	< 1.1	0.90 B	70.2
Central Mine																										
WP-PLT-31	07/11/03	EA	Onsite	251	< 1.3	< 1.4	290	0.13 B	0.85 B	17,800	1.7 B	< 0.57	6.1 B	409	2.1	5,310	191	0.092 B	< 0.6	15,100	< 0.97	< 0.63	338 B	< 1.6	0.97 B	43.7

NOTES:
Analysis was conducted by Severn Trent Laboratories, Inc., Colchester, VT per EPA Method 6010/7000 series.
Abbreviations: < value = analyte not detected above MDL, B = analyte detected between method detection limit (MDL) and practical quantification limit (PQL), mg/kg = milligrams per kilogram.

Table 8. Summary of the Nature and Extent of Contamination - Monumental Mine
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Location	Test Pit ID	GPS Coordinates [1]	XRF Arsenic Concentration[2] (Depth in Feet)	Sample ID Number	Laboratory Arsenic Concentration [3]	General Notes
Upper Waste Rock Pile Area						
Upper Waste Rock Pile	#1	N 44° 51.626' W 118° 21.121'	45 mg/kg (1 foot) 79 mg/kg (2 feet) 94 mg/kg (3 feet)	NA	NA	Appears to be outside of the waste rock pile boundary
Upper Waste Rock Pile	#2	N 44° 51.622' W 118° 21.138'	751 mg/kg (1 foot) 442 mg/kg (2 feet) 365 mg/kg (3 feet) 1,445 mg/kg (4 feet) 191 mg/kg (5 feet)	MMDGA-WR-2-4	164 mg/kg	Sample collected at 4 foot depth, out of waste rock at about 5 feet bgs
Upper Waste Rock Pile	#3	N 44° 51.627' W 118° 21.138'	429 mg/kg (1 foot) 1,189 mg/kg (4 feet) 992 mg/kg (8 feet)	MMDGA-WR-3-4	2,240 mg/kg	Sample collected at 4 foot depth. Waste Rock pile >8 feet deep.
Upper Waste Rock Pile	#4	N 44° 51.616' W 118° 21.128'	163 mg/kg (1 foot) 293 mg/kg (4 feet)	NA	NA	Waste Rock pile 4-5 feet deep.
Upper Waste Rock Pile	#5	N 44° 51.620' W 118° 21.134'	1,116 mg/kg (1 foot) 32 mg/kg (6 feet) 126 mg/kg (8 feet) 483 mg/kg (9 feet)	MMDGA-WR-5-1	2,920 mg/kg	Sample collected at 1 foot depth. Waste Rock pile >9 feet deep.
Upper Waste Rock Pile	#6	N 44° 51.576' W 118° 21.179'	<16 mg/kg (0.5 feet) 63 mg/kg (1 foot) 40 mg/kg (3 feet) 85 mg/kg (6 feet)	NA	NA	Not waste rock material
Upper Waste Rock Pile	#28	N 44° 51.619' W 118° 21.146'	1,309 mg/kg (surface) 727 mg/kg (0.5 feet)	MMDGA-WR-28-0.5	740 mg/kg	Refusal at 0.5 feet with hand auger, no access with excavator due to steep slopes
Upper Waste Rock Pile	#29	N 44° 51.619' W 118° 21.144'	568 mg/kg (0.5 feet) 137 mg/kg (2 feet)	NA	NA	Refusal at 2 feet with hand auger, no access with excavator due to steep slopes
Upper Waste Rock Pile	#30	N 44° 51.611' W 118° 21.148'	68 mg/kg (0.5 feet) 61 mg/kg (3 feet) 66 mg/kg (4 feet)	NA	NA	Appears to be a mix of waste rock and native soil, natural organic layer at 4 feet.

Table 8. Summary of the Nature and Extent of Contamination - Monumental Mine
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Location	Test Pit ID	GPS Coordinates [1]	XRF Arsenic Concentration[2] (Depth in Feet)	Sample ID Number	Laboratory Arsenic Concentration [3]	General Notes
Lower Waste Rock Pile/Crusher Area						
Lower Waste Rock Pile	#18	N 44° 51.660' W 118° 21.344'	1,445 mg/kg (1 foot) 104 mg/kg (2 feet) 979 mg/kg (2.5 feet) 1,369 mg/kg (3 feet) 1,108 mg/kg (4 feet) 595 mg/kg (8 feet)	MMDGA-WR-18-3.5	2,700 mg/kg	Sample collected at 3.5 feet bgs. Waste Rock pile >9 feet deep.
Lower Waste Rock Pile	#19	N 44° 51.660' W 118° 21.340'	111 mg/kg (1 foot) 2,206 mg/kg (3 feet) 99 mg/kg (7 feet)	MMDGA-WR-19-3	223 mg/kg	Sample collected at 3 feet bgs. Native material at 7 feet bgs.
Lower Waste Rock Pile	#20	N 44° 51.667' W 118° 21.353'	1,348 mg/kg (1 foot) 4,973 mg/kg (3 feet) 133 mg/kg (8 feet)	MMDGA-WR-20-3	4,610 mg/kg	Sample at 3 feet bgs, waste rock pile >8 feet deep.
Lower Waste Rock Pile	#21	N 44° 51.660' W 118° 21.366'	412 mg/kg (0.5 feet) 232 mg/kg (1 foot) 162 mg/kg (2 feet) 191 mg/kg (3 feet) 385 mg/kg (8 feet)	MMDGA-WR-21-1	258 mg/kg	Southern portion of the large waste rock pile. Sample collected at 1 foot bgs, pile >8 feet deep.
Lower Waste Rock Pile	#22	N 44° 51.671' W 118° 21.366'	208 mg/kg (0.5 feet) 840 mg/kg (1 foot) 69 mg/kg (4 feet) 749 mg/kg (8 feet) 181 mg/kg (9 feet)	NA	NA	Waste Rock pile >9 feet deep.
Lower Waste Rock Pile	#23	N 44° 51.673' W 118° 21.378'	64 mg/kg (0.5 feet) 101 mg/kg (3 feet) 69 mg/kg (7 feet)	NA	NA	Appears to be a mix of waste rock and native soil, with relatively low arsenic concentrations.
Crusher Fines Area	#24	N 44° 51.682' W 118° 21.353'	22,299 mg/kg (0.5 feet) 3,204 mg/kg (1 foot) 20 mg/kg (3.5 feet)	MMDGA-WR-24-0.5	8,150 mg/kg	Thin veneer of crusher fines/tailings about 1 foot deep. Sample collected at 0.5 feet bgs.
Crusher Fines Area	#25	N 44° 51.690' W 118° 21.351'	15,156 mg/kg (0.5 feet)	MMDGA-WR-25-0.5	9,360 mg/kg	Thin veneer of crusher fines/tailings about 1 foot deep. Sample collected at 0.5 feet bgs.
Crusher Fines Area	#26	N 44° 51.683' W 118° 21.349'	3,086 mg/kg (0.5 feet)	MMDGA-WR-26-0.5	5,690 mg/kg	Thin veneer of crusher fines/tailings about 1 foot deep. Sample collected at 0.5 feet bgs.
Adit #3 Waste Rock Pile	#27	N 44° 51.692' W 118° 21.354'	395 mg/kg (0.5 feet) 231 mg/kg (1 foot)	NA	NA	Small waste rock pile.
Adjacent to South of Cabin	#44	N 44° 51.657' W 118° 21.331'	74 mg/kg (0.5 feet)	NA	NA	Not waste rock material
Floodplain Below Lower Waste Rock Pile and Crusher Fines	#45	N 44° 51.687' W 118° 21.395'	58 mg/kg (0.5 feet) 44 mg/kg (1 foot) 14 mg/kg (2 feet)	NA	NA	Not waste rock material
Crusher Fines Area	#46	N 44° 51.688' W 118° 21.375'	1,447 mg/kg (0.5 feet) 699 mg/kg (2 feet) 3,147 mg/kg (3 feet)	MMDGA-WR-46-3.5	3,340 mg/kg	Thin veneer of crusher fines/tailings about 4 feet deep. Sample collected at 3.5 feet bgs.

Table 8. Summary of the Nature and Extent of Contamination - Monumental Mine
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Location	Test Pit ID	GPS Coordinates [1]	XRF Arsenic Concentration[2] (Depth in Feet)	Sample ID Number	Laboratory Arsenic Concentration [3]	General Notes
Monumental Mill Area						
Monumental Mill	#7	N 44° 51.595' W 118° 21.244'	50 mg/kg (1 foot) 43 mg/kg (3 feet) 35 mg/kg (5 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill	#8	N 44° 51.594' W 118° 21.241'	33 mg/kg (1 foot) 35 mg/kg (2 feet) 49 mg/kg (4 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill	#9	N 44° 51.590' W 118° 21.237'	3,397 (0.5 feet) 74 mg/kg (1 foot) 80 mg/kg (4 feet) 197 mg/kg (5 feet)	MMDGA-T-9-1	2,440 mg/kg	Apparent surficial erosion of floatation concentrates. Sample collected at 0.5 feet bgs.
Monumental Mill	#10	N 44° 51.592' W 118° 21.230'	64 mg/kg (0.5 feet) <13 mg/kg (1 foot) <13 mg/kg (2 feet) <14 mg/kg (3 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill	#11	N 44° 51.586' W 118° 21.237'	66 mg/kg (1 foot) 119 mg/kg (2 feet) 101 mg/kg (3 feet) 911 mg/kg (5 feet) 200 mg/kg (6 feet)	NA	NA	Mix of concentrates and native material with depth to 6 feet bgs.
Monumental Mill	#12	N 44° 51.587' W 118° 21.229'	4,989 mg/kg (2 feet)	NA	NA	Floatation table concentrate pile, ~ 4 feet in height.
Monumental Mill	#13	N 44° 51.586' W 118° 21.231'	31,910 mg/kg (1 foot)	MMDGA-T-13-1	10,200 mg/kg	Floatation table concentrate pile, ~ 4 feet in height. Sample collected at 1 foot bgs.
Monumental Mill	#14	N 44° 51.596' W 118° 21.216'	56 mg/kg (1 foot) 14 mg/kg (2.5 feet) 140 mg/kg (6 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill	#15	N 44° 51.593' W 118° 21.218'	92 mg/kg (1 foot) <14 mg/kg (2.5 feet) 64 mg/kg (6 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill	#16	N 44° 51.593' W 118° 21.197'	49 mg/kg (1 foot) 36 mg/kg (2.5 feet) 27 mg/kg (6 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill	#17	N 44° 51.603' W 118° 21.205'	16 mg/kg (1 foot) 22 mg/kg (2 feet) 18 mg/kg (6 feet)	NA	NA	Appears to be outside of the concentrate spill area
Monumental Mill (Adjacent to FS 7345)	#31	N 44° 51.603' W 118° 21.208'	16 mg/kg (2.5 feet) 33 mg/kg (6 feet)	NA	NA	Erosion channel downslope from mill.
Monumental Mill (Adjacent to FS 7345)	#32	N 44° 51.602' W 118° 21.211'	97 mg/kg (0.5 feet) 205 mg/kg (2 feet) 51 mg/kg (3 feet)	NA	NA	Erosion channel downslope from mill, minor contamination.
Monumental Mill (Adjacent to FS 7345)	#33	N 44° 51.598' W 118° 21.229'	<16 mg/kg (1 foot) <16 mg/kg (3 feet)	NA	NA	Erosion channel downslope from mill.

Table 8. Summary of the Nature and Extent of Contamination - Monumental Mine
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Location	Test Pit ID	GPS Coordinates [1]	XRF Arsenic Concentration[2] (Depth in Feet)	Sample ID Number	Laboratory Arsenic Concentration [3]	General Notes
Settling Ponds/Riparian Areas						
Upper Settling Pond	#34	N 44° 51.617' W 118° 21.227'	3,288 mg/kg (0.25 feet) 476 mg/kg (0.5 feet) 1,145 mg/kg (1 foot) 9,349 (1.5 feet) 382 mg/kg (3 feet) 433 mg/kg (5 feet)	MMDGA-T-34-0.25 MMDGA-T-34-2	1,900 mg/kg 9,610 mg/kg	Wet/fine tailings from 1 to 3 feet. Refusal at 5 feet. Samples collected at 0.25 and 2 feet bgs.
Upper Settling Pond	#35	N 44° 51.620' W 118° 21.237'	5,034 mg/kg (0.25 feet) 26 mg/kg (2 feet)	MMDGA-T-35-1	4,770 mg/kg	Thin veneer of tailings present, native material at 2 feet bgs. Sample collected at 1 foot bgs.
Upper Settling Pond	#36	N 44° 51.617' W 118° 21.243'	6,235 mg/kg (0.25 feet) 294 mg/kg (1 foot)	NA	NA	Thin veneer of tailings present, native material at 2 feet bgs.
Upper Settling Pond	#37	N 44° 51.615' W 118° 21.247'	10,000 mg/kg (0.25 feet) 150 mg/kg (0.5 feet)	MMDGA-T-37-0.25	1,360 mg/kg	Thin veneer of tailings present, native material at 0.5 feet bgs. Sample collected at 0.25 feet bgs.
Upper Settling Pond	#38	N 44° 51.615' W 118° 21.251'	155 mg/kg (0.5 feet)	NA	NA	Native material
Downstream of Upper Settling Pond	#39	N 44° 51.625' W 118° 21.245'	3,425 mg/kg (0.25 feet) 201 mg/kg (1 foot)	NA	NA	Thin veneer of tailings present, native material below 1 foot bgs.
Upper Settling Pond	#40	N 44° 51.623' W 118° 21.228'	3,955 mg/kg (2 feet)	MMDGA-T-40-2	6,310 mg/kg	Dam of upper settling pond constructed from tailings. Sample collected at 2 feet bgs.
Middle Settling Pond	#41	N 44° 51.636' W 118° 21.259'	7,663 mg/kg (1.5 feet) 595 mg/kg (2.5 feet)	MMDGA-T-41-2	8,750 mg/kg	Dam of middle settling pond constructed from tailings. Sample collected at 2 feet bgs.
Adjacent to Lower Settling Pond	#42	N 44° 51.643' W 118° 21.324'	44 mg/kg (0.5 feet)	NA	NA	Native material
Adjacent to Lower Settling Pond	#43	N 44° 51.649' W 118° 21.328'	61 mg/kg (0.5 feet) 1,172 mg/kg (1 foot) 71 mg/kg (2 feet) 69 mg/kg (2.5 feet)	NA	NA	Thin layer of tailings at 1 foot depth, native material deeper.

NOTES:

1 GPS = Global Positioning System.

2 X-ray fluorescence field screening.

3 Laboratory analysis conducted by ACZ Laboratories in Steamboat Springs, Colorado.

Table 9. Removal Action Technology Screening Summary
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest, Oregon

Technology Class	Process Option	Description	Effectiveness	Implementability	Cost	Operation and Maintenance	Land Impacts	Pros	Cons	Retained?
No Action										
No Action	**No Action**	**No Action**	**NA**	**NA**	**NA**	**NA**	**None**	**No Cost**	**Does not address risk**	**Yes**
Institutional Controls										
Access Restrictions	Fencing	Security fences installed around contaminated areas and adits to limit access	Medium	High	Low	High - Due to vandalism	Minimal impact to undisturbed areas	Low Cost Exposure to humans and terrestrial ecological receptors reduced	High potential for vandalism	No
	Land Use Controls	Legal restrictions to control current and future land use	Medium	Low	Low	None	None	Low Cost	Difficult to implement	No
Engineering Controls										
Solid Containment	Water- Balanced Topsoil Cover	Apply topsoil and establish vegetation to contain source using cover designed around annual precipitation (rain and snow)	High	High	Medium to High	Low - Inspect for erosion	Would impact 1-2 acres of undisturbed areas for stockpile and access	Surface infiltration into source material controlled by evapotranspiration	High cost if high quality topsoil not available onsite, effective if combined with other options.	No
	Soil Cover	**Soil cover (not topsoil) to provide medium for vegetation, does not control leaching through source**	**Medium**	**High**	**Low**	**Low - Inspect for erosion**	**Would impact 1-2 acres of undisturbed areas for stockpile and access**	**Easily implemented with onsite cover soil, for use when SPLP does indicate significant leaching**	**Does not control infiltration into waste material, effective if combined with other options**	**Yes**
	Geosynthetic Cover	Multilayer with geomembrane, cover soil, and seed	High	High	High	Low - Inspect for erosion	Would impact 1-2 acres of undisturbed areas for materials and access	Surface infiltration would be eliminated	Difficult to install and test, high cost	No
	Multi-Layered RCRA Cap	Compacted clay layer covered with soil and vegetation in contaminated surface areas	High	High	High	Low - Inspect for erosion	Would impact 1-2 acres of undisturbed areas for materials and access	Effective for isolated wastes, surface infiltration would be eliminated	Difficult to install and test, high cost	No
Surface Controls	**Consolidation**	**Combining wasterock/tailings into single area**	**High**	**High**	**Medium**	**Low - Inspect for erosion**	**Would impact 1-2 acres of undisturbed areas for grading and repository construction.**	**Easily implemented, waste material consolidated**	**Effectiveness dependent on combining with other options**	**Yes**
	Grading	**Level wasterock/tailings to reduce slopes for managing runoff, erosion, and surface infiltration**	**Medium**	**High**	**Medium**	**Low - Inspect for erosion**			**Effectiveness dependent on combining with other options**	**Yes**
	Revegetation	**Add amendments to wasterock/tailings and seed to promote vegetation for controlling water infiltration and erosion**	**High**	**High**	**Medium**	**Low - Inspect for erosion**	**Minimal impact to undisturbed areas**	**Easily implemented, offsite transport of waste greatly reduced**	**Effectiveness dependent on combining with other options, highly dependent on quantity and quality of cover soil.**	**Yes**
	Erosion Protection/ Run-on Control	**Erosion resistant materials, commercial fabrics placed on steep slopes; run-on diversion structures to channel water away from revegetation areas.**	**High**	**High**	**Low**	**Low - Inspect for erosion**			**Effectiveness dependent on combining with other options. Diverted water needs to be managed.**	**Yes**
Land Disposal										
Onsite Disposal	**Constructed Repository**	**Excavate wasterock/tailings and place in onsite repository with cover**	**High**	**High**	**Medium**	**Medium – Inspect stability of cap and erosion.**	**Would impact 1-2 acres of forest for suitable location**	**Human and ecological risk and exposure reduced**	**Medium cost, long term liability**	**Yes**
Offsite Disposal	**RCRA Landfill**	**Excavate wasterock/tailings/soil and disposed in RCRA-C landfill**	**High**	**High**	**High**	**None – Material hauled off site**	**Minor impacts to transport material off site**	**Easily implementable, risk and exposure eliminated**	**High transport and disposal costs**	**Yes**
	Solid Waste Landfill	**Excavate wasterock/tailings/soil and disposed in solid waste landfill**	**High**	**High**	**Medium**	**None – Material hauled off site**	**Minor impacts to transport material off site**	**Easily implementable, risk and exposure eliminated**	**High transport costs, Subtitle D facility may not accept material**	**Yes**
Treatment										
Solid Treatment	Reprocessing - Milling And Smelting	Shipping waste material to operating mill and/or smelter facility for extraction of metals	Medium	Low	High	Low – Inspect for erosion	Minor impact to transport material to be processed or process at mine	Human and ecological risk and exposure eliminated	High Costs, difficult to locate a facility willing to accept material, spent material must be disposed	No
	Thermal Treatment	Thermal treatment of waste material onsite	High	Medium	High	Low – Inspect for erosion	Minor impact to transport thermal unit onsite	Human and ecological risk and exposure eliminated	High Cost and spent material must be disposed	No
	Cement/ Pozzolan Additive	Tailings and ore/wasterock are solidified with non-leachable cement or pozzolan	High	High	High	Low – Inspect for erosion	Would impact 1-2 acres of undisturbed areas for repository construction.	Toxicity and mobility reduced, risk and exposure reduced	Volume of material will increase, need to be combined with water balance cap to control infiltration	No
	Physical/ Chemical Stabilization	Waste material treated in place when injected with stabilizing agent(s)	Medium	Low	Medium	Medium – May need to re inject agent	Minor impact to transport material to be injected	Toxicity and mobility reduced, risk and exposure reduced	Difficult to implement and mix thoroughly, need to be combined with water balance cap	No
Water Treatment / Control	**Lined Settling Pond**	**Remove tailings from settling ponds and construct lined settling pond for Upper Monumental spring seep discharge**	**Medium**	**High**	**Medium**	**Medium – Excavate and dispose sludge every 5-10 years**	**Minimal**	**Passive system that reduces sediment load to Unnamed Tributary, no pumps/motors**	**Only reduces sediments and precipitates formed on air contact. Sludge removal required**	**Yes**
	Infiltration Basin	**Remove tailings from settling ponds and construct an infiltration basin for Upper Monumental spring seep to infiltrate into native soils**	**Medium**	**High**	**Low**	**Low – Inspect for erosion and sludge build-up**	**Minimal**	**Passive system that reduces sediment load to Unnamed Tributary, no pumps/motors**	**Infiltration basin may clog over the years and need to be cleaned out**	**Yes**
	Anaerobic Wetland	**Remove tailings from settling pond and construct anaerobic wetlands for the Upper Monumental spring seep discharge**	**High**	**High**	**Medium**	**Low – Dredge and replace media every 5-10 years & baffles every 2 years**	**Minimal**	**Passive system that reduces metal load to Unnamed Tributary, no pumps/motors**	**Less effective in winter, size requirement**	**Yes**
	Aerobic Wetland	**Remove tailings from settling pond and construct aerobic wetlands for the Upper Monumental spring seep discharge**	**Low to Medium**	**Medium**	**Medium**	**Low – Inspect for erosion and sludge build-up**	**Minimal**	**Passive system that reduces metal load to Unnamed Tributary, no pumps/motors**	**Less effective in winter**	**Yes**

NOTES:
NA = not applicable
Bold items retained for evaluation

FIGURES

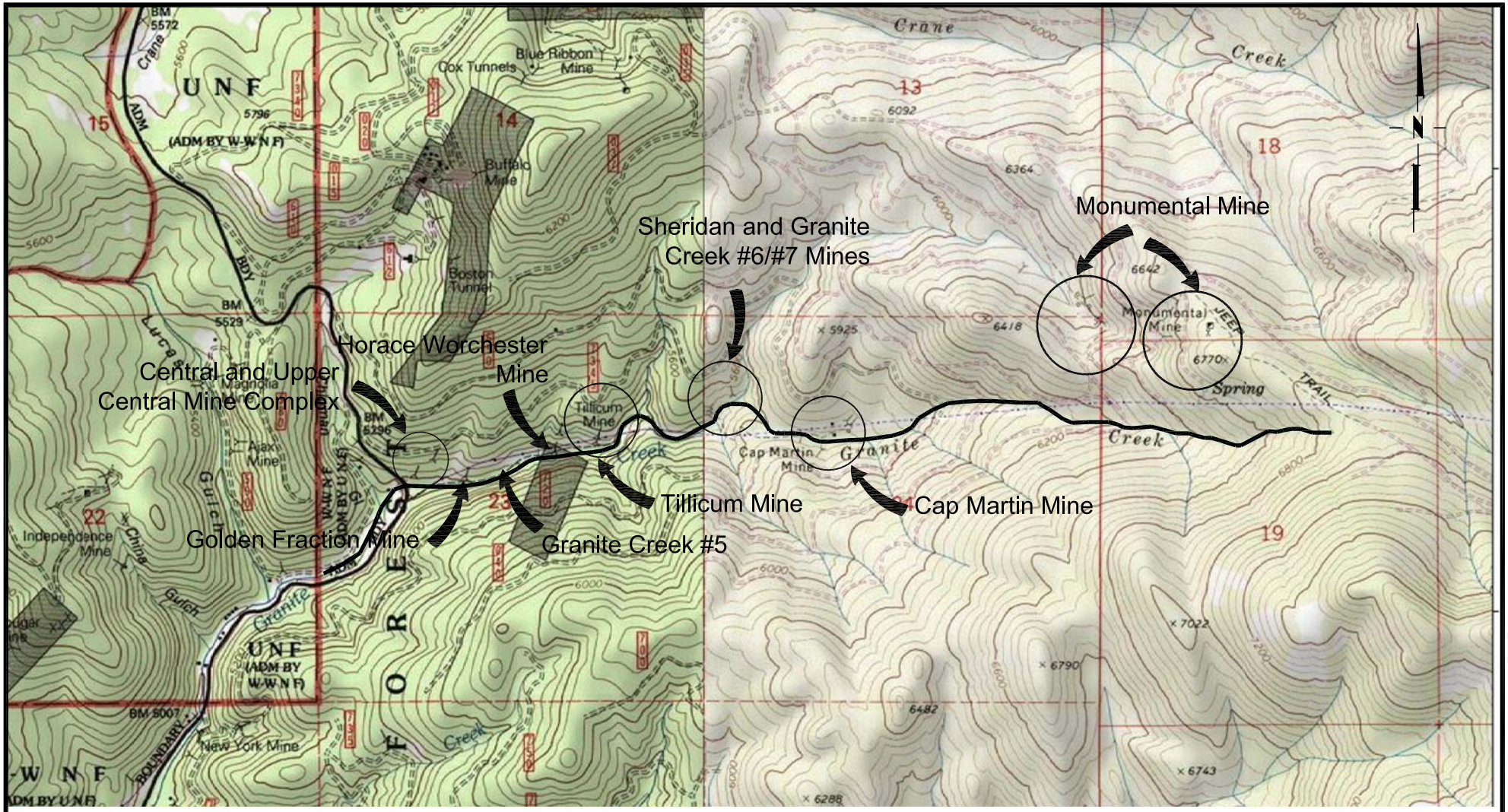


Figure 1. Site Location Map

0 2000 FEET

TOPO MAP SCALE

CONTOUR INTERVAL = 40 FEET

(SOURCE: USGS 7.5 Minute Topographic Maps of Oregon on CD-ROM, TOPO! Software ©2006 NGHT, Inc.)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018 F1.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 5/4/2011 6RKB	CES CASCADE EARTH SCIENCES A Valmont Industries Company

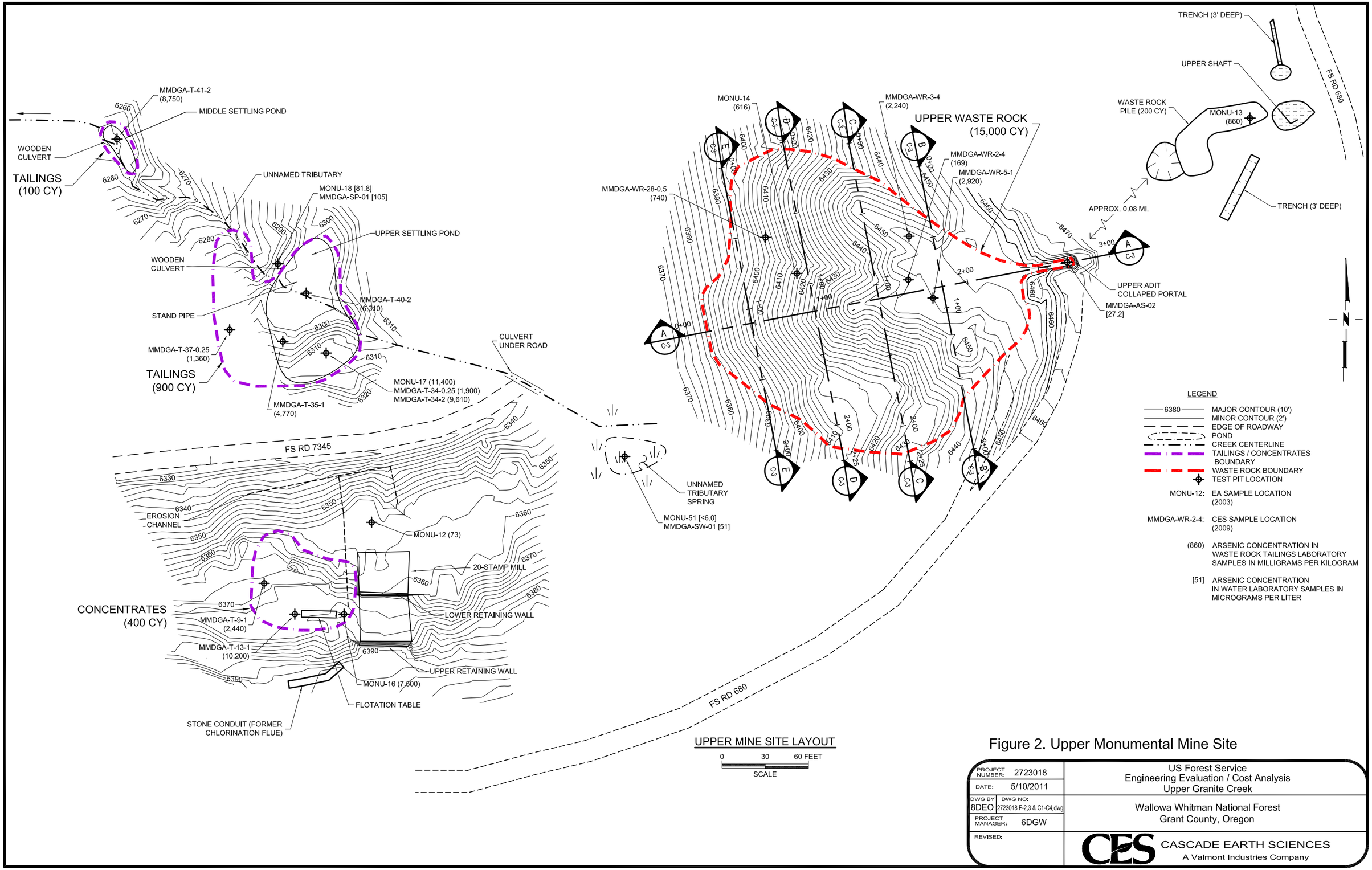
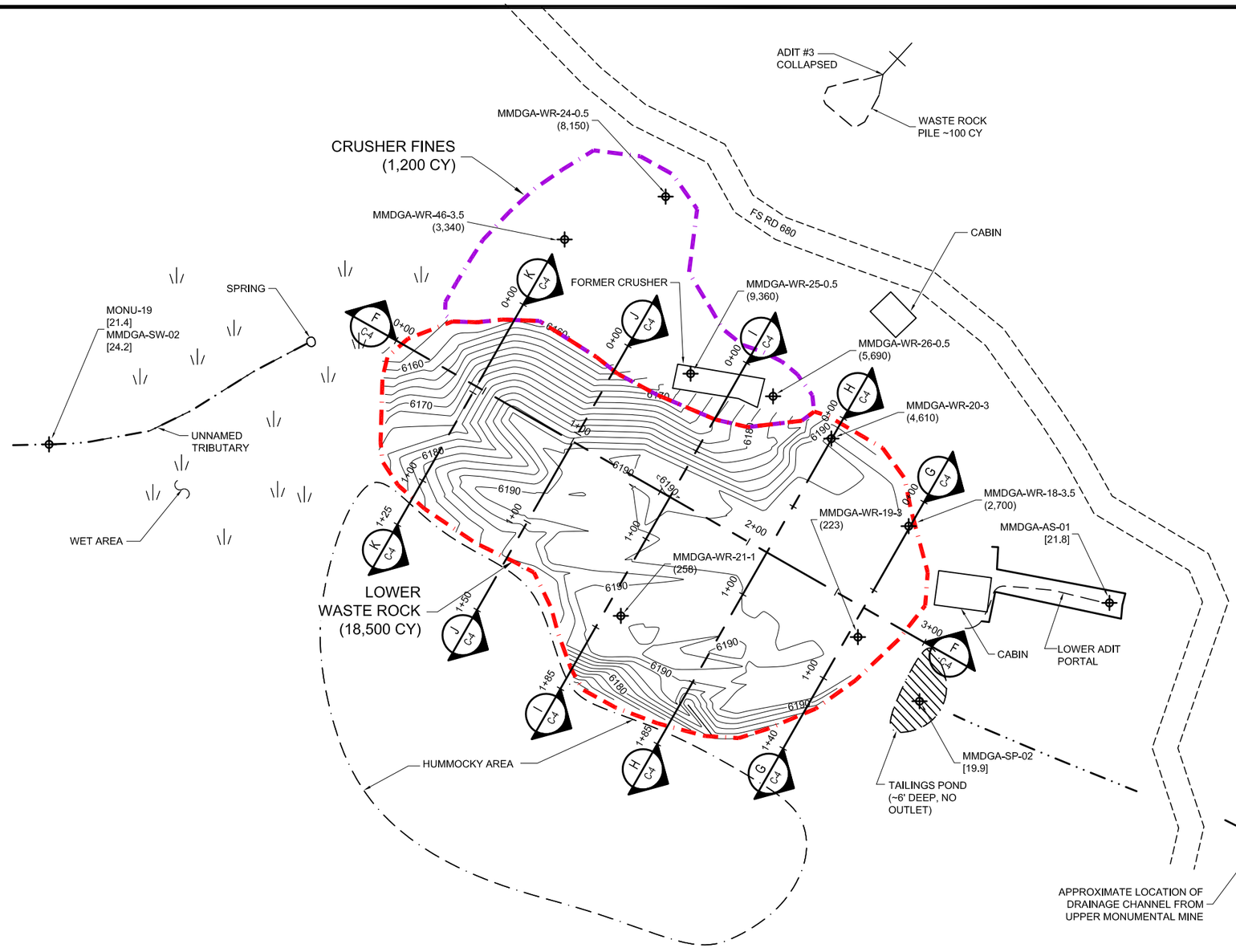


Figure 2. Upper Monumental Mine Site

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/10/2011	
DWG BY: 8DEO DWG NO: 2723018 F-2,3 & C1-C4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company



LOWER MINE SITE LAYOUT

0 30 60 FEET

SCALE

LEGEND

- 6380 — MAJOR CONTOUR (10')
- MINOR CONTOUR (2')
- EDGE OF ROADWAY
- POND
- CREEK CENTERLINE
- TAILINGS / CONCENTRATES BOUNDARY
- WASTE ROCK BOUNDARY
- TEST PIT LOCATION

MONU-12: EA SAMPLE LOCATION (2003)

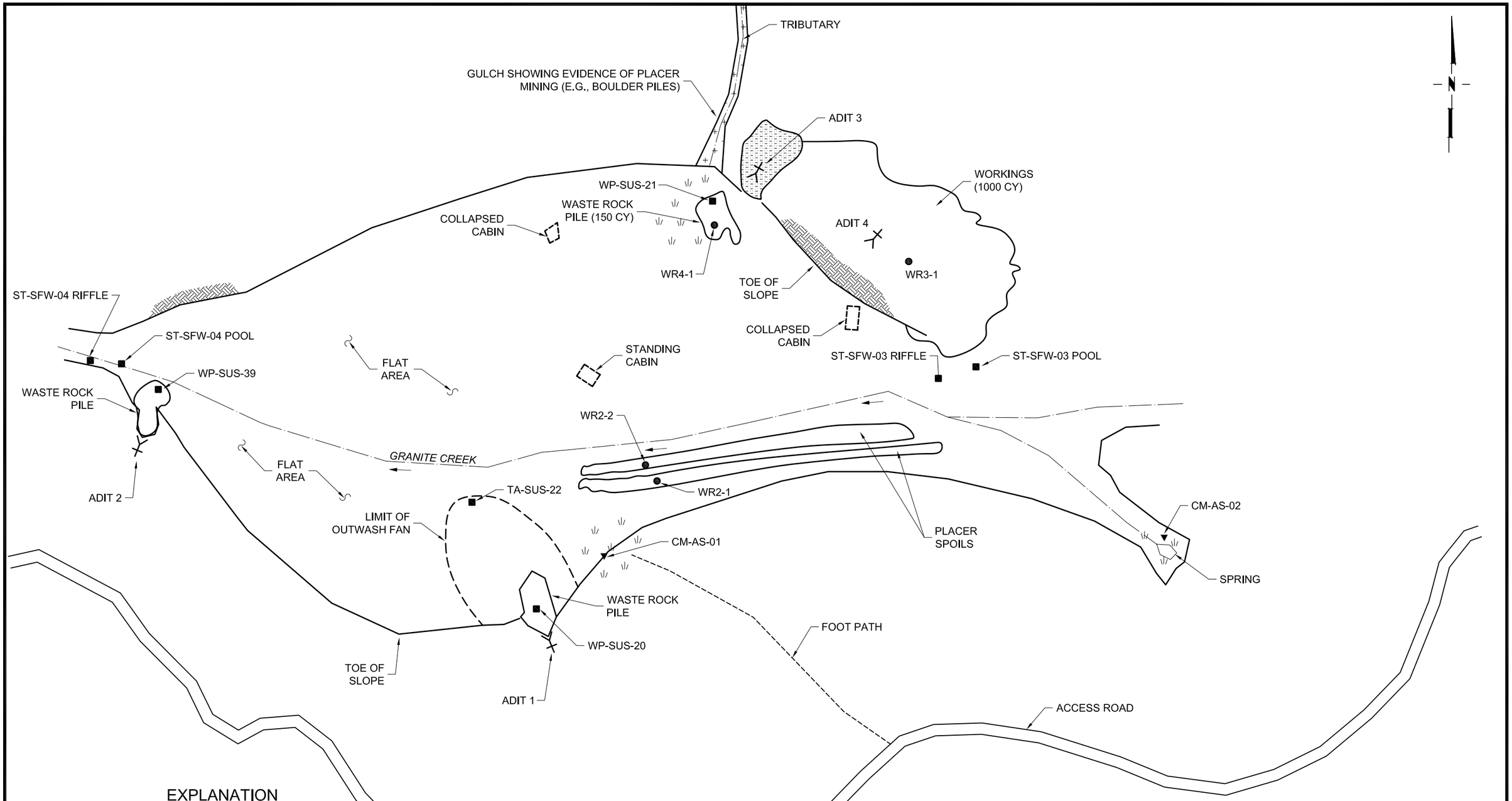
MMDGA-WR-2-4: CES SAMPLE LOCATION (2009)

(860) ARSENIC CONCENTRATION IN WASTE ROCK TAILINGS LABORATORY SAMPLES IN MILLIGRAMS PER KILOGRAM

[51] ARSENIC CONCENTRATION IN WATER LABORATORY SAMPLES IN MICROGRAMS PER LITER

Figure 3. Lower Monumental Mine Site

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 8DEO / DWG NO: 2723018 F-2,3 & C1-C4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

- Apparent Wetland
- Excavation
- Overland Flow
- Collapsed Adit
- WP-SUS-21 ■ EA Sample Location and ID (2003)
- WR4-1 ● CES Sample Location and ID (2007)
- CM-AS-02 ▼ Adit Seep Sample Location and ID

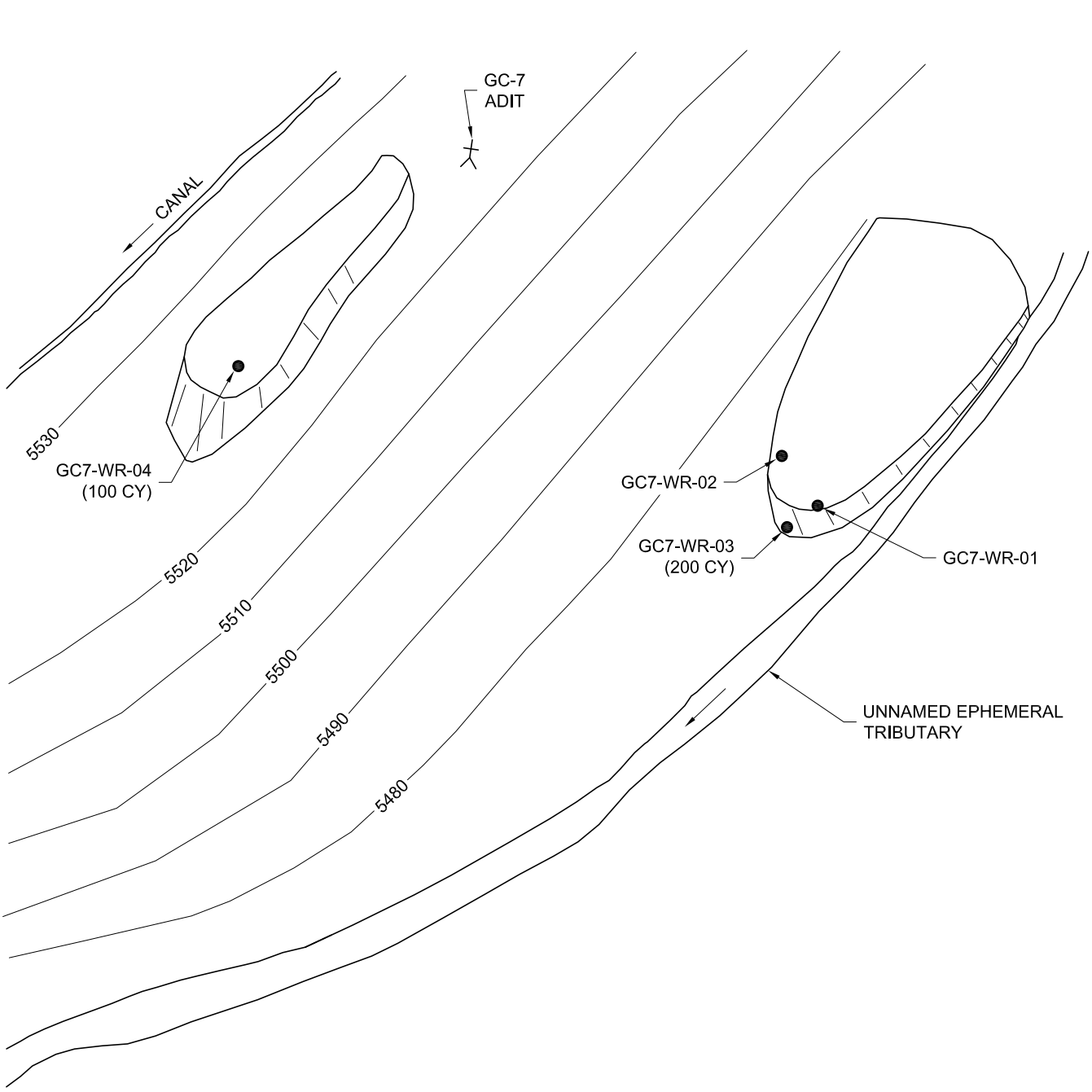
(SOURCE: Adapted from Figure 2, "Cap Martin Mine Site," prepared by EA ©, 12/9/03.)

0 100 FEET

SCALE
(LOCATIONS ARE APPROXIMATE)

Figure 4. Cap Martin Mine Site

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo	CES CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

Collapsed Adit

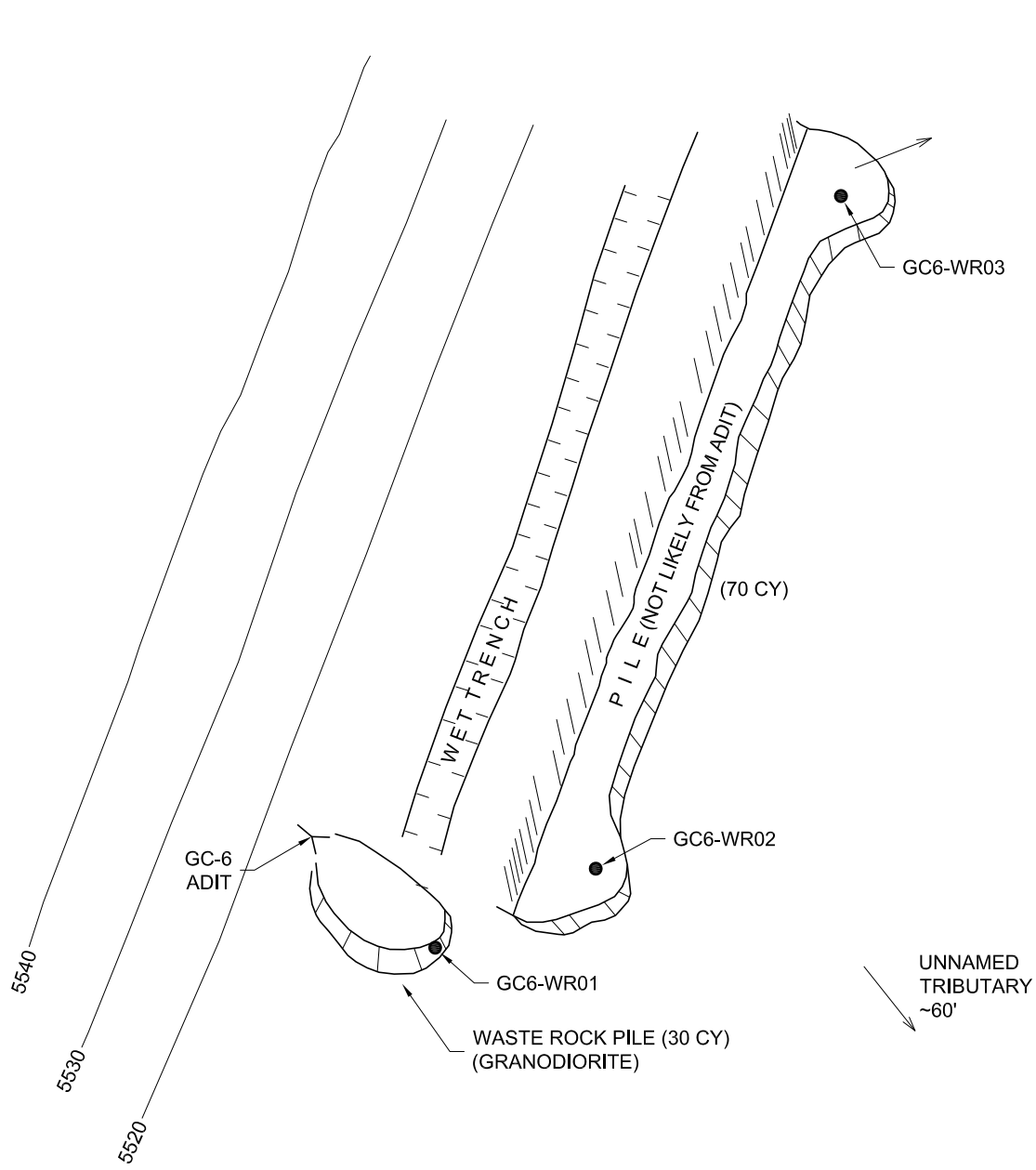
GC7-WR-03 ● CES Sample Location and ID (2007) (Laboratory)

Figure 5. GC-7 Mine Site

0 20 FEET

(SCALE & LOCATIONS ARE APPROXIMATE)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F5,6,9.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CES CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

Open Adit

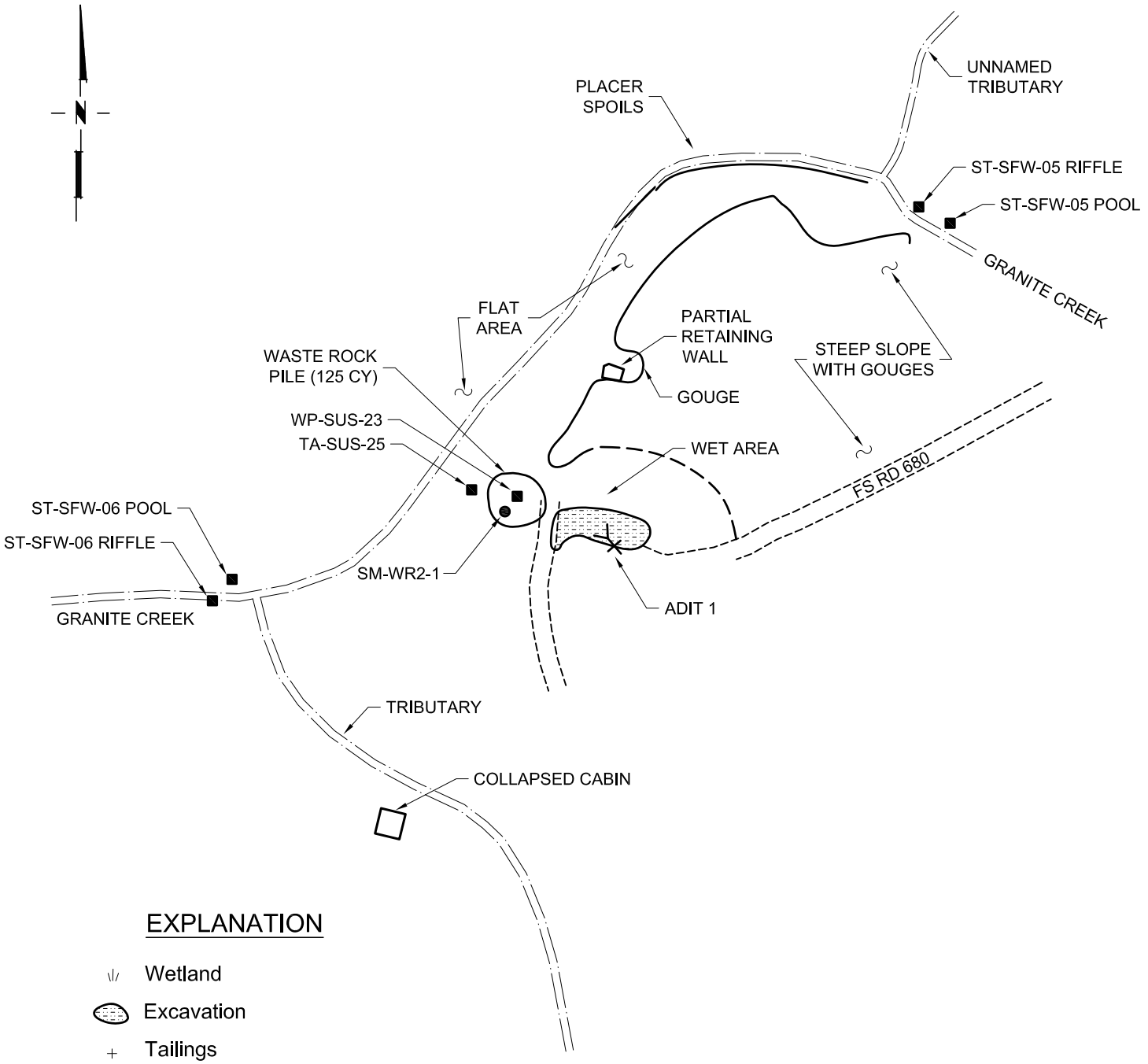
GC6-WR03 ● CES Sample Location and ID (2007)

Figure 6. GC-6 Mine Site

0 20 FEET

(SCALE & LOCATIONS ARE APPROXIMATE)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F5,6,9.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CES CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

- Wetland
- Excavation
- Tailings
- Overland Flow
- Collapsed Adit
- WP-SUS-23 ■ EA Sample Location and ID (2003)
- WR4-1 ● CES Sample Location and ID (2007)
- CM-AS-02 ▼ Adit Seep Sample Location and ID

Figure 7. Sheridan Mine Site

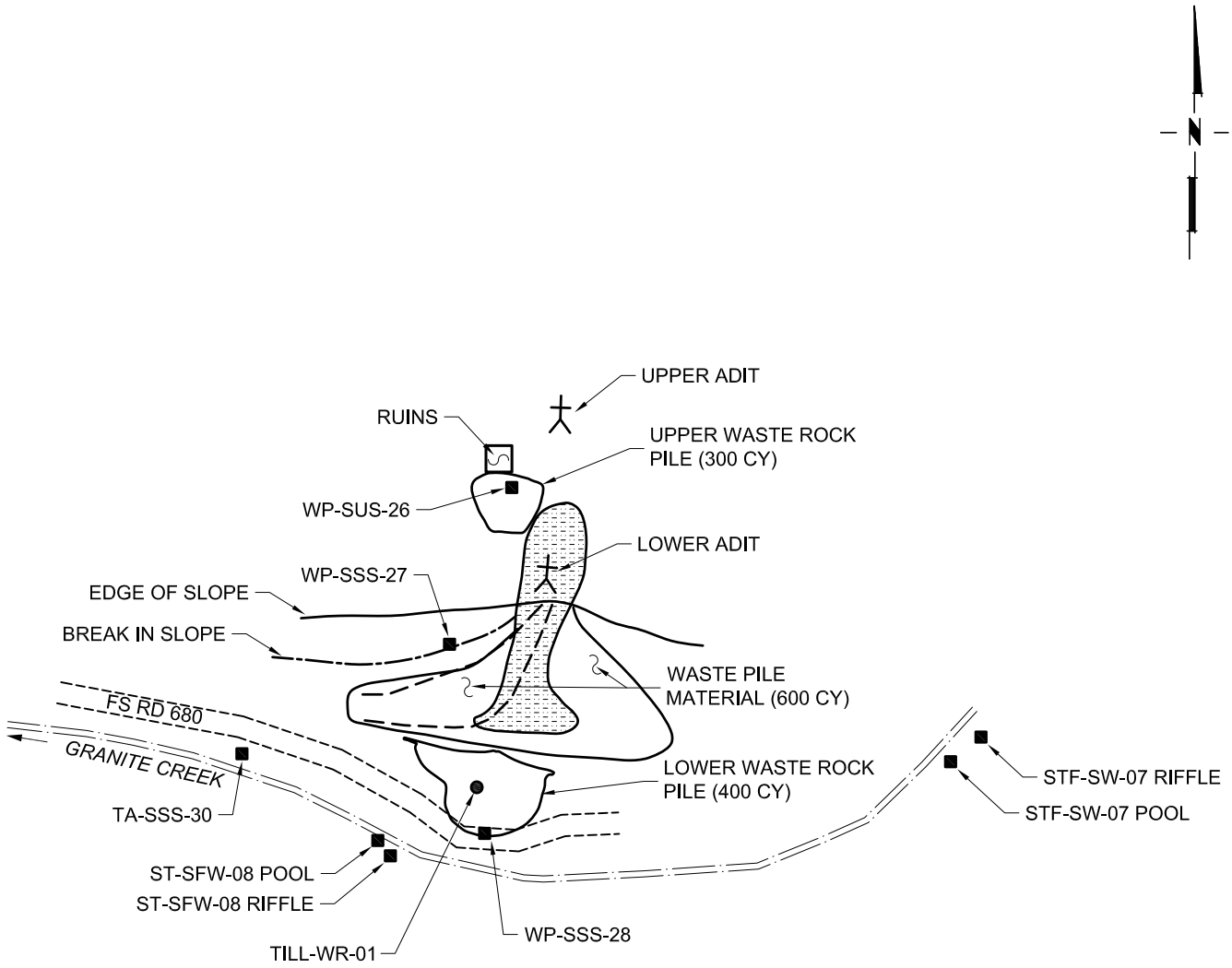
0 100 FEET

SCALE

(LOCATIONS ARE APPROXIMATE)

(SOURCE: Adapted from Figure 3, "Sheridan Mine Site," prepared by EA©, 12/9/03.)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F7.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

- Excavation
- Overland Flow
- Collapsed Adit
- ST-SFW-08 ■ EA Sample Location and ID (1003)
- TILL-WR-01 ● CES Sample Location and ID (2007)
- CM-AS-02 ▼ Adit Seep Sample Location and ID

Figure 8. Tillicum Mine Site

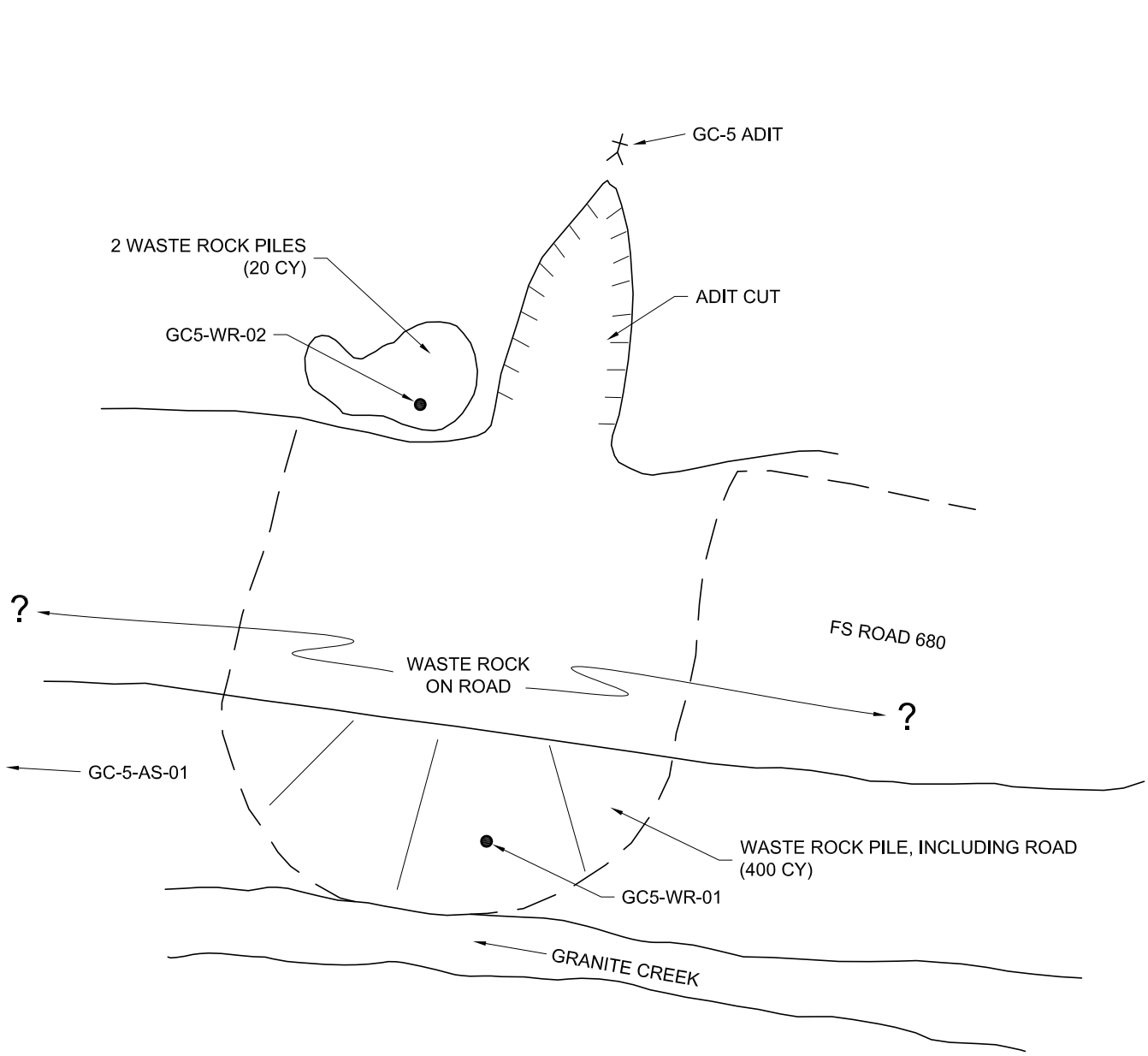
0 100 FEET

SCALE

(LOCATIONS ARE APPROXIMATE)

(SOURCE: Adapted from Figure 4, "Tillicum Mine Site," prepared by EA©, 12/9/03.)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F8.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

Collapsed Adit

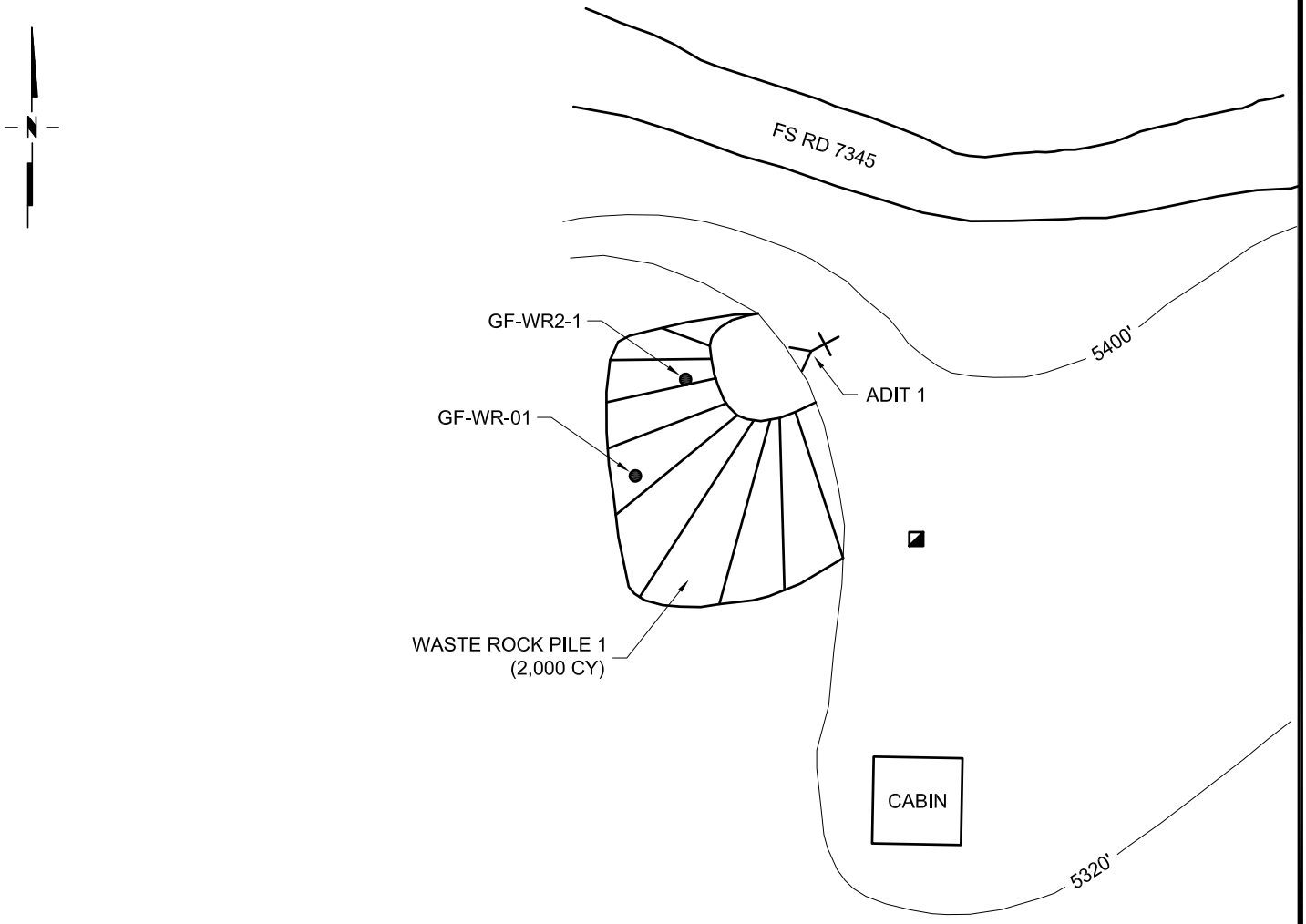
GC5-WR-02 ● CES Sample Location and ID (2007)

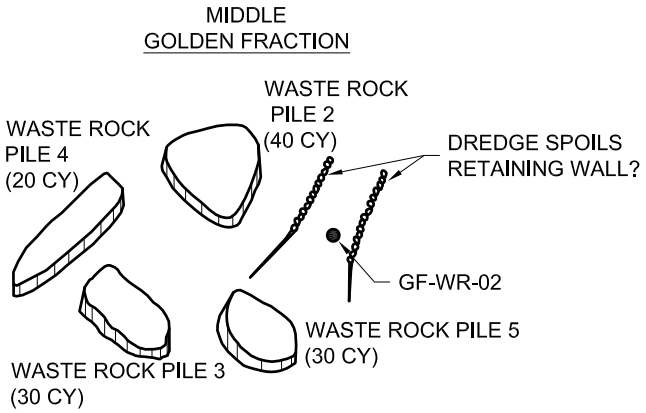
Figure 9. GC-5 Mine Site

0 20 FEET

(SCALE & LOCATIONS ARE APPROXIMATE)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac; DWG NO: 2723018F5,6,9.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CES CASCADE EARTH SCIENCES A Valmont Industries Company





EXPLANATION

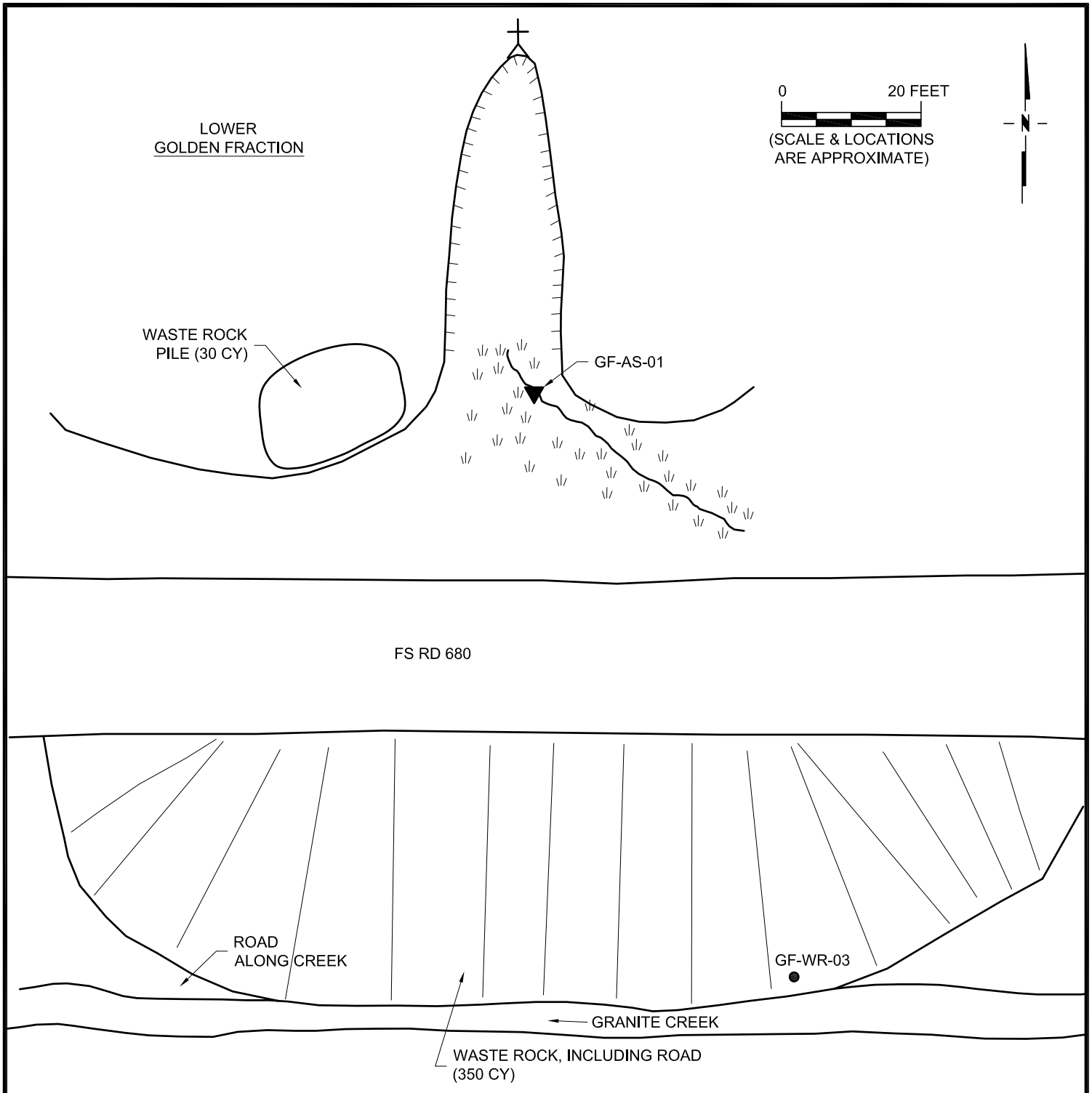
- Collapsed Adit
- Collapsed Shaft
- GF-WR-01 ● CES Sample Location and ID (2007)

0 40 FEET

(SCALE & LOCATIONS ARE APPROXIMATE)

Figure 10. Golden Fraction Mine Site - Upper and Middle Portions

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F10-11.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 2/15/08 3kac	CES CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

- Wetland
- Collapsed Adit
- GF-AS-01▼ CES Adit Seep Sample Location and ID (2007)
- GF-WR-03 ● CES Sample Location and ID (2007)

Figure 11. Golden Fraction Mine Site - Lower Portion

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F10-11.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 2/15/08 3kac	CES CASCADE EARTH SCIENCES A Valmont Industries Company

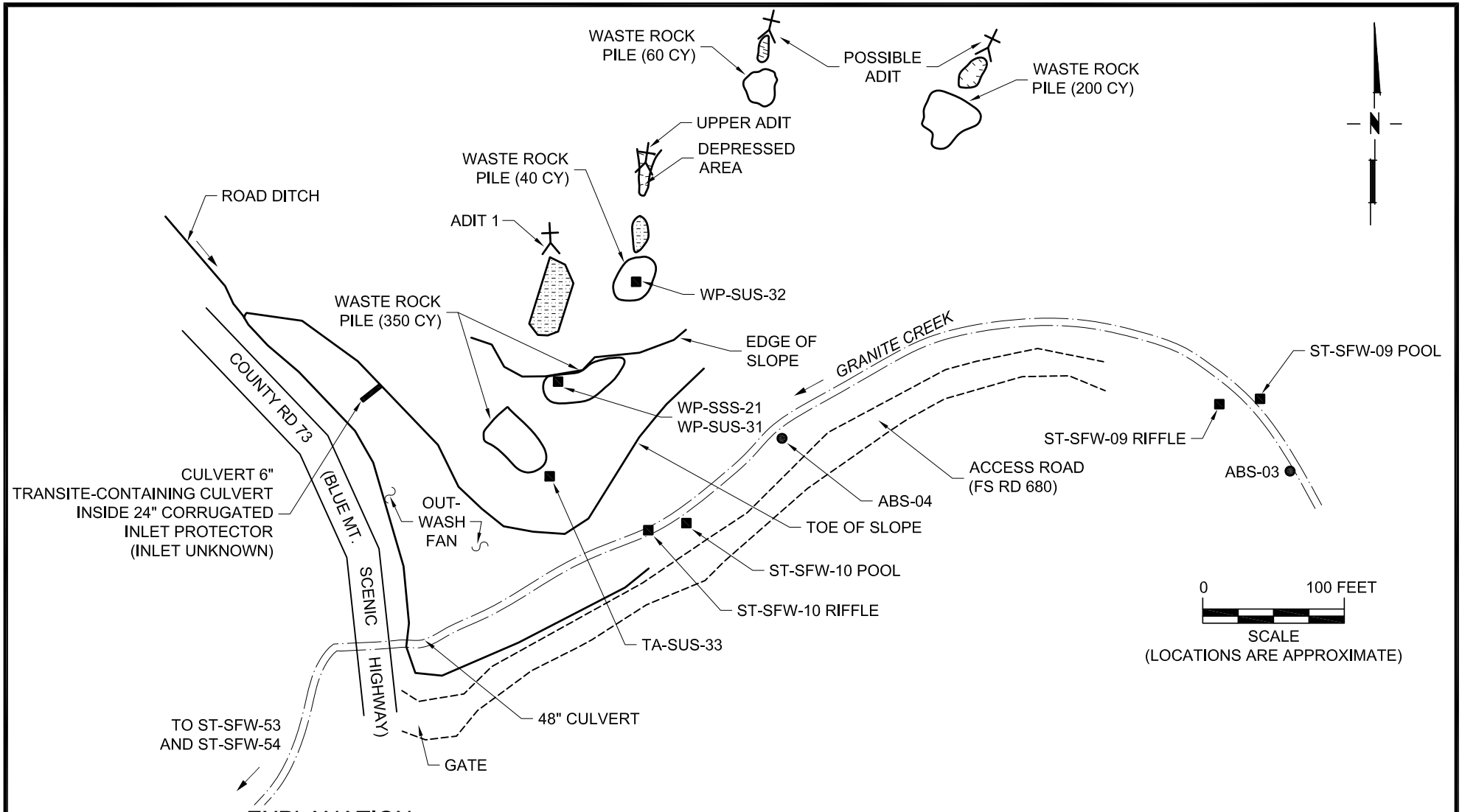
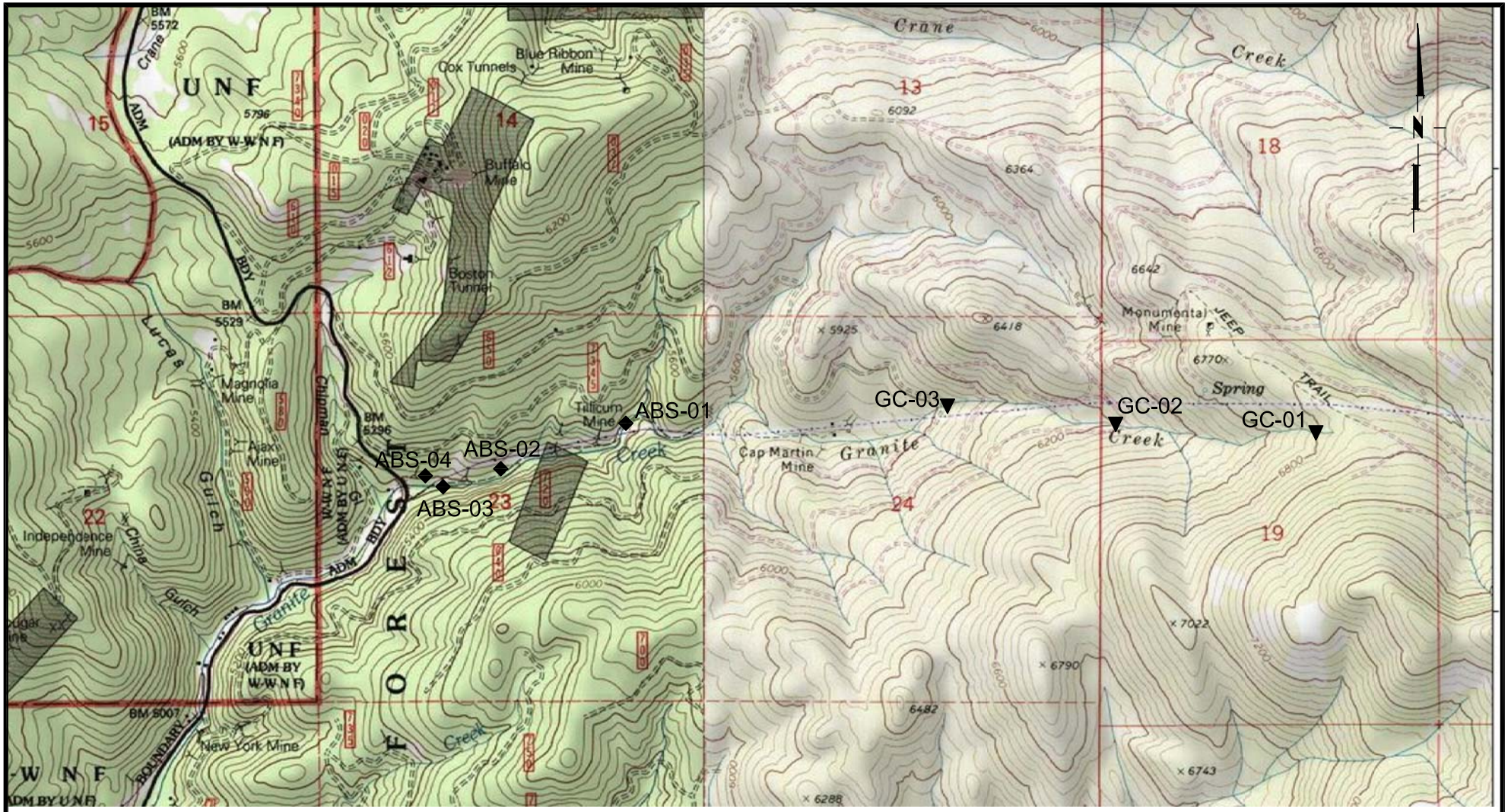


Figure 12. Central Mine Site

(SOURCE: Adapted from Figure 5, "Central Mine Site," prepared by EA©, 12/9/03.)

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/11/2011	
DWG BY: 3kac; DWG NO: 2723018F12.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

GC-01 ▼ CES Aquatic Sampling Station Location and ID (2007)

ABS-02 ◆ CES Floodplain Sampling Location and ID (2007)

(SOURCE: USGS 7.5 Minute Topographic Maps of Oregon on CD-ROM, TOPO! Software ©2006 NGHT, Inc.)

0 2000 FEET

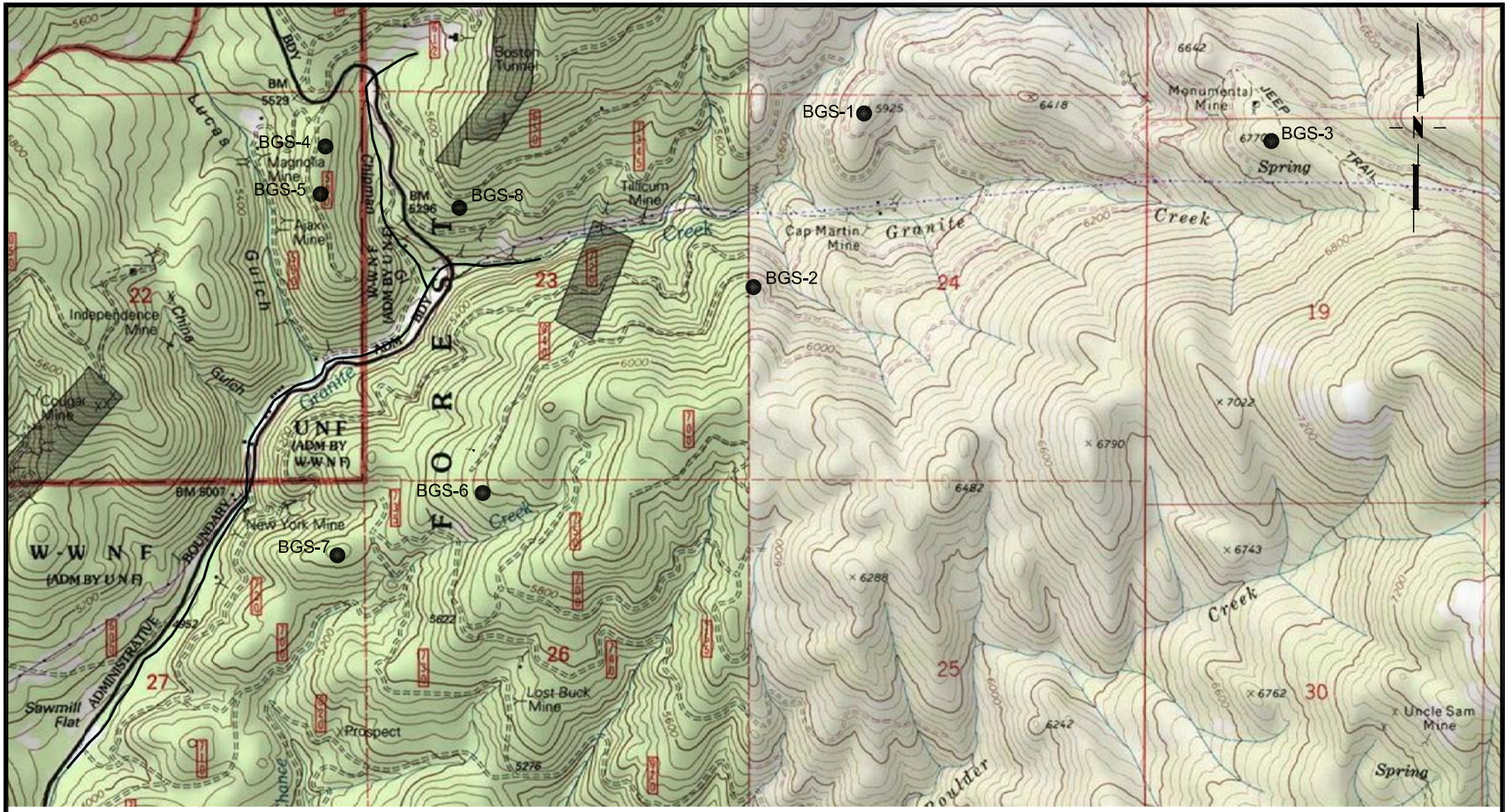
TOPO MAP SCALE

CONTOUR INTERVAL = 40 FEET

SAMPLING POINTS NOT TO SCALE; LOCATIONS APPROXIMATE

Figure 13. Aquatic Station and Floodplain Sample Locations

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac; DWG NO: 2723018F13.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo; 5/20/09 3kac	CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

BGS-1 ● Background Soil Sample Location and ID

0 2000 FEET

TOPO MAP SCALE

CONTOUR INTERVAL = 40 FEET

SAMPLING POINTS NOT TO SCALE; LOCATIONS APPROXIMATE

(SOURCE: USGS 7.5 Minute Topographic Maps of Oregon on CD-ROM, TOPO! Software ©2006 NGHT, Inc.)

Figure 14. Background Soil Sample Locations

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 3kac / DWG NO: 2723018F14.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED: 4/28/10 8deo 5/20/09 3kac	CASCADE EARTH SCIENCES A Valmont Industries Company

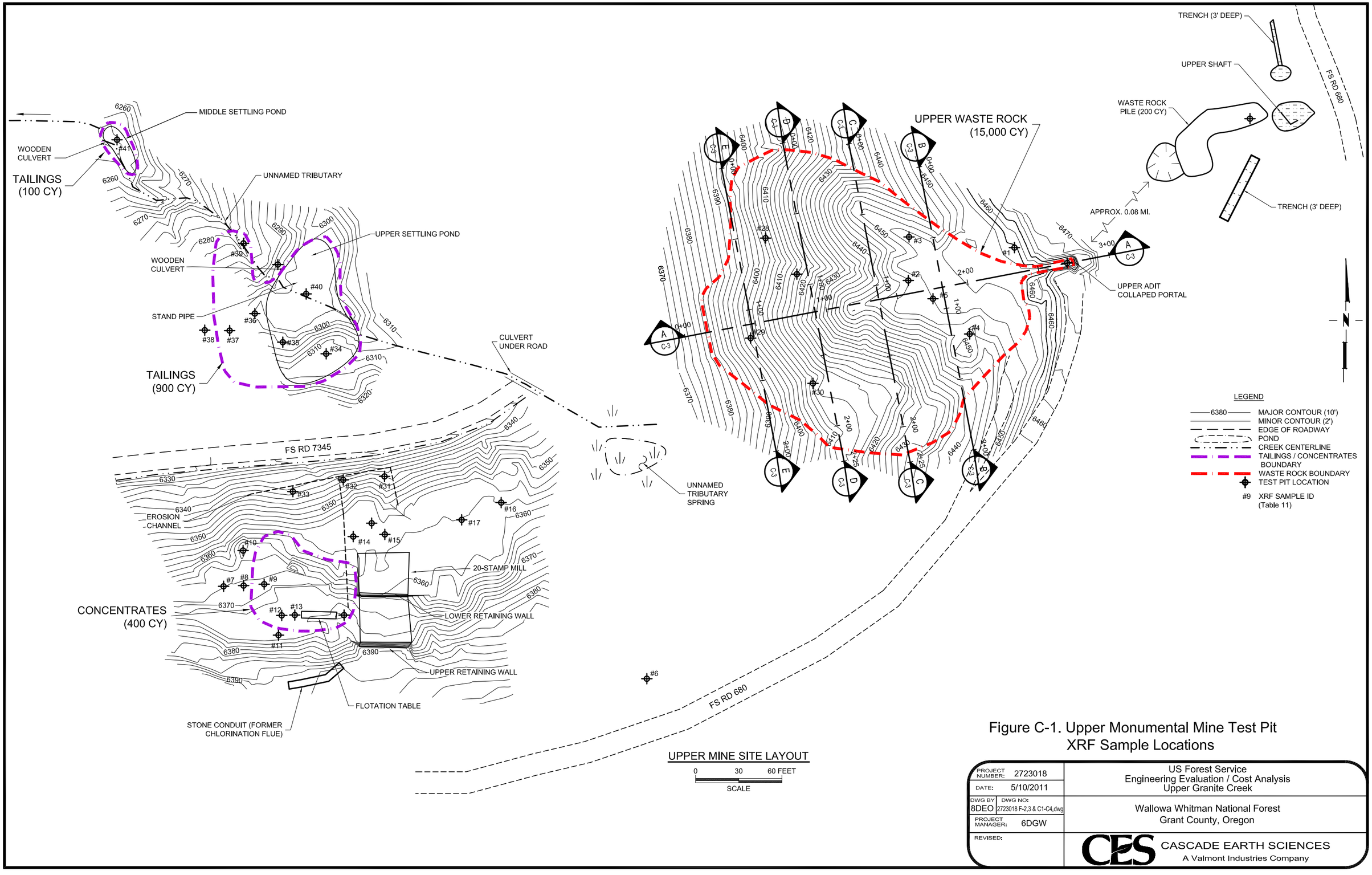
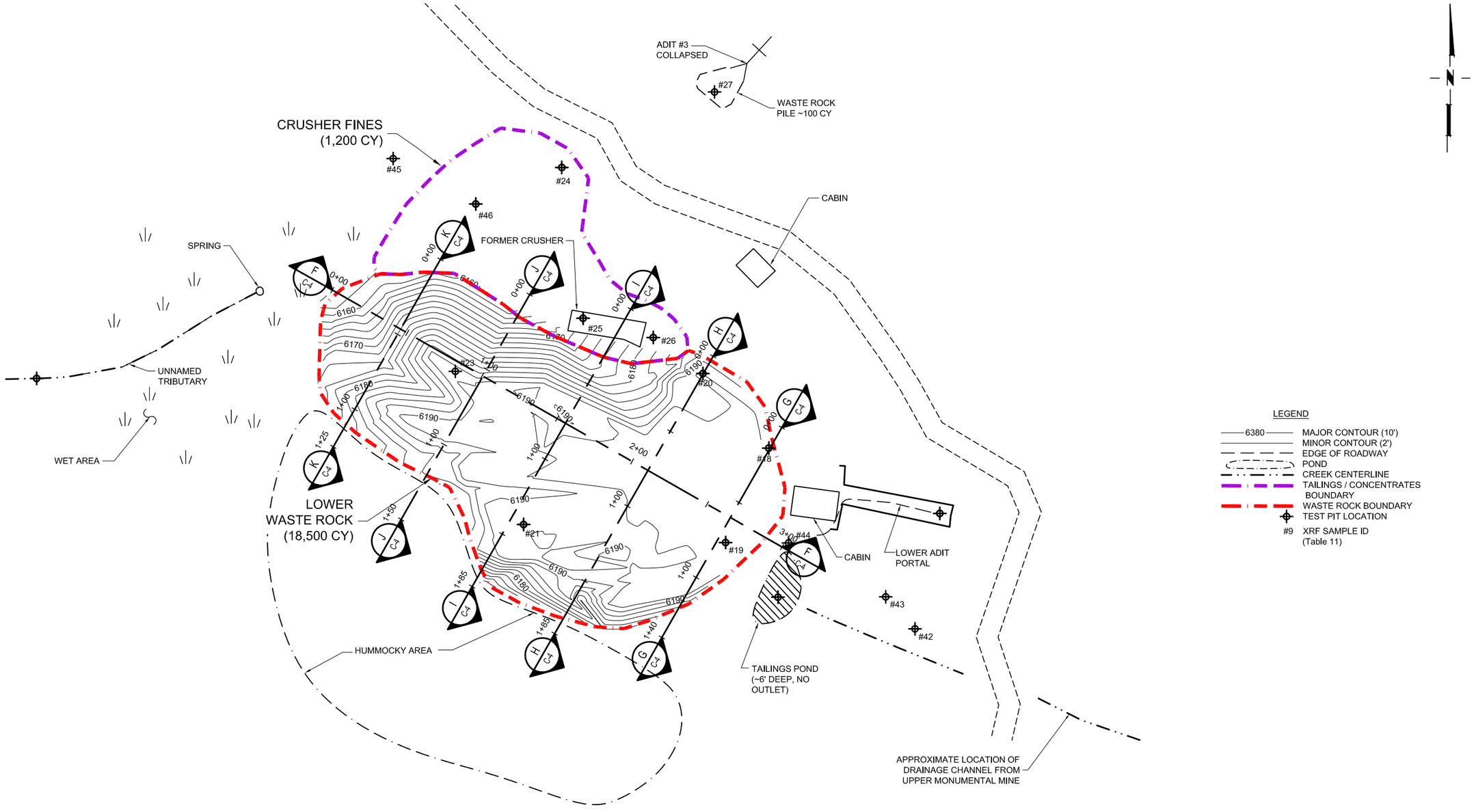


Figure C-1. Upper Monumental Mine Test Pit XRF Sample Locations

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/10/2011	
DWG BY: 8DEO DWG NO: 2723018 F-2,3 & C1-C4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company



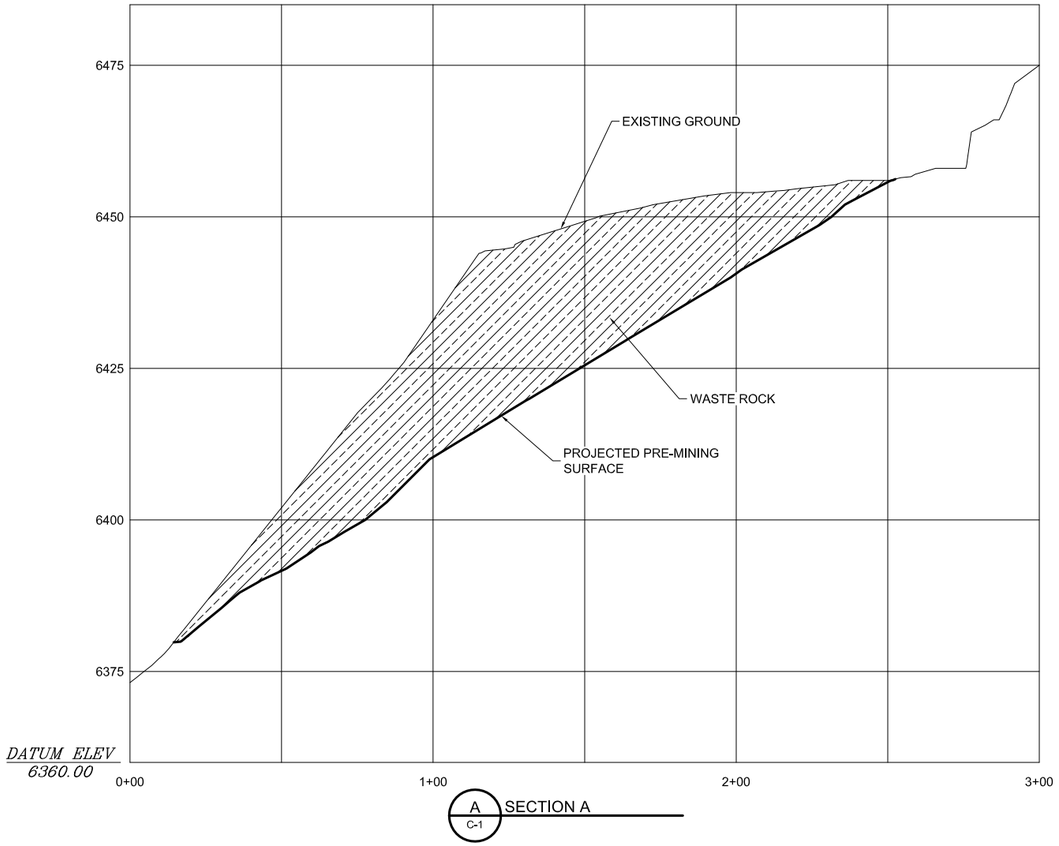
LOWER MINE SITE LAYOUT

0 30 60 FEET

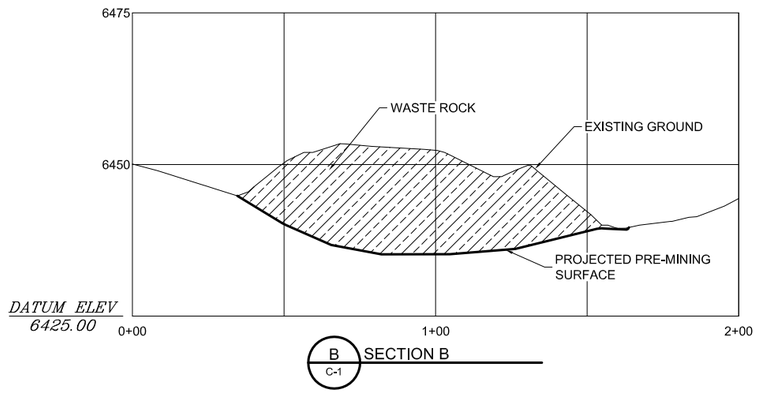
SCALE

Figure C-2. Lower Monumental Mine Test Pit XRF Sample Locations

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/10/2011	
DWG BY: 8DEO / DWG NO: 2723018 F-2,3 & C1-C4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company



A SECTION A
C-1



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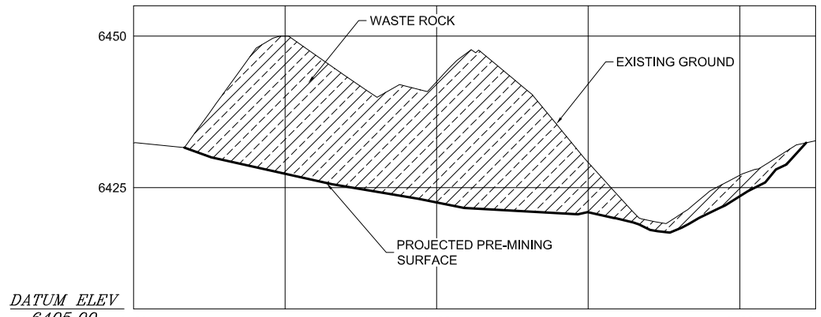
C-1



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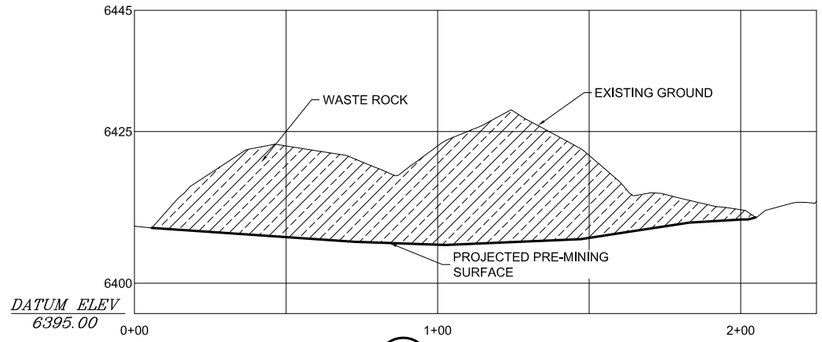
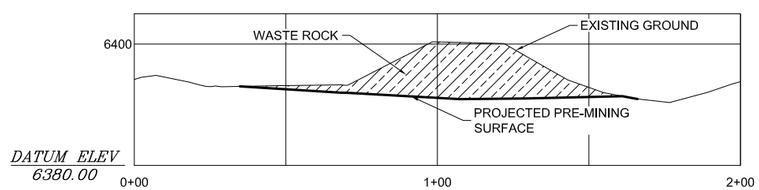
C-1



D SECTION D
C-1

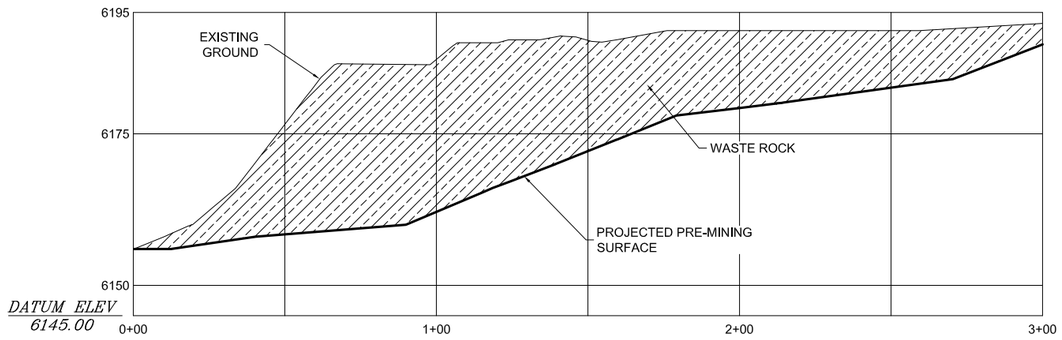


E SECTION E
C-1

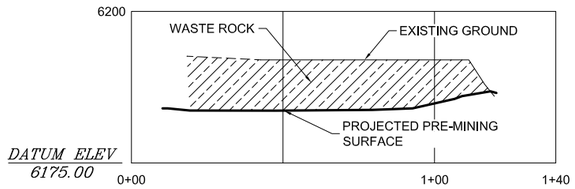
Figure C-3. Upper Waste Rock Sections

0 25 50 FEET
SCALE
2 X VERTICAL EXAGERATION

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Upper Granite Creek
DATE: 5/4/2011	
DWG BY: 8DEO / DWG NO: 2723018 F-2,3 & C1-C4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

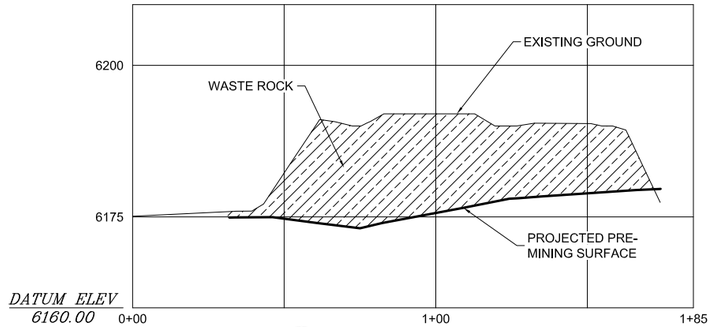


F C-2 SECTION F

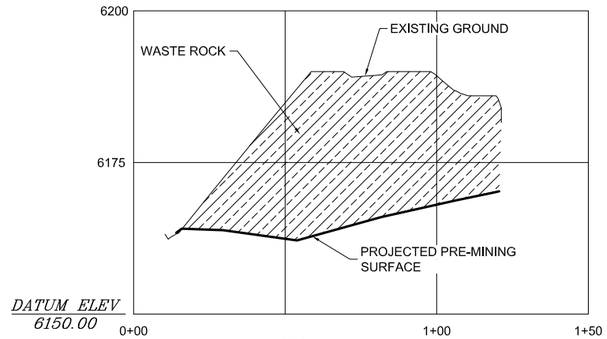


G C-2 SECTION G

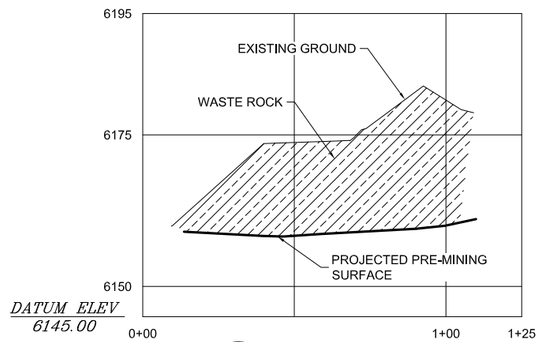
H C-2 SECTION H



I C-2 SECTION I



J C-2 SECTION J



K C-2 SECTION K

Figure C-4. Lower Waste Rock Sections

0 25 50 FEET
SCALE
2 X VERTICAL EXAGERATION

PROJECT NUMBER: 2723018	US Forest Service Engineering Evaluation / Cost Analysis Granite Creek EECA
DATE: 5/4/2011	
DWG BY: 8DEO DWG NO: 2723018 F-2,3 & C1-C4.dwg	Wallowa Whitman National Forest Grant County, Oregon
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

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Appendix B.

Wetland Delineation Report

Wetland Delineation Report
Monumental Mine Data Gap Assessment
Grant County, Oregon

May 2011

Project Number 2723018-007

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Wetland Delineation Report
Monumental Mine Data Gap Assessment
Grant County, Oregon

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Prepared By:	Cascade Earth Sciences 3511 Pacific Boulevard SW Albany, Oregon 97321 (541) 926-7737
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Report Date:	May 2011
Project Number:	2723018-007
Submitted By:	

Ryan Tobias, Project Biologist

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EXECUTIVE SUMMARY

Cascade Earth Sciences (CES) has prepared the following wetland delineation report in preparation of the remediation of mine-related contamination at the U.S. Forest Service (Forest Service) Monumental Mine (Site).

- This delineation was conducted in concurrence with the Engineering Evaluation / Cost Analysis (EE/CA) for completing a Non-Time-Critical Removal Action related to hazardous substances in the Upper Granite Creek Watershed near Granite, Oregon (Site).
- The purpose of this delineation was to identify wetland boundaries, characteristics, functions, values, and area, and provide mitigation recommendations for wetlands disturbed during Site remediation.
- Typically, the Oregon Department of State Land and U.S. Army Corps of Engineers (Corps) would have jurisdiction of any impacts to onsite wetlands. However, this delineation was conducted within the authority of a federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup. As such, the U.S. Environmental Protection Agency (USEPA) has jurisdiction over Site wetlands (40 Code of Federal Regulation [CFR] 300.400(e); USEPA, 1992).
- Per Executive Orders 12580 and 13106, the President of the United States has delegated authority to the U.S. Department of Agriculture (USDA) to conduct CERCLA actions for projects administered inside National Forest System (Forest Service) lands. Thus, the Forest Service is the lead agency for CERCLA actions at the Site.
- While the local, regional, and national wetland regulations are not applicable, they are relevant and appropriate. Therefore, efforts reported herein were conducted to comply with appropriate state and federal wetland regulations.
- The wetland delineation was conducted using criteria outlined in the 2008 Interim Regional Supplement to the Corps Wetland Delineation Manual. Results of the delineation identified one wetland area at the Site, approximately 0.08 acres in size.

Proposed remedial actions at the Site may include removal of mine-contaminated tailings within the delineated wetland. Loss of wetlands resulting from removal of the tailings material should be mitigated by restoring the disturbed portion of the wetland or creating a new area of wetland.

- Compensatory mitigation is required for fill or excavation activities within a wetland.
- The proposed remedial action may require excavation of the upper and middle tailings ponds portions of the wetland (about 0.04 acres). Wetland restoration and creation replacement ratios are as follows:
  - Restoration ratio is 1:1 (1 acre restored for every 1 acre lost).
  - Creation ration is 1.5:1 (1.5 acres created for every 1 acre lost).
- Restoration/creation of approximately 0.04 to 0.06 acres is recommended to compensate for wetlands excavated during possible Site remedial actions.
- The actual acreage of filled wetlands (if necessary) and subsequent final determination of mitigation acreage can be verified following development of the final remedial design.

1.0 INTRODUCTION AND PURPOSE

Cascade Earth Sciences (CES) has prepared the following Wetland Delineation report in concurrence with the Engineering Evaluation / Cost Analysis (EE/CA) for completing a Non-Time-Critical Removal Action (RA) related to hazardous substances at the abandoned Monumental Mine (Site) in Grant County, Oregon. The Site consists of an abandoned underground gold mine located in the Wallowa-Whitman National Forest, about 8 aerial miles north of Granite, Oregon, along Forest Road (FR) 7345 (Appendix A; Figure 1).

This Wetland Delineation was completed in general accordance with the Interim Regional Supplement to the Corps of Engineers (Corps) Wetland Delineation Manual (Corps, 2008). The purpose of the delineation is to document acreage and functions of onsite wetlands for the purposes of possible mitigation following removal of hazardous substances. This delineation was conducted within the authority of a federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup. As such, no federal, state, or local permits are required to perform on-site repose actions pursuant to CERCLA Sections 104, 106, 120, 121, or 122 (40 CFR 300.400(e)). Although procedural (permit or permit equivalency) approval is not and applicable or relevant and appropriate requirements under CERCLA Section 121(d)(2) and the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA, 1992), the efforts reported herein were conducted to comply with appropriate state and federal wetland regulations.

Proposed Removal Alternatives outlined in the EE/CA report include excavation and disposal of hazardous substances from areas at the Site with wetland characteristics. Therefore, a delineation is required to identify appropriate mitigation activities to be completed as part of the RA. Moreover, a functional assessment was performed to document current functions and values of wetlands located in the footprint of proposed RA areas.

2.0 SITE SETTING AND LAND USE

The wetland Assessment Area (AA) is located near the headwaters of an unnamed tributary to Granite Creek at an elevation of approximately 6,300 feet above mean sea level (amsl; USGS, 1982).

- The Monumental Mine, millsite, adits, settling ponds, tailings, and waste rock piles are approximately 10 acres in size (EA, 2003).
- The AA is about 0.1 acres in size, and includes two settling ponds and connecting riparian area located downslope from the former mill.
- This AA was selected because wetland characteristics and contaminated mine tailings were identified in this area of the Site. Therefore, RA activities at the Site could impact wetland functions and values.
- Additional wetlands are potentially located within boundaries of the 10-acre Site. These areas were not delineated as part this assessment since it in not anticipated they will be impacted during the RA.
- Slopes vary within the Site, but are moderately to relatively steep, with depositional areas near the headwaters of the unnamed tributary.
- These depositional areas are located downslope from the millsite, and were likely formed by dumping tailings from the mill. The two former settling ponds within the AA are the focus of this wetland delineation.
- Unvegetated to sparsely vegetated waste rock piles located upslope from the AA likely contribute to sedimentation and ongoing contaminant loading to the AA via overland erosion, leaching, infiltration, and subsurface transport.

- General topography trends downhill toward the northwest.
- The Site is administered by the Forest Service, with active claims at the Upper and Lower Monumental Mine adits (Appendix A; Figure 2).
- The landscape is dominated by mid to late-successional conifer forest with a subalpine fir/grand fir/ Engelmann spruce overstory.
- Runoff is directed to the northwest and locally toward the unnamed tributary, which bisects the AA.
- The settling ponds appear to be hydraulically connected. No outlet was observed from the lowest settling pond during field investigation activities.
- The unnamed tributary daylights downslope from the lowest waste rock pile and converges with Granite Creek, about 2.5 miles west of the Site.
- Color photographs of the AA are presented in Appendix C.

3.0 SITE ALTERATIONS

Gold mining activities began in the Granite Creek area in the 1860's (EA, 2003). The Monumental Mine was discovered and claimed in 1870. In 1875, a 20-stamp mill and chlorination plant were constructed and the mine and mill operated intermittently until about 1928.

Many of the remnants from mining operations remain at the Site, which include the following:

- The foundation and timbers of the former 20-stamp mill, floatation table, and chlorination flue (millsite upslope from the AA).
- Two adits and large waste rock piles. The upper adit and waste rock pile are located upslope from the AA and could contribute contaminant loading to the wetland.
- Contaminated tailings adjacent to the south and upslope from the upper settling pond. These tailings likely contribute to arsenic and other hazardous substances loading to the wetland.
- Two filled settling ponds in series, which are the focus of this delineation.
- The ponds are located to the northwest and downslope from the former millsite, adit, waste rock piles, and tailings piles.
- The former settling ponds were likely created to dump contaminated tailings from the mill. These depositional areas were also probably filled with depositional sediment since mining and milling operations ceased at the Site.
- The former settling ponds are primarily filled with tailings and depositional sediment and are vegetated with palustrine emergent wetland plants.

4.0 PRECIPITATION DATA AND ANALYSIS

The Site is located within the Blue Mountain physiographic province at an elevation of approximately 6,300 feet amsl.

- In the Blue Mountains, the fall, winter, and spring months are typically cold and wet, while summer months are warm and dry.
- At the Granite 4 west southwest (WSW) weather station, which operated from 1948 to 1967 about 8 miles southwest of the Site, approximately 84% of annual precipitation was recorded between the months of October and May, with snowfall the primary source of precipitation between November

and April (WRCC, 2010). Precipitation recorded at this weather station showed average annual precipitation was 26.37 inches per year.

The nearest continually operating weather station in the Blue Mountains is located at Meacham, Oregon, approximately 60 miles north of the Site at an elevation of 4,055 feet amsl.

- Precipitation totals average about 34.13 inches per year at the Meacham #2 (355394) station (NOAA, 2009).
- Table 1 (Appendix D) includes a summary of precipitation data for the 2008-2009 water year for the Meacham #2 weather station.
- In addition, the table below identifies precipitation during the three months preceding the delineation, as well as the water year beginning October 1, 2008.

Table A. Summary of Normal and Recorded Precipitation Between July 1, 2009 and September 31, 2009, Meacham, Oregon Station

Category	July 2009	August 2009	September 2009	Total Water Year to Date
Recorded Precipitation	0.39 in.	1.36 in.	Trace	34.13 in.
Precipitation Average	0.21 in.	0.77 in.	1.72 in.	27.21 in.
Percent of Normal	186%	176%	0%	125%

NOTE: Data obtained from the NOAA online weather data website: http://www.weather.gov/climate/. July 2009 data were obtained from the Weather Underground website: www.wunderground.com

As shown, precipitation trends varied in the months preceding the delineation.

- Precipitation totals in July and August 2009 were well above average.
- Very little precipitation fell in the month of September 2009, which is well below average.
- Collectively, precipitation for the three months preceding the delineation was about 65% of average.

Table B. Summary of Recorded Precipitation Between September 15-30, 2009 and October 1, 2009, Meacham, Oregon Station

Category	September 15-30 2009	October 1, 2009	Total Water Year to Date
Recorded Precipitation	Trace	0.05 in.	34.13 in.
Average*	~ 0.86 in.	--	27.21 in.
Percent of Normal	0%	--	125%

NOTE: Average was calculated from half the average monthly total of 1.72 inches.

As shown, about 0.05 inches of precipitation fell the day of the delineation, and a trace of precipitation was recorded for the two weeks preceding the investigation in September 2009.

- The monthly average for September is 1.72 inches of precipitation.
- As such, precipitation for the two weeks preceding the delineation was well below average.
- However, precipitation for the water year (October 1, 2008 – September 30, 2009) was about 125% of average.

5.0 WETLAND DELINEATION METHODS

On October 1, 2009, Ryan Tobias and Timothy Otis, P.E., of CES conducted a routine wetland delineation of the AA. The study area includes the upper settling pond, downslope along the riparian area of the unnamed tributary, to the second settling pond. The wetland delineation methodology for this investigation included the following:

- Previous investigations and public domain resources were reviewed prior to the field effort to determine, to the extent possible, existing conditions and potential wetland indicators on the subject property. These resources included:
  - Site Inspection Report (EA Engineering, Science, and Technology, 2003).
  - The Mt. Ireland, Oregon quadrangle National Wetland Inventory (NWI) map (Appendix A; Figure 3).
  - Forest Service Wallowa Whitman soils data (Appendix A; Figure 4).
  - Historic aerial photographs (Appendix A; Figures A1-A4).
- Nine data plot locations were identified, three within the wetland and six outside the wetland, to determine wetland/upland characteristics.
- Soil conditions at the Site were determined by advancing shallow hand auger borings at the established data plots to approximately 18 inches or refusal. A Munsell color chart was used to identify soil hue, value, and chroma at each data plot.
- Hydrologic conditions were documented at each data plot.
- Vegetation and estimated percent cover were documented within a 20-foot radius of each data plot.
- Wetland boundaries were delineated, flagged, and surveyed by Anderson Perry and Associates, Inc. in La Grande, Oregon
  - For each distinct wetland area, representative data plots were selected to characterize both wetland and upland habitats.
  - Nine data plots MMW-1 through MMW-9 (Figure 5) were established to collect vegetation, soils, and hydrology information. Each data plot was flagged and mapped with a handheld global positioning system (GPS) device.
- Wetland conditions were determined using the *2008 Corps Interim Regional Supplement to the Corps of Engineering Wetland Delineation Manual* (Corps, 2008).
- A routine wetland determination was used since wetlands within the subject property contained homogeneous vegetation, soil, and hydrologic regimes.
- Data regarding vegetation, soil, and hydrology were collected at each sample plot and recorded on routine wetland determination data forms, which are presented in Appendix B.
- The wetland boundaries were determined at the location in which upland conditions changed to wetland conditions. Wetland conditions were defined by the following three parameters:
  - Dominant plant species were considered hydrophytic by the U.S. Fish and Wildlife Service (USFWS) (Reed, 1988; Reed et, al, 1993).
  - Soil was considered hydric under federal definition.
  - Hydrologic conditions meeting the federal wetland definitions were present or inferred.
- Wetland functions and values were determined using the Oregon Wetland Assessment Protocol (ORWAP) (reference) method, as defined by DSL regulations and guidance (Oregon Administrative Rule [OAR] 141-090-005 to 0055; DSL, 2009) and were determined with consideration of the entire wetland system associated with onsite wetlands.

6.0 DESCRIPTION OF WETLAND AND NON-WETLAND WATERS

A 0.08-acre contiguous wetland was delineated within the AA during field activities at the Site. The boundaries and characteristics of the wetland system are described below:

- The delineated wetland is a Palustrine Emergent (PEM)/riverine wetland that extends from the upper settling pond, along the riparian corridor of the unnamed tributary, to the bottom of the second settling pond.
- Data plots MMW-2, MMW-5, and MMW-8 were located within the wetland area. Please refer to Appendix B for additional information regarding these sample plot characteristics.
- The wetland supports various hydric plant species, dominated by Pacific onion (*Allium validium* OBL); tall managrass (*Glyceria elata* FACW); spotted saxifrage (Saxifraga punctata FAC); cow parsnip (*Heracleum lanatum* FAC); and monkey flower (*Mimulus spp*.) (possibly musk flower).
- Upland plots included a variety of coniferous species such as subalpine fir (*Abies lasiocarpa* FACU), grand fir (*Abies grandis* NI), lodgepole pine (*Pinus contorta* FAC-), Engelmann spruce (*Picea* engelmannii FAC), and Western larch (*Larix occidentialis* FACU). Understory species in upland plots included Idaho fescue (*Fescue idahoensis* NI), one-sided wintergreen (*Pyrolla secunda* FACU), and Canada goldenrod (*Solidago canadensis* FACU).
- Wetland hydrology is provided by perennial flow from a spring that forms the headwaters of the unnamed tributary to Granite Creek. The spring is located approximately 150 feet upslope from the upper settling pond.
- Seeps also emanate adjacent to the unnamed tributary channel and appear to provide year-round flow to the wetland system.
- Saturated conditions and surface water flow were noted during the delineation throughout the wetland area.
- The frequency and duration of saturated conditions support hydric soil characteristics in the wetland.
- Hydric soil criteria were met in three of the nine data plots established at the Site.
    - Soils collected from data plots MMW-2, MMW-5, and MMW-8 exhibited characteristics commonly observed in hydric soils (e.g., saturation in the upper 12-inches, matrix color, and sediment deposits).
    - Gleyed soil conditions were noted within plot MMW-5 from 9 to 18 inches.
    - Apparent mine tailings were encountered in wetland plots MMW-2, and MMW-8 during the field investigation at depths ranging from 10 to 18 inches below ground surface.
    - Upland habitat (Data Plots MMW-1, MMW -3, MMW -4, MMW -6, MMW -7, and MMW -9) was dominated by dry shallow forest soils consisting of duff/litter, underlain by loamy silt and gravel.

7.0 DEVIATION FROM LOCAL WETLAND INVENTORY OR NATIONAL WETLAND INVENTORY

Prior to conducting field activities at the Site, the Mt. Ireland 7.5-minute Quadrangle NWI map was reviewed to identify the possible presence of wetlands (Appendix A; Figure 3). There is no known local wetland inventory (LWI) map for the Site or surrounding areas.

- A review of the NWI map of the Site identified the unnamed tributary channel as riverine, upper perennial, unconsolidated bottom, permanently flooded (R3UBH) (USFWS, 1994).

- The NWI map did not show the presence of wetlands at the site.
- The onsite delineation identified a wetland system within this channel, however; the primary feature of the wetland system is the two settling ponds, which support PEM/riverine vegetation.

8.0 MAPPING METHOD

Wetland boundaries were marked with numbered flags during delineation activities at the Site using ribbon flagging and/or colored pin flags.

- The wetland boundaries were surveyed by a Professional Land Surveyor from Anderson Perry Associates, Inc.
- Flags were surveyed to an accuracy of one foot and the survey was extended approximately 100-feet beyond the wetland boundary.

A map of the delineated wetland is included in Appendix A (Figure 5).

9.0 ADDITIONAL INFORMATION

A review of public domain documents provided soil, wetland, rare, threatened or endangered species presence information, and historical background information for the Site. This information is presented in the following sections.

9.1 Soils

Preliminary soils data for the Site were provided by the Wallowa-Whitman National Forest, Baker Ranger District (USFS, 2010). A copy of the soil survey map for the Site is presented in Appendix A (Figure 4).

- The AA is mapped within soil type 0991CS. This soil is characterized by the Elkhorn, Prouty, and Hoffer components on 30 to 60 percent slopes.
  - Elevations range from 6,273 to 7,037 feet amsl.
  - Soils are typically well-drained.
  - The typical profile includes ashy sandy and silty loam, underlain by sandy to cobbly loam, with bedrock encountered at approximately 15 inches to 57 inches below ground surface.

9.2 Aerial Photograph Review

Aerial photographs can sometimes help identify historic areas of inundation and/or wetland features at a property. Evaluation of aerials is controlled by the photograph scale and quality. CES reviewed reasonably available aerial photographs depicting the Site and surrounding vicinity at periodic intervals (UO, 2009).

A total of 4 aerial photographs were available for review for the years 1956, 1971, 1994, and 2005. CES has summarized information from the review in Table C and provided copies of the aerial photographs in Appendix A (Figures A1-A4).

Table C. Aerial Photograph Review of the Site and Surrounding Areas

Date	Description
1956	The Site appears to be primarily forested, although a slight change in vegetation type is apparent at the assessment area. Waste rock piles are visible to the east and west. A cleared area adjacent to the south of the Site appears to have one structure. Remaining areas surrounding the Site are primarily forested.
1971	The Site and surrounding areas are relatively unchanged from the 1956 photograph.
1994	The Site appears to be primarily forested, with a very slight change in vegetation type depicted at the assessment area. A road is visible adjacent to the east of the Site, beyond which, is an apparent waste rock pile. Additional roadways and clearcuts are depicted to the north and west of the Site. The remaining areas are primarily forested.
2005	The Site and surrounding areas are relatively unchanged from the 1994 photograph.

As shown, a slight difference in vegetation type was visible at the AA in the available historic aerial photographs. The AA appears to have a more open canopy than the surrounding forested areas. Wetlands at the Site could not be deciphered on the aerial photographs.

9.3 Historic Photograph – Monumental Mine

CES has included a historic photograph of the Monumental Mine for reference purposes (Figure 6). The photograph depicts the 20-stamp mill, chlorination plant and exhaust, and approximate location of the upper settling pond in the AA (Baker County, 2009). Widespread Site alterations are visible in the photograph, including logging around the upper settling pond and headwaters of the unnamed tributary.

9.4 Rare, Threatened, and Endangered Species

A review of the possible presence of Rare, Threatened, and Endangered species was conducted as part of the SI (EA, 2003). The report identified the potential presence of the following species:

- Mid-Columbia River steelhead (federal threatened)
- Bull trout (federal threatened)
- Inland redband trout (species of concern)
- Westslope cutthroat trout (species of concern)
- Olive sided flycatcher (species of concern)
- Columbia spotted frog (state sensitive)

The presence of these species was not field verified during wetlands delineation activities. However, fish have been documented in the unnamed tributary to Granite Creek, which originates at the Site wetland.

10.0 WETLAND FUNCTIONAL ASSESSMENT

The purpose of the wetland functional assessment is to document wetlands and values anticipated to be lost as a result of the project and to assess mitigation success in terms of lost function and value replacement.

- The Oregon Rapid Wetland Assessment Protocol (ORWAP; Adamus et al., 2009) was used to evaluate the functions and values of the Site wetland. Using the ORWAP provides a rating score between 0 (low) and 10 (high) for selected wetland functions and values. The highest ratings identify the principle functions and values for a given wetland that should be protected or replaced (mitigated for), and lower ratings identify functions and values that may be improved during mitigation actions.

- The tables of ORWAP output scores calculated for the Site wetland are provided in Appendix D.
- Functions are the physical, chemical, and biological processes that characterize wetland ecosystems.
- ORWAP function scores rate the relative effectiveness of the wetland in performing each function.
- Values are the importance (worth) of wetland functions that include public attitude and the opportunity for a wetland to provide a specific function based on location.

Function and value scores are described in the Table D.

Table D. Oregon Rapid Wetland Assessment Protocol Function Scores for the Forest Service – Monumental Wetland

Function	Relative Effectiveness of the Function	Relative Value of the Function
Water Storage and Delay (WS)	0.00	2.92
Sediment Retention and Stabilization (SR)	7.17	2.94
Phosphorus Retention (PR)	9.08	4.18
Nitrate Removal and Retention (NR)	5.33	4.35
Thermoregulation (T)	0.00	0.00
Carbon Sequestration (CS)	4.19	
Organic Matter Export (OE)	0.00	
Aquatic Invertebrate Habitat (INV)	3.50	5.28
Anadromous Fish Habitat (FA)	0.00	0.33
Non-Anadromous Fish Habitat (FR)	1.50	10.00
Amphibian and Reptile Habitat (AM)	4.80	6.67
Waterbird Feeding Habitat (WBF)	0.33	4.50
Waterbird Nesting Habitat (WNH)	0.00	3.00
Songbird, Raptor, & Mammal Habitat (SBM)	5.28	3.33
Pollinator Habitat (PH)	4.95	5.00
Native Plant Diversity (PD)	3.33	5.14

As shown, function and value scores varied greatly for the Site wetland. Based on this:

- Potential enhancement opportunities are available for a number of components that scored low in the ORWAP assessment.
- Some functional components such as anadromous fish habitat cannot be enhanced since these species do not inhabit the uppermost headwaters of Granite Creek and tributaries.

Grouped services are considered a "roll-up" of individual functions and their associated values. A summary of grouped service function scores is provided in Table E.

Table E. Oregon Rapid Wetland Assessment Protocol Group Service Function and Value Scores for the Forest Service – Monumental Wetland

Grouped Service Function	Group Function Scores	Group Value Scores
Hydrologic Function (WS)	0.00	2.92
Water Quality Support Group	9.08	4.35
Carbon Sequestration Function	4.19	
Fish Support Group (FISH)	1.50	10.00
Aquatic Support Group (AQ)	4.80	6.67
Terrestrial Support Group (TERR)	5.28	5.14
Public Use & Recognition (PU)		0.83
Provisioning Services		0.00
Other Attributables		
Wetland Ecological Condition [1]		5.73
Wetland Stressors [2]		6.44
Wetland Sensitivity [3]		5.07

NOTES:
1 Condition is the integrity or health of a wetland based primarily on the vegetation component.
2 Stressors include the degree to which the wetland has been recently altered by, or exposed to risk, from human alterations.
3 Sensitivity is the resistance and resilience of a wetland to human and natural stressors.

11.0 RESULTS AND CONCLUSIONS

CES has completed a wetland delineation of the former settling ponds and riparian channel at the Forest Service Monumental Mine in Grant County, Oregon. Results of this delineation identified the following:

- Based on soil, vegetation, and hydrological conditions exhibited during the field investigation, one 0.08-acre PEM/riverine wetland was delineated at the Site.
- An assessment of functions and values was completed using ORWAP. The assessment identified a wide variety of component values.
- The highest function scores were for phosphorus retention and sediment retention and stabilization. Function scores of 0 were exhibited for water storage and delay, thermoregulation, organic matter export, anadromous fish habitat, and waterbird nesting habitat. Other low function scores were identified for non-anadromous fish habitat, waterbird feeding habitat, and native plant diversity.
- The ecological condition of the wetland, based solely on the vegetative component, scored 5.73. The stressor score, which measures alterations and risk to the wetland, measured 6.44. The wetland sensitivity score was 5.07.
- The ponds will likely need to be remediated as part of the CERCLA non-time critical RA at the Site.
- The wetland is considered to have a high potential for enhancement.
- Remediation of hazardous substances within the settling ponds will result in unavoidable impacts to the wetland. The RA must therefore include measures to avoid and minimize wetland impacts, and impacts to the unnamed tributary channel between the settling ponds should be avoided.

12.0 PROPOSED WETLAND IMPACTS AND MITIGATION OPTIONS

Remedial alternatives for the Monumental Mine are described in the EE/CA document. Proposed remedial actions at the Site may include removal of tailings from the settling ponds and restoration of the wetland system. The contaminated tailings are proposed to be disposed in an onsite repository.

- Compensatory mitigation is required for fill or excavation activities within a wetland.
- The proposed remedial action would excavate tailings from approximately 0.04 acres of wetland.
- To meet the 1:1 restoration mitigation ratio requirements approximately 0.04 to 0.06 acres of the excavated area will be restored to equivalent or enhanced pre-remediation functions and values.
- The actual acreage of excavated wetlands and subsequent final determination of restoration acreage can be verified following development of the final remedial design.

12.1 Mitigation Assumptions and Alternatives

12.1.1 Assumptions

The following assumptions have been developed with respect to wetland remedial activities:

- The Site waste rock and tailings piles will be excavated and disposed in an onsite repository. As such, sources of arsenic contamination, including the contaminated tailings within the AA, will be removed from the wetland and upslope sources.
- Since the source of arsenic contamination will be removed during the RA, the newly restored wetland system will not need to be engineered to treat contaminated water originating from the mine.

12.1.2 Goals

The primary objective of wetland restoration is promotion of native wetland characteristics with functions and values higher than pre-remediation conditions. To meet this objective, the following mitigation alternatives have been developed for the Site:

Mitigation options should include preservation of the current riparian areal extent, connecting the upper and middle settling ponds, and restoration of about 0.04 acres of wetland impacted from RA activities at the Site.

- Details of the wetland restoration, if completed, will be provided at a later date. Restoration may include replacement of contaminated tailings with clean organic fill and contouring to promote water retention within these areas.
- Target wetland types should resemble the current filled settling ponds and could include replanting of dominant species.
- As discussed in Section 9.4, the fish have been documented in the unnamed tributary to Granite Creek, which originates at the Site wetland. Moreover, federally threatened summer steelhead have been documented at the confluence of the unnamed tributary and Granite Creek. Therefore, water quality at the Site and downstream from the Site; fish and wildlife habitat; and human health/ecological considerations should be the key functions and values targeted for wetland restoration planning.
- The restoration will include post-construction monitoring and ORWAP assessment to verify enhanced wetland functions and values.

13.0 DISCLAIMER

This report documents the investigation, best professional judgment, and conclusions of the investigator. It is correct and complete to the best of CES' knowledge. It should be considered a Preliminary Jurisdictional Determination of wetlands and other waters of the state and used for CERCLA response actions conducted entirely on-site, where such action is selected and carried out in compliance with CERCLA Section 121(e)(1).

LITERATURE CITATIONS

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15. United States Geological Survey (USGS), 1982. 7.5 Minute Series Topographic Map Mt. Ireland, Oregon. U.S. Geological Survey, Washington, D.C.

16. Western Regional Climate Center (WRCC), 2010. "Period of Record Monthly Climate Summary, Granite 4 WSW, Oregon (353430)." wrcc@dri.edu. Western Regional Climate Center website. Accessed January 4, 2010.

APPENDICES

A. Maps

Figure 1. Site Location Map
Figure 2. Tax Lot Map
Figure 3. National Wetland Inventory Map
Figure 4. Soil Survey Map
Figure 5. Wetland Delineation Map
Figure 6. Historic Mine Photograph

Aerial Photographs

A1. 1956 Aerial Photograph
A2. 1971 Aerial Photograph
A3. 1994 Aerial Photograph
A4. 2005 Aerial Photograph

B. Field Data Forms

C. Ground Level Color Photographs

D. Additional Tables and Information

1. **Summary of Precipitation for 2008-2009 Water Year**
2. **Precipitation Data from the NOAA Online Weather Database**
3. **ORWAP Calculation Tables**

Appendix A.

Maps

Aerial Photographs

Appendix B.

Field Data Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-1

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 30

Subregion (LRR): E Lat: N 44° 51.627' Long: W 118° 21.217' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes _____ No X**
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20-foot radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies lasiocarpa	30	Yes	FACU
2. Pinus contorta	10	No	FAC-
3.			
4.			
	40 = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Chimpaphilia umbellata	10	No	--
2. Vaccinium spp	5	No	--
3.			
4.			
5.			
	15 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Fragaria virginiana	5	No	UPL
2. Fescue idahoensis	15	No	NI
3. Solidago canadensis	5	No	FACU
4. Mertensia paniculata	<1	No	FACW
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	25 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 75

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes _____ No X**

Remarks:

SOIL

Sampling Point: MMW-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-4"							Duff/Litter	
4-15"	10YR 2/2	100					Loamy silt	Dark brown
15-18"	2.5YR 3/2	100						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-2

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 0

Subregion (LRR): E Lat: N 44° 51.618' Long: W 118° 21.225' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: PEMB

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No _____	**Is the Sampled Area within a Wetland?** **Yes X No _____**
Hydric Soil Present?	Yes X No _____	
Wetland Hydrology Present?	Yes X No _____	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Alnus tenuifolia	5	No	FACW
2. Ribes lacustre	5	No	FAC+
3. Ribes spp	5	No	--
4.			
5.			
	15 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Allium validium	30	Yes	OBL
2. Glyceria elata	35	Yes	FACW
3. Senecio triangularis	5	No	FACW+
4. Solidago canadensis	<1	No	FACU
5. Saxifraga punctata	20	Yes	FAC
6. Liverwort spp			
7. Moss spp			
8.			
9.			
10.			
11.			
	90 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

X Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X No _____**

Remarks:

SOIL

Sampling Point: MMW-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5”	7.5YR 3/1	100					Clayey silt	Dark brown
5-10”	7.5YR 4/4	100					Coarse sand	Brown/orange
10-18”	5YR 5/2	100					Tailings	Pink/brown/gray

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- X Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No _____

Remarks: Contaminated mine tailings encountered from 10-18”.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- X Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes X No _____ Depth (inches): At surface

Water Table Present? Yes X No _____ Depth (inches): 10”

Saturation Present? (includes capillary fringe) Yes X No _____ Depth (inches): At surface

Wetland Hydrology Present? Yes X No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-3

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 10-20

Subregion (LRR): E Lat: N 44° 51.621' Long: W 118° 21.240' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes _____ No X**
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20-foot radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies lasiocarpa	40	Yes	FACU
2. Larix occidentalis	20	Yes	FACU+
3. Pinus contorta	5	No	FAC-
4. Abies grandis	5	No	--
	70	= Total Cover	
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 20-foot radius)			
1. Pyrolla secunda	20	Yes	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	20	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____	= Total Cover	

% Bare Ground in Herb Stratum 80

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:	
OBL species	x 1 =	
FACW species	x 2 =	
FAC species	x 3 =	
FACU species	x 4 =	
UPL species	x 5 =	
Column Totals: (A)		(B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes _____ No X**

Remarks:

SOIL

Sampling Point: MMW-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5"							Duff/Litter	
5-8"	5YR 5/2	100					Tailings	Pink/brown
8-13"	10YR 2/2	100					Loamy silt	Dark brown
13-18"	2.5YR	100					Loamy silt	Brown

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks: Contaminated tailings from 5-8"

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-4

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 20

Subregion (LRR): E Lat: N 44° 51.630' Long: W 118° 21.244' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes _____ No X**
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20-foot radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies lasiocarpa	20	Yes	FACU
2. Picea engelmannii	30	Yes	FAC
3.			
4.			
	50 = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Chimpaphilia umbellata	5	No	--
2.			
3.			
4.			
5.			
	15 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Pyrola secunda	5	No	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	5 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 95

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes _____ No X**

Remarks:

SOIL

Sampling Point: MMW-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3"							Duff/Litter	
3-5"	5YR 5/2	100					Tailings	Pink/brown
5-14"	10YR 2/2	100					Loamy silt	Dark brown
14-18	2.5YR 3/2	100					Loamy silt	Brown

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks: Contaminated tailings present at 3-5"

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-5

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 10

Subregion (LRR): E Lat: N 44° 51.629' Long: W 118° 21.234' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: PEMB

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No _____	**Is the Sampled Area within a Wetland?** **Yes X No _____**
Hydric Soil Present?	Yes X No _____	
Wetland Hydrology Present?	Yes X No _____	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Alnus tenuifolia	5	No	FACW
2.			
3.			
4.			
5.			
	5 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Alium validium	30	Yes	OBL
2. Glyceria elata	30	Yes	FACW
3. Heracleum lanatum	<1	No	FAC
4. Solidago canadensis	5	No	FACU
5. Saxifraga punctata	10	Yes	FAC
6. grass spp	<1	No	--
7. Moss spp	--	--	--
8. Viola spp	5	No	--
9. Mimulus spp (moschatus)?	5	No	FACW+
10. Mertensia paniculata	2	No	FACW
11. Sandwort spp	2	No	--
	89 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 11

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

X Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X No _____**

Remarks:

SOIL

Sampling Point: MMW-5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8"	2.5YR 2.5/1	100					Clayey silt	Black
8-9"	7.5YR 3/2	100					Clayey sand	Brown
9-18"	Gley 3/5G	100					Clay	Gleyed

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- X Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No _____

Remarks: Possible iron/reducing conditions from 9-18".

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- X Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- X Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes X No _____ Depth (inches): At surface

Water Table Present? Yes _____ No X Depth (inches): --

Saturation Present? (includes capillary fringe) Yes X No _____ Depth (inches): At surface

Wetland Hydrology Present? Yes X No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-6

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 25

Subregion (LRR): E Lat: N 44° 51.621' Long: W 118° 21.240' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes _____ No X**
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20-foot radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies grandis	20	Yes	--
2. Pinus contorta	25	Yes	FACU-
3.			
4.			
	45 = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Chimpaphila umbellata	5	No	--
2.			
3.			
4.			
5.			
	5 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Pyrolla secunda	5	No	FACU
2. Solidago canadensis	10	Yes	FACU
3. Fragaria virginiana	5	No	UPL
4. Fescue idahoensis	10	Yes	NI
5. Eroginum spp	2	No	--
6. Penstemon spp	2	No	--
7.			
8.			
9.			
10.			
11.			
	34 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 66

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes _____ No X**

Remarks:

SOIL

Sampling Point: MMW-6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-4"							Duff/Litter	
4-8"	10YR 2/2	100					Loamy silt	Dark brown
8-18"	2,5YR 3/2	100					Loamy silt	Brown
18"		100					Gravel	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Gravel

Depth (inches): 18"

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-7

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 25

Subregion (LRR): E Lat: N 44° 51.638' Long: W 118° 21.262' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes _____ No X**
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20-foot radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies lasiocarpa	20	Yes	FACU
2. Picea engelmannii	30	Yes	FAC
3. Larix occidentalis	5	No	FACU
4. Pinus contorta	5	No	FAC-
	60 = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Vaccinium spp	<1	No	--
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Pyrola secunda	2	No	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	2 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 98

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes _____ No X**

Remarks:

SOIL

Sampling Point: MMW-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2"							Duff/Litter	
2-9 "	2.5YR 3/2	100					Loamy silt	Brown
9"	Refusal							

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Bedrock?

Depth (inches): 9"

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-8

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 0

Subregion (LRR): E Lat: N 44° 51.643' Long: W 118° 21.251' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: PEMB

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No _____	**Is the Sampled Area within a Wetland?** **Yes X No _____**
Hydric Soil Present?	Yes X No _____	
Wetland Hydrology Present?	Yes X No _____	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Saxifraga punctata	5	No	FACW
2. Solidago cana	5	No	FACU
3. Claytonia sibirica	5	No	FAC
4. Abies grandis	5	No	--
5.			
	20 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Moss spp	--	--	--
2. Glyceria elata	40	Yes	FACW
3. Heracleum lanatum	15	Yes	FAC
4. Mimulus spp (moschatus)?	10	Yes	FACW+
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	65 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 35

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

X Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X No _____**

Remarks:

SOIL

Sampling Point: MMW-8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2"	2.5YR 3/1	100					Peat	Organic/Black
2-6"	10YR 5/4	100					Coarse sand	Light brown
6-12"	2.5YR 2.5/1	100					Clayey silt	Black
12-18"	5YR 5/2	100					Tailings	Pink/brown/gray

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- X Histosol (A1)
- X Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- X Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ___

Remarks: Contaminated tailings present at 12-18"

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- X Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes X No ___ Depth (inches): At surface

Water Table Present? Yes X No ___ Depth (inches): 6"

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): At surface

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: USFS – Monumental Mine City/County: 8 Miles NE of Granite, Oregon Sampling Date: 10/1/2009

Applicant/Owner: U.S. Forest Service, Wallowa-Whitman National Forest State: Oregon Sampling Point: MMW-9

Investigator(s): Tobias/Otis Section, Township, Range: Section 18, Township 8 South, Range 36 East

Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): Concave Slope (%): 20

Subregion (LRR): E Lat: N 44° 51.634' Long: W 118° 21.262' Datum: NAD 1983

Soil Map Unit Name: Elkhorn, Prouty, Hoffer (0991CS) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes _____ No X**
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Site conditions were altered significantly due to mining practices that began in 1870. The area delineated includes two settling ponds from the mine with tailings material containing high concentrations of arsenic.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20-foot radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies grandis	<1	No	--
2. Picea engelmannii	50	Yes	FAC
3.			
4.			
	50 = Total Cover		
Sapling/Shrub Stratum (Plot size: 20-foot radius)			
1. Chimpaphila umbellata	5	No	--
2.			
3.			
4.			
5.			
	5 = Total Cover		
Herb Stratum (Plot size: 20-foot radius)			
1. Pyrola secunda	<1	No	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	0 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum 100

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	1	x 3 =	3
FACU species	1	x 4 =	4
UPL species	0	x 5 =	0
Column Totals:	2 (A)		7 (B)

Prevalence Index = B/A = 3.5

Hydrophytic Vegetation Indicators:

X Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes _____ No X**

Remarks:

SOIL

Sampling Point: MMW-9

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2"							Duff/Litter	
2-18 "	2.5YR 3/2	100					Loamy silt	Brown

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available: Aerial Photos reviewed from 1956, 1971, 1994 and 2005.

Remarks:

Appendix C.

Ground Level Color Photographs

Photograph 1.

Wetland vegetation in the upper settling pond.

Photograph 2.

Sample Plot MMW-2.

Photograph 3.

Upland Plot MMW-3.

Photograph 4.

Plot MMW-5 within the channel of the unnamed tributary.

Photograph 5.

Perennial spring at headwaters of the unnamed tributary .

Appendix D.

Additional Tables of Information

Table 1. Summary of Precipitation for 2008-2009 Water Year
Forest Service Monumental Mine - DGA Wetland Delineation
Wallowa-Whitman National Forest, Grant County, Oregon

Month	Recorded Precipitation[1]	Normal	Departure from Normal	Percent of Normal
	inches			
October 2008	1.59	2.34	-0.75	68%
November 2008	4.21	3.15	1.06	134%
December 2008	6.58	3.81	2.77	173%
January 2009	5.84	3.76	2.08	155%
February 2009	2.05	3.19	-1.14	64%
March 2009	6.91	2.55	4.36	271%
April 2009	3.59	1.25	2.34	287%
May 2009	3.19	2.79	0.4	114%
June 2009	1.79	2.16	-0.37	83%
July 2009[2]	0.39	0.21	0.18	186%
August 2009	1.36	0.77	0.59	177%
September 2009	Trace	1.72	1.72	0%
Total Precipitation	**34.13**	**27.21**	**6.92**	**125%**
Field Investigation and Preceding Dates[2]				
October 1, 2009	0.05	--	--	--
September 15-30, 2009	Trace	--	--	--

NOTES:

[1] From the Meacham #2 (355394) weather station located approximately 60 miles north of the Monumental Mine at an elevation of 4,055 feet msl. Data obtained from the National Oceanic and Atmospheric Administration (NOAA) website: www.weather.gov/climate

[2] Data obtained from the Weather Underground website: www.wunderground.com

[2] OAR 141-090-0035 requires precipitation data for the day of the investigation and preceding 1-2 weeks.

-- = Not Measured

NOWData - NOAA Online Weather Data

MEACHAM #2 (355394)
Monthly Totals/Averages
Precipitation (inches)
Year: 2009

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2009	5.84	2.05	6.91	3.59	3.19	1.79	-	1.36	0.00	3.04	2.60	3.76	34.13

Official data and data for additional locations and years are available from the Regional Climate Centers and the National Climatic Data Center.

Climate Data Requested

Back to the clickable map
Back to the data request form

Display Normals
Display Records

<-- Prev Month Next Month -->
<-- Prev Year Next Year -->

Observed Data for Meacham No 2 September 2008

Day	Max	Min	Precip	Snow	Depth
1	M	M	0.00	0.0	0
2	M	M	0.00	0.0	0
3	M	M	0.00	0.0	0
4	M	M	0.00	0.0	0
5	M	M	0.00	0.0	0
6	M	M	0.00	0.0	0
7	M	M	0.00	0.0	0
8	M	M	0.00	0.0	0
9	M	M	0.00	0.0	0
10	M	M	0.00	0.0	0
11	M	M	0.00	0.0	0
12	M	M	0.00	0.0	0
13	M	M	0.00	0.0	0
14	M	M	0.00	0.0	0
15	M	M	0.00	0.0	0
16	M	M	0.00	0.0	0
17	M	M	0.00	0.0	0
18	M	M	0.00	0.0	0
19	M	M	0.00	0.0	0
20	M	M	M	0.0	0
21	M	M	M	0.0	0
22	M	M	0.00	0.0	0
23	M	M	0.00	0.0	0
24	M	M	0.00	0.0	0
25	M	M	0.00	0.0	0
26	M	M	0.00	0.0	0
27	M	M	0.00	0.0	0
28	M	M	0.00	0.0	0
29	M	M	0.00	0.0	0
30	M	M	0.00	0.0	0
Avg	M	M	0.00	0.0	
Dep	M	M	M	M	*(Departure from climatological normals)

Climate Data Requested

Back to the clickable map
Back to the data request form

Display Normals
Display Records

<-- Prev Month Next Month -->
<-- Prev Year Next Year -->

Observed Data for Meacham No 2 October 2008

Day	Max	Min	Precip	Snow	Depth
1	M	M	0.00	0.0	0
2	M	M	0.00	0.0	0
3	M	M	0.62	0.0	0
4	M	M	0.23	0.0	0
5	M	M	0.13	0.0	0
6	M	M	0.03	0.0	0
7	M	M	0.02	0.0	0
8	M	M	M	0.0	0
9	M	M	0.13	0.0	0
10	M	M	0.21	2.7	2
11	M	M	0.00	0.0	M
12	M	M	0.00	0.0	M
13	M	M	0.00	0.0	0
14	M	M	0.00	0.0	0
15	M	M	0.00	0.0	0
16	M	M	T	0.0	0
17	M	M	0.00	0.0	0
18	M	M	0.03	0.0	0
19	M	M	0.00	0.0	0
20	M	M	0.00	0.0	0
21	M	M	0.19	0.0	0
22	M	M	0.00	0.0	0
23	M	M	0.00	0.0	0
24	M	M	0.00	0.0	0
25	M	M	0.00	0.0	0
26	M	M	0.00	0.0	0
27	M	M	0.00	0.0	0
28	M	M	0.00	0.0	0
29	M	M	0.00	0.0	0
30	M	M	0.00	0.0	0
31	M	M	0.00	0.0	0
Avg	M	M	1.59	2.7	
Dep	M	M	M	M	(Departure from climatological normals)

Climate Data Requested

Back to the clickable map
Back to the data request form

Display Normals
Display Records

<-- Prev Month Next Month -->
<-- Prev Year Next Year -->

Observed Data for Meacham No 2 November 2008

Day	Max	Min	Precip	Snow	Depth
1	M	M	0.08	0.0	0
2	M	M	0.02	0.0	0
3	M	M	0.10	0.0	0
4	M	M	0.05	0.0	0
5	M	M	0.88	3.9	3
6	M	M	0.02	0.0	2
7	M	M	0.07	0.0	1
8	M	M	0.01	0.0	0
9	M	M	0.17	0.0	0
10	M	M	0.25	0.0	0
11	M	M	0.04	0.0	0
12	M	M	1.28	0.0	0
13	M	M	1.02	0.0	0
14	M	M	0.00	0.0	0
15	M	M	0.00	0.0	0
16	M	M	0.00	0.0	0
17	M	M	0.00	0.0	0
18	M	M	0.00	0.0	0
19	M	M	0.00	0.0	0
20	M	M	0.00	0.0	0
21	M	M	0.13	0.7	0
22	M	M	0.00	0.0	0
23	M	M	0.01	T	0
24	M	M	0.00	0.0	0
25	M	M	0.00	0.0	0
26	M	M	0.00	0.0	0
27	M	M	0.00	0.0	0
28	M	M	0.02	0.0	0
29	M	M	0.06	0.0	0
30	M	M	0.00	0.0	0
Avg	M	M	4.21	4.6	
Dep	M	M	M	M	*(Departure from climatological normals)

Climate Data Requested

Back to the clickable map
Back to the data request form

Display Normals
Display Records

<-- Prev Month Next Month -->
<-- Prev Year Next Year -->

Observed Data for Meacham No 2 December 2008

Day	Max	Min	Precip	Snow	Depth
1	M	M	0.00	0.0	0
2	M	M	0.36	0.0	0
3	M	M	0.04	0.0	0
4	M	M	0.00	0.0	0
5	M	M	0.00	0.0	0
6	M	M	0.00	0.0	0
7	M	M	0.00	0.0	0
8	M	M	1.48	4.2	4
9	M	M	0.02	0.0	4
10	M	M	0.00	0.0	3
11	M	M	0.00	0.0	2
12	M	M	0.00	0.0	2
13	M	M	0.41	3.4	5
14	M	M	0.86	15.3	18
15	M	M	0.07	1.2	17
16	M	M	0.01	0.4	17
17	M	M	0.00	0.0	15
18	M	M	0.04	0.6	13
19	M	M	0.51	8.4	23
20	M	M	0.15	2.3	20
21	M	M	0.17	2.8	21
22	M	M	0.36	5.5	23
23	M	M	T	0.2	21
24	M	M	T	0.5	20
25	M	M	0.24	3.6	22
26	M	M	0.02	0.4	20
27	M	M	0.96	8.2	28
28	M	M	0.22	2.7	24
29	M	M	0.46	0.3	20
30	M	M	0.18	1.1	19
31	M	M	0.02	0.2	18
Avg	M	M	6.58	61.3	
Dep	M	M	M	M	*(Departure from climatological normals)

NOWData - NOAA Online Weather Data

MEACHAM #2 (355394)
Daily Almanac
Date: Oct 1, 2009

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	-	-	- in 0	-
Min Temperature	-	-	- in 0	-
Avg Temperature	-	-	- in 0	-
Precipitation	0.05	-	2.00 in 2000	0.00
New Snowfall	0.0	-	0.0 in 2009+	0.0
Snow Depth	0	-	0 in 2009+	0
HDD (base 65)	-	-	- in 0	-
CDD (base 65)	-	-	- in 0	-

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	-	-	- in 0	-
Avg Min Temperature	-	-	- in 0	-
Avg Temperature	-	-	- in 0	-
Total Precipitation	0.05	-	2.00 in 2000	0.00
Total Snowfall	0.0	-	0.0 in 2009	0.0
Avg Snow Depth	0	-	0 in 2009	0
Total HDD	-	-	- in 0	-
Total CDD	-	-	- in 0	-

+ indicates record also occurred in previous years (last occurrence listed).

Official data and data for additional locations and years are available from the Regional Climate Centers **and the** National Climatic Data Center.

GRANITE 4 WSW, OREGON (353430)

Period of Record Monthly Climate Summary

Period of Record : 7/ 2/1948 to 10/16/1967

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	30.3	36.4	40.1	49.0	58.0	66.2	77.5	76.2	68.9	55.8	40.0	32.2	52.6
Average Min. Temperature (F)	11.3	15.1	17.0	25.3	31.4	36.6	39.3	38.4	33.8	28.8	21.5	15.6	26.2
Average Total Precipitation (in.)	3.66	2.93	2.73	1.87	2.33	1.76	0.60	0.71	1.08	1.93	2.93	3.84	26.37
Average Total SnowFall (in.)	40.6	31.5	29.7	10.5	3.9	0.6	0.0	0.0	0.7	3.7	17.5	35.4	174.1
Average Snow Depth (in.)	28	35	35	16	1	0	0	0	0	0	3	14	11

Percent of possible observations for period of record.
Max. Temp.: 99.3% Min. Temp.: 99.2% Precipitation: 99.4% Snowfall: 99.1% Snow Depth: 98.6%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

CoverPg: Basic Description of Assessment

Site Name:	**USFS - Monumental Mine**
Investigator Name:	Tobias
Date of Field Assessment:	10/1/2009
County:	Grant
Nearest Town:	Granite
Latitude (decimal degrees):	44.8606
Longitude (decimal degrees):	-118.354
TRS, quarter/quarter section and tax lot(s)	T 8S, R 36E, Sec 18
Approximate size of the Assessment Area (AA, in acres)	0.1
AA as percent of entire wetland (approx.)	
If delineated, DSL file number (WD #) if known	
Soil Map Units within the AA (list these in approx. rank order by area, from WSS web site or published county survey; see manual)	0991CS
Soil Map Units surrounding and contiguous to the AA (list all present in approx. rank order by area; see manual)	9413BO
	0988BS
	0990BS
	0993CN
Cowardin Systems & Classes (indicate all present, based on field visit and/or aerial imagery):	
Systems: Palustrine =P, Riverine =R, Lacustrine =L, Estuarine =E	P
Classes: Emergent =EM, Scrub-Shrub =SS, Forested =FO, Aquatic Bed (incl. SAV) =AB, Open Water =OW, Unconsolidated Bottom =UB, Unconsolidated Shore =US	EM
HGM Class (Scores worksheet will suggest a class; see manual section 2.4.2)	Slope
If tidal, the tidal phase during most of visit:	
What percent (approx.) of the **wetland** were you able to visit?	100
What percent (approx.) of the **AA** were you able to visit?	100
Have you attended an ORWAP training session? If so, indicate approximate month & year.	
How many wetlands have you assessed previously using ORWAP (approx.)?	
Comments about the site or this ORWAP assessment (attach extra page if desired):	

ORWAP SCORES SHEET. Version 2.0.

Site Name:	USFS - Monumental Mine		
Investigator Name:	Tobias		
Date of Field Assessment:			10/1/2009
Latitude (decimal degrees):	44.86060	Longitude (decimal degrees):	-118.35400

Note: It is normal for some cells below to have non-zero values even when no data have been entered. This does not imply hidden weighting of those functions or values.

Please cite this method as: **Adamus, P., J. Morlan, and K. Verble. 2009. Oregon Rapid Wetland Assessment Protocol (ORWAP): calculator spreadsheet, databases, and data forms. Oregon Dept. of State Lands, Salem, OR.**

SPECIFIC FUNCTIONS:	Relative Effectiveness of the Function	Relative Values of the Function	(click on cells in this column to see definitions of the wetland functions)
Water Storage & Delay (WS)	0.00	2.92	
Sediment Retention & Stabilization (SR)	7.17	2.94	
Phosphorus Retention (PR)	9.08	4.18	
Nitrate Removal & Retention (NR)	5.33	4.35	
Thermoregulation (T)	0.00	0.00	
Carbon Sequestration (CS)	4.19		
Organic Matter Export (OE)	0.00		
Aquatic Invertebrate Habitat (INV)	3.50	5.28	
Anadromous Fish Habitat (FA)	0.00	0.33	
Non-anadromous Fish Habitat (FR)	1.50	10.00	
Amphibian & Reptile Habitat (AM)	4.80	6.67	
Waterbird Feeding Habitat (WBF)	0.33	4.50	
Waterbird Nesting Habitat (WBN)	0.00	3.00	
Songbird, Raptor, & Mammal Habitat (SBM)	5.28	3.33	
Pollinator Habitat (POL)	4.95	5.00	
Native Plant Diversity (PD)	3.33	5.14	

GROUPED SERVICES:	Group Scores (functions)	Group Scores (values)	
Hydrologic Function (WS)	0.00	2.92	(identical to Water Storage and Delay function and value scores)
Water Quality Support Group (WQ)	9.08	4.35	(maximum of scores for SR, PR, NR, and T)
Carbon Sequestration Function (CS)	4.19		(identical to Carbon Sequestration score above)
Fish Support Group (FISH)	1.50	10.00	(maximum of scores for FA and FR)
Aquatic Support Group (AQ)	4.80	6.67	(maximum of scores for OE, AM, INV, WBF, and WBN)
Terrestrial Support Group (TERR)	5.28	5.14	(maximum of scores for PD, POL, and SBM)
Public Use & Recognition (PU)		0.83	
Provisioning Services (PS)		0.00	

OTHER ATTRIBUTES:			
Wetland Ecological Condition		5.73	(click on this cell to see this attribute defined)
Wetland Stressors		6.44	(click on this cell to see this attribute defined)
Wetland Sensitivity		5.07	(click on this cell to see this attribute defined)

HGM Class - Relative Probabilities	
Estuarine	0.00
Riverine	0.00
Slope	3.15
Flat	0.00
Depressional	0.00
Lacustrine	0.00

Appendix C.

Human Health and Ecological Risk Assessments and Update Memorandums

TECHNICAL MEMORANDUM

TO: Ryan Tobias - Cascade Earth Sciences

FROM: Regina Skarzinskas - Technical Assessment Services
Rone Brewer - Sound Ecological Endeavors

DATE May 20, 2010

RE: RISK-BASED CLEANUP LEVELS
MONUMENTAL MINE DATA GAP ASSESSMENT
GRANITE, GRANT COUNTY, OREGON

INTRODUCTION

A human health and ecological risk assessment (RA) was conducted in 2006 for the Granite Creek mining area (including the Monumental Mine) near Granite, Grant County, Oregon. This risk assessment was updated in 2008 with the inclusion of analytical data from media samples collected in 2007. As part of addressing data gaps for the Engineering Evaluation/Cost Analysis of Monumental Mine remedial actions, Cascade Earth Sciences (CES) collected 20 additional soil/waste material samples in September 2009. These samples were analyzed primarily for metals and the resulting analytical data were added to the existing 2003 Monumental Mine data. While incorporating new data into the RA would likely change the exposure point concentrations (EPCs) and therefore could change the site-related contaminants of potential concern (COPCs) and predicted risks, incorporation of the new analytical data into the existing RA will not change the risk-based cleanup levels (RBCLs) for the RA. This is because RBCLs are dependent on a fixed level of acceptable risk, fixed chemical intake, and established toxicity values, which do not change when new data is added to the RA. The only way new data could impact the RBCLs in a particular risk assessment is if they resulted in new EPCs that reduced the predicted risk for a given COPC from an unacceptable to an acceptable level, thus eliminating a COPC from the need for remediation and eliminating the need for a RBCL for that COPC. This memorandum provides description of why the RBCLs will not change solely with the incorporation of new analytical data into the RA, and description of how new RBCLs could be calculated specifically for the Monumental Mine.

RISK-BASED CLEANUP LEVELS

For the purposes of this memorandum, only the human health RBCL calculation process will be described. The principles employed in the process are analogous to the ecological risk assessment process.

A generic formula for calculating non-carcinogenic RBCLs is:

$$\text{Soil RBCL (mg/kg)} = \frac{\text{RfD x BW x UCF x HQ x AT}}{\text{SIR x AB x EF x ED}}$$

Where:

RfD = Reference (mg/kg-day)
BW = Average body weight over the exposure duration (kg)
UCF = Unit conversion factor (1,000,000 mg/kg)
SIR = Soil ingestion rate (mg/day)
AB = Gastrointestinal absorption fraction (1; unitless)
EF = Exposure frequency (days/year)
HQ = Hazard quotient (1; unitless)
AT = Averaging time (days)
ED = Exposure duration (years)

As can be seen from the definitions of formula input factors, there are no factors dependent on the concentrations of the COIs. Rather, the input factors are all established based on default or acceptable (i.e., pre-defined) site-specific exposure scenarios and factors established for particular receptors (e.g. residents, recreational users, trespassers, or site workers) likely to be on exposed to site related COPCs, EPA approved toxicity values (e.g., RfDs), and regulatory standards for risk (e.g. HQ =1). The RBCL formulas for human carcinogenic risks or ecological receptors are slightly different, but still only contain receptor- and chemical-specific factors. The only way to obtain different RBCLs for the same COPCs and receptor is to change these factors. Thus, adding new analytical data, which only changes the exposure point concentration (EPC) does not change the RBCL because the EPC is not incorporated into the calculation of RBCLs.

RBCLs are only calculated for COPCs for which unacceptable risks are calculated. These risk calculations do include the EPCs. When additional data are added to an existing data set, it usually changes the EPCs (through changes to data skewness, mean, and confidence limits) and may also change the data distribution (e.g. from normal to lognormal or normal to gamma). When the data distribution changes, different methods are used to calculate the EPCs, therefore, with a change in EPCs due to the addition of new data, it is likely that previously predicted risks will also change. If the EPCs decrease, then lower potential risks will be calculated. If they decrease enough, a previously included contaminant may be eliminated from the COPCs. Or, if the EPCs increase, the opposite could occur, resulting in

higher risks and possible inclusion of additional COPCs in the RA. Thus, the EPC changes may have an impact on contaminants requiring cleanup, on hotspot number and location, and on the potential need to clean up certain areas, but do not change the magnitude of RBCLs. However, if the EPCs decreased enough to eliminate a COPC, then the need for remediation and for the RBCL for that contaminant, also would be eliminated.

IMPACT OF ADDING NEW ANALYTICAL DATA TO THE MONUMENTAL MINE RISK ASSESSMENT

A review of the new 2009 Monumental Mine analytical data (total arsenic, copper, lead, manganese, mercury, silver, and zinc) suggests that, more often than not, constituent concentrations are higher and the range of values is similar to or larger than in the original dataset. This indicates that the addition of new data would likely result in higher EPCs. Therefore, it is unlikely that the additional data would result in fewer COCs, and, if risks were recalculated with the new data, the recalculated potential risks would likely be higher than those originally calculated, given the same exposure scenarios and factors. This strongly suggests that no COPCs and no RBCLs would be eliminated, and introduces the potential for identification of additional hot spots and contaminants.

IMPACT OF COMPLETING A RISK ASSESSMENT FOR JUST THE MONUMENTAL MINE

A risk assessment generally assumes equal access to all parts of the site. The exposure assumptions used in the 2008 updated RA were set to represent exposure to all of the mines within the Granite Creek mining area. As described above, the RBCLs calculated in 2008 would not change with the addition of new data if the same exposure assumptions were used and no new COPCs resulted from the data addition. In order to investigate different RBCLs, either the original exposure assumptions would need to be re-examined and changed, or a new RA could be completed just for the Monumental Mine. In this case, the exposure assumptions could be made more site-specific, and thus, more accurate for the Monumental Mine. However, depending on access to the Monumental Mine, the predicted exposure could increase or decrease compared to the 2008 RA, resulting in a related decrease or increase, respectively, of the previously calculated RBCLs.

Human Health and Ecological Risk Assessment
Upper Granite Creek Mines
Wallowa-Whitman National Forest

May 2011

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Human Health and Ecological Risk Assessment
Upper Granite Creek Mines
Wallowa-Whitman National Forest

Prepared for:	USDA Forest Service Wallowa-Whitman National Forest
Site Location:	Granite Creek Mines Wallowa Whitman National Forest Grant County, Oregon
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Report Date:	May 2011
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Cover Photo: Monumental Mine Millsite

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ACRONYMS

CEEM	conceptual ecological exposure model
COI	chemical of interest
COPC	chemical of potential concern for human health
COPEC	chemical of potential ecological concern
ODEQ	Oregon Department of Environmental Quality
ERA	ecological risk assessment
ERBSC	ecological risk-based screening concentration
HHRA	human health risk assessment
PRG	Preliminary Remediation Goals
SI	Site Inspection
RTE	rare, threatened, or endangered
90UCL	90th percentile upper confidence limit on the arithmetic mean
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

- Potential human health and ecological risks associated with mining-related contamination at the Monumental, Cap Martin, Sheridan, Tillicum, Central Mines, Golden Fraction; and Granite Creek (GC)-5, GC-6, and GC-7 (unnamed) Mines (collectively referred to as the Granite Creek Mines) within the Upper Granite Creek Watershed (Site) were assessed through a streamlined risk assessment process.
- The mines are located in the upper portion of the Granite Creek watershed, approximately 5 to 8 aerial miles north of Granite, Oregon in Grant County in the Wallowa-Whitman National Forest (WWNF).
- The risk assessment process follows Oregon Department of Environmental Quality (ODEQ) and U.S. Environmental Protection Agency (USEPA) guidelines.
- Potential risks and hazards were evaluated using site-specific concentrations of chemicals of interest (COIs), selected human and ecological receptors and respective exposure pathways, and appropriate risk-based screening concentrations.

2.0 RISK ASSESSMENT DATA AND INITIAL SCREENING

- This section describes the data set used in this risk analysis and the initial screening for the human health risk assessment (HHRA) and ecological risk assessment (ERA).
- Data were selectively collected in areas where contamination was known or suspected to occur; therefore, the data set is skewed towards an understanding of the magnitude of contamination on Site rather than a full characterization of the Site.
- The data used in the risk assessment are from soil, vegetation, waste rock, surface water, pore water, and sediment samples collected during the Site Inspection (SI) conducted by EA Engineering, Science, and Technology, Inc. (EA) in January 2004 (EA, 2004) and the 2007 data gap investigation conducted by Cascade Earth Sciences (CES). The following samples were collected from five mines within the watershed:
  - 12 background soil samples
  - 48 surface and subsurface waste rock samples
    - 35 surface soil samples for the HHRA at 0-1.5 feet below the ground surface,
    - 38 surface soil samples for the ERA at 0-3 feet below the ground surface, and
    - 10 subsurface soil samples at greater than 1.5 feet below the ground surface for the HHRA.
  - 4 background vegetation samples
  - 6 vegetation samples
  - 3 background surface water samples
  - 17 surface water samples
  - 3 background pore water samples
  - 14 pore water samples
  - 3 background sediment samples
  - 27 sediment samples
- Overall, the data are likely to overestimate the concentrations found across the Site because samples were located to represent the areas of highest chemical of interest (COI) concentrations, not areas representative of overall human and ecological receptor exposure at and surrounding the Site. This is a conservative approach that is appropriate for screening level risk assessments.
- Initially, all data collected during the SI and deemed appropriate for use in the risk assessment were used to calculate the 90th percentile upper confidence level on the arithmetic mean (90UCL) for each medium:

- The 90UCL is an upper-bound (i.e., conservative) estimate of mean chemical concentration and is specified as an appropriate exposure point concentration (EPC) in Oregon's Revised Cleanup Rules (OAR 340-122-084).
- If fewer than 10 samples are available in a given medium, it is inappropriate to calculate a 90UCL (USEPA, 2003b). In these cases and if an appropriately calculated 90UCL exceeded the maximum detected concentration, the maximum detected concentrations was used as a substitute for the 90UCL.

- The data were screened using the ODEQ's Guidance for Conduct of Deterministic Risk Assessments (1998), which allows for prescreening of COIs based on the following criteria:
  - **Essential Nutrients:** calcium, magnesium, potassium, and sodium were removed from further assessment because they are considered to be essential nutrients.
  - **Frequency of Detection:** COIs in each medium that were detected in 5% or less of the samples Site-wide were removed from further assessment.
  - **Background:** 90UCL or maximum (as described above) concentrations of naturally-occurring chemicals that were present at concentrations less than maximum background concentrations were eliminated from further assessment.
- The results of these initial screening procedures for each potential exposure medium are also shown in Appendices A1 through A7. These appendices also show a sample reporting limit screening to ensure that undetected chemicals had reporting limits below background and below the lowest applicable medium-specific risk-based screening concentrations. If they did not, then that COI was conservatively included for further assessment at one-half the maximum sample reporting limit.
- The selected COIs for the HHRA and ERA are shown in Table 2-1.

Table 2-1. Chemicals of Interest Remaining Following the Initial Screening

COI	Soil/ Waste Material		Vegetation	Surface Water		Pore Water	Sediment	
	HHRA	ERA	ERA	HHRA	ERA	ERA	HHRA	ERA
Aluminum				X	X	X	X	X
Antimony	X	X		X	X		X	X
Arsenic, total	X	X	X	X	X	X	X	X
Barium	X	X		X	X	X	X	X
Beryllium			X				X	X
Cadmium	X	X	X	X	X		X	X
Chromium, total			X	X	X		X	X
Cobalt							X	X
Copper	X	X	X	X	X		X	X
Iron	X	X	X	X	X		X	X
Lead	X	X	X	X	X	X	X	X
Manganese	X	X		X	X		X	X
Mercury	X	X	X	X	X	X	X	X
Nickel							X	X
Selenium	X	X		X	X	X		
Silver	X	X		X	X	X	X	X
Thallium	X	X				X	X	X
Vanadium	X	X	X				X	X
Zinc	X	X	X	X	X	X	X	X

NOTE: X = COI selected for further screening

3.0 HUMAN HEALTH RISK ASSESSMENT

- A HHRA is an 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 objective of this HHRA is to incorporate analytical data and information on potential human exposure to the COIs in order to provide a baseline assessment of the potential for human health risks to be realized due to Site-related contamination.
- The following are primary elements of the HHRA:
  - **Hazard Identification and Selection of Contaminants of Potential Concern:** Evaluation of site data and identification of elevated concentrations of COIs in human exposure media, resulting in a list of contaminants of potential concern (COPCs) for the HHRA.
  - **Exposure assessment**: Identification of areas that pose human health risks under current or potential future site uses and conservative estimation of exposure.
  - **Toxicity assessment:** Quantification of the relationship between chemical exposure and adverse effects.
  - **Risk characterization:** Development of quantitative risk estimates using exposure and toxicity information previously developed for the COPCs.

3.1 Hazard Identification and Selection of COPCS

- This section presents the rationale for the selection of the COPCs; prescreening of the COIs was described in Section 2.0.
- The media of interest for human health included soil, waste rock, surface water, and sediment.
- The COIs retained for further assessment following the initial screening included aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, silver, thallium, vanadium and zinc as shown in Appendices A1, A2, A4, and A6 for surface soil, subsurface soil, surface water, and sediment, respectively.
- Maximum concentrations of these COIs were screened against USEPA Region IX Preliminary Remediation Goals (PRGs).
  - Industrial PRGs were selected as most appropriate screening criteria for soils and sediment.
  - Tap water PRGs represent a very conservative screen for surface water.
  - Appendix B1 presents the preliminary remediation goal (PRG) screening and results.
- Arsenic and lead were identified as COPCs for the Site.

3.2 Exposure Assessment

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

3.2.1 Potentially Exposed Population

- Maps and Figures of the Site are provided in the SI report (EA, 2004). The following is a brief summary of the rational for the potentially exposed population:
  - The Site consists of five mines located within the Granite Creek watershed.

Monumental Mine

- Monumental Mine, located near the headwaters of Granite Creek, includes two open adits, a shaft, three settling ponds, three waste rock piles, and a former mill site. Access to the mine is by way of FR 7345.
- The mine is situated on moderate to steep hillsides at the headwaters of Granite Creek.

- Water flows from an upper seep into a series of three settling ponds, all of which are connected by surface water flow. In addition, water seeps from the lower adit through a constructed ditch to the lower settling pond. No outlet for the settling pond was observed during SI activities.

Cap Martin Mine

- The Cap Martin Mine is situated approximately 1.4 miles downstream from the headwaters of Granite Creek and contains two observed collapsed adits, one additional reported adit, three waste rock piles, and an outwash fan from the south waste rock pile.
- The mine is located on both sides of Granite Creek and is accessed via FR 7345.

GC-7 Mine

- The GC-7 Mine is situated approximately 0.25 miles downstream from the Cap Martin Mine at the confluence with an unnamed tributary originating from the monumental Mine.
- The mine contains one observed collapsed adit and two waste rock piles.
- A former canal or placer ditch is located just upslope from the mine.
- The mine is located on moderately steep hillsides on the north side of Granite Creek and is accessed via FR 680.

Sheridan Mine

- Sheridan Mine is located about 0.40 miles downstream of the Cap Martin Mine, east of the bank of an unnamed tributary of Granite Creek. The mine includes two possible adits, one of which is collapsed at the portal and contains a seep that discharges into a marshy area. No acid mine drainage (AMD) was observed in the seep. In addition, there is one waste rock pile downgradient from the collapsed adit.
- The mine is situated on moderately steep slopes on the south side of Granite Creek and is accessed by way of FR 7345.

GC-6 Mine

- The GC-6 Mine is situated approximately 0.10 miles downstream from the Sheridan Mine, on the north side of Granite Creek, and contains one partially collapsed adit, and a waste rock pile.
- The mine is located on moderately steep hillsides on the north side of Granite Creek and is accessed via FR 680.

Tillicum Mine

- The Tillicum Mine is located approximately 0.25 miles downstream of the Sheridan Mine along Granite Creek and contains two primary collapsed adits and associated waste rock piles, and reportedly several additional adits. No water emanated from the adits during SI field activities.
- The Mine is situated on moderately steep slopes along the north bank of Granite Creek and is accessed by way of FR 7345.

GC-5 Mine

- The GC-5 Mine is located about 0.25 miles downstream of the Tillicum Mine, and contains one collapsed adit and two waste rock piles.
- FR 680, which accesses the mine, is cut through the larger waste rock pile adjacent to Granite Creek.
- Water was observed flowing from the collapsed adit during the CES data gap field investigation.
- The mine is situated on a moderately steep slope north of Granite Creek.

Golden Fraction Mine

- The Golden Fraction Mine is located about 0.125 miles downstream of the GC-5 Mine.
- The upper portion of the mine, situated just downslope from FR 7345, has an open adit, shaft, collapsed cabin, one large waste rock pile, and four smaller waste rock piles.
- The lower portion of the mine, just upslope from FR 680 along Granite Creek, contains one collapsed adit and two waste rock piles.
- FR 680, which accesses the mine, is cut through the larger waste rock pile adjacent to Granite Creek.
- Water was observed flowing from the collapsed lower adit during the CES data gap field investigation.
- The mine is situated on a moderately steep slope north of Granite Creek.

Central Mine

- The Central Mine is located about 0.125 miles downstream of the Golden Fraction Mine, southeast of the intersection of FR 73 (Elkhorn Drive Scenic Byway) and FR 7345.
- The mine contains two observed adits and one reported adit. The adits did not have water emanating from them at the time of the SI field investigation. Additionally, three waste rock piles are located at the mine. A waste rock berm, created as a result of hydraulic mining activities, runs in east-west direction about 75 to 100 feet upslope of Granite Creek.
- The mine is situated on a moderately steep slope north of Granite Creek.
- Given the types of human uses expected, the potential for long-term exposure to Site-related contaminants is considered very low.
- There are no onsite workers, or occupied structures on the Site or within 200 feet of the Site.
- Access is currently not restricted by fencing, nor were any "No Trespassing" signs observed. In general, land uses in this area are limited to recreation (hiking, fishing, camping, hunting, etc.) and possibly some minerals prospecting on nearby claims.
- The ingestion, dermal contact, and air exposure pathways are considered complete, because hikers, hunters, and campers have the potential to access the Site.
- The most likely pathway of exposure at the Site is inhalation of particulates.
- Fish consumption was eliminated as a potential pathway of concern because, with the exception of tribal fishing, all recreational fishing in Granite Creek and its tributaries was prohibited by the Oregon Department of Fish and Wildlife in 1997 (EA, 2004). The number and size of fish present also severely limits any potential for a recreational or subsistence fishing scenario.

3.2.2 Identification of Potential Exposure Pathways

- The conceptual human exposure model is presented in Figure 3-1.
- Exposures to COPCs were evaluated for all complete pathways for which there was a receptor. These pathways were determined to be:
  - Inhalation of soil/waste rock particulates,
  - Dermal contact with soil/waste rock,
  - Incidental ingestion of surface soil/waste rock,
  - Dermal contact with surface water
  - Incidental ingestion of surface water
  - Dermal contact with sediment, and
  - Incidental ingestion of sediment by current and future recreational receptors.

3.2.3 Current and Potential Future Receptors

- The Site is not currently occupied, nor is it expected to be occupied in the future.
- The only likely current and future receptors identified for the Site are hikers, campers, and hunters.

- Based on the Site topography and its isolated location within the WWNF, it is highly unlikely that recreational users would engage in activities at the Site that could result in significant ingestion or contact with soil, sediment or surface water. Therefore, the most likely pathway of exposure at the Site is inhalation of particulates.

3.2.4 Exposure Assumptions

- Exposure assumptions include factors such as body weight, averaging time, exposure frequency, exposure duration, and chemical bioavailability.
- Separate assumptions are made for both average or central tendency exposure (CTE) and reasonable maximum exposure (RME).
- In general, CTE represents a less conservative model of the Site risk, using exposure factors that are more indicative of the average recreational user rather than a maximally exposed user.
  - The exposure factors and assumptions used in this risk assessment are presented in Appendix B2.

3.2.5 Exposure Point Concentrations

- An EPC is used in coordination with the exposure factors to calculate the Average Daily Dose (ADD) of a chemical of potential concern (COPC).
- The EPC can be the maximum concentration detected or a statistical average.
- It is not reasonable to assume long-term contact with the maximum concentration.
- When sufficient data exists, an upper-bound estimate of average concentrations (i.e., the 90UCL) are used because an average concentration is most representative of the concentration contacted over this time period.
- As per the USEPA (1997), when data for a particular exposure medium were limited to less than 10 samples, the maximum detected concentration was used as the EPC. Where the data set contained greater than 10 samples, 90UCL was calculated and used as the EPC.
- The EPCs are presented in Table 3-1 and Appendix B3.

Table 3-1. Exposure Point Concentrations

COPC	N	Maximum	Central Tendency Exposure[1]	Reasonable Maximum Exposure[2]	Comments
Surface Soil (mg/kg)					
Total Arsenic	35	11,400	853	2,250	90UCL
Sediment (mg/kg)					
Total Arsenic	27	303	54.4	73.9	90UCL
Surface Water (mg/L)					
Total Arsenic	17	0.0818	0.00988	0.0188	90UCL

NOTES:
[1] Average concentration
[2] 90UCL if greater than 10 data points; Maximum concentration if less than 10 data points.
Abbreviations: EPC = Exposure point concentration, mg/kg = milligrams per kilogram, mg/L = milligrams per liter, N = Number of samples, UCL = Upper confidence Limit.

3.2.6 Exposure Doses

- The EPCs are then entered into exposure dose calculations to calculate the ADD of a contaminant for each receptor type. While presented individually in the equations, USEPA Region X allows for the calculation of Summary Intake Factors (Intake Factors) as follows:

- Intake Factors represent the sum lifetime exposure to contaminated soil, water, or air through the pathway. The Intake Factors are presented in Appendix B4.
- Dermal absorption factors are required to calculate dermal exposures to surface water and these are shown in Appendices B5 and B6.
- The Intake Factors when multiplied by the EPC provide the ADD for each chemical.

3.3 Toxicity Assessment

- The purpose of the toxicity assessment is to present the critical toxicity values for the COPCs. Toxicity is defined as the ability of a chemical to induce adverse effects at some dosage in biological systems. The purpose of the toxicity assessment is twofold:
  - To identify the carcinogenic (cancer) and non-carcinogenic (non-cancer) 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.

3.3.1 Toxicity Values

- Toxicity values are used to quantitatively describe the relationship between the extent of exposure to a COPC and the potential increased likelihood, or severity, of adverse effects.
- Where toxicity values are available, the following USEPA sources have been used to obtain this information.
  - Integrated Risk Information System (IRIS) computer database (USEPA, 2004b)
  - Health Effects Assessment Summary Table (USEPA, 1997)
- Both carcinogenic and non-carcinogenic effects were quantitatively evaluated as noted below:
  - The endpoints for these two different types of effects are assessed differently because the mechanisms by which chemicals cause cancer are assumed to be fundamentally different from the processes that cause non-carcinogenic effects.
  - The principal difference reflects the assumption that non-carcinogenic effects are assumed to exhibit a threshold dose below which no adverse effects occur, where USEPA assumes no such threshold exists for carcinogenic effects.
  - Because exposure to some chemicals may result in both carcinogenic and non-carcinogenic effect, both endpoints associated with a COPC were evaluated quantitatively when sufficient toxicity data are available.

3.3.2 Categorization of Chemicals as Non-Carcinogens or Carcinogen

- Chemicals are classified into those that cause cancer (carcinogens) and those that cause other, non-cancer, health effects (non-carcinogens).
- The methods for assessing the potential for these two different types of health effects are different. Where a chemical can cause both cancer and non-cancer health effects, the risk evaluation calculates the potential for both types of effects.
- The following sections provide background information on the toxicity values for carcinogenic and non-carcinogenic chemicals, how they are determined, and how they are used in the risk analysis.

Potential Adverse Non-carcinogenic Health Effect

- The following summarizes the purpose and usage of reference doses (RfDs):
  - Reference doses are critical toxicity factors for chemicals that can cause non-carcinogenic health effects.
  - An RfD represents an estimated intake rate that is unlikely to produce measurable adverse effects over a lifetime of exposure (USEPA, 1989).

- RfDs are determined by the USEPA RfD Work Group or from the health effects assessment documents developed by the USEPA Office of Research and Development.
- An RfD, expressed in units of milligrams per kilogram per day (mg/kg-day), assumes a threshold for adverse non-carcinogenic effects. An ADD below the RfD is considered unlikely to cause adverse health effects.
- RfDs are route-specific; that is, RfDs may be different for ingestion, inhalation, or other routes of exposure.
- RfDs are derived using uncertainty factors and modifying factors.
- The Critical Toxicity Factors for the non-carcinogenic COPCs are presented in Table 3-2 and Appendix B7.

Table 3-2. Critical Toxicity Values for the Non-carcinogenic COPCs

COPC	Oral Chronic Reference Dose* (mg/kg-day)	Confidence in Reference Dose	Endpoint
Arsenic	0.0003	Medium	hyperpigmentation, vascular

NOTE: * Reference Dose value from Region IX PRG Tables.

Potential Carcinogenic Effects

- Carcinogenic toxicity is not assumed to have a threshold concentration below which adverse effects do not occur; therefore, carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over their lifetime.
- Contaminant-specific dose response curves are used to establish slope factors that represent an upper-bound excess cancer risk from a lifetime exposure.
- Dose response curves for human carcinogens are developed from tumorgenic and laboratory studies; the slope factor is generated from the 90UCL of the extrapolated dose curve using probabilistic methods and represents a conservative upper-bound estimate of the potential risk associated with exposure.
- Based on USEPA guidelines documents, critical toxicity data for arsenic and chromium are presented in Table 3-3 and Appendix B8 (refer to USEPA 1999 for additional information).

Table 3-3. Critical Toxicity Values for the Carcinogenic COPCs

COPC	Slope Factor (mg/kg-day)-1		Weight of Evidence Classification *	Type of Cancer	Basis of Slope Factor
	Oral	Inhalation	Ingestion/Inhalation	Ingestion/ Inhalation	Oral/Inhalation
Arsenic	1.5E+00	1.5E+01	A	Skin	Epidemiologic Studies

NOTE: A = Known human carcinogen.

Lead Critical Toxicity Values

- Meaningful oral and inhalation critical toxicity values have not been developed for lead.
- Many of the non-carcinogenic effects associated with lead may not exhibit a threshold, especially in young children.
- USEPA considers lead to be a probable human carcinogen based on sufficient animal data (i.e., a class B2 carcinogen). In lieu of a reference dose or slope factor, USEPA has developed the Integrated Exposure Uptake/Biokinetic Model (IEUBK) and the Adult Lead Model (ALM) which correlate dose with blood lead levels.
- The Federal Action Level for Lead in drinking water is 0.015 mg/L.

- Lead exposure levels are as follows:
  - The lowest-observed adverse effect level (LOAEL) of lead is considered to be 10 micrograms per deciliter (µg/dl) in children and fetuses and 30 µg/dl in adults.
  - Empirically-derived ratios of 0.16 and 0.04 µg/dl per micrograms per day (µg/day) ingested by children and adults respectively, recommended by USEPA (1986) and FDA (1990), are used to predict concentrations in young children and adults.
  - Applying an uncertainty factor of 10 results in provisional tolerable intake levels of 6 µg/day for children six or less, 15 µg/day for children over six, 25 µg/day for pregnant women, and 75 µg/day for men.

3.4 Risk Characterization

- Potential human health impacts associated with exposure to COPCs at the Site were evaluated by estimating the potential for both non-carcinogenic and carcinogenic health effects.
- The following sections discuss the assessment of non-carcinogenic hazards, carcinogenic risks, and lead risk associated with exposure to COPCs at the Site.
- The sampling locations were selected as locations where levels of concentrations were suspected to be the highest.
- Targeted sampling identifies the worst-case situations and is intended to be a conservative data set that is sufficient for the specific purposes of risk assessment.

3.4.1 Non-Carcinogenic Hazard Assessment

- Non-carcinogenic hazard is estimated as the ratio of the ADD of the non-carcinogenic chemical through a specific exposure route to the chronic (or subchronic) RfD for that exposure route.
- For example, intakes from the ingestion route are compared to oral RfDs.
- The assessment is done as follows:
  - The ADD divided by the RfD for an individual chemical is termed the Hazard Quotient (HQ).
  - HQs greater than 1.0 indicate the potential for adverse health effects because the intake exceeds the RfD (USEPA, 1989).
  - An HQ is calculated for each chemical that elicits a non-carcinogenic health effect if an RfD is available for the chemical and exposure route.
  - The sum of all individual chemical-specific HQs is termed the Hazard Index (HI) and is calculated under each exposure pathway.
  - The HI considers exposure to a mixture of chemicals having non-carcinogenic effects based on the assumption that the effects of chemical mixtures are additive (USEPA, 1986b).
  - An HI greater than 1.0 indicates the potential for adverse non-carcinogenic effects. When the HI is greater than 1.0, the USEPA guidance allows for segregating HIs by critical effect categories. Major categories of critical effects include neurotoxicity, developmental effects, and effects on target organs to name a few.

3.4.2 Excess Cancer Risk Assessment

- Carcinogenic risk is an estimate of the probability that a COPC will produce a carcinogenic effect.
- The excess lifetime carcinogenic risk is the incremental increase in the probability of developing cancer compared to the background incremental probability of developing cancer with no exposure to site contaminants.
- An excess cancer risk (ECR) of 1×10^{-6}, represents an increase of one additional case of cancer (above background) in one million people exposed to a carcinogen over their lifetime (70 years).
- Estimates of carcinogenic risk using the slope factors developed by USEPA are generally upper-bound estimates; actual risks from exposures to chemical constituents at the Sites would likely be lower than the risks estimated herein.

- For estimating carcinogenic risk from exposure to more than one carcinogenic chemical from a single exposure route, risks from each individual chemical are summed to estimate total ECR.

3.4.3 Potential Non-carcinogenic Hazards and Excess Cancer Risks

Discussion of Non-carcinogenic Hazards

- Soils/Waste Rock
  - Arsenic and lead were identified as COPCs.
  - Arsenic is the only COPC that can be quantitatively evaluated.
  - The average concentration and the 90UCL concentration was used as the EPC.
  - None of the individual constituents exceeded the regulatory standard of 1.0 under CTE and RME exposure conditions (Appendix B9).
- Sediments
  - Arsenic and lead were identified as the COPCs.
  - Arsenic is the only COPC that can be quantitatively evaluated
  - The HQs are below the regulatory standard of 1.0 for both the RME and CTE exposure scenarios (Appendix B9).
- Surface water
  - Arsenic and lead identified as COPCs.
  - No toxicity values are available for lead in surface water, groundwater, or drinking water.
  - The EPC for lead in surface water, which is also the maximum concentration detected is 0.009 mg/L.
  - The Federal Action Level for lead in drinking water is 0.015 mg/L.
  - The HQs are below the regulatory standard of 1.0 for both the RME and CTE exposure scenarios (ppendix B9).

Discussion of Potential Excess Cancer Risks

- Soil/Waste Rock
  - The only carcinogenic constituent identified was arsenic.
  - The average concentration and the 90UCL concentration were used as the EPCs for the CTE and RME exposures, respectively.
  - The ECR exceeded the regulatory standard of 1×10^{-6} under both CTE and RME exposure conditions (Appendix B10).
  - For the CTE exposure conditions, ECRs for ingestion (2×10^{-6}) did not exceed the EPA risk range of 1×10^{-4} to 1×10^{-6} but did exceed Oregon's regulatory standard of 1×10^{-6}.
  - For the RME exposure condition, ECRs for ingestion (2×10^{-5}) and dermal contact (2×10^{-5}) did not exceed the EPA risk range of 1×10^{-4} to 1×10^{-6} but did exceed Oregon's regulatory standard of 1×10^{-6}.
  - Therefore, a carcinogenic risk is possible for exposure to arsenic impacted soil/waste rock under the CTE and the RME exposure scenarios.
  - Inhalation of particulates did not exceed the regulatory standard 1×10^{-6} under both CTE and RME exposure conditions (Appendix B10).
- Sediments
  - The only carcinogenic constituent identified in sediment is arsenic.
  - The ECRs for arsenic in sediment did not exceed the regulatory standard 1×10^{-6} under both CTE and RME exposure conditions (Appendix B10).
- Surface Water
  - Arsenic was the only carcinogenic constituent identified in surface water, for which exposure could be quantified.

- The ECRs for arsenic in surface water did not exceed the regulatory stand 1 x 10^{-6} under both the CTE and the RME exposure conditions (Appendix B10).
- Lead was identified as a COPC in surface water on the basis of no PRG, and is considered to be carcinogenic, but no toxicity values are available. Therefore it cannot be quantitatively addressed in the same manner as arsenic and is addressed qualitatively below.

Estimation of Potential Human Health Impacts from Exposure to Lead

- The USEPA's lead models simulate soil lead exposures at a single location. Two models have been developed, the IEUBK model and the ALM:
  - These models require a minimum of three months of continuous exposure of at least one day per week.
  - Three months exposure is the minimum to produce a quasi-steady-state lead concentration.
  - The reliability of the models for predicting lead concentrations for exposure durations shorter than three months has not been assessed.
  - In order to address non-continuous exposures, the USEPA Office of Solid Waste and Emergency Response has developed a guidance document for evaluating intermittent exposures to lead for scenarios such as recreational users and trespassers.
  - Since the exposure frequency is less than three months, predicted intake values were compared with the provisional values discussed in Section 3.3.2.3.
  - Table 3-5 present the results of the lead intake calculations and lead screening. Only the ingestion pathway is quantified.

Table 3-5. Lead Intake Screening

Exposure Point Concentrations		Intake		Predicted Intake		USEPA Provisional Intake Value	USEPA Provisional Intake Value
mg/kg		kg/day		µg/day			
CTE	RME	CTE	RME	CTE	RME	Men	Children <6
Soil							
375.8143	661.61739	6.7E-07	2.7E-06	0.25	1.786	75	6
Sediment							
24.24	39.3502	2.6E-07	2.1E-06	.006	0.083	75	6
			TOTAL INTAKE	0.256	1.869	**75**	**6**

- Summary of Lead Risks:
  - Soil and Waste Rock: The predicted intake was calculated to be 0.25 µg/day (CTE) and 1.786 µg/day (RME). The USEPA provisional ingestion intake value for men (most likely receptor) is 75 µg/day and children under six (least likely receptor) is 6 µg/day. If you assume that the total intake from dermal exposure and inhalation is equal to the intake from ingestion, no risk is expected for exposure to lead in soil and waste rock.
  - Sediment: The predicted intake was calculated to be 0.006 µg/day (CTE) and 0.083 µg/day (RME). Using the USEPA provisional ingestion intake listed above, no risk is expected for exposure to lead in sediment for the most likely recreational receptor (men), but a risk is possible for exposure to children under six using the RME EPC. Given the steep terrain and remote nature of the Site, children less than six are not expected to spend extended periods of time at the Site; therefore, a risk is not expected from exposure to lead impacted sediment.
  - Surface Water: The maximum concentration of lead in surface water was 9 micrograms per liter (µg/L), which is less than the USEPA National Primary Drinking Water Standard, Maximum

Containment Level of 15 µg/L (USEPA, 2003b). Therefore, exposure to lead in drinking water is not expected to be a risk.

3.5 Calculation of Cleanup Goals

- Site specific cleanup goals protective of the RME recreational users were calculated for soil/waste rock and sediment based on the regulatory standard of 1 x 10^{-6} ECR.
- The site-specific cleanup goals were calculated to be 143 mg/kg for soil/waste rock
- These clean-up goals are used to calculate hot spot concentrations in soil/waste rock

3.6 Determination of Potential Hot Spots

- The 1995 amendments to Oregon Revised Statute [ORS 465.315] and 1997 amendments to the Hazardous Substance Remedial Action Rules [OAR 340-122], commonly referred to as the Environmental Cleanup Rules, require that certain actions be taken for "hot spots" of contamination. These actions are:
  - The identification of hot spots as part of the Remedial Investigation and Feasibility Study, and
  - The treatment of hot spots, to the extent feasible, as part of a remedial action selected or approved by the Director of the ODEQ.
- The intent of the hot spot rule is to require treatment only for the worst contamination, as opposed to preferring treatment for all contamination at the Site.
- A hot spot in soil is generically defined as an area where the contamination is highly concentrated, highly mobile or cannot be reliably contained. The assessment of "highly concentrated" hot spots is performed by comparing the concentration of each individual site contaminant to its "highly concentrated" hot spot level as follows:
  - The "highly concentrated" hot spot levels correspond to a lifetime ECR of 1 x 10^{-4} for carcinogens and a hazard quotient of 10 for non-carcinogens.
  - Arsenic in surface soil/waste rock exceeded the regulatory standards for carcinogenic health effects.
  - The results of the hot spot evaluations are presented in Appendix B11. Using an ECR of 1 x 10^{-4} a hot spot concentration for arsenic in soil/waste rock was calculated to be 14,330 mg/kg.

3.7 Summary of Human Health Risks

- Arsenic was identified as the only COPCs in surface soil/waste rock, surface water, and sediment for non-carcinogenic effects.
- Lead was identified as a COPCs in surface water because there is no PRG for lead in this medium.
- Based on current and future land use, hunters, hikers, and campers were identified as potential receptors.
- No unacceptable non-carcinogenic health effects are anticipated from contact with sediment or soil/waste rock, nor from contact with surface water under CTE conditions.
- Arsenic was the only carcinogenic COPC identified at the Site.
- Risks due to ingestion under CTE exposure conditions, and due to ingestion and dermal contact with arsenic impacted soil under the RME exposure conditions exceeded the ODEQ's regulatory standard of 1 x 10^{-6} ECR.
- Based on the Site topography and its isolated location within the Wallowa Whitman National Forest, it is highly unlikely that recreational users would engage in activities at the Site that could result in significant ingestion of soil, thus, the most likely pathway of exposure at the Site is inhalation of particulates.
- The quantitative risk assessment determined that the inhalation pathway did not result in unacceptable health impacts.
- No hot spots were identified at the Site.

4.0 ECOLOGICAL RISK ASSESSMENT

- The goal of the ERA is to provide an understanding of the potential for ecological risks due to Site-related contamination and to allow a determination of whether remediation or more detailed ecological risk assessment are warranted. This ERA report consists of:
  - Description of the Site ecology and likely ecological receptors (including rare, threatened or endangered [RTE] species) at or near the Site;
  - Presentation of the conceptual ecological exposure model (CEEM), which provides a summary of potential and likely exposure media and pathways;
  - Delineation of assessment endpoints and measures;
  - Ecological risk-based screening; and
  - Risk characterization to assess the potential for ecological effects due to Site related COIs.
- An ecological survey was conducted as part of the SI (EA, 2004), which documented ecological features and conditions at and near the Site.
- The potential for Site-related ecological impacts were also assessed via an examination of stream benthic macroinvertebrate abundance and diversity.
- The ecological information collected during the SI has been incorporated into this risk assessment as appropriate.
- An ODEQ ecological scoping checklist was completed for this ERA, based on the SI ecological survey, and is provided in Appendix C.

4.1 Problem Formulation

- Problem formulation was completed as follows:
  - The physical and chemical characteristics of the Site and the important ecological habitats, plants, invertebrates, fish, and wildlife that exist are described.
  - This information is utilized to identify the COIs, the ecological receptors of concern, exposure pathways, and the exposure media.
  - This in turn, allows development of the CEEM which graphically depicts the expected fate and transport of chemicals at the Site, the potential exposure media, and likely exposure pathways for ecological receptor types of concern.
  - The problem formulation concludes with identification of the ecological endpoints that delineate the objectives of the remainder of the ERA.
  - Generally, problem formulation includes a description of the Site and summary of previous investigations; however, this information is provided in the SI, and is not repeated herein.

4.1.1 Ecological Stressors

- Ecological receptors may be affected through exposure to chemicals (i.e., toxicity), physical stresses (i.e., destruction of habitat), and biological stresses (i.e., viruses and bacteria).
- Biological stressors were assessed as follows:
  - While biological stressors may affect ecological receptors, they are more frequently associated with waste food or human waste and in areas where wildlife congregate in large numbers. Because the remote nature of the Site limits human presence and wastes, they are not considered to pose a threat to ecological receptors. Because of the lack of suitable habitat, ecological receptors are also unlikely to congregate in the vicinity of the Site in numbers that could result in significant biological infection or passage of wildlife diseases. Thus, biological stressors are unlikely to be a significant factor and are not considered further.
- Physical stressors were assessed as follows:
  - Past physical disturbances include development and operation of the mines and supporting structures, and possibly historic as well as current logging operations. Because the Site has been abandoned for decades, current physical disturbance is reduced to a relatively low number of

recreational users that visit or drive by the Site. Given the relatively remote nature of the Site within the Wallowa Whitman National Forest, the ecological impacts of ongoing current physical disturbances are limited.

4.1.2 Ecological Setting

- The regional and Site-specific ecology are briefly described in this section to provide an understanding of the climate, plants, invertebrates, wildlife, and fish that may inhabit the Site and surrounding region:
  - Other than RTE species that must be considered on an individual level, a particular species must be potentially present on or utilize the Site in numbers adequate to allow an exposure level that may result in effects to the species' population. Such significant exposure to Site related COIs will only occur for those species known or expected to use the Site on a regular basis and in high numbers or that bioaccumulated metals to a significant degree.
  - More detailed information on the regional and Site ecology, sensitive environments, and RTE species is presented in the SI.
  - Bull trout (*Salvelinus confluentus*) and the mid-Columbia steelhead (*Oncorhynchus mykiss*) were the only threatened or endangered (i.e., protected) species observed or expected at or in the vicinity of the Site (EA, 2005). Bull trout were identified in Granite Creek. Steelhead are expected primarily downstream of the site.
  - Four distinct habitat types were observed at the Site by EA. These include; drier south facing slopes, moister north facing slopes, riparian zones along Granite Creek, and spruce forest at Monumental Mine.
  - A lack of understory ground species was noted during SI activities and logging, fire, and insect infestations have likely occurred in areas surrounding the Site. Waste Rock piles typically contained early-successional coniferous species.
  - Overall, the relatively large number of species identified during this limited ecological survey suggested that numerous species are present in the vicinity of the Site and that they utilize varied habitat and foraging methods.
  - Granite Creek flows throughout the Site and is generally less than one meter wide, with a riparian area less than 20 meters wide. EA described the riparian vegetation as being dominated by red alder (EA, 2004), although it is more likely mountain alder that was observed.

4.1.3 Conceptual Ecological Exposure Model

- The CEEM (Figure 4-1) graphically depicts the sources of contamination, contaminant release and transport mechanisms, impacted exposure media, and exposure routes for ecological receptor types observed or expected at the Site. Based on current understanding of Site conditions, the potentially contaminated exposure media for ecological receptors include:
  - Surface soil/waste rock in the vicinity of the Site;
  - Vegetation at the Site;
  - Surface water in Granite Creek, adit and waste rock seep drainages;
  - Pore water within Granite Creek; and
  - Sediment in Granite Creek.
- Given these exposure media, the possible and likely ecological receptor groups include:
  - Terrestrial plants exposed to COIs in soil/waste rock;
  - Terrestrial invertebrates exposed to COIs in soil/waste rock;
  - Terrestrial and semi-aquatic wildlife (including birds, mammals, and reptiles) exposed to COIs in soil/waste rock, surface/adit water, pore water, and sediment;
  - Aquatic life (including aquatic plants, aquatic invertebrates, fish, and amphibians) exposed to COIs in surface/adit water, and pore water; and
  - Benthic invertebrates, birds, and mammals exposed to COIs in sediment.

4.1.4 Assessment Endpoints and Measures

Assessment Endpoints

- Assessment endpoints represent the ecological aspects to be protected at a site and link the ERA to risk management decisions.
- Within a screening level ERA, assessment endpoints are generalized to reflect the risk-based screening process and protective ecological risk-based screening concentrations (ERBSCs). The assessment endpoints for this ERA include:
  - Protection of the reproduction and survival of plants, terrestrial invertebrates, birds, mammals, and reptiles exposed to COIs in surface soil/waste rock and vegetation at the Site;
  - Protection of aquatic life reproduction survival exposed to COIs in water within the adit/seep drainages and Granite Creek;
  - Protection of the reproduction and survival of birds and mammals that may drink water from adit/seep drainages and Granite creek;
  - Protection of the reproduction and survival of aquatic life exposed to COIs in pore water within Granite Creek;
  - Protection of reproduction and survival of benthic macroinvertebrates exposed to COIs in sediment within Granite Creek; and
  - Protection of reproduction and survival of birds and mammals exposed via the aquatic/benthic food chain to COIs in sediment within Granite Creek.

Assessment Measures

- Assessment measures are characteristics of the Site, selected ecological receptors, or ecosystem aspects that are measured through monitoring or sampling activities and then related qualitatively or quantitatively to the selected assessment endpoint(s) to determine whether an ecological effect is occurring. For this ERA, the assessment measures are comprised of the following:
  - Measured concentrations in soil/waste rock, surface water, pore water, and sediment; and
  - Readily-available ERBSCs.

4.2 Ecological Risk-Based Screening

- Ecological risk-based screening begins with a list of COIs in the media of concern, a determination of EPCs, and a comparison of the EPCs to ERBSCs with consideration of exposure to multiple chemicals and media, reporting limit adequacy, and the inordinate contribution of individual chemicals to the overall receptor group risk.
- The result is a list of Site-related chemicals of potential ecological concern (COPECs) with the potential to pose risks to ecological receptors at the Site.
- The initial screening was completed in Section 2.0 and the chemicals retained as ecological COIs were presented in Table 2-1.
- The ERBSCs used in the risk-based screening were provided by ODEQ (ODEQ, 2001).
  - When a screening level value was not available for a given COI, then an alternative ecological risk-based screening concentration (ERBSC) was selected from peer-reviewed literature or a surrogate chemical ERBSC was substituted.
  - The ERBSCs are presented in Appendix D1.
- As per ODEQ guidance (2001), the EPCs for each medium were compared to the ERBSCs for each chemical and receptor group in each medium, resulting in chemical/receptor group-specific risk ratios (R_{ij} in Appendices D2 through D5). Assessment of risk ratios was as follows:
  - Risk ratios were summed for all chemicals within a receptor group to obtain receptor group-specific risk ratios (R_j in Appendices D2 through D5).
  - The potential for bioaccumulation of each COI was assessed, reporting limit adequacy was checked for undetected COIs, and the inordinate contribution of any given chemical to the overall receptor

group risk was determined. Risk ratios greater than 1 were considered unacceptable and indicative of potential risks for protected ecological receptors (bull trout and steelhead), aquatic life, and benthic macroinvertebrates.
  - Risk ratios greater than 5 were considered unacceptable for other ecological receptors.
  - The COIs for which potential ecological risks were indicated became COPECs for the Site.
  - No ERBSCs are available for vegetation, so a risk-based screening was not conducted for vegetation. The potential for COPECs in vegetation to result in ecological risks is discussed further in the risk characterization section below.
- The risk ratios for receptor groups exposed to COPECs are shown in Tables 4-1 through 4-4.

Table 4-1. Chemicals of Potential Ecological Concern and Risk Ratios for Surface Soil/Waste Rock

COPEC	Terrestrial Plants (R_{ij})	n*	Terrestrial Invertebrates (R_{ij})	n*	Birds (R_{ij})	n*	Mammals (R_{ij})	n*
Antimony	**8**	4	0.5	0	No ERBSC	0	3	0
Total Arsenic	**99**	25	**30**	9	**42**	25	**39**	16
Cadmium	1	0	0.2	0	0.8 Bioaccumulation	0	0.04 Bioaccumulation	0
Iron	**2,782**	17	**139**	17	No ERBSC	0	No ERBSC	0
Lead	**12**	6	1	0	**37**	12	0.1	0
Manganese	1	0	**6**	8	0.1	0	0.05	0
Mercury	**208**	4	**625**	5	**42**	2	0.9	0
Selenium	0.7	0	0.01	0	0.4 Bioaccumulation	0	0.03 Bioaccumulation	0
Silver	**23**	7	0.9	0	No ERBSC	0	No ERBSC	0
Vanadium	**22**	5	No ERBSC	0	1	0	2	0
Zinc	**7**	11	2	1	**6**	8	0.02	0
Total Receptor Group Risk (R_i)	**3,168**		**807**		**131**		**46**	

NOTES:
Bold = COPEC with risk ratio greater than acceptable levels; (>1 for protected species - none are expected; >5 for unprotected species)
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of stations with an unacceptable risk ratio.

Table 4-2. Chemicals of Potential Ecological Concern and Risk Ratios For Surface Water

COPEC	Aquatic Life (R_{ij})	n*	Birds (R_{ij})	n*	Mammals (R_{ij})	n*
Antimony	0.0006	0	No ERBSC		0.0009	0
Arsenic, Total	0.1	0	0.001 Bioaccumulation	0	0.003 Bioaccumulation	0
Barium	**16**	13	0.0004	0	0.002	0
Cadmium	0.2	0	0.00004 Bioaccumulation	0	0.00006 Bioaccumulation	0
Iron	0.6	0	No ERBSC		No ERBSC	
Lead	0.9	0	0.00008 Bioaccumulation	0	0.000007 Bioaccumulation	0
Mercury	0.1	0	0.00002 Bioaccumulation	0	0.000008 Bioaccumulation	0
Selenium	0.3	0	0.0003 Bioaccumulation	0	0.0008 Bioaccumulation	0
Silver	0.8 Reporting Limit Too High	0	No ERBSC		No ERBSC	
Zinc	2	1	0.002	0	0.0002	0
Total Receptor Group Risk (R_j)	**22**		0.004		0.01	

NOTES:
Bold = COPEC with risk ratio greater than acceptable levels (>1 for aquatic life; >5 for other species).
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of stations with an unacceptable risk ratio.

Table 4-3. Chemicals of Potential Ecological Concern and Risk Ratios for Pore Water

COPEC	Aquatic Life (R_{ij})	n*
Arsenic, Total	0.04 Bioaccumulation	0
Barium	**12**	11
Lead	0.5 Bioaccumulation	0
Mercury	0.07 Bioaccumulation	0
Selenium	0.3 Bioaccumulation	0
Silver	Reporting Limit Too High	0
Total Receptor Group Risk (R_j)	**13**	

NOTES:
Bold = COPEC with risk ratio greater than acceptable levels
(>1 for aquatic life; >5 for other species).
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of stations with an unacceptable risk ratio.

Table 4-4. Chemicals of Potential Ecological Concern in Sediment

COPEC	Benthic Macroinvertebrates (R_{ij})	n*	Birds and Mammals (R_{ij})	n*
Aluminum	No ERBSC		No ERBSC	
Arsenic, Total	**13**	8	**19**	8
Barium	No ERBSC		No ERBSC	
Cadmium	1	0	**216**	9
Cobalt	No ERBSC		No ERBSC	
Iron	No ERBSC		No ERBSC	
Mercury	0.5	0	No ERBSC Bioaccumulation	
Selenium	No ERBSC	0	5	0
Thallium	No ERBSC		1	0
Vanadium	No ERBSC		No ERBSC	
Zinc	0.7	1	**28**	19
Total Receptor Group Risk (R_j)	**18**		**265**	

NOTES:
Bold = COPEC with risk ratio greater than acceptable levels (>1 for benthic invertebrates; >5 for other species).
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of stations with an unacceptable risk ratio.

4.3 Ecological Risk Characterization

4.3.1 Risk Description

- Risk description involves examining the predicted risks in each medium to determine whether they are likely, or artifacts of the risk assessment process.

Surface Soil/Waste Rock

- The COPECs for soil/waste rock were listed in Table 4-1.
- Nine of 11 COPECs had at least one exceedance of an ERBSC but only 6 COPECs had exceedances at more than 5 sample locations. Total arsenic was the only COPEC with ERBSC exceedances at more than half of the sample locations. This suggests that other than total arsenic, the COPECs are not at consistently elevated concentrations across all of the mines.
  - Cadmium and selenium were selected as COPECs solely due to their potential to bioaccumulate. However, the synthetic precipitation leaching procedure results for these two COPECs (EA, 2005) suggest that they are strongly bound to soil/waste rock particles, and thus, are not readily bioavailable. As such, it is unlikely they will bioaccumulate to any significant degree in birds or mammals. Given this argument and the lack of an exceedance of ERBSCs at the EPC, cadmium and selenium are not considered to present a significant risk to ecological receptors.
  - Total arsenic, iron, and mercury risk ratios were inordinately high for at least one receptor group. Mercury only exceeded ERBSCs at 5 out of 38 sample locations. The highest three of these exceedances were in samples collected at the Monumental Mine. The largest exceedances of ERBSCs by mercury were for plants and invertebrates with the only other exceedances being for birds at two sample locations and mammals at one sample location, all at the Monumental Mine. While iron exceeded ERBSCs at 17 sample locations, it exceeded 2 times its background concentration in only one sample (GF-WR-2). Overall, predicted risks for total arsenic are spread across receptor groups and sampling locations, whereas predicted risks for mercury and iron are limited primarily to plants and invertebrates at the Monumental Mine.

- Total arsenic, iron, lead, manganese, silver, vanadium, and zinc had unacceptable risk ratios at more than five sample locations. Potential risks due to iron were discussed above. Total arsenic had multiple unacceptable risk ratios for multiple receptors at all the mines with a majority at the Monumental Mine, but the Tillicum and Golden Fraction Mines also had unacceptable risk ratios for all receptors. Lead had unacceptable risk ratios (six for plants and 12 for birds) an 12 sample locations at five of the mines. Manganese had exceedances of ERBSCs for invertebrates at six Monumental and Tillicum Mine sample locations and in two samples (WR-01 and WR-02) collected at GC-5, but did not exceed its background concentration by more than a factor of two. Silver had only eight unacceptable risk ratios (seven plant and one invertebrate) in four samples collected at the Monumental Mine and one each at GC-7, GC-3, and Golden Fraction Mine (GF-WR-2). Vanadium had five unacceptable risk ratios for plants spread across the Monumental, Tillicum, Cap Martin, Central, and Sheridan mines but only exceeded its background concentration by more than a factor of two in one sample from the Central Mine. Zinc had 19 unacceptable risk ratios (11 for plants, one for invertebrates, and 8 for birds), in samples located at the Monumental, Tillicum, Cap Martin, Central and Golden Fraction Mines, and at GC-3.

- Based on the magnitude of the risk ratio and the number and locations of samples where the unacceptable exceedances of ERBSCs and background concentrations occurred, the results of the risk-based screening suggest that:
  - Total arsenic, lead, and zinc are the COPECs with the highest predicted potential to present risks at more than a few localized areas. The majority of risks were predicted for samples collected at the Monumental and Tillicum Mines. Mercury may also present a relatively high risk to plants and invertebrates in a few very limited areas.
- As discussed above, individual birds or small mammals that inhabit or feed within the waste rock piles have been indicated to be at risk due to exposure to the COPECs. However, given the small size of the waste rock piles in comparison to the surrounding high quality habitat, and the relatively large home range of most wildlife species, populations of mobile and wide-ranging wildlife are unlikely to spend large amounts of time on or around any one mine area. Thus, other than for their possible exposure to total arsenic, which has elevated concentrations at all the mines, wildlife species are considered unlikely to be impacted by the COPECs.

Vegetation

- Vegetation samples were collected from four background and six locations likely to be impacted by Site-related COPECs.
- The COPECs present in vegetation above background concentrations were total arsenic, beryllium, cadmium, total chromium, copper, iron, lead, mercury, vanadium, and zinc (See Appendix A4).
- The maximum ratios of on-Site concentrations to background concentrations were total arsenic, (10), beryllium (1), cadmium (7), total chromium (5), copper (1), iron (2), lead (2), mercury (2), vanadium (1), and zinc (3).
- Beryllium, copper, iron, lead, mercury, and vanadium are present at less than or approximately equivalent to two times the background concentration, and thus are not considered to present a significant potential for ecological impacts.
- Zinc is a essential nutrient in the environment that only moderately elevated in vegetation compared to its background concentrations. This diminishes the predicted potential for impacts due to zinc.
- Total arsenic and cadmium significantly exceeded background concentrations at the Monumental Mine, while total chromium significantly exceeded background concentrations at the Central Mine.
- Overall, total arsenic, cadmium, and total chromium are the COPECs of most concern in vegetation.
- There is a very limited amount of vegetation on or near the waste rock piles at the Site. This also significantly reduces the potential exposure of herbivores to site-related contamination.

Surface Water

- The COPECs for surface water are listed in Table 4-2. The only exceedance of ERBSCs was for barium. No background concentrations were determined for barium. Given that the differences between the highest and lowest detected barium concentrations was less than a factor of three, barium is not considered to be significantly elevated at the Site.
- Antimony and iron were selected as a COPECs due solely to a lack of ERBSCs. Iron concentrations exceeded background by a factor of more than two at four adit seep sample locations (CMM-AS-01, 02, GC5-AS-01, and GF-AS-01). Antimony was not detected (0.4 µg/L) in background samples but was detected in only two adit seep samples (GC5-AS-01 and GF-AS-01) at concentrations less than 2 times the background detection limit. Silver also had no ERBSCs for birds and mammals, and for data collected in 2003 had elevated reporting limits compared to the ERBSC for aquatic life. However, new data with adequate detection limits were collected in 2007 and none of these new samples had concentrations that exceeded the ERBSCs and were very near the detection limits for background samples. Given these arguments, antimony, iron, and silver are not considered to present a significant risk in surface water at the Site.
- Total arsenic, lead, mercury, and selenium concentrations did not exceed ERBSCs, but were selected as COPECs due solely to their potential to bioaccumulate. Out of 17 total samples, total arsenic was detected in 7 samples; lead was detected in 6 samples; mercury in 6 samples; and selenium in 2 samples. These detections occurred primarily in two adit seeps (GC5-AS-01 and GF-AS-01), at the Monumental Mine (MM-SP-SFW-18, MM-SP-SFW-19, and MM-SP-SFW-51), downstream in Granite Creek (GC-ST-SFW-53 and 54). These represent some of the farthest upstream and/or the farthest downstream samples. While the limited number of detections suggests that these COPECs are not widespread and thus, are not likely to bioaccumulate significantly, the fact that they are present at the Monumental Mine area and then reappear downstream of the last mine suggests a potential for the Monumental Mine and Central Mine to be sources of these COPECs to Granite Creek.
- Overall, slightly elevated concentrations of a few COPECs were noted primarily at upstream and downstream stations, but are not consistently elevated, suggesting that widespread (i.e., significant population level) direct or bioaccumulation-related ecological impacts are unlikely due to COPECs in surface water.

Pore Water

- The COPECs for pore water were listed above in Table 4-3. Barium was the only detected COPEC that exceeded an ERBSC. Similar to surface water, barium was not analyzed in background pore water and so, did not have a respective background concentration determined. However, the difference between the lowest and highest detected concentrations was less than a factor of 2 across the 11 samples, all of which had detected concentrations of barium. Thus, barium is not considered to be significantly elevated at the Site.
- Total arsenic, lead, mercury, and selenium concentrations did not exceed ERBSCs, but were selected as COPECs due solely to their potential to bioaccumulate. However, similar to surface water, their presence in only a few sample locations at very low concentrations strongly suggests their presence is not likely to result in population level ecological impacts. However, the highest detected total arsenic concentrations were at the two farthest downstream stations.
- Silver was not detected in pore water at the site, but one-half the maximum reporting limit exceeds the ERBSC by a maximum factor of 12. Given that silver was not detected in any surface water nor pore water samples and the detection limits are still relatively low (2.9 µg/L), it is deemed unlikely that silver contributes to ecological risks at the site.

Sediment

- The COPECs for sediment were listed above in Table 4-4. Total arsenic, cadmium, and zinc were the only COPECs with unacceptable risk ratios. Concentrations of total arsenic, cadmium, and zinc exceeded background concentration by more than a factor of 2 at 5, 8, 7, and 10 samples (out of 27 possible), respectively. Most of the concentrations of these COPECS that exceeded ERBSCs were downstream from the Cap Martin Mine, with the highest concentrations at or downstream of the Tillicum Mine.
- Hazard quotients for aluminum (3), barium (4), cobalt (5), iron (7), thallium (14), and vanadium (12) were selected solely due to a lack of ERBSCs. Iron was the only one of these COPECs with a respective background concentrations and exceeded this by more than a factor of two in only four samples, including a maximum background exceedences factor of three at GC-ABS-3. With no background concentrations for comparison, the difference between the highest detection and lowest detection limit was examined for the remaining COPECs. Aluminum, barium, cobalt, and iron all had differences of less than a factor of 10. Thallium and vanadium had differences that were factors of 14 and 12, respectively. Three stations (SM-ST-PSD-06, TM-ST-PSD-08, and TM-ST-RSD-07) had high concentrations of aluminum, barium, and cobalt. Aluminum was also high at GC-ST-RSD-53 and GC-ST-PSD-53. Three different stations (CMM-ST-PSD-03, SM-ST-RSD-06, and CM-ST-RSD-10) contained the highest concentrations of thallium and vanadium. However, these 6 stations do not correspond to the locations of the highest concentrations of total arsenic and cadmium which are more likely related to past mining activities.
- Mercury was selected as a COPEC due to the lack of a bird/mammal ERBSC and its potential for bioaccumulation. The maximum mercury detection is approximately 34 times higher than the lowest detection at station GC-ST-PSD-54 and 24 times higher at GC-ABS-1. The remainder of the highest detected concentrations were approximately a factor of 4 greater than the lowest detected concentrations, located at or downstream from the Tillicum Mine.
- Overall, iron, selenium, thallium, vanadium, and zinc had a few elevated concentrations that were spread along Granite Creek, while elevated concentrations of total arsenic and cadmium and mercury were detected primarily at multiple downstream locations. Aluminum, barium, and cobalt had elevated concentrations in the vicinity of the Sheridan and Tillicum Mines.

4.3.2 Ecological Hot Spots

- For this ERA, hot spot levels corresponded to a chemical concentrations that exceed both ERBSCs and background concentrations by a factor of 10 or more. For COPECs without corresponding background concentrations, the hot spot analysis is based solely upon exceedance of the ERBSC by a factor of 10 or more.
- There are ecological hot spots in waste rock for antimony, total arsenic, copper, lead, mercury, silver, and zinc. Hot spot concentrations for these were 50, 180, 500, 160, 3, 20, and 905 mg/kg, respectively for waste rock.
- Ecological hot spots were identified for barium and silver in surface water and pore water. A hot spots for zinc also was identified in surface water. The hot spot concentrations (based on exceedance of the ERBSC only) for barium and silver were 40 and 1.2 µg/L, respectively. The hot spot screening for these two COPECs in these two media should not be used for removal action decisions without prior consideration for the lack of background concentrations. A hot spot was also identified for zinc in surface water, with a hot spot concentration of 1,200 µg/L.
- One ecological hot spot was identified for cadmium in sediment. The hot spot concentration for cadmium was 2.2 mg/kg. Aluminum, barium, cobalt, and vanadium could not be assessed for hot spots because no background concentrations were determined for them and no sediment ERBSCs were available.

Table 4-5. Locations of Ecological Hot Spots

Soil	Surface Water	Pore Water	Sediment
MM-ML-SS-12	See text above prior to using surface water or pore water hot spots for removal action decision making.		GC-ST-PSD-54
MM-ML-SSS-16	MM-SP-SFW-18	TM-ST-PWP-07	
MM-ML-SSS-38	MM-SP-SFW-19	TM-ST-PWP-08	
MM-WP-SSS-13	MM-SP-SFW-51	CM-ST-PWP-09	
MM-WP-SSS-14	SM-ST-SFW-06	CM-ST-PWP-10	
MM-WP-SSS-15	TM-ST-SFW-07	CM-ST-PWR-10	
MM-WP-SSS-17	TM-ST-SFW-08	GC-ST-PWP-53	
CMM-WP-SUS-21	CM-ST-SFW-09	GC-ST-PWP-54	
CM-WP-SSS-31	CM-ST-SFW-10		
GF-WR-2	GC-ST-SFW-53		
TILL-WR-1	GC-ST-SFW-54		
CMM-WR4-1	CMM-AS-01		
GC3-WR-01			
GC7-WR-03			

4.3.3 Uncertainty Analysis

- The uncertainty analysis lists the common uncertainties associated with ecological risk-based screening and assesses whether they are likely to over- or underestimate the potential for ecological risks to be realized at the Site.
- This information is combined with that provided above in the risk description section to present conclusions regarding ecological risks. The primary uncertainties associated with this ecological risk-based screening and the impacts on the prediction of the potential for ecological risks are discussed below:
  - The lack of background concentrations for some COIs in surface water, pore water, and sediment, may result in the inclusion of COIs as COPECs that would otherwise be excluded, and increases the number of chemicals and sample locations predicted as hot spots.
  - The risk-based screening assumes the receptors are constantly exposed to the chemical at a concentration equal to the EPC. While this may be true for immobile species such as plants and some terrestrial invertebrates, unless the contamination is widely and evenly spread, it is not realistic for wildlife species. Because the metals are primarily located around waste rock piles and small centers of mining activity, the risks calculated above overestimate the actual risks posed to wildlife.
  - The use of maximum detected concentration or 90UCL as the EPC is a conservative approach that is purposefully designed to result in some overestimation of the potential for ecological risks. Because of this, the risks predicted are likely to overestimate actual ecological risks.
  - Including a sample reporting limit screening is a conservative approach that includes COIs as COPECs when they are actually not detected. Because the undetected COI is likely present at concentrations less than the reporting limit, possibly much less, including the COI as a COPEC result in an overestimation of the potential for ecological risks.
  - The lack of site specific bioavailability data does not allow for a formal assessment of risks due to some COPECs for upper trophic level receptors (i.e., birds and mammals). However, the fact that many metals, especially those that have been exposed to the surface for many years, tend to bind strongly to soil and sediment particles suggesting that many of the metals may not be readily bioavailable. Given this evidence, risks due to the bioaccumulation of COPECs are likely overestimated.
  - Except for aquatic life and benthic macroinvertebrates, the ERBSCs used for this ERA are intended to be no-observed-adverse-effect-levels (NOAELs). Because actual ecological effects occur at an unknown concentration somewhere between the NOAEL and the LOAEL, simply exceeding an

ERBSC does not necessarily indicate the potential for significant ecological effects. Thus, the use of NOAEL-based ERBSCs likely results in an overestimation of the potential for ecological risk.
  - The lack of ERBSCs for some receptors precludes the calculation of risk for those receptors. This may result in an over- or underestimation of the potential for ecological risks. The use of a bioaccumulation screening is a conservative measure used to assess the potential for risks posed to upper trophic level ecological receptors when appropriate ERBSCS are missing.
  - Within this ERA, predictions are made regarding the significance of ecological exposures under current conditions at the Site. Overall, the risk-based screening is designed to overestimate the potential for ecological risks.

4.4 Summary Of Ecological Risks

- Predicted risks due to total arsenic in waste rock piles were predicted at all nine mines, but are especially prevalent at the Monumental, Tillicum, and Golden Fraction Mines, and in waste rock sample collected along Granite Creek. Antimony, lead, mercury, silver, and zinc also contributed notably to the overall predicted risks, but to a lesser extent than total arsenic. It is likely that immobile receptors such as terrestrial plants and invertebrates are adversely impacted within and near waste rock piles. Individual birds and small mammals are likely to be exposed to COPECs in the waste rock piles and may be impacted, but population level impacts are not expected to these terrestrial species because of the relatively limited distribution of the COPECs compared to the home ranges of these more wide-ranging species. The most hot spots were noted for total arsenic at the Monumental Mine. Antimony, lead, mercury, and silver also had hot spots spread primarily across the Monumental Mine, but also present at the Tillicum, Golden Fraction, Cap Martin, and Central Mines and in a couple sample collected from waste rock along Granite Creek.
- Total arsenic, cadmium, and total chromium in vegetation were the only COPECs present at concentrations greater than five times higher than in background vegetation. Only total arsenic was elevated more than 10 times higher than background.
- The only elevated risk ratios for COPECs in surface water and pore water were for barium and zinc. Silver also had elevated risk ratios in pore water. The risks attributed to barium and silver likely would not have been as pronounced if background COPEC concentrations were available for these media. All other COPECs other than barium were selected solely due to their potential to bioaccumulate or a lack of ERBSCs. While barium and silver were indicated as having hot spots in both surface water and pore water, these hot spots may be solely related to the lack of background concentrations for barium and the elevated detection limits for silver. The farthest upstream and farthest downstream stations have the highest concentrations of several COPECs in surface water and pore water. This suggests Monumental Mine and Tillicum Mine (or other downstream source) may be contributing a majority of the COPECs to the Creek.
- Total arsenic, cadmium, and zinc in sediment had elevated risk ratios. These appear likely to have the potential to impact immobile receptors or those that are frequently exposed to COPECs in sediment. Cadmium was the only COPEC that had a hot spot that exceeded both the ERBSC and background concentrations by a factor of more than 10.

5.0 CONCLUSIONS

- The following conclusions were developed from the human health risk assessment:
  - The risk assessment determined that there are no unacceptable non-carcinogenic human health risks from exposure to waste rock, and sediment.
  - Ingestion of arsenic in waste rock exceeded the regulatory standard for ECR under CTE exposure conditions.
  - Risks from ingestion and dermal contact with arsenic impacted soil under the RME exposure conditions exceeded the ODEQ's regulatory standard of 1×10^{-6}.

- Based on the Site topography and its isolated location within the WWNF, it is highly unlikely that recreational users would engage in activities at the Site that could result in significant ingestion of soil, thus, the most likely pathway of exposure at the Site is inhalation of particulates. The quantitative risk assessment determined that the inhalation pathway did not result in unacceptable health impacts.
- No hot spots were identified at the Site.

- The following conclusions were developed from the ecological risk assessment:
  - Ecological impacts were predicted primarily for terrestrial plants and terrestrial invertebrates (i.e., immobile species), due to COPECs in soil/waste rock at several of the mines. Local and regional populations of these and other terrestrial species are unlikely to be significantly impacted.
  - Likely insignificant ecological impacts were predicted for aquatic life and wildlife exposed to COPECs in surface water and pore water. However, the lack of background concentrations for some COPECs in these media made it difficult to predict the potential for impacts.
  - Benthic invertebrates and wildlife appear to have the potential to be impacted due primarily to total arsenic, cadmium, and zinc, which are present at elevated concentrations in many sediment sample locations, but are particularly prevalent in the downstream portions of the creek.
  - The Monumental and Tillicum Mines appear to have more locations with elevated COPEC concentrations in waste rock than the other mines and, in general, the sediment sample locations near and downstream of the Tillicum Mine had the highest COPEC concentrations.

6.0 REFERENCES

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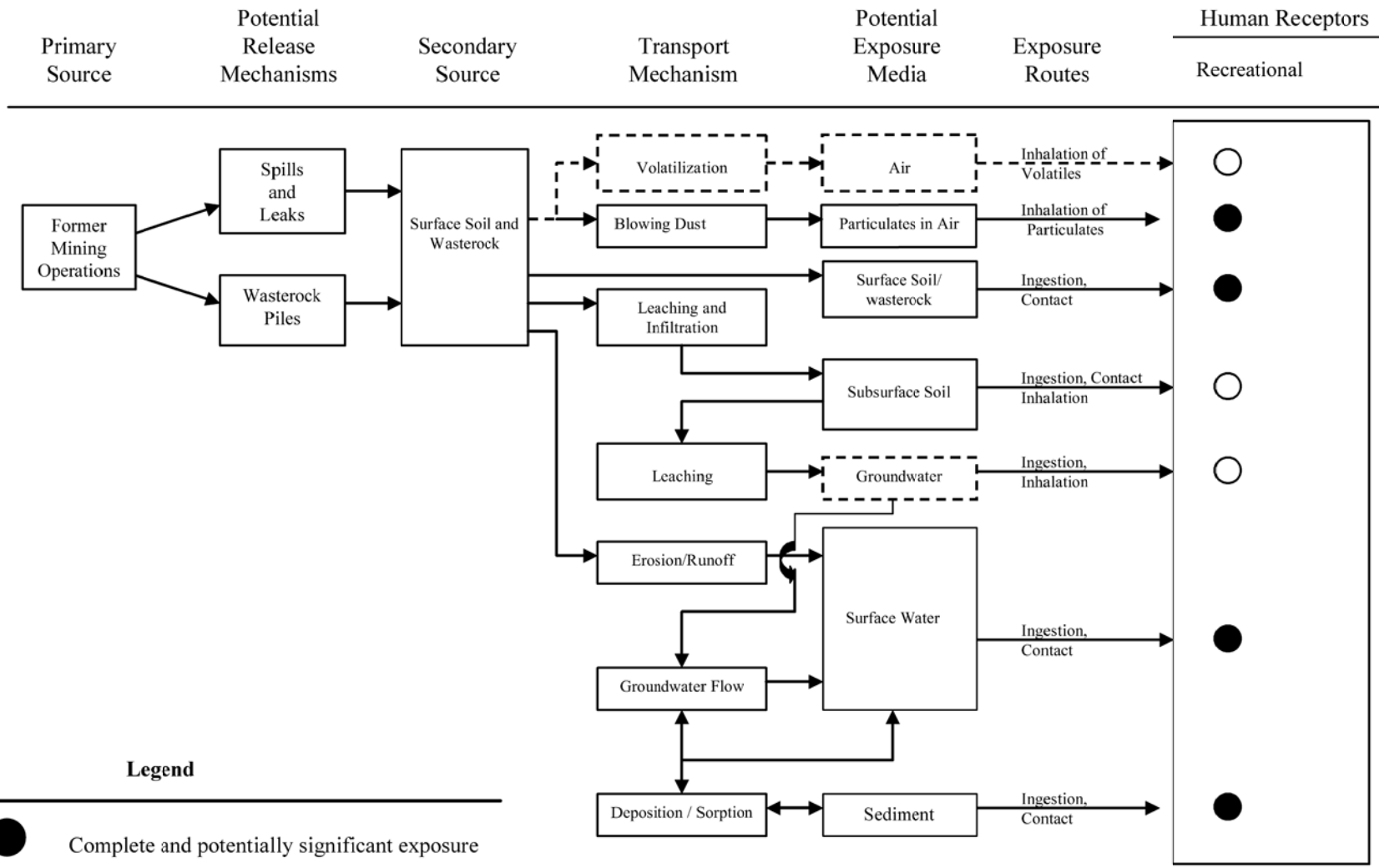
Figure 3-1. Conceptual Human Health Exposure Model

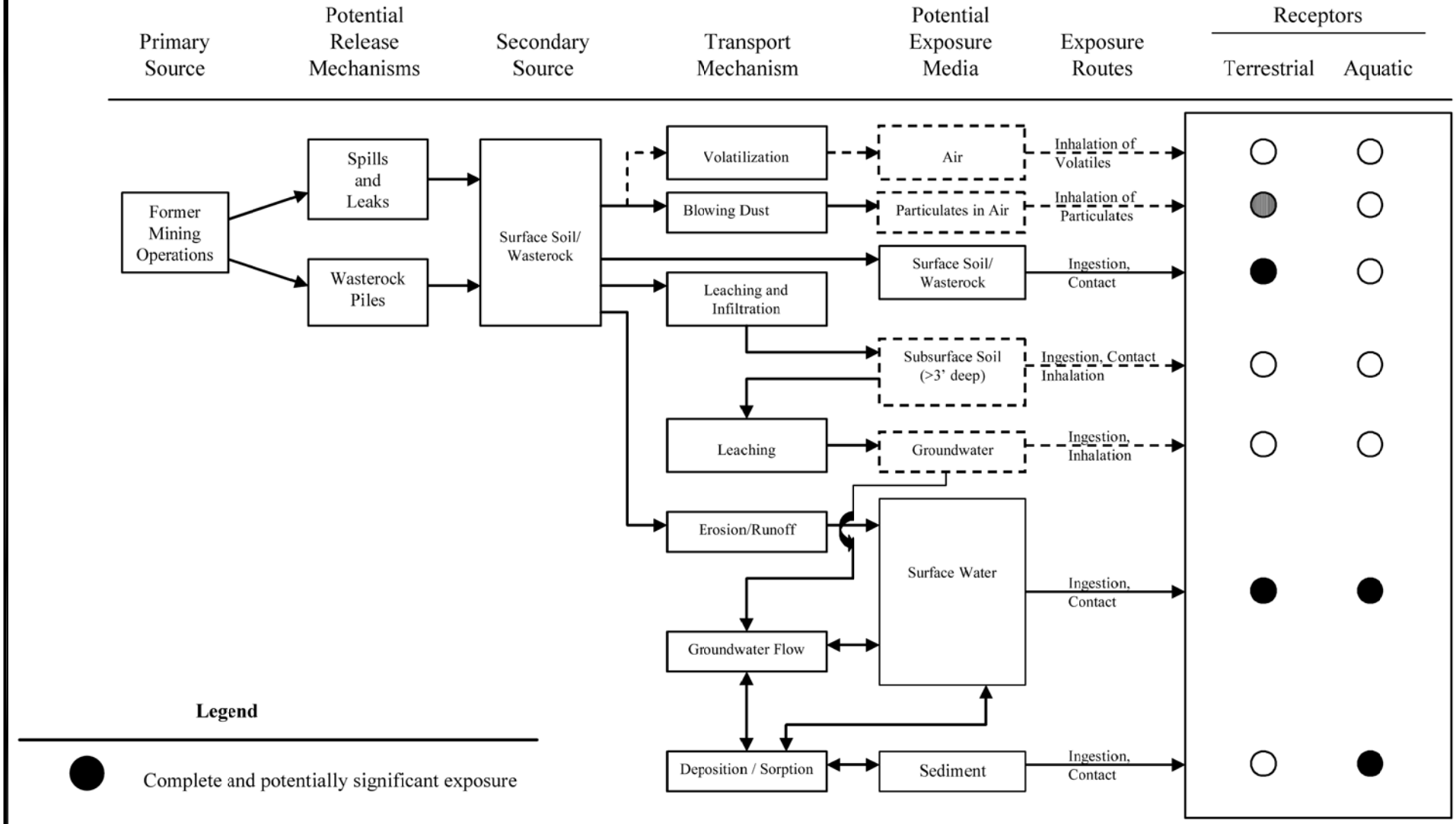


(SOURCE: TAS, 1/30/06)

Figure 3-1. Conceptual Human Exposure Model

PROJECT NUMBER: 2523046	RISK ASSESSMENT
DATE: 04/08/06	
DWG. DGW / DWG NO: 2523046F1.dwg	GRANITE CREEK TRIBUTARY WALLOWA WHITMAN NATIONAL FOREST
PROJECT MANAGER: DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

Figure 4-1. Conceptual Ecological Exposure Model



(SOURCE: TAS, 1/30/06)

Figure 4-1. Conceptual Ecological Exposure Model

PROJECT NUMBER: 2523046	RISK ASSESSMENT
DATE: 04/08/06	
DWG. DGW / DWG NO: 2523046F2.dwg	GRANITE CREEK TRIBUTARY WALLOWA WHITMAN NATIONAL FOREST
PROJECT MANAGER: DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

Appendix A. Data Summary and Initial Screening

Appendix A1. Data Summary and Initial Ecological Screening for Surface Soil
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Soil Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?	Human Health Chemical of Interest?
				mg/kg														
Metals																		
Aluminum	17	17	100%	1.11E+03	1.75E+04	1.06E+04	1.06E+04	NA	NA	5.00E+01	1.00E+05	3.12E+04	Yes	No	No	No	No	No
Antimony	38	31	82%	3.00E-01	3.68E+02	4.11E+01	4.11E+01	1.00E-01	5.00E-01	5.00E+00	4.09E+02	8.40E-01	Yes	No	No	Yes	Yes	Yes
Arsenic, total	38	38	100%	1.70E+00	1.14E+04	1.79E+03	1.79E+03	NA	NA	1.00E+01	1.59E+00	4.35E+01	Yes	No	No	Yes	Yes	Yes
Barium	17	17	100%	3.28E+01	3.22E+02	1.82E+02	1.82E+02	NA	NA	8.50E+01	6.66E+04	3.19E+02	Yes	No	No	Yes	Yes	Yes
Beryllium	38	31	82%	3.30E-02	7.00E-01	3.40E-01	3.40E-01	1.00E-01	1.00E-01	1.00E+01	1.94E+03	1.20E+00	Yes	No	No	No	No	No
Cadmium	38	34	89%	1.70E-01	2.34E+01	4.77E+00	4.77E+00	1.25E-02	3.20E-02	4.00E+00	4.51E+02	2.03E+00	Yes	No	No	Yes	Yes	Yes
Chromium, Total	38	37	97%	1.40E+00	2.00E+01	8.64E+00	8.64E+00	5.00E-01	5.00E-01	4.00E-01	4.48E+02	7.00E+01	Yes	No	No	No	No	No
Cobalt	17	17	100%	6.00E-01	1.05E+01	7.49E+00	7.49E+00	NA	NA	2.00E+01	1.92E+03	1.13E+01	Yes	No	No	No	No	No
Copper	38	38	100%	3.00E+00	6.98E+02	5.21E+01	5.21E+01	NA	NA	5.00E+01	4.09E+04	6.70E+01	Yes	No	No	Yes	Yes	Yes
Iron	38	38	100%	2.65E+03	9.73E+04	2.78E+04	2.78E+04	NA	NA	1.00E+01	1.00E+05	3.53E+04	Yes	No	No	Yes	Yes	Yes
Lead	38	38	100%	8.50E-01	2.43E+03	5.95E+02	5.95E+02	NA	NA	1.60E+01	8.00E+02	8.40E+00	Yes	No	No	Yes	Yes	Yes
Manganese	38	38	100%	2.53E+01	1.26E+03	5.85E+02	5.85E+02	NA	NA	1.00E+02	1.95E+04	1.06E+03	Yes	No	No	Yes	Yes	Yes
Mercury	38	33	87%	4.80E-02	7.84E+02	6.25E+01	6.25E+01	2.00E-02	2.50E-02	1.00E-01	3.07E+02	1.40E-01	Yes	No	No	Yes	Yes	Yes
Nickel	38	37	97%	4.00E-01	9.60E+00	4.97E+00	4.97E+00	5.00E-01	5.00E-01	3.00E+01	2.04E+04	7.00E+01	Yes	No	No	No	No	No
Selenium	38	38	100%	1.70E-01	3.26E+00	7.21E-01	7.21E-01	NA	NA	1.00E+00	5.11E+03	7.60E-01	Yes	No	No	Yes	Yes	Yes
Silver	38	37	97%	8.00E-02	3.19E+02	4.70E+01	4.70E+01	1.05E-01	1.05E-01	2.00E+00	5.11E+03	6.30E-01	Yes	No	No	Yes	Yes	Yes
Thallium	17	13	76%	3.40E-01	3.30E+00	1.52E+00	1.52E+00	1.15E-01	2.30E-01	1.00E+00	6.75E+01	9.70E-01	Yes	No	No	Yes	Yes	Yes
Vanadium	17	17	100%	5.10E+00	9.61E+01	4.49E+01	4.49E+01	NA	NA	2.00E+00	1.02E+03	4.78E+01	Yes	No	No	Yes	Yes	Yes
Zinc	38	38	100%	4.00E+00	2.41E+03	3.67E+02	3.67E+02	NA	NA	5.00E+01	1.00E+05	1.45E+02	Yes	No	No	Yes	Yes	Yes

NOTES:
Abbreviations: mg/kg = milligrams per kilogram, NA = not applicable.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix A2. Data Summary and Initial Human Health Screening for Surface Soil
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Soil Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?	Human Health Chemical of Interest?
				mg/kg														
Metals																		
Aluminum	14	14	100%	1.11E+03	1.75E+04	1.03E+04	1.03E+04	NA	NA	5.00E+01	1.00E+05	3.12E+04	Yes	No	No	No	No	No
Antimony	35	28	80%	3.00E-01	3.68E+02	4.44E+01	4.44E+01	1.00E-01	5.00E-01	5.00E+00	4.09E+02	8.40E-01	Yes	No	No	Yes	Yes	Yes
Arsenic, total	35	35	100%	1.70E+00	1.14E+04	2.25E+03	2.25E+03	NA	NA	1.00E+01	1.59E+00	4.35E+01	Yes	No	No	Yes	Yes	Yes
Barium	14	14	100%	3.28E+01	3.22E+02	1.86E+02	1.86E+02	NA	NA	8.50E+01	6.66E+04	3.19E+02	Yes	No	No	Yes	Yes	Yes
Beryllium	35	28	80%	3.30E-02	7.00E-01	3.33E-01	3.33E-01	1.00E-01	1.00E-01	1.00E+01	1.94E+03	1.20E+00	Yes	No	No	No	No	No
Cadmium	35	32	91%	1.70E-01	2.34E+01	4.51E+00	4.51E+00	1.35E-02	3.20E-02	4.00E+00	4.51E+02	2.03E+00	Yes	No	No	Yes	Yes	Yes
Chromium, Total	35	34	97%	1.40E+00	2.00E+01	8.81E+00	8.81E+00	5.00E-01	5.00E-01	4.00E-01	4.48E+02	7.00E+01	Yes	No	No	No	No	No
Cobalt	14	14	100%	6.00E-01	1.05E+01	7.36E+00	7.36E+00	NA	NA	2.00E+01	1.92E+03	1.13E+01	Yes	No	No	No	No	No
Copper	35	35	100%	3.00E+00	6.98E+02	5.46E+01	5.46E+01	NA	NA	5.00E+01	4.09E+04	6.70E+01	Yes	No	No	Yes	Yes	Yes
Iron	35	35	100%	2.65E+03	9.73E+04	2.84E+04	2.84E+04	NA	NA	1.00E+01	1.00E+05	3.53E+04	Yes	No	No	Yes	Yes	Yes
Lead	35	35	100%	8.50E-01	2.43E+03	7.19E+02	7.19E+02	NA	NA	1.60E+01	8.00E+02	8.40E+00	Yes	No	No	Yes	Yes	Yes
Manganese	35	35	100%	2.53E+01	1.26E+03	5.92E+02	5.92E+02	NA	NA	1.00E+02	1.95E+04	1.06E+03	Yes	No	No	Yes	Yes	Yes
Mercury	35	30	86%	4.80E-02	7.84E+02	6.78E+01	6.78E+01	2.00E-02	2.50E-02	1.00E-01	3.07E+02	1.40E-01	Yes	No	No	Yes	Yes	Yes
Nickel	35	34	97%	4.00E-01	9.60E+00	5.03E+00	5.03E+00	5.00E-01	5.00E-01	3.00E+01	2.04E+04	7.00E+01	Yes	No	No	No	No	No
Selenium	35	35	100%	1.70E-01	3.26E+00	7.28E-01	7.28E-01	NA	NA	1.00E+00	5.11E+03	7.60E-01	Yes	No	No	Yes	Yes	Yes
Silver	35	34	97%	8.00E-02	3.19E+02	6.33E+01	6.33E+01	1.05E-01	1.05E-01	2.00E+00	5.11E+03	6.30E-01	Yes	No	No	Yes	Yes	Yes
Thallium	14	11	79%	3.40E-01	3.30E+00	1.60E+00	1.60E+00	1.30E-01	2.30E-01	1.00E+00	6.75E+01	9.70E-01	Yes	No	No	Yes	Yes	Yes
Vanadium	14	14	100%	5.10E+00	9.61E+01	4.58E+01	4.58E+01	NA	NA	2.00E+00	1.02E+03	4.78E+01	Yes	No	No	Yes	Yes	Yes
Zinc	35	35	100%	4.00E+00	2.41E+03	3.61E+02	3.61E+02	NA	NA	5.00E+01	1.00E+05	1.45E+02	Yes	No	No	Yes	Yes	Yes

NOTES:
Abbreviations: mg/kg = milligrams per kilogram, NA = not applicable.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix A3. Data Summary and Initial Human Health Screening for Subsurface Soil
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Soil Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Human Health Chemical of Interest?
				mg/kg													
Metals																	
Aluminum	10	10	100%	4.68E+03	1.76E+04	1.30E+04	1.30E+04	NA	NA	5.00E+01	1.00E+05	3.12E+04	Yes	No	No	No	No
Antimony	10	10	100%	3.80E-01	6.00E+00	3.74E+00	3.74E+00	NA	NA	5.00E+00	4.09E+02	8.40E-01	Yes	No	No	Yes	Yes
Arsenic, total	10	10	100%	1.01E+01	5.44E+02	2.41E+02	2.41E+02	NA	NA	1.00E+01	1.59E+00	4.35E+01	Yes	No	No	Yes	Yes
Barium	10	10	100%	1.38E+02	2.25E+02	1.91E+02	1.91E+02	NA	NA	8.50E+01	6.66E+04	3.19E+02	Yes	No	No	No	No
Beryllium	10	10	100%	2.10E-01	5.00E-01	FALSE	5.00E-01	NA	NA	1.00E+01	1.94E+03	1.20E+00	Yes	No	No	No	No
Cadmium	10	8	80%	5.20E-01	1.41E+01	5.35E+00	5.35E+00	1.25E-02	1.35E-02	4.00E+00	4.51E+02	2.03E+00	Yes	No	No	Yes	Yes
Chromium, Total	10	10	100%	3.30E+00	1.33E+01	8.42E+00	8.42E+00	NA	NA	4.00E-01	4.48E+02	7.00E+01	Yes	No	No	No	No
Cobalt	10	10	100%	6.40E+00	9.90E+00	8.62E+00	8.62E+00	NA	NA	2.00E+01	1.92E+03	1.13E+01	Yes	No	No	No	No
Copper	10	10	100%	5.50E+00	4.35E+01	FALSE	4.35E+01	NA	NA	5.00E+01	4.09E+04	6.70E+01	Yes	No	No	No	No
Iron	10	10	100%	1.88E+04	2.82E+04	2.34E+04	2.34E+04	NA	NA	1.00E+01	1.00E+05	3.53E+04	Yes	No	No	No	No
Lead	10	10	100%	3.60E+00	1.20E+02	5.37E+01	5.37E+01	NA	NA	1.60E+01	8.00E+02	8.40E+00	Yes	No	No	Yes	Yes
Manganese	10	10	100%	2.70E+02	8.33E+02	6.82E+02	6.82E+02	NA	NA	1.00E+02	1.95E+04	1.06E+03	Yes	No	No	No	No
Mercury	10	10	100%	2.60E-02	6.10E-01	2.96E-01	2.96E-01	NA	NA	1.00E-01	3.07E+02	1.40E-01	Yes	No	No	Yes	Yes
Nickel	10	10	100%	3.90E+00	9.70E+00	6.54E+00	6.54E+00	NA	NA	3.00E+01	2.04E+04	7.00E+01	Yes	No	No	No	No

NOTES:
Abbreviations: mg/kg = milligrams per kilogram, NA = not applicable.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix A4. Data Summary and Initial Ecological Screening for Vegetation
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Terrestrial Ecological Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?
				mg/kg											
Metals															
Aluminum	6	6	100%	1.53E+02	2.84E+02	NA	2.84E+02	NA	NA	No Data	3.12E+02	Yes	No	No	No
Antimony	6	0	0%	ND	ND	NA	0.00E+00	4.70E-01	6.50E-01	No Data	0.00E+00	No	No	No	No
Arsenic, total	6	3	50%	1.00E+00	1.06E+01	NA	1.06E+01	6.00E-01	7.00E-01	No Data	0.00E+00	Yes	No	Yes	Yes
Barium	6	6	100%	5.19E+01	2.90E+02	NA	2.90E+02	NA	NA	No Data	5.05E+02	Yes	No	No	No
Beryllium	6	6	100%	8.70E-02	1.60E-01	NA	1.60E-01	NA	NA	No Data	1.20E-01	Yes	No	Yes	Yes
Cadmium	6	5	83%	5.00E-01	2.60E+00	NA	2.60E+00	7.50E-02	7.50E-02	No Data	3.70E-01	Yes	No	Yes	Yes
Chromium, Total	6	2	33%	4.80E-01	1.70E+00	NA	1.70E+00	1.80E-01	1.90E-01	No Data	0.00E+00	Yes	No	Yes	Yes
Cobalt	6	0	0%	ND	ND	NA	0.00E+00	2.00E-01	2.85E-01	No Data	0.00E+00	No	No	No	No
Copper	6	6	100%	4.60E+00	6.10E+00	NA	6.10E+00	NA	NA	No Data	5.70E+00	Yes	No	Yes	Yes
Iron	6	6	100%	1.97E+02	6.42E+02	NA	6.42E+02	NA	NA	No Data	3.15E+02	Yes	No	Yes	Yes
Lead	6	6	100%	5.00E-01	2.70E+00	NA	2.70E+00	NA	NA	No Data	1.10E+00	Yes	No	Yes	Yes
Manganese	6	6	100%	1.18E+02	2.91E+02	NA	2.91E+02	NA	NA	No Data	3.24E+02	Yes	No	No	No
Mercury	6	4	67%	5.00E-02	9.20E-02	NA	9.20E-02	2.30E-02	2.60E-02	No Data	0.00E+00	Yes	No	Yes	Yes
Nickel	6	0	0%	ND	ND	NA	0.00E+00	2.10E-01	3.00E-01	No Data	0.00E+00	No	No	No	No
Selenium	6	2	33%	7.00E-01	9.10E-01	NA	9.10E-01	4.35E-01	4.85E-01	No Data	1.40E+00	Yes	No	No	No
Silver	6	0	0%	ND	ND	NA	0.00E+00	2.20E-01	3.15E-01	No Data	0.00E+00	No	No	No	No
Thallium	6	0	0%	ND	ND	NA	0.00E+00	5.50E-01	8.00E-01	No Data	0.00E+00	No	No	No	No
Vanadium	6	6	100%	7.60E-01	1.20E+00	NA	1.20E+00	NA	NA	No Data	9.40E-01	Yes	No	Yes	Yes
Zinc	6	6	100%	1.67E+01	7.02E+01	NA	7.02E+01	NA	NA	No Data	2.14E+01	Yes	No	Yes	Yes

NOTES:
Abbreviations: mg/kg = milligrams per kilogram, NA = not applicable, ND = not detected.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix A5. Data Summary and Initial Screening for Surface Water
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Surface Water Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?	Human Health Chemical of Interest?
				mg/L														
Metals																		
Aluminum	13	3	23%	2.64E-02	1.26E-01	4.87E-02	4.87E-02	1.18E-02	3.16E-02	8.70E-02	3.65E+01	0.00E+00	Yes	No	No	Yes	Yes	Yes
Antimony	17	2	12%	7.00E-04	9.00E-04	2.27E-03	9.00E-04	2.00E-04	2.50E-03	1.00E+00	1.46E-02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Arsenic, Total	17	7	41%	1.30E-03	8.18E-02	1.78E-02	1.78E-02	2.50E-04	3.00E-03	1.50E-01	4.48E-05	6.00E-04	Yes	No	Yes	Yes	Yes	Yes
Barium	13	13	100%	3.49E-02	9.95E-02	6.22E-02	6.22E-02	NA	NA	4.00E-03	2.55E+00	0.00E+00	Yes	No	No	Yes	Yes	Yes
Beryllium	17	0	0%	ND	ND	1.53E-04	0.00E+00	5.00E-05	2.00E-04	5.30E-03	7.30E-02	0.00E+00	No	No	No	No	No	No
Cadmium	17	2	12%	1.00E-04	7.00E-04	4.47E-04	4.47E-04	5.00E-05	6.00E-04	2.20E-03	1.82E-02	0.00E+00	Yes	No	No	Yes	Yes	Yes
Chromium, Total	17	1	6%	7.40E-04	7.40E-04	2.37E-03	7.40E-04	7.00E-04	5.00E-03	1.10E-02	No Data	0.00E+00	Yes	No	No	Yes	Yes	Yes
Cobalt	13	0	0%	ND	ND	1.62E-03	0.00E+00	9.00E-04	1.85E-03	2.30E-02	7.30E-01	0.00E+00	No	No	No	No	No	No
Copper	17	2	12%	7.00E-04	3.80E-03	1.56E-03	1.56E-03	2.50E-04	1.65E-03	9.00E-03	1.46E+00	0.00E+00	Yes	No	No	Yes	Yes	Yes
Iron	17	6	35%	3.23E-02	2.03E+00	6.43E-01	6.43E-01	8.40E-03	3.34E-02	1.00E+00	1.09E+01	1.00E-01	Yes	No	No	Yes	Yes	Yes
Lead	17	6	35%	1.00E-04	9.00E-03	2.13E-03	2.13E-03	5.00E-05	7.50E-04	2.50E-03	No Data	1.00E-04	Yes	No	No	Yes	Yes	Yes
Manganese	17	13	76%	7.20E-04	3.74E-01	1.01E-01	1.01E-01	3.50E-04	9.50E-04	1.20E-01	8.76E-01	0.00E+00	Yes	No	No	Yes	Yes	Yes
Mercury	17	6	35%	9.50E-07	2.00E-04	7.57E-05	7.57E-05	5.00E-05	5.00E-05	7.70E-04	1.09E-02	4.80E-07	Yes	No	No	Yes	Yes	Yes
Nickel	17	0	0%	ND	ND	2.88E-03	0.00E+00	1.00E-03	5.00E-03	5.20E-02	7.30E-01	0.00E+00	No	No	No	No	No	No
Selenium	17	2	12%	5.00E-04	2.60E-03	1.26E-03	1.26E-03	5.00E-05	1.70E-03	5.00E-03	1.82E-01	0.00E+00	Yes	No	No	Yes	Yes	Yes
Silver	17	1	6%	9.00E-05	9.00E-05	1.20E-03	9.00E-05	2.50E-05	1.45E-03	1.20E-04	1.82E-01	0.00E+00	Yes	Yes	No	Yes	Yes	Yes
Thallium	13	0	0%	ND	ND	2.22E-03	0.00E+00	1.40E-03	2.85E-03	4.00E-02	2.41E-03	0.00E+00	No	No	Yes	No	No	Yes
Vanadium	13	0	0%	ND	ND	1.52E-03	0.00E+00	1.00E-03	1.80E-03	2.00E-02	3.65E-02	0.00E+00	No	No	No	No	No	No
Zinc	17	14	82%	2.00E-03	1.31E+00	2.31E-01	2.31E-01	2.85E-03	5.00E-03	1.20E-01	1.09E+01	1.00E-02	Yes	No	No	Yes	Yes	Yes

NOTES:
Abbreviations: mg/L = milligrams per liter, NA = not applicable, ND = not detected.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix A6. Data Summary and Initial Screening for Pore Water
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Surface Water Ecological Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?
				mg/L											
Metals															
Aluminum	11	2	18%	4.57E-02	6.05E-02	3.17E-02	3.17E-02	1.18E-02	3.16E-02	8.70E-02	0.00E+00	Yes	No	Yes	Yes
Antimony	14	0	0%	ND	ND	2.24E-03	0.00E+00	2.00E-04	2.50E-03	1.00E+00	0.00E+00	No	No	No	No
Arsenic, Total	14	7	50%	8.00E-04	1.67E-02	6.49E-03	6.49E-03	2.40E-03	3.00E-03	1.50E-01	3.40E-03	Yes	No	Yes	Yes
Barium	11	11	100%	3.10E-02	6.08E-02	4.85E-02	4.85E-02	NA	NA	4.00E-03	0.00E+00	Yes	No	Yes	Yes
Beryllium	14	0	0%	ND	ND	4.42E-04	0.00E+00	1.00E-04	1.00E-03	5.30E-03	0.00E+00	No	No	No	No
Cadmium	14	0	0%	ND	ND	3.75E-04	0.00E+00	5.00E-05	6.00E-04	2.20E-03	0.00E+00	No	No	No	No
Chromium, Total	14	3	21%	1.00E-02	1.00E-02	4.41E-03	4.41E-03	7.00E-04	9.50E-04	1.10E-02	1.00E-02	Yes	No	No	No
Cobalt	11	0	0%	ND	ND	1.39E-03	0.00E+00	1.00E-03	1.85E-03	2.30E-02	0.00E+00	No	No	No	No
Copper	14	0	0%	ND	ND	2.79E-03	0.00E+00	1.20E-03	5.00E-03	9.00E-03	0.00E+00	No	No	No	No
Iron	14	2	14%	2.33E-02	5.56E+00	1.21E+00	1.21E+00	8.40E-03	3.34E-02	1.00E+00	5.56E+00	Yes	No	No	No
Lead	14	6	43%	2.00E-04	2.40E-03	1.16E-03	1.16E-03	6.50E-04	6.50E-04	2.50E-03	3.00E-04	Yes	No	Yes	Yes
Manganese	14	11	79%	7.00E-04	2.59E-01	5.61E-02	5.61E-02	9.50E-04	2.50E-03	1.20E-01	2.59E-01	Yes	No	No	No
Mercury	14	3	21%	2.40E-07	1.20E-04	5.74E-05	5.74E-05	5.00E-08	5.00E-05	7.70E-04	6.60E-07	Yes	No	Yes	Yes
Nickel	14	0	0%	ND	ND	2.70E-03	0.00E+00	1.05E-03	5.00E-03	5.20E-02	0.00E+00	No	No	No	No
Selenium	14	1	7%	3.50E-03	3.50E-03	1.47E-03	1.47E-03	5.00E-05	1.70E-03	5.00E-03	0.00E+00	Yes	No	Yes	Yes
Silver	14	0	0%	ND	ND	1.12E-03	0.00E+00	2.50E-05	1.45E-03	1.20E-04	0.00E+00	No	Yes	No	Yes
Thallium	11	1	9%	4.10E-03	4.10E-03	2.76E-03	2.76E-03	1.40E-03	2.85E-03	4.00E-02	0.00E+00	Yes	No	Yes	Yes
Vanadium	11	0	0%	ND	ND	1.36E-03	0.00E+00	1.00E-03	1.80E-03	2.00E-02	0.00E+00	No	No	No	No
Zinc	14	11	79%	1.70E-03	5.90E-03	4.52E-03	4.52E-03	5.00E-03	5.00E-03	1.20E-01	0.00E+00	Yes	No	Yes	Yes

NOTES:
Abbreviations: mg/L = milligrams per liter, NA = not applicable, ND = not detected.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix A7. Data Summary and Initial Screening for Sediment
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Number of Analyses	Number of Detections	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	90% Upper Confidence Limit	Exposure Point Concentration [1]	Half of Minimum Sample Reporting Limit	Half of Maximum Sample Reporting Limit	Minimum Sediment Ecological Risk-Based Screening Concentration	Minimum Human Health Risk-Based Screening Concentration	Maximum Background Concentration [1]	Exceeds 5% Frequency of Detection?	Reporting Limit Too High For Ecological Receptors?	Reporting Limit Too High for Human Health?	Maximum Concentration Exceeds Background?	Ecological Chemical of Interest?	Human Health Chemical of Interest?
				mg/kg														
Metals																		
Aluminum	20	20	100%	3.82E+03	1.17E+04	7.89E+03	7.89E+03	NA	NA	No Data	1.00E+05	0.00E+00	Yes	No	No	Yes	Yes	Yes
Antimony	27	16	59%	3.00E-01	5.10E+00	1.43E+00	1.43E+00	1.00E-01	2.75E-01	3.00E+00	4.09E+02	3.00E-01	Yes	No	No	Yes	Yes	Yes
Arsenic, total	27	27	100%	6.30E+00	3.03E+02	7.71E+01	7.71E+01	NA	NA	4.00E+00	1.59E+00	3.65E+01	Yes	No	No	Yes	Yes	Yes
Barium	20	20	100%	5.23E+01	2.17E+02	1.35E+02	1.35E+02	NA	NA	No Data	6.66E+04	0.00E+00	Yes	No	No	Yes	Yes	Yes
Beryllium	27	25	93%	1.10E-01	8.00E-01	3.50E-01	3.50E-01	1.00E-01	1.00E-01	1.22E+02	1.94E+03	8.00E-01	Yes	No	No	No	No	No
Cadmium	27	15	56%	6.90E-02	2.80E+00	6.47E-01	6.47E-01	2.65E-02	4.30E-02	3.00E-03	4.51E+02	2.20E-01	Yes	No	No	Yes	Yes	Yes
Chromium, Total	27	27	100%	2.30E+00	4.56E+01	1.71E+01	1.71E+01	NA	NA	3.70E+01	4.48E+02	1.00E+01	Yes	No	No	Yes	Yes	Yes
Cobalt	20	20	100%	1.90E+00	9.60E+00	6.72E+00	6.72E+00	NA	NA	No Data	1.92E+03	0.00E+00	Yes	No	No	Yes	Yes	Yes
Copper	27	27	100%	1.30E+00	3.00E+01	9.92E+00	9.92E+00	NA	NA	1.00E+01	4.09E+04	0.00E+00	Yes	No	No	Yes	Yes	Yes
Iron	27	27	100%	5.65E+03	5.46E+04	2.46E+04	2.46E+04	NA	NA	No Data	1.00E+05	1.66E+04	Yes	No	No	Yes	Yes	Yes
Lead	27	27	100%	1.89E+00	1.48E+02	3.39E+01	3.39E+01	NA	NA	3.50E+01	8.00E+02	2.63E+00	Yes	No	No	Yes	Yes	Yes
Manganese	27	27	100%	1.00E+02	6.11E+02	3.03E+02	3.03E+02	NA	NA	1.10E+03	1.95E+04	2.98E+02	Yes	No	No	Yes	Yes	Yes
Mercury	27	18	67%	2.70E-02	3.20E-01	1.14E-01	1.14E-01	9.50E-03	2.50E-02	2.00E-01	3.07E+02	1.00E-01	Yes	No	No	Yes	Yes	Yes
Nickel	27	25	93%	1.00E+00	7.60E+00	4.43E+00	4.43E+00	5.00E-01	5.00E-01	1.80E+01	2.04E+04	1.00E+00	Yes	No	No	Yes	Yes	Yes
Selenium	27	27	100%	9.00E-02	8.80E-01	5.06E-01	5.06E-01	NA	NA	1.00E-01	5.11E+03	3.10E-01	Yes	No	No	Yes	Yes	Yes
Silver	27	24	89%	5.00E-02	7.90E+00	2.02E+00	2.02E+00	4.70E-02	5.00E-02	4.50E+00	5.11E+03	1.30E-01	Yes	No	No	Yes	Yes	Yes
Thallium	20	12	60%	3.00E-01	1.80E+00	7.89E-01	7.89E-01	1.25E-01	3.35E-01	7.00E-01	6.75E+01	0.00E+00	Yes	No	No	Yes	Yes	Yes
Vanadium	20	20	100%	1.30E+01	1.54E+02	7.10E+01	7.10E+01	NA	NA	No Data	1.02E+03	0.00E+00	Yes	No	No	Yes	Yes	Yes
Zinc	27	27	100%	2.07E+01	1.86E+02	8.28E+01	8.28E+01	NA	NA	3.00E+00	1.00E+05	3.60E+01	Yes	No	No	Yes	Yes	Yes

NOTES:
Abbreviations: mg/kg = milligrams per kilogram, NA = not applicable.
1 90th percentile upper confidence limit on the mean or maximum (whichever is lower).

Appendix B. Human Health Risk-Based Screening Tables

Appendix B1. Selection of Human Health Chemicals of Potential Concern
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Media: Surface Soil					Media: Subsurface soil					Media: Sediment					Media: Surface Water				All Exposure Media	
	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (Rij)	Chemical of Potential Concern?	Inordinate Contribution to Medium-Specific Risks?	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (Rij)	Chemical of Potential Concern?	Inordinate Contribution to Medium-Specific Risks?	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (Rij)	Chemical of Potential Concern?	Inordinate Contribution to Medium-Specific Risks?	Preliminary Remediation Goal	Exposure Point Concentration	Risk Ratio (Rij)	Chemical of Potential Concern?	Sum of Medium-Specific Risk Ratios	Chemical of Potential Concern?
	mg/kg					mg/kg					mg/kg					µg/L					
Aluminum											1.00E+05	7.89E+03	7.89E-02	No	No	3.65E+04	4.87E-02	1.33E-06	No	7.89E-02	No
Antimony	4.09E+02	4.44E+01	1.08E-01	No	No	4.09E+02	3.74E+00	9.14E-03	No	No	4.09E+02	1.43E+00	3.49E-03	No	No	1.46E+01	9.00E-04	6.16E-05	No	1.21E-01	No
Arsenic	1.59E+00	2.25E+03	1.42E+03	**YES**	**YES**	1.59E+00	2.41E+02	1.51E+02	**YES**	**YES**	1.59E+00	7.71E+01	4.85E+01	**YES**	**YES**	4.48E-02	1.78E-02	3.97E-01	No	1.62E+03	**YES**
Barium	6.66E+04	1.86E+02	2.80E-03	No	No						6.66E+04	1.35E+02	2.02E-03	No	No	2.55E+03	6.22E-02	2.43E-05	No	4.84E-03	No
Beryllium											1.94E+03	3.50E-01	1.80E-04	No	No					1.80E-04	No
Cadmium	4.50E+02	4.51E+00	1.00E-02	No	No	4.50E+02	5.35E+00	1.19E-02	No	No	4.50E+02	6.47E-01	1.44E-03	No	No	1.82E+01	4.47E-04	2.45E-05	No	2.34E-02	No
Chromium											2.10E+02	1.71E+01	8.12E-02	No	No	5.47E+04	7.40E-04	1.35E-08	No	8.12E-02	No
Cobalt											1.92E+03	6.72E+00	3.50E-03	No	No					3.50E-03	No
Copper	4.09E+04	5.46E+01	1.34E-03	No	No						4.09E+04	9.92E+00	2.43E-04	No	No	1.46E+03	1.56E-03	1.07E-06	No	1.58E-03	No
Iron	1.00E+05	2.84E+04	2.84E-01	No	No						1.00E+05	2.46E+04	2.46E-01	No	No	1.09E+04	6.43E-01	5.87E-05	No	5.30E-01	No
Lead	8.00E+02	7.19E+02	8.99E-01	No	No	8.00E+02	5.37E+01	6.71E-02	No	No	8.00E+02	3.39E+01	4.24E-02	No	No	1.50E+01	2.13E-03	1.42E-04	No	1.01E+00	**YES**
Manganese	1.95E+04	5.92E+02	3.04E-02	No	No						1.95E+04	3.03E+02	1.55E-02	No	No	8.76E+02	1.01E-01	1.16E-04	No	4.61E-02	No
Mercury	3.07E+02	6.78E+01	2.21E-01	No	No	3.07E+02	2.96E-01	9.67E-04	No	No	3.07E+02	1.14E-01	3.73E-04	No	No	1.09E+01	7.57E-05	6.91E-06	No	2.22E-01	No
Nickel											1.60E+03	4.43E+00	2.77E-03	No	No					2.77E-03	No
Selenium	5.11E+03	7.28E-01	1.42E-04	No	No	5.11E+03	8.37E-01	1.64E-04	No	No						1.82E+02	1.26E-03	6.90E-06	No	3.13E-04	No
Silver	5.11E+03	6.33E+01	1.24E-02	No	No	5.11E+03	1.18E+01	2.31E-03	No	No	5.11E+03	2.02E+00	3.96E-04	No	No	1.82E+02	9.00E-05	4.93E-07	No	1.51E-02	No
Thallium	6.75E+01	1.60E+00	2.37E-02	No	No	6.75E+01	1.65E+00	2.45E-02	No	No	6.75E+01	7.89E-01	1.17E-02	No	No	2.41E+00	2.85E-03	1.18E-03	No	6.11E-02	No
Vanadium	1.02E+03	4.58E+01	4.48E-02	No	No	1.02E+03	5.31E+01	5.20E-02	No	No	1.02E+03	7.10E+01	6.94E-02	No	No					1.66E-01	No
Zinc	1.00E+05	3.61E+02	3.61E-03	No	No	1.00E+05	2.43E+02	2.43E-03	No	No	1.00E+05	8.28E+01	8.28E-04	No	No	1.09E+04	2.31E-01	2.11E-05	No	6.89E-03	No
	Sum of Rij: 1.4E+03					Sum of Rij: 1.5E+02					Sum of Rij: 4.9E+01					Sum of Rij: 4.0E-01					
	No. of Samples: 1.4E+01					No. of Samples: 1.0E+01					No. of Samples: 1.8E+01					No. of Samples: 1.5E+01					
	1/No. of Samples: 7.1E-02					1/No. of Samples: 1.0E-01					1/No. of Samples: 5.6E-02					1/No. of Samples 6.7E-02					

NOTE:
Abbreviation: mg/kg = milligrams per kilogram.

Appendix B2. Chemical Exposure and Intake Factors
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Exposure Factors	Recreational Receptor				Source
	Child		Adult		
	Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure	
Body Weight (kg)	15	15	70	70	EPA, 1997
Exposure Frequency (d/yr) soil	6	12	6	24	Site Specific
Exposure Frequency (d/yr) sediment	6	12	6	24	Site Specific
Exposure Frequency (d/yr) surface water	6	12	6	24	Site Specific
Event time (hrs/event) soil	1	2	2	2	Site Specific
Event Frequency (events per day)	1	1	1	1	Site Specific
Exposure Duration (yr)	6	6	9	24	EPA, 1997
Averaging Time (d) [1]					
carcinogens	25,550	25,550	25,550	25,550	EPA, 1989
noncarcinogens	2,190	2,190	3,285	8,760	EPA, 1989
Intake Factors					
Ingestion of soil (mg/d)	100	200	50	100	EPA, 1997
Incidental ingestion of sediment (mg/d)	50	100	25	50	EPA, 1997
Incidental surface water ingestion (L/hr)	0.05	0.05	0.05	0.05	EPA, 1997
Exposed skin surface area (cm^2)	6,600	7,300	18,000	22,000	EPA, 2004a
Inhalation rate (m^3/d)	8.3	8.3	15.2	15.2	EPA, 1997
Dermal absorption factor					
volatile vp> 12000 Pa	0.0005	0.0005	0.0005	0.0005	EPA, 2004a
volatile vp< 12000 Pa	0.03	0.03	0.03	0.03	EPA, 2004a
inorganics	0.1	0.01	0.01	0.01	EPA, 2004a
Soil Adherence Factor (mg/cm^2-event)	0.01	0.07	0.01	0.07	EPA, 2004a
PEF (mg^3/kg)	1.32E+09	1.32E+09	1.32E+09	1.32E+09	EPA, 2004a

NOTES:

Abbreviations: cm^2 = square centimeters, d = day, d/yr = days per year, kg = kilograms, L/hr = liters per hour, m^3/d = cubic meters per day, mg/cm^2 = milligrams per square centimeter, mg^3/kg = cubic milligrams per kilogram, mg/d = milligrams per day, Pa = Pascal, PEF = Particulate Emission Factor, vp = vapor pressure, yr = year.

1 Averaging Time = Exposure Duration (yrs) X 365 days per year.

SOURCES:

EPA, 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

EPA, 1997. "Exposure Factors Handbook". Volumes I - III. EPA Office of Research and Development. August

EPA, 2004a. "Risk Assessment Guide for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment." July

EPA, 2004b. "Region IV Preliminary Remediation Goals". 2004 Update. EPA. December

Appendix B3. Exposure Point Concentrations
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Chemical of Potential Concern	n	Maximum Concentrations	Central Tendency Exposure [1]	Reasonable Maximum Exposure [2]
Surface Soil (mg/kg)				
Arsenic	35	1.14E+04	8.53E+02	2.25E+03
Sediment (mg/kg)				
Arsenic	27	3.03E+02	5.44E+01	7.71E+01
Surface Water (mg/L)				
Arsenic	17	8.18E-02	9.88E-03	1.78E-02

NOTES:
Abbreviations: mg/kg = milligrams per kilogram, mg/L = milligrams per liter, n = number of samples.
1 Average Concentration
2 90% Upper Confidence Limit on the mean if greater then 10 datapoints or
maximum concentration if less than 10 datapoints.

Appendix B4. Human Chemical Intake Rates
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Scenario (Recreational)	Carcinogen		Noncarcinogen	
	Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure
	mg/kg-day			
Surface Soil				
Ingestion	9.1E-10	5.8E-09	1.0E-08	4.4E-08
Inhalation of particulates	1.29E-12	9.78E-12	1.23E-11	4.92E-11
Dermal	5.43E-01	7.09E+00	4.23E+00	2.07E+01
Sediments				
Ingestion	1.1E-09	2.9E-09	5.1E-09	2.2E-08
Dermal	5.43E-01	7.09E+00	4.23E+00	2.07E+01
Surface Water				
Ingestion	2.2E-07	1.0E-06	6.3E-08	6.7E-07
Dermal	8.01E-01	2.01E+00	7.23E+00	1.60E+01

NOTE:
Abbreviation: mg/kg-day = milligrams per kilogram per day.

Appendix B5. Human Health Dermal Absorption Factors for Soil
Non-Carcinogenic Dermal Exposure
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Chemical of Potential Concern	Dermal Absorption Factor	Conversion Factor	Recreational Adherence Factors		Recreational Dermal Absorption	
			Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure
Arsenic	0.01	0.000001	1.00E-02	7.00E-02	1.00E-10	7.00E-10

Appendix B6. Human Health Dermal Absorption Factors for Carinogens
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Chemical of Potential Concern	Dermal Absorption Factor	Conversion Factor	Recreational Adherence Factors		Recreational Dermal Absorption	
			Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure
Arsenic	0.01	0.000001	1.00E-02	7.00E-02	1.00E-10	7.00E-10

Appendix B7. Critical Toxicity Factors for Non-Carcinogenic Chemicals of Potential Concern
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Contaminant	CAS Number	Chronic Oral RfD [1]		Confidence in RfD	Endpoint
		Oral	Inhalation		
		mg/kg-day			
Arsenic	7440-38-2	0.0003	NA	Medium	hyperpigmentation, vascular

NOTES:

Abbreviations: CAS = chemical abstracts scientific (registration), mg/kg-day = milligrams per kilograms per day, RfD = non-cancer reference dose.

1 RfD value from Region IX Preliminarty Remediation goal tables.

Appendix B8. Critical Toxicity Factors for Carcinogenic Chemicals of Potential Concern
Upper Granite Creek Mines Human Health and Ecological Risk Assessment
Wallowa-Whitman National Forest, Oregon

Contaminant	CAS Number	Slope Factor (mg/kg-day)-1		Weight of Evidence Classification	Type of Cancer	Basis of Slope Factor
		Oral	Inhalation	Oral/Inhalation	Oral/ Inhalation	Oral/ Inhalation
Arsenic	7440-38-2	1.5E+00	1.5E+01	A	skin	EPI studies

NOTES:

Abbreviations: A = known human carcinogen, CAS = chemical abstracts scientific (registration), mg/kg-day = milligrams per kilograms per day.

Appendix B9. Hazard Quotients for Non-Carcinogenic Chemicals of Potential Concern - Recreation Scenario
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Route of Exposure	Chemicals of Potential Concern	Exposure Point Concentration		Average Daily Dose [1]		Oral Reference Dose	Hazard Quotient [2]	
		Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure		Central Tendency Exposure	Reasonable Maximum Exposure
Soil		**mg/kg**		**mg/kg-day**				
Ingestion	Arsenic	6.82E+02	1.80E+03	1.01E-08	4.44E-08	3.00E-04	2.E-02	3.E-01
Dermal	Arsenic	6.82E+02	1.80E+03	4.23E-10	1.45E-08	3.00E-04	1.E-03	9.E-02
Sediments		**mg/kg**		**mg/kg-day**				
Ingestion	Arsenic	4.35E+01	6.17E+01	5.06E-09	2.22E-08	3.00E-04	7.E-04	5.E-03
Dermal	Arsenic	4.35E+01	6.17E+01	4.23E-10	1.45E-08	3.00E-04	6.E-05	3.E-03
Surface Water		**mg/L**		**mg/L-day**				
Ingestion	Arsenic	7.90E-03	1.42E-02	6.29E-08	6.71E-07	3.00E-04	2.E-06	3.E-05
Dermal	Arsenic	7.90E-03	1.42E-02	7.23E-06	1.60E-05	3.00E-04	2.E-04	8.E-04
						Total HI [3]	**2.E-02**	**4.E-01**

NOTES:

Abbreviations: HI = Hazard Index, mg/kg = milligrams per kilogram, mg/kg-day = milligrams per kilogram per day, mg/L = milligrams per liter, mg/L-day = milligrams per liter per day.

1 Average Daily Dose = Exposure Point Concentration x Intake (Appendix B4).

2 Hazard quotient = Average Daily Dose / Oral Reference Dose (RfDo).

3 Hazard Index = sum of all Hazard Quotients.

Appendix B10. Excess Cancer Ricks for Carcinogenic Chemicals of Potential Concern - Recreational Scenario
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Route of Exposure	Chemicals of Potential Concern	Exposure Point Concentration		Average Daily Dose		Oral Slope Factor	Inhalation Slope Factor	Excess Cancer Risk [1]	
		Central Tendency Exposure	Reasonable Maximum Exposure	Central Tendency Exposure	Reasonable Maximum Exposure			Central Tendency Exposure	Reasonable Maximum Exposure
Soil		**mg/kg**		**mg/kg-day**					
Ingestion	Arsenic	6.82E+02	1.80E+03	9.09E-10	5.81E-09	1.5E+00		9.E-07	**2.E-05**
dermal	Arsenic	6.82E+02	1.80E+03	5.43E-11	4.96E-09	1.5E+00		6.E-08	**1.E-05**
Inhalation of particulates	Arsenic	6.82E+02	1.80E+03	1.29E-12	9.78E-12		1.5E+01	1.E-08	3.E-07
Sediments		**mg/kg**		**mg/kg-day**					
Ingestion	Arsenic	4.35E+01	6.17E+01	1.15E-09	2.91E-09	1.5E+00		7.E-08	3.E-07
dermal	Arsenic	4.35E+01	6.17E+01	5.43E-11	4.96E-09	1.5E+00		4.E-09	5.E-07
Surface Water		**mg/L**		**mg/L-day**					
Ingestion	Arsenic	7.90E-03	1.42E-02	2.17E-07	1.03E-06	1.5E+00		3.E-09	2.E-08
dermal	Arsenic	7.90E-03	1.42E-02	8.01E-07	2.01E-06	1.5E+00		9.E-09	4.E-08
						Total Excess Cancer Risk		**1.E-06**	**3.E-05**

NOTES:

Abbreviations: mg/kg = milligrams per kilogram, mg/kg-day = milligrams per kilogram per day, mg/L = milligrams per liter.

Bold = Unacceptable Excess Cancer Risk

1 Excess Cancer Risk = Exposure Point Concentration x Average Daily Dose x Slope Factor (Sfo or Sfi).

Appendix B11. Human Health Hotspot Evaluation
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Sample Number	Sampling Depth	Arsenic, Total	Hotspot Concentration	Hotspot?
	feet	mg/kg		
GF-WR-01		2.9E+01	1.43E+04	No
GF-WR-2		1.3E+03	1.43E+04	No
GF-WR-3		8.9E+01	1.43E+04	No
TILL-WR-01		1.4E+02	1.43E+04	No
TM-TA-SSS-30	0.4	7.3E+01	1.43E+04	No
CMM-WR1-1-0.5'	0.5	7.5E+03	1.43E+04	No
CMM-WR2-1-0.5'	0.5	4.5E+03	1.43E+04	No
CMM-WR2-2-0.5'	0.5	8.6E+02	1.43E+04	No
CMM-WR3-1-0.5'	0.5	6.2E+02	1.43E+04	No
CMM-WR4-1-0.5'	0.5	5.7E+02	1.43E+04	No
CM-WP-SSS-31	0.5	1.1E+04	1.43E+04	No
GC3-WR-01	0.5	2.0E+01	1.43E+04	No
GC5-WR-01	0.5	9.7E+00	1.43E+04	No
GC5-WR-02	0.5	2.7E+01	1.43E+04	No
GC6-WR-01	0.5	1.3E+02	1.43E+04	No
GC6-WR-02	0.5	2.6E+02	1.43E+04	No
GC6-WR-03	0.5	6.3E+00	1.43E+04	No
GC7-WR-01	0.5	1.7E+01	1.43E+04	No
GC7-WR-02	0.5	2.6E+01	1.43E+04	No
GC7-WR-03	0.5	3.7E+02	1.43E+04	No
GC7-WR-04	0.5	5.9E+01	1.43E+04	No
GF-WR2-1-0.5'	0.5	8.8E+01	1.43E+04	No
MM-ML-SSS-16	0.5	1.8E+02	1.43E+04	No
MM-ML-SSS-38	0.5	2.7E+01	1.43E+04	No
MM-WP-SSS-15	0.5	3.0E+02	1.43E+04	No
SM-WR2-1-0.5'	0.5	3.4E+02	1.43E+04	No
MM-ML-SSS-12	0.7	1.6E+02	1.43E+04	No
MM-WP-SSS-14	0.7	1.7E+02	1.43E+04	No
TM-WP-SSS-27	0.8	9.3E+00	1.43E+04	No
TM-WP-SSS-28	0.8	6.6E+00	1.43E+04	No
MM-WP-SSS-13	1	1.7E+00	1.43E+04	No
MM-WP-SSS-17	1	1.9E+02	1.43E+04	No
CMM-TA-SUS-22	1.5	1.4E+02	1.43E+04	No
CM-TA-SUS-33	1.5	2.2E+02	1.43E+04	No
SM-TA-SUS-25	1.5	2.3E+01	1.43E+04	No

NOTE:
Abbreviation: mg/kg = milligrams per kilogram.

Appendix C. Ecological Scoping Checklist

Ecological Scoping Checklist

Site Name	Granite Creek Mines
Date of Site Inspection	Summer 2005
Site Location	Wallowa Whitman National Forest; Granite, Oregon
Site Visit Conducted by	EA Engineering, Science, and Technology

Part ❶

CONTAMINANTS OF INTEREST Types, Classes, Or Specific Hazardous Substances‡ Known Or Suspected	Onsite	Adjacent to or in locality of the facility†
Metals	Yes	Yes

‡ As defined by OAR 340-122-115(34) † As defined by OAR 340-122-115(38)

Part ❷

OBSERVED IMPACTS ASSOCIATED WITH THE SITE	Finding
Onsite vegetation (None, Limited, Extensive)	E
Vegetation in the locality of the site (None, Limited, Extensive)	L
Onsite wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other (None, Limited, Extensive)	N
Wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other in the locality of the site (None, Limited, Extensive)	L
Other readily observable impacts (None, Discuss below)	D
Discussion: Drainage from several adits.	
Vegetation is sparse on waste material piles and in the vicinity of the disturbed mine areas.	
Past forest cutting surrounding mines	

Ecological Scoping Checklist (cont'd)
Part ❸

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Terrestrial – Wooded	
Percentage of site that is wooded	82
Dominant vegetation type (Evergreen, Deciduous, Mixed)	E
Prominent tree size at breast height, i.e., four feet (<6", 6" to 12", >12")	6"- 12"
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	Ma, B, M
Terrestrial – Natural Scrub/Shrub/Grasses	
Percentage of site that is scrub/shrub/Grass	3
Dominant vegetation type (Scrub, Shrub, Grasses, Other)	G
Prominent height of vegetation (<2', 2' to 5', >5')	2' – 5'
Density of vegetation (Dense, Patchy, Sparse)	P
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	Ma, B
Terrestrial – Ruderal	
Percentage of site that is ruderal	10
Dominant vegetation type (Landscaped, Agriculture, Bare ground)	B, Successional
Prominent height of vegetation (0', >0' to <2', 2' to 5', >5')	<2 and >5'
Density of vegetation (Dense, Patchy, Sparse)	S
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	Ma, B
Aquatic – Non-flowing (lentic)	
Percentage of site that is covered by lakes or ponds	0
Type of water bodies (Lakes, Ponds, Vernal pools, Impoundments, Lagoon, Reservoir, Canal)	
Size (acres), average depth (feet), trophic status of water bodies	
Source water (River, Stream, Groundwater, Industrial discharge, Surface water runoff)	
Water discharge point (None, River, Stream, Groundwater, Wetlands impoundment)	
Nature of bottom (Muddy, Rocky, Sand, Concrete, Other)	
Vegetation present (Submerged, Emergent, Floating)	
Obvious wetlands present (Yes / No)	
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	

Aquatic - Flowing (lotic)	
Percentage of site that is covered by rivers, streams (brooks, creeks), intermittent streams, dry wash, arroyo, ditches, or channel waterway	2
Type of water bodies (Rivers, Streams, Intermittent Streams, Dry Wash, Arroyo, Ditches, Channel waterway)	Adit Drainage into stream
Size (acres), average depth (feet), approximate flow rate (cfs) of water bodies	~1-5 ft wide, 0.1-0.5 ft deep, 1-5 cfs
Bank environment (cover: Vegetated, Bare / slope: Steep, Gradual / height (in feet))	B / G to S 0 – 2 ft.
Source water (River, Stream, Groundwater, Industrial discharge, Surface water runoff)	Adit, groundwater, and surface runoff,
Tidal influence (Yes / No)	N
Water discharge point (None, River, Stream, Groundwater, Wetlands impoundment)	River
Nature of bottom (Muddy, Rocky, Sand, Concrete, Other)	Rocky, Sand
Vegetation present (Submerged, Emergent, Floating)	None
Obvious wetlands present (Yes / No)	Y
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Fish, Birds, Mammals, Other)	Ma, Fish

Aquatic – Wetlands	
Obvious or designated wetlands present (Yes / No)	3
Wetlands suspected at site is/has (Adjacent to water body, in Floodplain, Standing water, Dark wet soils, Mud cracks, Debris line, Water marks)	Adj.; Fl.; St. Wat.; Veg.
Vegetation present (Submerged, Emergent, Scrub/shrub, Wooded)	Emergent
Size (acres) and depth (feet) of suspected wetlands	<1 acre/0.5 ft
Source water (River, Stream, Groundwater, Industrial discharge, Surface water runoff)	Str.; Grdwat.; Surf Wat.
Water discharge point (None, River, Stream, Groundwater, Impoundment)	Stream
Tidal influence (Yes / No)	No
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	Ma; B

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

Part ❹

ECOLOGICALLY IMPORTANT SPECIES / HABITATS OBSERVED

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 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? AND Are ecologically important species or habitats present? AND Could hazardous substances reach these receptors via groundwater?		 X X	X
When answering the above questions, consider the following: Known or suspected presence of hazardous substances in groundwater. 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")

ATTACHMENT 2
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? AND Are ecologically important species or habitats present? 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")

ATTACHMENT 2
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? AND Are ecologically important species or habitats present? AND Could hazardous substances reach these receptors via incidental ingestion of or dermal contact with surficial soils?	X X 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 subsurface soils? AND Are ecologically important species or habitats present? AND Could hazardous substances reach these receptors via vapors or fugitive dust carried in surface air or confined in burrows?	X	 X 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-m^3/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")

Appendix D. Ecological Risk-Based Screening Tables

Appendix D1. Ecological Risk-Based Screening Concentrations
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest	Oregon Soil Screening Level Values				Oregon Freshwater Screening Level Values			Oregon Sediment Screening Level Values	
	Plants	Invertebrates	Birds	Mammals	Aquatic Life	Birds	Mammals	Freshwater	Bioaccumulation
	mg/kg				mg/L			mg/kg	
Aluminum	5.0E+01 pH<5.5	6.0E+02 pH<5.5	4.5E+02 pH<5.5	1.07E+02 pH<5.5	8.70E-02	7.97E+02	8.00E+00	No Data	No Data
Antimony	5.0E+00	7.80E+01 USEPA, 2005a	No Data	1.50E+01	1.60E+00	No Data	1.00E+00	3.00E+00	1.00E+01
Arsenic, Total	1.8E+01 USEPA, 2005b	6.0E+01 Arsenic III	4.3E+01 USEPA, 2005b	4.6E+01 USEPA, 2005b	1.50E-01 Arsenic III	1.80E+01 Arsenic III	6.00E+00 Arsenic III	6.00E+00 Arsenic III	4.00E+00 Arsenic III
Barium	5.0E+02	3.0E+03	8.5E+01	6.4E+02	4.00E-03	1.50E+02	3.90E+01	No Data	No Data
Beryllium	1.0E+01	4.0E+01 USEPA, 2005c	1.0E+01 Efroymsen et. al., 1997	8.3E+01	5.30E-03	No Data	No Data	No Data	1.22E+02
Cadmium	4.0E+00	2.0E+01	6.0E+00	1.3E+02	2.20E-03	1.00E+01	8.00E+00	6.00E-01	3.00E-03
Chromium, Total	1.0E+00 Chromium III	4.0E-01 Chromium III	4.0E+00 Chromium III	4.1E+02 Chromium VI	1.10E-02 Chromium VI	7.20E+00 Chromium III	2.50E+01 Chromium VI	3.70E+01 Chromium, Total	4.20E+03 Chromium, Total
Cobalt	2.0E+01	1.0E+03	1.2E+02 USEPA, 2005d	1.5E+02	2.30E-02	No Data	9.00E+00	No Data	No Data
Copper	1.0E+02	5.0E+01	1.9E+02	3.9E+02	9.00E-03	3.41E+02	5.30E+01	3.60E+01	1.00E+01
Iron	1.0E+01	2.0E+02	No Data 5>pH>8	No Data 5>pH>8	1.00E+00	No Data	No Data	No Data	No Data
Lead	5.0E+01	5.0E+02	1.6E+01	4.0E+03	2.50E-03	2.80E+01	3.23E+02	3.50E+01	1.28E+02
Manganese	5.0E+02	1.0E+02	4.1E+03	1.1E+04	1.20E-01	7.24E+03	6.76E+02	1.10E+03	No Data
Mercury	3.0E-01	1.0E-01	1.5E+00	7.3E+01	7.70E-04	3.30E+00	1.00E+01	2.00E-01	No Data
Nickel	3.0E+01	2.0E+02	3.2E+02	6.3E+02	5.20E-02	5.62E+02	3.80E+01	1.80E+01	3.16E+02
Selenium	1.0E+00	7.0E+01	2.0E+00	2.5E+01	5.00E-03	3.60E+00	1.50E+00	No Data	1.00E-01
Silver	2.0E+00	5.0E+01	No Data	No Data	1.20E-04	No Data	No Data	4.50E+00	No Data
Thallium	1.0E+00	1.0E+00 CCME, 1999	No Data	1.0E+00	4.00E-02	No Data	6.00E-02	No Data	7.00E-01
Vanadium	2.0E+00	No Data	4.7E+01	2.5E+01	2.00E-02	8.20E+01	1.60E+00	No Data	No Data
Zinc	5.0E+01	2.0E+02	6.0E+01	2.0E+04	1.20E-01	1.05E+02	1.23E+03	1.23E+02	3.00E+00

NOTES:
Use of surrogate chemical toxicity data indicated by chemical name adjacent to concentration.
Abbreviations: mg/kg = milligrams per kilogram, mg/L = milligrams per liter.

SOURCES:
CCME, 1999. Canadian Soil Quality Guidelines. Canadian Council of Resource and Environmental Ministers. Canadian Council of Ministers of the Environment, Winnipeg.
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, Office of Environmental Management.
USEPA, 2005a. Ecological Soil Screening Levels for Antimony – Interim Final. Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-61. February.
USEPA, 2005b. Ecological Soil Screening Levels for Arsenic – Interim Final. Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-62. March.
USEPA, 2005c. Ecological Soil Screening Levels for Beryllium – Interim Final. Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-64. February.
USEPA, 2005d. Ecological Soil Screening Levels for Cobalt – Interim Final. Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-67. March.

Appendix D2. **Ecological Risk-Based Screening for Surface Soil/Waste Rock**
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest [1]	Maximum Detected Concentration	Exposure Point Concentration [2]	Half of Maximum Sample Reporting Limit	Risk-Based Screening Value				Risk Ratio for				Potential Bioaccumulator? [4]
				Plants	Invertebrates	Birds	Mammals	Plants (Rij) [3]	Invertebrates (Rij) [3]	Birds (Rij) [3]	Mammals (Rij) [3]	
	mg/kg											
Metals												
Antimony	3.68E+02	4.11E+01	5.00E-01	5.00E+00	7.80E+01	No Data	1.50E+01	**8E+00**	5E-01	0E+00	3E+00	No
Arsenic, Total	1.14E+04	1.79E+03	NA	1.80E+01	6.00E+01	4.30E+01	4.60E+01	**9.9E+01**	**3.0E+01**	**4.2E+01**	**3.9E+01**	**Yes**
Barium	3.22E+02	1.82E+02	NA	5.00E+02	3.00E+03	8.50E+01	6.38E+02	4E-01	6E-02	2E+00	3E-01	No
Cadmium	2.34E+01	4.77E+00	3.20E-02	4.00E+00	2.00E+01	6.00E+00	1.25E+02	1E+00	2E-01	8E-01	4E-02	**Yes**
Copper	6.98E+02	5.21E+01	NA	1.00E+02	5.00E+01	1.90E+02	3.90E+02	5E-01	1E+00	3E-01	1E-01	No
Iron	9.73E+04	2.78E+04	NA	1.00E+01	2.00E+02	No Data	No Data	**2.782E+03**	**1.39E+02**	0E+00	0E+00	No
Lead	2.43E+03	5.95E+02	NA	5.00E+01	5.00E+02	1.60E+01	4.00E+03	**1.2E+01**	1E+00	**3.7E+01**	1E-01	**Yes**
Manganese	1.26E+03	5.85E+02	NA	5.00E+02	1.00E+02	4.13E+03	1.10E+04	1E+00	**6E+00**	1E-01	5E-02	No
Mercury	7.84E+02	6.25E+01	2.50E-02	3.00E-01	1.00E-01	1.50E+00	7.30E+01	**2.08E+02**	**6.25E+02**	**4.2E+01**	9E-01	Yes
Selenium	3.26E+00	7.21E-01	NA	1.00E+00	7.00E+01	2.00E+00	2.50E+01	7E-01	1E-02	4E-01	3E-02	**Yes**
Silver	3.19E+02	4.70E+01	1.05E-01	2.00E+00	5.00E+01	No Data	No Data	**2.3E+01**	9E-01	0E+00	0E+00	No
Thallium	3.30E+00	1.52E+00	2.30E-01	1.00E+00	1.00E+00	No Data	1.00E+00	2E+00	2E+00	0E+00	2E+00	No
Vanadium	9.61E+01	4.49E+01	NA	2.00E+00	No Data	4.70E+01	2.50E+01	**2.2E+01**	0E+00	1E+00	2E+00	No
Zinc	2.41E+03	3.67E+02	NA	5.00E+01	2.00E+02	6.00E+01	2.00E+04	**7E+00**	2E+00	**6E+00**	2E-02	No

3.168E+03	**8.07E+02**	**1.31E+02**	**4.6E+01**	:Sum of Rij (Rj)
1.4E+01	1.4E+01	1.4E+01	1.4E+01	:Number of COIs (Nij)
7E-02	7E-02	7E-02	7E-02	:1/Nij

NOTES:

Abbreviations: **Bold** = indicates chemcials of potential concern that may require further assessment at the site, mg/kg = milligrams per kilogram, NA = not applicable, NC = not calculated, Unknown = chemical was detected but no screening criterial are available.

1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.

2 Upper confidence limit on the mean or maximum (whichever is lower).

3 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).

4 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).

5 The chemical of interest is considered a chemical of potential ecological concern if:

a) The risk ratio (Rij) is greater than 5 (non-protected) or 1 (protected).

b) The chemical of interest is a bioaccumulator.

c) No SLV or bioaccumulation vaule is available.

d) Not Calculated = Risk was not calculated for analytes with no screening criteria or bioaccumulation data.

Appendix D2. Ecological Risk-Based Screening for Surface Soil/Waste Rock (continued)
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest [1]	Risked Posed to Non-Protected				Risks Posed to Protected				Risks Posed to Non-Protected				Risks Posed to Protected			
	Plants (Rij>5) [5]	Invertebrates (Rij>5) [5]	Birds (Rij>5) [5]	Mammals (Rij>5) [5]	Plants (Rij>1) [5]	Invertebrates (Rij>1) [5]	Birds (Rij>1) [5]	Mammals (Rij>1) [5]	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals
									Due to Elevated Reporting Limit				Due to Elevated Reporting Limit			
Metals																
Antimony	**Yes**	No	NC	No	**Yes**	No	NC	**Yes**	No	No	No	No	No	No	No	No
Arsenic, Total	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No
Barium	No	No	No	No	No	No	**Yes**	No	No	No	No	No	No	No	No	No
Cadmium	No	No	**Yes**	**Yes**	No	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No
Copper	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Iron	**Yes**	**Yes**	NC	NC	**Yes**	**Yes**	NC	NC	No	No	No	No	No	No	No	No
Lead	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No
Manganese	No	**Yes**	No	No	No	**Yes**	No	No	No	No	No	No	No	No	No	No
Mercury	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No
Selenium	No	No	**Yes**	**Yes**	No	No	**Yes**	**Yes**	No	No	No	No	No	No	No	No
Silver	**Yes**	No	NC	NC	**Yes**	No	NC	NC	No	No	No	No	No	No	No	No
Thallium	No	No	NC	No	**Yes**	**Yes**	NC	**Yes**	No	No	No	No	No	No	No	No
Vanadium	**Yes**	NC	No	No	**Yes**	NC	No	**Yes**	No	No	No	No	No	No	No	No
Zinc	Yes	**No**	**Yes**	No	**Yes**	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No

NOTES:
Abbreviations: **Bold** = indicates chemcials of potential concern that may require further assessment at the site, mg/kg = milligrams per kilogram, NA = not applicable, NC = not calculated, Unknown = chemical was detected but no screening criterial are available.
1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
2 Upper confidence limit on the mean or maximum (whichever is lower).
3 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
4 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).
5 The chemical of interest is considered a chemical of potential ecological concern if:
a) The risk ratio (Rij) is greater than 5 (non-protected) or 1 (protected).
b) The chemical of interest is a bioaccumulator.
c) No SLV or bioaccumulation vaule is available.
d) Not Calculated = Risk was not calculated for analytes with no screening criteria or bioaccumulation data.

Appendix D2. **Ecological Risk-Based Screening for Surface Soil/Waste Rock (continued)**
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest [1]	Inordinate Contribution to Overall Risk for Protected Species ($R_{ij}/R_j > 1/N_{ij}$)				Inordinate Contribution to Overall Risks ($R_{ij}/R_j > 5/N_{ij}$)				Risks Posed to Protected Species				Risks Posed to Non-Protected Species			
	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals	Plants	Invertebrates	Birds	Mammals
Metals																
Antimony	No	No	Unkown	No	No	No	Unkown	No	**Yes**	No	No	**Yes**	**Yes**	No	No	No
Arsenic, Total	No	No	**Yes**	**Yes**	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Barium	No	No	No	No	No	No	No	No	No	No	**Yes**	No	No	No	No	No
Cadmium	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	No	**Yes**	**Yes**
Copper	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Iron	**Yes**	**Yes**	Unkown	Unkown	**Yes**	No	Unkown	Unkown	**Yes**	**Yes**	No	No	**Yes**	**Yes**	No	Yes
Lead	No	No	Yes	No	No	No	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**
Manganese	No	No	No	No	No	No	No	No	No	**Yes**	No	No	No	**Yes**	No	No
Mercury	No	**Yes**	**Yes**	No	No	**Yes**	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Selenium	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	No	**Yes**	**Yes**
Silver	No	No	Unkown	Unkown	No	No	Unkown	Unkown	**Yes**	No	No	No	**Yes**	No	No	No
Thallium	No	No	Unkown	No	No	No	Unkown	No	**Yes**	**Yes**	No	**Yes**	No	No	No	No
Vanadium	No	Unkown	No	No	No	Unkown	No	No	**Yes**	**Unknown**	No	**Yes**	**Yes**	**Unknown**	No	No
Zinc	No	No	No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No

NOTES:
Abbreviations: **Bold** = indicates chemcials of potential concern that may require further assessment at the site, mg/kg = milligrams per kilogram, NA = not applicable, NC = not calculated, Unknown = chemical was detected but no screening criterial are available.
1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.
2 Upper confidence limit on the mean or maximum (whichever is lower).
3 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).
4 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).
5 The chemical of interest is considered a chemical of potential ecological concern if:
a) The risk ratio (Rij) is greater than 5 (non-protected) or 1 (protected).
b) The chemical of interest is a bioaccumulator.
c) No SLV or bioaccumulation vaule is available.
d) Not Calculated = Risk was not calculated for analytes with no screening criteria or bioaccumulation data.

Appendix D3. **Ecological Risk-Based Screening for Surface Wate**
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest (COI) [1]	Exposure Point Concentration [2]	Half of Maximum Sample Reporting Limit	Freshwater Risk-Based Screening Value			Risk Ratio			Bioaccumulator? [3]	Risks Posed				
			Aquatic Life	Birds	Mammals	Aquatic Life (Rij) [2]	Birds (Rij) [2]	Mammals (Rij) [2]		Aquatic Life (Rij>1) [4]	Protected Birds (Rij>1) [4]	Non-Protected Birds (Rij>5) [4]	Protected Mammals (Rij>1) [4]	Non-Protected Mammals (Rij>5) [4]
	mg/L													
Metals														
Aluminum	4.87E-02	3.16E-02	8.70E-02	7.97E+02	8.00E+00	6E-01	6E-05	6E-03	No	No	No	No	No	No
Antimony	9.00E-04	2.50E-03	1.60E+00	No Data	1.00E+00	6E-04	0E+00	9E-04	No	No	NC	NC	No	No
Arsenic, Total	1.78E-02	3.00E-03	1.50E-01	1.80E+01	6.00E+00	1E-01	1E-03	3E-03	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Barium	6.22E-02	NA	4.00E-03	1.50E+02	3.90E+01	**1.6E+01**	4E-04	2E-03	No	**Yes**	No	No	No	No
Cadmium	4.47E-04	6.00E-04	2.20E-03	1.00E+01	8.00E+00	2E-01	4E-05	6E-05	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Chromium, Total	7.40E-04	5.00E-03	1.10E-02	7.20E+00	2.50E+01	7E-02	1E-04	3E-05	No	No	No	No	No	No
Copper	1.56E-03	1.65E-03	9.00E-03	3.41E+02	5.30E+01	2E-01	5E-06	3E-05	No	**No**	No	No	No	No
Iron	6.43E-01	3.34E-02	1.00E+00	No Data	No Data	6E-01	0E+00	0E+00	No	No	NC	NC	NC	NC
Lead	2.13E-03	7.50E-04	2.50E-03	2.80E+01	3.23E+02	9E-01	8E-05	7E-06	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Manganese	1.01E-01	9.50E-04	1.20E-01	7.24E+03	6.76E+02	8E-01	1E-05	1E-04	No	No	No	No	No	No
Mercury	7.57E-05	5.00E-05	7.70E-04	3.30E+00	1.00E+01	1E-01	2E-05	8E-06	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Selenium	1.26E-03	1.70E-03	5.00E-03	3.60E+00	1.50E+00	3E-01	3E-04	8E-04	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Silver	9.00E-05	1.45E-03	1.20E-04	No Data	No Data	8E-01	0E+00	0E+00	No	No	NC	NC	NC	NC
Zinc	2.31E-01	5.00E-03	1.20E-01	1.05E+02	1.23E+03	**2E+00**	2E-03	2E-04	No	**Yes**	No	No	No	No

NOTES:

Abbreviations: **Bold** = indicates chemicals of potential ecological concern that may require further assessment at the site was detected but no screening criteria are available,
mg/L = milligrams per liter, NA = not applicable, Unknown = Chemical was detected but no screening criteria are available.

1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.

2 Upper confidence limit on the mean or maximum (whichever is lower).

2 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).

3 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).

4 The chemical of interest is considered a chemical of potential ecological concern if:

a) The risk ratio (Rij) is greater than 1 for protected species and aquatic life.

b) The risk ratio (Rij) is greater than 5 for other species.

c) The chemical of interest is a bioaccumulator.

d) The chemical of interest has an elevated detection limit.

e) No risk-based screening or bioaccumulation vaule is available.

f) Inordinate contribution to overall risk (Rj).

2.2E+01	4E-03	1E-02	:Sum of Rij (Rj)
14	14	14	:Number of COIs (Nij)
7E-02	7E-02	7.1E-02	:1/Nij

Appendix D3. **Ecological Risk-Based Screening for Surface Water (continuec**
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest (COI) [1]	Risks Posed to					Inordinate Contribution to Overall Risk for Protected Species ($R_{ij}/R_j > 1/N_{ij}$)			Inordinate Contribution to Overall Risks for Non-Protected Species ($R_{ij}/R_j > 5/N_{ij}$)			Risks Posed to Protected Species			Risks Posed to Non-Protected Species		
	Aquatic Life	Protected Birds	Non-Protected Birds	Protected Mammals	Non-Protected Mammals												
	Due to Elevated Reporting Limit					Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals
Metals																	
Aluminum	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Antimony	No	No	No	No	No	No	No	No	No	No	No	No	**Unknown**	No	No	**Unknown**	No
Arsenic, Total	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Barium	No	No	No	No	No	**Yes**	No	No	**Yes**	No	No	**Yes**	No	No	**Yes**	No	No
Cadmium	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Chromium, Total	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Copper	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Iron	No	No	No	No	No	No	No	No	No	No	No	No	**Unknown**	**Unknown**	No	**Unknown**	**Unknown**
Lead	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Manganese	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Mercury	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Selenium	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Silver	**Yes**	No	No	No	No	No	No	No	No	No	No	**Yes**	**Unknown**	**Unknown**	**Yes**	**Unknown**	**Unknown**
Zinc	No	No	No	No	No	No	No	No	No	No	No	**Yes**	No	No	**Yes**	No	No

NOTES:

Abbreviations: **Bold** = indicates chemicals of potential ecological concern that may require further assessment at the site was detected but no screening criteria are available,
mg/L = milligrams per liter, NA = not applicable, Unknown = Chemical was detected but no screening criteria are available.

1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.

2 Upper confidence limit on the mean or maximum (whichever is lower).

2 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).

3 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).

4 The chemical of interest is considered a chemical of potential ecological concern if:

a) The risk ratio (Rij) is greater than 1 for protected species and aquatic life.

b) The risk ratio (Rij) is greater than 5 for other species.

c) The chemical of interest is a bioaccumulator.

d) The chemical of interest has an elevated detection limit.

e) No risk-based screening or bioaccumulation vaule is available.

f) Inordinate contribution to overall risk (Rj).

Appendix D4. **Ecological Risk-Based Screening for Pore Wate**

Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest (COI) [1]	Exposure Point Concentration [2]	Half of Maximum Sample Reporting Limit	Freshwater Risk-Based Screening Value			Risk Ratio			Bioaccumulator? [3]	Risks Posed				
			Aquatic Life	Birds	Mammals	Aquatic Life (Rij) [2]	Birds (Rij) [2]	Mammals (Rij) [2]		Aquatic Life (Rij>1) [4]	Protected Birds (Rij>1) [4]	Non-Protected Birds (Rij>5) [4]	Protected Mammals (Rij>1) [4]	Non-Protected Mammals (Rij>5) [4]
	mg/L													
Metals														
Aluminum	3.17E-02	3.16E-02	8.70E-02	7.97E+02	8.00E+00	4E-01	4E-05	4E-03	No	No	No	No	No	No
Arsenic, Total	6.49E-03	3.00E-03	1.50E-01	1.80E+01	6.00E+00	4E-02	4E-04	1E-03	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Barium	4.85E-02	NA	4.00E-03	1.50E+02	3.90E+01	**1.2E+01**	3E-04	1E-03	No	**Yes**	No	No	No	No
Lead	1.16E-03	6.50E-04	2.50E-03	2.80E+01	3.23E+02	5E-01	4E-05	4E-06	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Mercury	5.74E-05	5.00E-05	7.70E-04	3.30E+00	1.00E+01	7E-02	2E-05	6E-06	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Selenium	1.47E-03	1.70E-03	5.00E-03	3.60E+00	1.50E+00	3E-01	4E-04	1E-03	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Silver	0.00E+00	1.45E-03	1.20E-04	No Data	No Data	0E+00	0E+00	0E+00	No	No	No	NC	NC	NC
Thallium	2.76E-03	2.85E-03	4.00E-02	No Data	6.00E-02	7E-02	0E+00	5E-02	No	No	No	NC	NC	No
Zinc	4.52E-03	5.00E-03	1.20E-01	1.05E+02	1.23E+03	4E-02	4E-05	4E-06	No	No	No	No	No	No

NOTES:

Abbreviations: **Bold** = indicates chemicals of potential ecological concern that may require further assessment at the site was detected but no screening criteria are available,
mg/L = milligrams per liter, NA = not applicable, NC = not calculated, Unknown = Chemical was detected but no screening criteria are available.

1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.

2 Upper confidence limit on the mean or maximum (whichever is lower).

2 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).

3 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).	**1.3E+01**	1E-03	5E-02	:Sum of Rij (Rj)
4 The chemical of interest is considered a chemical of potential ecological concern if:	9.0.E+00	9.0.E+00	9.0.E+00	:Number of COIs (Nij)
a) The risk ratio (Rij) is greater than 1 for protected species and aquatic life.	1.1.E-01	1.1.E-01	1.1.E-01	:1/Nij

b) The risk ratio (Rij) is greater than 5 for other species.

c) The chemical of interest is a bioaccumulator.

d) The chemical of interest has an elevated detection limit.

e) No risk-based screening or bioaccumulation vaule is available.

f) Inordinate contribution to overall risk (Rj).

Appendix D4. **Ecological Risk-Based Screening for Pore Water (continued**

Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest (COI) [1]	Risks Posed to					Inordinate Contribution to Overall Risk for Protected Species ($R_{ij}/R_j > 1/N_{ij}$)			Inordinate Contribution to Overall Risks for Non-Protected Species ($R_{ij}/R_j > 5/N_{ij}$)			Risks Posed to Protected Species			Risks Posed to Non-Protected Species		
	Aquatic Life	Protected Birds	Non-Protected Birds	Protected Mammals	Non-Protected Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals	Aquatic Life	Birds	Mammals
	Due to Elevated Reporting Limit																
Metals																	
Aluminum	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Arsenic, Total	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Barium	No	No	No	No	No	**Yes**	No	No	**Yes**	No	No	**Yes**	No	No	**Yes**	No	No
Lead	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Mercury	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Selenium	No	No	No	No	No	No	No	No	No	No	No	No	**Yes**	**Yes**	No	**Yes**	**Yes**
Silver	**Yes**	No	No	No	No	Unknown	No	No	Unknown	No	No	**Yes**	No	**Unknown**	**Yes**	**Unknown**	**Unknown**
Thallium	No	No	No	No	No	No	No	No	No	No	No	No	No	**Unknown**	No	**Unknown**	No
Zinc	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

NOTES:

Abbreviations: **Bold** = indicates chemicals of potential ecological concern that may require further assessment at the site was detected but no screening criteria are available,
mg/L = milligrams per liter, NA = not applicable, NC = not calculated, Unknown = Chemical was detected but no screening criteria are available.

1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.

2 Upper confidence limit on the mean or maximum (whichever is lower).

2 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).

3 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).

4 The chemical of interest is considered a chemical of potential ecological concern if:

a) The risk ratio (Rij) is greater than 1 for protected species and aquatic life.

b) The risk ratio (Rij) is greater than 5 for other species.

c) The chemical of interest is a bioaccumulator.

d) The chemical of interest has an elevated detection limit.

e) No risk-based screening or bioaccumulation vaule is available.

f) Inordinate contribution to overall risk (Rj).

Appendix D5. Ecological Risk-Based Screening for Sediment
Upper Granite Creek Mines Human Health and Ecological Risk Assessment, Wallowa-Whitman National Forest, Oregon

Chemical of Interest (COI) [1]	Maximum Detected Concentration	Sediment Exposure Point Concentration [2]	Maximum Sample Reporting Limit	Freshwater Sediment Risk-Based Screening Value		Risk Ratio		Bioaccumulator? [4]	Risks Posed to		Risks Posed		Inordinate Contribution to Overall Risks ($R_{ij}/R_j > 5/N_{ij}$)		Risks Posed?	
				Benthic Invertebrates	Bioaccumulation	Benthic Invertebrates (Rij) [3]	Birds and Mammals (Rij) [3]		Invertebrates (Rij>1) [5]	Non-Protected Birds and Mammals (Rij>5) [5]	Invertebrates	Non-Protected Birds and Mammals	Benthic Invertebrates	Birds, and Mammals	Benthic Invertebrates	Birds and Mammals
	mg/kg										Due to Elevated Reporting Limit					
Metals																
Aluminum	1.17E+04	7.89E+03	NA	No Data	No Data	0.E+00	0.E+00	No	NC	No	No	No	Unknown	Unknown	**Unknown**	No
Antimony	5.10E+00	1.43E+00	2.75E-01	3.00E+00	1.00E+01	5E-01	1E-01	Not Required	No	No	No	No	No	No	No	No
Arsenic, Total	3.03E+02	7.71E+01	NA	6.00E+00	4.00E+00	**1.3E+01**	**1.9E+01**	Not Required	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**
Barium	2.17E+02	1.35E+02	NA	No Data	No Data	0E+00	0E+00	No	NC	No	No	No	No	No	**Unknown**	No
Cadmium	2.80E+00	6.47E-01	4.30E-02	6.00E-01	3.00E-03	1E+00	**2.16E+02**	Not Required	No	**Yes**	No	**Yes**	No	No	No	**Yes**
Chromium, Total	4.56E+01	1.71E+01	NA	3.70E+01	4.20E+03	5E-01	4.1E-03	Not Required	No	No	No	No	No	No	No	No
Cobalt	9.60E+00	6.72E+00	NA	No Data	No Data	0E+00	0E+00	No	NC	No	No	No	No	No	**Unknown**	No
Copper	3.00E+01	9.92E+00	NA	3.60E+01	1.00E+01	3E-01	9.9E-01	Not Required	No	No	No	No	No	No	No	No
Iron	5.46E+04	2.46E+04	NA	No Data	No Data	0E+00	0.00E+00	No	NC	No	No	No	No	No	**Unknown**	No
Lead	1.48E+02	3.39E+01	NA	3.50E+01	1.28E+02	1E+00	3E-01	Not Required	No	No	No	No	No	No	No	No
Manganese	6.11E+02	3.03E+02	NA	1.10E+03	No Data	3E-01	0E+00	No	No	No	No	No	No	No	No	No
Mercury	3.20E-01	1.14E-01	2.50E-02	2.00E-01	No Data	6E-01	0E+00	**Yes**	No	**Yes**	No	No	No	No	No	**Yes**
Nickel	7.60E+00	4.43E+00	5.00E-01	1.80E+01	3.16E+02	2E-01	1E-02	Not Required	No	No	No	No	No	No	No	No
Selenium	8.80E-01	5.06E-01	NA	No Data	1.00E-01	0E+00	5E+00	Not Required	NC	No	No	No	No	No	**Unknown**	No
Silver	7.90E+00	2.02E+00	5.00E-02	4.50E+00	No Data	4E-01	0E+00	No	No	No	No	No	No	No	No	No
Thallium	1.80E+00	7.89E-01	3.35E-01	No Data	7.00E-01	0E+00	1E+00	Not Required	NC	No	No	No	No	No	**Unknown**	No
Vanadium	1.54E+02	7.10E+01	NA	No Data	No Data	0E+00	0E+00	No	NC	No	No	No	No	No	**Unknown**	No
Zinc	1.86E+02	8.28E+01	NA	1.23E+02	3.00E+00	7E-01	**2.8E+01**	No	No	**Yes**	No	No	No	No	No	**Yes**

NOTES:

Abbreviations: **Bold** = indicates chemcials of potential concern that may require further assessment at the site, mg/kg = milligrams per kilogram, NA = not applicable, NC = not calculated, Unknown = chemical was detected but no screening criterial are available.

1 Chemicals remaining following the frequency of detection, essential nutrient, and background concentrations screening procedures.

2 Upper confidence limit on the mean or maximum (whichever is lower)

3 The risk ratio is the exposure point concentration divided by the Screening Level Values (SLV).

4 As listed in the Draft Sediment Evaluation Framework (USACE et al., 2005).	**1.8E+01**	**2.65E+02**	:Sum of Rij (Rj)
Bioaccumulation screening not required when a bioaccumulation screening value is available.	18	18	:Number of COIs (Nij)
5 The chemical of interest is considered a chemical of potential ecological concern if:	0.1	0.1	:1/Nij

a) The risk ratio (Rij) is greater than 1 for protected species and benthic invertebrates.

b) The risk ratio (Rij) is greater than 5 for other species.

c) The chemical of interest is a bioaccumulator.

d) The chemical of interest has an elevated detection limit.

e) No risk-based screening or bioaccumulation vaule is available.

f) Inordinate contribution to overall risk (Rj).

Appendix D.

Applicable and Relevant and Appropriate Requirements

Table 1. Chemical-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
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, since surface water and groundwater are not used as drinking water in the area surrounding the Site.
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 (see Page 2 – State ARARs).
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.
Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (formerly PRGs)	US Environmental Protection Agency (EPA) Regions 3, 6, and 9	RSLs 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 RSLs contained in the 2008 Table are generic; they are calculated without site specific information. However, they may be re-calculated using site specific data. RSLs should be viewed as Agency guidelines, not legally enforceable standards. They are used for site "screening" and as initial cleanup goals if applicable.	Potentially Relevant and Appropriate Requirement
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 exempt. Parts of the RCRA regulations may be potentially relevant and appropriate; however, and are discussed under action-specific requirements.

Table 1. Chemical-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF OREGON			
Hazardous Substance Remedial Action Rules	OAR 340-122-0040, 0084, and 0115	Establishes Oregon Department of Environmental Quality (ODEQ) Guidelines for assessing human and ecological risk assessments from contamination according to ODEQ risk guidelines and levels. Also specifics the use of risk-based cleanup concentrations and the use of background concentrations.	Potentially Applicable Requirement
Hazardous Substance Occupational Exposure	OAR 437	Establishes Oregon-Occupational Safety and Health Administration (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)	Potentially Applicable Requirement
Numeric Soil Cleanup Levels for Motor Fuel and Heating Oil	OAR 340-122-305 through 360	Establishes cleanup standards for contamination of soil by motor fuel and heating oil.	To Be Considered
Oregon Soil Cleanup Rules for Simple Sites	OAR 340-122-045 and 046	Establishes ODEQ rules for streamlined cleanup processes and cleanup standards at simple sites.	To Be Considered
Oregon Water Pollution Control Statutes	ORS 468B.005-ORS 468B.190	Address effluent standards, permit requirements for discharges to US waters and minimum Federal water quality criteria. Applicable to the protection of surface water during removal activities.	Potentially Relevant and Appropriate Requirement
Groundwater Quality Protection Program	OAR Chapter 340 Division 40	Establishes the mandatory minimum groundwater quality protection requirements for federal and state agencies, cities, industries, and citizens.	Potentially Relevant and Appropriate Requirement
State of Oregon is authorized by the USEPA to implement the Clean Water Act in Oregon	ORS 468B.050 OAR Chapter 340 Division 41, Table 20	Establishes acceptable contaminant levels for ingestion of aquatic organisms and for intake by aquatic organisms in surface water.	Potentially Applicable Requirement
Oregon Air Pollution Laws	ORS 468A.005-ORS 468A.085	Provides a state program with laws governing air pollution control, abatement, and prevention.	Potentially Relevant and Appropriate Requirement, during Removal Action.
Ambient Air Quality Standards and PSD Increments	OAR Chapter 340 Division 202	Establish concentrations, exposure time, and frequency of occurrence of an air contaminant in the ambient air that must not be exceeded.	Potentially Relevant and Appropriate Requirement, during Removal Action.
Asbestos Removal	OAR 340-32-5620 through 5650	Establishes ODEQ requirements for licensing and certification for asbestos workers. All workers who handle asbestos-containing materials must meet certain training and certification requirements.	Potentially Applicable Requirement

Table 2. Location-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
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.	Potentially Relevant and Appropriate Requirement
	40 CFR §§ 257.3-1 through 257.3-4	Location standards and restrictions for municipal solid waste (MSW) facilities.	Potentially Relevant and Appropriate Requirement
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.	Potentially 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 alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Potentially Relevant and Appropriate Requirement
The Archaeological Resources Protection Act of 1979	43 CFR 7	Regulates requirements for authorized removal of archaeological resources from public or tribal lands.	Potentially Relevant and Appropriate Requirement
Executive Order 11593	16 USC § 469 40 CFR § 6.301(c)	Provides for the inventory and nomination of historical and archeological sites.	Potentially Relevant and Appropriate Requirement
Federal Land Policy and Management Act of 1976	43 USC 1701	Provides for multiple use and inventory, protection, and planning for cultural resources on public lands.	Potentially Relevant and Appropriate Requirement
Native American Graves Protection and Repatriation Act	25 USC 3001-3013 43 CFR Part 10	Regulations that pertain to the identification, protection, and appropriate disposition of human remains, funerary objects, sacred objects, or objects of cultural patrimony.	Potentially Relevant and Appropriate Requirement

Table 2. Location-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL (continued)			
Federal Land Policy and Management Act of 1976	43 USC 1701	Provides for multiple use and inventory, protection, and planning for cultural resources on public lands.	Potentially Relevant and Appropriate Requirement
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.	Potentially Relevant and Appropriate 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	Potentially 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.	Potentially Relevant and Appropriate Requirement
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.	Potentially 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.	Potentially 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.	Potentially 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.	Potentially Applicable Requirement

Table 2. Location-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF OREGON			
Plants: Wildflowers and Endangered, Threatened and Candidate Species	OAR 635 Div 100	Provides for protection of certain plants, wildflowers, and shrubs; guidelines on the listing, reclassification, and delisting of plant species as threatened or endangered.	Potentially Applicable Requirement
Wildlife Diversity Program	OAR 635 Div 100	Provides rules for maintaining Oregon's wildlife diversity by protecting and enhancing populations and habitats of native wildlife at self-sustaining levels throughout geographic ranges.	Potentially Relevant and Appropriate Requirement

Table 3. Action-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
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.	Potentially Relevant and Appropriate Requirement.
Surface Mining Control and Reclamation Act	30 USC §§ 1201-1328	Performance standards for surface mining activities.	Potentially Relevant and Appropriate Requirement
Hazardous Materials Transportation Act	49 USC §§ 1801-1813 49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials.	Potentially Applicable Requirement, if any hazardous materials are transported offsite.
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.	Potentially Relevant and Appropriate Requirement
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*.	Potentially Relevant and Appropriate Requirement
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.	Potentially Relevant and Appropriate Requirement
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.	Potentially Relevant and Appropriate Requirement

Table 3. Action-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL (continued)			
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.	Potentially Relevant and Appropriate Requirement
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.	Potentially Relevant and Appropriate Requirement
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for determining which solid waste disposal practices pose threats to human health and the environment.	Potentially Relevant and Appropriate Requirement
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.	To Be Considered
Fugitive Dust Emissions	40 CFR Section 50.6	Establishes standards for PM-10.	Potentially Relevant and Appropriate Requirement

Table 3. Action-Specific Potential Applicable or Relevant and Appropriate Requirements
Upper Granite Creek Removal Action Engineering Evaluation / Cost Analysis, Wallowa-Whitman National Forest

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF OREGON			
Regulations pertaining to NPDES and WPCF Permits	OAR 340 Div 45	Prescribes limitations on discharge of wastes and the requirements and procedures for obtaining NPDES and WPCF permits from the ODEQ	Potentially Relevant and Appropriate Requirement
Groundwater Quality Protection Program	OAR 340 Div 40	Establishes the mandatory minimum groundwater quality protection requirements for federal and state agencies, cities, counties, industries, and citizens.	Potentially Relevant and Appropriate Requirement
Solid Waste: Land Disposal Sites other than Municipal Solid Waste Landfills	OAR 340 Div 95	Regulates the siting, operation and maintenance of any non-municipal land disposal site.	Potentially Relevant and Appropriate Requirement
Storage, Treatment and Disposal of Hazardous Waste	ORS Chapter 466	Regulates the transportation and disposal of hazardous waste.	Potentially Relevant and Appropriate Requirement
Reduction of use of Toxic Substances and Hazardous Waste Generation	ORS 465.200 - .455 and 465.900	Establishes ODEQ removal and remedial action program	Potentially Relevant and Appropriate Requirement
Asbestos Removal	OAR 340-32-5620 through 5650	Establish ODEQ requirements for licensing and certification for asbestos workers. All workers who handle asbestos-containing materials must meet certain training, licensing and certification requirements.	Potentially Applicable Requirement
	OAR 340-33-010 through 100	Establish ODEQ 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.	Potentially Applicable Requirement

Appendix E.

Cost Estimates

COST ESTIMATE FOR
ALTERNATIVE 2 - ONSITE CONTAINMENT

Task	Quantity	Units	Unit Cost	Cost
MOBILIZATION, BONDING & INSURANCE	1	LS	$ 10,000	$ 10,000
LOGISTICS				
Access Road Improvements - Monumental, Borrow Area, other Mines	1	LS	$ 20,000	$ 20,000
Site Clearing/Tree Removal/Preparation	1	LS	$ 5,000	$ 5,000
Erosion Control/BMPs - Silt Fences - Spring Diversion	1	LS	$ 10,000	$ 10,000
ONSITE CONTAINMENT - MONUMENTAL MINE				
Placement and Grading of Upper Shaft Waste Material	3,000	BCY	$ 2	$ 6,000
Re-grading of Upper Adit Waste Material	15,000	BCY	$ 2	$ 30,000
Grading of Monumental Mill Tailings	400	BCY	$ 2	$ 800
Regrading of Lower Adit Wasterock	18,500	BCY	$ 3	$ 55,500
Regrading of Lower Crusher Waste Material	1,200	BCY	$ 3	$ 3,600
EXCAVATION AND PLACEMENT - OTHER MINES				
Excavation, Placement, and Grading - Cap Martin Mine Waste Material	1,200	BCY	$ 10	$ 12,000
Grading - GC-7 Mine Waste Material	300	BCY	$ 10	$ 3,000
Excavation, Placement, and Grading - Tillicum Mine Waste Material	1,300	BCY	$ 10	$ 13,000
Excavation, Placement, and Grading - GC-5 Mine Waste Material	400	BCY	$ 10	$ 4,000
Excavation, Placement, and Grading - Lower Golden Fraction Waste Material	380	BCY	$ 10	$ 3,800
Excavation, Placement, and Grading - Middle Golden Fraction Waste Material	120	BCY	$ 10	$ 1,200
Excavation, Placement, and Grading - Central Mine Waste Material	650	BCY	$ 5	$ 3,250
Grading of Upper Granite Creek Waste Material	20	BCY	$ 25	$ 500
STREAM RECONSTRUCTION AND STABILIZATION				
Upper Monumental Mine - Adit Discharge/Pipe Construction/Infiltration	1	LS	$ 1,500	$ 1,500
Lower Monumental Mine - Lower Pond Discharge Channel	1	LS	$ 7,000	$ 7,000
HDPE Culvert Under Access Roads	2	Each	$ 1,000	$ 2,000
REVEGETATION AND ROAD OBLITERATION				
Cover Soil Load, Haul, Place, and Grade - Upper Monumental Shaft	50	LCY	$ 10	$ 500
Cover Soil Load, Haul, Place, and Grade - Upper Monumental Pile	1,600	LCY	$ 10	$ 16,000
Cover Soil Load, Haul, Place, and Grade - Lower Monumental Pile/Crusher	1,700	LCY	$ 10	$ 17,000
Cover Soil Load, Haul, Place, and Grade - Monumental Millsite/Settling Ponds	100	LCY	$ 10	$ 1,000
Cover Soil Load, Haul, Place, and Grade - Central Mine	100	LCY	$ 2	$ 200
Cover Soil Load, Haul, Place, and Grade - Middle Golden Fraction Mine	30	LCY	$ 2	$ 60
Cover Soil Load, Haul, Place, and Grade - Upper Granite Creek (GC-3)	10	LCY	$ 2	$ 20
Seed/Fertilization	5	Acre	$ 2,000	$ 10,000
Mulch	5	Acre	$ 3,000	$ 15,000
Road Decommissioning, water bars and ripping	1	LS	$ 10,000	$ 10,000
DEMOLITION AND DISPOSAL OF BUILDINGS, EQUIPMENT, AND DEBRIS				
Asbestos Transite Pipe Abatement and Disposal (Baker County Landfill)	1	LS	$ 2,000	$ 2,000
HEALTH AND SAFETY, DECON, CONFIRMATION SAMPLES, AND NITON	1	LS	$ 20,000	$ 20,000
DEMOBILIZATION	1	LS	$ 10,000	$ 10,000
			Subtotal Capital Costs	**$ 293,930**

COST ESTIMATE FOR
ALTERNATIVE 2 - ONSITE CONTAINMENT

Task	Quantity	Units	Unit Cost	Cost
Design Expenses (10%)				$ 29,393
Construction Oversight (15%)				$ 44,090
Post Construction Monitoring (6 years)				$ 75,000
Subtotal Indirect Capital Costs				$ 442,413
Contingency (10%)				$ 44,241
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				**$ 486,654**
POST CLOSURE MONITORING AND MAINTENANCE COSTS - FS				
Inspections	1	per year	500	$ 500
Maintenance	1	LS	1,000	$ 1,000
TOTAL ANNUAL O&M COSTS				**$ 1,500**
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				$ 486,654
PRESENT WORTH O&M COST				
20 YRS. (10%)				$ 12,770
TOTAL PRESENT WORTH COST				**$ 499,000**

NOTE:
Abbreviations: BCY = bank cubic yards, LCY = loose cubic yards (120% of BCY), LS = lump sum.

COST ESTIMATE FOR
ALTERNATIVE 3 - EXCAVATION AND ONSITE CONTAINMENT IN REPOSITORY

Task	Quantity	Units	Unit Cost	Cost
MOBILIZATION, BONDING & INSURANCE	1	LS	$ 10,000	$ 10,000
LOGISTICS				
Access Road Improvements - Monumental, Borrow Area, other Mines	1	LS	$ 20,000	$ 20,000
Site Clearing/Tree Removal/Preparation	1	LS	$ 5,000	$ 5,000
Erosion Control/BMPs - Silt Fences - Spring Diversion	1	LS	$ 10,000	$ 10,000
EXCAVATION, TRANSPORT, AND PLACEMENT - MONUMENTAL MINE				
Excavation of Upper Shaft Waste Material	3,000	BCY	$ 2	$ 6,000
Transport, Placement, and Grading of Upper Shaft Waste Material in Repository	3,600	LCY	$ 2	$ 7,200
Excavation of Upper Adit Waste Material	15,000	BCY	$ 5	$ 75,000
Transport, Placement, and Grading of Upper Adit Waste Material in Repository	18,000	LCY	$ 5	$ 90,000
Excavation of Monumental Mill Tailings	400	BCY	$ 10	$ 4,000
Transport, Placement, and Grading of Monumental Mill Tailings in Repository	480	LCY	$ 5	$ 2,400
Excavation of Settling Ponds Tailings	1,000	BCY	$ 10	$ 10,000
Transport, Placement, and Grading of Settling Ponds Tailings in Repository	1,200	LCY	$ 5	$ 6,000
Excavation of Lower Adit Wasterock	18,500	BCY	$ 5	$ 92,500
Transport, Placement, and Grading of Lower Adit Wasterock in a Repository	22,200	LCY	$ 5	$ 111,000
Excavation of Lower Crusher Waste Material	1,200	BCY	$ 5	$ 6,000
Transport, Placement, and Grading of Lower Crusher Waste Material in Repository	1,440	LCY	$ 5	$ 7,200
EXCAVATION AND PLACEMENT - OTHER MINES				
Excavation, Placement, and Grading - Cap Martin Mine Waste Material	1,200	BCY	$ 10	$ 12,000
Grading - GC-7 Mine Waste Material	300	BCY	$ 10	$ 3,000
Excavation, Placement, and Grading - Tillicum Mine Waste Material	1,300	BCY	$ 10	$ 13,000
Excavation, Placement, and Grading - GC-5 Mine Waste Material	400	BCY	$ 10	$ 4,000
Excavation, Placement, and Grading - Lower Golden Fraction Waste Material	380	BCY	$ 10	$ 3,800
Excavation, Placement, and Grading - Middle Golden Fraction Waste Material	120	BCY	$ 10	$ 1,200
Excavation, Placement, and Grading - Central Mine Waste Material	650	BCY	$ 5	$ 3,250
Grading of Upper Granite Creek Waste Material	20	BCY	$ 25	$ 500
WETLAND REHABILITATION - MONUMENTAL MINE				
Reworking Local Material	500	LCY	$ 15	$ 7,500
Channel Relocation/Meander	250	LCY	$ 10	$ 2,500
Grading, Contouring, Planting	1	LS	$ 5,000	$ 5,000
STREAM RECONSTRUCTION AND STABILIZATION				
Upper Monumental Mine - Adit Discharge/Pipe Construction/Infiltration	1	LS	$ 1,500	$ 1,500
Lower Monumental Mine - Lower Pond Discharge Channel	1	LS	$ 7,000	$ 7,000
HDPE Culvert Under Access Roads	2	Each	$ 1,000	$ 2,000

COST ESTIMATE FOR
ALTERNATIVE 3 - EXCAVATION AND ONSITE CONTAINMENT IN REPOSITORY

Task	Quantity	Units	Unit Cost	Cost
REPOSITORY COVER CONSTRUCTION				
Repository Subgrade Excavation and Stockpile	3,000	LCY	$ 7	$ 21,000
Repository Cover Soil Placement and Grading	3,600	LCY	$ 5	$ 18,000
Seed/Fertilization	1	Acre	$ 2,000	$ 2,000
Mulch	1	Acre	$ 3,000	$ 3,000
REVEGETATION AND ROAD OBLITERATION				
Seed/Fertilization	5	Acre	$ 2,000	$ 10,000
Mulch	5	Acre	$ 3,000	$ 15,000
Road Decommissioning, water bars and ripping	1	LS	$ 10,000	$ 10,000
DEMOLITION AND DISPOSAL OF BUILDINGS, EQUIPMENT, AND DEBRIS				
Asbestos Transite Pipe Abatement and Disposal (Baker County Landfill)	1	LS	$ 2,000	$ 2,000
HEALTH AND SAFETY, DECON, CONFIRMATION SAMPLES, AND NITON	1	LS	$ 20,000	$ 20,000
DEMOBILIZATION	1	LS	$ 10,000	$ 10,000
			Subtotal Capital Costs	**$ 639,550**
Data Gaps				
Design Expenses (5%)				$ 31,592
Construction Oversight (10%)				$ 63,183
Post Construction Monitoring (5 years)				$ 75,000
Subtotal Indirect Capital Costs				$ 809,325
Contingency (10%)				$ 80,932
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				**$ 890,257**
POST CLOSURE MONITORING AND MAINTENANCE COSTS				
Inspections	1	per year	500	$ 500
Maintenance	1	LS	1,000	$ 1,000
TOTAL ANNUAL O&M COSTS				**$ 1,500**
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				$ 890,257
PRESENT WORTH O&M COST				
20 YRS. (10%)				$ 12,770
TOTAL PRESENT WORTH COST				**$ 903,000**

NOTE:
Abbreviations: BCY = bank cubic yards, LCY = loose cubic yards (120% of BCY), LS = lump sum.

PRELIMINARY COST ESTIMATE FOR
ALTERNATIVE 4 - EXCAVATION AND OFFSITE DISPOSAL

Task	Quantity	Units	Unit Cost	Cost
MOBILIZATION, BONDING & INSURANCE	1	LS	$ 50,000	$ 50,000
LOGISTICS				
Access Road Improvements - Monumental, Borrow Area, other Mines	1	LS	$ 50,000	$ 50,000
Site Clearing/Tree Removal/Preparation	1	LS	$ 5,000	$ 5,000
Erosion Control/BMPs - Silt Fences - Spring Diversion	1	LS	$ 10,000	$ 10,000
EXCAVATION, TRANSPORT, AND DISPOSAL - MINES				
Excavation and Loading of Upper Shaft Waste Material	3,000	BCY	$ 2	$ 6,000
Transportation and Disposal	3,600	LCY	$ 100	$ 360,000
Excavation and Loading of Upper Adit Waste Material	15,000	BCY	$ 5	$ 75,000
Transportation and Disposal	18,000	LCY	$ 100	$ 1,800,000
Excavation and Loading of Monumental Mill Tailings	400	BCY	$ 10	$ 4,000
Transportation and Disposal	480	LCY	$ 100	$ 48,000
Excavation and Loading of Settling Ponds Tailings	1,000	BCY	$ 10	$ 10,000
Transportation and Disposal	1,200	LCY	$ 100	$ 120,000
Excavation and Loading of Lower Adit Wasterock	18,500	BCY	$ 5	$ 92,500
Transportation and Disposal	22,200	LCY	$ 100	$ 2,220,000
Excavation and Loading of Lower Crusher Waste Material	1,200	BCY	$ 5	$ 6,000
Transportation and Disposal	1,440	LCY	$ 100	$ 144,000
Excavation and Loading of Cap Martin Mine Waste Material	1,200	BCY	$ 5	$ 6,000
Transportation and Disposal	1,440	LCY	$ 100	$ 144,000
Excavation of and Loading Lower Golden Fraction Waste Material	380	BCY	$ 10	$ 3,800
Transportation and Disposal	456	LCY	$ 100	$ 45,600
Excavation of and Loading Middle Golden Fraction Waste Material	120	BCY	$ 10	$ 1,200
Transportation and Disposal	144	LCY	$ 100	$ 14,400
Excavation and Loading of Tillicum Mine Waste Material	1,300	BCY	$ 10	$ 13,000
Transportation and Disposal	1,560	LCY	$ 100	$ 156,000
Excavation and Loading of GC-07 Mine Waste Material	300	BCY	$ 10	$ 3,000
Transportation and Disposal	360	LCY	$ 100	$ 36,000
Excavation and Loading of GC-05 Mine Waste Material	400	BCY	$ 10	$ 4,000
Transportation and Disposal	480	LCY	$ 100	$ 48,000
Excavation and Loading of Central Mine Waste Material	650	BCY	$ 10	$ 6,500
Transportation and Disposal	780	LCY	$ 100	$ 78,000
WETLAND REHABILITATION - MONUMENTAL MINE				
Reworking Local Material	500	LCY	$ 15	$ 7,500
Channel Relocation/Meander	250	LCY	$ 10	$ 2,500
Grading, Contouring, Planting	1	LS	$ 5,000	$ 5,000
STREAM RECONSTRUCTION AND STABILIZATION				
Upper Monumental Mine - Adit Discharge/Pipe Construction/Infiltration	1	LS	$ 1,500	$ 1,500
Lower Monumental Mine - Lower Pond Discharge Channel	1	LS	$ 7,000	$ 7,000
HDPE Culvert Under Access Roads	2	Each	$ 1,000	$ 2,000

PRELIMINARY COST ESTIMATE FOR
ALTERNATIVE 4 - EXCAVATION AND OFFSITE DISPOSAL

Task	Quantity	Units	Unit Cost	Cost
REVEGETATION AND ROAD OBLITERATION				
Seed/Fertilization	5	Acre	$ 2,000	$ 10,000
Mulch	5	Acre	$ 3,000	$ 15,000
Road Decommissioning, water bars and ripping	1	LS	$ 20,000	$ 20,000
DEMOLITION AND DISPOSAL OF BUILDINGS, EQUIPMENT, AND DEBRIS				
Asbestos Transite Pipe Abatement and Disposal (Baker County Landfill)	1	LS	$ 2,000	$ 2,000
HEALTH AND SAFETY, DECON, CONFIRMATION SAMPLES, AND NITON	1	LS	$ 20,000	$ 20,000
DEMOBILIZATION	1	LS	$ 10,000	$ 10,000
			Subtotal Capital Costs	**$ 5,662,500**
Data Gaps				
Design Expenses				$ 45,000
Construction Oversight (5%)				$ 75,000
Post Construction Monitoring (5 years)				$ 75,000
Subtotal Indirect Capital Costs				$ 5,857,500
Contingency (5%)				$ 292,875
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				**$ 6,150,375**
POST CLOSURE MONITORING AND MAINTENANCE COSTS				
Inspections	1	per year	250	$ 250
Maintenance	1	LS	250	$ 250
TOTAL ANNUAL O&M COSTS				**$ 500**
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				$ 6,150,375
PRESENT WORTH O&M COST				
20 YRS. (10%)				$ 4,257
TOTAL PRESENT WORTH COST				**$ 6,155,000**

NOTE:
Abbreviations: BCY = bank cubic yards, LCY = loose cubic yards (120% of BCY), LS = lump sum.

COST ESTIMATE FOR
RECOMMENDED ALTERNATIVE

Task	Quantity	Units	Unit Cost	Cost
MOBILIZATION, BONDING & INSURANCE	1	LS	$ 10,000	$ 10,000
LOGISTICS				
Access Road Improvements - Monumental Mine and Borrow Area	1	LS	$ 15,000	$ 15,000
Site Clearing/Tree Removal/Preparation	1	LS	$ 5,000	$ 5,000
Erosion Control/BMPs - Silt Fences - Spring Diversion	1	LS	$ 10,000	$ 10,000
EXCAVATION, TRANSPORT, AND PLACEMENT - MONUMENTAL MINE				
Excavation of Upper Shaft Waste Material	3,000	BCY	$ 2	$ 6,000
Transport, Placement, and Grading of Upper Shaft Waste Material in Repository	3,600	LCY	$ 2	$ 7,200
Excavation of Upper Adit Waste Material	15,000	BCY	$ 5	$ 75,000
Transport, Placement, and Grading of Upper Adit Waste Material in Repository	18,000	LCY	$ 5	$ 90,000
Excavation of Monumental Mill Tailings	400	BCY	$ 10	$ 4,000
Transport, Placement, and Grading of Monumental Mill Tailings in Repository	480	LCY	$ 5	$ 2,400
Excavation of Settling Ponds Tailings	1,000	BCY	$ 10	$ 10,000
Transport, Placement, and Grading of Settling Ponds Tailings in Repository	1,200	LCY	$ 5	$ 6,000
Regrading of Lower Adit Wasterock	18,500	BCY	$ 3	$ 55,500
Regrading of Lower Crusher Waste Material	1,200	BCY	$ 3	$ 3,600
EXCAVATION AND PLACEMENT - OTHER MINES				
Excavation, Placement, and Grading - Middle Golden Fraction Waste Material	120	BCY	$ 10	$ 1,200
Excavation, Placement, and Grading - Central Mine Waste Material	650	BCY	$ 5	$ 3,250
Grading of Upper Granite Creek Waste Material	20	BCY	$ 25	$ 500
WETLAND REHABILITATION - MONUMENTAL MINE				
Reworking Local Material	500	LCY	$ 15	$ 7,500
Channel Relocation/Meander	250	LCY	$ 10	$ 2,500
Grading, Contouring, Planting	1	LS	$ 5,000	$ 5,000
STREAM RECONSTRUCTION AND STABILIZATION				
Upper Monumental Mine - Adit Discharge/Pipe Construction/Infiltration	1	LS	$ 1,500	$ 1,500
Lower Monumental Mine - Lower Pond Discharge Channel	1	LS	$ 7,000	$ 7,000
HDPE Culvert Under Access Roads	2	Each	$ 1,000	$ 2,000
REPOSITORY COVER CONSTRUCTION				
Repository Subgrade Excavation and Stockpile	2,500	LCY	$ 7	$ 17,500
Repository Cover Soil Placement and Grading	3,000	LCY	$ 5	$ 15,000
Seed/Fertilization	0.75	Acre	$ 2,000	$ 1,500
Mulch	0.75	Acre	$ 3,000	$ 2,250
REVEGETATION AND ROAD OBLITERATION				
Seed/Fertilization	5	Acre	$ 2,000	$ 10,000
Mulch	5	Acre	$ 3,000	$ 15,000
Road Decommissioning, water bars and ripping	1	LS	$ 10,000	$ 10,000
DEMOLITION AND DISPOSAL OF BUILDINGS, EQUIPMENT, AND DEBRIS				
Asbestos Transite Pipe Abatement and Disposal (Baker County Landfill)	1	LS	$ 2,000	$ 2,000
HEALTH AND SAFETY, DECON, CONFIRMATION SAMPLES, AND NITON	1	LS	$ 20,000	$ 20,000
DEMOBILIZATION	1	LS	$ 10,000	$ 10,000
			Subtotal Capital Costs	**$ 433,400**

COST ESTIMATE FOR
RECOMMENDED ALTERNATIVE

Task	Quantity	Units	Unit Cost	Cost
Data Gaps				
Design Expenses (10%)				$ 43,340
Construction Oversight (15%)				$ 65,010
Post Construction Monitoring (5 years)				$ 75,000
Subtotal Indirect Capital Costs				$ 616,750
Contingency (10%)				$ 61,675
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				**$ 678,425**
POST CLOSURE MONITORING AND MAINTENANCE COSTS				
Inspections	1	per year	500	$ 500
Maintenance	1	LS	1,000	$ 1,000
TOTAL ANNUAL O&M COSTS				**$ 1,500**
TOTAL CAPITAL AND INDIRECT CAPITAL COSTS				$ 678,425
PRESENT WORTH O&M COST				$ 681,425
20 YRS. (10%)				$ 12,770
TOTAL PRESENT WORTH COST				**$ 691,000**

NOTE:
Abbreviations: BCY = bank cubic yards, LCY = loose cubic yards (120% of BCY), LS = lump sum.