# EXPANDED ENGINEERING EVALUATION / COST ANALYSIS

## Forest Rose Mine Site

Prepared for

Montana Department of Environmental Quality

May 2011

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## Forest Rose Mine Site

Prepared for

Montana Department of Environmental Quality
Abandoned Mine Section
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# Acronyms and Abbreviations

| | |
|---|---|
| A | area |
| ABA | acid base accounting |
| ASA | American Society of Agronomy |
| ASTM | American Society for Testing and Materials |
| BMP | best management standard |
| BW | body weight |
| CEC | cation exchange capacity |
| CLP | contract laboratory program |
| COC | contaminant of concern |
| COPC | contaminant of potential concern |
| cy | cubic yard |
| DEQ/MWCB | Montana Department of Environmental Quality/Mine Waste Cleanup Bureau |
| DQO | data quality objective |
| EEE/CA | expanded engineering evaluation and cost analysis |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| FSP | field sampling plan |
| ft | foot |
| GCL | geosynthetic clay liner |
| HHS | human health standards |
| HMI | hazardous materials inventory |
| in. | inch |
| IRI | integrated risk information |
| J | estimated quantity |
| LAP | laboratory analytical plan |
| lb | pound |
| LCS | laboratory control standard |
| LFG | landfill gas |
| MBMG | Montana Bureau of Mines and Geology |
| MCL | maximum contaminant level |
| µg/L | micrograms per liter |
| $mg/m^3$ | milligrams per cubic meter |
| mg/kg | milligrams per kilogram |
| MS | matrix spike |
| oz | ounce |
| pcf | pound per cubic foot |
| ppm | parts per million |
| PRG | preliminary reclamation goal |
| QA | quality assurance |
| QC | quality control |
| RA | risk assessment |
| RAG | risk assessment guidance |

| | |
|---|---|
| RBCG | risk-based cleanup guidelines |
| RfD | reference dose |
| RI | reclamation investigation |
| RPD | relative percent difference |
| RSL | regional screening levels |
| RWP | reclamation work plan |
| SCR | soil consumption rate |
| TAL | target analyte level |
| TDS | total dissolved solids |
| TRL | target reporting level |
| U | undetected |
| USCS | unified soil classification system |
| USDA | United States Department of Agriculture |
| USFS | United States Forest Service |
| cy | cubic yard |

# 1.0 Introduction

This Expanded Engineering Evaluation/Cost Analysis (EEE/CA) was conducted in accordance with Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ/MWCB) Contract No. 407032 Task Order No. 8. Under a previous task order, Herrera Environmental Consultants (Herrera) was responsible for preparing a Reclamation Work Plan (RWP), collecting onsite field and laboratory data, and preparing a Reclamation Investigation (RI) report for the Forest Rose Mine and Mill Complex (Forest Rose Mine Site). This EEE/CA uses the site characterization results to identify and evaluate potential reclamation technology processes, assembles reclamation alternatives, and develops a preferred alternative for reclamation of the Forest Rose Mine Site.

## 1.1 Purpose and Objectives

The purpose of an EEE/CA is to propose an approach for substantial, prioritized risk reduction in a short time frame. The EEE/CA is based on requirements of Section 300.415(b)(4)(i) of the National Contingency Plan (NCP), outlining non-time-critical removal actions. The EEE/CA identifies objectives of the removal action and analyzes the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. The objective of this EEE/CA is to screen process options and to develop and evaluate potential response alternatives appropriate for reclamation of mining wastes associated with the Forest Rose Mine Site. In general, alternatives are evaluated based on effectiveness, implementability, and cost effectiveness is evaluated in terms of protectiveness and ability to achieve the removal goals. Protectiveness of the alternatives is assessed in terms of how well they protect public health and the community, protects workers during implementation, protect the environment, and comply with applicable or relevant and appropriate requirements (ARARs). Implementability of the alternatives is based on their technical feasibility, the availability of necessary resources to support the alternatives, and their administrative feasibility. Cost of the alternatives is determined by evaluating capital costs, as well as costs for post removal site control, based on present worth.

Once the alternatives have been described and individually assessed against the criteria, a comparative analysis is conducted to evaluate the relative performance of each alternative in relation to each criterion. This process identifies key trade-offs affecting remedy selection, resulting in a preferred alternative recommendation.

## 1.2 Report Organization

This report is organized according to the standard DEQ format, with Sections 2 through 5 summarizing information compiled and generated through the RI process and Sections 6 through 10 identifying and screening candidate reclamation technologies, assembling alternatives, comparing alternatives, and selecting a preferred approach for site reclamation.

Each alternative is evaluated against the following seven evaluation criteria during the comparison process:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

# 2.0 Site Background

## 2.1 Mining History

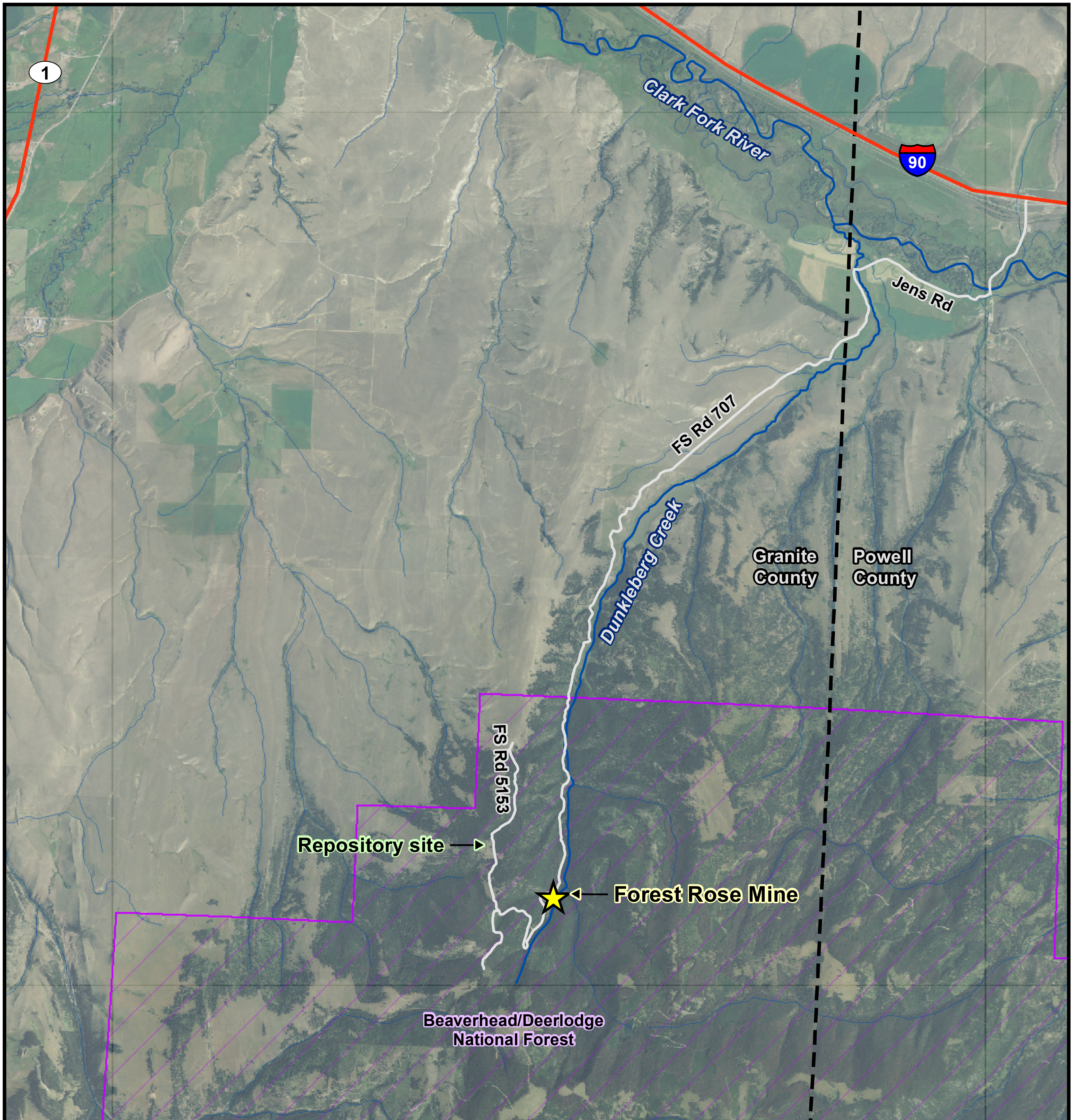
Lode mining in the Dunkleberg mining district began in the early 1880s. The Forest Rose and several other claims were located in 1884; the Forest Rose Mine Site operated intermittently through the 1940s. Approximately $200,000 in silver and lead were produced by 1916 in the Dunkleberg mining district, of which about half was produced by the Forest Rose Mine Site. Other mines in the district included the Hatta, Jackson, Monarch or Old Tanglefoot, Pearl or Happy New Year, Summit, Sunset, and Wasa. The majority of production came from the Forest Rose, Wasa, and Jackson Mines (DEQ 2002).

The Forest Rose Mine is located north of the Wasa Mine, on the steep western slope of the Dunkleberg Creek ravine. The mine was first located by Frank Carnes and is on the patented Forest Rose and Acrobat claims. J.T. Pardee visited the mine in 1916 and, according to his notes, the size of the dumps indicated extensive underground development. The ore consists of quartz, limonite, galena, and pyrite (DEQ 2002).

The mine reopened in 1918 and recorded production until 1927. Forest Rose and Wasa Mine were reopened again during World War II. Together, the mines produced 113,000 tons of ore. The main adit is at 5,150 feet above sea level. It is driven 480 feet west into the hill, with 3,000 feet of underground workings located off the adit. In 1941, the Forest Rose Syndicate built a 100-ton concentrator to process the mine's ore. The product was conditioned for lead flotation and then the ore was reconditioned for the zinc circuit. Lead concentrates were sent to East Helena and zinc concentrates were sent to Anaconda (DEQ 2002).

## 2.2 Site Setting

The Forest Rose Mine Site is located in Granite County, within lands administered by the United States Forest Service (USFS), Beaverhead-Deerlodge National Forest. The site is accessible from Interstate 90, approximately 8 miles east of Drummond, at Exit 162 (Jens Exit), then traveling south-southwest approximately 11 miles on Dunkleberg Creek Road (USFS Forest Development Road (FDR) 707) (Figure 2-1). The mine is situated on the east side of FDR 707. The legal description of the site is Section 22, Township 9 North, Range 12 West, Granite County, Montana (Latitude North 46° 30' 29"; Longitude West 113° 05' 21"). The mine and mill complex is comprised of approximately 4 acres of metal mining-impacted land along Dunkleberg Creek, which flows north to the Clark Fork River. Surrounding areas consist of moderately steep to steep mountain slopes and hillsides (25 degrees). The mine is located at an elevation of approximately 5,500 feet above sea level.




Legend

- Highway
- Road
- County boundary
- Stream
- National forest

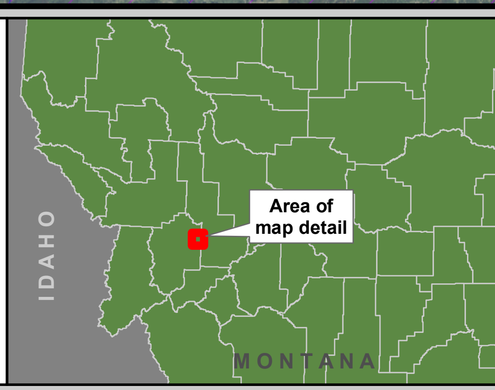



Figure 2-1. Vicinity Map, Forest Rose Mine.

N

0 3,000 6,000 12,000 Feet

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Aerial photograph: USDA, 2009

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The impacted area includes a waste rock pile and three tailings impoundments, a collapsed adit, and several dilapidated buildings and concrete foundations. Tailings were placed in the Dunkleburg Creek drainage creating three relatively flat terraces bound by steep ravine walls to the east and west. Waste rock was deposited immediately upstream of the three tailings impoundments. The upstream waste rock pile and the downstream tailings impoundment both slope steeply to the creek bed at the south and north ends, respectively. Creek water flows into the waste rock, emerging to some extent below the third tailings impoundment (T3). This water collects on top of the second tailings impoundment (T2) and is piped to the impoundment below (T1). This water pools and then is piped to the natural creek channel below the site, where it combines with water emanating from the toe of T1. The downstream slope of the T1 tailings impoundment experienced a structural failure in 1992, resulting in a release of tailings down the creek. A small amount of adit water also flows down the western ravine side slope onto tailings impoundment T3.

### 2.2.1 Geology and Soils

The Forest Rose Mine Site is located within heavily folded and intruded Cretaceous rocks in the northeast quarter of the Sapphire tectonic block. Gabbroic and dioritic sills, up to 1,000 feet or more in thickness, outcrop within a half-mile of the Forest Rose Mine Site. These sills are intruded at a higher stratigraphic level than the Forest Rose Mine Site and predate local folding. The Forest Rose Mine is located near the axial plane of the west limb of a northeast trending, northward plunging anticline, near a local marker bed of Lower Cretaceous Kootenai formation gastropod bearing limestone (MCS Environmental, Inc. 2004). Mineralization of the limestone produces ore that consists mainly of galena, sphalerite, pyrite, quartz, and calcite. Along Dunkleberg Ridge, most of the lodes containing lead, zinc, silver and other metals are simple quartz veins in fissures that follow bedding planes or cut across the sediments and diorite sills. The veins are usually narrow, but widen in places to flat lenses 3 or 4 feet thick.

Soil mapped at the Forest Rose Mine Site is a combination of Lamellic Haplustepts and Typic Haplustalfs (USDA-NRCS 2010). Both types of soil are located on 10 to 35 percent slopes in elevations ranging from 4,500 to 6,000 feet. Lamellic Haplustepts are well drained soils that formed in glacial till and colluvium and are defined as gravelly loam. Typic Haplustalfs are well drained soils that formed in colluvium and till from mixed rock sources and are defined as gravelly loam (USDA-NRCS 2010).

### 2.2.2 Hydrogeology

Four piezometers (PZ-1, PZ-2, PZ-3, and PZ-4) were installed as part of the Forest Rose Mine and Mill Complex Draft Site Investigation (MCS 2004). The piezometers were installed at depths of 31.5, 28.5, 60.5, and 43.5 feet, respectively. Water surface elevations in the piezometers varied from a depth of 2.0 to 16.0 feet below ground surface. The Montana Bureau of Mines and Geology Groundwater Information Center (GWIC) database only list two springs within a mile of the project area, identified as Forest Rose Mine-Upstream and Forest Rose Mine-Seep at Toe. No well information is available for either listing. It is assumed that water exists along the bottom of the creek ravine above bedrock near the ground surface (the hyporheic zone).

### 2.2.3 Surface Water Hydrology

The Forest Rose Mine Site is located within the Dunkleberg Creek sub-watershed of the Upper Clark Fork River watershed (HUC 17010201). Dunkleberg Creek flows 27.9 miles north through the Beaverhead-Deerlodge National Forest and drains directly into the Clark Fork River. Winter snowmelt and stormwater runoff combined with spring and seep flows provide enough water to Dunkleberg Creek to qualify the creek at the mine site as a perennial stream.

Dunkleberg Creek flows onto the site from the south through a steep-sided ravine. The stream channel has been filled by waste rock and tailings to a depth of approximately 50 feet at its base. Water flows into the bottom of the waste deposits, with no apparent upstream ponding. Water has been found to be distributed throughout the waste rock and tailings deposits, with some ponding at the surface. Drains have been installed by the United States Forest Service (USFS) to facilitate movement of ponded water out of the tailings impoundments and back to the creek below the waste deposits.

### 2.2.4 Vegetation and Wildlife

The Forest Rose Mine Site is characterized by native and introduced species of vegetation. These include plants growing on undisturbed areas around the site, while little or no vegetation is growing on the tailings impoundments. Dominant trees include lodge pole pine (*Pinups contorta*), Douglas fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*). Shrubs and other vegetative species include grouse whortleberry (*Vaccinium scoparium*), snowberry (*Symphoricarpos alba*), and blue huckleberry (*Vaccinium globurlare*) (MNHP 2010). There is regrowth of the forest on the T2 tailings impoundment dam face.

The habitat supports a variety of wildlife – deer, elk, black bear, bobcat, potentially lynx, and miscellaneous smaller mammals such as rabbits, squirrels, mice, and voles (MNHP 2010). Many species of bird are found around the site, including owls, eagles, and raptors. Dunkleberg Creek provides habitat for amphibians, fish, and other aquatic organisms and serves as water source for other wildlife. Brown trout and Westslope Cutthroat trout also reside in Dunkleberg Creek.

### 2.2.5 Land Use and Population

The Forest Rose Mine Site is located in Granite county on private land and lands administered by the Beaverhead-Deerlodge National Forest. The primary land use in the vicinity of the site is recreational, with some residences located downstream along Dunkleberg Creek. The population in Granite County is 2,879 people, with a density of 2 persons per square mile (USCB 2009).

### 2.2.6 Climate

Climate information was obtained from the Drummond, Montana airport (WRCC 2010). Average monthly temperatures range from a high of 85°F to a low of 45°F in July and a high of 32°F to a low of 12°F in January. Average annual precipitation is 13 inches, with May and June being the wettest months of the year. Precipitation is mostly in the form of snow in the winter, snow and rain in the spring and fall, and rain in the summer.

### 2.2.7 Land Ownership

The current private property owners of the Forest Rose Mine site are the Forest Rose Mining Company and JoJamette Antonioli. The majority of the lower tailings impoundment (T1) is located on lands administered by the Beaverhead-Deerlodge National Forest.

# 3.0 Waste Characteristics and Summary of Existing Data

## 3.1 Previous Investigations

### 3.1.1 1993 Hazardous Material Inventory

Pioneer Technical Services, Inc. completed a site inspection and a Hazardous Materials Inventory (HMI) of the Forest Rose Mine Site in June 1993 (P.A. # 20-004). Three surface water and three sediment samples were collected at the site from Dunkleberg Creek. Three composite samples were collected from the tailings impoundments and waste rock areas. The tailings samples were collected from each of the three impoundments. Sampling results indicated:

- Antimony, arsenic, cadmium, iron, lead, and zinc exceeded Environmental Protection Agency's (EPA) Regional Screening Levels (RSL)

- Antimony, arsenic, cadmium, manganese, and lead exceeded the DEQ Risk Based Cleanup Guidelines (RBCG)

Pioneer identified potential safety hazards as an open discharging adit, 12 collapsing structures, and 2 unstable tailings dams. Approximately 23,000 cubic yards (cy) of tailings and 8,000 cy of waste rock were estimated on the site (DEQ/MWCB 1993).

### 3.1.2 1993 Removal Site Evaluation

USFS Region 1 conducted a removal evaluation at the site in 1993 in response to the tailings dam failure. In May 1993, a portion of the lower tailings dam (T1) slumped, resulting in an unknown amount of tailings material and native shale entering Dunkleberg Creek. In response to the slumping, the USFS initiated a time critical removal action. This action involved draining ponded water off the lower tailings impoundment, stabilizing the existing dam structure, and installing drainage structures to control and facilitate drainage of surface water from the lower impoundment area (USFS 1993).

### 3.1.3 1998 Montana Bureau of Mines and Geology

The Montana Bureau of Mines and Geology (MBMG) investigated abandoned mine sites in the Deerlodge National Forest in 1998. Water seeps from two caved adits were identified on the southern end of the mine site.. Three surface water samples were collected; one from 1,500 feet upstream of the site, one from seeps at the toe of the T1 impoundment, and one from a seep at the base of T2. Mercury concentrations exceeded the chronic aquatic life standard, but no other metals exceeded water quality standards (MBMG 1998).

### 3.1.4 2004 Site Investigation

A site investigation was conducted by MCS Environmental for the USFS in 2004. The report estimated 95,000 cy of tailings and approximately 21,000 cy of waste rock present at the site (MCS 2004).

Four near-surface composite soil samples were collected from the tailings impoundments and one composite soil sample was collected from the waste rock area. One sediment sample was collected 300 feet upstream of mine operations and another sediment sample was collected below the slumped area of the lower impoundment dam. Four soil borings were advanced through the tailings to the native soil below; each was completed as a piezometer to measure water levels and collect water samples. Six subsurface tailings grab samples and two underlying native soils samples were collected from the soil borings. Eight surface water samples also were collected for analysis from the creek, adit discharge, and seep discharges at the lower tailings impoundment. The investigation indicated:

- Tailings and waste rock samples with elevated levels of arsenic, cadmium, copper, iron, mercury, lead, antimony, and zinc (arsenic, cadmium, and lead exceeded both EPA RSLs and DEQ RBCGs).
- Surface water and groundwater samples indicated elevated levels of arsenic, cadmium, copper, iron, lead, and zinc (groundwater was collected from the tailings impoundments, not from beneath the native soil interface and samples were not filtered).
- Sediment samples indicated elevated levels of arsenic, copper, iron, and lead.

## 3.2 2010 DEQ Reclamation Investigation

Field sampling activities at the Forest Rose Mine Site were performed between July 26 and July 31, 2010. A total of 39 samples were collected, including waste rock, tailings, soil, sediment, and water (Figures 3-1 and 3-2); two background soil samples were collected at locations distant from the site (Figure 3-3). In addition to standard background samples, “area-wide” samples were also collected to evaluate potential residual contamination remaining along the periphery of the active mine and mill area. The area-wide samples were collected on the west side and east of the ravine for surface soils, two small waste rock deposits were collected near the site, and a surface water sample was collected associated with adit drainage.

### 3.2.1 Background Samples

Two soil samples were collected to evaluate background concentrations of metals in surface soils. Soil samples FR-BG-SS-01-00 was collected near the proposed repository site and sample FR-BG-SS-02-00 was collected in naturally occurring soil above USFS FDR 5153. The two samples were collected in areas where native vegetation is present and no disturbance to the

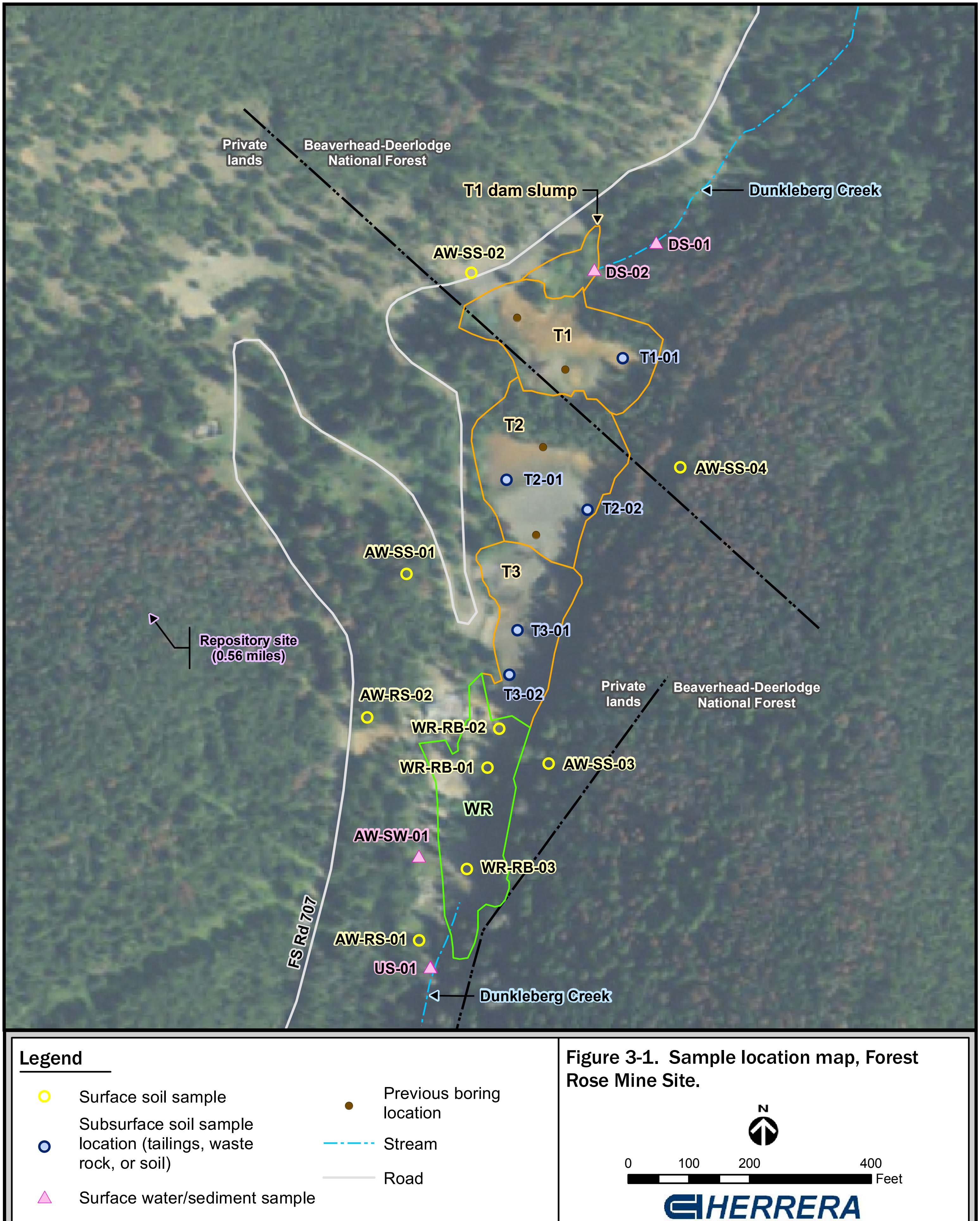


Figure 3-1. Sample location map, Forest Rose Mine Site.

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Aerial photograph: USDA, 2009

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**Legend**

- Surface soil sample and test pit
- Monitoring well
- Approximate repository boundary
- Road

**Figure 3-2. Sample location map, Forest Rose Mine Site repository.**

N

0 75 150 300 Feet

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Aerial photograph: USDA, 2009

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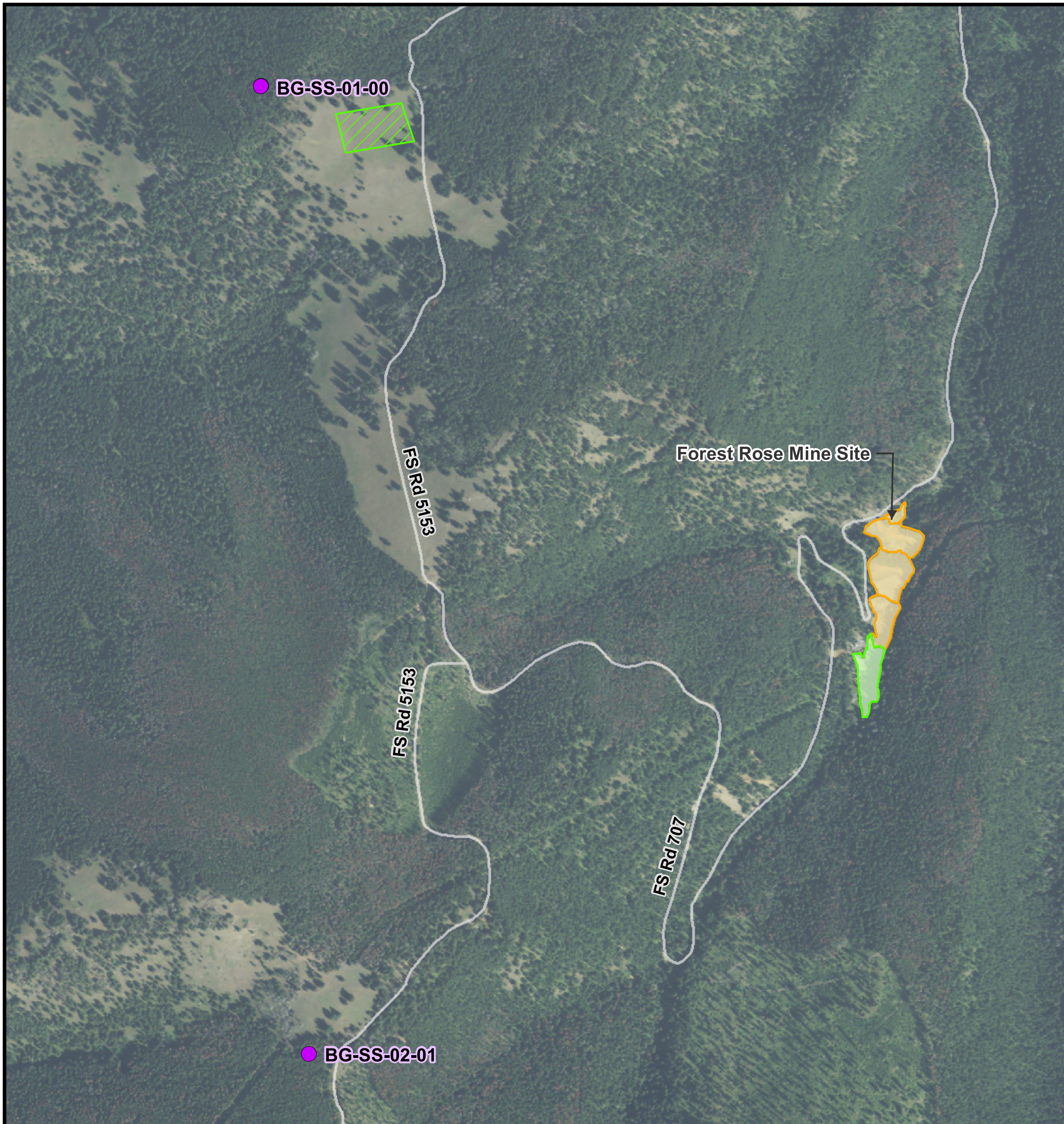


Legend

- Background sample
- Waste Rock area
- Tailings impoundment
- Approximate repository boundary
- Road

**Figure 3-3. Background sample location map, Forest Rose Mine Site**

N

0 375 750 1,500 Feet

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Aerial photograph: USDA, 2009

\\herrera\hecnet\gis-k\Projects\06-03425-080\Project\sample_locations-background_samples.mxd landscape is evident. The soils consisted of light brown silty sand (FR-BG-SS-01-00) and brown gravelly sand (FR-BG-SS-02-00) and were sampled by scraping off duff/decomposing plant material from the surface to expose the soil. Table 3-1 presents the metals concentrations compared to EPA Regional 9 RSLs for residential soil (EPA 2010) and DEQ RBCGs for composite, conservative soil cleanup guidelines associated with recreational visitors (DEQ 1996). DEQ RBCGs are the primary decision drivers while EPA RSLs are used for reference purposes.

**Table 3-1. Background soil concentrations (mg/kg) compared to EPA RSLs and DEQ RBCGs, Forest Rose Mine Site.**

| Parameter | EPA RSL [a] | DEQ RBCG[c] | Mean Background | FR-BG-SS-01-00 | FR-BG-SS-02-00 |
|---|---|---|---|---|---|
| Antimony | 31 | 293 | 0.39 | 0.49U | 0.54 |
| Arsenic | 0.39 (40)[b] | 0.7** | **17.8** | **16.2** | **19.3** |
| Barium | 15,000 | 4,975 | 322.5 | 416 | 229 |
| Cadmium | 70 | 19.5** | 1.8 | 0.5 | 3.1 |
| Chromium | 280 | 735,000 | 29.1 | 32.2 | 25.9 |
| Copper | 3,100 | 27,100 | 27 | 30.4 | 23.6 |
| Iron | 55,000 | Not applicable | 23,950 | 20,900 | 27,000 |
| Lead | 400 | 1,100 | 21 | 14.8 | 27.1 |
| Manganese | Not applicable | 665 | **1,605** | **1,780** | **1,430** |
| Mercury | 6.7 | 220 | 0.046 | 0.054 | 0.037 |
| Nickel | 14,000 | 14,650 | 39.8 | 50.7 | 28.9 |
| Silver | 390 | Not applicable | 0.22U | 0.39U | 0.49U |
| Zinc | 23,000 | 220,000 | 141.9 | 76.8 | 207 |

[a] EPA RSL = Regional Screening Level Table, Residential Soil Values (EPA 2010).

[b] 0.39 is the arsenic residential soil RSL for the carcinogenic endpoint; Montana DEQ uses a soil screening value of 40 mg/kg for arsenic based on background arsenic values for Montana soils (DEQ 2005).

[c] RBCG = Risk Based Cleanup Guidelines – Composite, Conservative Soil Cleanup Guidelines for Recreational Visitors, Table 7-10 (DEQ 1996).

** Concentrations shown for arsenic and cadmium are for a carcinogenic risk of 5E-07.

**Bold** Value exceeds the RBCG.

U The material was analyzed for but was not detected. The associated numerical value is the sample Practical Quantitation Limit (PQL). Concentrations were calculated using 1/2 the detection limit for non-detects.

Metals tested in background soils are below EPA RSLs. Individual and mean background arsenic and manganese values exceed DEQ RBCGs of 0.7 and 665 mg/kg, respectively.

### 3.2.2 Solid Matrix Samples

Thirty three samples were collected from the mine and mill site and repository site locations. Five borings were advanced through tailings impoundments into the soil below; one in T1, two in T2, and two in T3 (supplementing the two in T1 and two in T2 installed during the 2004 site investigation). Samples were tested for total recoverable metals to characterize both waste and soil. Analytical results for soil and waste rock samples are presented in Table 3-2. Metals concentrations are compared to EPA Region 9 RSLs for residential soil and DEQ RBCGs, which can be summarized as follows:

**Table 3-2. Solid matrix total recoverable metals analytical results (mg/kg) compared to EPA RSLs and DEQ RBCG, Forest Rose Mine Site.**

| Parameter (mg/kg) | EPA RSLs[a] | DEQ RBCG[b] | T1 | | T2 | | | | | | T3 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | T1-TB-01-00 | T1-SB-01-15 | T2-TB-01-00 | T2-TB-01-10 | T2-SB-01-20 | T2-TB-02-00 | T2-TB-02-10 | T2-SB-02-15 | T3-TB-01-00 | T3-TB-01-10 | T3-TB-01-20 | T3-SB-01-30 | T3-TB-02-00 | T3-TB-02-10 | T3-SB-02-20 |
| Antimony | 31 | 293 | 4.6 | 0.79 | 1.8 | 1.4 | 0.51 U | 47.6 | 4.5 | 1.1 | 21.7 | 49.5 J | 20.7 | 2 | 13.8 | 31.7 | 0.81 |
| Arsenic | 0.39(40)[b] | 0.7** | 445 | 23.2 | 239 | 264 | 10 | 456 | 300 | 22 | 355 | 331 | 330 | 41.6 | 370 | 555 | 18.3 |
| Barium | 15,000 | 4,975 | 29.6 | 54.6 | 13.6 | 6.6 | 18.7 | 35.2 | 13.2 | 46.3 | 32.1 | 28.8 | 19.4 | 40.2 | 39.4 | 25.1 | 94.5 |
| Cadmium | 70 | 19.5** | 1.4 | 4.1 | 3.1 | 48 | 1.1 | 68 | 39.7 | 1.8 | 75.9 | 64.2 | 44.7 | 3.6 | 70.7 | 29.8 | 1.3 |
| Chromium | 280 | 735,000 | 4 | 19.9 | 7.6 | 4.2 | 26.1 | 4 | 3.9 | 17.2 | 4.5 | 5.8 | 2.4 | 16.7 | 4.5 | 1.5 | 20.1 |
| Copper | 3,100 | 27,100 | 215 | 70.8 | 728 | 371 | 29.6 | 567 | 363 | 55.5 | 560 | 709 | 254 | 117 | 458 | 196 | 42.6 |
| Iron | 55,000 | NA* | 137,000 | 33,100 | 164,000 | 113,000 | 34,600 | 54,700 | 78,800 | 26,700 | 59,200 | 38,000 | 49,100 | 36,900 | 54,000 | 71,200 | 29,300 |
| Lead | 400 | 1,100 | 657 | 249 | 768 | 206 | 12.4 | 7850 | 1090 | 83.6 | 4860 | 9500 | 4600 | 441 | 5140 | 9820 | 57.7 |
| Manganese | NA* | 665 | 173 | 740 | 551 | 1570 | 277 | 2210 | 1420 | 506 | 1860 | 2070 | 1890 | 1930 | 2290 | 4340 | 577 |
| Mercury | 6.7 | 220 | 0.21 | 0.023 J | 0.074 | 0.035 | 0.047 | 0.39 | 0.054 | 0.053 | 0.3 | 0.037 | 0.022 U | 0.22 U | 0.16 | 0.036 | 0.02 U |
| Nickel | 14,000 | 14,650 | 12.6 | 24.9 | 14.7 | 24.7 | 32.6 | 7.5 | 13.8 | 25.7 | 10.2 | 7.3 | 9 | 29.4 | 21.2 | 4.9 | 27.3 |
| Silver | 390 | NA* | 8.7 | 0.53 | 6.4 | 4.3 | 0.51 U | 30.7 | 9.9 | 1.5 | 19.1 | 68.7 J | 13.8 | 1.6 | 16 | 16.5 | 0.79 |
| Zinc | 23,000 | 220,000 | 1600 | 282 | 1900 | 8300 | 174 | 7870 | 6610 | 145 | 7450 | 6910 | 7260 | 759 | 8130 | 8110 | 1100 |

| Parameter (mg/kg) | EPA RSLs[a] | DEQ RBCG[a] | WR | | | Area Wide | | | | | | Repository | | | | Dunkleberg Creek | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WR-RB-01-00 | WR-RB-02-00 | WR-RB-03-00 | AW-RS-01 | AW-RS-02 | AW-SS-01 | AW-SS-02 | AW-SS-03 | AW-SS-04 | RY-SS-01-00 | RY-SS-02-00 | RY-SS-03-00 | RY-WELL-01-0 | US-SD-01 | DS-SD-01 | DS-SD-02 |
| Antimony | 31 | 293 | 9.4 | 27.9 J | 10.3 | 2.1 | 0.89 | 1.3 | 0.53 | 2 | 1.7 | 0.56 U | 0.46 U | 0.53 UJ | 0.54 U | 29.6 | 1.2 | 0.68 |
| Arsenic | 0.39(40)[b] | 0.7** | 101 | 486 | 319 | 25.7 | 23.7 | 29 | 14.2 | 35.6 | 39.7 | 11.7 | 7 | 17.7 J | 9.1 | 36.2 | 24.3 J | 14.5 |
| Barium | 15,000 | 4,975 | 59.8 | 27.3 J | 21.1 | 113 | 112 | 290 | 66.6 | 182 | 257 | 204 | 304 | 248 | 242 | 169 | 65.4 J | 63 |
| Cadmium | 70 | 19.5** | 5.2 | 5 | 18.9 | 2.5 | 4.2 | 2.7 | 1.2 | 1.9 | 4.1 | 0.42 | 0.27 | 0.25 | 0.39 | 20.2 | 6.6 J | 2.7 |
| Chromium | 280 | 735,000 | 22.5 | 4.6 | 12.4 | 26.3 | 21.5 | 20.5 | 27.8 | 23.8 | 17.7 | 52.7 | 95.9 | 111 | 57.9 | 21 | 30.3 J | 27.9 |
| Copper | 3,100 | 27,100 | 249 | 628 | 259 | 60.6 | 48.6 | 35.5 | 37.1 | 39.6 | 33.3 | 38.8 | 51.5 | 50.1 J | 34.6 | 65.1 | 69 J | 38.6 |
| Iron | 55,000 | NA* | 47,700 | 46,200 | 123,000 | 30,200 | 33,000 | 23,200 | 32,100 | 23,300 | 22,700 | 31,600 | 40,800 | 30,900 | 21,700 | 35,200 | 37,100 | 33,500 |
| Lead | 400 | 1,100 | 4560 | 2640 | 2610 | 141 | 76.9 | 79.8 | 26 | 123 | 146 | 12.1 | 8.2 | 8.2 | 6.5 | 389 | 448 | 120 |
| Manganese | NA* | 665 | 813 | 95.8 J | 529 | 748 | 773 | 1300 | 796 | 1050 | 4170 | 831 | 717 | 674 | 599 | 1220 | 796 | 510 |
| Mercury | 6.7 | 220 | 0.23 | 0.9 | 0.42 | 0.13 | 0.038 | 0.045 | 0.026 | 0.076 | 0.13 | 0.058 | 0.02 | 0.026 | 0.036 | 0.053 | 0.023 | 0.02 U |
| Nickel | 14,000 | 14,650 | 33.2 | 5.7 | 33.7 | 35 | 26.7 | 24.2 | 37.1 | 33.7 | 24.4 | 55.8 | 98.2 | 97.3 | 53.9 | 45.6 | 41.1 J | 37.3 |
| Silver | 390 | NA* | 9.7 | 28.9 J | 19.5 | 1 | 0.42 U | 0.48 | 0.42 U | 0.55 | 5.3 | 0.56 U | 0.46 U | 0.53 U | 0.54 U | 2.1 | 1.1 J | 0.59 |
| Zinc | 23,000 | 220,000 | 1260 | 1070 | 2960 | 352 | 463 | 269 | 131 | 254 | 248 | 72.6 | 62.6 | 68 J | 65.5 | 2210 | 1160 | 563 |

[a]EPA RSL = Regional Screening Level Table, Residential Soil Values (EPA 2010)

[b]RBCG = Risk Based Cleanup Guidelines – Composite, Conservative Soil Cleanup Guidelines for Recreational Visitors, Tables 7-10 (DEQ 1996)

** - concentrations shown for arsenic and cadmium are for a carcinogenic risk of 5E-07.

Underlined indicates the sample result or detection limit is greater than the EPA RSL limit

Shaded indicates the sample result or detection limit is greater than the DEQ RBCG limit.

J - The result is considered an estimated value due to data quality.

U – the material was analyzed for but was not detected. The associated numerical value is the sample Practical Quantitation Limit (PQL).

NA* - Not Applicable

- EPA REGION 9 RSLs:
  - Antimony exceeds the EPA RSL in samples collected from 10 feet below ground surface (bgs) at two locations in T3
  - Arsenic exceeds the EPA RSL in 14 samples: all 10 tailings and 3 waste rock samples, plus 1 soil sample collected from beneath the tailings in T2
  - Cadmium exceeds the EPA RSL in one T3 surface tailings sample
  - Iron exceeds the EPA RSL in seven samples: six tailing samples in T1, T2, and T3, and one waste rock sample (all other tailings and waste rock samples were close to the RSL; all five soil samples collected from below the tailings had markedly lower iron concentrations, similar to area-wide and repository results)
  - Lead exceeds the EPA RSL in 14 samples: 9 of 10 tailing samples, all 3 waste rock samples, 1 underlying soil sample in T3, and 1 downstream sediment sample
- DEQ RBCGs
  - Arsenic exceeds the DEQ RBCG in every sample
  - Cadmium exceeds the DEQ RBCG in nine samples: three tailings samples in T2, five tailings samples in T3, and one waste rock sample
  - Lead exceeds the DEQ RBCG in nine samples: one tailing sample in T2, five tailings samples in T3, and three waste rock samples
  - Manganese exceeds the DEQ RBCG in 24 samples: one downstream sediment sample, one tailings sample in T1, three tailings samples in T2, five tailings samples in T3, one underlying soil sample in T3, three waste rock samples, six-area-wide samples, three repository samples, and one upstream sediment sample
  - All analytes, except barium, exceed mean background concentrations

In general, a similarity exists between samples collected in 2010 and those collected in previous sampling events, where the same analytes exceed EPA and DEQ limits.

Soil samples collected from borings beneath the tailings displayed lower concentrations of metals than the tailings. Only one soil sample exceeds EPA RSLs for arsenic, while the remaining soil samples, area-wide samples, and repository samples did not exceed any EPA

RSLs. All samples exceeded the DEQ RBCG for arsenic, including soil samples beneath tailings, area-wide samples, and repository samples. No other DEQ RBCG was exceeded in any soil sample, except manganese, found at elevated levels in most samples, including those from both background locations.

### 3.2.3 Water-Matrix Samples

Dunkleberg Creek flows through the waste rock pile/tailings impoundments placed in the stream channel during mining and milling operations. A total of six water samples were collected (Figure 3-1). Three samples were collected from Dunkleberg Creek – 200 feet downstream of the T1 slump (DS-SW-T1), 10 feet downstream of the T1 slump (DS-SW-T2), and 100 feet upstream of the waste rock berm (US-SW-T1); an area-wide surface water sample also was collected from the adit on the west slope of the Dunkleberg Creek ravine (AW-SW-T1). All water samples were submitted for total recoverable metals and alkalinity/acidity tests; aluminum was tested for as a dissolved metal at each location using the "–D1" or "–D2" sample designation. Field parameter measurements presented in Table 3-3 indicate a 50 percent increase in conductivity and a slight decrease in pH after flowing through the waste rock pile/tailings impoundments.

**Table 3-3. Water field measurements, Forest Rose Mine Site.**

| Sample | Temperature (ºC) | Specific Conductivity (µs/cm) | Dissolved Oxygen (mg/L) | pH (standard units) | Discharge (cfs) |
|---|---|---|---|---|---|
| DS-SW-T1 | 6.38 | 457 | 11.4 | 7.91 | 0.269 |
| DS-SW-T2 | 7.11 | 430 | 10.3 | 7.37 | 0.180 |
| US-SW-T1 | 10.4 | 290 | 10.4 | 8.42 | 0.033 |
| AW-SW-T1 | 6.32 | 411 | 8.05 | 7.00 | NM |

ºC degrees Celsius
µs/cm microsiemens per centimeter
mg/L milligrams per liter
cfs cubic feet per second
NM not measured

Table 3-4 presents total recoverable metals results compared to DEQ RBCGs and Table 3-5 presents total recoverable and dissolved metals results compared to DEQ Circular-7 water quality standards for aquatic (chronic and acute levels) and human health (surface water), which can be summarized as follows:

- Arsenic exceeds the DEQ RBCG in the upstream sample and the sample collected 200 feet downstream of the T1 slump; slightly higher in the upstream sample than the downstream sample. Arsenic was below the detection limit (0.50 µg/L) in duplicate samples collected 10 feet downstream of the T1 slump, as well as at the adit.

**Table 3-4. Water total recoverable metals analytical results (µg/L) compared to DEQ RBCG, Forest Rose Mine Site.**

| Parameter | DEQ RBCG [a] | DS-SW-T1/D1 | DS-SW-T2/D2 | AW-SW-T1/D2 | US-SW-T1/D1 | DS-QC-T1/D1 |
|---|---|---|---|---|---|---|
| pH at 25 Degrees C | NA | 7.9 J | 7.6 J | 7.4 J | 8.3 J | NA |
| Alkalinity, Total as CaCO3 (mg/L) | NA | 170 | 170 | 175 | 133 | NA |
| Acidity (mg/L) | NA | 5 U | 5 U | 5 U | 5 U | NA |
| Antimony (ug/L) | 91.1 | 0.64 | 0.6 | 1.1 | 0.5 U | 0.57 |
| Arsenic (ug/L) | 0.06* | 0.59 | *0.5* U | *0.5* U | 0.68 | *0.5* U |
| Barium (ug/L) | 17,474 | 16.3 | 16.5 | 20.5 | 10.5 | 16.3 |
| Cadmium (ug/L) | 66.5 | 0.72 | 0.65 | 6.1 | 0.98 | 0.65 |
| Chromium (ug/L) | 100,246 | **0.5** U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Copper (ug/L) | 472 | 1.7 | 1 | 1.1 | 0.79 | 0.99 |
| Iron (ug/L) | NA | 67 | 57.4 | 50 U | 117 | 50 U |
| Lead (ug/L) | 47.1 | 10.2 J | 5.9 | 0.46 | 2.1 | 5.8 |
| Manganese (ug/L) | 16.6 | 21.5 J | 11.9 | 4.2 | 10.8 | 11.5 |
| Mercury (ug/L) | 0.15 | 0.000567 | 0.000505 | 0.000797 | 0.00112 | 0.000643 |
| Nickel (ug/L) | 931 | 0.5 U | 0.5 U | 2.1 | 0.68 | 0.5 U |
| Silver (ug/L) | NA | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Zinc (ug/L) | 17.2 | 91.7 | 76 | 1360 | 113 | 75.6 |
| Aluminum, Dissolved (ug/L) | NA | 15.3 | 13.8 | 12 | 15.6 | 14.8 |

[a] RBCG = Risk Based Cleanup Guidelines – Composite, Conservative Soil Cleanup Guidelines for Recreational Visitors, Table 7-11 (DEQ 1996)

* concentrations shown for arsenic are for a carcinogenic risk of 5E-07.

*Italicized* – indicates the sample detection limit is greater than the DEQ RBCG limit.

Shaded – indicates the sample result or detection limit is greater than the DEQ RBCG limit.

J – The result is considered an estimated value due to data quality

U – the material was analyzed for but was not detected. The associated numerical value is the sample Practical Quantitation Limit (PQL).

NA – Not Applicable

## Table 3-5. Water total recoverable metals analytical results (µg/L) compared to Circular DEQ-7, Forest Rose Mine Site.

| Parameter | Human Health Standards [a] | Acute Aquatic Life Standard | Chronic Aquatic Life Standard | FR-DS-SW-T1/D1 | FR-DS-SW-T2/D2 | FR-AW-SW-T1/D2 | FR-US-SW-T1/D1 | FR-DS-QC-T1/D1 |
|---|---|---|---|---|---|---|---|---|
| at 25 Degrees C | NA* | NA* | NA* | 7.9 J | 7.6 J | 7.4 J | 8.3 J | NA* |
| Alkalinity, Total as CaCO3 (mg/L) | NA* | NA* | NA* | 170 | 170 | 175 | 133 | NA* |
| Acidity (mg/L) | NA* | NA* | NA* | 5 U | 5 U | 5 U | 5 U | NA* |
| Antimony (ug/L) | 5.6[b] | None | None | 0.64 | 0.6 | 1.1 | 0.5 U | 0.57 |
| Arsenic (ug/L) | 10[b] | 340[b] | 150[b] | 0.59 | 0.5 U | 0.5 U | 0.68 | 0.5 U |
| Barium (ug/L) | 1,000[g] | None | None | 16.3 | 16.5 | 20.5 | 10.5 | 16.3 |
| Cadmium (ug/L) | 5[c] | 0.52[e] | 0.097[e] | 0.72 | 0.65 | **6.1** | 0.98 | 0.65 |
| Chromium (ug/L) | 100[c] | 579[e] | 27.7[e] | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Copper (ug/L) | 1,300[b] | 3.79[e] | 2.85[e] | 1.7 | 1 | 1.1 | 0.79 | 0.99 |
| Iron (ug/L) | 300[d] | None | 1,000[g] | 67 | 57.4 | 50 U | 117 | 50 U |
| Lead (ug/L) | 15[b] | 13.98[e] | 0.545[e] | 10.2 J | 5.9 | 0.46 | 2.1 | 5.8 |
| Manganese (ug/L) | 50[d] | None | None | 21.5 J | 11.9 | 4.2 | 10.8 | 11.5 |
| Mercury (ug/L) | 0.05[b] | 1.7[b] | 0.91[b] | 0.000567 | 0.000505 | 0.000797 | 0.00112 | 0.000643 |
| Nickel (ug/L) | 100[f] | 145[e] | 16.1[e] | 0.5 U | 0.5 U | 2.1 | 0.68 | 0.5 U |
| Silver (ug/L) | 100[f] | 0.374[e] | None | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Zinc (ug/L) | 2,000[f] | 37[e] | 37[e] | 91.7 | 76 | 1360 | 113 | 75.6 |
| Aluminum, Dissolved (ug/L) | None | 750[g] | 87[g] | 15.3 | 13.8 | 12 | 15.6 | 14.8 |

[a] Human Health Standards for Surface Water, Circular DEQ-7, "Montana Numeric Water Quality Standards" (DEQ 2010)
[b] Priority Pollutant, Circular DEQ-7, "Montana Numeric Water Quality Standards" (DEQ 2010)
[c] Maximum containment level (DEQ 2010)
[d] Secondary maximum contaminant level based on aesthetic properties (DEQ 2010)
[e] @25 mg/L hardness (DEQ 2010)
[f] Health advisory (DEQ 2010)
[g] Non-priority pollutant (DEQ 2010)
**Bold** – indicates the sample result or detection limit is greater than the Human Health Standard limit
Underlined – indicates the sample result or detection limit is greater than the Acute Aquatic Life Standard limit
Shaded – indicates the sample result or detection limit is greater than the Chronic Aquatic Life Standard limit
U – the material was analyzed for but was not detected. The associated numerical value is the sample Practical Quantitation Limit (PQL)
NA* – Not Applicable
J – The result is considered an estimated value due to data quality

Manganese exceeds the DEQ RBCG in the sample collected 200 feet downstream of the T1 slump.

- Zinc exceeds the DEQ RBCG in all samples collected.
- Cadmium exceeds both Acute and Chronic Aquatic Life Standards in all samples collected and the Human Health Standard in the adit sample.
- Lead exceeds the Chronic Aquatic Life Standard in all samples collected.
- Zinc exceeds both Acute and Chronic Aquatic Life Standards in all samples collected.

### 3.2.4 Hazardous Materials Inventory

A hazardous materials inventory was performed to identify and document potential safety hazards. Thirteen buildings were located at the Forest Rose Mine Site in various states of disrepair. Two adits were identified onsite; one collapsed and one partially open. The 2001 Abandoned Mines Hazardous Materials Inventory identified two adits located at the mine site (DEQ/MWCB 1993). The original workings were shown to be at a depth of 160 feet, while the main tunnel on the west bank of Dunkleberg Creek associated with the Acrobat lode was at the 330 foot level (DEQ/MWCB 1993). Soon after the mine closed in 1945, a Bureau of Mines geologist surveyed the site and identified the main tunnel in 500 feet and 3,000 feet of winzes, drifts, and crosscut. The longest underground feature was a drift into the Monarch Mine property 1,800 feet long and a winze that sunk 400 feet below the main tunnel had flooded (DEQ/MWCB 1993). In 2010, field personnel were able to identify only two of the three adits. In addition to the buildings and adits, onsite refuse includes a car body, a 50-gallon drum, and several tires in an eroded area between tailings impoundments T3 and T2.

### 3.2.5 Reclamation and Land Use Characterization Results

#### *3.2.5.1 Repository Site Suitability*

Site observations, subsurface data, and preliminary geotechnical engineering evaluations indicate that the proposed 2-acre repository site located on USFS administered lands is suitable for mine waste storage. Potential geotechnical engineering concerns, such as groundwater seeps, boggy areas, peat deposits, hillside instability, and excessive erosion, were not encountered during the site investigation.

A hydrogeologic investigation was not performed as part of the current scope of work and groundwater level data are limited to observations made while boring RY-Well-01 in August 2010 (Figure 3-2). Since no groundwater was encountered in the test pits or boring and no seasonal groundwater influence was evident in the explorations, it is expected that seasonal groundwater levels are below the depth of the current explorations. Additional attempts at groundwater measurements at RY-Well-01 will be conducted during spring thaw.

Depth to bedrock is variable, with bedrock observed at the ground surface along the higher ridges bordering the site and up to 12.5 feet deep at the lower site elevations. The volume of tailings and waste rock is estimated at 90,000 cy. The available repository acreage and depth to bedrock will dictate the height and shape of the repository to accommodate the volume of mine waste. Based on initial calculations and repository layouts, the volume of waste would be able to be placed in the proposed repository location.

Native soils are moderately permeable and the bedrock will transmit groundwater through existing fractures; therefore, a hydrogeologic barrier may be required for the repository liner and cover.

### *3.2.5.2 Repository Site Geotechnical Sampling Results*

Three surface samples collected from 0 to 4 inches deep generally consisted of brown sandy silt (Figure 3-2). Three test pits encountered bedrock between 7 and 10 feet deep. A summary of subsurface conditions encountered in each test pit is presented in Table 3-6.

**Table 3-6. Test pit data summary, Forest Rose Mine Site repository.**

| Test Pit | Location | Total Depth (feet) | Depth Interval (feet) | Material Description |
|---|---|---|---|---|
| RY-SS-01 | NW area of repository | 7.0 | 0.0 – 0.5<br>0.5 – 4.0<br>4.0 – 7.0<br>Bedrock at 7.0 ft | Silty sand with organics [Topsoil]<br>Silty to clayey gravel with sand [Residuum]<br>Gravelly sand with angular cobbles [Residuum] |
| RY-SS-02 | SE area of repository | 10.0 | 0.0 – 0.5<br>0.5 – 8.0<br>8.0 – 10.0<br>Bedrock at 10.0 ft | Silty sand with organics [Topsoil]<br>Silty sand and sand [Residuum]<br>Gravelly sand with angular cobbles [Residuum] |
| RY-SS-03 | NE area of repository | 9.0 | 0.0 – 0.3<br>0.3 – 5.5<br>5.5 – 9.0<br>Bedrock at 9.0 ft | Silty sand with organics [Topsoil]<br>Sand and silty sand with gravel [Residuum]<br>Gravelly sand with angular cobbles [Residuum] |

Soils were classified in accordance with the Unified Soil Classification System (USCS), as specified in ASTM D2487. Grain size distribution analyses (ASTM D422) and Atterberg limit tests (ASTM D4318) were performed on selected samples. Soil particle sizes larger than 3 inches (cobbles and boulders) were discarded and only the soil fraction passing the 3-inch sieve was used for laboratory analysis. Table 3-7 summarizes soil classification test results.

USCS soil classification information provides a general indication of engineering soil properties, such as soil strength, hydraulic conductivity (permeability), compressibility, and susceptibility to frost or erosion. Useful empirical relationships can be used for estimating engineering soil properties and for designing soil filter criteria for drainage materials. A USCS chart is included in Appendix B.

**Table 3-7. Summary of soil classification tests, Forest Rose Mine Site repository.**

| Lab I.D. No. | Location | Depth (ft) | Particle Size Distribution [a] Gravel (%) | Sand (%) | Fines (%) | Atterberg Limits [b] | Natural Moisture Content (%) [c] | USCS Symbol [d] |
|---|---|---|---|---|---|---|---|---|
| | RY-SS-01/S1 | 0 – 0.5 | | | | | 11.1 | SM |
| | RY-SS-01/S2 | 3.0 | | | | | 7.3 | SM |
| 9481 | RY-SS-01/S3 | 2.0 – 4.0 | 42 | 29 | 29 | LL=24 PL=17 | 9.8 | GC-GM |
| | RYSS-02/S1 | 2.5 | | | | | 9.8 | SM |
| | RY-SS-02/S2 | 4.0 | | | | | 6.0 | SP-SM |
| 9485 | RY-SS-02/S3 | 5.0 – 6.0 | 0 | 83 | 17 | NP | 6.0 | SM |
| 9487 | RY-SS-02/S4 | 8.5 – 9.0 | 2 | 83 | 15 | NP | 5.6 | SM |
| | RY-SS-03/S1 | 1.5 | | | | | 5.4 | SM |
| | RY-SS-03/S2 | 3.0 | | | | | 5.0 | SM |
| 9491 | RY-SS-03/S3 | 3.0 – 5.0 | 3 | 79 | 18 | NP | 5.9 | SM |

[a] Percent by weight
[b] Atterberg limits: LL=liquid limit; PL=plastic limit; NP=non-plastic
[c] Weight of water as a percentage of the weight of solids
[d] USCS Symbols: GC=clayey gravels; GM=silty gravels; SP=poorly graded sands; SM=silty sands

Three representative soil samples were tested to determine the soil moisture/density relationship for the standard Proctor compaction method (ASTM D698 and D4718). Specific gravities were determined for estimating void ratios (volume of voids/total sample volume) of soil compacted to a specified density. Natural moisture contents were also determined. A comparison of the natural water content and the optimum moisture content of the compacted soil specimen provides an indication of moisture conditioning required when placing and compacting this material. Natural moisture contents and Moisture/Density test results are summarized in Table 3-8.

**Table 3-8. Standard proctor moisture/density test results, Forest Rose Mine Site repository.**

| Lab I.D. No. | Location (depth in ft) | Material Description | Specific Gravity | Maximum Dry Density (pcf) | Optimum Moisture Content (%) [a] | Natural Moisture Content (%) [a] |
|---|---|---|---|---|---|---|
| 9481 | RY-SS-01/S-3 (2.0-4.0) | Silty to clayey gravel with sand (GC-GM) | 2.75 | 126.5 | 11.5 | 11.1 |
| 9485 | RY-SS-02/S-3 (5.0-6.0) | Silty sand (SM) | 2.85 | 115.7 | 13.8 | 6.0 |
| 9487 | RY-SS-02/S-4 (8.5-9.0) | Silty sand (SM) | 2.89 | 112.9 | 16.6 | 5.6 |
| 9491 | RY-SS-03/S-3 (3.0-5.0) | Silty sand (SM) | 2.88 | 117.7 | 14.1 | 5.4 |

[a] Weight of water as a percentage of the weight of solids
pcf – pounds per cubic foot

Soil boring RY-Well-01 was drilled to refusal at a depth of 12.5 feet. A geologist was onsite throughout the fieldwork program to observe the boring, assist in sampling, and prepare a descriptive log of the material encountered. Soils were classified in general accordance with ASTM D-2488, "Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)" as described in the "Key to Log of Borings" included in Appendix B. A summary of subsurface conditions is presented in Table 3-9.

**Table 3-9. RY-Well-01 boring data summary, Forest Rose Mine Site repository.**

| Location | Total Depth (ft) | Depth Interval (ft) | Material Description / SPT |
|---|---|---|---|
| SW area of repository | 12.5 | 0.0 – 0.5<br>0.5 – 3.0<br>3.0 – 7.5<br>7.5 – 11.5<br>Bedrock at 11.5 ft | Topsoil<br>Sandy silt [Residuum] / 14<br>Silty sand [Residuum] / 48<br>Gravelly sand with angular cobbles [Residuum] / 100 [a] |

SPT – standard penetration test (blows per foot of sampler penetration).
[a] for 9 inches

A groundwater observation well was installed in the boring. The well consists of a 1-inch diameter, slotted PVC pipe (10-slot) from 8 to 13 feet deep surrounded by a sand filter pack. Well construction details are provided on the boring log.

### *3.2.5.3 Repository Site Agronomic Sampling Results*

Agronomic tests were performed on three topsoil samples (the topsoil layer varied in thickness from 4 to 12 inches) to evaluate suitability for reuse as topsoil during site reclamation. The agronomic tests included United States Department of Agriculture (USDA) soil classification, grain size distribution, soil pH, available nitrate, available phosphorus, potassium, percent organic matter, cation exchange capacity, and lime requirements. A summary of the test results is provided in Tables 3-10 and 3-11.

### *3.2.5.4 Repository Site General Observations*

The site is generally underlain by topsoil over residual soil over bedrock, except for bedrock exposed along the ridge at the northern edge of the repository area. Residual soil is derived from completely weathered-in-place bedrock. The transition from soil to bedrock is gradual and may be difficult to distinguish. The estimated soil thickness varied from about 7 feet to 11.5 feet.

Residuum generally consisted of medium dense to dense silty fine to coarse sand, with varying amounts of gravel. At depth, residual soil is less weathered, resembling the parent bedrock, but easily degrades to gravelly sand with angular cobbles when excavated. These in-situ soils have relatively high shear strength, low compressibility, and moderate to high permeability.

**Table 3-10. Topsoil classification test results, Forest Rose Mine Site repository.**

| Location/Depth (ft) | Grain Size Distribution [a] | | | Natural Moisture Content (%) [b] | Organic Content (%) [c] | USDA Classification |
|---|---|---|---|---|---|---|
| | Sand (%) | Silt (%) | Clay (%) | | | |
| RY-SS-01-00 | 55 | 27.5 | 17.5 | 13.6 | 8.9 | Sandy loam |
| RY-SS-02-00 | 67.5 | 17.5 | 15 | 3.8 | 5.2 | Sandy loam |
| RY-SS-03-00 | 63.8 | 19.9 | 16.3 | 7.2 | 8.0 | Sandy loam |

[a] Percent by weight
[b] Weight of water as a percentage of the weight of solids.
[c] Weight of organics as a percentage of the weight of solids.

**Table 3-11. Topsoil analytes test results, Forest Rose Mine Site repository.**

| Analyte | RY-SS-01-00 | RY-SS-02-00 | RY-SS-03-00 |
|---|---|---|---|
| pH, saturated paste (std units) | 6.8 | 6.9 | 7.2 |
| Available nitrate (mg/kg) | 5.0 | 5.0 | 5.0 |
| Available phosphorous (mg/kg) | 12.1 | 18.4 | 6.6 |
| Potassium (mg/kg) | 120.0 | 140.0 | 140.0 |
| Cation exchange capacity (meq/100g) | 49.7 | 35.6 | 47.5 |
| Specific conductance saturated paste (mmhos/cm) | 0.38 | 0.38 | 0.19 |
| SMP buffer pH (std. units) | 6.2 | 6.8 | 6.2 |
| SMP lime requirement (tons/1000) | 5.3 | 1.0 | 5.3 |

SMP – Shoemaker, McLean, and Pratt

Groundwater or seeps were not encountered within the test pits or in the boring. Groundwater levels will fluctuate according to seasonal precipitation, infiltration, and percolation of surface water; however, saturated soils or oxidized soil zones indicative of seasonally high groundwater were not observed in the test pits or samples taken from the boring, and the subsurface soils appeared well-drained. Based on this preliminary information, it is expected that groundwater levels are consistently deeper than the exploration depths.

Highly weathered and fractured bedrock was encountered in all of the test pits, as well as the boring. Bedrock that refused backhoe excavation in the test pits was encountered at depths varying from 7 to 10 feet. Hollow-stem auger refusal was encountered at a depth of 12.5 feet in the boring.

### *3.2.5.5 Repository Site Development*

The few trees present on the site should be removed, along with the large root balls. Topsoil should be stripped from ground surface to a depth ranging from 4 to 12 inches (average 8 inches) bgs from the site and stockpiled for later use.

Residual soils can be excavated with conventional excavation and earth moving equipment. Excavators and dozers equipped with ripper teeth could achieve some additional penetration into the bedrock layer, depending on the degree of bedrock weathering and fracturing (rock quality). Temporary excavation slopes for the repository should be cut at 1.5H:1V (horizontal to vertical), or flatter.

Native soils with less than 3-inch particle size could be used to construct containment berms. These soils are moisture sensitive, due to a high percentage of fines, and would be difficult to compact in wet weather conditions. The fill should be placed in 8-inch loose lifts within 2 percent of optimum moisture content and compacted to 95 percent of maximum dry density (ASTM D698).

Fine-grained soils (e.g., silt, clay, or clayey sand) considered suitable for use as a hydrologic barrier were not found at the site. The native silty sand could be used, if amended with bentonite to produce the desired hydraulic properties. Native soils should be screened to remove particles larger than 1/4 inch.

Alternatively, a geosynthetic membrane could be used as a repository liner and cover. The subgrade should be smoothed to remove angular cobbles and then covered with a 12-inch thick layer of bedding sand prior to placing the liner.

Based on the observed subsurface soil and groundwater conditions, the need for dewatering during repository construction is not anticipated. Stormwater best management practices (BMPs) should be implemented during construction and while new vegetation is established.

### 3.2.6 Revegetation Potential

#### *3.2.6.1 Agricultural Analyses*

Soils from the repository test pits were tested for pH, conductivity, cation exchange capacity, nitrate, phosphorous, potassium, organic matter, and lime (Table 3-12). The following provides a summary of the agricultural analyses and how they may affect current and future plant growth:

- The soils exhibited neutral pH readings, which is good for nutrients and plant establishment.
- Soil conductivity ranged from 0.19 to 0.38 mmhos/cm, which is within a good working range needed for establishing vegetation (Bohn 1979).
- Nitrate was not detected (<5.0 mg/kg), so it is likely that nitrogen amendment in a slow release form will be required during revegetation. It should be noted that grasses and trees are currently growing on the proposed repository site.
- Phosphorus/phosphate levels range from 6.6 to 18.4 mg/kg, which is in the low to medium range to ensure seedling growth. The existing levels should be substantial enough to support revegetation (Munshower 1993).

- Potassium levels range from non-detect (<120 mg/kg) to 140 mg/kg, which should support revegetation.

- Organic matter ranged from 5.2 to 8.9 percent, which is in the high range and will support revegetation (Munshower 1993).

- Natural lime in soils will buffer or neutralize acid-producing elements found in mine waste while facilitating plant uptake of nitrogen. Based on the near neutral soil pHs found at the proposed repository location, a small amount of lime may be needed.

**Table 3-12. Agricultural analysis of repository soil, Forest Rose Mine Site.**

| Parameter | RY-SS-01-00 | RY-SS-02-00 | RY-SS-03-00 |
|---|---|---|---|
| Soil Moisture Content (%) | 13.6 | 3.8 | 7.2 |
| pH, Saturated Paste (Std. Units) | 6.8 | 6.9 | 7.2 |
| Organic Matter % (w/w) | 8.9 | 5.2 | 8 |
| Percent Silt % (w/w) | 27.5 | 17.5 | 19.9 |
| Percent Clay % (w/w) | 17.5 | 15 | 16.3 |
| Percent Sand % (w/w) | 55 | 67.5 | 63.8 |
| Texture | 0 | 0 | 0 |
| Available Nitrate (mg/kg) | 5.0 U | 5.0 U | 5.0 U |
| Available Phosphorus (mg/kg) | 12.1 | 18.4 | 6.6 |
| Potassium (mg/kg) | 120.0 U | 140.0 | 140.0 |
| Cation Exchange Capacity (meq/100g) | 49.7 | 35.6 | 47.5 |
| Conductance, Saturated Paste (mmhos/cm) | 0.38 | 0.38 | 0.19 |
| SMP Buffer pH (Std. Units) | 6.2 | 6.8 | 6.2 |
| SMP Lime Requirement (tons/1000) | 5.3 | 1.0 | 5.3 |

U – The material was analyzed for, but was not detected. The associated numerical value is the detection limit (PQL).

The agricultural analytical results indicate the following amendments will be required:

- Nitrate – 25 to 30 pounds per acre, based on a grass crop with a projected yield of 1.5 tons.

- Lime – 0 to 5 pounds per acre, based on a grass crop with a projected yield of 1.5 tons.

### *3.2.6.2 Acid Base Accounting Analyses*

Acid base accounting (ABA) was performed on tailings and waste rock to examine naturally occurring levels of basic material (e.g. lime) versus acid-generating material (e.g. sulfur) and how the two may interact over time. ABA analyses evaluate sulfur, pyritic sulfur, organic sulfur, and sulfate sulfur contents that indicate the potential to generate acidity when contacted by water. ABA also determines acid potential versus neutralization potential, indicating the quantity of lime required to neutralize the overall acid potential produced by the waste. These analyses determine the likelihood of the tested material to generate acid when exposed to water over time, and the natural buffering capacity (e.g. lime) to offset its effects. If sulfur contents of the mine waste exceed its buffering capacity, often due to weathering or leaching of the material, additional lime may be required to counteract the acid potential.

ABA results, analyzed using the static modified Sobek method, are provided in Table 3-13 and summarized below:

- The sulfur levels in the samples ranged from 0.25 to 10.4 percent
- The acid potential ranged from 4.8 to 250 ton per kiloton (t/kt)
- The neutralization potential ranged from >0.5 to 600 t/kt
- The lime requirements ranged from 13 to 310 t/kt

These results indicate that lime would need to be added to waste material to neutralize the acid potential.

## Table 3-13. Acid Base Accounting (ABA) analysis of soil and waste rock, Forest Rose Mine Site.

| Parameter | T1-TB-01-00 | T2-TB-01-00 | T2-TB-01-10 | T2-TB-02-00 | T2-TB-02-10 | T3-TB-01-00 | T3-TB-01-10 | T3-TB-01-20 |
|---|---|---|---|---|---|---|---|---|
| SMP Buffer pH (Std. Units) | 4 | 5.3 | 7.5 | 7.6 | 7.5 | 7.6 | 7.6 | 7.6 |
| Sulfur, Hot Water Extractable % (w/w) | 2.21 | 2.92 | 2.58 | 1.61 | 4.9 J | 2.04 | 1.08 | 1.37 |
| Sulfur, HNO3 Extractable % (w/w) | 0.13 | 0.15 | 6.33 | 4.84 | 7.87 | 4.6 | 1.85 | 5.66 |
| Sulfur, HCl Extractable % (w/w) | 0.741 | 0.435 | 1.45 | 0.05 U | 0.05 U | 0.05 U | 0.248 | 0.05 U |
| Total Sulfur % (w/w) | 3.09 | 3.51 | 10.4 | 3.69 | 9.92 | 3.76 | 3.19 | 4.83 |
| Sulfur, Residual % (w/w) | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| Acid Potential (tons/1000) | 21 | 15 | 230 | 150 | 250 | 140 | 64 | 180 |
| Acid/Base Potential (tons/1000) | -21 | -15 | -6.6 | 450 | 88 | 450 | 450 | 360 |
| Neutralization Potential (tons/1000) | <0.5 | <0.5 | 230 | 600 | 330 | 590 | 520 | 540 |
| Lime Requirement (tons/1000) | 46 | 33 | 290 | 190 | 310 | 180 | 80 | 220 |
| SMP Lime Requirement (tons/1000) | > 15.5 | 12 | 0 | 0 | 0 | 0 | 0 | 0 |

| Parameter | T3-TB-02-00 | T3-TB-02-10 | WR-RB-01-00 | WR-RB-02-00 | WR-RB-03-00 |
|---|---|---|---|---|---|
| SMP Buffer pH (Std. Units) | 7.5 | 7.6 | 6.2 | 3.8 | 6.6 |
| Sulfur, Hot Water Extractable % (w/w) | 1.52 | 0.895 | 0.09 | 3.11 | 1.14 |
| Sulfur, HNO3 Extractable % (w/w) | 4.75 | 6.54 | 0.114 | 0.861 | 1.32 |
| Sulfur, HCl Extractable % (w/w) | 0.05 U | 0.05 U | 0.05 U | 1.17 | 0.05 U |
| Total Sulfur % (w/w) | 3.03 | 5.43 | 0.253 | 5.14 | 2.34 |
| Sulfur, Residual % (w/w) | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| Acid Potential (tons/1000) | 150 | 200 | 4.8 | 54 | 41 |
| Acid/Base Potential (tons/1000) | 380 | 370 | -1.7 | -54 | -18 |
| Neutralization Potential (tons/1000) | 530 | 570 | 3 | <0.5 | 23 |
| Lime Requirement (tons/1000) | 190 | 260 | 13 | 87 | 54 |
| SMP Lime Requirement (tons/1000) | 0 | 0 | 5.3 | > 15.5 | 2.4 |

U - The material was analyzed for, but was not detected. The associated numerical value is the detection limit (PQL).

J - The result is considered an estimated value due to data quality.

# 4.0 Summary of Applicable and Relevant or Appropriate Requirements

Applicable or Relevant and Appropriate Requirements (ARARs) are categorized as 1) contaminant-specific requirements that define acceptable exposure limits, as 2) location-specific requirements that may set restriction activities at a location, or as 3) action-specific requirements that may set controls or restrictions for a particular treatment or disposal activity for the proposed response. ARARs assist in the development and selection of reclamation remedies. The State of Montana has the authority, delegated by the U.S. Office of Surface Mining, Reclamation and Enforcement, to administer the Abandoned Mines Reclamation Program in accordance with the State of Montana's Reclamation Plan.

Applicable requirements address a specific hazardous substance, pollutant, or contaminant; remedial action; location; or other circumstances. Relevant and appropriate requirements address problems or situations sufficiently similar to those encountered at another site. The DEQ/MWCB has developed a summary of federal and state ARARs for reclamation projects that apply to the Forest Rose Mine Site. Table 4-1 presents a list of these ARARs and indicates whether the ARAR is likely to be applicable, possibly applicable, or not likely applicable to the reclamation project.

**Table 4-1. Applicable or relevant and appropriate requirements (ARARs), Forest Rose Mine Site.**

| ARARs | Citation | Description | ARAR Status |
|---|---|---|---|
| **Federal Contaminant-Specific ARARs** | | | |
| Safe Drinking Water Act | 42 USC 300f et seq. | Establishes maximum contaminant levels (MCL) for chemicals in drinking water | Relevant and Appropriate |
| Clean Water Act | 33 USC 1251 et seq. | Allows the State to promulgate water quality standards | Applicable |
| National Ambient Air Quality Standards | 40 CFR 50.6, 50.12 | Establishes standards for PM-10 and lead emissions to air | Applicable |
| **State Contaminant-Specific ARARs** | | | |
| Groundwater Protection | ARM 17.30 1005, 1006, 1011 | Classifies, assigns beneficial uses, and identifies standards for groundwater, including non-degradation requirements | Applicable |
| Montana Water Quality Act | ARM 17.30.637 | Limits water quality in discharges to surface water | Applicable |
| | 75-5-101, 303, 605, 705 MCA | Establishes requirements to protect, maintain and improve the quality of surface and groundwater | |
| Montana Ambient Air Quality Regulations | ARM 17.8, 206, 220, 221, 222, 223 | Establishes compliance monitoring requirements to meet ambient air quality standards, with limits for settled particulate matter, particulate matter in ambient air, lead emissions, and PM-10 concentrations | Applicable |
| **Federal Location-Specific ARARs** | | | |
| National Historic Preservation | 16 USC 470 et seq. | Requires assessment of reclamation on identified or eligible Register of Historic Places features | Applicable |
| Archaeological and Historic Preservation Act | 16 USC 469 et seq. | Requirements for evaluation and preservation of historical and archaeological data | Applicable |
| Historic Sites Act of 1935 | 16 USC 461 et seq. | Requires consideration of the existence and location of landmarks on the National Registry of National Landmarks and to avoid undesirable impacts | Applicable |
| Protection and Enhancement of the Cultural Environment | 16 USC 470 et seq. | Requires programs contribute to preservation and enhancement of non-federally owned historic resources | Applicable |

**Table 4-1 (continued). Applicable or relevant and appropriate requirements (ARARs), Forest Rose Mine Site.**

| ARARs | Citation | Description | ARAR Status |
|---|---|---|---|
| **Federal Location-Specific ARARs (continued)** | | | |
| The Archeological Resources Protection Act of 1979 | 16 USC 470 et seq. | Requires a permit for any excavation or removal of archeological resources from public lands or Indian lands | Relevant and Appropriate |
| American Indian Religious Freedom Act | 42 USC 1996 | Requires reclamation activities to consider and protect Indian religious freedom | Applicable |
| Native American Graves Protection and Repatriation Act | 25 USC 3001 et seq. | Prioritizes ownership or control over Native American cultural items | Applicable |
| Fish and Wildlife Coordination Act | 16 USC 661 et seq. | Modification of water bodies must provide for adequate protection of fish and wildlife resources | Applicable |
| Endangered Species Act | 16 USC 1531 | Reclamation activities may not jeopardize the continued existence of any threatened or endangered species | Applicable |
| Floodplain Management Act | Executive Order No. 11988 and 40 CFR ' 6.302(b) | Require avoidance or minimizing of adverse effects associated with development on a floodplain | Applicable |
| Protection of Wetlands Regulation | 40 CFR 6, Appendix A; Executive Order 11990 | Requires avoidance or mitigation of adverse impacts causing destruction or loss of wetlands | Applicable |
| Clean Water Act | 33 USC 1251 et seq. | Regulates discharge of dredged or fill materials into waters of the United States | Applicable |
| Migratory Bird Treaty Act | 16 USC 703 et seq. | Provides for protection of the international migratory bird resources | Applicable |
| Bald Eagle Protection Act | 16 USC 668 et seq. | Provides for protection of bald and golden eagles | Applicable |
| Resource Conservation and Recovery Act | 40 CFR ' 264.18 (a) and (b) | Provides seismic and floodplain restrictions on locating waste management units | Relevant and Appropriate |

**Table 4-1 (continued). Applicable or relevant and appropriate requirements (ARARs), Forest Rose Mine Site.**

| ARARs | Citation | Description | ARAR Status |
|---|---|---|---|
| **State Location-Specific ARARs** | | | |
| Montana Antiquities Act | 22-3-421et seq., MCA | Requires avoidance or mitigation of adverse impacts to heritage property or paleontological remains | Relevant and Appropriate |
| Montana Human Skeletal Remains and Burial Site Protection Act | 22-3-801 et seq., MCA | Prohibits purposefully or knowingly disturbing or destroying human skeletal remains or burial sites | Applicable |
| Montana Floodplain and Floodway Management Act | Section 76-5-101 et seq., MCA | Specifies types of uses and structures allowed or prohibited in designated 100-year floodways and floodplains | Applicable |
| Montana Stream Protection Requirements | 75-7-101 et seq., MCA | | Applicable |
| Montana Solid Waste Management Act | 75-10-201 et seq., MCA | Provides that solid waste management systems must<br>protect the public health and safety and conserve natural resources wherever possible | Applicable |
| Endangered Species and Wildlife Act | 87-5-106, 107 and 111 MCA | Lists endangered species, prohibited acts, and penalties | Applicable |
| **Action-Specific ARARs** | | | |
| **Federal and State Water Protection Requirements** | | | |
| Clean Water Act | 33 USC 1342 et seq. | Authorizes issuance of permits for discharge of pollutants | Applicable |
| Montana Pollutant Discharge Elimination System Requirements | ARM 17.30.1342-1344, 1203 and 1344 | Identifies substantive MPDES and NPDES permit requirements, including technology-based treatment | Applicable |
| Montana Water Quality Act and Regulations | 75-5-303, 605 MCA; ARM 17.30.637. 705, 1011 | Prohibits causing pollution of any state waters | Applicable |
| Stormwater Runoff Control Requirements | ARM 17.24.633, 17.30.1341 | Surface drainage from disturbed areas must be treated by the best technology currently available and requires compliance with the General Permit for Storm Water Discharge Associated with Construction Activity | Applicable |

**Table 4-1 (continued). Applicable or relevant and appropriate requirements (ARARs), Forest Rose Mine Site.**

| ARARs | Citation | Description | ARAR Status |
|---|---|---|---|
| **Action-Specific ARARs (continued)** | | | |
| **Federal and State RCRA Subtitle C Requirements** | | | |
| Repository Requirements | 42 USC 6921 et seq. and 40 CFR 264 | Guides management of hazardous wastes generated, placed, or disposed of after 1980 | Relevant and Appropriate |
| General Facility Standards and Closure Requirements | 40 CFR Part 264 Subpart F | Waste management unit management requirements | Relevant and Appropriate |
| **Federal and State RCRA Subtitle D and Solid Waste Management Requirements** | | | |
| Federal Requirements | 40 CFR 257 | Establishes criteria for classification of solid waste disposal facilities and practices | Applicable |
| State of Montana Solid Waste Requirements | 75-10-201 et seq., MCA | Controls management and disposal of solid wastes, including mine wastes at sites that are not currently subject to operating permit requirements | Applicable |
| **Federal and State Mine Reclamation Requirements** | | | |
| Surface Mining Control and Reclamation Act | 30 USC 1201-1326 | Establishes provisions to protect the environment from the effects of mining | Applicable |
| Montana Strip and Underground Mine Reclamation Act and Montana Metal Mining Act | 82-4-201, 231, 233, 031, 336 MCA<br>ARM 17.24.501, 519, 631, 633, 634, 637-641, 646, 702,703, 711, 713, 714, 716-718, 721, 723, 724, 726, 731, 751 | Establishes grading, drainage, erosion control, groundwater protection, revegetation, and fish & wildlife protection requirements | Relevant and Appropriate |
| **State Air Requirements** | | | |
| Montana Ambient Air Quality Regulations | ARM 17.8.304, 308, 604 | Requirements to ensure that existing air quality will not be adversely affected | Applicable |
| Montana Ambient Air Quality Regulations | ARM 17.24.761 | Requirements to ensure control of fugitive dust emissions | Relevant and Appropriate |

# 5.0 Risk Assessment Summary

Human Health and Ecological Risk Assessments were conducted as part of the Forest Rose Mine Site RI. The following summarizes findings of both assessments; detailed calculations and backup information can be found in the RI report (Herrera 2010).

## 5.1 Human Health Risk Assessment

### 5.1.1 Hazard Identification

Contaminants of Potential Concern (COPCs) for the Forest Rose Mine Site were determined by comparing each heavy metal identified at the site to criteria set by the Recreational Clean-up Guidelines for soil and water (Tables 7-10 and 7-11 in DEQ RBCG) and the Water Quality Standards set by DEQ (DEQ 1996, 2010).COPC determination also included screening EPA's Risk Assessment Guidance for Superfund (RAGS) (EPA 2004b). EPA criteria for COPCs include:

1. The contaminant is present at the site.
2. The contaminant has a concentration significantly above background levels (generally 3 times higher).
3. The measured concentration of the contaminant is at least 20 percent greater than the detection limit.
4. Analytical results have acceptable QA/QC results.

#### *5.1.1.1 Solid Matrix Samples*

Inorganic analytical results for solid matrix samples (soil, tailings, waste rock, and sediment) were compared to the aforementioned criteria and the listed cleanup guidelines for soils. Based on this comparison, 10 COPCs were identified (COPCs exceeding Table 7-10 Cleanup Guidelines from DEQ RBCG are in bold):

1. Antimony
2. **Arsenic**
3. **Cadmium**
4. Copper
5. Iron
6. **Lead**
7. **Manganese**
8. Mercury
9. Silver
10. Zinc

Arsenic, cadmium, lead, and manganese concentrations were greater than DEQ cleanup guidelines for recreational visitors.

#### *5.1.1.2 Water Matrix Samples*

Inorganic analytical results for Dunkleberg Creek water samples were compared to EPA criteria, the listed clean-up guidelines for water, and Montana water quality standards (adit discharge was not evaluated, per the DEQ Recreational Risk Assessment Spreadsheets for Abandoned Mine Sites). Eight COPCs were identified (COPCs exceeding Table 7-11 Clean-up Guidelines from DEQ RBCG are in bold):

1. Antimony
2. **Arsenic**
3. Barium
4. **Cadmium**
5. Copper
6. Lead
7. **Manganese**
8. **Zinc**

None of these COPCs exceeded the Human Health Standard for Surface Water, Circular DEQ-7, or "Montana Numeric Water Quality Standards" (DEQ 2010); however, cadmium, lead, and zinc exceed the Chronic Aquatic Life Standard and cadmium and zinc exceed the Acute Aquatic Life Standard. Arsenic, cadmium, manganese, and zinc concentrations were greater than DEQ clean-up guidelines for recreational visitors for water.

#### *5.1.1.3 Exposure Assessment*

The exposure assessment identifies potential human receptors, exposure routes through which receptors may come into contact with COPCs, and the parameters used to quantify exposure to COPCs identified in the previous section.

The gold panner/rock hound was selected as the primary exposure scenario for recreational use at the Forest Rose Mine Site. Because Dunkleberg Creek is a tributary to the Clark Fork River, fish consumption was also considered. The DEQ RBCG (DEQ 1996) does not list angler use for Dunkleberg Creek, but does list 16,120 angler days for the Clark Fork River. There are also a few residences and cabins along Dunkleberg Creek, downstream of the mine site.

Although hunting and all-terrain vehicle recreational use may be plausible at the Forest Rose Mine Site, the gold panner/ rock hound scenario was chosen because it is the most conservative scenario in the DEQ RBCG (DEQ 1996) and most protective of human health. Additional exposures analyzed produce a more conservative risk assessment and incorporates possible exposure pathways for a recreational fisherman through fish consumption (the only exposure not considered in the gold panner/rock hound scenario). Inhalation exposure was determined using solid matrix concentrations (mg/kg) in samples collected from the site, with the exposure calculation modified for particulate inhalation (air monitoring data were not collected). The exposure routes and associated exposure parameters used in the risk assessment include:

- Incidental soil ingestion (gold panner/rock hound – adult and child)
- Dermal exposure to soil (gold panner/rock hound – adult and child)
- Inhalation of particulate matter (gold panner/rock hound – adult and child)
- Incidental water ingestion (gold panner/rock hound – adult and child)
- Dermal contact with water (gold panner/rock hound – adult and child)
- Incidental sediment ingestion (gold panner/rock hound – adult and child)
- Fish ingestion (fisherman – adult)

Conservative exposure parameters were used in this risk assessment, due to the presence of residences and cabins downstream of the mine site. This decision was also based on the fact that Dunkleberg Creek is a tributary to the Clark Fork River and has the potential to provide trout habitat. Therefore, the conservative fish consumption exposure pathway option listed in the DEQ RBCG (DEQ 1996) of 42 meals per year was used in the exposure calculations. For the gold panner/rock hound scenario, the exposure frequency of 50 days per year was used in the associated exposure calculations (DEQ 1996).

It is recommended in both EPA RAGS (2004b) and the DEQ RBCG (DEQ 1996) guidance to utilize the 95 percent upper confidence limit (UCL) of the mean for each COPC exposure point concentration within a medium; however, if this statistic cannot be calculated based on sample size, the maximum COPC concentration found at the site should be used. A total of 24 solid matrix samples were collected from the site, including 9 soil, 5 waste rock, and 10 tailings samples; however, only 3 surface water and 1 adit discharge samples were collected. To be consistent among media (solids and water), maximum concentrations for each COPC were used as exposure point concentrations (EPCs) in the exposure calculations (Table 5-1). In addition, the higher sediment concentration of the two samples collected was used as the ECP in the associated exposure calculations. There are some uncertainties associated with using the maximum concentration versus the 95 percent UCL, which are outlined later within this risk assessment.

Guidance for COPC exposure calculations and exposure pathways, and exposure parameters used in the calculations, was obtained from Figure 4-2 in the DEQ RBCG (DEQ 1996).

Exposures for the Estimated Lifetime Cancer Risk (ELCR) incorporates a lifetime exposure duration of 70 years to obtain the lifetime exposure for the given exposure pathway. Guidance for these calculations was provided in DEQ RBCG (DEQ 1996).

#### *5.1.1.4 Toxicity Assessment*

Chronic oral reference dose (RfD) values obtained from EPA's Integrated Risk Information System (IRIS) for antimony, arsenic, barium, cadmium, iron, manganese, silver, and zinc were used as toxic thresholds in this risk assessment. Cadmium has specific RfD values for food (solids and fish) versus water, which were used accordingly in the Hazard Quotient (HQ) calculations. The chronic oral RfD for a specific substance is determined using the equation:

$$\text{RfD} = \text{NOAEL} \div (\text{UF} \times \text{MF})$$

Where: NOAEL is the no observed adverse effects level

UF is the uncertainty factor, ranging from 1 to 1,000

MF is the modifying factor, determined by EPA professional judgment (EPA 1993).

**Table 5-1. Maximum exposure point concentrations (EPCs) for each media used in exposure calculations, Forest Rose Mine Site.**

| COPCs | Solids [a] (mg/kg) | Water [b] (µg/L) | Sediment (mg/kg) |
|---|---|---|---|
| Antimony | 47.6 | 1.10 | 1.20 |
| Arsenic | 486.0 | 0.59 | 24.30 |
| Barium | NA | 20.50 | NA |
| Cadmium | 75.9 | 6.10 | 6.60 |
| Copper | 728.0 | 1.70 | 69.00 |
| Iron | 164,000.0 | NA | 37,100.00 |
| Lead | 7,850.0 | 10.20 | 448.00 |
| Manganese | 4,170.0 | 21.50 | 796.00 |
| Mercury | 0.9 | NA | 0.02 |
| Silver | 30.7 | NA | 1.10 |
| Zinc | 8,130.0 | 1,360.00 | 1,160.00 |

[a] Solids include soils, tailings, and waste rock

[b] Water includes surface water and adit discharge

NA indicates that that chemical is not a COPC for the specific medium

For copper, the oral RfD was obtained from EPA's Health Effects Assessment Summary Tables (HEAST) (EPA 1997a). The RfD and inhalation reference concentration (RfC) for lead were obtained by back-calculation methods from DEQ RBCG (DEQ 1996). Chronic inhalation RfC values were obtained from IRIS for manganese and mercury. The RfC for barium was obtained from HEAST (EPA 1997a).

Dermal toxic thresholds were calculated using oral RfD values for each COPC using the Gastrointestinal Absorption percentages (GI ABS %) obtained from RAGS Part E, Exhibit 4-1 (EPA 2004b). The following equation was used to determine the dermal RfD:

$$\text{Dermal RfD} = \text{Oral RfD} \times \text{GI ABS \%}$$

When no GI ABS % was available, the oral RfD was extrapolated to the Dermal RfD. GI ABS % were available for antimony, barium, cadmium, manganese, and silver.

Cancer Slope Factor (SF) values were obtained from (IRIS) for arsenic (oral) and cadmium (inhalation).

### 5.1.2 Risk Characterization

Risk characterization combines exposure and toxicity evaluations to calculate quantitative carcinogenic risk and non-carcinogenic hazards for the exposure scenario. The following sections detail the quantitative human health risk assessment.

#### *5.1.2.1 Risk Calculations*

A Hazard Quotient (HQ) was calculated to compare exposure to toxic thresholds (oral or dermal RfD or RfC) for each COPC and exposure route. This HQ helps quantify non-carcinogenic human health hazards for each COPC present onsite. The equation used was:

$$HQ = \text{Exposure} \div \text{Toxic Threshold Value}$$

A HQ greater than 1.0 indicates an exposure value higher than the given threshold value and that the COPC is a COC for the Forest Rose Mine Site. The EPA HQ benchmark of 1.0 has been established to protect human health from these contaminants. An HQ greater than 1.0 indicates the need for an exposure reduction. HQs for adult and child receptors were calculated for each COPC within each media (solids, sediment, and water), with an exposure duration of 30 years for the gold panner/rock hound recreational scenario (adult exposure duration of 24 years and child exposure duration of 6 years). A HQ for adult fish consumption was also calculated by comparing fish ingestion exposure to the oral RfD.

HQs were summed across exposures (oral, dermal, and inhalation) for each COPC within each media (solids, water, sediments, and fish). The HQs for each COPC were then combined for an overall COPC HQ. The Total HQ represents the Total Hazard Quotient among all COPC present in solids, sediment, water, and fish for an adult (Table 5-2) and child (Table 5-3). The relative contribution of each individual COPC HQ to the Total HQ is also calculated to determine which COPCs are of greater concern.

Carcinogenic risk was calculated for arsenic and cadmium using the following equation:

$$ELCR = \text{Slope Factor} \times \text{Lifetime Exposure}$$

Carcinogenic exposures for arsenic and cadmium were calculated in the same manner as the non-carcinogenic exposure, except the Average Time for pathway-specific exposure period was adjusted to 365 days for 70 years (lifetime).

EPA considers an ELCR greater than 1.0E-06 as unacceptable (EPA 2004b). This benchmark indicates that one person in a population of 1,000,000 will be at risk for developing cancer from the given COPC. ELCRs were determined for both adult and child, and then exposures were combined for a true lifetime estimated cancer risk.

Combined adult and child ELCRs for each COPC within each media are summed across exposure pathways for a total media ELCR and then combined for a total COPC ELCR are provided in Table 5-4.

## Table 5-2. Adult non-carcinogenic hazard summary, Forest Rose Mine Site.

| COPC | Tailings/Waste Rock/Soil HQ | Surface and Adit Water HQ | Sediment HQ | Fish Consumption HQ [a] | Combined HQ [b] | Percent Contribution |
|---|---|---|---|---|---|---|
| Antimony | 1.46E-01 | 5.92E-03 | 1.41E-03 | 2.97E-04 | 0.15 | 2.93% |
| **Arsenic** | **1.31E+00** | 3.91E-03 | 3.80E-02 | 1.61E-02 | **1.37** | **26.17%** |
| Barium | NA | 2.44E-04 | NA | NA[d] | 0.0002 | 0.00% |
| Cadmium | 7.01E-02 | 3.10E-02 | 3.10E-03 | 1.08E-02 | 0.12 | 2.20% |
| Copper | 1.06E-02 | 8.44E-05 | 8.10E-04 | 1.58E-03 | 0.01 | 0.25% |
| Iron | 1.37E-01 | NA | 2.49E-02 | NA | 0.16 | 3.08% |
| **Lead** | **3.05E+00** | 1.35E-02 | 1.40E-01 | 6.19E-02 | **3.27** | **62.40%** |
| Manganese | 9.88E-02 | 4.13E-04 | 2.67E-03 | 1.37E-03 | 0.10 | 1.97% |
| Mercury | 1.75E-03 | NA | 3.13E-05 | NA | 0.002 | 0.03% |
| Silver | 2.03E-02 | NA | 1.03E-04 | NA | 0.02 | 0.39% |
| Zinc | 1.58E-02 | 8.95E-03 | 1.82E-03 | 2.67E-03 | 0.03 | 0.56% |
| **TOTAL HQ** | | | | | **5.24** | |

[a] The more conservative exposure frequency of 42 meals per year was used in the fisherman exposure scenario for this exposure pathway
[b] The sum of all exposure routes at Forest Rose Mine Site for each COPC and values over 1
[c] Percentage of each COPC HQ of the Total HQ
[d] No available Bioconcentration Factor for Barium for fish ingestion exposure calculation
**Bold** indicates Contaminant of Concern (COC) for Forest Rose Mine Site
NA indicates that the chemical is not a COPC for the associated media

## Table 5-3. Child non-carcinogenic hazard summary, Forest Rose Mine Site.

| COPC | Tailings/Waste Rock/Soil HQ | Surface and Adit Water HQ | Sediment HQ | Combined HQ [a] | Percent Contribution [b] |
|---|---|---|---|---|---|
| Antimony | 2.39E-01 | 2.59E-02 | 2.74E-03 | 0.27 | 2.83% |
| **Arsenic** | **2.28E+00** | 1.80E-02 | 7.40E-02 | **2.37** | **25.09%** |
| Barium | NA | 9.96E-04 | NA[c] | 0.001 | 0.01% |
| Cadmium | 1.19E-01 | 1.21E-01 | 6.03E-03 | 0.25 | 2.61% |
| Copper | 1.96E-02 | 3.90E-04 | 1.58E-03 | 0.02 | 0.23% |
| Iron | 2.52E-01 | NA | 4.84E-02 | 0.30 | 3.18% |
| **Lead** | **5.64E+00** | 6.24E-02 | 2.73E-01 | **5.97** | **63.23%** |
| Manganese | 1.51E-01 | 1.56E-03 | 5.19E-03 | 0.16 | 1.67% |
| Mercury | 3.23E-03 | NA | 6.09E-05 | 0.003 | 0.03% |
| Silver | 3.08E-02 | NA | 2.01E-04 | 0.03 | 0.33% |
| Zinc | 2.92E-02 | 4.15E-02 | 3.53E-03 | 0.07 | 0.79% |
| **TOTAL HQ** | | | | **9.45** | |

[a] The sum of all exposure routes at Forest Rose Mine Site for each COPC
[b] Percentage of each COPC HQ of the Total HQ
NA indicates that the chemical is not a COPC for the associated media
**Bold** indicates Contaminant of Concern (COC) for Forest Rose Mine Site

**Table 5-4. Combined adult and child carcinogenic risk summary, Forest Rose Mine Site.**

| Carcinogen COPC | Tailings / Waste Rock / Soil ELCR [a] | Surface and Adit Water ELCR [a] | Sediment ELCR [a] | Fish Consumption ELCR [b] | Combined ELCR [c] | Percentage of ELCR [d] |
|---|---|---|---|---|---|---|
| **Arsenic** | **3.47E-04** | **1.30E-06** | **8.72E-06** | **3.10E-06** | **3.61E-04** | **100.00%** |
| Cadmium | 1.07E-08 | NA | NA | NA | 1.07E-08 | 0.00% |
| **TOTAL ELCR** | | | | | **3.61E-04** | |

[a] Combined adult and child estimated lifetime cancer risk across all specific media exposure pathways
[b] Adult exposure only used in the fish ingestion ELCR
[c] The sum of all exposure pathways for each COPC
[d] Percentage of the Total ELCR at Forest Rose Mine Site
NA indicates inhalation route not appropriate for associated media
**Bold** indicates carcinogenic Contaminant of Concern (COC)

**The non-carcinogen COCs for the Forest Rose Mine Site are arsenic and lead for both the adult and child recreational gold panner/rock hound scenarios**. The overall adult arsenic combined HQ was 1.37 and the overall child arsenic combined HQ was 2.37, contributing 26 percent and 25 percent of the Total HQs, respectively. The overall adult lead combined HQ was 3.27 and the overall child lead combined HQ was 5.97, contributing 62 percent and 63 percent of the Total HQs, respectively. The Total Adult HQ for all COPCs was 5.24 and the Total Child HQ for all COPCs was 9.45. The majority of the arsenic and lead exposure results from ingestion, contact with, or inhalation of tailings, waste rock, and soil.

**Arsenic is the only carcinogen COC for the Forest Rose Mine Site** with an ELCR of 3.61E-04 through all exposure routes for a recreationalist at the Forest Rose Mine Site. This indicates an estimated three to four persons in every 10,000 would be at risk for developing cancer from arsenic exposure through recreational activities at the site.

#### *5.1.2.2 Risk-Based Clean-up Goals*

The risk-based clean-up goals for the Forest Rose Mine Site are derived from Tables 7-10 and 7-11 in the DEQ RCBG (DEQ 1996). The cleanup guidelines for arsenic in soil are 0.7 mg/kg and 0.06 µg/L in surface water. The mean background soil concentration is 25 times the soil cleanup guideline level, indicating a relatively high naturally occurring level of arsenic in the vicinity. DEQ RBCG allows for use of the background soil UCL concentration as an alternative cleanup concentration (DEQ 1996). Similarly, the upstream water sample arsenic level is 11 times greater than the water cleanup guideline level. The DEQ RBCG document states that health protective levels may be assumed if the maximum contaminant level (MCL) for arsenic is set as the water reclamation goal. The background samples for lead are not higher than the RBCG; therefore, the RBCG shall be used for lead. Using the aforementioned information for arsenic and lead, Table 5-5 summarizes the cleanup guidelines for arsenic and lead.

**Table 5-5. Risk-based clean-up guidelines for recreational users, Forest Rose Mine Site.**

| COC | Soil Cleanup Guideline (mg/kg) | Surface Water Cleanup Guideline (µg/L) |
|---|---|---|
| Arsenic | 44[a] | 10[b] |
| Lead | 1,100 | 47.1 |

[a] UCL = 95th Upper confidence limit on the mean concentration
[b] MCL = State of Montana drinking water standard, maximum contaminant level (August 2010)

#### *5.1.2.3 Uncertainty Assessment*

Uncertainty in this human health risk assessment is potentially associated with the use of maximum concentrations in a given media, based on the small number of water samples collected. RAGS (EPA 2004b) and DEQ RBCG (DEQ 1996) guidance documents recommend using the 95 percent UCL of the mean for each medium analyzed in a site-specific risk assessment. EPA indicates that using the maximum concentration can result in an over-estimate of the human health recreational risk. A conservative approach was used in this case to account for recreational users at and below the mine site and to address water flowing into the Clark Fork River. Uncertainty also can be attributed to the dermal toxic thresholds extrapolated from the oral RfD, as this is not an accurate representation of the exposure route; however, this represents the best available option for calculating risk.

In addition, back calculations are not a reliable method for determining toxic thresholds for lead, as the concentration of lead considered to be "safe" has not yet been determined (EPA 2004a).

There is also uncertainty associated with inhalation exposures calculated that rely on soil concentrations instead of air particulate concentrations (no air monitoring was performed).

#### *5.1.2.3 Risk Characterization Summary*

The risk assessment identified Total HQs of 5.2 for adults and 9.5 for children, indicating the potential for adverse health effects among recreational users at the Forest Rose Mine Site. **COCs are arsenic and lead present in tailings and waste rock of the mine workings.** Arsenic is a carcinogenic COC associated with all exposure pathways and media analyzed in this risk assessment for recreational users exposed to soil, tailings, waste rock, surface waters, sediment, and fish**. Reclamation should focus on removing arsenic from human exposure pathways associated with soil, tailings, waste rock, sediment, and surface waters, as well as removing lead from exposure pathways associated with soil, tailings, and waste rock**.

## 5.2 Ecological Risk Assessment

The ecological risk assessment identified contaminants of concern and presented estimated risks to ecological receptors associated with aquatic life, terrestrial plant, and terrestrial wildlife communities. Of particular note, the Westslope Cutthroat Trout (*Oncorhynchus Clarkii Lewisi*) found in Dunkleberg Creek, is a Montana Fish of Special Concern (Westslope Cutthroat Trout is the Montana State Fish).

The assessment is classified as Step 2 in the guidance document Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA 1989). This is a preliminary, qualitative screening-level ecological risk assessment providing:

> "…exposure estimates based on conservative assumptions and maximum concentrations present; and hazard quotients indicating which (if any) contaminants and exposure pathways might pose ecological threats."

Cleanup decisions should not be solely based on a screening-level ecological risk assessment, but rather in combination with conclusions from the human health risk assessment and other supporting factors.

### 5.2.1 Hazard Identification for Ecological Effects and Habitats

The same human health risk COPCs are evaluated for threats to ecological receptors in this risk assessment, including:

- Soil – antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, silver, and zinc

- Water – antimony, arsenic, barium, cadmium, copper, lead, manganese, and zinc

In addition, aluminum and nickel were also evaluated for ecological risk. Of these COPCs, none exceed the DEQ Circular-7 Water Quality Human Health Standards for surface water. Aquatic Life Standards from DEQ are adjusted for water hardness before comparing concentrations.

#### *5.2.1.1 Ecological Receptors of Concern*

Three communities classified as ecological receptors of concern in this risk assessment include:

- Terrestrial plant
- Terrestrial wildlife
- Aquatic life

The Forest Rose Mine Site covers an area of approximately 4 acres. Native forest land surrounds the disturbed mine site. Little vegetation grows on the tailings and waste rock, likely due to the physical and chemical properties such as pH, metals concentrations, texture, and lack of soil nutrients and beneficial organisms. The terrestrial plant community is one of the ecological receptors of concern evaluated in this ecological risk assessment.

The mine site provides habitat for several species of terrestrial wildlife. Wildlife are exposed to metals through consumption of soil, salt precipitates, surface water, and adit drainage. Whitetail deer will represent the terrestrial wildlife community as an ecological receptor of concern evaluated in this risk assessment.

Both Brown trout and Westslope Cutthroat trout have been identified in Dunkleberg Creek, which flows through the mine site and is a tributary to the Clark Fork River. This creek provides habitat to these and other ecological receptors. Tailings, waste rock, and soils from surrounding areas, and adit discharge provide input to the creek. The aquatic life community is evaluated as an ecological receptor in this risk assessment.

### 5.2.2 Exposure Assessment

Exposures to COPCs present at the Forest Rose Mine site are determined for each scenario through the processes described below. The maximum surface concentration for each COPC (listed above) from solid matrix samples were used as the EPC for the associated solid exposure pathways. The maximum surface water concentration for each COPC was used as the EPC for the associated water exposure pathways. Adit discharge COPC concentrations were incorporated as specified in the individual scenario. The maximum COPC concentrations used in the exposure calculations are listed in Table 5-1.

Three ecological scenarios were used in this risk assessment, each to evaluate the three ecological receptor communities identified previously for the site.

#### *5.2.2.1 Exposures for Aquatic Life Communities*

This scenario evaluates the threat to fish and other aquatic life health from COPCs in Dunkleberg Creek water and sediment. Adit discharge flows into the creek, but was not included as a possible exposure route for aquatic life, as it is not considered suitable habitat. Maximum creek water and sediment concentrations for each COPC were used to evaluate the two exposure pathways, respectively.

#### *5.2.2.2 Exposures for Terrestrial Wildlife Communities*

This scenario evaluates the threat to wildlife health from COPCs for those species that include the Forest Rose Mine Site as part of their home range. Whitetail deer was chosen to represent the ecological receptor for the terrestrial wildlife community because of the availability of the exposure parameters and toxic thresholds in toxicology literature. It was assumed that deer using the site as part of their home range would be exposed to contaminants at the site through ingesting surface waters and soil or salt precipitates from tailings, waste rock, or exposed soil. Exposure through vegetation consumption was not considered based on of the lack of vegetation growing on disturbed portions of the mine. Dermal or inhalation exposures were not considered, due to lack of exposure data.

Exposure parameters for whitetail deer were taken from Estimating Exposure of Terrestrial Wildlife to Contaminants (Sample et al. 1994). Conservative estimates for body weight, soil consumption rate, water intake rate, and home range for a representative whitetail deer were used in the exposure calculations per the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA 1989) for screening-level ecological risk assessments. It was assumed that a whitetail deer's body weight (BW) is 68.0 kg (a male deer) (Sample et al. 1994). The following equation from Sample and Suter II (1996) was used to determine a water ingestion rate (WIR):

$$WIR = 0.099(BW)^{0.90}$$

The resulting WIR is 4.41 liters per day (L/d). A soil consumption rate (SCR) was assumed based on the estimated soil in the diet of whitetail deer (<2 percent) (Beyer et al. 1994), resulting in a SCR of 0.0348 kilogram soil per day (kg/day).

The maximum concentration for each COPC from surface water and adit discharge was used in the following exposure calculation for water ingestion:

$$E_{water} = (WIR * [C_{COPC}*(1/1000)]) / BW$$

The maximum concentration for each COPC from surface of tailings, waste rock, and soils was used in the following exposure calculation for soil consumption:

$$E_{soil} = (SCR * C_{COPC}) / BW$$

The 4-acre impacted area (A) of the mine site is incorporated into the equation relative to the home range (HR) reported for a whitetail deer of 59 hectares (~146 acres) as the most conservative estimate (Sample et al. 1994). The exposure results for both exposure pathways for each COPC were added and then multiplied by the area ratio, based on the following equation:

$$ECOPC = (A/HR) \left[ \sum_{i=1}^{m} \left( \frac{(IR * C)}{BW} \right) \right]$$

### *5.2.2.3 Exposures for Terrestrial Plant Communities*

This scenario evaluates threats to the health of terrestrial plants within the Forest Rose Mine Site, and investigates soil chemistry related to the lack of vegetation on disturbed areas and possible phytotoxic effects to plants. The exposure pathway to terrestrial plant communities is through root-to-soil contact and the resulting uptake of COPCs. Maximum COPC concentrations from surface soil, tailings, and waste rock were used as representative concentrations a plant or seed would be exposed to at the site.

### 5.2.3 Ecological Effects Assessment

#### *5.2.3.1 Toxic Thresholds for Aquatic Life Communities*

Water quality aquatic life standards from Circular DEQ-7 were used as toxic thresholds for the aquatic life community scenario water exposure pathway. The standards for cadmium, copper, lead, nickel, silver, and zinc were first adjusted for water hardness measured in Dunkleberg Creek (170 mg/L) using the equations given in Circular DEQ-7 before they were used in the risk assessment. Sediment quality guidelines developed by the National Oceanographic and Atmospheric Administration were used for toxic thresholds for the aquatic life community scenario's sediment exposure pathway (NOAA 1999). Toxic thresholds for both water and sediment are provided in Table 5-6.

**Table 5-6. Aquatic life community risk characterization for COPCs, Forest Rose Mine Site.**

| COPCs | Max. Surface Water Conc. (µg/L) [a] | Max. Sediment Conc. (mg/kg) | Acute Standards (µg/L) [b] | Chronic Standards (µg/L) [b] | Sediment Quality Guidelines (mg/kg) [c] | Acute Aquatic EQ | Chronic Aquatic EQ | Sediment EQ |
|---|---|---|---|---|---|---|---|---|
| Aluminum | 15.3 | NA | 750.0 | 87.0 | NA | 0.02 | 0.18 | NA |
| Antimony | 0.64 | 1.2 | NA | NA | NA | NA | NA | NA |
| **Arsenic** | 0.59 | 24.3 | 340.0 | 150.0 | 8.2 | 0.00 | 0.00 | **3.0** |
| **Cadmium** [d] | 0.72 | 6.6 | 3.7 | 0.4 | 1.2 | 0.19 | 1.80 | **5.5** |
| **Copper** [d] | 1.7 | 69 | 23.1 | 14.7 | 34.0 | 0.07 | 0.12 | **2.0** |
| Iron | 93.5 | 37100 | NA | 1000.0 | NA | NA | 0.09 | NA |
| **Lead** [d] | 10.2 | 448 | 160.4 | 6.3 | 46.7 | 0.06 | 1.63 | **9.6** |
| Manganese | 21.5 | 796 | NA | NA | NA | NA | NA | NA |
| Mercury | NA | 0.02 | 1.7 | 0.9 | 0.2 | NA | NA | 0.2 |
| **Nickel** [d] | NA | 41.1 | 145.2 | 16.1 | 20.9 | NA | NA | **2.0** |
| **Silver** [d] | NA | 1.1 | 0.4 | NA | 1.0 | NA | NA | **1.1** |
| **Zinc** [d] | 91.7 | 1160 | 187.8 | 187.8 | 150.0 | 0.49 | 0.49 | **7.7** |
| **TOTAL** | | | | | | **0.834** | **4.303** | **31.030** |

[a] Maximum surface water concentration excluding adit discharge
[b] Aquatic Life Standards are from Circular DEQ-7 Montana Numeric Water Quality Standards (WQB-7), 2010
[c] Sediment Quality Guidelines from NOAA (1999); Most conservative range (Low) due to presence of Westslope Cutthroat Trout
[d] Aquatic Life Standards are adjusted for the hardness value of 170 mg/L as measured in Dunkleberg Creek.
NA indicates not available because either not detected in samples or no standard/criteria are available
**Bold** indicates COCs for aquatic life communities

#### *5.2.3.2 Toxic Thresholds for Terrestrial Wildlife Communities*

COPC NOAELs for whitetail deer were used as toxic thresholds for the terrestrial wildlife community scenario (Sample et al. 1996). These NOAELs were adjusted from toxicological studies with rats. Toxic thresholds for deer ingestion are provided in Table 5-7.

**Table 5-7. Terrestrial wildlife community risk characterization for COPCs, Forest Rose Mine Site.**

| COPCs | Max. Water Conc. (µg/L)[a] | Max. Solid Conc. (mg/kg)[b] | Deer Intake (mg/kg-day)[c] | NOAELs or Toxic Thresholds (mg/kg-day)[d] | Deer Ingestion EQ | Toxic Endpoint Source |
|---|---|---|---|---|---|---|
| Aluminum | 15.6 | NA | 0.001 | 0.294 | 0.003 | Sample et al. 1996 |
| Antimony | 1.1 | 47.6 | 0.001 | 0.019 | 0.039 | Sample et al. 1996 |
| Arsenic | 0.68 | | 0.007 | 0.019 | 0.361 | Sample et al. 1996 |
| Cadmium | 6.1 | 75.9 | 0.001 | 0.271 | 0.005 | Sample et al. 1996 |
| Chromium | NA | 27.8 | 0.000 | 768 | 0.000 | Sample et al. 1996 |
| Copper | 1.7 | 728 | 0.010 | 4.3 | 0.002 | Sample et al. 1996 |
| **Lead** | 10.2 | 9500 | 0.134 | 0.005 | **26.772** | ATSDR 1993 |
| Manganese | 21.5 | 4170 | 0.060 | 25 | 0.002 | Sample et al .1996 |
| Mercury | NA | 0.9 | 0.000 | 0.36 | 0.000 | Sample et al. 1996 |
| Nickel | 2.1 | 37.1 | 0.001 | 11.22 | 0.000 | Sample et al. 1996 |
| Zinc | 1360 | 8130 | 0.202 | 44.9 | 0.005 | Sample et al. 1996 |
| **TOTAL** | | | | | **27.194** | |

[a] Maximum surface water concentrations including adit discharge
[b] Maximum concentrations from soil, tailings, waste rock surface samples
[c] Soil and water exposure; exposure Parameters were obtained from Sample and Suter II (1994)
[d] The most recent and most conservative estimated NOAELs are used for toxic threshold values
NA indicates not available because not detected in samples
**Bold** indicates COCs for terrestrial wildlife communities

#### *5.2.3.3 Toxic Thresholds for Terrestrial Plant Communities*

Literature-based phytotoxicity soil concentrations from several terrestrial plant toxicology studies were used as toxic thresholds for the terrestrial plants scenario. These concentrations are the most conservative estimates from a range of toxic reference values (TRVs) related to plant health acquired from these studies. The phytotoxic concentrations used in this risk assessment were summarized in the Clark Fork River Ecological Risk Assessment (ISSI Consulting Group 1999). The individual sources and associated phytotoxic concentrations used are provided in Table 5-8.

### 5.2.4 Risk Characterization

#### *5.2.4.1 Aquatic Life Communities*

Water exposure concentrations were compared to both acute and chronic life standards to create a ratio of exposure-to-aquatic life standard for each COPC. This represents the ecological impact quotient (EQ) for aquatic life to contaminants in surface waters. Because long-term water quality sampling was not part of this investigation, only the acute EQ is incorporated into the Total EQ.

Sediment exposure concentrations were compared to toxic thresholds to create a ratio of exposure to sediment quality guidelines for each COPC. This represents the sediment EQ for aquatic life to contaminants in surface water sediments. A water or sediment EQ greater than 1 for a specific COPC indicates a condition that possibly threatens the health of aquatic life. Table 5-6 provides acute aquatic life and sediment EQs for each COPC.

**Table 5-8. Terrestrial plant community risk characterization COPCs at Forest Rose Mine Site.**

| COPCs | Max. Solid Conc. (mg/kg)[a] | Phytotoxic Soil Conc. (mg/kg)[b] | Phytotoxicity EQ | Toxic Threshold Source |
|---|---|---|---|---|
| **Arsenic** | 486 | 10 | **48.6** | Efroymson et al. 1997 |
| **Cadmium** | 75.9 | 3 | **25.3** | Kabata-Pendias and Pendias 1992 |
| **Copper** | 728 | 60 | **12.1** | Kabata-Pendias and Pendias 1992 |
| **Lead** | 9500 | 50 | **190.0** | Efroymson et al. 1997 |
| Mercury | 0.9 | 5 | 0.2 | CH2M Hill 1987 |
| **Zinc** | 8130 | 50 | **162.6** | Efroymson et al. 1997 |
| **TOTAL** | | | **438.8** | |

[a] Maximum concentrations from soil, tailings, waste rock surface samples

[b] Most conservative estimated toxic reference value for phytotoxicity from several toxicology studies

**Bold** indicates COCs for terrestrial plant communities

**COCs for aquatic life communities at the Forest Rose Mine Site include arsenic, cadmium, copper, lead, nickel, silver, and zinc**. All of these COCs originate through exposure to sediments present in Dunkleberg Creek. Contaminants in these sediments originate from erosion of mine tailings and waste rock.

### *5.2.4.2 Terrestrial Wildlife Communities*

Whitetail deer exposures from soil and water ingestion were summed for each COPC and then compared to toxic thresholds to create a ratio of COPC exposure to NOAEL. This ratio represents the deer ingestion EQ for terrestrial wildlife to contaminants in surface waters, soil, tailings, and waste rock at the site. An EQ greater than 1 for a specific COPC indicates an environmental concentration that possibly threatens the health of terrestrial wildlife. Table 5-7 provides the resulting deer ingestion EQs for each COPC.

**Lead is the only COC for terrestrial wildlife communities at the Forest Rose Mine Site**, with an EQ of 26.8.

### *5.2.4.3 Terrestrial Plant Communities*

Terrestrial plant exposures were compared to TRVs to obtain a ratio of the exposure to phytotoxic threshold for each COPC. The resulting ratio represents the phytotoxic EQ. An EQ greater than 1 for a specific COPC indicates an environmental concentration that inhibits growth and/or is phytotoxic to the terrestrial plant community. Table 5-8 provides the resulting phytotoxic EQs for each COPC.

**COCs for terrestrial plant communities at the Forest Rose Mine Site include arsenic, cadmium, copper, lead, and zinc**, all resulting from contaminants in soil, tailings, and waste rock. These COCs are inhibiting vegetation growth on the impacted areas at Forest Rose Mine Site.

#### *5.2.4.4 Risk Characterization Summary*

All EQs from the evaluated scenarios in this risk assessment are summarized in Table 5-9. The COPC EQ is the sum of all of the ecological impact quotients across all ecological receptors and exposure pathways for that contaminant. The Total EQ represents the total ecological impact quotient across all contaminants present at the Forest Rose Mine Site.

**Table 5-9. Summary of all EQs for all ecological receptors, exposure pathways, and COPCs, Forest Rose Mine Site.**

| COPCs | Aquatic Life-Surface Water (Acute) EQ | Aquatic Life-Sediment EQ | Deer Ingestion EQ | Plant Phytotoxicity EQ | COPC EQ |
|---|---|---|---|---|---|
| Aluminum | 0.020 | NA | 0.003 | NA | 0.024 |
| Antimony | NA | NA | 0.039 | NA | 0.039 |
| **Arsenic** | 0.002 | **2.96** | 0.361 | **48.6** | **51.926** |
| **Cadmium** | 0.197 | **5.50** | 0.005 | **25.3** | **31.002** |
| **Copper** | 0.074 | **2.03** | 0.002 | **12.1** | **14.239** |
| Iron | NA | NA | NA | NA | NA |
| **Lead** | 0.064 | **9.59** | **26.772** | **190.0** | **226.429** |
| Manganese | NA | NA | 0.002 | NA | 0.002 |
| Mercury | NA | 0.15 | 0.000 | 0.2 | 0.333 |
| **Nickel** | NA | **1.97** | 0.000 | NA | **1.967** |
| **Silver** | NA | **1.10** | NA | NA | **1.100** |
| **Zinc** | 0.488 | **7.73** | 0.005 | **162.6** | **170.826** |
| **TOTAL EQ** | 0.844 | 31.41 | 27.194 | 438.8 | **497.891** |

**Bold** indicates EQs greater than 1.0 and are considered COCs

This risk assessment qualitatively presents potential threats to the health of terrestrial plants and wildlife, as well as aquatic life communities, that may use Forest Rose Mine Site for habitat. This ecological risk assessment is a conservative screening-level assessment and provides conservative EQs. Results indicate several contaminants present at the site threaten the health of its ecosystem.

## 5.3 Site Hazards Summary

### 5.3.1 Chemical Hazards

A total of 33 solid matrix samples were collected from the Forest Rose Mine Site and proposed repository. Sample locations were selected to represent downstream sediment, tailings, waste rock, area-wide soils surrounding the active mine area, and upstream sediment. Additional sample locations were selected to characterize background conditions and conditions at the repository.

The human health risk assessment indicates that tailings and waste rock exceed an HQ of 1 for arsenic and lead, identifying them as COCs. Additionally, the Estimated Lifetime Cancer Risk for arsenic exceeds EPA guidelines in all human exposure pathways.

Contaminants present in Dunkleberg Creek sediments pose a significant risk (EQs greater than 1) to the health of aquatic life (COCs for aquatic life communities include arsenic, cadmium, copper, lead, nickel, silver, and zinc). Contaminants present in tailings and waste rock are a contributing factor to the lack of vegetative growth on impacted areas of the mine site (COCs for terrestrial plant communities include arsenic, cadmium, copper, lead, and zinc). In addition, lead in tailings and waste rock poses a threat to the health of terrestrial wildlife.

Arsenic and manganese were identified as COPCs in area-wide soil samples collected from hillsides surrounding the tailings impoundments. Although arsenic concentrations exceeded the DEQ RBCG, all six samples were below the calculated cleanup goal of 44 mg/kg. No cleanup goal has been established for manganese; however, the mean background concentration is approximately 2-1/2 times the DEQ RBCG. Only one area-wide sample exceeded the mean background concentration.

Remedial actions for the waste rock, tailings, and creek sediment will be required to reduce human and ecological risks at the site. Sampling results indicate that no remedial action is required for soil surrounding the tailings impoundments.

A total of five water samples were collected from the Forest Rose Mine Site. The samples were collected from upstream of the mine site in Dunkleberg Creek, the west slope adit, and downstream of the mine site in Dunkleberg Creek at two locations (a duplicate sample was collected downstream of the tailings). The upstream sample indicated higher concentrations of arsenic, cadmium, iron, nickel, and aluminum than water at the two downstream sample locations. This may be a legacy of historic mining activities located near the top of the Dunkleberg Creek drainage.

### 5.3.2 Physical Hazards

There are 13 buildings onsite that pose multiple potential hazards. An archaeological assessment will be performed to determine how the structures should be managed during and following site remediation. If the buildings are to be demolished, a location for the refuse will be identified.

# 6.0 Reclamation Objectives and Goals

Reclamation objectives for the Forest Rose Mine Site include taking sufficient measures to ensure public safety, to prevent the pollution of air and water, and to prevent degradation of adjacent lands. To meet these goals, actions will be taken to control contaminant sources by minimizing the amount of precipitation infiltrating into disturbed areas that are graded, covered, or vegetated, while preventing objectionable groundwater discharge through adits. Specific objectives include:

- Minimize direct contact potential with contaminated media (e.g., tailings, waste rock, sediment, and surface water)
- Prevent contaminant transfer from solid matrices to surface water, groundwater, and air
- Prevent contaminant transfer from groundwater (i.e., adit discharge) to surface water, tailings, waste rock, and sediment
- Limit impacts to human and ecological receptors associated with historic contaminant releases
- Stabilize soil in disturbed areas to prevent erosion
- Leave the site in a condition that supports sustainable ecological communities (terrestrial and aquatic)
- Minimize post-reclamation visual contrasts between the site and adjacent land

These objectives can be attained based on goals developed through regulatory and technical guidance (ARAR-based goals) and through risk-based goals developed for the site.

## 6.1 ARAR-based Removal Reclamation Goals

No regulatory-based cleanup goals have been developed for soil.

No groundwater has been sampled at the site (groundwater collected in 2004 was extracted from tailings impoundments, not from natural soils) and is not used at or near the site for drinking water. No groundwater cleanup goal will be considered as part of the removal action.

Dunkleberg Creek flows into the base of the waste rock pile and through the three tailings impoundments before resuming its natural course along the base of the ravine. Surface water samples indicate contamination resulting from entrainment of mining- and mill-related metals, including arsenic, cadmium, and lead. ARAR-based cleanup goals are derived from Montana's

Circular DEQ-7 Water Quality Standards applied for protection of human health and aquatic life (Table 6-1).

**Table 6-1. ARAR-based reclamation goals for surface water, Forest Rose Mine Site.**

| Contaminant of Concern | Standard | ARAR-based Concentration (µg/L) | Background Concentration (µg/L) |
|---|---|---|---|
| Arsenic | Human Health (MCL) | 10 | 0.68 |
| Cadmium | Aquatic Life (chronic) | 0.4 [a] | 0.98 |
| Lead | Aquatic Life (chronic) | 6.3 [a] | 2.1 |

[a] Adjusted for 170 mg/L hardness found in Dunkleberg Creek
MCL – Maximum Contaminant Level (40 CFR 141)
µg/L – microgram per liter

## 6.2 Risk-based Removal Reclamation Goals

### 6.2.1 Soil

The human health risk assessment indicates that tailings and waste rock exceed an HQ of 1 for arsenic and lead, identifying them as COCs. Additionally, the Estimated Lifetime Cancer Risk for arsenic exceeds EPA guidelines in all human exposure pathways. Due to relatively high background arsenic levels at the Forest Rose Mine Site, DEQ allows use of the background soil UCL concentration of 44 mg/kg as an alternative to the cleanup guideline of 0.7 mg/kg (DEQ 1996). Background samples for lead are not higher than the RBCG; therefore, the RBCG of 1,100 mg/kg will be used for lead.

Ecological COCs include arsenic, cadmium, copper, lead, and zinc based on EQs greater than 1 (an EQ greater than 1 indicates an environmental concentration that inhibits growth and/or is phytotoxic to the terrestrial plant community or possibly threatens the health of terrestrial wildlife). Concentrations of these contaminants are a contributing factor in the lack of vegetation growth on impacted areas of the mine site. In addition, lead poses a threat to the health of terrestrial wildlife, with an EQ of 26.8. Risk-based cleanup goals for protection of ecological receptors derived from the most conservative estimated toxic reference values for phytotoxicity are lower than those for human health (Table 6-2).

**Table 6-2. Risk-based reclamation goals for soil, Forest Rose Mine Site.**

| Contaminant of Concern | Risk Issue | Risk-based Concentration (mg/kg) | Average Background Concentration (mg/kg) |
|---|---|---|---|
| Arsenic | Phytotoxic Limit | 10 | 17.8 |
| Cadmium | Phytotoxic Limit | 3 | 1.8 |
| Copper | Phytotoxic Limit | 60 | 27 |
| Lead | Phytotoxic Limit | 50 | 21 |
| Zinc | Phytotoxic Limit | 50 | 141.9 |

mg/kg – milligram per kilogram

### 6.2.2 Sediment

Dunkleberg Creek sediment COCs include arsenic, cadmium, copper, lead, nickel, silver, and zinc, with EQs ranging between 1.1 and 9.6. Risk-based cleanup goals for protection of ecological receptors derived from the conservative range of NOAA Sediment Quality Guidelines are provided in Table 6-3.

**Table 6-3. Risk-based reclamation goals for sediment, Forest Rose Mine Site.**

| Contaminant of Concern | Risk Issue | Concentration (mg/kg) | Background Concentration (mg/kg)[a] |
|---|---|---|---|
| Arsenic | Westslope Cutthroat Trout | 8.2 | 36.2 |
| Cadmium | Westslope Cutthroat Trout | 1.2 | 20.2 |
| Copper | Westslope Cutthroat Trout | 34 | 65.1 |
| Lead | Westslope Cutthroat Trout | 46.7 | 389 |
| Nickel | Westslope Cutthroat Trout | 20.9 | 45.6 |
| Silver | Westslope Cutthroat Trout | 1.0 | 2.1 |
| Zinc | Westslope Cutthroat Trout | 150 | 2210 |

[a] Based on upstream sediment sample
mg/kg – milligram per kilogram

### 6.2.3 Surface Water

Similar to soil, the upstream water sample arsenic level is 11 times greater than the water cleanup guideline level. DEQ RBCG states that human health protective levels may be assumed if the MCL for arsenic is set as the water reclamation goal.

Ecological COPCs include cadmium and lead based on EQs greater than 1. Risk-based cleanup goals for protection of ecological receptors derived from Circular DEQ-7 Water Quality Standards are provided in Table 6-4.

**Table 6-4. Risk-based reclamation goals for surface water, Forest Rose Mine Site.**

| Contaminant of Concern | Standard | Concentration (µg/L)[a] | Background Concentration (µg/L)[b] |
|---|---|---|---|
| Cadmium | Aquatic Life (chronic) | 0.4 | 0.98 |
| Lead | Aquatic Life (chronic) | 6.3 | 2.1 |

[a] Adjusted for 170 mg/L hardness found in Dunkleberg Creek
[b] Based on upstream surface water sample.
µg/L – microgram per liter

## 6.3 Removal Reclamation Goals

Analytical results indicate higher metal concentrations in surface water and sediment samples collected upstream of the Forest Rose Mine Site compared to results from samples collected downstream. A hypothesis can be made, based on these analytical results, that surface water and sediment at the Forest Rose Mine Site are impacted by the legacy of historical mining operations located further upgradient in the watershed. Removal reclamation goals for the site are based first on background concentrations or the next higher ARAR- or risk-based concentration reported (Table 6-5).

**Table 6-5. Removal reclamation goals, Forest Rose Mine Site.**

| Contaminant of Concern | Surface Water (µg/L) | Sediment (mg/kg) | Soil (mg/kg) |
|---|---|---|---|
| Arsenic | 10[a] | 36.2[b] | 17.8[b] |
| Cadmium | 0.98[b] | 20.2[b] | 3.0[c] |
| Copper | – | 65.1[b] | 60.0[c] |
| Lead | 6.3[c] | 389[b] | 50[c] |
| Nickel | – | 45.6[b] | – |
| Silver | – | 2.1[b] | – |
| Zinc | – | 2210[b] | 141.9[b] |

[a] ARAR based
[b] background based
[c] risk based
mg/kg – milligram per kilogram
µg/L – microgram per liter
– not considered a contaminant of concern

# 7.0 Development and Screening of Reclamation Alternatives

This section provides a process for identification and screening of reclamation technologies and alternatives for the Forest Rose Mine Site. The process analyzes a variety of potential reclamation solutions based on effectiveness, implementability, and cost. Alternatives retained for further analysis are evaluated in more detail in Section 8.

## 7.1 Identification and Screening of Reclamation Technologies

The purpose of this section is to define the general response actions and their associated reclamation technologies that provide the basis of more specific technology screening.

The following general response actions identify basic approaches to site remediation:

- No action
- Institutional controls
- Engineering controls
- Treatment

### 7.1.1 General Response Action Descriptions

#### *7.1.1.1 No Action*

In the no-action response, it is assumed that remediation would rely strictly on natural processes. The no-action option is being considered as a baseline to assist in evaluating proactive remedial technologies.

#### *7.1.1.2 Institutional Controls*

Institutional controls may take the form of physical barriers to restrict access to the site, such as fences with signage or may simply be administrative actions, such as deed restrictions. These controls do not reduce the volume, toxicity, or mobility of contaminants. Although they frequently are used in combination with other actions, institutional controls are not preferred as a stand-alone general response action.

#### *7.1.1.3 Engineering Controls*

Engineering controls include containment, removal, and disposal processes. Containment actions physically restrict the migration of contaminants, such as capping. Capping provides a structural barrier between contaminated material and humans and the environment. Mine waste removal may be conducted by excavation. Removal is required if contaminated media are to be treated or disposed offsite. Disposal is the permanent placement of contaminated material into a controlled facility that does not allow contaminant release to the environment. This may be achieved by constructing a waste repository on or near the site, or using an existing offsite facility. These engineering controls minimize direct exposure to contamination and reduce the mobility of contaminants; however, the toxicity and volume of contaminants are not reduced. They are generally considered low-preference options, preferable only to institutional controls.

#### *7.1.1.4 Treatment*

General response actions that involve treatment processes include:

- Destruction or detoxification
- Separation or volume reduction followed by reuse, recycling, destruction, or detoxification of the residual hazardous substance
- Immobilization of the hazardous substance

Treatment technologies can be categorized as physical, thermal, chemical, or biological. Some technologies may combine these basic processes where, for instance, both chemical reactions and physical treatment take place. Treatment processes may produce residuals that also can be hazardous substances, requiring disposal or further treatment. Treatment may be performed *in situ* (in place) or *ex situ* (following removal).

#### *7.1.1.5 Summary of General Response Actions*

The general response actions described above may be combined in various ways to create alternatives that achieve cleanup at the site; selected alternatives will be presented later in this document. First, technologies associated with each general response action will be evaluated according to a standard set of criteria to determine applicability to the Forest Rose Mine site. Some of the actions described above will not be carried forward for detailed consideration, as discussed in the following section.

### 7.1.2 Reclamation Technology Screening

The purpose of this section is to identify reclamation technologies for use at the Forest Rose Mine Site and to screen their applicability. General response actions that stand alone (e.g., no action, institutional controls) and reclamation technology process options are compared and evaluated on the basis of general effectiveness, implementability, and relative cost. This preliminary screening process is used to limit the number of process options carried forward for more detailed analysis. Reclamation technology process options are summarized in Table 7-1. Those process options that warrant further attention will be retained and combined into reclamation alternatives for evaluation in detail in Section 8.

**Table 7-1. Reclamation technology screening summary, Forest Rose Mine Site.**

| General Response Action | Reclamation Technology | Process Option | Description | Screening Comment |
|---|---|---|---|---|
| No Action | None | Not applicable | No action | Baseline alternative for comparison purposes. |
| Institutional Controls | Access control | Fencing, signs | Install fencing and post signs at contaminated areas. | Does not achieve reclamation objectives. May be effective in combination with other processes. |
| | | Land-use restrictions | Legal restrictions to control current and future land use (development, access, etc.). | May not be amenable with private landowners/USFS. Does not achieve reclamation objectives. |
| Engineering Controls | In-place Containment | Capping – In-place containment | Cap mine waste solids in place with clean fill or synthetic system; prevent surface water run-on and erosion. | May not be amenable with private landowners/USFS. Would not address creek loading or other critical metal loading mechanisms without additional engineering features, i.e. diversions and subsurface cutoff walls. Effective when used in combination with other processes. Option is implementable. |
| | | Capping – Creek culverting | Install culvert either by removing waste and re-covering or by jacking. | Effective separation of tailings and waste rock from creek, but culvert provides poor fish habitat. Option is implementable. May be effective in combination with other processes. |
| | | Capping – In onsite repository | Grade, consolidate, and shape site features to expose Dunkleberg Creek; prevent surface water run-on and erosion. | May not be amenable with private landowners/USFS. Would not address creek loading without additional engineering features. Effective when used in combination with other processes. Option is implementable. |
| | | Capping – Adit opening | Adit plug. | Mine openings are significantly collapsed and the condition of the inner mine workings is unknown. Significant cost to determine feasibility of source controls. |
| | Surface Controls | Creek stabilization | Install grade control to stabilize the creek channel to ensure sediment does not become mobile; floodplain would be revegetated following construction. | Provides for good fish habitat. Option is implementable. Only effective in combination with processes that remove mine waste from streambed. |
| | Removal and Containment | Removal and disposal in onsite repository | Excavate waste and transfer to an onsite repository. | Not implementable due to lack of available land. |
| | | Removal and capping in repository on USFS-administered lands | Excavate waste and transfer to a repository constructed on USFS property. | Effective and option is implementable. |

**Table 7-1 (continued). Reclamation technology screening summary, Forest Rose Mine Site.**

| General Response Action | Reclamation Technology | Process Option | Description | Screening Comment |
|---|---|---|---|---|
| Engineering Controls (cont'd) | | Removal and disposal in offsite permitted facility | Excavate waste and transfer to an offsite permitted solid waste facility. | Effective and option is implementable. Cost may be prohibitive. |
| Treatment | Ex-situ Treatment | Removal of mine waste solids for processing at an offsite mill | Excavate waste and ship to mill for processing and beneficiation. | Cost prohibitive and insignificant mineral value is likely. |
| | | Removal of mine waste solids, fixation, and disposal | Excavate waste, mix with lime or cement in batches, and dispose offsite. | Potentially implementable, but additives would increase bulk, exceeding capacity of USFS repository and likely become cost prohibitive for other offsite disposal options. |
| | In-situ Treatment | Fixation and stabilization of mine waste solids | In-situ mixing with lime or cement. Application of surface binders. | Pilot study required. Difficult to implement (potential for incomplete mixing of amendments and degradation of surface binders). Cost prohibitive. |

Shaded options retained for further consideration

#### *7.1.2.1 No Action*

The no-action Response Action is the baseline against which other reclamation options are compared. Under this Response Action, no additional reclamation, treatment, controls, or assessment would be required. The tailings impoundments and waste rock areas would remain and Dunkleberg Creek would remain buried.

The no-action response is not effective at reducing the volume, toxicity, or mobility of mine waste contaminants. Natural biodegradation and chemical transformation of contaminants are expected to be insignificant at the site. Site contamination would continue to be a source of ecological and human health risk. The risk-based site cleanup goals presented in Section 6.2 would not be met.

Public acceptance is not expected to be gained and the probability is high that remediation would be required at a later date.

No short-term costs would be incurred; however, remedial action likely would be required at a later date if target concentrations are not met.

The no-action response is unlikely to meet reclamation action objectives in a timely manner and has likely public opposition; however, the no-action response is retained as a baseline for comparative purposes.

#### *7.1.2.2 Institutional Controls*

The institutional control Response Action is technically simple to implement, but public acceptance is not expected to be gained and the probability is high that remediation would be required at a later date.

Costs associated with fencing, signage, or restrictions on development can be considered low. This does not include the cost of retroactively implementing another cleanup action, if required at a later time.

Due to the low chance of success in meeting cleanup goals and the low level of community acceptance, institutional controls would be difficult to implement administratively as a stand-alone remedy. A separate institutional control alternative will not be developed.

#### *7.1.2.3 Engineering Controls*

Engineering controls include options for in-place containment or removal and containment at another location. In either case, containment provides a physical barrier to separate contamination from access by humans or environmental receptors. Barrier systems may include using soil, synthetic materials such as liners, or asphalt or concrete paving. Stormwater controls would be designed to route run-on away from waste and to control the potential for waste leaching.

*In-place Containment*

Mine waste solids can be contained in place by:

- Reworking existing tailings impoundments and the waste rock pile, placing a cap over the entire area, and placing a culvert beneath to eliminate direct contact between creek water and mine waste solids
- Reshaping the tailings and waste rock in such a way as to expose Dunkleberg Creek (allowing for a natural flow regime), structurally supporting the solid material with a retaining wall system, and placing a cap over the mine waste solids

Installing a culvert could be performed by either trenching or jacking in place beneath the mine waste solids. If trenching is conducted, mine waste solids would be replaced over the culvert pipe; jacking would require less materials handling. Exposing the creek would require extensive grading, consolidation, and shaping to rearrange waste. Installation of retaining walls would require extending waste material further up the ravine sidewalls and/or lengthwise further upstream or downstream.

The condition of the adit is unknown because the adit is collapsed and the inner mine workings are not accessible. This makes source control options within the mine workings impracticable, due to the high costs associated with reopening the adit, reinforcing the opening for construction, and implementing a control technology.

*Removal and Containment*

This set of options includes removal of contaminated material and transfer to an engineered containment system at another location. Construction of a repository on the mine site property is not considered a viable option, since there is not enough suitable land available. The mine waste would be excavated from the creek channel to be consistent with stream rehabilitation goals and either a repository would be constructed or an existing disposal facility would be used to manage the waste.

Mine waste solids at the Forest Rose Mine Site are not considered hazardous waste according to the Bevill exemption, which excludes "solid waste from the extraction, beneficiation, and processing of ores and minerals" from regulation as hazardous waste under Subtitle C of RCRA. [40 CFR 261.4(b)(7)]. Total metals analyses and Synthetic Precipitation Leaching Procedure (SPLP) analysis from the 2004 site investigation indicates the waste poses an unacceptable risk to human health and the environment when exposed to infiltrating water. An adequate repository cover system would be required to achieve the project reclamation objectives presented in Section 6.2.

Excavating and placing mine waste in a repository located on USFS-administered lands can be engineered and constructed to achieve project reclamation objectives presented in Section 6.2. A proposed location exists within 1.5 miles of the Forest Rose Mine site. The cover system would consist of a low permeability earthen material layer or geosynthetic lining system, overlain by an earthen cap providing growth medium for vegetation.

Removal and disposal in a permitted facility includes transporting mine waste solids for disposal at an existing Subtitle D-permitted solid waste landfill or an alternative permitted facility.

Both repository construction and offsite disposal in a permitted facility will be retained for further analyses.

#### *7.1.2.4 Treatment*

Treatment is a favored general response action, as long as it involves destruction or detoxification of contaminants. Treatment may be conducted either *in situ* (in place) or *ex situ* (following removal). *In situ* technologies include biological, chemical, thermal, and physical processes that have been applied to solid matrices cleanup with varying degrees of success. A major controlling factor is the requirement for complete access to contaminants and control of the surrounding natural environment. *In situ* processes have had limited success at remote and physically constrained sites. *Ex situ* technologies include biological, chemical, and physical processes, with the contaminated material placed into a controlled environment that allows physical manipulation to achieve complete access to contaminants.

Stabilization techniques limit the solubility or mobility of contaminants, even though the physical characteristics of the waste may not be changed. Solidification methods result in a solid, low-permeable block of contaminated material. Both techniques require chemical admixtures applied to mechanically lock contaminants within the solid matrix. This may or may not involve chemical bonding between the toxic contaminant and the additive. By decreasing the exposed surface area and/or encapsulating the waste, contaminant migration can be significantly decreased. Chemical fixation implies transformation of toxic contaminants to nontoxic forms. This requires specially designed or proprietary reagents incorporated during the mixing process to effect destruction, alteration, or chemical bonding of the contaminants.

*In-Situ Treatment*

*In-situ* treatment options for mine waste solids include solidification by mixing with lime, cement, or chemical additives to stabilize waste materials. *In situ* treatmentmay be used in combination with in-place containment. *In situ* solidification typically is problematic due to the difficulty of complete additive mixing. It requires heavy equipment, which could not easily be supported by the unconsolidated tailings piles. Vitrification, which turns waste to glass, is another technology that is considered viable; however, inadequate access and available power limit its use at the Forest Rose Mine site. As such, neither technology warrants further analysis.

*Ex-situ Treatment*

Ex situ treatment options for mine waste solids include reprocessing at an offsite mill and solidification followed by disposal; no treatment option will be considered for adit water discharge, since it would require a commitment to long-term operations and maintenance. Solids reprocessing involves excavation and transportation of contaminated materials to an existing mill or smelter for processing and recovery of valuable metals. Reprocessing involves milling and/or leaching to extract useful metals from the tailings and waste rock. Acid or cyanide leaching, roasting, floatation, and concentration may be utilized. Reprocessing viability depends on economic value of the metals that can be extracted from the mine waste compared to the cost of disposal. It is likely that the Forest Rose Mine waste material would not provide enough income to offset the high cost of reprocessing.

*Ex-situ* solidification may be implementable; however, it would increase the waste bulk significantly. Typical mine waste stabilization processes include amending with lime, fly ash, or pozzolan/cement. A treatability study would be required to determine the optimal additive and mix ratio resulting in contaminant immobilization. ABA analysis of tailings indicates that stabilization would require a significant addition of lime to reduce the acid potential. Stabilization technologies that minimize waste mobility through stabilization are often considered temporary and require reapplications as the binders degrade. This option would require siting of additional repository space and long-term monitoring to determine continued effectiveness. As such, it does not warrant further analysis.

*Summary*

If implementable, treatment would destroy or immobilize contaminants and would be effective in segregating them from the sensitive creek environment. However, *ex-situ* options would require significant testing and additional space, which is not readily available near the site. In-situ options appear non-implementable due to logistical constraints associated with the remote location and restrictive operational footprint. Costs for any of the technologies reviewed would be high.

## 7.2 Identification and Evaluation of Process Options

This section analyzes Process Options based on the initial reclamation technology screening conducted above. Each retained option is evaluated based on effectiveness, implementability, and cost.

Effectiveness is evaluated based on how completely the option achieves the reclamation objective and cleanup goals in both the short and long term. To be effective, the Process Option must be protective of human health and the environment and comply with ARARs. Considerations used in determining effectiveness include site-specific factors, contaminant toxicity and mobility reduction, and waste volume reduction.

Implementability is evaluated based on feasibility of an option from technical and administrative standpoints. Technical feasibility considerations include availability of resources to implement the option, site-specific factors, and maintenance and reliability considerations. Administrative issues that may affect implementability include logistics, permits, schedules, and land ownership.

Cost screening consists of developing order-of-magnitude cost estimates for each Process Option. The estimates are based on previous similar projects performed for DEQ, unit cost data from RSMeans, and quotes from local suppliers and contractors. Administrative costs and contingencies are also included in the cost estimate. Present worth calculations are based on a three percent inflation rate.

Table 7-2 provides a list of the preliminary Process Options based on the technology screening process.

**Table 7-2. Preliminary process option alternatives, Forest Rose Mine Site.**

| Process Option 1 | No Action |
|---|---|
| Process Option 2 | Institutional controls – fencing and signage |
| Process Option 3 | Capping – In-place containment |
| Process Option 4 | Capping – Creek culverting |
| Process Option 5 | Capping – In onsite repository |
| Process Option 6 | Creek stabilization |
| Process Option 7 | Removal and capping in repository located on USFS administered lands |
| Process Option 8 | Removal and disposal in offsite permitted facility |

### 7.2.1 Process Option 1: No Action

The no action option is the baseline condition and is used to compare against the other options. No reclamation activities would be performed at the site to control contaminant mobility or reduce toxicity or volume. The waste would remain onsite and Dunkleberg Creek would continue to have water quality issues.

*Effectiveness:* Toxicity, mobility, and volume of contaminants would not be reduced under the no action option. It would not protect against ecological and human health risks associated with metals in waste at Forest Rose Mine Site. The reclamation goals and risk-based cleanup goals presented in Section 6.2 of this EEE/CA are not achieved under this option.

*Implementability:* Technical and administrative feasibility criteria do not apply to this option because no work would be performed.

*Cost*: No capital or operating costs would be incurred under the no action option.

*Screening Summary*: The no action option is used as a baseline against which other options are compared. The no action option is retained for detailed evaluation in Section 8.

### 7.2.2 Process Option 2: Institutional Controls

The institutional control option includes erecting fences or other non-engineered barriers around the waste areas and imposition of property-use restrictions to prevent development.

*Effectiveness*: Option 2 provides protection of human health by limiting future site development and by creating a barrier around site wastes. Option 2 would also provide a barrier against larger wildlife species depending on the size of the fence or barrier. Institutional controls do not reduce toxicity, mobility, and/or volume of the contaminants and they do not achieve project cleanup goals. Additionally, Dunkleberg Creek would remain impacted. The potential for direct human contact with site wastes cannot be completely eliminated because fencing may be vandalized or degraded by natural events over time.

*Implementability*: Institutional controls are easy to implement and can be completed with a minimum of technical and administrative considerations. Reliability of this option is considered good for controlling direct contact, as long as the physical controls are maintained and deed restrictions remain in place. Administrative feasibility poses a challenge because a portion of the site is on private property and a portion of the site is on public property.

*Cost*: Table 7-3 presents cost details associated with implementing this option. The total present worth for institutional controls over 30 years is estimated at $69,000. Costs for Option 2 would be relatively low compared to other reclamation Process Options.

**Table 7-3. Process Option 2 cost estimate, Forest Rose Mine Site.**

| Activity / Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $3,900 | $3,100 | |
| Site Access, Clearing, and Preparation | 1 | LS | $4,700 | $4,700 | |
| Perimeter Fencing | 3,130 | LF | $7.50 | $23,500 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Land-Use Control (Note to Deed) | 1 | LS | $200 | $200 | |
| Subtotal | | | | $34,500 | |
| **TOTAL CAPITAL COST** | | | | | **$34,500** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $900 | $900 | |
| Subtotal | | | | $1,750 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$1,750** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$34,300** |
| **TOTAL PRESENT VALUE COST** | | | | | **$68,800** |

*Screening Summary*: While low in cost, institutional controls provide limited effectiveness for protection of human health and the environment. It does not achieve the risk-based site cleanup goals; Option 2 will not be considered further as a stand-alone reclamation option, but may be used in conjunction with other selected Process Options.

### 7.2.3 Process Option 3: Capping – In-place Containment

Process Option 3 includes shaping the waste and capping in-place. Spot shaping would be performed to lessen steep grades and a soil cover cap would be constructed over the waste. The cap would consist of a soil cover that would be vegetated with native plants to reduce erosion and minimize infiltration of precipitation and run-on. As part of Process Option 3, Dunkleberg Creek would remain impacted and would not allow for fish passage. BMPs for erosion control and stormwater would be utilized on all reclaimed areas.

*Effectiveness*: Capping does not reduce contaminant volume or toxicity, but restricts mobility by isolating the waste. Dunkleberg Creek would still be covered by tailings and waste rock and creek flow could mobilize contaminants downstream or destabilize the cover system. This option could be combined with Process Option 4 to address creek separation from the waste (limitations of this approach are discussed in the next Section). Consolidation of waste material would not be part of Process Option3, which would require additional post-construction monitoring and maintenance. Process Option 3 does not achieve the reclamation goals set forth in Section 6.

*Implementability*: Process Option 3 is technically feasible and can be readily implemented with standard construction techniques. It would require administrative controls to ensure that reclaimed portions of the waste on private property are not disturbed by future site development and use.

*Cost*: Table 7-4 presents cost details associated with implementing this alternative. The total present worth for capping with in-place containment for 30 years is estimated at $312,000. Costs for Process Option 3 are lower than other capping options because the cap would be constructed using soil and vegetation, and minimal grading would be performed.

*Screening Summary*: Process Option 3 would not be fully protective of human health and the environment and there are administrative issues associated with implementation. Due to the limited effectiveness and implementability, it will not be considered in further detail.

### 7.2.4 Process Option 4: Capping – Creek Culverting

Process Option 4 would include removing waste in the relic channel of Dunkleberg Creek, installing a culvert (either round or arched culvert), and placing waste back in place. The culvert could be placed at the natural creek grade or could be aligned such that portions of the culvert would lie on top of some of the tailings impoundments.

*Effectiveness*: Process Option 4 would successfully separate Dunkleberg Creek from the mine waste. Although the creek would flow along its historical path, a culvert would not likely allow fish passage, due to the slope and length required (15 percent slope over 650 feet).This option would not meet the reclamation goals for the creek. This option would need to be considered in conjunction with Process Option 3 to also address the solid mine waste material.

**Table 7-4. Process Option 3 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $23,600 | $23,600 | |
| Site Access, Clearing and Preparation | 1 | LS | $7,600 | $7,600 | |
| Soil Cover Cap (Imported) | 1 | LS | $112,400 | $112,400 | |
| Final Grading | 18731 | Y | $3.00 | $56,200 | |
| Planting | 3.87 | AC | $4,000 | $15,500 | |
| Seeding, Fertilizer, Mulch | 3.87 | AC | $2,000 | $7,700 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Temporary Fencing | 3130 | LF | $7.50 | $23,500 | |
| Stormwater BMPs | 1 | LS | $10,000 | $10,000 | |
| Land-Use Control (Note to Deed) | 1 | LS | $200 | $200 | |
| Subtotal | | | | $259,700 | |
| **TOTAL CAPITAL COST** | | | | | **$259,700** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $1,800 | $1,800 | |
| Subtotal | | | | $2,650 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$2,650** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$51,900** |
| **TOTAL PRESENT VALUE COST** | | | | | **$311,600** |

*Implementability*: Process Option 4 is technically feasible and can be readily implemented with standard construction techniques. It would require administrative controls to ensure that waste on private property would not be disturbed by future site development and use.

*Cost*: Table 7-5 presents cost details associated with implementing Process Option 4. The total present worth for culverting Dunkleberg Creek for 30 years is estimated at $1,013,000. The estimated costs do not include those required for otherwise controlling solid waste material.

*Screening Summary*: Process Option 4 would not be fully protective of human health and the environment as a stand-alone alternative. It would also not meet reclamation goals set forth in Section 6. It will not be analyzed in further detail, due to limited effectiveness.

**Table 7-5. Process Option 4 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $87,400 | $87,400 | |
| Site Access, Clearing and Preparation | 1 | LS | $7,600 | $7,600 | |
| Earthwork (Excavate Waste from Creek Area) | 1 | LS | $67,400 | $67,400 | |
| Waste Placement and Compaction | 1 | LS | $38,500 | $38,500 | |
| Final Grading | 2889 | SY | $3.00 | $8,700 | |
| Culvert | 1,300 | LF | $550 | $715,000 | |
| Planting | 3.87 | AC | $4,000 | $15,500 | |
| Seeding, Fertilizer, Mulch | 3.87 | AC | $2,000 | $7,700 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Stormwater BMPs | 1 | LS | $10,000 | $10,000 | |
| Land-Use Control (Note to Deed) | 1 | LS | $200 | $200 | |
| Subtotal | | | | $961,000 | |
| **TOTAL CAPITAL COST** | | | | | **$961,000** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $1,800 | $1,800 | |
| Subtotal | | | | $2,650 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$2,650** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$51,900** |
| **TOTAL PRESENT VALUE COST** | | | | | **$1,012,900** |

### 7.2.5 Process Option 5: Capping in Onsite Repository

Process Option 5 would include completely removing the waste from the tailings impoundments and waste rock areas, constructing a repository onsite, and placing the waste in the constructed repository. To fit the repository onsite, tailings and waste rock would be moved to the west side of Dunkleberg Creek and the natural creek bed would be moved to the east side of the ravine. Waste would extend further uphill from the creek bed and further up- and down-stream. An engineered retaining wall would be required to contain the waste. The waste removal would have to be performed in stages and then placed behind the wall as it was built. The repository would be capped with a geomembrane or low-permeability soil and then covered with topsoil and vegetated. The repository cover would be seeded with a native seed mix and would be fenced off to protect against animal browsing. BMPs for erosion control and stormwater control would be installed to protect the repository from run-on.

The small waste rock areas identified on the west side of the ravine also would be placed behind the retaining wall system and the areas revegetated.

*Effectiveness*: Process Option 5 provides for protection of human health and the environment by isolating site wastes. Contaminant toxicity and volume would not be reduced, but the waste would be immobile and protected in the repository. The creek would flow along its historical path, although enhancing the creek bed to provide immediate fish habitat is not a part of this option (see Process Option 6).

*Implementability*: Construction of the onsite repository would require a staged process, which would be difficult due to the lack of available space. It would involve extending waste material up one side of the ravine and in both up- and down-stream directions. The retaining wall would need to be at least 30 feet tall starting at the creek bed, stretching 1,300 feet along the creek flow path. Process Option 5 would require administrative controls to ensure that the waste on private property would not be disturbed by future site development and use.

*Cost*: Table 7-6 presents cost details associated with implementing Process Option 5. The total present worth for an onsite repository for 30 years is estimated at $4,010,000. The costs are estimated to be relatively high due to the retaining wall and the phased construction process.

*Screening Summary*: Process Option 5 would not be fully protective of human health and the environment and there are associated administrative issues associated with implementation. There are also constructability issues associated with construction staging. , Based on implementability issues, it will not be analyzed in further detail.

### 7.2.6 Process Option 6: Creek Stabilization

Process Option 6 consists of removing waste from the creek channel, and reconstructing Dunkleberg Creek to a natural grade. This would include installing grade control to stabilize the creek channel and to ensure that sediment does not become mobile. The floodplain would be revegetated following construction.

*Effectiveness*: Process Option 6 would restore Dunkleberg Creek to natural conditions; the tailings impoundments would no longer be a fish barrier. Although this option would meet reclamation goals for Dunkleberg Creek, the solid mine waste would still have to be addressed. The tailings impoundments and waste rock piles would still have the potential of waste washing into the stabilized creek and would not address the human and ecological risk associated with sediment mobilizing in the creek. This option would need to be considered in conjunction with other Process Options that include waste removal from the creek bed.

*Implementability*: Process Option 6 is technically feasible and can be readily implemented with standard construction techniques. It would require administrative controls to ensure that reclaimed portions of the waste on private property are not disturbed by future site development and use.

**Table 7-6. Process Option 5 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $361,600 | $361,600 | |
| Site Access, Clearing and Preparation | 1 | LS | $15,100 | $15,100 | |
| Earthwork | 1 | LS | $1,260,000 | $1,260,000 | |
| Waste Placement and Compaction | 1 | LS | $900,000 | $900,000 | |
| Final Grading | 18731 | SY | $3.00 | $56,200 | |
| Repository Geomembrane | 18731 | SY | $3.00 | $56,200 | |
| Soil Cover Cap (Imported 3-ft thick) | 18731 | CY | $9.00 | $168,600 | |
| Engineered Retaining Wall | 1 | LS | $1,100,000 | $1,100,000 | |
| Planting | 3.87 | AC | $4,000 | $15,500 | |
| Seeding, Fertilizer, Mulch | 3.87 | AC | $2,000 | $7,700 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Temporary Fencing | 3,130 | LF | $7.50 | $23,500 | |
| Stormwater BMPs | 1 | LS | $10,000 | $10,000 | |
| Land-Use Control (Note to Deed) | 1 | LS | $200 | $200 | |
| Subtotal | | | | $3,977,600 | |
| **TOTAL CAPITAL COST** | | | | | **$3,997,600** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $12,000 | $12,000 | |
| Subtotal | | | | $12,850 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$12,850** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$251,900** |
| **TOTAL PRESENT VALUE COST** | | | | | **$4,010,450** |

*Cost*: Table 7-7 presents cost details associated with implementing Process Option 6. The total present worth for stabilizing Dunkleberg Creek for 30 years is estimated at $309,000. These costs include only those associated with stabilizing Dunkleberg Creek, not those required for controlling solid waste material.

*Screening Summary*: Process Option 6 would not be fully protective of human health and the environment as a stand-alone alternative. It would be used in conjunction with a waste removal alternative to address all of the human health and ecological risk presented in Section 6. This Process Option will be combined with other alternatives for further evaluation in Section 8.

**Table 7-7. Process Option 6 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $23,400 | $23,400 | |
| Site Access, Clearing and Preparation | 1 | LS | $7,600 | $7,600 | |
| Earthwork (Excavate Waste from Creek Area) | 1 | LS | $67,400 | $67,400 | |
| Waste Placement and Compaction | 1 | LS | $38,500 | $38,500 | |
| Grading of Creek | 2889 | SY | $3.00 | $8,700 | |
| Grade Control Structure | 130 | EA | $400 | $52,000 | |
| Planting | 3.87 | AC | $4,000 | $15,500 | |
| Seeding, Fertilizer, Mulch | 3.87 | AC | $2,000 | $7,700 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Temporary Fencing | 3130 | LF | $7.50 | $23,475 | |
| Stormwater BMPs | 1 | LS | $10,000 | $10,000 | |
| Land-Use Control (Note to Deed) | 1 | LS | $200 | $200 | |
| Subtotal | | | | $257,500 | |
| **TOTAL CAPITAL COST** | | | | | **$257,500** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $1,800 | $1,800 | |
| Subtotal | | | | $2,650 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$2,650** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$51,900** |
| **TOTAL PRESENT VALUE COST** | | | | | **$309,400** |

### 7.2.7 Process Option 7: Removal and capping in a repository located on USFS Administered Lands

Process Option 7 would include completely removing the tailings and waste rock, constructing a repository on USFS administered lands, and placing the waste in the constructed repository. The proposed repository would be located approximately two miles from the site. Over-excavation of the waste would be performed to ensure that the risk-bask cleanup goals presented in Section 6.2 are met. The repository would be capped with a geomembrane or low-permeability soil and then covered with topsoil and vegetated. The repository cover would be seeded with a native seed mix and fenced off to protect against animal browsing. BMPs for erosion and stormwater control would be installed to protect the repository from run-on.

The waste rock areas and tailings impoundments would be reclaimed and revegetated following removal of the waste. Alldisturbed areas will be graded and seeded. No special creek enhancement would be provided for.

*Effectiveness*: Process Option 7 provides for protection of human health and the environment by removing and isolating site wastes. This option would reduce contaminant mobility at the site by removing and containing the waste in a secure repository. Contaminant toxicity and volume would not be reduced.

*Implementability*: Construction of the repository on USFS administered land can be readily implemented with standard construction techniques. This option would include long-term administrative issues associated with managing the waste on USFS administered lands. The proposed repository location provides a nearby viable site; however, the road from the Forest Rose Mine to the repository would require improvement to allow for truck traffic for hauling of waste and borrow.

*Cost*: Table 7-8 presents cost details associated with implementing this Process Option. The total present worth for the repository for 30 years is estimated at $2,767,000.

*Screening Summary*: Process Option 7 would be an effective alternative as protection for human health and the environment. It is implementable and will be analyzed in further detail in Section 8.

### 7.2.8 Process Option 8: Removal and Disposal in Offsite Permitted Facility

Process Option 8 would include completely removing tailings and waste rock and hauling them to an offsite permitted facility. Over-excavation of the waste would be performed to ensure that the risk-bask cleanup goals presented in Section 6.2 are met. The material would be loaded into trucks and hauled to the closest permitted waste facility, where the waste would be disposed of under provisions of the Montana Solid Waste Management Act, MCA 75-10-201.

The waste rock areas and tailings impoundments would be reclaimed and revegetated following removal of the waste, with grading and revegetation on all disturbed areas. No special creek enhancement would be provided for.

*Effectiveness*: Process Option 8 provides for protection of human health and the environment by removing and isolating site wastes. This option would reduce contaminant mobility at the site by removing and containing the waste in a secure landfill. Contaminant toxicity and volume would not be reduced.

*Implementability*: Construction components of Process Option 8 can be readily implemented with standard construction techniques. The road from the Forest Rose Minewould require upgrading to allow for truck traffic for hauling of waste and borrow.

**Table 7-8. Process Option 7 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $244,600 | $244,600 | |
| Clearing and Grubbing | 1 | LS | $20,900 | $20,900 | |
| Road Grade Preparation | 17600 | SY | $4.00 | $70,400 | |
| Excavation | 130000 | CY | $7.00 | $910,000 | |
| Haul | 90000 | CY | $6.00 | $540,000 | |
| Waste Placement and Compaction | 130000 | CY | $4.00 | $520,000 | |
| Final Grading | 31654 | SY | $3.00 | $95,000 | |
| Repository Geomembrane | 13000 | SY | $3.00 | $39,000 | |
| Soil Cover Cap (from onsite) | 12922 | CY | $3.00 | $38,800 | |
| Planting | 6.54 | AC | $4,000 | $26,200 | |
| Seeding, Fertilizer, Mulch | 6.54 | AC | $2,000 | $13,100 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Temporary Fencing | 2660 | LF | $7.50 | $20,000 | |
| Stormwater BMPs | 1 | LS | $150,000 | $150,000 | |
| Subtotal | | | | $2,691,000 | |
| **TOTAL CAPITAL COST** | | | | | **$2,691,000** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $3,000 | $3,000 | |
| Subtotal | | | | $3,850 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$3,850** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$75,500** |
| **TOTAL PRESENT VALUE COST** | | | | | **$2,766,500** |

*Cost*: Table 7-9 presents cost details associated with implementing this Process Option. The total present worth for offsite disposal is estimated at $8,270,200. The estimate is based on standard loading techniques and hauling with side dumps or belly dumps with pups to maximize load hauling on the freeway to the nearest permitted facilityl. No operations or maintenance costs are factored in.

*Screening Summary*: Process Option 8 would be an effective alternative as protection for human health and the environment. It is implementable and will be analyzed in further detail in Section 8.

**Table 7-9. Process Option 8 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $748,700 | $748,700 | |
| Clearing and Grubbing | 1 | LS | $7,600 | $7,600 | |
| Road Grade Preparation | 96800 | SY | $4.00 | $290,400 | |
| Earthwork | 90,000 | CY | $7.00 | $630,000 | |
| Waste Haul and Disposal | 90,000 | CY | $70.00 | $6,300,000 | |
| Final Grading | 18731 | SY | $3.00 | $56,200 | |
| Planting | 3.87 | AC | $4,000 | $15,500 | |
| Seeding, Fertilizer, Mulch | 3.87 | AC | $2,000 | $7,700 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Stormwater BMPs | 1 | LS | $80,000 | $80,000 | |
| Subtotal | | | | $8,235,900 | |
| **TOTAL CAPITAL COST** | | | | | **$8,235,900** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $900 | $900 | |
| Subtotal | | | | $1,750 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$1,750** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$34,300** |
| **TOTAL PRESENT VALUE COST** | | | | | **$8,270,200** |

## 7.3 Process Option Screening Summary

Table 7-10 summarizes the results of the Process Option screening process. The costs shown include the present worth value of construction, monitoring, and maintenance (considered “order of magnitude” estimates).

As a result of the screening process, four Process Options have been retained for detailed analysis in Chapter 8:

- Process Option 1: No Action
- Process Option 6: Creek Stabilization
- Process Option 7: Removal and capping in Repository on USFS Administered Land

- Process Option 8: Removal and disposal in Offsite Permitted Facility

**Table 7-10. Process option screening summary, Forest Rose Mine Site.**

| Process Option | Effectiveness | Implementability | Cost | Retained for Detailed Analysis |
|---|---|---|---|---|
| 1. No Action | NA | NA | $0 | Yes |
| 2. Institutional Controls | Low | Low | $69,000 | No |
| 3. Capping – In-place Containment | Medium | Low | $312,000 | No |
| 4. Capping – Creek Culverting | High | Low | $1,013,000 | No |
| 5. Capping – In Onsite Repository | High | Low | $4,010,000 | No |
| 6. Creek Stabilization | High | High | $309,000 | Yes, included in retained disposal alternatives |
| 7. Removal and Capping in Repository located on USFS administered lands | High | High | $2,767,000 | Yes |
| 8. Removal and disposal in Offsite Permitted Facility | High | High | $8,270,000 | Yes |

NA = Not Applicable

Process Options 2, 3, 4, and 5 will not be considered further because they are ineffective, difficult to implement, or do not achieve the project reclamation goals.

# 8.0 Detailed Analysis of Reclamation Alternatives

This section assembles process options into alternatives and presents a detailed analysis of each alternative. The five process options retained for further analysis in Section 7 have been combined to form the following three alternatives to be examined for the Forest Rose Mine Site:

- Alternative 1: No Action
- Alternative 2: Removal and capping in Repository located on USFS administered lands, and Creek Stabilization
- Alternative 3: Removal and disposal in Offsite Permitted Facility and Creek Stabilization

Each reclamation alternative is classified as an interim or removal action and is not considered a complete reclamation action. The alternatives presented only address the contaminated solid media, and do not analyze groundwater or surface water in detail and, therefore, cannot be considered complete. It is assumed that removing contaminated solid media from the Dunkleberg Creek drainage path will reduce or eliminate human and ecological risks associated with surface water and groundwater at a reduced cost. Adit discharge will be infiltrated to protect from human and terrestrial wildlife from exposure and will not be treated per the scope of the project.

The detailed analysis evaluates the following criteria, in accordance with the NCP:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Agency acceptance
- Community acceptance

Agency acceptance and community acceptance are modifying criteria to be evaluated after DEQ and the public have reviewed and commented on the EEE/CA. The criteria address requirements and considerations (EPA 1988); serving as the basis for the detailed analysis and subsequent selection of the preferred reclamation alternative. The criteria listed above are categorized into three groups, each with distinct functions in selecting the preferred alternative, including:

- Threshold criteria – overall protection of human health and the environment and compliance with ARARs
- Primary balancing criteria – long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost

- Modifying criteria – agency and community acceptance

Threshold criteria are directly related to statutory requirements that must ultimately be satisfied. These criteria represent thresholds of acceptability - an alternative that does not meet these criteria is not acceptable. The primary balancing criteria represent the major factors evaluated to determine whether a cleanup action is permanent to the maximum extent practicable. These criteria take into account technical, cost, institutional, and risk considerations. Threshold and primary balancing criteria are the basis of the detailed analysis and selection criteria of the preferred alternative. Modifying criteria are formally considered after public comment on the proposed plan (Federal Register, No. 245, 51394-50509, December 1998). Each criterion is briefly described in the following paragraphs and factors to be addressed for each alternative during the detailed analyses are presented in Table 8-1.

*Overall Protection of Human Health and the Environment* – The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Adequate protection must be demonstrated by elimination, reduction, or control for each exposure pathway by treatment, engineering, or institutional controls. Short-term or cross-media impacts also must be acceptable.

*Compliance with ARARs* – This criterion assesses how each alternative complies with applicable or relevant and appropriate standards, criteria, advisories, or other guidelines. Waivers are identified if necessary. A comprehensive list of federal and state ARARs has been developed for the Forest Rose Mine Site and is presented in detail in Appendix A. The ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Contaminant-specific ARARs are waste-related requirements that effect how a waste must be managed, treated, and/or disposed depending on classification of the waste material. Location-specific ARARs specify how the reclamation activities must take place depending on where the wastes are physically located (i.e. sensitive environment) or where the wastes may be treated and or disposed of and what permits may be required. Action-specific ARARs describe methods used in the reclamation alternative.

*Long-term Effectiveness and Permanence* – This criterion evaluates alternative effectiveness in protecting human health and the environment after the reclamation objectives have been achieved. The assessment considers degree of certainty that the alternative will be successful, its long-term reliability, the magnitude of residual risk, and effectiveness of controls required to manage treatment residues of remaining wastes.

*Reduction of Toxicity, Mobility, or Volume through Treatment* – This criterion evaluates the statutory preference for selecting actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substance as their principle element. This preference is satisfied when treatment is used to reduce the principle threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. Typical issues include:

**Table 8-1. Summary of reclamation alternative evaluation criteria, Forest Rose Mine Site.**

<table>
<tr><th colspan="10">Threshold Criteria</th></tr>
<tr><td colspan="5">Overall Protection of Human Health and the Environment<br>▪ How the alternative as a whole protects human health and the environment</td><td colspan="5">Compliance with ARARs<br>▪ Compliance with chemical-specific ARARs<br>▪ Compliance with action-specific ARARs<br>▪ Compliance with location-specific ARARs<br>▪ Compliance with appropriate criteria, advisories, and guidelines</td></tr>
<tr><th colspan="10">Primary Balancing Criteria</th></tr>
<tr><td colspan="2">Long-term Effectiveness and Permanence<br>▪ Magnitude of residual risk<br>▪ Adequacy of controls<br>▪ Reliability of controls</td><td colspan="2">Reduction of Toxicity, Mobility, or Volume through Treatment<br>▪ Treatment process used and materials tested<br>▪ Amount of hazardous materials destroyed or treated<br>▪ Degree of expected reductions in toxicity, mobility, and volume<br>▪ Degree to which treatment is irreversible<br>▪ Type and quantity of residuals remaining after treatment</td><td colspan="2">Short-term Effectiveness<br>▪ Human health impacts during implementation<br>▪ Environmental impacts during construction<br>▪ Time until reclamation objective is achieved</td><td colspan="2">Implementability<br>▪ Technical feasibility<br>▪ Administrative feasibility</td><td colspan="2">Cost<br>▪ Capital Cost<br>▪ Operation and maintenance cost<br>▪ Current worth of all costs</td></tr>
<tr><th colspan="10">Modifying Criteria [a]</th></tr>
<tr><td colspan="5">Supporting Agency Acceptance<br>▪ Features of the alternative that are supported by DEQ<br>▪ Features of the alternative that DEQ question<br>▪ Features of the alternative that DEQ oppose</td><td colspan="5">Community Acceptance<br>▪ Features of the alternative that are supported by the community<br>▪ Features of the alternative that the community question<br>▪ Features of the alternative that the community oppose</td></tr>
</table>

[a] Assessed after the public and agency comment on the EEE/CA

- The amount of hazardous material that would be destroyed
- The degree of expected reduction in contaminant toxicity, mobility, or volume
- The degree to which treatment would be irreversible

*Short-term Effectiveness* – This criterion examines the effectiveness of each alternative in protecting human health and the environment during construction and implementation of a remedy until response objectives have been met. The length of time to reach remedial action objectives is also considered. Typical issues include:

- Protection of the community from dust during excavation, processing, and transport
- Protection of workers during reclamation actions
- Protection of sensitive plants and animals during reclamation actions
- The length of time required to implement reclamation actions

*Implementablility* – This criterion examines the technical and administrative feasibility of an alternative and availability of the required goods and services. Technical feasibility includes the ability to construct, install, operate, and maintain the system to be used; to determine the possibility of technical difficulties; and to monitor and review the effectiveness of operations. Administrative feasibility refers to the ability to obtain normal legal approvals (i.e., permits), conduct public relations, achieve favorable community response, and coordinate government regulatory agencies. Implementability also takes into account integration with existing facility operations, as well as other current or potential remedial actions.

*Cost* – This criterion evaluates the estimated capital, operation, and maintenance costs of an alternative. It should be noted that this is a simplified cost analysis for the purpose of comparing projects and that the calculated capitalized cost does not reflect actual project financing. A cleanup action is not considered practical if the incremental cost of the cleanup action is substantial and disproportionate to the incremental degree of protection it would achieve over a lower preference cleanup action. Typically, study-estimate costs made during the EEE/CA are expected to provide an accuracy of +50 percent to -30 percent.

*Agency Acceptance* – This criterion evaluates the technical and administrative issues and concerns of DEQ in relation to the preferred reclamation alternative. The evaluation of agency acceptance is considered after agency and public comment on the preferred alternative.

*Community Acceptance* – This criterion evaluates public concerns with the reclamation alternatives, with an emphasis on the preferred alternative. The evaluation of community acceptance is considered after agency and public comment on the proposed plan.

The final step of this process is to conduct a comparative analysis of the alternatives. The analysis includes a discussion of each reclamation alternative's relative strengths and weaknesses with respect to each evaluation criterion and how reasonable key uncertainties could change expectations of their relative performance.

Once completed, this evaluation will be used to select the preferred alternative. A public meeting will be held to present the preferred and other reclamation alternatives evaluated by this EEE/CA. Written public comments will be addressed in writing by DEQ before the Final EEE/CA and the Action Memorandum (AM) are issued. The selection of the preferred alternative will be documented in the AM.

## 8.1 Quantitative Evaluation of Threshold Criteria

Each reclamation alternative, with the exception of the no-action alternative, is designed to achieve risk reduction necessary to meet the reclamation objective and risk-based cleanup goals. No additional calculation or modeling of relative risk reduction between the reclamation alternatives will be performed in this evaluation.

## 8.2 Alternative 1: No Action

Evaluation of the no action alternative is required by the NCP and is used as the baseline against which the other alternatives are compared. No reclamation would be performed under the no action alternative and Forest Rose Mine Site conditions would remain virtually unchanged (i.e., significant contaminant reduction or containment would not occur). Site contamination would continue to pose an unacceptable risk to human health and the environment and site reclamation objectives would not be achieved.

### 8.2.1 Overall Protection of Human Health and the Environment

The no action alternative provides no control of site wastes and no reduction in risk to human health or the environment. Under the no-action alternative, the recreational user would continue to be exposed to arsenic and lead through oral and dermal exposure pathways. Terrestrial and aquatic wildlife would continue to be exposed to contaminants in site wastes through dermal contact and ingestion, and plants would continue to be exposed through direct contact.

Table 8-2 presents a risk reduction summary based on Alternative 1 for the exposure pathways and contaminants of concern identified in the baseline human health risk assessment and ecological risk assessment. Only contaminants with an EQ or HI greater than 1 are evaluated in the matrix.

**Table 8-2. Risk reduction matrix for Alternative 1, Forest Rose Mine Site.**

| COCs | Human Health Exposure Pathway: Recreational User Soil | Human Health Exposure Pathway: Recreational User Water | Ecological Exposure Pathway: Terrestrial Wildlife | Ecological Exposure Pathway: Aquatic Life | Ecological Exposure Pathway: Terrestrial Plant Community |
|---|---|---|---|---|---|
| Arsenic | None | None | – | None | None |
| Cadmium | – | – | – | None | None |
| Copper | – | – | – | None | None |
| Lead | None | None | None | None | None |
| Nickel | – | – | – | None | – |
| Silver | – | – | – | None | – |
| Zinc | – | – | – | None | – |

None No risk reduction achieved
– Not applicable; EQ or HI not greater than 1 for pathway

### 8.2.2 Compliance with ARARs

No contaminated materials would be treated, removed, or actively managed under the no action alternative. The no action alternative would not meet federal or state contaminant-specific ARARs applicable to surface water and groundwater quality at the Forest Rose Mine Site. Surface water quality exceeds the following contaminant specific ARARs:

- Human health standards for arsenic
- Chronic aquatic life standards for cadmium, lead, and zinc
- Acute aquatic life standards for cadmium and zinc

Groundwater was not analyzed as part of the reclamation investigation.

### 8.2.3 Long-term Effectiveness and Permanence

No administrative or engineering controls would be implemented as a result of the no action alternative. Protection of human health and the environment would not be achieved, and site risks would remain to human recreational users and ecological receptors. Alternative 1 does not offer long-term effectiveness or permanence.

### 8.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The no action alternative does not achieve any reduction of toxicity, mobility, or volume of contaminants through treatment.

### 8.2.5 Short-term Effectiveness

No administrative or engineering controls would be implemented as a result of the no action alternative. Protection of human health and the environment would not be achieved, and site risks would remain to human recreational users and ecological receptors. Alternative 1 does not provide a short-term effective solution.

### 8.2.6 Implementability

No action is performed under Alternative 1, therefore, there are no technical or administrative feasibility criteria that apply.

### 8.2.7 Costs

No costs (capital, operating, or monitoring) are incurred as part of the no action alternative. The future costs of no action (human health and ecological impacts) are unknown.

## 8.3 Alternative 2: Capping in repository located on USFS Administered Lands and Creek Stabilization

Alternative 2 would include removal of waste rock and tailings from the Forest Rose Mine Site and disposal in a constructed repository located on USFS administered lands (Figure 2-1). The proposed repository location is approximately 2 miles from the Forest Rose Mine Site. Reclamation work at the site would consist of:

- Over-excavating mine waste
- Capping waste in an engineered repository
- Regrading and recontouring the reclaimed surfaces
- Regrading and stabilizing Dunkleberg Creek
- Site revegetation
- Implementing BMPs to reduce erosion on reclaimed features
- Infiltrating intermittent adit discharge from the adit on the west slope of the ravine
- Temporary fencing

The engineered repository on USFS administered lands would consist of an impoundment extending both below and above ground, with a low-permeability cap. The cap would consist of a geosynthetic clay liner and/or low-permeability soil overlain by growth media. The bedding material on the bottom of the liner may be amended with a lower-permeability soil media (e.g., bentonite) to reduce the potential of infiltration. The soil capping material would be 3 feet thick. The cap would be revegetated with a mix of native grasses to reduce erosion and minimize infiltration of rain and snowmelt. Temporary fencing would be installed around the new repository to exclude wildlife until the vegetation is established. BMPs, including berms and ditches, would be utilized around the repository to minimize erosion, ensure cover stability, and minimize surface water run-on.

The volume of waste to be removed from the Forest Rose Mine Site and disposed of, including one foot of over-excavation, has been estimated at 90,000 cy (Table 8-3). Two configuration options were identified for the repository to account for the fill volume and three-foot thick cap. The volume of soil excavated from the repository would be approximately 40,000 cy, based on the proposed footprint and test pit excavation depths. Configuration option one assumes 14:1 side slopes, a maximum elevation of 5,902, and a waste capacity of 96,000 cy. Figures 8-1 and 8-2 show conceptual plans of the excavation and final grading, as well as typical cross sections of a repository for configuration option one. Configuration option two assumes 3:1 side slopes, a maximum elevation of 5,909, and a waste capacity of 91,000 cy. Figures 8-3 and 8-4 show conceptual plans of the excavation and final grading, as well as typical cross sections of a repository for configuration option one.

**Table 8-3. Waste volumes, Forest Rose Mine Site.**

| Area | Fill (Cu. Yd) | Total |
|---|---|---|
| Waste Rock Area 1 | 5,918.93 | |
| Waste Rock Area 2 | 1,675.61 | |
| Tailings Impoundment 3 | 13,152.16 | |
| Tailings Impoundment 2 | 44,867.99 | |
| Tailings Impoundment 1 | 24,384.54 | **89,999.23** |

The site would be recontoured to match preexisting mining slopes. Approximately 1,300 linear feet of Dunkleberg Creek would be graded to provide a slope consistent with the upstream and downstream portions of Dunkleberg Creek that have not been impacted by mine waste. The grade of Dunkleberg Creek would be controlled by structures to prevent the creek from head cutting upstream. Grade control structures would be built with natural materials (wood and/or rock), located and sized to allow fish passage. Recontoured areas and the Dunkleberg Creek floodplain would be revegetated following construction.

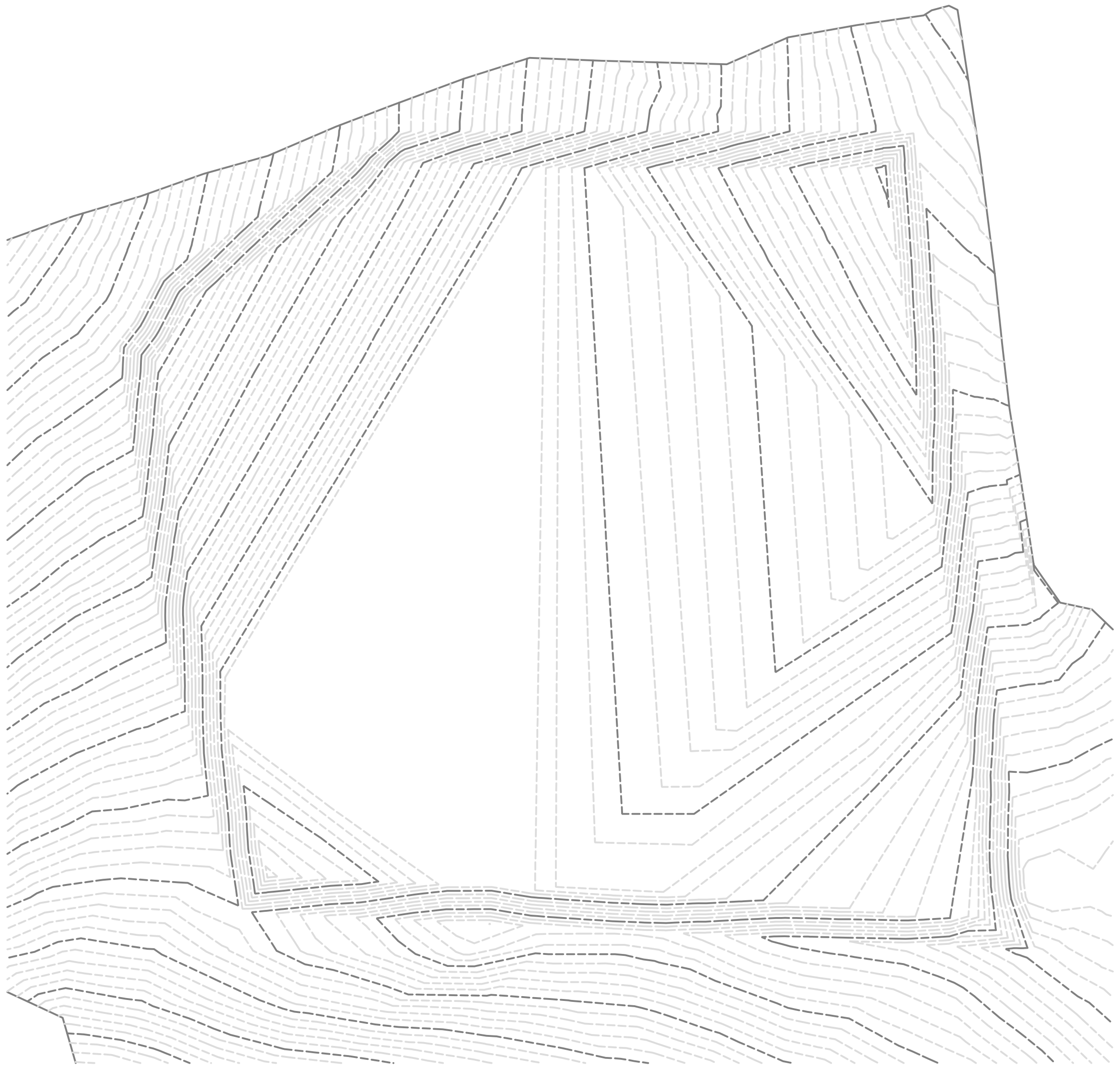
### 8.3.1 Overall Protection of Human Health and the Environment

Alternative 2 provides control of site wastes and contaminant transport by complete removal and encapsulation of site waste in a repository constructed on USFS administered lands. The human recreational user would be protected from arsenic and lead exposure in soil and surface water through the ingestion and dermal exposure pathways. Terrestrial wildlife and aquatic life would be protected from contaminant exposure by dermal contact and ingestion, and plant phytotoxicity due to arsenic, cadmium, copper, lead, and zinc would be mitigated by removing the waste from the site.

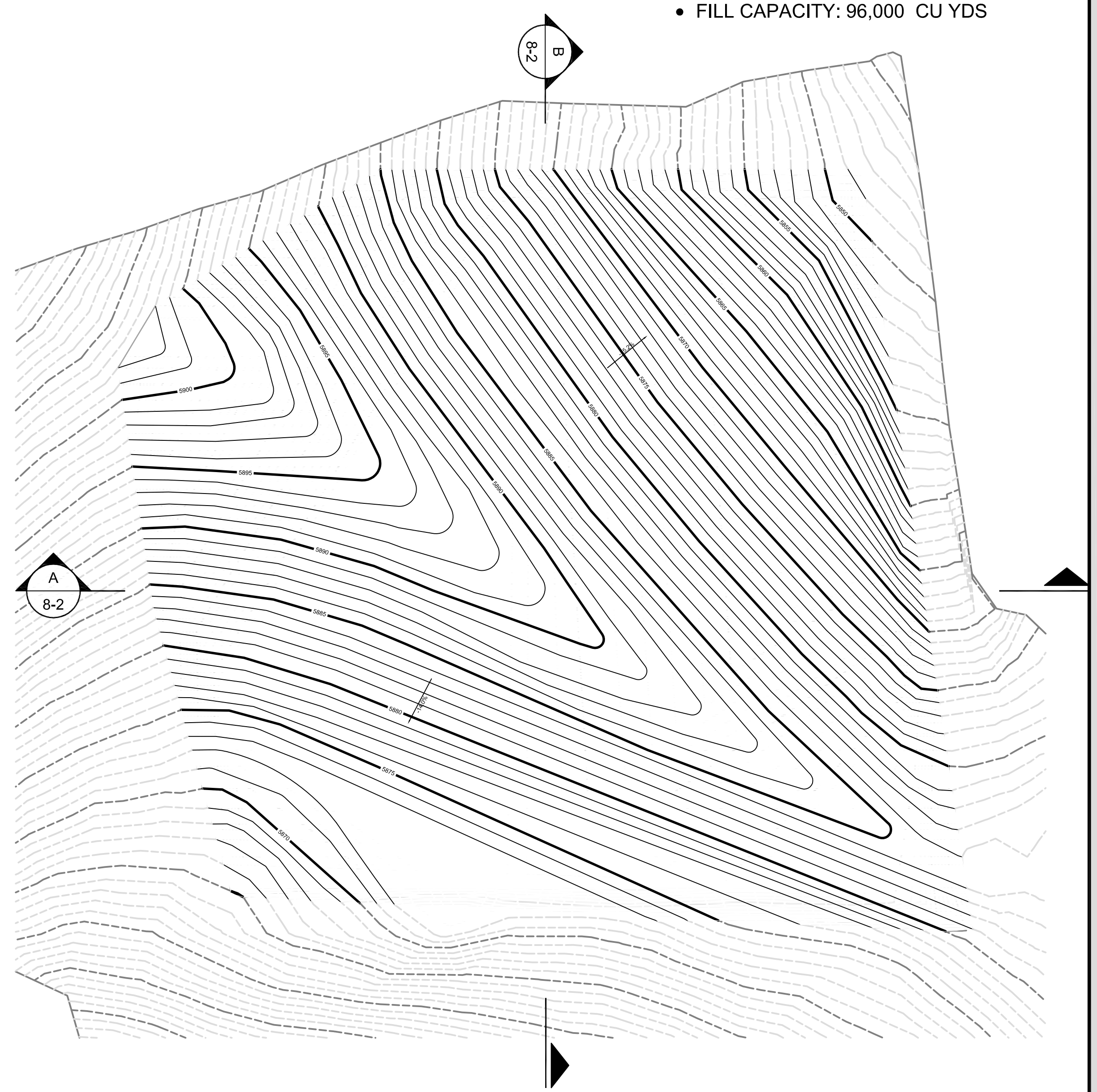
# Figure 8.1
# Repository Excavation and Option 1 Grading Plan

REPOSITORY CAP NOTES:

- TOP SLOPE 14 - 15%
- 2H:1V SIDE SLOPES
- FILL CAPACITY: 96,000 CU YDS



EXCAVATION PLAN
SCALE: 1"=100'
1
-




GRADING PLAN
SCALE: 1"=100'
2
-

***Legend***

Proposed Contour in Feet

Existing Contour in Feet

N

0 50 100 200

scale in feet

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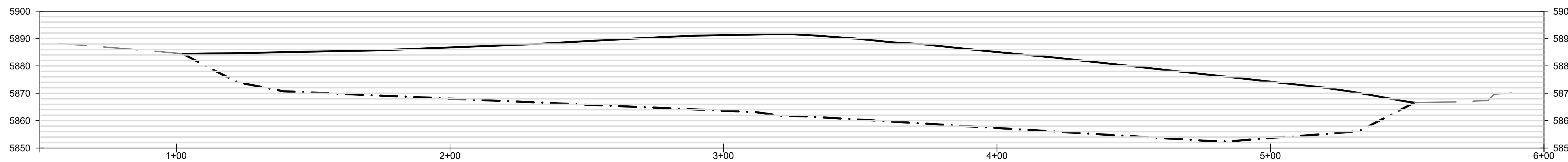
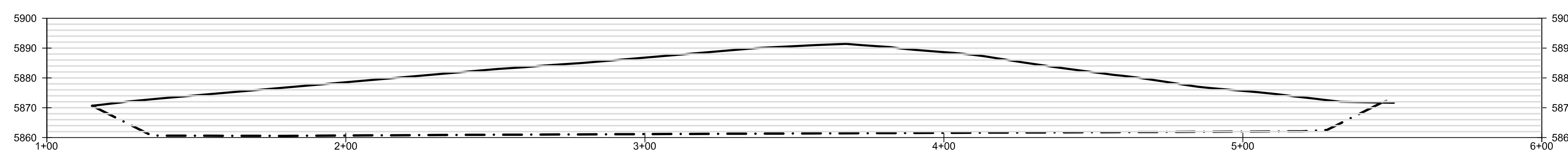



CROSS-SECTION A
SCALE: 1"=50'




CROSS-SECTION B
SCALE: 1"=50'

# Figure 8-2 Repository Option 1 Cross-Sections

***Legend***

EXISTING GROUND

REPOSITORY CAP

REPOSITORY EXCAVATION

0 25 50 100

scale in feet

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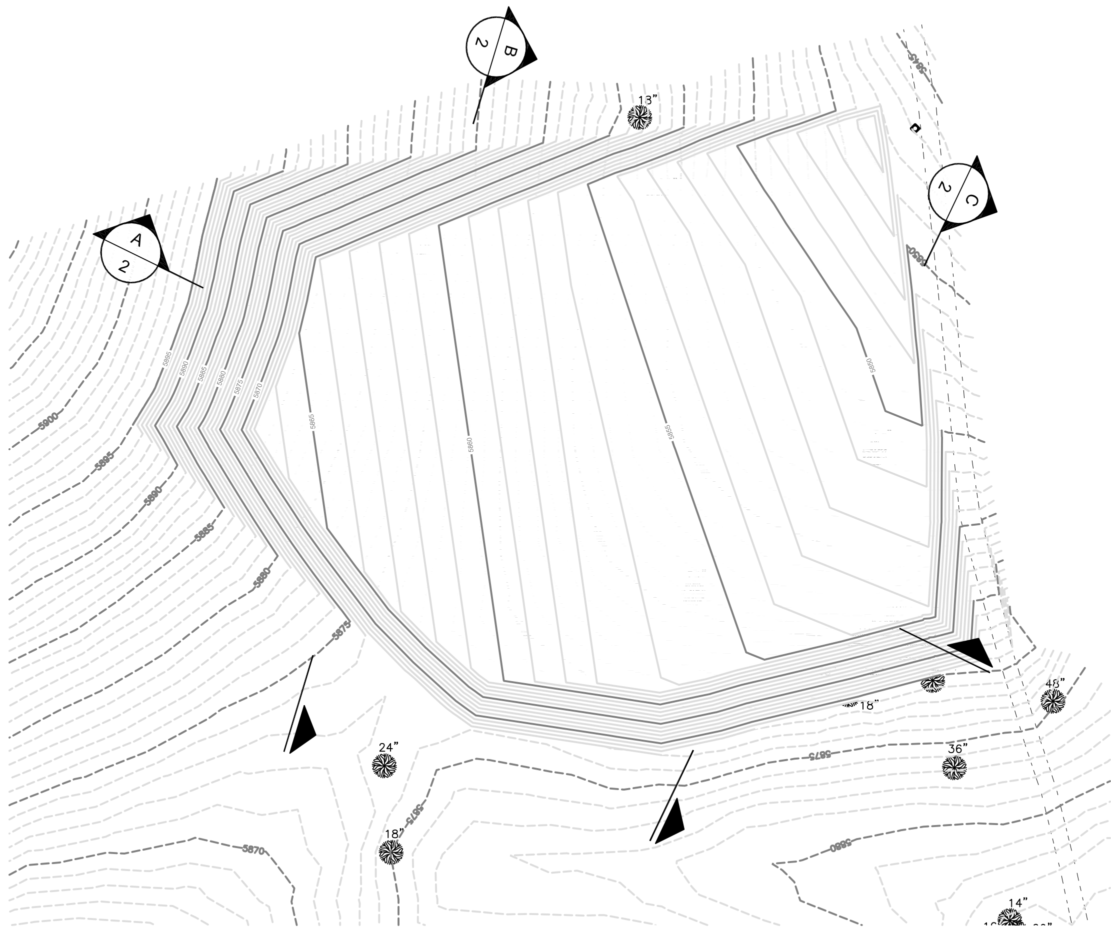
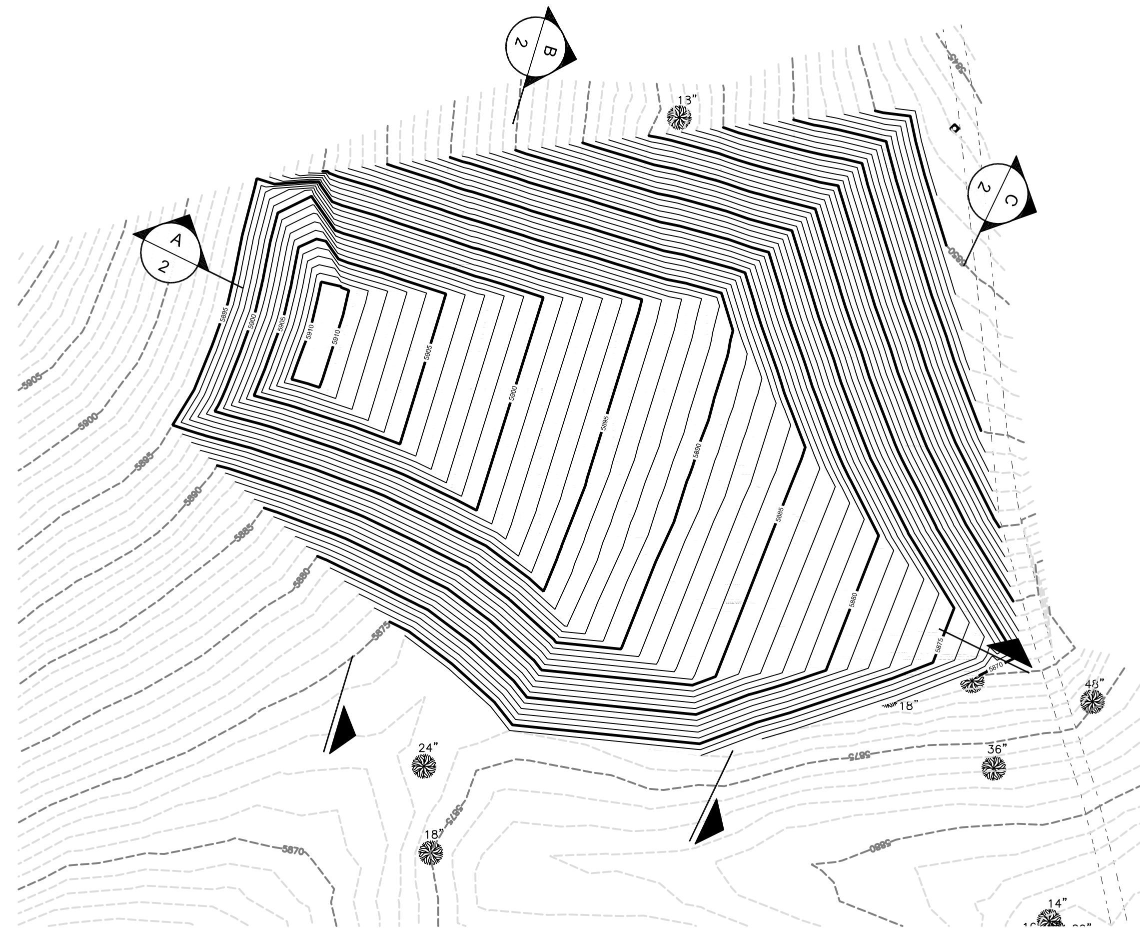
# Figure 8.3
# Repository Excavation and Option 2 Grading Plan

Repository Cap:
- 13' above Excavation Limits
- 5H:1V Side Slopes
- Fill Capacity: 90,417 Cu Yds



EXCAVATION PLAN
SCALE: 1"=100'



GRADING PLAN
SCALE: 1"=100'

*Legend*

- Proposed Contour in Feet
- Existing Contour in Feet

N

0 50 100 200
scale in feet

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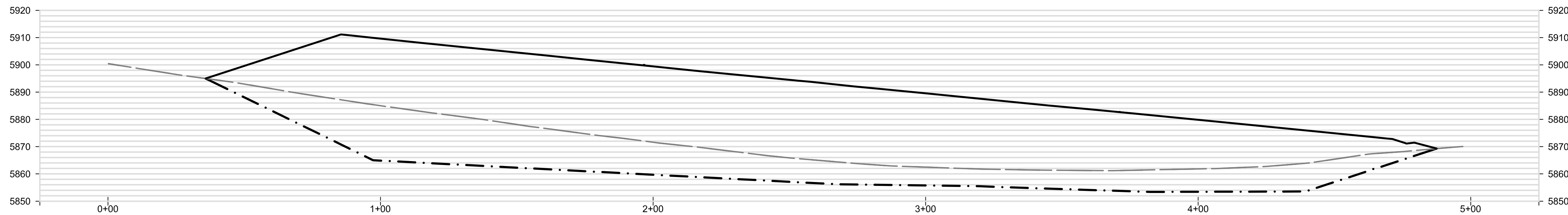
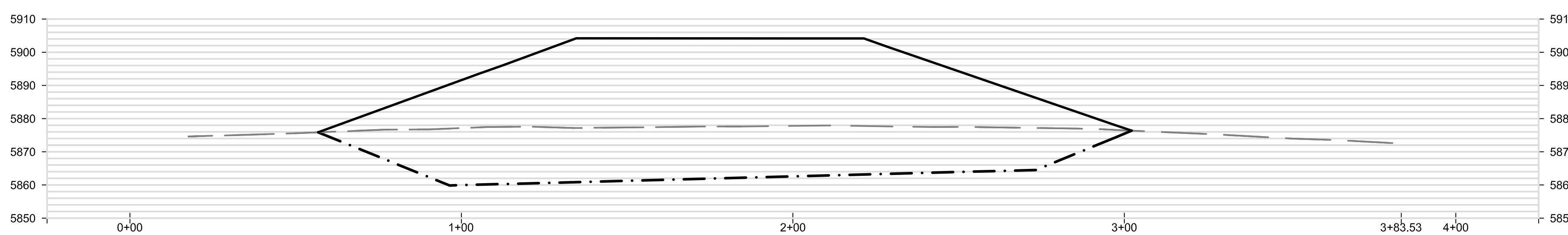
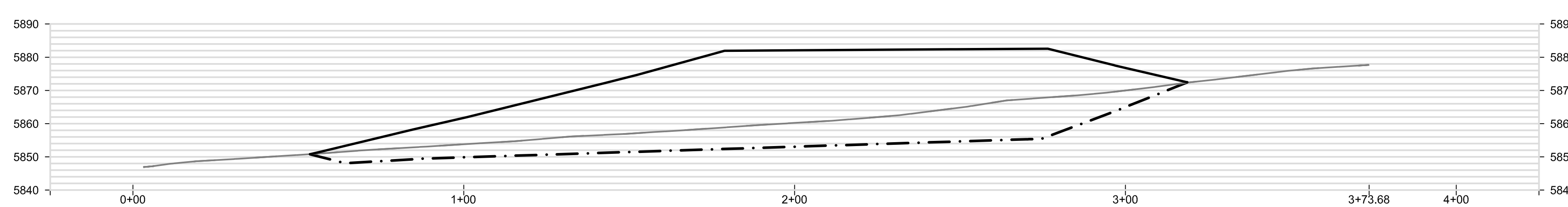
# Figure 8-4
# Repository Option 2 Cross-Sections




CROSS-SECTION A
SCALE: 1"=50'
-




CROSS-SECTION B
SCALE: 1"=50'
-




CROSS-SECTION C
SCALE: 1"=50'
-

*Legend*

- EXISTING GROUND
- REPOSITORY CAP
- REPOSITORY EXCAVATION

0 25 50 100
scale in feet

HERRERA
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Table 8-4 presents a risk reduction summary based on Alternative 2 for the exposure pathways and contaminants of concern identified in the baseline human health risk assessment and ecological risk assessment. Only contaminants with an EQ or HI greater than 1 are evaluated in the matrix.

**Table 8-4. Risk reduction matrix for Alternative 2, Forest Rose Mine Site.**

| COCs | Human Health Exposure Pathway: Recreational User Soil | Human Health Exposure Pathway: Recreational User Water | Ecological Exposure Pathway: Terrestrial Wildlife | Ecological Exposure Pathway: Aquatic Life | Ecological Exposure Pathway: Terrestrial Plant Community |
|---|---|---|---|---|---|
| Arsenic | Yes | Yes | – | Yes | Yes |
| Cadmium | – | – | – | Yes | Yes |
| Copper | – | – | – | Yes | Yes |
| Lead | Yes | Yes | Yes | Yes | Yes |
| Nickel | - | - | – | Yes | – |
| Silver | - | - | – | Yes | – |
| Zinc | - | - | – | Yes | – |

Yes Risk reduction achieved
– Not applicable; EQ or HI not greater than 1 for pathway

### 8.3.2 Compliance with ARARs

Implementation of Alternative 2 would meet all location- and action-specific ARARs including:

- Evaluation of culturally and historically significant site features by DEQ and documented to satisfy requirements of the National Historic Preservation Act (NHPA), the Montana Antiquities Act, and other historic preservation laws
- Requirements of the Surface Mining Control and Reclamation Act (SMCRA) for grading, drainage, erosion control, revegetation, and fish and wildlife protection
- Occupational Safety and Health Administration (OSHA) requirements for appropriate training, certification, personal protective equipment, and site safety controls by requiring contractors to comply with 29 CFR 1910.120 during all construction phases of the work.

Contaminant-specific ARARs are applicable to air quality, surface water, and groundwater quality at the Forest Rose Mine Site. State and federal numeric air quality would be met by controlling construction-generated dust. The tailings and waste rock would be removed from Dunkleberg Creek, eliminating mine waste and contaminated sediment at the site as exposure sources. The west slope adit discharge would be routed to an infiltration basin or trench, which would eliminate the adit discharge as an exposure source. This would also eliminate the direct-contact exposure pathway for human recreational users, terrestrial wildlife, and aquatic life. Groundwater was not characterized during the RI because it was not a part of the project scope.

### 8.3.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence of Alternative 2 would be ensured by the complete removal of waste and containment in the engineered repository. The repository would be shaped to promote surface water run-off and to eliminate surface water run-on. Waste would be placed and compacted to minimize settlement over time. The cap would be designed to minimize surface water infiltration and degradation of the cap by root penetration/or burrowing animals. The soil cover would be designed to promote vegetation of native plant species, which would further stabilize the cap through root cohesion and minimize infiltration through evapotranspiration. Once vegetation has been established, minimal long-term site monitoring and maintenance would be required.

Similarly, a soil cover would be placed over excavated areas at the mine site, designed to promote vegetation of native plant species.

Creek stabilization would ensure against headcut and provide features that are fish passable. Floodplain areas would be revegetated to provide erosion control and cover. Once the vegetation is established, minimal long-term site monitoring and maintenance would be required.

### 8.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Contaminant mobility would be greatly reduced by removing the waste and placing it in an engineered repository. The waste would no longer be susceptible to mobilization through surface water leaching, surface water erosion, sediment mobility in Dunkleberg Creek, wind erosion, or human disturbance. The waste volume would not be significantly reduced and no waste treatment (destruction) would occur under this alternative. The waste would be effectively isolated from humans and the environment.

### 8.3.5 Short-term Effectiveness

Alternative 2 would be implemented in one construction season. The design would be finalized and a construction bid package prepared in the spring. Construction bidding and contracting would be performed in the late spring and early summer, and construction would occur in the summer and fall. Construction would utilize standard construction techniques and equipment with readily available material resources.

Short-term environmental impacts from construction could include dust and surface water contaminant mobilization. Impacts would be mitigated by employing BMPs, including water trucks for dust suppression and silt fencing across Dunkleberg Creek at the downstream extent of the site to block sediment and waste movement offsite. Other BMPs would include wattles as erosion control, berms and other surface water run-on/run-off controls, and revegetation of disturbed areas.

The Forest Rose Mine Site is situated in a remote location and implementation of Alternative 2 would provide short-term impacts to the public during construction. Construction crews would utilize USFS Roads 707 and 5153 to support excavation and hauling processes. Local business would experience an increase in activity during construction seasons in terms of goods, services, and housing for construction workers.

### 8.3.6 Implementability

Alternative 2 is both technically and administratively feasible. The construction methods used to remove the waste, construct a repository, and reclaim site disturbances are considered standard in the construction field. Design methods and specifications are well documented and have been implemented at similar sites. Materials, equipment, and contractors are available to implement Alternative 2.

### 8.3.7 Costs

The total present worth cost of implementing Alternative 2 is estimated to be $2,833,300 (Table 8-5). The present worth value of 30 years of annual maintenance and monitoring costs are included in addition to capital costs. The major cost components of the project include:

- Contractor mobilization and demobilization
- Clear, grub, excave, and prepare repository
- Excavate and haul waste to the repository
- Place, compact, and grade waste in the repository
- Construct repository cap and soil cover
- Grade and shape reclaimed Forest Rose Mine Site
- Stabilize Dunkleberg Creek
- Install adit discharge infiltration feature
- Seed, mulch, and plant reclaimed area and repository
- Install temporary fencing
- Annual inspection and maintenance

## 8.4 Alternative 3: Offsite Disposal in Permitted Solid Waste Disposal Facility and Creek Stabilization

Alternative 3 would include removal of waste rock and tailings from the Forest Rose Mine Site and disposal in an offsite permitted facility. The material would be loaded into trucks and hauled with side dumps or belly dumps with pups to maximize freeway load sizes for transfer to the nearest facility permitted to accept the waste, according to provisions of Montana solid waste disposal regulations.

Subtitle D landfills are required to have a multilayer cap/liner, a leachate collection system, and a landfill gas collection system. The multilayer cap/liner consists of a plastic geomembrane on the outside with a geosynthetic clay liner (GCL) inside of the geomembrane. Subtitle D landfills are designed to keep water out, but a leachate collection system is included for water that comes into contact with the refuse or moisture created in the decomposition process. Additionally the gas collection system collects landfill gas created during the decomposition process, which is routed to flare systems or to a facility to create energy.

**Table 8-5. Alternative 2 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $250,700 | $250,700 | |
| Clearing and Grubbing | 1 | LS | $20,900 | $20,900 | |
| Road Grade Preparation | 17600 | SY | $4.00 | $70,400 | |
| Excavation | 130000 | CY | $7.00 | $910,000 | |
| Haul | 90000 | CY | $6.00 | $540,000 | |
| Waste Placement and Compaction | 130000 | CY | $4.00 | $520,000 | |
| Final Grading | 31654 | SY | $3.00 | $95,000 | |
| Grading of Creek | 2889 | SY | $3.00 | $8,700 | |
| Grade Control Structures | 130 | EA | $400 | $52,000 | |
| Repository Geomembrane | 13000 | SY | $3.00 | $39,000 | |
| Soil Cover Cap (from onsite) | 12922 | CY | $3.00 | $38,800 | |
| Planting | 6.54 | AC | $4,000 | $26,200 | |
| Seeding, Fertilizer, Mulch | 6.54 | AC | $2,000 | $13,100 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Temporary Fencing | 2,660 | LF | $7.50 | $20,000 | |
| BMPs | 1 | LS | $150,000 | $150,000 | |
| Subtotal | | | | $2,757,800 | |
| **TOTAL CAPITAL COST** | | | | | **$2,757,800** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $3,000 | $3,000 | |
| Subtotal | | | | $3,850 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$3,850** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$75,500** |
| **TOTAL PRESENT VALUE COST** | | | | | **$2,833,300** |

Reclamation work at the site would consist of

- Over-excavating mine waste
- Hauling the contaminated waste to a permitted offsite disposal area

- Regrading and recontouring the reclaimed surfaces
- Regrading and stabilizing Dunkleberg Creek
- Site revegetation
- Implementing BMPs to reduce erosion on reclaimed features
- Infiltrating intermittent surface water discharge from the adit on the west slope of the ravine
- Temporary fencing

The site would be recontoured to match preexisting mining slopes. Approximately 1,300 linear feet of Dunkleberg Creek would be graded to provide a slope that is consistent with the upstream and downstream portions of Dunkleberg Creek not impacted by mine waste. The grade of Dunkleberg Creek would be controlled by structures to prevent the creek from head cutting upstream. Grade control structures would be built with natural materials (wood and/or rock), located and sized to allow fish passage. Recontoured areas and the Dunkleberg Creek floodplain would be revegetated following construction.

The estimated volume of waste removal is 90,000 cubic yards. See Table 8-3 for waste volumes.

### 8.4.1 Overall Protection of Human Health and the Environment

Alternative 3 provides control of site wastes and contaminant transport by complete removal and encapsulation of site waste at a permitted offsite disposal facility. The human recreational user would be protected from arsenic and lead exposure in soil and surface water through ingestion and dermal exposure pathways. Terrestrial wildlife and aquatic life would be protected from contaminant exposure by dermal contact and ingestion, and plant phytotoxicity due to arsenic, cadmium, copper, lead, and zinc would be mitigated by removing the waste from the site.

Table 8-6 presents a risk reduction summary based on Alternative 3 for the exposure pathways and contaminants of concern identified in the baseline human health risk assessment and ecological risk assessment. Only contaminants with an EQ or HI greater than 1 are evaluated in the matrix.

### 8.4.2 Compliance with ARARs

Implementation of Alternative 3 would meet all location and action-specific ARARs including:

- Evaluation of culturally and historically significant site features by DEQ and documented to satisfy the requirements of NHPA, the Montana Antiquities Act, and other historic preservation laws

- SMCRA requirements for grading, drainage, erosion control, revegetation, and fish and wildlife protection
- OSHA requirements for appropriate training, certification, personal protective equipment, and site safety controls will be met by requiring the contractors to comply with 29 CFR 1910.120 during all construction phases of the work

**Table 8-6. Risk reduction matrix for Alternative 3, Forest Rose Mine Site.**

| COCs | Human Health Exposure Pathway: Recreational User Soil | Human Health Exposure Pathway: Recreational User Water | Ecological Exposure Pathway: Terrestrial Wildlife | Ecological Exposure Pathway: Aquatic Life | Ecological Exposure Pathway: Terrestrial Plant Community |
|---|---|---|---|---|---|
| Arsenic | Yes | Yes | – | Yes | Yes |
| Cadmium | – | – | | Yes | Yes |
| Copper | | | – | Yes | Yes |
| Lead | Yes | Yes | Yes | Yes | Yes |
| Nickel | – | – | – | Yes | – |
| Silver | | | | Yes | |
| Zinc | – | – | – | Yes | – |

Yes Risk reduction achieved
– Not applicable; EQ or HI not greater than 1 for pathway

Contaminant-specific ARARs are applicable to air quality, surface water, and groundwater quality at the Forest Rose Mine Site. State and federal numeric air quality would be met by controlling construction-generated dust. The tailings and waste rock would be removed from Dunkleberg Creek, eliminating mine waste and contaminated sediment at the site as exposure sources. This would also eliminate the direct-contact exposure pathway for human recreational users, terrestrial wildlife, and aquatic life. The west slope adit discharge would be routed to an infiltration basin or trench, which would eliminate the adit discharge as an exposure source. Groundwater was not characterized during the RI because it was not a part of the project scope.

### 8.4.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence of Alternative 3 would be ensured by the complete removal of waste and disposal in an offsite permitted disposal facility designed in accordance with the Montana Solid Waste Management Act.

A soil cover would be placed over excavated areas at the mine site, designed to promote vegetation of native plant species.

Creek stabilization would ensure against headcut and provide features that are fish passable. Floodplain areas would be revegetated to provide erosion control and cover. Once the vegetation is established, minimal long-term site monitoring and maintenance would be required.

### 8.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Contaminant mobility would be greatly reduced by removing the waste and placing the waste in a permitted offsite solid waste facility. The waste would no longer be susceptible to mobilization through surface water leaching, surface water erosion, sediment mobility in Dunkleberg Creek, wind erosion, or human disturbance. The waste volume would not be significantly reduced and no waste treatment (destruction) would occur under this alternative. The waste would be effectively isolated from humans and the environment.

### 8.4.5 Short-term Effectiveness

Alternative 3 would be implemented in one construction season. A design would be finalized and a construction bid package prepared in the spring. Construction bidding and contracting would be performed in the spring, and construction would occur in the summer and fall. The site would be seeded and planted no earlier than September 15, 2011 and prior to ground freeze or snow covering the site. Construction would utilize standard construction techniques and equipment with readily available material resources.

Short-term environmental impacts from construction could include dust and surface water contaminant mobilization. Impacts would be mitigated by employing BMPs, including water trucks for dust suppression and silt fencing across Dunkleberg Creek at the downstream extent of the site to block sediment and waste movement offsite. Other BMPs would include wattles as erosion control, berms and other surface water run-on/run-off controls, and revegetation of disturbed areas.

The Forest Rose Mine Site is situated in a remote location and implementation of Alternative 3 would provide short-term impacts to the public during construction. Construction crews would utilize 11 miles of USFS Road 707 during excavation and hauling, as well as federal highways while hauling to the nearest permitted solid waste facility. Local business would experience an increase in activity during construction in terms of goods, services, and housing for construction workers.

### 8.4.6 Implementability

Alternative 3 is both technically and administratively feasible. The construction methods used to remove the waste, and reclaim site disturbances are considered standard in the construction field. Design methods and specifications are well documented and have been implemented at similar sites. Materials, equipment, and contractors are available to implement Alternative 3.

### 8.4.7 Costs

The total present worth cost of implementing Alternative 3 is estimated to be $8,337,000 (Table 8-7). The present worth value of 30 years of annual maintenance and monitoring costs are included in addition to capital costs. The major cost components of the project include:

- Contractor mobilizationand demobilization
- Excavate and haul waste to the offsite permitted facility
- Grade and shape reclaimed Forest Rose Mine Site
- Stabilize Dunkleberg Creek
- Install adit discharge infiltration feature
- Seed, mulch, and plant reclaimed area
- Annual inspection and maintenance (3 years).

**Table 8-7. Alternative 3 cost estimate, Forest Rose Mine Site.**

| Activity/ Material/ Description | Quantity | Unit | Unit Price | Cost (rounded) | Sum |
|---|---|---|---|---|---|
| **CAPITAL COSTS** | | | | | |
| Mobilization/Demobilization (not to exceed 10% of Capital Costs) | 1 | LS | $754,800 | $754,800 | |
| Clearing and Grubbing | 1 | LS | $7,600 | $7,600 | |
| Road Grade Preparation | 96800 | SY | $4.00 | $290,400 | |
| Excavation | 90,000 | CY | $7.00 | $630,000 | |
| Waste Haul and Disposal | 90,000 | CY | $70.00 | $6,300,000 | |
| Final Grading | 18731 | SY | $3.00 | $56,200 | |
| Grading of Creek | 2889 | SY | $3.00 | $8,700 | |
| Grade Control Structures | 130 | EA | $400 | $52,000 | |
| Planting | 3.87 | AC | $4,000 | $15,500 | |
| Seeding, Fertilizer, Mulch | 3.87 | AC | $2,000 | $7,700 | |
| Infiltration Trench/Basin | 1 | LS | $3,000 | $3,000 | |
| Stormwater BMPs | 1 | LS | $80,000 | $80,000 | |
| Subtotal | | | | $8,302,700 | |
| **TOTAL CAPITAL COST** | | | | | **$8,302,700** |
| **ANNUAL O+M COSTS** | | | | | |
| Inspections (1/yr) | 1 | EA | $450 | $450 | |
| Sampling and Analysis (1/yr) | 1 | EA | $400 | $400 | |
| Maintenance | 1 | LS | $900 | $900 | |
| Subtotal | | | | $1,750 | |
| **TOTAL ANNUAL O+M COST** | | | | | **$1,750** |
| Present Value of O+M Cost (2011) | 30 | yr | | | **$34,300** |
| **TOTAL PRESENT VALUE COST** | | | | | **$8,337,000** |

# 9.0 Comparative Analysis of Reclamation Alternatives

This section summarizes results of the detailed analysis performed on the three proposed reclamation alternatives and provides a comparison of the retained alternatives to threshold and primary balancing criteria.

Threshold criteria include:

- Protection of human health and the environment
- Compliance with ARARs

Primary balancing criteria include:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Table 9-1 provides a summary of the alternatives with respect to the assessment criteria.

## 9.1 Threshold Criteria

**Alternative 1, No Action**, would not be protective of human health and the environment and would not comply with ARARs. No contaminated materials would be treated, removed, or actively managed under the no action alternative. Contaminant-specific ARARs are applicable to surface water and groundwater quality at the Forest Rose Mine Site and would not be addressed under Alternative 1. The human health and ecological risk-based cleanup goals would not be met.

**Alternative 2, Capping in Repository located on USFS administered lands and Creek Stabilization,** is protective of human health and the environment, since the source of contamination would be removed and contained in an engineered repository. The repository would include a low permeability cap with a geomembrane liner to prevent surface water infiltration and minimize leaching of contaminants into the subsurface. Lime could be added to waste during placement in the repository to balance the acid generating potential; a soil liner amended with bentonite could be used to provide a factor of safety against leaching. Alternative 2 complies with contaminant-, location-, and action-specific ARARs, protecting human and ecological receptors from COCs in soil and surface water. The alternative also complies with applicable preservation laws and regulations.

**Alternative 3, Offsite Disposal in Permitted Solid Waste Disposal Facility and Creek Stabilization** is protective of human health and the environment, since the source of

## Table 9-1. Comparative analysis of reclamation activities and assessment criteria, Forest Rose Mine Site.

| Assessment Criteria | Alternative 1:<br>No Action | Alternative 2:<br>Disposal in Repository Located on USFS-administered Lands and Creek Stabilization | Alternative 3:<br>Offsite Disposal in Permitted Solid Waste Disposal Facility and Creek Stabilization |
|---|---|---|---|
| **Threshold Criteria** | | | |
| Overall protection of human health | No protection to human health | Protective of human health and achieves human health risk based cleanup goals. | Protective of human health and achieves human health risk based cleanup goals. Most protective of the human health due to the requirements of the disposal facility. |
| Overall protection of the environment | No protection to the environment | Protective of the environment and achieves project reclamation goals. | Protective of the environment and achieves project reclamation goals. Most protective of the environment due to the requirements of the disposal facility. |
| **Compliance with ARARs** | | | |
| Contaminant specific | Does not comply with ARARs | Complies with surface water ARARs. Does not comply with groundwater ARARs because groundwater was not included in the project scope. | Complies with surface water ARARs. Does not comply with groundwater ARARs because groundwater was not included in the project scope. |
| Location specific | Does not comply with ARARs | Complies with ARARs. Install BMPs during reclamation to avoid impacting Westslope Cutthroat. | Complies with ARARs. Install BMPs during reclamation to avoid impacting Westslope Cutthroat. |
| Action specific | Does not comply with ARARs | Complies with ARARs | Complies with ARARs |
| **Primary Balancing Criteria** | | | |
| Long-term effectiveness | Not effective. Exposure hazards, pathways, and transport mechanisms continue to exist. May cost more in the long-term. | Effective in the long-term. Removal of waste and disposal in an engineered repository would isolate human and ecological receptors from the waste. | Most effective long-term alternative. Waste would be isolated from human and ecological receptors by hauling it offsite. |
| Reduction of toxicity, mobility, and volume of waste | No reduction of toxicity, mobility, and volume of waste | Waste volume would not be reduced, but the waste would be isolated and immobilized in the repository. | Waste volume would not be reduced, but the waste would be isolated and immobilized in the offsite disposal facility. |
| Short-term effectiveness | Not effective. | Minimal environment impacts in the short-term. The road from the mine site to the repository is two miles and there are no houses on that section of road. Dust suppression and road blading should be performed during reclamation activities. Reclamation could be performed in one construction seasons. | Minimal short-term impacts to the environment. Hauling 11 miles on Forest Service/Granite County roads to the freeway would degrade during hauling activities. The roads would have to be bladed during reclamation activities to ensure a safe traveling surface. Haul trucks would have to travel past four houses and would impact local travel on the gravel road. Dust suppression would also have to be performed during hauling activities. Reclamation could be performed in one season. |
| Implementability | Not applicable | Implemented with standard construction equipment and personnel. Labor, equipment, and materials are locally available. | Implemented with standard construction equipment and personnel. Labor, equipment, and materials are locally available. |
| **Cost** | **$0** | **$2,833,300** | **$8,337,000** |

contamination would be removed and placed in an engineered facility with a bottom liner, multilayer cap, a leachate collection system, and a landfill gas collection system. Alternative 3 complies with contaminant-, location-, and action-specific ARARs, protecting human and ecological receptors from COCs in soil and surface water. The alternative also complies with applicable preservation laws and regulations.

## 9.2 Primary Balancing Criteria

The primary balancing criteria does not apply to Alternative 1, based on the following:

- It does not provide long-term effectiveness and permanence
- It does not reduce toxicity, mobility, or volume of waste through treatment
- It is not effective in the short-term
- There is no action to implement
- There are no costs

Alternative 1 is not retained for further consideration.

Alternative 2 is effective in the long-term and provides permanent protection for the site. Contaminant mobility would be reduced by removing the waste and placing it in an engineered repository. The proposed repository would be designed to control potential leachate generation with a cover system and surface water drainage system. Amending the waste with lime during construction would provide additional insurance, if deemed necessary. Short-term issues, such as contaminant mobilization by wind and water, would be mitigated through the use of BMPs and proper personal protective equipment (PPE). Alternative 2 would require substantial use of USFS roads over the two mile distance between the mine site and repository. Thepossibility of accidents and waste release during transport could be mitigated by improving and maintaining the roads at critical locations along the haul route. These roads are not routinely used by local residents and local traffic would be minimal. Alternative 2 may be implemented with conventional construction equipment and personnel.

Alternative 3 is also effective in the long-term and provides permanent protection for the site. Contaminant mobility would be reduced by removing the waste and placing it in a permittedfacility, with a cover and stormwater drainage system, bottom liner, and groundwater monitoring system meeting RCRA Subtitle D design requirements. Short-term issues, such as contaminant mobilization by wind and water, would be mitigated through the use of BMPs and proper PPE. Alternative 3would require substantial use of USFS Road 707 over the 11-mile distance between the mine site and Interstate 90. Thepossibility of accidents and waste release during transport could be mitigated by improving the road at critical locations to minimize failure potential. USFS Road 707 is routinely utilized by local residents for access and agricultural use. Alternative 3 may be implemented with conventional construction equipment and personnel. Alternative 3 is the most costly alternative, due to hauling and waste disposal fees. Alternative 3 would result in more truck traffic and waste hauling on local roads, increasing the potential for public exposure to contaminated waste and traffic-related accidents.

# 10.0 Preferred Alternative

Alternative 2 is selected as the preferred alternative – it provides the same level of protection at the site as Alternative 3, but is less costly and would have less traffic impacts on the populated portion of USFS roads. The more strict design features of a Subtitle D permitted facility compared to the proposed repository would provide a minimal measure of added long-term effectiveness. Proposed reclamation activities would achieve project goals of minimizing human and ecological exposure to contaminants associated with mine waste and reduce the mobility of contaminants.

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# APPENDIX A

# ARARs Table

# APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

# (ARARS)

# FOR

# ABANDONED MINE LANDS RECLAMATION PROJECTS

**NOVEMBER, 2010**

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## ARARS FOR ABANDONED MINE LANDS RECLAMATION PROJECTS

### 1.0 INTRODUCTON- HISTORY OF ARARS AT ABANDONED MINE LANDS RECLAMATION SITES

After the enactment of the Federal Surface Mining Control and Reclamation Act in 1977 ("SMCRA", 30 USC §§ 1201-1238), the State of Montana (State) was delegated the authority to implement the Abandoned Mine Lands Reclamation ("AMLR") program and was granted funding for implementation of that program, by the Federal Office of Surface Mining, Reclamation, and Enforcement ("OSM"). The State enacted necessary legislation to implement the AMLR program according to State law and developed a plan ("Reclamation Plan") to do so, which was approved by OSM. Delegation of exclusive authority for the program would follow. Montana passed necessary legislation for reclamation of coal mines (*The Montana Strip and Underground Reclamation Act,* 82-4-201, *et seq.*, MCA), as well as legislation for reclamation of other types of mines (*The Metal Mine Reclamation* Act, 82-4-301, *et seq.*, MCA and *The Opencut Mining Act,* 82-4-401, *et seq.*, MCA).

Satisfaction of the requirements of SMCRA by the State resulted in delegation by OSM to the State the exclusive authority to implement the Reclamation Plan on November 24, 1980. While the delegation of the program in 1980 was limited to abandoned coal mine reclamation, it was expanded by Montana's showing it had reclaimed all eligible abandoned coal mines, whereupon OSM approved the 1995 amendments to the State's Reclamation Plan to include non-coal abandoned mines. This approval resulted in additional delegation of authority to the State to implement reclamation of abandoned hardrock mines as well as quarries.

In the 1995 Amendments to its Reclamation Plan, the State of Montana stated that the AMLR program would comply with the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"). 40 Code of Federal Regulations (CFR) Part 300 (1990). Among other things, the NCP provides a procedure for evaluating alternative cleanup methods for hazardous wastes. The NCP also establishes cleanup standards for hazardous wastes, referred to as Applicable or Relevant and Appropriate Requirements ("ARARs"). By requiring compliance with the NCP, the State adopted the NCP procedures for evaluation of alternatives in addressing AMLR Reclamation Projects, as well as ARARS. In addition, the evaluation of alternatives procedures found in the NCP satisfy the requirements of the National Environmental Policy Act ("NEPA", 42 USC 4321 – 4370) to evaluate alternatives where actions undertaken could have a significant effect on the environment.

AMLR, which is based upon SMCRA, is one of several legal authorities available in the State for cleanup of mine wastes, the others being the Federal Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA" or "Superfund", 42 USC 9601 – 9675) and the State's counterpart to the Federal Superfund law, the

Comprehensive Environmental Cleanup and Responsibility Act ("CECRA," §§ 75-10-701 - 752 MCA).

The ARARs described below are, by necessity, generic because they are to be used as part of the evaluation process developed by the AMLR program for analysis of alternatives for AMLR Projects. This evaluation results in the Expanded Engineering Evaluation/Cost Analysis ("EEE/CA") which precedes selection of a Reclamation alternative.

## 2.0 TYPES OF ARARS

ARARs are either "applicable" or "relevant and appropriate." Both types of requirements are mandatory under the NCP. Applicable requirements are those cleanup standards, standards of control, requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location or other circumstances found at a abandoned mine reclamation site.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at a mining reclamation site, address problems or situations sufficiently similar to those found at the mining reclamations site that their use is well suited to the particular site.

The determination that a requirement is relevant and appropriate is a two-step process: (1) determination if a requirement is relevant; and (2) determination if a requirement is appropriate. In general, this involves a comparison of a number of site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action; the medium and substances regulated by the requirement and the proposed requirement; the actions or activities regulated by the requirement and the remedial action; and the potential use of resources addressed in the requirement and the remedial action. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were an applicable requirement.

ARARs are divided into contaminant specific, location specific, or action specific requirements, as described in the NCP and EPA Guidance. Contaminant specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals which may be found in or discharged to the ambient environment. Location specific requirements are restrictions placed upon 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 sites, rather than to the nature of contaminants at sites. Action specific requirements are usually technology based or activity based requirements or limitations on actions taken with respect to hazardous substances, pollutants or contaminants. A given cleanup activity will trigger an action specific requirement. Such requirements do not themselves determine the cleanup alternative, but define how chosen cleanup methods should be performed.

Each ARAR or group of related ARARs indentified herein is followed by a specific statutory or regulatory citation, a classification describing whether the ARAR is applicable or relevant and appropriate, and a description which summarizes the requirements.

Many requirements listed as ARARs are promulgated as identical or nearly identical requirements in both federal and state law, usually pursuant to delegated environmental programs administered by both EPA and the states, such as many of the requirements of the federal Clean Water Act and the Montana Water Quality Act. The Preamble to the NCP states that such a situation results in citation to the state provision as the appropriate standard, but treatment of the provisions is a federal requirement. ARARs and other laws which are unique to state law are identified as state ARARs.

As noted previously, the 1995 Reclamation Plan provides that the NCP was adopted for Reclamation activities. Reclamation activities are directly analogous to “removal actions” under CERCLA. As stated in the NCP at 55 Federal Register (Fed. Reg.) 8695 (March 8, 1990):

> The purpose of removal actions generally is to respond to a release…so as to prevent, minimize, or mitigate harm to human health and the environment. Although all removals must be protective…removals are distinct from remedial actions in that they may mitigate or stabilize the threat rather than comprehensively address all the threats at a site. Consequently, <u>removal actions cannot be expected to attain all ARARs.</u> Remedial actions, in contrast, must comply with all ARARs or obtain a waiver. (emphasis added).

Consequently, the NCP, at 40 CFR 300.410 provides that ARARS at removal actions:

> …shall, to the extent practicable, considering the exigencies of the situation, attain…[ARARs]. In determining whether compliance with ARARs is practicable, the lead agency may consider appropriate factors, including:
>
> a) the urgency of the situation; and
>
> b) the scope of the removal action to be conducted.

Therefore, based upon the NCP, after an ARAR has been identified for a Reclamation activity, the EEE/CA should evaluate how the alternatives will attain ARARs and select an alternative that complies with ARARs to the extent practicable. If an ARAR cannot be complied with, the EEE/CA should indicate why, utilizing the two part test set out above, attainment is not practicable.

## 3.0 CONTAMINANT-SPECIFIC ARARs

### 3.1 Federal

#### 3.1.1 Safe Drinking Water Act

**Safe Drinking Water Act, 42 U.S.C. § 300f, et seq., National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141 and 142 (relevant and appropriate).** The National Primary and Secondary Drinking Water Regulations (40 CFR Parts 141 and 143) establish maximum contaminant levels (MCL) for chemicals in drinking water distributed in public water systems. These are enforceable in Montana under the Public Water Supplies, Distribution, and Treatment Act and corresponding regulations, MCA § 75-6-101, *et seq.*, and ARM § 17.38.203. Safe Drinking Water Act MCLs are relevant and appropriate for reclamation projects because the groundwater in a reclamation project area is a potential source of drinking water.

The determination that the drinking water standards are relevant and appropriate for reclamation projects is supported by the regulations and guidance. The Preamble to the NCP clearly states that the MCLs are relevant and appropriate for ground or surface water that is a current or potential source of drinking water. *See* 55 Fed. Reg. 8750, March 8, 1990, and 40 CFR § 300.430(e)(2)(I)(B). MCLs developed under the Safe Drinking Water Act generally are ARARs for current or potential drinking water sources. *See EPA Guidance On Remedial Action For Contaminated Groundwater at Superfund Sites*, OSWER Dir. #9283.1-2, December 1988.

In addition, maximum contaminant level goals (MCLG) may also be relevant and appropriate. *See* 55 Fed. Reg. 8750-8752. MCLGs are health-based goals that are established at levels at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety. According to the NCP, MCLGs that are set at levels above zero must be attained for ground or surface waters that are current or potential sources of drinking water. Where the MCLG for a contaminant has been set at a level of zero, the MCL promulgated for that contaminant must be attained.

The MCLs and MCLGs for contaminants of concern are:

| Contaminant | MCL (mg/L) | MCLG[a] (mg/L) |
|---|---|---|
| Antimony | 0.006 | 0.006 |
| Arsenic | 0.01 | NE |
| Cadmium | 0.005[b] | 0.005[b] |

| | | |
|---|---|---|
| Copper | 1.3[c] | 1.3[c] |
| Iron | 0.3[d] | NE |
| Lead | 0.015[c] | 0 |
| Manganese | 0.05[d] | NE |
| Mercury | 0.002[b] | 0.002[b] |
| Silver | 0.10[d] | NE |
| Thallium | 0.002[b] | 0.0005 |
| Zinc | 5.0[d] | NE |

NE - Not Established

[a] 40 CFR § 141.51(b)
[b] 40 CFR § 141.62(c)
[c] 40 CFR § 141.80(c) – No MCL, but specifies BAT to be applied.
[d] 40 CFR § 143.3 – Secondary MCL

ARM 17.38.203 incorporates by reference into State law the MCLs for inorganic substances set forth in 40 CFR Part 141 (Primary Drinking Water Standards).

### 3.1.2 Clean Water Act

**Federal Surface Water Quality Requirements, Clean Water Act, 33 USC § 1251, *et seq.* (applicable).** As provided under Section 303 of the Clean Water Act, 33 U.S.C. § 1313, the State of Montana has promulgated water quality standards. See the discussion concerning State surface water quality requirements.

### 3.1.3 National Ambient Air Quality Standards

**National Ambient Air Quality Standards, 40 CFR § 50.6 (PM-10); 40 CFR § 50.12 (lead) (applicable).** These provisions establish standards for PM-10 and lead emissions to air. (Corresponding state standards are found at ARM § 17.8.222 [lead] and ARM § 17.8.223 [PM-10].

## 3.2 State

### 3.2.1 Groundwater Protection

**Application of Groundwater Standards and Basis for Classificaitons, ARM 17.30.1005 (applicable).** Explains the applicability and basis for the groundwater standards in ARM § 17.30.1006, which establish the maximum allowable changes in groundwater quality and may limit discharges to groundwater.

**Classification, Beneficial Uses and Specific Standards for Groundwater, ARM 17.30.1006 (applicable).** Provides that groundwater is classified into Classes I through IV based on its specific conductance and establishes the applicable groundwater quality standards with respect to each groundwater classification.

Concentrations of dissolved substances in Class I or II groundwater may not exceed the human health standards listed in department Circular DEQ-7.[1] These levels are listed below for the primary contaminants of concern.

| Contaminant | DEQ-7 Standard (µg/L)[a] |
|---|---|
| Antimony | 6 |
| Arsenic | 10 |
| Cadmium | 5 |
| Copper | 1,300 |
| Iron | NE[b] |
| Lead | 15 |
| Manganese | NE[b] |
| Mercury | 2 |
| Silver | 100 |
| Thallium | 2 |
| Zinc | 2,000 |

NE- Not Established

[a] DEQ-7 standards for metals and arsenic in ground water are based on the dissolved portion of the sample (after filtration through a 0.45 $\mu$m membrane filter).

[b] Concentrations of iron and manganese must not reach values that interfere with the uses specified in the surface and groundwater standards (ARM 17.30.601 et seq. and ARM 17.30.1001 et seq.). The secondary maximum contaminant levels of 300 $\mu$g/L for iron and 50 $\mu$g/L for manganesemay be considered guidance to determine levels that will interfere with the specified uses.

Reclamation activities must meet the DEQ-7 standards for all contaminants at a site. In addition, for Class I and Class II groundwater, no increase of a parameter may cause a violation of Section 75-5-303, MCA (nondegradation).

ARM 17.30.1006 requires that concentrations of other dissolved or suspended substances must not exceed levels that render the waters harmful, detrimental or injurious to public health. Maximum allowable concentrations of these substances also must not exceed acute or chronic problem levels that would adversely affect existing or designated beneficial uses of groundwater of that classification.

**Nondegradation, ARM 17.30.1011 (applicable).**

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[1] Montana Department of Environmental Quality, Water Quality Division, Circular DEQ-7, Montana Numeric Water Quality Standards (August 2010).

Provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality in accordance with Section 75-5-303, MCA, and ARM Title 17, Chapter 30, Subchapter 7.

An additional concern with respect to ARARs for groundwater is the impact of groundwater upon surface water. If significant loadings of contaminants from groundwater sources to any surface water within a Reclamation Project contribute to the inability of the stream to meet classification standards, then alternatives to alleviate such groundwater loading must be evaluated and, if appropriate, implemented. Groundwater in certain areas may have to be remediated to levels more stringent than the groundwater classification standards in order to achieve the standards for affected surface water. *See* Compliance with Federal Water Quality Criteria, OSWER Publication 9234.2-09/FS (June 1990) ("Where the ground water flows naturally into the surface water, the ground-water remediation should be designed so that the receiving surface-water body will be able to meet any ambient water-quality standards [such as State WQSs or FWQC] that may be ARARs for the surface water.")

### 3.2.2 Montana Water Quality Act

**State of Montana Surface Water Quality Requirements, Montana Water Quality Act, Section 75-5-101, *et seq.*, MCA, and implementing regulations (applicable).** The Clean Water Act, 33 U.S.C. § 1251, *et seq.*, provides the authority for each state to adopt water quality standards (40 CFR Part 131) designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. The Montana Water Quality Act, 75-5-101, *et seq*., MCA, establishes requirements to protect, maintain and improve the quality of surface and groundwater. Montana's regulations classify State waters according to quality, place restrictions on the discharge of pollutants to State waters, and prohibit degradation of State waters. Pursuant to this authority and the criteria established by Montana surface water quality regulations, ARM § 17.30.601, *et seq*., Montana has established the Water-Use Classification system. The classification for specific surface water bodies within the State are set for in ARM 17.30.607, *et seq.* The applicable standards for each classification are set forth in ARM 17.30.621 through ARM 17.30.629, inclusive.

**General Prohibitions, ARM 17.30.637 (applicable).** Provides that surface waters must be free of substances attributable to industrial practices or other discharges that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; (e) create conditions which produce undesirable aquatic life.

No waste may be discharged and no activities conducted which, either alone or in combination with other waste activities, will cause violation of surface water quality standards.

Leaching pads, tailings ponds, or water or waste or product holding facilities must be located, constructed, operated and maintained in such a manner and of such materials to prevent any discharge, seepage, drainage, infiltration, or flow which may result in pollution of state waters, and a monitoring system may be required to ensure such compliance.

**Prohibited Activities, Section 75-5-605, MCA (applicable).** Provides that it is unlawful to cause pollution of any state waters or to place or cause to be placed, any wastes where they will cause pollution of any state waters.

**Nondegredation Policy, Section 75-5-303, MCA (applicable).** Provides that existing uses of state waters and the level of quality of state waters necessary to protect those uses must be maintained and protected.

**Nondegredation Policy – Applicability and Level of Protection, ARM 17.30.705 (applicable).** For all state waters, existing and anticipated uses and water quality necessary to support those uses must be maintained and protected.

### 3.2.3 Montana Ambient Air Quality Regulations

**Montana Ambient Air Quality Regulations, ARM 17.8.206, -.220, -.221, -.222 and -.223 (applicable).** The following provisions establish air quality standards:

> **Methods and Data, ARM 17.8.206 (applicable).** Establishes sampling, data collection, and analytical requirements to ensure compliance with ambient air quality standards.
>
> **Settled Particulate Matter, ARM 17.8.220 (applicable).** Settled particulate matter shall not exceed a thirty (30) day average of 10 grams per square meter.
>
> **Visibility, ARM 17.8.221 (applicable).** Concentrations of particulate matter in ambient air shall not exceed annual scattering coefficient particulate matter of $3 \times 10^{-5}$ per meter.
>
> **Lead, ARM 17.8.222 (applicable).** Lead emissions to ambient air shall not exceed a ninety (90) day average of 1.5 micrograms per cubic meter of air.
>
> **PM-10, ARM 17.8.223 (applicable).** PM-10 concentrations in ambient air shall not exceed a 24 hour average of 150 micrograms per cubic meter of air and an annual average of 50 micrograms per cubic meter of air.

# 4.0 LOCATION-SPECIFIC ARARS

The statutes and regulations set forth below relate to solid waste, floodplains, floodways, streambeds, and the preservation of certain cultural, historic, natural or other national resources located in certain areas that may be adversely affected by Reclamation activities.

## 4.1 Federal

### 4.1.1 National Historic Preservation Act

**National Historic Preservation Act, 16 USC § 470, 40 CFR § 6.301(b), 36 CFR Part 63, Part 65, and Part 800 (NHPA) (applicable).** This statute and implementing regulations require Federal agencies to take into account the effect of Reclamation activities upon any district, site, building, structure, or object that is included in or eligible for the Register of Historic Places. If the effect of Reclamation activities cannot be reasonably avoided, measures should be implemented to minimize or mitigate the potential effects of the activity. In addition, Indian cultural and historical resources must be evaluated and effects avoided, minimized or mitigated.

### 4.1.2 Archaeological and Historic Preservation Act

**Archaeological and Historic Preservation Act, 16 USC § 469, 40 CFR 6.301(c) (applicable).** This statute and implementing regulations establish requirements for the evaluation and preservation of historical and archaeological data, including Indian cultural and historic data, which may be destroyed through alteration of terrain as a result of a Federal program (such as AMLR). This requires the AMLR Program to survey the site for covered scientific, prehistoric or archaeological artifacts. If eligible scientific, prehistoric, or archeological data are encountered during Reclamation activities, they shall be preserved in accordance with these requirements.

### 4.1.3 Historic Sites Act of 1935

**Historic Sites Act of 1935, 16 USC § 461, *et seq.*, 40 CFR 6.310(a) (applicable).** This statute and implementing regulations require Reclamation activities to consider the existence and location of landmarks on the National Registry of National Landmarks and to avoid undesirable impacts on such landmarks.

### 4.1.4 Protection and Enhancement of the Cultural Environment

**Executive Order 11593 Protection and Enhancement of the Cultural Environment, 16 USC § 470 (applicable).** Directs federal agencies to institute procedures to ensure programs contribute to the preservation and enhancement of non-federally owned historic resources. Consultation with the Advisory Council on Historic Preservation is required if Reclamation activities should threaten cultural resources.

### 4.1.5 The Archaeological Resources Protection Act of 1979

**<u>The Archaeological Resources Protection Act of 1979, 16 USC §§ 470aa-47011 (relevant and appropriate)</u>.** Requires a permit for any excavation or removal of archeological resources from public lands or Indian lands. Substantive portions of this act may be relevant and appropriate if archeological resources are encountered during Reclamation activities.

### 4.1.6 American Indian Religious Freedom Act

**<u>American Indian Religious Freedom Act, 42 U.S.C. § 1996, *et seq.* (applicable).</u>** This Act establishes a federal responsibility to protect and preserve the inherent right of American Indians to believe, express and exercise the traditional religions of American Indians. This right includes, but is not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. The Act requires Reclamation activities to consider and protect Indian religious freedom by refraining from interfering with access, possession and use of religious objects, and by consulting with Indian organizations regarding proposed Reclamation activities affecting their religious freedom.

### 4.1.7 Native American Graves Protection and Repatriation Act

**<u>Native American Graves Protection and Repatriation Act, 25 U.S.C. § 3001, *et seq.* (applicable).</u>** The Act prioritizes ownership or control over Native American cultural items, including human remains, funerary objects and sacred objects, excavated or discovered on Federal or tribal lands. Federal agencies and museums that have possession or control over Native American human remains and associated funerary objects are required under the Act to compile an inventory of such items and, to the extent possible, identify their geographical and cultural affiliation. Once the cultural affiliation of such objects is established, the Federal agency or museum must expeditiously return such items, upon request by a lineal descendent of the individual Native American or tribe identified**.**

### 4.1.8 Fish and Wildlife Coordination Act

**<u>Fish and Wildlife Coordination Act, 16 USC § 661, 40 CFR 6.302 (applicable)</u>.** This statute and implementing regulations require that Federal agencies or federally funded projects ensure that any modification of any stream or other water body affected by any action authorized or funded by the Federal agency provide for adequate protection of fish and wildlife resources. This ARAR requires consultation with the U.S. Fish and Wildlife Service and the Montana Department of Fish, Wildlife, and Parks. Further consultation will occur during Reclamation design and construction.

### 4.1.9 Endangered Species Act

**<u>Endangered Species Act, 16 USC § 1531, 50 CFR Parts 17 and 402 (applicable)</u>.** This statute and implementing regulations provide that Reclamation activities not jeopardize the continued existence of any threatened or endangered species. This

ARAR will be achieved through consultation with the U.S. Fish and Wildlife Service and the Montana Department of Fish, Wildlife and Parks during Reclamation design and construction activities.  Specific avoidance or other mitigation measures identified shall be incorporated into the Reclamation design and implemented as part of construction.

#### 4.1.10 Floodplain Management Regulations

**Floodplain Management Regulations, Executive Order No. 11988 and 40 CFR § 6.302(b) (applicable)**.  These require that actions be taken to avoid, to the extent possible, adverse effects associated with direct or indirect development of a floodplain, or to minimize adverse impacts if no practicable alternative exists.

#### 4.1.11 Protection of Wetlands Regulations

**Protection of Wetlands Regulations, 40 CFR Part 6, Appendix A, and Executive Order No. 11990 (applicable).**  Steps will be taken to avoid or mitigate the adverse impacts associated with the destruction or loss of wetlands to the extent possible and avoidance of new construction in wetlands if a practicable alternative exists.  Wetlands are defined as those areas that are inundated or saturated by groundwater or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.  Compliance with this ARAR will be achieved through consultation with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers, to determine the existence and category of wetlands present at the site, and any avoidance or mitigation and replacement which may be necessary.

#### 4.1.12 Clean Water Act

**Section 404, Clean Water Act, 33 USC §§ 1251 *et seq.*, 33 CFR Part 330 (applicable)**.  Regulates discharge of dredged or fill materials into waters of the United States.  Substantive requirements of portions of Nationwide Permit No. 38 (General and Specific Conditions) are applicable to Reclamation activities conducted within waters of the United States within the Reclamation Project area.

#### 4.1.13 Migratory Bird Treaty Act

**Migratory Bird Treaty Act, 16 USC § 703, *et seq.* (applicable).**  This requirement establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during Reclamation design and construction to ensure that Reclamation activities at the site does not unnecessarily impact migratory birds.

#### 4.1.14 Bald Eagle Protection Act

**Bald Eagle Protection Act, 16 USC § 668, *et seq.* (applicable).**  This requirement establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the U.S. Fish and Wildlife Service during Reclamation design and construction to ensure that Reclamation activities at the site do not unnecessarily adversely affect bald and golden eagles.

### 4.1.15 Resource Conservation and Recovery Act

**Resource Conservation and Recovery Act and regulations, 40 CFR § 264.18 (a) and (b) (relevant and appropriate).** These regulations provide seismic and floodplain restrictions on the location of a waste management unit.

## 4.2 State

### 4.2.1 Montana Antiquities Act

**Montana Antiquities Act, Section 22-3-421, *et seq.*, MCA (relevant and appropriate).** The Montana Antiquities Act addresses the responsibilities of State agencies regarding historic and prehistoric sites including buildings, structures, paleontological sites, archaeological sites on state owned lands. The Montana Antiquities Act requires avoidance or mitigation of impacts to heritage property or paleontological remains. Each State agency is responsible for establishing rules regarding historic resources under their jurisdiction which address National Register eligibility, appropriate permitting procedures and other historic preservation goals. The State Historic Preservation Office maintains information related to the responsibilities of State Agencies under the Antiquities Act.

### 4.2.2 Montana Human Skeletal Remains and Burial Site Protection Act

**Montana Human Skeletal Remains and Burial Site Protection Act (1991), Section 22-3-801, *et seq.* MCA (applicable).** The Human Skeletal Remains and Burial Site Protection Act is the result of years of work by Montana Tribes, State agencies and organizations interested in ensuring that all graves within the State of Montana are adequately protected. The Human Skeletal Remains and Burial Site Protection Act prohibits purposefully or knowingly disturbing or destroying human skeletal remains or burial sites. If human skeletal remains or burial sites are encountered during Reclamation activities, then requirements will be applicable.

### 4.2.3 Montana Floodplain and Floodway Management Act

**Montana Floodplain and Floodway Management Act and Regulations, Section 76-5-101, *et seq.*, MCA, ARM 36.15.601, *et seq.* (applicable).** The Floodplain and Floodway Management Act and regulations specify types of uses and structures that are allowed or prohibited in the designated 100-year floodway[2] and floodplain.[3] If a

[2] The "floodway" is the channel of a watercourse or drainway and those portions of the floodplain adjoining the channel that are reasonably required to carry and discharge the floodwater of the watercourse or drainway. ARM 36.15.101(13).

Reclamation Project contains streams or creeks capable of flooding or may impact such areas, these standards are applicable to all Reclamation activities within these floodplains.

**A. Prohibited uses.** Uses prohibited anywhere in either the floodway or the floodplain are:

- solid and hazardous waste disposal; and
- storage of toxic, flammable, hazardous, or explosive materials.

ARM 36.15.605(2) and 36.15.703 (Applicable); *see also* ARM 36.15.602(5)(b) (Applicable). These provisions effectively prohibit the placement of mine waste repositories within the 100-year floodplain and require mine wastes addressed by Reclamation activities to be removed from the floodplain.

In the floodway, additional prohibitions apply, including prohibition of:

- a building for living purposes or place of assembly or permanent use by human beings;
- any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; and
- the construction or permanent storage of an object subject to flotation or movement during flood level periods.

Section 76-5-403, MCA (applicable).

**B. Applicable considerations in use of floodplain or floodway.** Applicable regulations also specify factors that must be considered in allowing diversions of the stream, changes in place of diversion of the stream, flood control works, new construction or alteration of artificial obstructions, or any other nonconforming use within the floodplain or floodway. Many of these requirements are set forth as factors that must be considered in determining whether a permit can be issued for certain obstructions or uses. While permit requirements are not directly applicable to Reclamation activities conducted entirely on site, the substantive criteria used to determine whether a proposed obstruction or use is permissible within the floodway or floodplain are applicable standards. Factors which must be considered in addressing any obstruction or use within the floodway or floodplain include:

- the danger to life and property from backwater or diverted flow caused by the obstruction or use;

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[3] The "floodplain" is the area adjoining the watercourse or drainway which would be covered by the floodwater of a base (100-year) flood except for sheetflood areas that receive less than one foot of water per occurrence. The floodplain consists of the floodway and flood fringe. ARM 36.15.101(11).

- the danger that the obstruction or use will be swept downstream to the injury of others;

- the availability of alternate locations;

- the construction or alteration of the obstruction or use in such a manner as to lessen the danger;

- the permanence of the obstruction or use; and

- the anticipated development in the foreseeable future of the area which may be affected by the obstruction or use.

*See* Section 76-5-406, MCA; ARM 36.15.216 (applicable, substantive provisions only). Conditions or restrictions that generally apply to specific activities within the floodway or floodplain are:

- the proposed activity, construction, or use cannot increase the upstream elevation of the 100-year flood a significant amount (½ foot or as otherwise determined by the permit issuing authority) or significantly increase flood velocities, ARM 36.15.604 (applicable, substantive provisions only); and

- the proposed activity, construction, or use must be designed and constructed to minimize potential erosion and may not reduce the carrying capacity of the floodway. *See* ARM 36.15.605.

For the substantive conditions and restrictions applicable to specific obstructions or uses, see the following applicable regulations:

- Excavation of material from pits or pools - ARM 36.15.602(1).

- Water diversions or changes in place of diversion - ARM 36.15.603.

- Flood control works (levees, floodwalls, and riprap must comply with specified safety standards) - ARM 36.15.606.

- Roads, streets, highways and rail lines (must be designed to minimize increases in flood heights) - ARM 36.15.701(3)(c).

- Structures and facilities for liquid or solid waste treatment and disposal (must be floodproofed to ensure that no pollutants enter flood waters and may be allowed and approved only in accordance with Montana Department of Environmental Quality (DEQ) regulations, which include certain additional prohibitions on such disposal) - ARM 36.15.701(3)(d).

- Residential structures – ARM 36.15.702(1)

- Commercial or industrial structures – ARM 36.15.702(1).

### 4.2.4 Montana Stream Protection Requirements

**Montana Natural Streambed and Land Preservation Act of 1975 and Regulations, Section 75-7-101, *et seq.*, MCA, and ARM 36.2.401, *et seq.*, (applicable).** Applicable if Reclamation activities alter or affect a streambed or its banks. The adverse effects of any such action must be minimized.

> **Standards and Guidelines, ARM 36.2.410 (applicable).** Establishes minimum standards which would be applicable if Reclamation activities alter or affect a streambed, including any channel change, new diversion, riprap or other streambank protection project, jetty, new dam or reservoir or other commercial, industrial or residential development. Reclamation Projects must be designed and constructed using methods that minimize adverse impacts to the stream (both upstream and downstream) and future disturbances to the stream. All disturbed areas must be managed during construction and reclaimed after construction to minimize erosion. Temporary structures used during construction must be designed to handle high flows reasonably anticipated during the construction period. Temporary structures must be completely removed from the stream channel at the conclusion of construction, and the area must be restored to a natural or stable condition. Channel alterations must be designed to retain original stream length or otherwise provide hydrologic stability. Streambank vegetation must be protected except where removal of such vegetation is necessary for the completion of the Reclamation activities. When removal of vegetation is necessary, it must be kept to a minimum. Riprap, rock, and other material used in a project must be of adequate size, shape, and density and must be properly placed to protect the streambank from erosion. The placement of road fill material in a stream, the placement of debris or other materials in a stream where it can erode or float into the stream, reclamation activities that permanently prevent fish migration, operation of construction equipment in a stream, and excavation of streambed gravels are prohibited unless specifically authorized by the district. Reclamation activities must also protect the use of water for any useful or beneficial purpose. *See* Section 75-7-102, MCA.
>
> **Sections 87-5-502 and 504, MCA (applicable -- substantive provisions only)**. Provide that a state agency or subdivision shall not construct, modify, operate, maintain or fail to maintain any construction project or hydraulic project which may or will obstruct, damage, diminish, destroy, change, modify, or vary the natural existing shape and form of any stream or its banks or tributaries in a manner that will adversely affect any fish or game habitat.
>
> While the administrative/ procedural requirements, including the consent and approval requirements set forth in these statutes and regulations are not ARARs, consultation with the Montana Department of Fish, Wildlife and Parks, and any conservation district or board of county commissioners (or consolidated city/county government) is encouraged during the design and implementation of Reclamation activities to assist in the evaluation of the factors discussed above.

### 4.2.5 Montana Solid Waste Management Act

**Montana Solid Waste Management Act and regulations, Section 75-10-201, *et seq.*, MCA, ARM 17.50.101*, et seq.* (applicable) .** Provides that solid waste management systems must protect the public health and safety and conserve natural resources wherever possible.

These standards apply to any solid waste facility for the treatment, storage, or disposal of mine wastes, including, for example, any mine waste repository, tailing deposit, or waste rock pile that is actively managed as part of a response action.

> **Floodplains, ARM 17.50.1004 (applicable)**. A solid waste facility located within the 100-year floodplain may not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste that poses a hazard to human health or the environment. *See also* **ARM 17.50.1009(1)(h) (applicable).**
>
> **Wetlands, ARM 17.50.1005 (applicable).** A solid waste facility may not be located in a wetland, unless there is no demonstrable practicable alternative.
>
> **Fault Areas, ARM 17.50.1006 (applicable).** A solid waste facility cannot be located within 200 feet (60 meters) of a fault that has had displacement in Holocene time without demonstration that an alternative setback will prevent damage to the structural integrity of the solid waste facility and will be protective of human health and the environment.
>
> **Seismic Areas, ARM 17.50.1007 (applicable).** A solid waste facility may not be located in a seismic impact zone without demonstration, by a Montana licensed engineer, that the solid waste structure is designed to resist the maximum horizontal acceleration in lithified earth material for the site.
>
> **Unstable Areas, ARM 17.50.1008 (applicable)**. A solid waste facility may not be located in an unstable area (determined by consideration of local soil conditions, local geographic or geomorphologic features, and local artificial features or events, both surface and subsurface) without demonstration, by a Montana licensed engineer, that the solid waste facility is designed to ensure that the integrity of the structural components will not be disrupted.
>
> **Location Restrictions, ARM 17.50.1009 (applicable).** Sets forth general requirements applying to the location of any solid waste facility. Among other things, the location must have sufficient acreage, including adequate separation of wastes from underlying groundwater or adjacent surface water, must be located so as to prevent pollution of ground, surface, and private and public water supply systems, and must allow for reclamation of the land.

Under ARM 17.50.1009, a facility for the treatment, storage or disposal of solid wastes:

1. must be located where a sufficient acreage of land is suitable for solid waste management, including adequate separation of wastes from underlying ground water or adjacent surface water;[4]

2. must be located where local roads are capable of providing access in all weather conditions and local bridges are capable of supporting vehicles with maximum rated loads;

3. must be located in a manner that does not allow the discharge of pollutants in excess of state standards for the protection of state waters, public water supply systems, or private water supply systems;

4. drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and

5. must be located to allow for closure, post-closure, and planned uses of the land.

**Section 75-10-212, MCA (applicable).** For solid wastes, prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted.

### 4.2.6 Endangered Species and Wildlife

**Sections 87-5-106, 107 and 111, MCA (applicable).** Endangered species should also be protected in order to maintain and to the extent possible, enhance their numbers. These Sections list endangered species, prohibited acts, and penalties. Section 87-5-201, MCA (applicable) concerns protection of wild birds, nests and eggs and under ARM 12.5.201 certain activities are prohibited with respect to specified endangered species.

[4] The extent of separation shall be established on a case-by-case basis, considering terrain and the type of underlying soil formations, and facility design.

# 5.0 ACTION-SPECIFIC ARARS

## 5.1 Federal and State Water Protection Requirements

### 5.1.1 Clean Water Act

**Clean Water Act, Point Source Discharges Requirements, 33 USC § 1342 (applicable, substantive provisions only).** Section 402 of the Clean Water Act, 33 USC § 1342, *et seq.*, authorizes the issuance of permits for the "discharge" of any "pollutant." This includes storm water discharges associated with "industrial activity." *See*, 40 CFR § 122.1(b)(2)(iv). "Industrial activity includes inactive mining operations that discharge storm water contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations, *see*, 40 CFR § 122.26(b)(14)(iii); landfills, land application sites, and open dumps that receive or have received any industrial wastes including those subject to regulation under RCRA subtitle D, *see*, 40 CFR § 122.26(b)(14)(v); and construction activity including clearing, grading, and excavation activities, *see*, 40 CFR § 122.26(b)(14)(x). Because the State of Montana has been delegated the authority to implement the Clean Water Act, these requirements are enforced in Montana through the Montana Pollutant Discharge Elimination System (MPDES). The MPDES requirements are set forth below.

### 5.1.2 Montana Pollutant Discharge Elimination System Requirements

**Substantive MPDES Permit Requirements, ARM 17.30.1342-1344 (applicable)**. These regulations set forth the substantive requirements applicable to all MPDES and National Pollutant Discharge Elimination System (NPDES) permits. The substantive requirements, including the requirement to properly operate and maintain all facilities and systems of treatment and control, are applicable requirements for a repository containing mine waste.

**Technology-Based Treatment, ARM 17.30.1203 and 1344 (applicable).** Provisions of 40 CFR Part 125 for criteria and standards for the imposition of technology-based treatment requirements are adopted and incorporated in MPDES permits. Although the permit requirement would not apply to on-site discharges, the substantive requirements of Part 125 are applicable, i.e., for toxic and nonconventional pollutants treatment must apply the best available technology economically achievable (BAT); for conventional pollutants, application of the best conventional pollutant control technology (BCT) is required. Where effluent limitations are not specified for the particular industry or industrial category at issue, BCT/BAT technology-based treatment requirements are determined on a case by case basis using best professional judgment (BPJ). *See* CERCLA Compliance with Other Laws Manual, Vol. I, August 1988, p. 3-4 and 3-7.

### 5.1.3 Montana Water Quality Act and Regulations

**Causing of Pollution, Section 75-5-605, MCA (applicable).** This section of the Montana Water Quality Act prohibits causing pollution of any state waters. Pollution is defined as contamination or other alteration of physical, chemical, or biological properties of state waters which exceeds that permitted by the water quality standards or the discharge, seepage, or drainage of any substances into state water that will likely create a nuisance or render the water harmful, detrimental or injurious to public health, recreation, safety, or welfare, or to livestock or wild animals. Also, it is unlawful to place or caused to be placed any wastes where they will cause pollution of any state waters.

**Nondegradation, Section 75-5-303, MCA (applicable).** This provision states that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected. Section 75-5-317, MCA, provides an exemption from nondegradation requirements which allows changes of existing water quality resulting from an emergency or Reclamation that is designed to protect the public health or the environment and that is approved, authorized, or required by the department. Degradation meeting these requirements may be considered nonsignificant.

**Surface Water, ARM 17.30.637 (applicable).** Prohibits discharges containing substances that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; or (e) create conditions which produce undesirable aquatic life.

**Nondegradation Policy – Application and Level of Protection, ARM 17.30.705 (applicable)**. This provides that for all state waters, existing and anticipated uses and the water quality necessary to protect these uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM 17.30.708.

**Nondegradation, ARM 17.30.1011 (applicable).** Provides that any groundwarer whose existing quality is higher than the standard for its classification mist be maintained at that high quality unless degradation may be allowed under the principles established in Section 75-5-303, MCA and the nondegradation rules at ARM 17.30.701, *et seq.*

### 5.1.4 Stormwater Runoff Control Requirements

**Water Quality Performance Standards, ARM 17.24.633 (applicable).** All surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Sediment control through BTCA must be maintained until the disturbed area has been reclaimed, the revegetation requirements have been met, and the area meets state and federal requirements for the receiving stream.

**General Permits, ARM 17.30.1341 (applicable).** DEQ issues general storm water permits for certain activities. The substantive requirements of the following permits are applicable for the following activities: for construction activities – General Permit for Storm Water Discharge Associated with Construction Activity, Permit No. MTR100000 (April 16, 2007); for mining activities – General Discharge Permit for Storm Water Associated with Mining and with Oil and Gas Activities, Permit No. MTR300000 (November 17, 2002);[5] and for industrial activities – General Permit for Storm Water Discharge Associated with Industrial Activity, Permit No. MTR000000 (October 1, 2006).[6]

Generally, the permits require the permittee to implement best management practices (BMPs) and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, an individual MPDES permit or alternative general permit may be required.

### 5.2 Federal and State RCRA Subtitle C Requirements

**Federal and State RCRA Subtitle C Requirements, 42 U.S.C. Section 6921, *et seq.* (relevant and appropriate for solid wastes, applicable for hazardous wastes).** The presentation of RCRA Subtitle C requirements in this section assumes that there will be solid wastes left in place in “waste management areas” (i.e., a repository) as a result of Reclamation activities. Because of the similarity of this waste management area to the RCRA “waste management unit,” certain discrete portions of the RCRA Subtitle C implementing regulations will be relevant and appropriate for Reclamation activities. RCRA Subtitle C and implementing regulations are designated as applicable for any hazardous wastes that are actively “generated” as part of this Remedial activity or that were “placed” or “disposed” after 1980. Also, should hazardous wastes be discovered

5 This permit covers point source discharges of storm water from mining and milling activities (including active, inactive, and abandoned mine and mill sites) including activities with Standard Industrial Code 14 (metal mining).

6 Industrial activities are defined as all industries defined in 40 CFR §§ 122, 123, and 124, excluding construction, mining, oil & gas extraction activities and storm water discharges subject to effluent limitations guidelines. This includes wood treatment operations, as well as the production of slag.

as part of any Reclamation activity, RCRA Subtitle C requirements will be provided in more detail at a later date. All federal RCRA Subtitle C requirements set forth below are incorporated by reference as State of Montana requirements as provided for under ARM 17.53.105(2) unless mentioned otherwise below.

**40 CFR Part 264 Subpart F, (relevant and appropriate).**

**General Facility Standards**. These are potentially relevant and appropriate for solid wastes at Reclamation sites. Any waste management unit or similar area would be required to comply with the following requirements.

**40 CFR § 264.92, .93. and .94( relevant and appropriate).** Prescribes groundwater protection standards.

**40 CFR § 264.97 (relevant and appropriate).** Prescribes general groundwater monitoring requirements.

**40 CFR § 264.98 (relevant and appropriate).** Prescribes requirements for monitoring and detecting indicator parameters.

**Closure requirements.**

**40 CFR § 264.111 (relevant and appropriate).** Provides that the owner or operator of a hazardous waste management facility must close the facility in a way that minimizes the need for further maintenance, and controls or eliminates the leaching or escape of hazardous waste or its constituents, leachate, or runoff to the extent necessary to protect human health and the environment.

**40 CFR § 264.117 (relevant and appropriate).** Incorporates monitoring requirements in Part 264, including those mentioned at Part 264.97 and Part 264.303. It governs the length of the post-closure care period, permits a lengthened security period, and prohibits any use of the property which would disturb the integrity of the management facility.

**40 CFR § 264.310(relevant and appropriate).** Specifies requirements for caps, maintenance, and monitoring after closure.

**40 CFR § 264.301 (relevant and appropriate).** Prescribes design and operating requirements for landfills.

**40 CFR § 264.301(a) (relevant and appropriate).** Provides for a single liner and leachate collection and removal system.

**40 CFR § 264.301(f) (relevant and appropriate).** Requires a run-on control system.

**<u>40 CFR § 264.301(g) (relevant and appropriate)</u>.** Requires a run-off management system.

**<u>40 CFR § 264.301(h) (relevant and appropriate)</u>.** Requires prudent management of facilities for collection and holding of run-on and run-off.

**<u>40 CFR § 264.301(i) (relevant and appropriate)</u>.** Requires that wind dispersal of particulate matter be controlled.

### 5.3 Federal and State RCRA Subtitle D and Solid Waste Management Requirements

40 CFR Part 257 establishes criteria under Subtitle D of the Resource Conservation and Recovery Act for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment. *See* 40 CFR § 257.1(a). This part comes into play whenever there is a "disposal" of any solid or hazardous waste from a "facility." "Disposal" is defined as "the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters." *See* 40 CFR § 257.2. "Facility" means "any land and appurtenances thereto used for the disposal of solid wastes." Solid waste requirements are either applicable to mine wastes as solid waste or are relevant and appropriate for the management, handling, storage, monitoring and disposal of the mine wastes to be addressed in a Reclamation Project.

#### 5.3.1. Federal Requirements

**<u>40 CFR § 257 (applicable)</u>.** Establishes Criteria for Classification of Solid Waste Disposal Facilities and Practices. Reclamation activities must comply with the following requirements:

**<u>40 CFR § 257.3-1 (applicable)</u>..** Washout of solid waste in solid waste facilities in a floodplain posing a hazard to human life, wildlife, or land or water resources shall not occur.

**<u>40 CFR § 257.3-2 (applicable)</u>..** Solid waste facilities shall not contribute to the taking of endangered species or the endangering of critical habitat of endangered species.

**<u>40 CFR § 257.3-3 (applicable)</u>.** A solid waste facility shall not cause a discharge of pollutants, dredged or fill material, into waters of the United States in violation of Sections 402 and 404 of the Clean Water Act, as amended, and shall not cause non-point source pollution, in violation of applicable legal requirements implementing an area wide or statewide water quality management plan that has been approved by the Administrator under Section 208 of the Clean Water Act, as amended.

**<u>40 CFR § 257.3-4 (applicable)</u>.** A solid waste facility shall not contaminate an underground source of drinking water beyond the solid waste boundary or beyond an alternative boundary specified in accordance with this section.

**<u>40 CFR § 257.3-8(d) (applicable)</u>.** Access to a solid waste facility shall be controlled so as to prevent exposure of the public to potential health and safety hazards at the site.

### 5.3.2. State of Montana Solid Waste Requirements.

**<u>The Montana Solid Waste Management Act, Section 75-10-201 *et seq.*, MCA, and regulations (applicable).</u>** Control the management and disposal of all solid wastes, including mine wastes at sites that are not currently subject to operating permit requirements.

**<u>Transportation, ARM 17.50.523 (applicable)</u>.** Specifies that solid waste must be transported in such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle.

**<u>Location Restrictions, ARM 17.50.1009(1)(c) (applicable).</u>** Requires that solid waste facilities not discharge pollutants in excess of state standards. A solid waste facility must contain a leachate collection system unless there is no potential for migration of a constituent in Appendix I or II to 40 CFR 258.

**<u>Design Requirements, ARM 17.50.1204 (applicable).</u>** Solid waste facilities must either be designed to ensure that MCLs are not exceeded or the solid waste facility must contain a composite liner and leachate collection system that complies with specified criteria.

**<u>Access Requirements, ARM 17.50.1108 (applicable).</u>** Requires that the owner or operator of a solid waste facility use barriers to control public access.

**<u>Run-On and Run-Off Control Systems, ARM 17.50.1109 (applicable).</u>** Requires that owners or operators of solid waste facilities design, construct and maintain a run-on control system to prevent flow onto the active portion of the solid waste facility during the peak discharge from a 25-year storm and a run-off control system from the active portion of the solid waste facility to collect and control at least the water volume result from a 24-hour, 25-year storm.

**<u>Surface Water Requirements, ARM 17.50.1110 (applicable).</u>** Prohibits any discharge of a pollutant from a solid waste facility to state waters, including wetlands, that violates any requirement of the Montana Water Quality Act. Prohibits any discharge from a solid waste facility of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or statewide water quality management plan approved under the Federal Clean Water Act.

**Liquid Restrictions, ARM 17.50.1111 (applicable).** Prohibits placement of bulk or noncharacterized waste into a solid waste facility, unless the waste is household waste other than septic liquid waste or leachate derived from and placed back into a facility with a composite liner and leachate collection and removal system.

**Operating Criteria, ARM 17.50.1116, (applicable).** Sets forth requirements for operation of a solid waste facility, including: that solid waste facilities be created and maintained with supervision, fencing and signage; that owners or operators of solid waste facilities take effective measures to control litter and prevent the public from salvaging materials at the facility; and that the facility be designed to control litter, insects, rodents, odor, residues, waste water and air pollutants.

**Closure Criteria, ARM 17.50.1403 (applicable).** Sets forth closure requirements for solid waste facilities. Solid waste facilities must meet the following criteria: (1) install a final cover that is designed to minimize infiltration and erosion; (2) design and construct the final cover system to minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and has a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils or a permeability no greater than 1 X 10-5 cm/sec, whichever is less; and (3) minimize erosion of the final cover by the use of a seed bed layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

**Post-Closure Criteria, ARM 17.50.1404 (applicable).** Sets forth post-closure care requirements for solid waste facilities. Post-closure care must be conducted for a period sufficient to protect human health and the environment. Post-closure care requires maintenance of the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover and comply with the groundwater monitoring requirements found at ARM Title 17, chapter 50, subchapter 7.

**Section 75-10-206, MCA,(applicable).** Allows variances to be granted from solid waste regulations if failure to comply with the rules does not result in a danger to public health or safety or compliance with specific rules would produce hardship without producing benefits to the health and safety of the public that outweigh the hardship.

### 5.4 Federal and State Mine Reclamation Requirements

#### 5.4.1 Surface Mining Control and Reclamation Act

**Surface Mining Control and Reclamation Act, 30 USC §§ 1201-1326 (relevant and appropriate).** This Act and implementing regulations found at 30 CFR Parts 784 and 816 establish provisions designed to protect the environment from the effects of surface coal mining operations, and to a lesser extent non-coal mining. These requirements are relevant and appropriate to the covering of discrete areas of contamination. The regulations require that revegetation be used to stabilize soil covers over reclaimed areas. They also require that revegetation be done according to a plan which specifies schedules, species which are diverse and effective, planting methods, mulching techniques, irrigation if appropriate, and appropriate soil testing. Reclamation performance standards are currently relevant and appropriate to mining waste sites.

### 5.4.2 Montana Statutory and Regulatory Requirements

**Montana Strip and Underground Mine Reclamation Act, Section 82-4-201, *et seq.*, MCA (relevant and appropriate) and Montana Metal Mining Act, Section 82-4-301, *et seq.*, MCA (relevant and appropriate).** The specified portions of the following statutory or regulatory provisions, as identified below, are relevant and appropriate requirements.

> **Section 82-4-231, MCA (relevant and appropriate).** Requires operators to reclaim and revegetate affected lands using most modern technology available. Operators must grade, backfill, topsoil, reduce high walls, stabilize subsidence, control water, minimize erosion, subsidence, land slides, and water pollution.
>
> **Section 82-4-233, MCA (relevant and appropriate).** Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration.
>
> **Section 82-4-336, MCA (relevant and appropriate).** Disturbed areas must be reclaimed to utility and stability comparable to adjacent areas.
>
> **General Backfilling and Grading Requirements, ARM 17.24.501 (relevant and appropriate).** Provides general backfilling and grading requirements. Backfill must be placed so as to minimize sedimentation, erosion, and leaching of acid or toxic materials into waters, unless otherwise approved. Final grading must be to the approximate original contour of the land.
>
> **Monitoring for Settlement, ARM 17.24.519 (relevant and appropriate).** Requires monitoring of settling of regraded areas.
>
> **General Hydrology Requirements, ARM 17.24.631(1), (2), (3)(a) and (b) (relevant and appropriate).** Requires minimization of disturbances to the prevailing hydrologic balance. Changes in water quality and quantity, in the depth to groundwater and in the location of surface water drainage channels should be minimized. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation,

regulating channel velocity of water, lining drainage channels with rock or vegetation, mulching, and control of acid-forming, and toxic-forming waste materials.

**Water Quality Performance Standards, ARM 17.24.633 (relevant and appropriate).** Surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.

**Reclamation of Drainage Basins, ARM 17.24.634 (relevant and appropriate).** Requires disturbed drainages be restored to the approximate pre-disturbance configuration. Drainage design must emphasize channel and floodplain dimensions that approximate the pre-mining configuration and that will blend with the undisturbed drainage above and below the area to be reclaimed. The average stream gradient must be maintained with a concave longitudinal profile. This regulation provides specific requirements for designing the reclaimed drainage to: (1) approximate an appropriate geomorphic habit or characteristic pattern; (2) remain in dynamic equilibrium with the system without the use of artificial structural controls; (3) improve unstable premining conditions; (4) provide for floods and for the long-term stability of the landscape; and (5) establish a premining diversity of aquatic habitats and riparian vegetation.

**Diversions, ARM 17.24.635 through 17.24.637 (relevant and appropriate).** Set forth requirements for temporary and permanent diversions.

**Sediment Control Measures, ARM 17.24.638 (relevant and appropriate).** Sediment control measures must be implemented during operations.

**Sedimentation Ponds and other Treatment Facilities, ARM 17.24.639 (relevant and appropriate).** Sets forth requirements for construction and maintenance of sedimentation ponds, including that sedimentation ponds be located as near as possible to the disturbed area and out of any major stream courses.

**Discharge Structures, ARM 17.24.640 (relevant and appropriate).** Requires discharges from sedimentation ponds, permanent and temporary impoundments, and diversions be controlled to reduce erosion, deepening, or enlargement of stream channels, and to minimize disturbance of the hydrologic balance.

**Acid- and Toxic-Forming Spoils, ARM 17.24.641 (relevant and appropriate).** Requires drainage from acid- and toxic-forming spoil into ground and surface water be avoided and establishes practices to avoid such drainage.

**Groundwater, ARM 17.24.643 through 17.24.646 (relevant and appropriate).** Sets forth provisions for groundwater protection, groundwater recharge protection, and groundwater and surface water monitoring.

**<u>Soil, ARM 17.24.701 and 17.24.702 (relevant and appropriate)</u>.** Sets forth requirements for redistributing and stockpiling of soil for reclamation. Also, outlines practices to prevent compaction, slippage, erosion, and deterioration of biological properties of soil.

**<u>Substitute Materials, ARM 17.24.703 (relevant and appropriate)</u>.** When using materials other than, or along with, soil for final surfacing in reclamation, the operator must demonstrate that the material (1) is at least as capable as the soil of supporting the approved vegetation and subsequent land use, and (2) the medium must be the best available in the area to support vegetation. Such substitutes must be used in a manner consistent with the requirements for redistribution of soil in ARM 17.24.701 and 17.24.702.

**<u>Establishment of Vegetation, ARM 17.24.711 (relevant and appropriate)</u>.** Requires that a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected shall be established except on road surfaces and below the low-water line of permanent impoundments. *See also* Section 82-4-233, MCA (relevant and appropriate). Vegetative cover is considered of the same seasonal variety if it consists of a mixture of species of equal or superior utility when compared with the natural vegetation during each season of the year. This requirement may not be appropriate where other cover is more suitable for the particular land use or another cover is requested by the landowner.

**<u>Timing of Seeding and Planting, ARM 17.24.713 (relevant and appropriate)</u>.** Requires seeding and planting of disturbed areas must be conducted during the first appropriate period favorable for planting after final seedbed preparation.

**<u>Soil Stabilizing Practices, ARM 17.24.714 (relevant and appropriate)</u>.** Requires mulch or cover crop or both must be used until adequate permanent cover can be established.

**<u>Method of Revegetation, ARM 17.24.716 (relevant and appropriate)</u>.** Requires revegetation be carried out in a manner that encourages prompt vegetation establishment, such as by drill or broadcast seeding, by seedling transplants or by established sod plugs, and in a manner that avoids the establishment of noxious weeds. Seeding must be done on the contour, wherever possible. Seed mixes should be frtee of weedy or other undesirable species. Noxious weeds mist be controlled in accordance with the Noxious Weed Management Act, 7-22-2101, *et seq.*,MCA.

**<u>Planting of Trees and Shrubs, ARM 17.24.717 (relevant and appropriate).</u>** Relates to the planting of trees and other woody species if necessary, as provided in Section 82-4-233, MCA, to establish a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the affected area and capable of self-regeneration and plant succession at least equal to the natural vegetation of the area, except that introduced species may be used in the revegetation process where desirable and necessary to achieve the approved land use plan.

**<u>Soil Amendments, ARM 17.24.718 (relevant and appropriate)</u>.** Requires soil amendments, irrigation, management, fencing, or other measures, if necessary to establish a diverse and permanent vegetative cover.

**<u>Eradication of Rills and Gullies, ARM 17.24.721 (relevant and appropriate)</u>.** Specifies that rills or gullies in reclaimed areas must be filled, graded or otherwise stabilized and the area reseeded or replanted if the rills and gullies are disrupting the reestablishment of the vegetative cover or causing or contributing to a violation of water quality standards for a receiving stream.

**<u>Monitoring, ARM 17.24.723 (relevant and appropriate)</u>.** Requires operators conduct approved periodic measurements of vegetation, soils, water, and wildlife, and if data indicate that corrective measures are necessary, propose and implement such measures.

**<u>Revegetation Success Criteria, ARM 17.24.724 (relevant and appropriate)</u>.** Specifies that revegetation success must be measured against approved technical standards or unmined reference areas. Reference areas and standards must be representative of vegetation and related site characteristics occurring on lands exhibiting good ecological integrity. Sets forth required management for reference areas.

**<u>Vegetation Measurements, ARM 17.24.726 (relevant and appropriate)</u>.** Requires standard and consistent field and laboratory methods to obtain and evaluate revegetated area data with reference area data and/or technical standards and sets forth the required methods for measuring productivity.

**<u>Analysis for Toxicity, ARM 17.24.731 (relevant and appropriate)</u>.** If toxicity to plants or animals on the revegetated area or the reference area is suspected due to the effects of the disturbance, comparative chemical analyses may be required.

**<u>Protection and Enhancement of Fish and Wildlife, ARM 17.24.751 (relevant and appropriate)</u>.** Sets forth requirements to protect and enhance fish and wildlife habitat.

### 5.5 Air Requirements

Reclamation activities will comply with the Montana Ambient Air Quality Regulations (above) and with the following requirements to ensure that existing air quality will not be adversely affected:

**<u>Airborne Particulate Matter, ARM 17.8.308(1), (2) and (3) (applicable)</u>.** There shall be no production, handling, transportation, or storage of any material, use of any street, road, or parking lot, or operation of a construction site or demolition project unless reasonable precautions are taken to control emissions of airborne particles. Emissions shall not exhibit an opacity exceeding 20% or greater averaged over 6 consecutive minutes.

**Visible Air Contaminants, ARM 17.8.304(2) (applicable).** Emissions into the outdoor atmosphere shall not exhibit an opacity of 20% or greater averaged over 6 consecutive minutes.

**Materials Prohibited from Open Burning, ARM 17.8.604 (applicable)**. Lists certain wastes that may not be disposed of by open burning, including oil or petroleum products, RCRA hazardous wastes, chemicals, and wood and wood byproducts that have been coated, painted, stained, treated or contaminated by a foreign material. Any waste which is moved from the site where it was generated and any trade waste (material resulting from construction or operation of any business, trade, industry, or demolition project) may be open burned only in accordance with the substantive requirements of ARM 17.8.611 or 17.8.612.

**Fugitive Dust Emissions, ARM 17.24.761 (relevant and appropriate)**. Specifies a range of measures for controlling fugitive dust emissions during mining and reclamation activities. Some of these measures could be considered relevant and appropriate to control fugitive dust emissions in connection with excavation, earth moving and transportation activities conducted as part of Reclamation at the site. Such measures include, for example, paving, watering, chemically stabilizing, or frequently compacting and scraping roads, promptly removing rock, soil or other dust-forming debris from roads, restricting vehicle speeds, revegetating, mulching, or otherwise stabilizing the surface of areas adjoining roads, restricting unauthorized vehicle travel, minimizing the area of disturbed land, and promptly revegetating regraded lands.

### 5.6 Noxious Weeds

**Noxious Weeds, Section 7-22-2101(8)(a), MCA.** Defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (I) as a statewide noxious weed by rule of the department; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM 4.5.201 through 4.5.204 and must be managed consistent with weed management criteria developed under Section 7-22-2109(2)(b), MCA.

## 6.0 TO BE CONSIDERED (TBC) DOCUMENTS

A list of TBC documents is included in the Preamble to the NCP, 55 Fed. Reg. 8765 (March 8, 1990). Those documents, plus any additional similar or related documents issued since that time, should be considered during the conduct of the Reclamation design and construction.

## 7.0 OTHER LAWS (NON-EXCLUSIVE LIST)

CERCLA defines as ARARs only federal environmental and state environmental and siting laws. Reclamation activities, inclduing design, implementation, and operation and maintenance must comply with other applicable laws, except as may be provided in SMCRA.

The following “other laws” are included here to provide a reminder of other legal requirements for Reclamation activity. They are not an exhaustive list of such requirements, but are included because they set out matters that must be addressed and, in some cases, may require advance planning. They are not included as ARARs because they are not “environmental or facility siting laws.” Because they are not ARARs, they are not subject to ARAR waiver provisions.

### 7.1 Other Federal Laws

**<u>Occupational Safety and Health Regulations</u>.** The federal Occupational Safety and Health Act regulations found at 29 CFR Part 1910 and Part 1926 are applicable to worker protection during the conduct of Reclamation .

### 7.2 Other State Laws

### A. Groundwater Act

The Groundwater Act, ' 85-2-501, *et seq.,* MCA, and implementing regulations, ARM 17.30.601, *et seq.* govern uses of groundwater and provide measures to protect groundwater from depletion or contamination. The regulations also set requirements for water wells.

Section 85-2-505, MCA, precludes the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.

Section 85-2-516, MCA, states that within 60 days after any well is completed a well log report must be filed by the driller with the DNRC and the appropriate county clerk and recorder.

### B. Public Water Supply Regulations

If Reclamation activities at the site require any reconstruction or modification of any public water supply line or sewer line, the construction standards specified in ARM 17.38.101(4) (applicable) must be observed.

### C. Water Rights

Section 85-2-101, MCA, declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.

Parts 3 and 4 of Title 85, Chapter 2, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the State. Some of the specific requirements are set forth below.

Section 85-2-301, MCA, provides that a person may only appropriate water for a beneficial use.

Section 85-2-302, MCA, specifies that a person may not appropriate water or commence construction of diversion, impoundment, withdrawal or distribution works therefore except by applying for and receiving a permit from the Montana Department of Natural Resources and Conservation (DNRC). While the permit itself may not be required under federal law, appropriate notification and submission of an application should be performed and a permit should be applied for in order to establish a priority date in the prior appropriation system.

Section 85-2-306, MCA, specifies the conditions on which groundwater may be appropriated, and, at a minimum, requires notice of completion and appropriation within 60 days of well completion.

Section 85-2-311, MCA, specifies the criteria that must be met in order to appropriate water and includes requirements that:

1. there are unappropriated waters in the source of supply;
2 the proposed use of water is a beneficial use; and
3. the proposed use will not interfere unreasonably with other planned uses or developments.

Section 85-2-402, MCA, specifies that an appropriator may not change an appropriated right except as provided in this section with the approval of the DNRC.

Section 85-2-412, MCA, provides that, where a person has diverted all of the water of a stream by virtue of prior appropriation and there is a surplus of water over and above what is actually and necessarily used, such surplus must be returned to the stream.

## D. Controlled Groundwater Areas

Pursuant to Section 85-2-507, MCA, DNRC may grant either a permanent or a temporary controlled groundwater area. The maximum allowable time for a temporary area is two years, with a possible two-year extension.

Pursuant to Section 85-2-506, MCA, designation of a controlled groundwater area may be proposed if: (i) excessive groundwater withdrawals would cause contaminant migration; (ii) groundwater withdrawals adversely affecting groundwater quality within the groundwater area are occurring or are likely to occur; or (iii) groundwater quality within the groundwater area is not suited for a specific beneficial use.

## E. Occupational Health Act, Section 50-70-101, *et seq.*, MCA.

ARM 17.74.101 addresses occupational noise. In accordance with this section, no worker shall be exposed to noise levels in excess of the levels specified in this regulation. This rule is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.95 applies.

ARM 17.74.102 addresses occupational air contaminants. The purpose of this rule is to establish maximum threshold limit values for air contaminants under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. In accordance with this rule, no worker shall be exposed to air contaminant levels in excess of the threshold limit values listed in the rule. This rule is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.1000 applies.

## F. Montana Safety Act

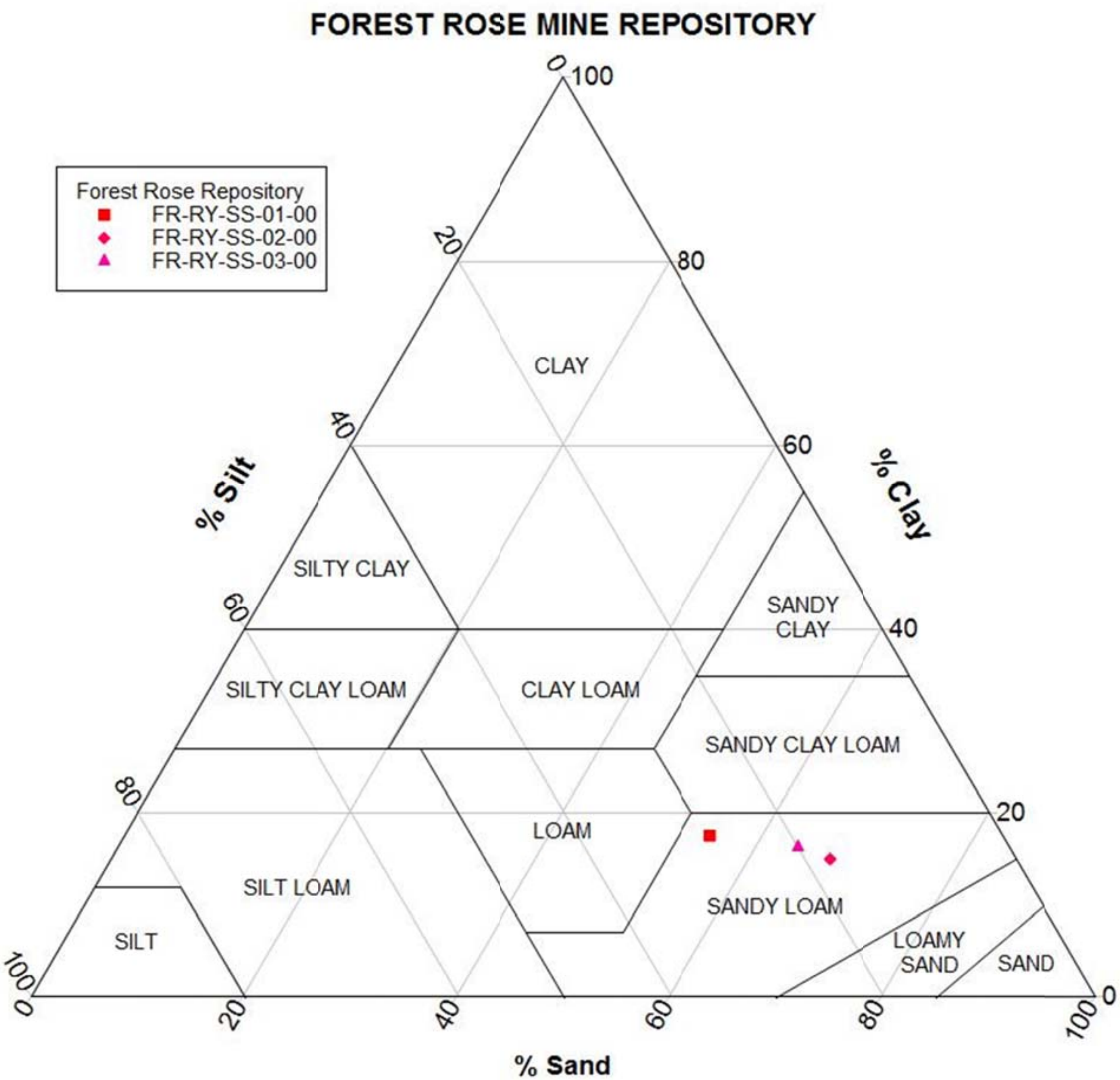
Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe. The employer must also do every other thing reasonably necessary to protect the life and safety of its employees. Employees are prohibited from refusing to use or interfering with the use of safety devices.

## G. Employee and Community Hazardous Chemical Information

Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.

# APPENDIX B

# Boring Log and Test Pits


FOREST ROSE MINE REPOSITORY
Forest Rose Repository
FR-RY-SS-01-00
FR-RY-SS-02-00
FR-RY-SS-03-00
CLAY
SILTY CLAY
SANDY CLAY
SILTY CLAY LOAM
CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
SILT
LOAMY SAND
SAND
% Silt
% Clay
% Sand
0
20
40
60
80
100

# Key to Log of Boring / Test Pit

HERRERA ENVIRONMENTAL CONSULTANTS

**Project: Forest Rose Mine**
**Granite County, Montana**

| UNIFIED SOIL CLASSIFICATION SYSTEM AND SYMBOL CHART | | | | |
|---|---|---|---|---|
| MAJOR DIVISIONS | | | SYMBOLS | DESCRIPTIONS |
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | CLEAN GRAVELS LITTLE OR NO FINES | GW | Well-graded gravels, gravel-sand mixtures, little or no fines |
| | MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE | | GP | Poorly graded gravels, gravel-sand mixtures, little or no fines |
| | | GRAVELS WITH FINES APPRECIABLE AMOUNT OF FINES | GM | Silty gravels, gravel-sand-silt mixtures |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures |
| MORE THAN 50% OF MATERIAL COARSER THAN NO. 200 SIEVE SIZE | SAND AND SANDY SOILS | CLEAN SANDS LITTLE OR NO FINES | SW | Well-graded sands, gravelly sands, little or no fines |
| | MORE THAN 50% OF COARSE FRACTION PASSING NO.4 SIEVE | | SP | Poorly graded sands, gravelly sands, little or no fines |
| | | SANDS WITH FINES APPRECIABLE AMOUNT OF FINES | SM | Silty sands, sand-silt mixtures |
| | | | SC | Clayey sands, sand-clay mixtures |
| FINE GRAINED SOILS | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 50 | ML | Inorganic silts, very fine sands, rock flour, silty/clayey fine sands or clayey silts of slight plasticity |
| | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | | | OL | Organic silts and organic silty clays of low plasticity |
| MORE THAN 50% OF MATERIAL FINER THAN NO. 200 SIEVE SIZE | SILTS AND CLAYS | LIQUID LIMIT GREATER THAN 50 | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silt |
| | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | OH | Organic clays of medium to high plasticity, organic silts |
| HIGHLY ORGANIC SOILS | | | PT | Peat, humus, swamp soils with high organic content |

NOTE: DUAL SYMBOLS USED FOR BORDERLINE CLASSIFICATIONS

## Abbreviations

| | |
|---|---|
| **AL** | Atterberg Limits |
| **C** | Consolidation |
| **DS** | Direct Shear |
| **HA** | Hydrometer Analysis |
| **LL** | Liquid Limit |
| **LV** | Laboratory Vane Shear |
| **N** | Number of hammer blows for last 12 inches driven |
| **OVA** | Organic Vapor Analyzer |
| **Pc** | Constant Head Permeability |
| **Pf** | Falling Head Permeability |
| **PI** | Plasticity Index |
| **PP** | Pocket Penetrometer |
| **SA** | Sieve Analysis |
| **SG** | Specific Gravity |
| **TV** | Torvane Shear |
| **TX** | Triaxial Shear |

## Sampler Symbols

2-inch-O.D. Split Spoon Sampler Driven with 140-lb Auto Hammer and 30-inch Drop (SPT)

3-inch-O.D. Split Spoon Sampler with Brass Rings Driven with 300-lb Hammer and 30-inch Drop

Non-Standard Penetration Test

3-inch-O.D. Shelby Tube Sampler

Bulk Sample

3-inch-O.D. Pitcher Tube Sampler

DCPT= Dynamic Cone Penetrometer Test Blowcounts

## Groundwater Level Symbol

▼ Water level at time of drilling or excavation

## Relative Density and Consistency Relationships

| Coarse-Grained Soils | | | Fine-Grained Soils | | |
|---|---|---|---|---|---|
| Relative Density | N - SPT (blows/ft) | Manual Field Test | Relative Consistency | N, SPT (blows/ft) | Manual Penetration Test |
| Very loose | 0 - 4 | Easily penetrated by 1/2-inch rod pushed by hand | Very soft | <2 | Easy several inches by fist |
| Loose | 5 - 10 | Easily penetrated by 1/2-inch rod pushed by hand | Soft | 2 - 4 | Easy several inches by thumb |
| Medium dense | 11 - 30 | Penetrated 1 foot by 1/2-inch rod driven by 5-lb hammer | Medium stiff | 5 - 8 | Moderate several inches by thumb |
| Dense | 31 - 50 | Penetrated 1 foot by 1/2-inch rod driven by 5-lb hammer | Stiff | 9 - 15 | Readily indented by thumb |
| Very dense | >50 | Penetrated only few inches by 1/2-inch rod driven by 5-lb hammer | Very Stiff | 16 - 30 | Readily indented by thumbnail |
| | | | Hard | >30 | Difficult by thumbnail |

## Minor Descriptors

| | |
|---|---|
| Trace clay, silt, sand, gravel | <5% |
| Few clay, silt, sand, gravel | 5 - 10% |
| Little clay, silt, sand, gravel | 15 - 25% |
| Some clay, silt, sand, gravel | 30 - 45% |

## Moisture Content

| | |
|---|---|
| Dry | Absence of moisture, dusty |
| Moist | Damp but no visible water |
| Wet | Visible free water, from below the water table |

## General Notes

1. Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on these logs apply only at the specific test pit locations and at the time the test pits were excavated; they are not warranted to be representative of subsurface conditions at other locations or times.

2. Soil descriptions are recorded in the following order: SOIL CLASSIFICATION (USCS Symbol), relative density or consistency, color, moisture, plasticity or gradation, angularity, minor constituents, additional comments (organics, odor, etc.) [GEOLOGIC UNIT].

3. Soil relative density or consistency was estimated based on manual inspection and/or ease or difficulty of excavation by the backhoe.