DRAFT
ENGINEERING EVALUATION / COST ANALYSIS
POORMAN / BALM CREEK MINE SITE
BAKER COUNTY, OREGON

Prepared for:

U.S. Department of Interior
Bureau of Land Management
Vale District Office

National Science & Technology Center
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TABLE OF CONTENTS

LIST OF FIGURES iv

LIST OF PLATES iv

LIST OF TABLES v

LIST OF ATTACHMENTS vi

LIST OF ACRONYMS vii

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1

2.0 SITE DESCRIPTION AND BACKGROUND 1
2.1 Site Description 2
2.1.1 Topography 5
2.1.2 Geology/Soil Information 5
2.1.3 Surface Water 7
2.1.4 Groundwater 7
2.1.5 Surrounding Land Use and Populations 8
2.1.6 Sensitive Ecosystems 8
2.1.7 Meteorology 9
2.1.8 Cultural Resources 9
2.2 Physical Hazards 10

3.0 SOURCE, NATURE, AND EXTENT OF CONTAMINATION 10
3.1 Site Characterization 11
3.2 Tailings and Waste Rock Characterization 11
3.2.1 Sampling 11
3.2.2 Tailings and Waste Rock Analytical Results 13
3.3 Surface Water Characterization 15
3.4 Repository Site Characterization 16
3.4.1 Soil Classification 16
3.4.2 Geophysical Survey Results 17
3.4.3 Laboratory Geotechnical Analysis 17
3.5 Borrow Area Material Characterization 18
3.5.1 Sample Collection 18
3.5.2 Laboratory Geotechnical Analysis 18
3.5.3 Laboratory Agronomic Analyses 19
3.6 HELP Modeling 19

4.0 STREAMLINED RISK ASSESSMENT 19

4.1 Human Health Risk Assessment 20
4.2 Ecological Risk Assessment 20
4.3 Uncertainty Analysis 21
4.4 Risk Assessment Results 22
4.5 Removal Action Criteria 22
4.6 Schedule 23

5.0 APPLICABLE, OR RELEVANT, AND APPROPRIATE REQUIREMENTS 23

6.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES 25

7.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES . . . 26
7.1 Description of Alternatives 26
7.1.1 No Action 26
7.1.2 Institutional Controls 26
7.1.3 In-Situ Stabilization and Surface Water Diversion 26
7.1.4 On-Site Repository 27
7.1.5 Off-Site Repository 28
7.1.6 Remove Tailings to a Solid Waste Landfill 28
7.1.7 Remove Tailings to a Hazardous Waste Landfill 29
7.2 Description of Evaluation Criteria 29
7.2.1. Effectiveness 29
7.2.2 Implementability 30
7.2.3 Costs 31
7.3 Evaluation of Potential Removal Action Alternatives 31
7.3.1 Alternative 1 - No Action 31
7.3.2 Alternative 2 - Institutional Controls 31
7.3.3 Alternative 3 - In-Situ Stabilization and Surface Water Diversion 32
7.3.4 Alternative 4 - On-Site Repository 32
7.3.5 Alternative 5 - Off-Site Repository 33
7.3.6 Alternative 7 - Remove Tailings to a Hazardous Waste Landfill 34

8.0 COMPARATIVE ANALYSIS OF RETAINED ALTERNATIVES 34
8.1 Effectiveness 35
8.2 Implementability 36
8.3 Cost 36

9.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE 37

10.0 REFERENCES 38

LIST OF FIGURES

Figure 1	Site Map
Figure 2	Project Site Plan
Figure 3	Upper Poorman Mine - Site A
Figure 4	Lower Poorman Mine - Site B
Figure 5	Balm Creek Shaft Mine - Site C
Figure 6	Lower Holding Pond Site
Figure 7	Proposed Repository Site
Figure 8	Streamlined Risk Assessment Conceptual Site Model

LIST OF PLATES

Plate 1 - Soil Observation Pits
Plate 2 - Geophysical Survey

LIST OF TABLES

Table 1	Mine Waste Volumes
Table 2	XRF Analytical Results
Table 3	Total Metals Analytical Results
Table 4	Leachable Metals Analytical Results
Table 5	Acid Base Accounting Results
Table 6	Surface Water Analytical Results
Table 7	Proposed Repository Geotechnical Laboratory Results
Table 8	Borrow Soils Geotechnical Laboratory Results
Table 9	Borrow Soils Agronomic Results
Table 10	Summary of Preliminary HELP Model Analysis
Table 11	Comparison of Analytical Results and Risk Management Criteria
Table 12	Summary of Potential Chemical Specific ARARs
Table 13	Summary of Potential Action Specific ARARs
Table 14	Summary of Potential Location Specific ARARs

LIST OF ATTACHMENTS

Attachment A	Botanical Evaluation
Attachment B	Monthly Average Temperature & Precipitation Data for Pendleton
Attachment C	Poorman/Balm Creek Sampling and Analysis Report (2003)
Attachment D	Geophysical Report
Attachment E	Materials Testing and Tailings Shear Strength Results
Attachment F	HELP Modeling Results
Attachment G	Technical Note: Risk Management Criteria for Metals at BLM Mining Sites
Attachment H	Detailed Costs Estimates

LIST OF ACRONYMS

ACEC	Area of Critical Environmental Concern
ACM	Asbestos containing materials
ABA	Acid Base Accounting
AML	Abandoned Mine Lands
ARAR	Applicable or Relevant and Appropriate Requirements
ARD	Acid Rock Drainage
ATV	All-terrain Vehicle
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic Feet per Second
cm/s	Centimeters per Second
COC	Chemical of Concern
DAF	Dilution-Attenuation Factor
DQO	Data Quality Objective
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
HELP	Hydrologic Evaluation of Landfill Performance
msl	mean sea level
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
NCP	National Contingency Plan
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSTC	National Science and Technology Center
ODEQ	Oregon Department of Environmental Quality
OSC	On-Scene Coordinator
OWQC	Oregon Water Quality Criteria
ppm	Parts Per Million
RAO	Removal Action Objective
RCRA	Resource Conservation and Recovery Act
RMC	Risk Management Criteria
SAR	Sodium Absorption Ratio
SPLP	Synthetic Precipitation Leaching Procedure
sq. mi.	Square Miles
TBC	To Be Considered
TRV	Toxicity Reference Value
µg/L	Micrograms per Liter
USGS	U.S. Geologic Survey
XRF	X-Ray Fluorescence Spectrometer
WAD	Weak acid dissociable

EXECUTIVE SUMMARY

The U.S. Department of Interior, Bureau of Land Management (BLM), National Science and Technology Center (NSTC) and the Vale District Office of BLM prepared this Engineering Evaluation/Cost Analysis (EE/CA) for the Poorman/Balm Creek Mine Site.

The Balm Creek Mine was most commonly known as the Mother Lode Mine. This Mine was a consolidation of the Mother Lode, Balm Creek, Gilkenson, and Poorman workings. These sites have been consolidated for the purposes of the Engineering Evaluation/Cost Analysis and are collectively referred to as the Poorman/Balm Creek Mine Site. The Site is located approximately 19.5 miles north east of Baker, Oregon.

The site characterization performed as part of the field work associated with this EE/CA focused on gathering the data needed to support conceptual removal action designs. Samples were collected of composited tailings and native soils for analysis of geotechnical and agronomic parameters. Using a portable X-ray fluorescence analyzer, both in-situ and intrusive measurements of tailings were collected for concentrations of selected metals and cyanide. Surface water samples were taken and submitted to laboratories for analysis of metals and ions. To determine the thickness and chemical analysis of tailings in each pond, hand-augured boreholes were advanced through the tailings in the tailings ponds. The estimated total volume of the Site tailings and waste rock needing remediation is 47,900 cubic yards.

The results of the sampling show that the tailings and waste rock contain metals concentrations that pose a risk to human health and the environment.

The streamlined risk assessment determined that there may be risks to human health and to wildlife from the metals in the tailings and waste rock. Removal and containment of the tailings in conjunction with run-on controls will eliminate risks from direct contact, leaching and erosion, and will reduce the impending threat of failure of the dams and subsequent release of metals-containing tailings to the Balm Creek and down gradient receptors.

Following the site characterization and preparation of the risk assessment, preliminary removal action objectives (RAOs) were developed for the site. These objectives are as follows:

- Reduce or eliminate the release of metals originating at the site to air pathways via fugitive dust emissions.
- Reduce or eliminate the release of metals originating at the site to surface water.
- Reduce or eliminate the release of metals during flood events.
- Reduce or eliminate the potential for exposure to humans and wildlife from inhalation, ingestion or direct contact with contaminated surface soils.
- Consider measures to minimize or avoid adverse effects on historic and prehistoric resources at the Site, as required by the National Historic Preservation Act.

Based on the RAOs, general potential response actions and technologies were assembled into Removal Action Alternatives which have been analyzed with respect to the evaluation criteria (effectiveness, implementability, and cost). These alternatives have been developed based on the known nature and extent of soil contamination and results of the human and ecological risk assessments and are described in the paragraphs to follow. The alternatives initially screened as part of the evaluation were:

- No Action
- Institutional Controls
- In-Situ Stabilization and Surface Water Diversion
- On-Site Repository
- Off-Site Repository
- Removal to a Municipal Solid Waste Landfill
- Removal to a Hazardous Waste Landfill

Several alternatives were eliminated in the initial screening either because they were not protective or not implementable. The alternatives retained through the comparative analysis are:

- Alternative 3: In-Situ Stabilization and Surface Water Diversion
- Alternative 4: On-site Repository
- Alternative 7: Removal to a Hazardous Waste Landfill

Alternative 3 would involve regrading of tailings and waste rock areas, placement of a vegetative cover over the tailings areas and diversion and armoring of the creek in the stream reaches that cut into or threaten the tailings or waste rock areas.

Alternative 4 involves the construction of an on-site engineered repository for isolation of the tailings. The selected site is located to the south and west of the Balm Creek workings. This area was selected based on the field investigations conducted by BLM, including geophysical surveys completed in November 2002 and the archeological clearance. The on-site repository alternative requires clearing and excavating an adequate area to accommodate up to 30,000 cubic yards of material. Run-on control would be provided along the upgradient edge of the site and the repository would be capped with native materials and revegetated to minimize infiltration. The former tailings areas would be recontoured and revegetated or covered with rip-rap for erosion control.

Based on the evaluation of effectiveness, implementability and cost, the recommendation is made to select a combination of Alternative 3 and Alternative 4.

1.0 INTRODUCTION

The U.S. Department of Interior, Bureau of Land Management (BLM), prepared this Engineering Evaluation/Cost Analysis (EE/CA) for the Poorman/Balm Creek Mine Site. This EE/CA has been prepared in accordance with the criteria established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), sections of the National Contingency Plan (NCP) applicable to removal actions (40 CFR § 300.415 (b)(4)(I)). The EE/CA is also consistent with the U.S. Environmental Protection Agency (EPA) guidance document, *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA.*

A removal action is selected when one of the following criteria, as identified in Section 300.415(b)(2)(i-viii) of the NCP, is satisfied:

- Actual or potential exposure to nearby populations, animals or the food chain from hazardous substances, pollutants or contaminants;
- Actual or potential contamination of drinking water supplies or sensitive ecosystems;
- Hazardous substances in drums, barrels, tanks or other bulk containers that may pose a threat of release;
- High levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface that may migrate;
- Weather conditions that may promote migration of hazardous substances;
- Threat of fire or explosion;
- Availability of other appropriate Federal or State response mechanisms to respond to the release;
- Other situations or factors that may pose threats to public health, welfare or the environment.

Removal actions are categorized in three ways: emergency, time-critical, and non-time-critical, based on the type of situation, the urgency and threat of release or potential release, and the subsequent time frame in which the action must be initiated. Emergency and time-critical removal actions are responses to releases requiring action within six months; non-time-critical removal actions are responses to releases where actions can start later than six months after the determination that a response is necessary.

This non-time-critical removal action is necessary because tailings and waste rock contain metals concentrations that pose a risk to human health and the environment.

2.0 SITE DESCRIPTION AND BACKGROUND

The Balm Creek Mine was most commonly known as the Mother Lode Mine. This Mine was a consolidation of the Mother Lode, Balm Creek, Gilkenson, and Poorman workings. These sites have been consolidated for the purposes of the Engineering Evaluation/Cost Analysis and are collectively referred to as the Poorman/Balm Creek Mine Site. The Site is located in Sections 31 and 32 of Township 7 South, Range 43 East, approximately 20 miles northeast of Baker, Oregon. The Site can be accessed by driving east on highway 86 from Baker City, Oregon for approximately 7 miles and turning left (north) onto Keating Road. From Keating Road, veer right onto Keating Grange Lane and head east approximately 4 miles to Mother Lode Road. At a fork in Mother Lode Road, go left (the least used road) and travel approximately 2 ½ miles to the Poorman/Balm Creek Mine Site.

On-the-ground abandoned mine land (AML) inventories were conducted under a 1993 BLM directive that put into place common data elements to ensure that AML is characterized consistently. The AML data collected during that 1993-1995 inventory period has been compiled into an Abandoned Mine Lands Inventory System (AMLIS). The AMLIS Number for the Poorman/Balm Creek Mine Site is OR-035800002.

CERCLA Section 120(c) requires EPA to establish and maintain a "Federal Agency Hazardous Waste Compliance Docket" which contains information on Federal facilities while engaging in hazardous waste activities or having the potential to release hazardous substances into the environment. The Site was added to the 15th Revision of the Federal Facilities Compliance Docket on July 1, 2002.

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database contains general information on sites across the nation and US territories including location, status, contaminants, and actions taken. The CERCLIS Hazardous Waste Site number for the Poorman/Balm Creek Site is #ORN001002416.

2.1 Site Description

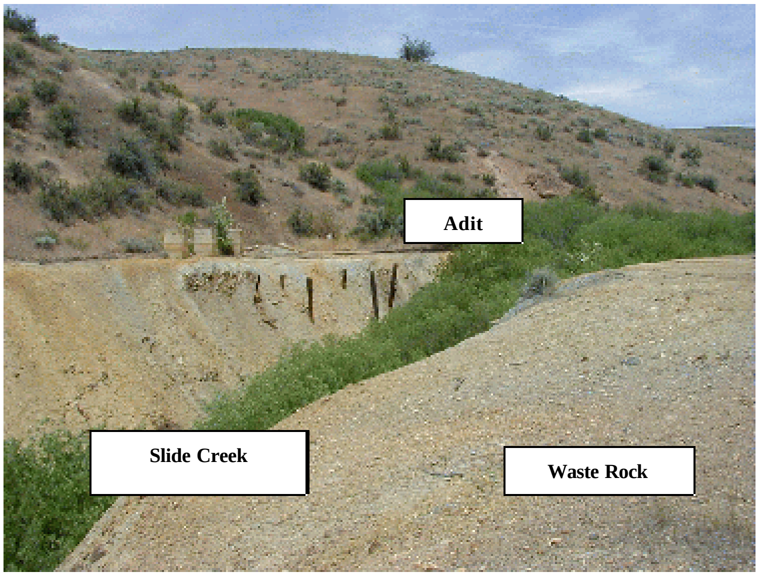
The Site is located in the southerly foothills of the Wallowa Mountains approximately 20 miles northeast of Baker City, Oregon. The hydrology of the site includes Balm Creek and its tributary, Slide Creek. As seen in Figure 1, the Poorman Mine is located on Slide Creek and the Balm Creek Mine is located on Balm Creek. Below the site, Balm Creek flows south approximately seven miles to the Powder River which then flows east to the Snake River. The estimated drainage area above the site is 4,225 acres.

The site consists of four sub-sites all located in the Balm Creek watershed at elevations ranging from approximately 3,400 to 3,700 feet above sea level. Sites A and B are the Upper and Lower Poorman mine workings, respectively. Site A consists of waste rock and a collapsed dry shaft. Site B consists of waste rock and an adit with seepage. At each of these sites, Slide Creek has bisected the waste rock dumps.

Site A: <u>Upper Poorman Mine</u>

Site B: <u>Lower Poorman Mine</u>

A collapsed adit is located along the right bank of Slide Creek. A substantial amount of waste rock has been placed into the riparian area and into the creek itself.

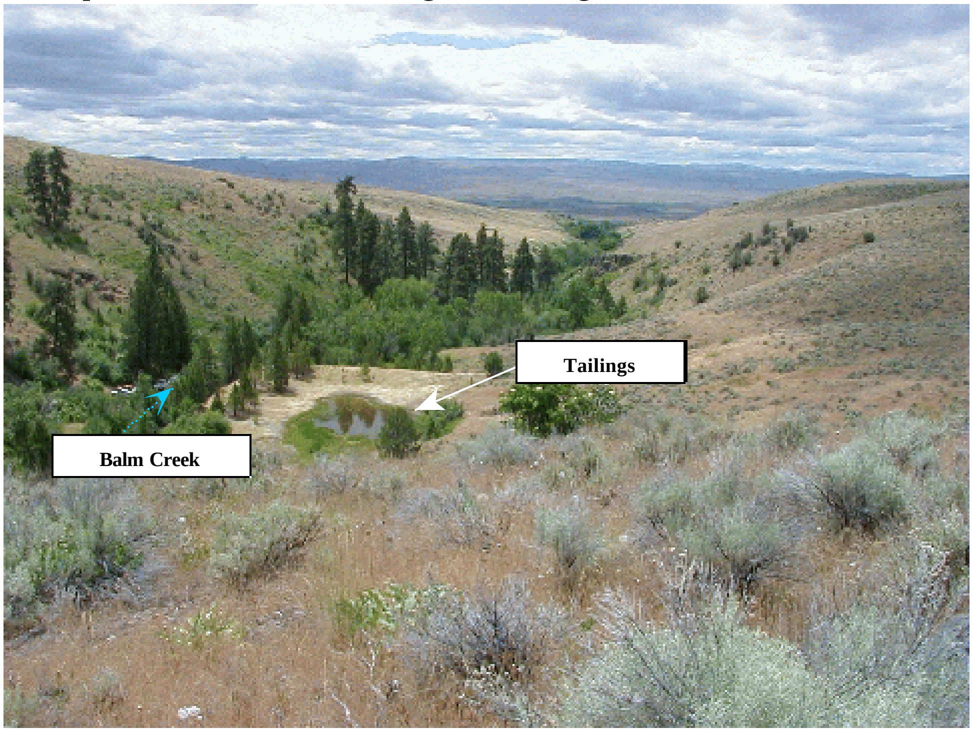


Site C: <u>Balm Creek Mine Complex</u>

Site C is located on Balm Creek at the Balm Creek Mine. It consists of a shaft and headframe, a mill site foundation, waste rock and a tailings pond located adjacent to Balm Creek. The Balm Creek Mine shaft discharges water to Balm Creek. The fourth site is a tailings pond located approximately 1,500 feet south of the confluence of Slide and Balm Creeks. This pond is adjacent to Balm Creek and portions of the flow from Balm Creek enter the upstream of the pond, thus impounding water in the tailings pond.

<u>Lower Holding Pond Site</u>

The tailings were placed in the riparian area of Balm Creek, diverting it toward the left bank. Additional waste material has been placed along the stream banks upstream of this pond. The material is composed of contaminated, fine-grained tailings.



2.1.1 Topography

The Poorman/Balm Creek Site is located in the southerly foothills of the Wallowa Mountains, a range of mountains in northeast Oregon. The Eagle Cap Wilderness lies in the heart of the Wallowa Mountains on the Wallowa -Whitman National Forest. To the south of the Site is the Lower Powder River valley and to the east is the Hell's Canyon Wilderness along the Snake River.

The Site is located in a remote canyon at 3,600 feet above mean sea level (msl). The topography is rolling but is incised by steep, narrow stream valleys of 200-500 ft width, demonstrating 80 -160 ft. of vertical relief. The canyon is drained by Balm and Slide Creeks which flow to the south into the Powder River and then to the Snake River. As shown in the previous photographs, the vegetation consists of spruce and deciduous riparian habitat in the drainages and shrub/steppe habitat on the ridges. The native vegetation is mainly bunchgrasses, sagebrush, shrubs, and forbs. It is estimated that approximately 10 acres have been impacted within the Poorman / Balm Creek Mine Site.

2.1.2 Geology/Soil Information

Poorman / Balm Creek Mine is located in the Columbia Plateau physiographic province in the Wallowa Mountains in northeastern Oregon.

Most of the area is underlain by the Tucker Creek Formation of the Clover Creek Greenstone Group of Triassic age. Greenstones units in northeast Oregon are considered to be accreted terranes, pertaining to the Seven Devils Group. The local exposures are low-grade metamorphic units (pumpellyite-prenhite facies) that originated as basaltic to rhyolitic flows. Spilltes and keratophyres are the most common rock types, with variable amounts of interbedded tuffs, sandstones, wackestones and other volcanoclastic sediments. The unit underlying the Poorman site is a medium-bedded, green, porphyritic andesite flow with rounded volcanoclastic sedimentary clasts. At higher elevations there are beds of featureless greenstone and metasediments. The greenstones are gently folded, they strike east-west, northeast and northwest and dip moderately (20-50 degrees) to the north and northwest. In the Poorman site the units strike east-west and northeast and dip about 50 degrees to the north or northwest.

Plutons of albite granite and hornblende quartz diorite are present 2-10 miles to the south and southeast of the Poorman site. These intrusives are considered to be of Lower Triassic age. Pebbles of these units occur in the Clover Creek Greenstone.

The hills around the Poorman site are capped by thick beds flat-lying, Late Miocene age olivine basalt. These are the youngest units in the area of concern. They are rarely fractured and generally lie above the local water tables.

A light-colored tuff unit of probable Miocene-age occurs in the Poorman area. It is exposed only near the Balm Creek Shaft, in the landslide area on the west side of the stream valley (across from the mine). The tuff is an off-white, highly friable with a very low specific gravity. It is a unit of concern since it may act as an aquatard and as a potential landslide base/surface (in areas of inclination).

The soils at the Poorman/Balm Creek Mine Sites (A, B, & C) are Taterpa loam. This deep, well-drained soil formed in colluvium and residuum derived from quartz diorite and related granitic rocks. Typically, the surface layer is black loam about 13 inches thick. The subsoil is very dark brown loam about 21 inches thick. The substratum is dark brown gravelly, sandy loam about 15 inches thick. The depth to weathered bedrock is 40 to 60 inches. Permeability is moderate to a depth of about 13 inches in the Taterpa soil and moderately rapid below that depth. Runoff is medium, and the hazard of water erosion is moderate to high.

The soils at the Lower Holding Pond are Ridley-Keating silt loams. This unit is about 50 percent Ridley silt loam and 40 percent Keating silt loam. The Ridley-Keating soil is deep and well drained. It formed in colluvium derived from greenstone and basalts and is influenced by loess and volcanic ash in the surface layer. Typically, the surface layer is very dark brown silt loam about 9 inches thick. The upper 15 inches of the subsoil is dark brown silty clay loam. The lower 18 inches are dark brown clay and silty clay. Below this to a depth of 60 inches or more is dark brown silty clay loam. Permeability in the soils is moderately slow to a depth of about 24 inches and slow below that depth. Runoff is slow or medium, and the hazard of water erosion is slight or moderate.

The only mapped regional fault is a west-northwest trending normal fault that occurs about 2.5 miles south of the Poorman site. The Poorman mines occur along a northeast-trending shear zone.

Northwest-trending normal faults of minor extent are also observed, corresponding to Tertiary-age movement.

2.1.3 Surface Water

Slide Creek and Balm Creek lie within the Powder Basin in eastern Oregon. The creeks are small, intermittent to perennial streams with summer flows of <5 cfs. As indicated elsewhere, Balm Creek joins the Powder River which then joins the Snake River. Upstream of the site, Balm Creek's flow is regulated by 2,926 acre-feet Balm Creek Reservoir located about six miles to the north of the site. This reservoir is situated on Forest Service land and owned by an irrigation company. The Reservoir is contained by a 65-foot high by 460-foot long earthen dam constructed in 1963. The Reservoir has a maximum authorized discharge of 400 cfs and a normal storage capacity of 2,926 acre-feet. Since the Balm Creek flow is regulated, it's potential for flooding is reduced, but not eliminated. The 100-year flood discharge is 207 cfs using regression equations for eastern Oregon (USGS, 1983). This flow when added to the 400 cfs from the Reservoir yields 607 cfs used to estimate the width and elevation of the 100-year flood plain.

2.1.4 Groundwater

The groundwater aquifers in Idaho, Oregon, and Washington differ considerably in thickness and permeability, and well yields differ accordingly. In the arid and the semiarid parts of eastern Oregon, most precipitation replenishes soil moisture, evaporates, or is transpired by vegetation. Little is left to maintain streamflow or to recharge aquifers.

There are two general types of regional aquifer systems in the Idaho, Oregon and Washington area (USGS 1994). One type consists of an extensive set of aquifers and confining units that might locally be discontinuous but that function hydrologically as a single aquifer system on a regional scale. The Snake River Plain, the Columbia Plateau, and the Puget-Willamette Trough aquifer systems are examples of this type. The second type consists of a set of virtually independent aquifers that share common hydrologic characteristics. In this type of aquifer system, common hydrologic factors and principles control the occurrence, the movement, and the quality of ground water. The Great Basin and the Northern Rocky Mountains intermontane basins aquifer systems are examples of this type.

In Baker, Harney, and Malheur Counties, ground water is withdrawn by wells completed in unconsolidated deposits, Pliocene and younger basaltic rocks, volcanic and sedimentary rocks, and Miocene basaltic rocks (USGS).

Miocene basaltic-rock aquifers consist primarily of flood-type basaltic lava flows that were extruded from major fissures; some flows extend along former lowlands for about 100 miles. Many of the flows have been folded into anticlines and synclines. Structural features in the flows include cooling joints, rubble zones, and faults. Open spaces along cooling joints and fractures and in rubble and interflow zones are less common in these flows than in Pliocene and younger basaltic lava flows. In the Miocene basaltic lava flows, some of the open spaces that initially formed during cooling or subsequently formed during folding have been filled with secondary clay minerals, calcite, silica, or unconsolidated alluvial deposits emplaced by streams or in lakes. Except where such fill materials are coarse grained, they tend to decrease markedly the permeability of the Miocene basaltic-rock aquifers.

Shallow wells yield water from unconsolidated-deposit aquifers; deeper wells yield water from Miocene basaltic-rock aquifers for public-supply, domestic and commercial, and agricultural purposes. The wells range in depth from about 10 to more than 650 feet. The closest groundwater wells are in the nearby Sparta and Keating area. These wells typically have static water levels ranging from 6 to 245 feet below land surface. Water was typically encountered during drilling operations between 30 and 100 feet below land surface.

Local groundwater levels near the proposed repository are indicated by an intermittent spring that occurs about 2, 000 ft. west-southwest of the first proposed site, at an elevation of about 3420 ft. A groundwater monitoring well will be installed to further characterize the underlying geologic formation and provide groundwater monitoring data prior to construction of the proposed repository.

2.1.5 Surrounding Land Use and Populations

There are no cities or towns located within the affected watershed from Balm Creek to the Snake River. The principal land uses are ranching, farming and recreation.

2.1.6 Sensitive Ecosystems

A botanical evaluation for the Poorman/Balm Creek Site was completed by BLM in July 2001 [Attachment A]. Historic and recent threatened and endangered species inventories were evaluated. There are no federally listed threatened, endangered or candidate plant species known or likely to occur at the mine site. On-site surveys and reviews of records for the area indicate the presence of Bebb's sedge (Carex bebbii), a BLM designated "assessment" species, within the area and upstream of the Site. The evaluation surmises that the proposed action is unlikely to impact the local populations or its future listing status.

According to the Oregon Department of Fish and Wildlife Aquatic Inventory Project conducted in 1996, Redband trout, a BLM sensitive species, has been found in Balm Creek upstream and downstream of the site. Water quality of Balm Creek exceeds the fisheries acute level for copper at all sites sampled in April 2001. Mitigation of the Site impact to surface water is necessary to protect the trout species.

Wildlife species associated with the habitat in and around the Poorman/Balm Creek Site include: sage grouse, mule deer, antelope, elk, many raptor species, and a variety of neotropical migratory birds. The area is also considered reintroduction habitat for the Columbian sharp-tailed grouse, a BLM sensitive species. Habitat of sensitive species is to be managed in a manner that does not contribute to the need to list the species under the Endangered Species Act.

The lower portion of the Site is located within the Balm Creek Area of Critical Environmental Concern (ACEC). This BLM area is designated to protect and maintain natural riparian ecological systems for research and educational purposes.

2.1.7 Meteorology

The climate in Baker County is semiarid with an average annual precipitation of less than 15 inches in Baker City. The summers are warm and dry, with a rather short growing season and the winters are rather cold with temperatures frequently well below zero degrees F. The evaporation rate in the summer is moderate and relative humidity is low. Due to lack of site-specific climate information, the monthly average temperature and precipitation data used for the Hydrologic Evaluation for Landfill Performance (HELP) Model were for Pendleton, Oregon located approximately 100 air miles northwest of the site. While the Site is at a higher elevation than Pendleton, the higher latitude of Pendleton causes both sites to experience similar precipitation and temperatures. Pendleton annual precipitation is 12.2 inches. Monthly average temperature and precipitation data for Pendleton are shown in Attachment B.

2.1.8 Cultural Resources

Historic mining in the Powder River watershed began with the discovery of gold at Griffin Gulch in 1861. During the ensuing gold rush, miners fanned out into nearby mountains and by 1900 hundreds of placer and lode claims were being worked throughout the Blue Mountain region. Early mining claims were located in the Balm Creek vicinity in 1883, at the eastern edge of the old Eagle Creek mining district. During 1907 through 1937, the Poorman/Balm Creek Mine property (also known as the Mother Lode Mine) was developed for copper and gold, most notably by the Oregon Copper Company and later the Balm Creek Gold Mining Company.

Between 1907 and the early 1930s, a mining camp and mine operations were established on Balm Creek and Slide Creek. Underground development consisted of 15,000 feet from two shafts and three tunnels (Brooks and Ramp 1968: 99). The Balm Creek Shaft was sunk to about 700 feet and the Poorman Shaft to 420 feet. In 1935, a 100 ton flotation processing mill was erected and commenced shipments of ore and concentrates to the Tacoma smelter. Acid mine water was used in the flotation circuit. About 0.22 to 0.26 pound of potassium xanthate was used per ton of ore. In addition, a mixture of 10% tar oil, 40% acid creosote and 50% pine oil was fed at the rate of 25 to 40 drops a minute. Occasionally, about 25 pounds of lime per shift was added to the tails to promote settling. Flotation tailings were sent to ponds and dumps. According to the Oregon Metal Mines Handbook, production from the mine amounted to at least 8,108 ounces of gold and 4,047,015 pounds of copper, with a total value of about $405,000 (Department of Geology and Mineral Industries 1939: 43-44). In 1939, the mine shut down and was never re-opened, although exploration continued until the 1970s. During the 1990s, the various claims were declared null and void (Dynamac, 2000).

An intensive cultural resource survey was conducted for the area of potential effect. Today, features at the mine property include collapsed and dismantled building remains, mill foundations, tailings and waste rock landscape, and other historic features associated with its operation. Remaining standing structures include the Balm Creek Mine shaft head frame, and a concrete vault. The Balm Creek-Poorman Mine property is locally important for its historic role in the copper-gold belt developments of the Eagle

Creek mining district. Remediation actions at three locations would remove or alter some old mine structures and features, as well as the landscape of tailings and waste rock. These effects would be mitigated by historic research, recording and documentation of the historic mine property and its features.

The project area is located in the homeland and 1855 Treaty area of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Following a consultation meeting with CTUIR in February, 2002, BLM developed further protection measures. No Native American archaeological sites would be affected by the planned remediation actions. Avoidance measures would be implemented by project design, with additional stipulations pertaining to any inadvertent discoveries under the National Historic Preservation Act and Native American Graves Protection and Repatriation Act.

2.2 Physical Hazards

Section 2.1 discussed the major structures remaining at the Site, including the foundation of the flotation processing mill, and the two tailings impoundments, several shafts and adits, and the main shaft and headframe. A collapsed vent shaft is also located at the Balm Creek Mine. The potential for additional collapse of the vent shaft surface is unknown, but considered highly probable. The main shaft is filled with water from the underground workings and is flowing over and through the waste rock pile and tailings into the adjacent creek. The wooden head frame structure over the main shaft is structurally unsound and at a great risk of collapse.

The physical hazards must be addressed at the site. The risk associated with the collapsed vent shaft could be reduced by placement of large rock or reinforced concrete in the area with appropriate fencing restricting access. The headframe over the main shaft at Balm Creek should be removed and dismantled or refurbished. A reinforced concrete cap with a drainage outlet could be placed over the open shaft to eliminate the physical hazard. Several of the adits have collapsed and present minimal physical hazards. The remaining adits should be evaluated for closure.

A detailed evaluation of remedies for physical hazards is outside the scope to the EE/CA and will be addressed by BLM as part of the site removal design and reclamation. The main shaft discharge and its impact to the environment is discussed later in the EE/CA.

3.0 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The site investigation was conducted to obtain the data necessary to further characterize the nature and extent of contamination, evaluate human and ecological risk, develop removal action objectives and determine Applicable or Relevant and Appropriate Requirements (ARARs). The chemical and physical properties of tailings and native soils were determined to assist in evaluating alternatives. By targeting the collection of data to evaluate this alternative, enough detailed information about the site and characteristics of the tailings was collected to develop removal alternatives.

Site characterization was conducted during phases. The first work was conducted on September 22, 2000 and consisted of an X-ray Fluorescence spectrometer (XRF) survey of the surficial metals concentrations and collection of the low-flow surface water samples. Additional sampling of surface water sampling occurred during seasonal spring runoff on April 18, 2001 and during the summer on June 26, 2001.

As part of the field investigation, all significant Site areas were surveyed using an electronic total station resulting in detailed topographic maps, Figures 2-6. These maps, in conjunction with the site characterization, were used to determine the area and volume of tailings contained in each of the ponds and the identification of features that influence the development of removal alternatives.

3.1 Site Characterization

The activities conducted to obtain these data were: surface water sampling for metals, soil/tailings sampling for metals and cyanide, metals and cyanide leaching potential, geotechnical and agronomic analyses of borrow soils, evaluation of the headframe and shaft closure and surveying. Each of these sampling activities is described in detail in the sections to follow.

Objectives of the site investigation were as follows.

- Determine the chemistry, area and volume of tailings and waste rock dumps;
- Determine geotechnical characteristics of borrow area and soil;
- Determine the agronomic properties and availability of nearby borrow topsoil;
- Determine the location of the 100-year flood plain;
- Determine the approach for shaft closure and stability of the headframe.

The data quality objective (DQO) process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity, and quality of environmental data used in the decision making are appropriate for the intended purpose. Based on the objectives of this investigation, data collected during the course of this project satisfied Level III requirements. The following analytical methods were selected for site characterization.

- EPA Method 200 series for water samples
- 6200 - Field Portable X-ray Fluorescence Spectrometry
- 6010 - Analysis by Inductively Coupled Plasma (ICP) for total metals
- Weak acid dissociable (WAD) cyanide by SM 4500I-CN
- 1312 - Sample Preparation via Synthetic Precipitation Leaching Procedure (SPLP) for total metals and weak acid dissociable (WAD) cyanide
- Acid Base Accounting (ABA)

3.2 Tailings and Waste Rock Characterization

3.2.1 Sampling

To further define the spatial distribution and chemical characteristics of contaminants in the tailings and adjacent native soils, a variety of samples were collected and analyzed via XRF, total metals via 6010, and WAD cyanide. The objective of the sampling focused on identifying the distribution of contaminants in the waste rock dumps and tailings impoundments, and any conditions that have the potential to vary the chemical properties of contaminants.

Surface XRF samples were analyzed in-situ or collected using stainless steel trowels or disposable/single-use sampling equipment, and analyzed for metals via XRF. Subsurface samples were collected using hand augers. XRF analyses were conducted using a Niton Model 702 Multi Element Bulk Sample Analyzer.

Sample locations for the XRF analysis were distributed in the four sites by a random pattern and by visible changes in the surface material's characteristics, such as, color and gradation. These samples help define the spatial distribution of contaminants and the extent of contamination.

Surface tailings samples were collected from zero to two inches below ground surface. Care was taken to ensure that stones and all biotic matter (i.e., roots, plant material, etc.), were removed prior to analysis such that the sample was representative of actual mineral soils. These steps were taken to ensure that the most accurate and precise results are generated by XRF analyses. Prior to the collection of each tailings surface sample, the sampling tool (i.e., hand trowel, hand auger, split spoon) were decontaminated using a soapy wash and tap water rinse.

Samples were taken at depth in the tailings by hand augering, collecting samples and mixing the samples along the interval to create a vertical composite of the tailings.

Subsurface samples were collected from tailings within the impoundments of Poorman / Balm Creek Mine. Two hand borings were conducted in each tailing pond. A composite sample from each boring was collected at depths ranging from zero to 5.5 feet below ground surface to determine the average vertical composition of metals and cyanide contamination in tailings.

The data below summarizes the depth and sample identification for the four vertical composite samples.

Pond	Sample	Depth Composite
1	C-Tails-SPLP-1	0-5.5'
1	C-Tails-SPLP-2	0-5.5'
2	Pond-Tails-SPLP-1	0-5.5'
2	Pond-Tails-SPLP-2	0-4'

In addition to these samples of the tailings impoundments, grab samples of the waste rock dumps at

Upper Poorman (Site A) and Lower Poorman (Site B) were collected. Table 1 shows the estimated calculated volumes of the two tailings impoundments and the two waste rock dumps.

The area and depth of the four tailing impoundments were calculated using topographic maps together with the results of the subsurface sampling and field measurements of the height of the tailing dams. The estimated total volume of tailings Ponds 1 and 2 plus waste rock at Upper and Lower Poorman Mine is 34,010 cubic yards, including a 10 percent contingency factor. The additional waste rock at the Balm Creek Mine site is stable and not in the flood plain. The EE/CA further evaluates options for reducing infiltration at Site C by placement of cover material over waste rock and reducing or eliminating shaft water discharge.

Upon collection, samples were immediately placed in an appropriate container. The sample containers were then labeled and prepared for shipment to the analytical laboratory. The information provided on the sample labels included: date the sample was collected; sampling location; preservative used; initials of person who collected the sample; and a unique sample number. Finally, all sampling activities and locations were recorded in the field notebook. The table below provides the sampling protocol and analyses for metals and cyanide analysis.

Sample Group	Sample Quantity	Analysis	Volume / Container
Tailings and Waste Rock	67 points	XRF	Ziplock
Tailings and Waste Rock	4 hand borings 2 grab samples	XRF, ICP, cyanide (T+WAD), SPLP, ABA	Ziplock

The hand boring and waste rock samples were also collected for SPLP (Method 1312) for metals and WAD cyanide and Acid/Base Accounting (ABA) analysis. A modification to the SPLP was made by use of deionized water as the extractant for WAD cyanide. WAD cyanide measures “free” plus the weak cyanide complexes that dissociate in a weak acid extraction (pH 4.5), so WAD is always less than total cyanide. Metals were extracted per the published SPLP method. The objective of these sample analyses is to assess the cyanide leachability of the tailings material and to identify the characteristics of the cyanide forms present.

3.2.2 Tailings and Waste Rock Analytical Results

Table 2 presents the surficial XRF analytical results for lead, arsenic, mercury, zinc, copper, iron, and manganese. Blank and certified standards used in calibrating the XRF were within normal ranges.

In discussing XRF concentrations, the term “high” is used here for values greater than 2,000 ppm, “moderate” for 500-2000 ppm and “low” for <500 ppm. The XRF metals concentrations for the Balm Creek site (Site C) are highly variable with high copper, manganese and zinc in some tailings samples (but not the rest), and low concentrations of arsenic, lead and mercury in all of the samples. Upper Poorman (Site A) had a similar range of concentrations, with high to low concentrations of copper, manganese, lead, and zinc and low to moderate concentrations arsenic. Lower Poorman (Site B) had primarily low to moderate concentrations of all metals except for lead in an area of assay crucibles. The Pond results showed low to moderate concentrations of the same metals except two samples near the inlet to the Pond in grey tailings showed extremely high copper concentrations over 100,000 ppm.

The metals and cyanide analyses were performed by Analytical Laboratory in Thornton, Colorado. Table 3 shows the laboratory metals analyses results for the vertical composite tailings samples and for the waste rock. Balm Creek tailings (Site C) showed high copper concentrations with other metals of moderate to low concentration. Upper and Lower Poorman waste rock (samples A and B) showed moderate to low concentrations. Table 4 shows the leaching results from the same samples analyzed for total metals in Table 2. The only significant leaching is for copper and zinc in samples C-SPLP-1 and P-Tails-SPLP-2, where greater than 1 mg/L of copper and zinc were leached.

Table 5 shows the ABA results as analyzed by ACZ Laboratories of Steamboat Springs, Colorado. Acid Base Accounting is a debit and a credit analysis concerned with the ability to generate sulfuric acid or acid rock drainage (ARD). Simple pH measurements do not accurately predict future acid generating potential. The acid generation potential is the debit in tons of calcium carbonate required per ton of waste (tCaCO3/kt), normally signified as a minus value, and the acid neutralization potential is the credit in positive tons of calcium carbonate present in the waste. The acid base potential is the sum of the debit and credits (same units). An acid base potential that is negative is acid generating. The waste rock at Upper and Lower Poorman average -35, and the Pond tailings average -13. The tailings at Balm Creek Mine showed two very different results. C-SPLP-1 taken from the middle of the pond, and which contained a black slime at 2.5' and was highly acid generating (-96), whereas C-SPLP-2, taken from nearer the dam, was all oxidized (no black slime) and had an acid base potential of -17. This indicates this sample was more completely oxidized and has less stored acid potential.

The significance of the ABA results relates to the ARD potential of the waste. Mine waste with a negative acid base potential will oxidize to produce sulfuric acid (ARD). The acidity produced can continue for many decades, depending on the magnitude of the acid base potential. Considering the -96 value for sample C-SPLP-1 for material that has been in place for at least 60 years, the acid base potential is still very high. It will continue to leach highly acidic water for an indefinite period. Highly acidic conditions:

- cause mobilization of heavy metals into leachates, groundwater and surface water,
- completely prevent plant growth when soil pH is less than 3.5.

Therefore, measures must be taken to deal with the acid generating potential of the waste if the material is to be reclaimed.

Based on the total metals and leachable metals results, the ABA results and the location of the mine waste, the waste rock dumps at Upper Poorman (Site A), the waste rock dumps at Lower Poorman (Site B), and the tailings at the Balm Creek Mine (Site C) and the Pond warrant a removal action. Each of these waste units is leaching or eroding hazardous substances into surface water and/or poses an imminent threat to release hazardous substances into surface water if a major flood event occurs. Each of these units is denuded of vegetation due to acidity and metals concentrations, is high susceptible to erosion and cannot be stabilized with vegetation unless covered by suitable growth medium.

Of the four sites, the tailings in the Pond are the greatest concern as they exhibit very high leachable copper and zinc concentrations, high acid base potential, and are already situated in the stream channel, and are inundated by normal flows of Balm Creek. The waste rock at Balm Creek Mine is also partially in the flood plain and should be regraded against the hillside to place its toe as far as possible out of the flood plain, but a complete removal does not seem necessary at this time as it is not being actively eroded by the stream.

3.3 Surface Water Characterization

The objective of the sampling focused on identifying the distribution of contaminants in surface waters at the site, for both low-flow and high flow conditions. Table 6 shows the analytical results for surface water completed during 2000 and 2001. Only one exceedance of Oregon water quality criteria for the protection of freshwater aquatic life (chronic) was observed in September 2000 for silver at the Lower Poorman adit.

During the spring runoff sampling in April 2001, exceedances were noted for cadmium (Decant Pipe, Upper Poorman seep and Main Site Puddle), copper at all locations except the Upper Poorman seep, silver (Decant Pipe) and zinc (Decant Pipe, Headframe and Main Site Puddle). Working from upstream to downstream beginning with Slide Creek, the spring sample collected above Upper Poorman on Slide Creek carries a background loading of copper that exceeds water quality criteria and is slightly increased below Lower Poorman. The Upper Poorman seep exceeds water quality criteria for cadmium, but this seep does not enter Slide Creek. In Balm Creek, the water from the headframe seep meets water quality criteria except for copper and zinc. This water flows approximately 100 yards before joining Balm Creek and it is likely there is attenuation along this segment as evidenced by the iron precipitates in the sediment. Neither of the adits sampled have an acidic discharge. The surface water below Lower Poorman is degraded from releases of copper and zinc, justifying that the removal action address waste rock from Sites A and B.

Additional sampling was performed in November 2002 in accordance the Field Sampling Plan and Quality Assurance Plan (Dynamac, November 2002). Samples were collect at five of the possible ten sites. Sites along Slide Creek and at the Decant Pipe (Sites A-SW-1, A-SW2, B-SW-1, B-SW-2 and D-SW1) were not taken due to insufficient surface water flow. Additional sampling is planned in the future. Results are documented in Final Sampling and Analysis Report [Attachment C]. Results indicate that the shaft is a major source for calcium, sulfate, iron, manganese, and zinc. Most of the iron disappears probably through precipitation by the time the flow reaches the seep. Concentrations of manganese and zinc decline almost linearly from the shaft to the Balm Creek above Slide Creek sampling location. A combination of precipitation and dilution is the most likely cause, with precipitation being more important between the shaft and the seep, and dilution being dominant in Balm Creek. The ODEQ criterion for total iron is exceeded in the shaft discharge, the seep, and the furthest downstream sampling location. The criterion for manganese is exceeded in the shaft discharge, the seep, and both of the downstream sampling locations. The seep is contributing mercury that persists downstream but the concentrations do not exceed the criterion. The most interesting development is the heretofore unknown, but apparently contributing source(s) of aluminum and copper between the seep and Balm Creek above Slide Creek. Concentrations of copper exceed the ODEQ criterion at the Balm Creek above Slide Creek sampling location and the downstream sampling location, and concentrations of aluminum exceed the EPA recommended criterion at the same two sampling locations. Also, the increase in barium, iron, magnesium, potassium, and zinc between Balm Creek above Slide Creek and the downstream sampling location may indicate a subsurface contribution from Slide Creek. More focused investigations may be required to identify these unknown sources (BLM, 2002d).

Mitigation of waste source discharge to surface water is necessary to protect the trout species and its habitat. Additional seasonal surface water sample data should be compiled and evaluated to supplement the existing EE/CA analytical database, facilitate the selection of appropriate remedial alternatives, and support federal cleanup obligations/decisions regarding mined tailings impacts to the Balm Creek and Slide Creek watersheds.

3.4 Repository Site Characterization

BLM has selected a location to the south and west of the Poorman/Balm Creek Mine Site for the proposed repository (Figure 7). The selection of this location was based on proximity to the waste sites, access to the repository, geologic stability, and the archeological survey.

Because of its complex geologic setting, a geologic characterization of the proposed Poorman/Balm Creek repository location was necessary to assess its suitability. Specific objectives of this effort were to understand the local stratigraphy, its lateral continuity, local geologic structures such as faulting, and its surface soils. The November 2002 characterization effort conducted by BLM consisted of the backhoe excavation and logging of seven soil observation pits from which the soil profiles were recorded for texture, horizon thickness and overall soil morphology. Representative samples were taken during the excavation to characterize the physical nature of the soils. BLM's National Science and Technology Center (NSTC) implemented a surface geophysical survey, utilizing two-dimensional electrical resistivity technology, to image spatial variations and thickness of overburden. The complete geologic characterization report can be found in Attachment D.

3.4.1 Soil Classification

Seven soil observation pits were excavated using a backhoe and soil profiles were recorded and photographed (Plate 1). Standard soil-horizon nomenclature for major horizons was used for the descriptions. The need for formal soil taxonomic classification was not necessary, because it is the physical soil condition rather than the soil's order or suborder which has direct bearing on the suitability of the site as a repository. A Munsell color chart (1994 edition) was used to record soil color. Depths and overall horizon thickness were recorded to the nearest centimeter, and soil texture was recorded in the field. Additional soil characteristics such as clay films, clay coats and clay bridges were also recorded.

The soils of the site resemble the Keating series, but have a thinner A horizon, which is likely caused by local erosion. The clayey loam top soils and clayey subsoils are suitable for cover material and the excavation depths of the soil pits indicate the excavation depths of the area will provided a suitable repository footprint that will accommodate the estimated volume of tailing at the Poorman and Balm Creek mines. Based upon the overall soil morphology of the site, its setting is stable and suitable for a repository.

3.4.2 Geophysical Survey Results

BLM personnel implemented a two-dimensional electrical resistivity survey to assess the near surface geologic conditions of the proposed repository location. This specific methodology acquired two-dimensional images, e.g., cross section images, of the underlying geologic setting. The equipment utilized for this surface geophysical survey is manufactured by Advanced Geosciences Inc., of Austin, Texas.

Three electrical resistivity lines were acquired (Plate 2). All three resistivity profiles indicate a basalt in the western half of the site which limited the excavation depth of a few soil pits. This excavation limitation is directly associated to the degree of weathering, e.g., decomposition, of the bedrock lithology. Due to the relative younger aged basalt, and subsequent lesser amounts of weathering, the thickness of the weathered zone increases eastward as the thickness of basalt decreases. The primary bedrock type is greenstone which forms the more weathered substrata, producing a 12ft thick weathered zone of low resistivity in the east side of the site. The areal extent and degree of weathering at the site provide an ample repository footprint that will accommodate the estimated volume of tailings. Faulting or large fracture zones were not found to exist on this site.

3.4.3 Laboratory Geotechnical Analysis

Samples were taken from four of the seven test pits at the proposed repository location. The bulk samples were collected and analyzed for geotechnical properties by Materials Testing and Inspection of Ontario, Oregon for the properties specified below.

Geotechnical Testing of Soils	Sample Type / Volume
Particle size using ASTM 422-63 (1990)e	Bulk Composite one 5-gallon bucket
Liquid and plastic limits using ASTM D4318-95a	
Maximum compacted density using Proctor Test ASTM D698	
Recompacted permeability using ASTM D5856-95	
Moisture content using ASTM D2216-92	

These samples provide an estimate of the average geotechnical properties of the proposed repository site. The soils were classified as a sandy silt. Table 7 provides the geotechnical laboratory results for the soils from the proposed repository site. These results will be used in the evaluation of the cover and repository design and in determining compaction specifications for the waste.

3.5 Borrow Area Material Characterization

BLM assessed several areas within the Poorman/Balm Creek Mine Site vicinity as potential borrow locations. The borrow material may be used as construction material for covers and for site reclamation. The area across Balm Creek from Site C was considered the most suitable as a borrow area.

3.5.1 Sample Collection

Samples were collected from several test pits at the borrow material location. One additional sample was taken in the Balm Creek tailings to evaluate the characteristics of the tailings. The data below summarizes the field description of the Site C borrow soils.

Site	Depth	Description
Site C Borrow Area	0-3'	topsoil (brown/grayish silt)
	3'-9'	clay with few individual rocks brown to dark brown, damp
	9-10'	moist clay layer
	10-12'	sandy clay layer, >25% moisture, groundwater

3.5.2 Laboratory Geotechnical Analysis

Test pit samples were collected from the tailings and the proposed soil borrow area described above. The composite bulk samples were collected and analyzed for geotechnical properties by Materials Testing and Inspection of Boise, Idaho for the properties specified below.

Geotechnical Testing of Soils	Sample Type / Volume
Particle size using ASTM 422-63 (1990)e	Bulk Composite one 5-gallon bucket
Liquid and plastic limits using ASTM D4318-95a	
Maximum compacted density using Proctor Test ASTM D698	
Recompacted permeability using ASTM D5856-95	
Moisture content using ASTM D2216-92	

These samples provide an estimate of the average geotechnical properties of the Site C borrow area and the tailings. The borrow soils were classified as a sandy silt; the tailings were classified as a silt with sand. Table 8 provides the geotechnical laboratory results. These results are used in the evaluation of the cover material and will be used in determining compaction specifications for the waste. Attachment E shows the results of materials testing and shear stress analysis.

3.5.3 Laboratory Agronomic Analyses

An aliquot from each of three bulk native soil samples was submitted for analysis of agronomic parameters to the Colorado State University Soils Testing Laboratory in Fort Collins, Colorado. These tests helped determine the need for the addition of nutrients to support vegetation or any toxic conditions that may inhibit vegetation. The agronomic suite of analysis included the following parameters: nitrate, potassium, phosphorous, pH, soluble salts, sodium, conductivity, and sodium absorption ratio (SAR). Table 9 presents the agronomic test results.

The sampling results indicate that the soils are favorable for vegetation growth, especially if native species adapted to low nutrients and organic matter, and alkaline pH are used. Fertilizers are not recommended as they tend to encourage noxious weeds. The limiting factor will be soil moisture.

3.6 HELP Modeling

The Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07 was developed by the Army Corps of Engineers to evaluate infiltration of precipitation through landfill covers (USACE, 1999). The HELP Model was used to evaluate an engineered repository at Poorman/Balm Creek Mine Site composed of a 24-inch soil cover with a six-inch capillary barrier overlying fifteen feet of tailings. The soil cover evaluated used the geotechnical data of the borrow material characterization (the texture and permeability) from Section 3.4 of this report. The precipitation, temperature and other climatic data used were from a similar climatic regime at Pendleton, Oregon as described in Section 2.1.6. Table 10 shows the results of the HELP modeling. Minimal annual percolation through the waste layer was found for this modeling effort (<0.15 inch). Attachment F contains the input data and full results of the modeling.

4.0 STREAMLINED RISK ASSESSMENT

Mining activities at the site have influenced the site's ecology since the 1900s. Tailings generated from mining activity have contributed to releases of heavy metals into air, water, and soils. The area is used currently for farming, wildlife habitat and recreation. Recreational demands are expected to increase at the site where exposure to relatively high metal concentrations in tailings, sediments, and surface waters exist. Figure 8 is the site conceptual model for exposure to mining waste at the site.

To address these issues, BLM developed acceptable multi-media risk management criteria (RMC) for the chemicals of concern (COCs) as they relate to human use and wildlife habitat on or near BLM lands (Attachment G). The primary objective of this section is to perform a streamlined risk assessment for the site and to establish the magnitude of risk to human health and wildlife. RMCs for soil protective of human receptors for the metals of concern were developed using available toxicity data and standard U.S. Environmental Protection Agency (EPA) exposure assumptions. Acceptable soil and sediment concentrations protective of wildlife receptors (ecological RMCs) for the metals of concern were developed using toxicity values and wildlife intake assumptions reported in the current ecotoxicology literature.

The COCs and migration pathways were identified from historical information and site evaluation. The COC selection process utilized chemicals documented to have been released to surface water and observed contamination in tailings at the site. Potential receptors, receptor exposure routes, and exposure scenarios were identified from on-site visits and discussions with BLM personnel. Representative wildlife receptors at risk were chosen using a number of criteria, including likelihood of inhabitation, and availability of data.

The human and ecological COC for the Poorman Balm Mine site are principally copper and zinc. The most important exposure pathway is leaching and erosion of the contaminants to surface water yielding potential exposure to aquatic life.

4.1 Human Health Risk Assessment

The human exposure scenarios were developed to provide realistic estimates of the types and extent of exposure which individuals might experience to the metals of concern in the water, soils, and sediments on BLM property. Such exposures might occur to individuals who use BLM lands for camping, or all-terrain-vehicle (ATV) driving, or individuals who work on BLM lands. Contamination may migrate from the BLM tracts to adjoining property.

The RMC corresponds to either a target excess cancer risk level of 1×10^{-5}, or a target non-cancer hazard index of 1.0. In the case of metals posing both carcinogenic and non-cancer threats to health, the lower (more protective) concentration was selected as the RMC. The concept behind the RMC is that people will not experience adverse health effects from metal contamination on BLM lands in their lifetimes, while exposure is limited to soil, sediments, and waters with concentrations at or below the RMC. A target excess cancer risk of 1×10^{-5} means that for an individual exposed at these RMC, there is only a one in a hundred thousand chance that he would develop any type of cancer in a lifetime as a result of contact with the COCs. A hazard index of <1.0 means that the dose of non-cancer metals assumed to be received at the site by any of the receptors in a medium is lower than the dose that may result in any adverse non-cancer health effects. The RMC are protective for exposures to multiple chemicals and media. Lead RMC for the child receptors were determined from EPA's Integrated Exposure Uptake Biokinetic Model (EPA, 1993) and other EPA regulations and guidance.

4.2 Ecological Risk Assessment

Wildlife at the Site may be exposed to metal contamination via several environmental pathways. The potential exposure pathways include soil and sediment ingestion, vegetation ingestion, surface water ingestion, and inhalation of airborne dust. Ecological RMCs have been established for metals in soil and sediments. This has been accomplished using the best data available, including: ecotoxicological effects data for the metals of concern, wildlife receptors representative of the Middle Rocky Mountain Steppe ecosystem, body weights and food intake rates for each receptor, and soil ingestion rates for each receptor.

The site lies within the Middle Rocky Mountain Steppe (Bailey, 1995) dominated by sagebrush semidesert or steppe. The wildlife receptors evaluated for this area are: deer mouse, cottontail, mule deer, and elk.

The literature was surveyed for toxicity data relevant to either wildlife receptors at the site or to closely related species. In the absence of available toxicity data for any receptor, data were selected on the basis of phylogenetic similarity between ecological receptors and the test species for which toxicity data were reported. Soil ingestion data for each receptor were obtained from a recent study on dietary soil content of wildlife from the U.S. Fish and Wildlife Service (Beyer, et. al., 1994). Where no dietary soil content data were available for a particular receptor, the soil content was assumed to be equal to that of an animal with similar diets and habits. The amount of soil ingested by each receptor was estimated as a proportion of their daily food intake (Beyer, et. al., 1994). The food intake in grams for each receptor was calculated as a function of body weight (Nagy, 1987).

RMC were calculated for each chemical of concern in soil based upon assumed exposure factors for the selected receptors, and species- and chemical-specific toxicity reference values (TRVs). Essentially, the TRVs represent daily doses of the metals for each wildlife receptor that will not result in any adverse toxic effects. TRVs were computed by metal of concern for each wildlife receptor/metal combination for which toxicity data were available. Phylogenetic and intraspecies differences between test species and ecological receptors have been taken into account by the application of uncertainty factors in derivation of critical toxicity values. These uncertainty factors were applied to protect wildlife receptors which might be more sensitive to the toxic effects of a metal than the test species. The uncertainty factors were applied to the test species toxicity data in accordance with a method developed by BLM. In accordance with this system, a divisor of two (EPA, 1990) was applied to the toxicity reference dose for each level of phylogenetic difference between the test and wildlife species, i.e. individual, species, genus, and family.

4.3 Uncertainty Analysis

Toxic doses for each metal were selected from the literature without regard to the chemical speciation that was administered in the toxicity test.

The process of calculating human health RMC, using a target hazard quotient and target excess lifetime carcinogenic risk, has inherent uncertainty. The COCs may have synergistic (or antagonistic) effects on human or wildlife receptors. Cumulative effects were quantitatively dealt with for the human assessment, although not all metals are elevated. Additionally, it is improbable that human receptors would be exposed concurrently via all possible exposure pathways, although this has been assumed for conservatism (Ford, 1996). There is uncertainty in deriving wildlife RMCs due to the lack of toxicity data for these species. A standard uncertainty factor approach was used for interspecies extrapolation (Ford, 1996).

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4.4 Risk Assessment Results

Because of the proximity of the tailings to Balm Creek, RMCs were also derived based on leaching characteristics of the waste. The leaching RMC is intended to protect aquatic life from leaching of metals and was derived using Oregon water quality criteria (OWQC) and available analytical results. The mean proportion leaching under the SPLP test was computed by dividing the SPLP concentration by the total metals concentration. A dilution-attenuation factor (DAF) of 20 was then applied using EPA's Soil Screening Level guidance (EPA, 1996). Since only copper and zinc were found to be leachable, leaching RMCs were computed for copper and zinc according to the formula below and are shown in Table 11.

Leaching RMC=OWQS*total metal*DAF/SPLP

Table 11 compares the maximum concentrations at the site with the selected appropriate RMCs (see Attachment G). The ratio of the environmental media concentration to the RMC is analogous to a hazard quotient of 1.0; that concentration that should present negligible risk. Media concentrations exceeding RMCs for humans or wildlife greater than 1.0 are flagged "+"; these occurrences may pose a chronic threat. Media concentrations exceeding RMCs by more than 10 and 100-fold for humans or wildlife are flagged as "++" and "+++", respectively. For tailings, copper is moderately high risk, and cadmium and zinc are low-moderate risk. For surface water, the Main Site Puddle shows high risk for copper and moderate risk for cadmium silver and zinc.

The metals concentrations and acid potential of the two tailings ponds and the Poorman waste rock exceed RMCs, are degrading water quality and require remediation. The waste rock at the Balm Creek Mine is probably similar to the waste rock at Poorman, but it is in a more stable location and not as subject to erosion into surface water. Hence, this material may not need to be removed, but perhaps only regraded. However, the drainage from the shaft at the Head Frame should be re-routed or lined to prevent contact with the waste rock.

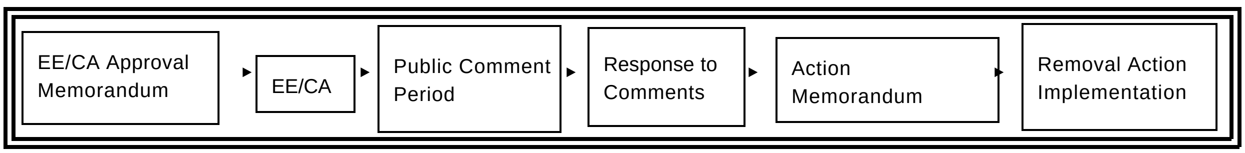
The two tailings dams are in the flood plain and a significant flood event would be expected to breach one or both of the dams, releasing tailings in a mudflow down gradient. While there are no human receptors in the immediate path, such a release would multiply the costs of cleanup.
Expeditious containment of the tailings will eliminate risks from direct contact to humans and wildlife and will reduce release of metals to the Balm Creek downstream.

4.5 Removal Action Criteria

The leaching RMC and the camper RMC shown in Table 11 are the proposed removal action criteria for tailing materials. Based on visual evidence, it appears that tailings and waste rock are migrating into the Balm Creek below the Poorman Balm Mine site. Since the risk criteria are based on ingestion, inhalation, and leaching, areas of soil/tailings exceeding these criteria will be removed or covered.

4.6 Schedule

The figure below shows the process for the development of the EE/CA and implementation of the removal action. The NCP requires a public comment period of 30 days following submittal of the final EE/CA. The schedule for the completion of the removal action is dependent upon funding. Unless a financially viable responsible party can be located, it is likely that the BLM will implement the selected remedy. If full funding for the removal action is not available, a phased-approach for implementation of the selected remedy will be considered. The individual components of the approach will be determined during design.



5.0 APPLICABLE, OR RELEVANT, AND APPROPRIATE REQUIREMENTS

The lead Federal agency or designated on-scene coordinator (OSC) is responsible for the identification of applicable or relevant and appropriate requirements (ARARs) of all environmental laws that pertain to any CERCLA removal actions. As defined in the Guidance on Consideration of ARARs During Removal Actions (EPA 1991):

> "Applicable requirements are cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances found at a CERCLA site.
>
> Relevant and appropriate requirements are 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 a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site and are well-suited to the particular site.
>
> In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, and guidances that are not legally binding, but that may serve as useful guidance for response actions. These are not potential ARAR, but are" To Be Considered" (TBC) guidance. These guidelines generally falls within three categories: health effects information with a high degree of credibility; technical information on how to perform or evaluate site investigations or response actions; and policy."

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. Requirements must be both relevant and appropriate for compliance to be necessary. In the case where both a federal and state ARAR are available, or where two potential ARARs address the same issue, the more stringent regulation must be selected. The final NCP states that a state standard must be legally enforceable and more stringent than a corresponding federal standard to be relevant and appropriate (*55 FR 8756*, March 8, 1990).

CERCLA on-site response actions must only comply with the substantive requirements of an ARAR and not the administrative requirements. "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely onsite, where such remedial action is selected and carried out in compliance with this section" [CERCLA § 121(e)(1)].

Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. The NCP defines onsite as "the areal extent of contamination and all areas in very close proximity to the contamination necessary for implementation of the response action." BLM recognizes that certain administrative requirements, such as consultation with state and local agencies and reporting, are accomplished through the involvement with such agencies throughout the removal process and through public participation requirements of the NCP.

The ARARs presented and evaluated for this EE/CA are divided into three groups:

- Chemical specific requirements - are usually health, risk or technology based standards that limit the concentration of a chemical found in or discharged to the environment.

- Location specific requirements - "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 FR 51394).

- Action specific requirements- sets controls, restrictions or performance standards based on basic activities related to the management of hazardous substances, pollutants or contaminants associated with the removal action.

The matrix presented in Tables 12, 13 and 14 identify a preliminary list of the major Federal and State chemical-specific, action-specific and location specific ARARS considered for the site. Identification and evaluation of ARARs is an iterative process, which continues throughout the response process as a better understanding is gained concerning site conditions, contaminants and cleanup alternatives.

The text below discusses several key ARAR that apply to the Poorman/Balm Creek Site. These ARAR are:

Resource Conservation and Recovery Act (RCRA) Subtitle C Hazardous Waste: The waste rock and tailings generated during the operation of the mine are not considered as a "hazardous waste" as defined by RCRA 40 CFR § 261. Under 40 CFR § 261.4(b)(7), the Bevill Exclusion, solid waste from the extraction and beneficiation of ores and minerals are excluded from the definition of hazardous waste and therefore are not subject to RCRA Subtitle requirements.

Oregon Administrative Rule OAR 340 Division 101: Identification and Listing of Hazardous Waste. Identifies those residues which are subject to regulation as hazardous wastes under divisions 100 to 106, 108, 109, 111, 113 and 124. Specifically under 340-101-004, Oregon State adopts the provisions of 40 CFR 261.4(b)(7) that are applicable to the Poorman/Balm Creek Site (Bevill Amendment).

Clean Water Act: The discharge from any passive treatment system implemented at the Site will be required to meet federal Clean Water Act requirements under the National Pollution Discharge Elimination System (NPDES) or the Oregon Water Quality Standards.

Oregon Administrative Rule OAR 340 Division 95: Solid Waste: Land Disposal Sites Other Than Municipal Solid Waste Landfills: Regulates the siting, operation and maintenance of any non-municipal land disposal site. Applicable to the construction and closure of a tailings repository.

National Historic Preservation Act: Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (16USC 470f), requires that BLM consider the effects of actions on historic properties.

Native American Graves Protection and Repatriation Act. Regulations that pertain to the protection and disposition of human remains, funerary objects, sacred objects, or objects of cultural patrimony (43 CFR 10).

The process of identifying additional ARARs or modifying this initial determination will continue in consultation with the State as removal action alternatives are selected and further developed. The designations suggested should be used as guidance when working with Federal and State regulators involved in the final removal action.

6.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

Removal action objectives (RAOs) are the link from the site characterization and risk assessment to the removal action alternatives. RAOs are written for each medium that is causing exposure and that needs exposure reduction. These objectives are as follows:

- Reduce or eliminate the release of metals originating at the site to air pathways via fugitive dust emissions.
- Reduce or eliminate the release of metals originating at the site to surface water.
- Reduce or eliminate the release of metals during flood events.
- Reduce or eliminate the potential for exposure to humans and wildlife from inhalation, ingestion or direct contact with contaminated surface soils.
- Consider measures to minimize or avoid adverse on historic and prehistoric resources at the Site, as required by the National Historic Preservation Act.

The leaching RMC and the camper RMC shown in Table 11 are the removal criteria for tailing materials.

7.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The NCP (40 CFR §300.415(e)) identifies appropriate removal actions for situations where human health or the environment may be affected. The list is not exhaustive and the lead agency may take other actions as deemed necessary and the EPA guidance recommends that only the most qualified technologies that apply to the media or source should be discussed in the EE/CA.

Alternatives for the removal of contamination have been selected to address site conditions as depicted in this EE/CA. The removal options were chosen to address the removal action objectives discussed in Section 6.0. Based on available site information, the following removal action alternatives have been identified as applicable to the Site.

- No Action
- Institutional Controls
- In-Situ Stabilization and Surface Water Diversion
- On-Site Repository
- Off-Site Repository
- Removal to a Municipal Solid Waste Landfill
- Removal to a Hazardous Waste Landfill

7.1 Description of Alternatives

7.1.1 No Action

The No Action alternative is included in the EE/CA as a baseline for comparison with other removal action options. The No Action alternative requires no remediation or removal work to be performed at the Site. The Site would remain as it exists today or would further degrade due to outside influences.

7.1.2 Institutional Controls

Alternative 2 consists solely of those measures which will prevent access to the tailings areas and the diversion of surface water away from those materials. Examples of institutional controls include fencing, placement of warning signs, capping the shaft at Site C and blocking access roads into the tailings areas.

7.1.3 In-Situ Stabilization and Surface Water Diversion

Alternative 3 would involve regrading of tailings and waste rock areas, placement of a vegetative cover over the tailings areas and diversion and armoring of the creek in the stream reaches that cut into or threaten the tailings or waste rock areas. The stream reconfiguration would be designed to contain the

100-year flood event.

Waste rock from Slide Creek at Sites A & B would be excavated and re-graded to minimize the potential infiltration from Slide Creek. As waste rock is moved into place, a stabilizing agent may be applied to reduce the acid rock drainage potential. The Slide Creek channel would be contoured to reestablish a more natural channel flow. Soil and plants would then be incorporated in the channel area to restore the riparian zone.

The Balm Creek area would be addressed in a similar fashion. The waste rock at Site C would be regraded to minimize ponding and reduce infiltration. A stabilizing agent may be incorporated into the waste rock pile to reduce the acid rock drainage potential. The headframe would be removed and the shaft would be collared/capped, allowing the water from the shaft to gravity-drain to a treatment system prior to discharge to Balm Creek. Tailings from the "Pond" area would be relocated to the upper Site C area as an adequate area for in-situ stabilization is not available. Tailings material lying within the Balm Creek channel and flood plain would be removed to an up-slope area. All tailings at site C would then be regraded to the optimum slope to ensure stability while reducing infiltration. Available access trails to the stabilized tailings pile would be blocked or removed. The Balm Creek channel would then be armored to reduce the potential for future erosion of the bank toward the tailings. The use of biological materials for armoring the channel would be used in conjunction with more traditional armoring techniques such as rip rap.

Isolation of the tailings through the use of a cover system will minimize potential for water and oxygen from entering the tailings. The proposed vegetative cover system would consist of up to three feet of native soils with a minimum of eight inches of loosely placed topsoil and a gravel veneer. Native species would be used to establish a vegetative cover. The cover would be designed to promote run-off and the soil and vegetative component would store infiltrated water to be recycled back to the atmosphere through evaporation and transpiration. A drainage layer may be included within the cover to provide a high capacity system for removing water that infiltrates through the soil cover and to act as a capillary break to encourage storage in the upper layers. If it determined necessary in the design phase, a geomembrane component would be added to further prevent migration of water into the tailings. Run-on control would be provided along the upgradient edge of the tailings pile.

A geotechnical evaluation of the existing conditions at the site will be necessary as part of the design phase. The analysis will help identify critical stability issues and assist in optimizing slope grade for the waste piles. As part of the analysis, the placement of cover materials should be evaluated to establish a reasonable factor of safety for the cover system. In every slope there are forces that promote downslope movement and opposing forces which resist that movement. The factor of safety is the ratio of the shearing strength (opposing forces) to the shearing force (downslope forces). A factor of safety greater than one means that the resisting forces exceed the driving forces. Engineered slopes generally aim to have a factor of safety greater than 1.3.

7.1.4 On-Site Repository

Alternative 4 involves the construction of an on-site engineered repository for isolation of all tailings.

The selected site is located to the south and west of the Balm Creek workings. This area was selected based on the geophysical surveys complete in November of 2002 and the archeological clearance completed by BLM. Other potential repository sites were evaluated but were eliminated because they could have effects on cultural resources or were considered geologically or hydrologically unsound. The on-site repository alternative requires clearing and excavating an adequate area to accommodate up to 30,000 cubic yards of material.

The repository cover would consist of up to three feet of native soils with a minimum of eight inches of loosely placed topsoil and a gravel veneer. Native species would be used to establish a vegetative cover. The cover would be designed to promote run-off and the soil and vegetative component would store infiltrated water to be recycled back to the atmosphere through evaporation and transpiration. A drainage layer may be included within the cover to provide a high capacity system for removing water that infiltrates through the soil cover and to act as a capillary break to encourage storage in the upper layers. If it determined necessary in the design phase, a geomembrane component would be added to further prevent migration of water into the tailings. Run-on control would be provided along the upgradient edge of the repository and monitoring wells would be installed prior to placement of waste to determine background concentrations of the primary contaminants for the site.

Tailings would be excavated and hauled to the repository using conventional excavation and hauling methods. Tailings exceeding optimum moisture would be blended at the point of origin with nearby tailings or waste rock to reduce the overall moisture content. In order to facilitate removal of tailings, a temporary bridge would need to be constructed in the "Pond" area to minimize impacts to Balm Creek. The former tailings areas would be recontoured and revegetated or covered with rip-rap for erosion control.

Temporary fencing of the repository area may be necessary until vegetation is well established.

7.1.5 Off-Site Repository

Alternative 5 involves the construction of an off-site engineered repository for isolation of the tailings. Construction of an off-site repository would require clearing and excavating approximately 30,000 cubic yards of material. The site location and construction would comply with the requirements specified in 40 CFR Subpart B for solid waste landfills and with Oregon Administrative Rules, Chapter 340 Division 95 for Solid Waste Landfills. As the facility would be located outside the boundaries of the Poorman/Balm Creek CERCLA site, a permit would be required. The cover design and excavation activities would be similar to that of the on-site repository.

7.1.6 Remove Tailings to a Solid Waste Landfill

Alternative 6 involves the excavation of all tailings material from the two tailings areas and transportation of the material to a solid waste landfill in the state of Oregon. Conventional excavation and hauling techniques would be employed. Trucks would travel on public road and would be covered with tarps to minimize the potential for spillage. Traffic control may be necessary in some areas.

There is not a solid waste landfill within the area that has sufficient capacity to accept the volume of tailings to be generated during this removal action. Additionally, it is generally unacceptable to dispose of mineral beneficiation waste in a solid waste landfill. This alternative is therefore was ***eliminated from further consideration.***

7.1.7 Remove Tailings to a Hazardous Waste Landfill

Alternative 7 involves the removal of tailings to a hazardous waste landfill. Tailings would be excavated and hauled approximately 170 miles to the Arlington facility. Conventional excavation and hauling techniques would be employed. Trucks would travel on public road and would be covered with tarps to minimize the potential for spillage. Traffic control may be necessary in some areas. The former tailings areas would be recontoured and revegetated or covered with rip-rap for erosion control.

7.2 Description of Evaluation Criteria

There are three types of criteria against which each alternative is evaluated. These criteria are derived from the Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA, Final Revised Draft, June 1993 (EPA/540-R-93-057). The criteria are:

1. Effectiveness
    - Overall protection of human health and the environment
    - Compliance with ARARs and TBC
    - Long-term effectiveness and permanence
    - Reduction of toxicity, mobility, or volume through treatment
    - Short-term effectiveness
2. Implementability
    - Technical feasibility
    - Administrative feasibility
    - Availability of services and material
    - State and community acceptance
3. Cost
    - Long-term cost for operation and maintenance
    - Reasonable cost

A description of each of these criteria is provided in the following sections.

7.2.1. Effectiveness

7.2.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion is a threshold requirement that serves as a final check to assess whether each alternative provides adequate protection of public health and environment. Alternatives are further examined after the assessment under the other evaluation criteria, including long-term effectiveness and permanence and compliance with ARARs.

7.2.1.2 Compliance with ARARs

This evaluation criterion is also a threshold requirement and is used to determine if each alternative would attain federal and state ARARs, to the extent practicable considering the urgency of the situation and the scope of the removal. At certain sites, ARARs may from the basis of the removal action.

7.2.1.3 Reduction of Toxicity, Mobility, or Volume Through Treatment

This evaluation criterion address the EPA preference for selecting remedies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous materials at the Site.

7.2.1.4 Long-Term Effectiveness and Permanence

This evaluation criterion addresses the long-term effectiveness of alternatives in maintaining protection of public health and the environment, and the magnitude of residual risk posed by treatment residuals or untreated waste remaining at the Site, after site objectives have been satisfied. The adequacy and reliability of controls proposed as part of the alternative are also evaluated.

7.1.1.5 Short-term Effectiveness

Short-term effectiveness addresses the effects of each alternative during the implementation of the action before removal objectives are met and should include the effects on human health and the environment directly following implementation. The following factors should be addressed as appropriate:

- Protection of the community
- Protection of the workers
- Environmental impacts
- Time until response objectives are achieved.

7.2.2 Implementability

This criterion evaluates the technical feasibility and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. This should include an assessment of the ability of the technology to implement the remedy and the reliability of the technology. Operational considerations should also be factored into the evaluation. In some cases it may be necessary to determine whether the alternative is not inconsistent with potential future remedial actions. The EE/CA should also evaluate the feasibility of coordinating with other offices and agencies to implement an alterative and the ability and time required to obtain any necessary permits or approvals from agencies. The following factors should be addressed as appropriate:

- Technical Feasibility
- Administrative Feasibility
- Availability of Services and Materials
- State Acceptance
- Community Acceptance

State acceptance and community acceptance are evaluated during the public comment period. The final selection of the alternative will take into comments received by the state and public into consideration. A response to comments will be included with the Action Memorandum.

7.2.3 Costs

The cost of each alternative includes all capital, construction, and operation and maintenance (O&M) costs incurred over the life of the project. The assessment against the criterion is based on the estimated present worth of the costs for each alternative. The present worth of alternatives that last longer than 12 months should be calculated. Each potential alternative will be evaluated with regard to its projected costs. Costs have been calculated using information from *RSMeans Environmental Remediation Cost Data - Assemblies Cost Book* and *Unit Cost Book*, the Draft BLM Cost Estimating Handbook and past contract data when available and appropriate. Local vendors may provide services for less than the costs projected in this document.

7.3 Evaluation of Potential Removal Action Alternatives

The following section contains an analysis of the ability of the remedial alternatives to satisfy the evaluation criteria. Alternatives that do not satisfy the removal action objectives and do not meet the removal action criteria are screened from further evaluation in this EE/CA

7.3.1 Alternative 1 - No Action

Effectiveness - Alternative 1 does not protect human health or the environment or comply with ARAR. The tailings area surfaces will still be exposed to the atmosphere and precipitation may continue to erode and leach contaminants from the areas into surface water. The area surfaces will still present a direct contact threat to humans and other organisms.

Implementability - The No Action alternative is readily implementable; however, it would not be a reliable or effective means of meeting the removal action objectives.

Cost - There are no costs associated with this alternative.

This alternative is not protective of human health and the environment, does not satisfy ARAR nor meet the removal action criteria for the site and is therefore **eliminated from further consideration.**

7.3.2 Alternative 2 - Institutional Controls

Effectiveness - Alternative 2 reduces the risk of direct contact with tailings through the implementation of access restrictions, however the use of institutional controls will not prevent contaminant releases in the future or comply with ARAR. The tailings area surfaces will still be exposed to the atmosphere and precipitation will continue to erode and leach contaminants from the areas into both ground water and surface water. Long-term risk associated with the tailings are not reduce since the toxicity, mobility or volume of the contaminant has not be affected.

Implementability - Institutional controls are technically implementable. Fencing contractors are available in several cities and towns near the site. Standard installation of signage and fencing could be used at the site. The administrative feasibility of this alternative would be low as access is necessary to Balm Creek Reservoir and public and private lands beyond the site.

Cost - The costs for this alternative are considered low. Cost include design mobilization and installation of approximately 1,700 feet of chain link fencing (900 feet at the “Pond” and - 800 feet at Site C) and six warning signs. Capital costs are estimated at $58,000. Operation and maintenance costs for maintenance of fencing and replacement of sign is estimated at approximately $4,000.

This alternative is not protective of human health and the environment, does not satisfy ARAR nor meet the removal action criteria for the site and is therefore **eliminated from further consideration.**

7.3.3 Alternative 3 - In-Situ Stabilization and Surface Water Diversion

Effectiveness - Alternative 3 provides adequate protection of human health and the environment and comply with ARAR. In-situ stabilization of waste rock and mill tailings will prevent direct contact with wastes, prevent airborne migration of contaminated dusts, minimize the potential for erosion of tailings material directly into the creek, and reduce the potential for mobilization of metals through leaching. Although toxicity and volume of contaminants remains the same, mobility of the contaminants would be reduce by the construction of a soil cover and use of the phosphate stabilizer. Short term air quality impacts may occur during construction activities but these impacts could be minimized using standard dust suppression techniques. Potential risks to site workers would include risks from the performance of construction activities and potential exposure to contaminants in the tailings and waste rock. These risks will be minimized through the development and implementation of the site-specific health and safety plan.

Implementability - This alternative would be readily implementable using conventional construction equipment and services for regrading of waste rock and tailings, reconfiguration of surface drainage and placement of cover material. Sufficient land area may not be available at Site C to include the tailing from the lower holding pond.

Cost - Cost for Alternative 3 were determined based on removal of the lower tailings pond and consolidation with the waste at Site C, regrading of the waste rock and reclamation of the disturbed area. Total cost for Alterative 3 is $902,000. Annual inspection and maintenance of the stream channel and tailings cap and surface water sampling will be required. Operation and maintenance costs for maintenance is estimated at approximately $90,000.

7.3.4 Alternative 4 - On-Site Repository

Effectiveness - Alternative 4 is protective of human health and the environment and satisfies ARAR. Placement of mill tailings in a repository will prevent human and ecological contact with wastes and prevent airborne migration of contaminants. The tailings will be isolated from Slide and Balm Creek watershed area away from the 100-year flood plain, thereby preventing erosion of tailings material into the creek and reducing leaching of associated metals. Although toxicity and volume of contaminates would remain the same, the mobility of the contaminants would be reduce by minimizing infiltration through the use of construction of a vegetative soil cover. Short term air quality impacts may occur during repository construction and tailings excavation activities but these impacts could be minimized using standard dust suppression techniques. Potential risks to site workers would include risks from the performance of construction activities and potential exposure to contaminants in the tailings and waste rock. These risks will be minimized through the development and implementation of the site-specific health and safety plan.

Implementability - It is technically feasible to implement the design and construction of a repository and soil cover system. Site earthwork can be completed using conventional construction equipment and services for the construction of the repository and removal and transportation of the tailings.

Cost - The cost of designing and constructing a repository, and transporting the tailings to the preferred location is approximately $1,042,000. Long-term inspection, maintenance and monitoring of the repository will be required. Operation and maintenance costs is estimated at approximately $104,000.

7.3.5 Alternative 5 - Off-Site Repository

Effectiveness - Alternative 5 is protective of human health and the environment and satisfies ARAR. Placement of mill tailings in a repository will prevent human and ecological contact with wastes and prevent airborne migration of contaminants. The tailings will be isolated from Slide and Balm Creek watershed area away from the 100-year flood plain, thereby preventing erosion of tailings material into the creek and reducing leaching of associated metals. Although toxicity and volume of contaminates would remain the same, the mobility of the contaminants would be reduce by minimizing infiltration through the use of construction of a vegetative soil cover. Short term air quality impacts may occur during construction and tailings excavation activities but these impacts could be minimized using standard dust suppression techniques. This alternative involves a substantial amount of construction-related activity and traffic on public roads. Continuous truck traffic during work hours could impact local residents along the haulage route. Potential risks to site workers would include risks from the performance of construction activities and potential exposure to contaminants in the tailings and waste rock. These risks will be minimized through the development and implementation of the site-specific health and safety plan.

Implementability - It is technically feasible to implement the design and construction of a repository and soil cover system. Site earthwork can be completed using conventional construction equipment and services for the construction of the repository and removal and transportation of the tailings. At this time, an off-site repository location has not been determined. Considerable effort would be required to find a suitable location for a repository. An off-site repository is less administratively feasible than an on-site facility due to the requirement established in OAR 340-093-0050 requiring a permit from Oregon Department of Environmental Quality to establish, operate, maintain or substantially alter, expand, improve or close a disposal site.

Cost - The cost of designing and constructing an off-site repository, and transporting the tailings to the facility would be greater than that of the on-site facility. Cycle times for hauling material would significantly increase, resulting in cost increase of up to 50% for each additional mile from the Site. Long-term inspection and maintenance of the repository cover would be required. Operation and maintenance costs would be similar as those for the on-site facility.

Due to the short-term impacts to local residents, potential siting considerations, the administrative requirement of permitting the facility and the increased cost, the off-site repository alternative is **eliminated from further consideration.**

7.3.6 Alternative 7 - Remove Tailings to a Hazardous Waste Landfill

Effectiveness -Alternative 7 is protective of human health and the environment and satisfies ARAR. Placement of mill tailings in a hazardous waste landfill will isolate the wastes, prevent human and ecological contact, and prevent airborne migration of contaminants. The tailings will be removed from Slide and Balm Creek watershed area away from the 100-year flood plain, eliminating erosion of tailings material and leaching of associate metals into the creek. Although toxicity and volume of contaminates would remain the same, the mobility of the contaminants would be reduce through disposal in a RCRA Subtitle C treatment, storage and disposal facility (TSDF). Short term air quality impacts may occur during excavation activities but these impacts could be minimized using standard dust suppression techniques. This alternative involves a substantial amount of construction-related activity and traffic on public roads. Continuous truck traffic during work hours could impact local residents along the haulage route. Baker City and surrounding communities would be impacted by increased truck traffic, noise, dust and public road degradation. Potential risks to site workers would include risks from the performance of construction activities and potential exposure to contaminants in the tailings and waste rock. These risks will be minimized through the development and implementation of the site-specific health and safety plan.

Implementability - It is technically feasible to implement this alternative using conventional heavy equipment for excavation of the tailings and transportation of material to the hazardous waste landfill. Implementation of this alternative would require coordination with appropriate state and local agencies. Transportation of tailings on public highways may require communication with the Oregon Department of Transportation and Oregon Department of Environmental Quality, local agencies and the community.

Cost - The cost for alternative 7 is estimated to be $7,500,000. No operation and maintenance costs would be imposed for the disposal of the tailings at a TSDF.

8.0 COMPARATIVE ANALYSIS OF RETAINED ALTERNATIVES

The *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* states that the purpose of the comparative analysis of the remaining alternatives is to “identify the advantages and disadvantages of each alternative relative to one another.” The alternatives considered here are:

- Alternative 3: In-Situ Stabilization and Surface Water Diversion

- Alternative 4: On-Site Repository
- Alternative 7: Removal to a Hazardous Waste Landfill

Alternatives 4 and 7 do not address waste rock or shaft water. If Alternative 4 or 7 are selected for management of all tailings, it is likely that they would be used in combination with part of Alternative 3 in the remediation of the Site.

A relative comparison of each alternative is completed for each of the evaluation criteria.

8.1 Effectiveness

Overall protection of human health and the environment.
The three alternatives offer similar levels of protection of human health and the environment for tailings management. Alternative 7 would be the most protective for management of tailings as the material would be placed in a RCRA-compliant Subtitle C hazardous waste facility. Alternative 3 would be the least protective as there is a greater potential for infiltration of water in the form of seeps or surface water. Additional considerations are:

- Leaving the tailings in-place would likely be less protective than removing the tailings from the area surrounding the creek.
- Hauling the tailing off-site would have a greater potential of impacting public health than managing the waste on-site.

Compliance with ARARs and TBC.
All alternatives would have similar impacts to the riparian area and surface water during the removal of tailings from the "Pond" and regrading of waste rock. All alternatives under consideration in this EE/CA involve potential impacts to cultural resources. The design and implementation of any of the alternatives would seek to minimize the impact to these resources. The most visibly impacted historic resource would be the headframe, which must be removed or stabilized. Building foundations may be covered during regrading of the waste rock in all alternatives and the regrading the tailings in Alternative 3. Additional considerations are:

- Only Alternative 7 would necessitate further evaluation of hazardous waste regulations. Additional sampling may be required to further characterize the tailings prior to shipment to a hazardous waste facility.
- Alternative 4 would require assessment of the Oregon solid waste regulations during design of the repository to assure that substantive requirement are satisfied.
- All alternatives would require air monitoring during earthwork activities.

Long-term effectiveness and permanence.
As waste rock will remain on site for all alternatives, the magnitude of the remaining risk should be evaluated after the completion of the removal action. Both alternatives 4 and 7 include removal of tailings and placement in a designed facility, but tailings will remain on BLM land in Alternative 4. Alternative 7 will assure long-term management of the waste in an off-site commercial permitted facility.

Both tailings disposal options have the waste isolated from populated areas.

Reduction of toxicity, mobility, or volume through treatment.
All alternatives would have similar reduction of mobility of the contaminants through isolation of tailings using a protective cover system and the potential use of a stabilizing agent on waste rock. Alternatives 4 and 7 would be more protective than Alternative 3 as tailings will be removed from the riparian area. Alternative 7 would have some additional reduction of mobility as the hazardous waste facility utilizes a liner and leachate collection system.

Short-term effectiveness.
All alternatives would be completed in a similar amount of time, although weather restrictions would play a part in the schedule for implementation. Alternative 3 and 4 would pose no additional risk to the community as actions will be taken at the Site. Alternative 7 would have considerable effects to the surrounding communities through transportation of the waste along public roads and highways by increased truck traffic, noise, dust and toad surface degradation. Similar risks to workers would be posed by all three alternatives, but Alternative 7 would require long haul trips for transportation of the waste to Arlington, Oregon. Potential risks to workers will be reduced by development and implementation of a site-specific Health and Safety Plan.

8.2 Implementability

Technical feasibility.
It is technically feasible to implement each of the alternatives. Waste removal and regrading can be accomplished through standard construction techniques. Design and construction of a cover system and repository and surface water diversion are proven technologies and easily implemented. The terrain of the area and limited access will have similar effects on each alternative.

Administrative feasibility.
Coordination with the appropriate state and local agencies and tribal governments will be required to implement any of the alternatives. Vehicle permits may be required for transportation of the waste in Alternative 7. Hauling waste off-site to a hazardous waste landfill may require coordination with local government agencies concerning impacts to roads and traffic.

Availability of services and material.
The difference between Alternatives 3 and 4 and Alternative 7 is largely related to the availability of material and expertise necessary for the construction of cover systems and for the construction of the repository. These differences are not considered a constraint as an appropriate site has been located for the repository and a source for borrow material for additional covers and reclamation activities has been located on site across from site C.

State and community acceptance.
State and community acceptance will be addressed through the public comment period.

8.3 Cost

The cost for Alternatives 3, 4, and 7 are $902,000, $1,042,000, and $7,500,000, respectively. Each alternative would require regrading of waste rock and surface water diversion and long-term maintenance of the waste rock piles. This cost for waste rock management would be an additional cost to the estimated cost for Alternatives 4 and 7. The cost for Alternative 7 is substantially greater than the remaining two alternatives. Alternatives 3 and 4 require long-term maintenance of the cover system and monitoring of groundwater (as required).

9.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

The alternatives evaluated in this EE/CA are similar when evaluated against the criteria. Alternative 3 is the only alternative that addresses waste rock and surface water diversion and will be retained in the preferred alternative. The Bureau of Land Management has selected Alternative 4 for the management all tailings. The combined removal alternatives are effective, readily implementable and cost effective for the contamination associated with the Poorman/Balm Creek Mine Site.

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FIGURES

PLATES

TABLES

ATTACHMENTS

Attachment A

Botanical Evaluation

Attachment B
Monthly Average Temperature & Precipitation Data for Pendleton

Attachment C
Poorman/Balm Creek Sampling and Analysis Report (2003)

Attachment D
Geophysical Report

Attachment E
Materials Testing and Tailings Shear Strength Results

Attachment F

HELP Modeling Results

Attachment G

Technical Note: Risk Management Criteria for Metals at BLM Mining Sites

Attachment H

Detailed Costs Estimates