Portage

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Reclamation Investigation Report for the Broken Hill Mine Site, Sanders County, Montana

Applicability: Broken Hill Mine Site

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History of Revisions

Revision	Issue Date	Action	Description
0	01/26/10	New Document	Initial Issue.

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ACRONYMS

ABA	acid base accounting
AIMSS	Abandoned and Inactive Mines Scoring System
ALAD	aminolevulinic acid dehydrase
ARAR	applicable or relevant and appropriate requirements
ARM	administrative rule making
ATSDR	Agency for Toxic Substances and Disease Registry
BHMS	Broken Hill Mine Site
BRHS	British Regional Heart Study
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	contaminant of potential concern
EEE/CA	expanded engineering evaluation and cost analysis
ELCR	estimated lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EQ	ecological impact quotients
GWIC	Groundwater Information Center
HHS	human health standard
HI	hazard index
HMO	hazardous mine opening
HQ	hazard quotient
IDL	instrument detection limit

IQ	intelligence quotient
LOAEL	lowest observed adverse effects level
MBMG	Montana Bureau of Mines and Geology
MDEQ	Montana Department of Environmental Quality
MCA	Montana Code Annotated
MS	matrix spike
MSD	matrix spike duplicate
MWCB	Mine Waste Cleanup Bureau
NCP	National Contingency plan
NHANES	National Health and Nutrition Examination Survey
NOAEL	no observed adverse effects levels
QA/QC	quality assurance/quality control
RAGS	Risk Assessment Guidance for Superfund
RBCG	risk-based cleanup guidelines
RfD	reference dose
RI	reclamation investigation
RPD	relative percent difference
RSL	regional screening level
SPLP	synthetic precipitation leaching procedure
s.u.	standard units
TAL	target analyte list
TDS	total dissolved solids
UCL	upper confidence limit
USFS	United States Forest Service

1. INTRODUCTION

This reclamation investigation (RI) report describes environmental conditions found at the Broken Hill Mine Site (BHMS) located in northwestern Montana. It was prepared by Portage, Inc., for the Montana Department of Environmental Quality (MDEQ), Mine Waste Cleanup Bureau (MWCB). This report satisfies the provisions of Portage Contract No. 407025, Task Order #7, Task 3. Previously completed tasks under this task order have included:

- Task 1: Preparation of a reclamation work plan (April 2009)
- Task 2: Completion of the onsite reclamation investigation (July 2009).

Portage Task 3 required the completion of data review and analysis sufficient to prepare an RI report. The elements of this RI report include this introduction, background, a description of field activities, site and waste characterization results, reclamation and land use characterization, a reclamation investigation summary, human health and ecological risk assessments, reclamation objectives and goals, the preliminary identification of applicable or relevant and appropriate requirements (ARARs), preliminary identification of reclamation alternatives, a summary of RI costs, and conclusions.

2. BACKGROUND

The BHMS is an abandoned hard rock mine located in Sanders County, Montana (Figure 1). The BHMS produced silver, lead, and zinc. Previous investigations indicated elevated arsenic, cadmium, copper, iron, mercury, lead, antimony, and zinc in onsite waste rock and elevated arsenic and lead in the adit discharge. The July 2009 RI was performed to confirm and expand on previous data (Portage 2009).

The BHMS is located approximately 4 miles north of Heron, Montana, north of U.S. Highway 200. The site falls within the Blue Creek Mining District; this district is bounded to the west by the Clark Fork Mining District, to the south by the Clark Fork River, and the east/northeast by the Blue Creek drainage. The BHMS is situated at an elevation of approximately 4,200 ft above mean sea level in Section 10, Township 27 North, Range 34 West, Montana, principal meridian. The physical location of the BHMS is 48° 07’ 15” North Latitude and 115° 58’ 06” West Longitude. The BHMS comprises approximately 1.5 acres of land impacted by historic metal mining. The surrounding area consists of moderately steep to steep mountain slopes and hillsides (25°).

The climate of the BHMS is based on the nearest climate station at the Kalispell, Montana, International Airport. Average monthly temperatures range from a high of 80.1°F in July to a low of 12.7°F in January. Average annual precipitation is 50 to 60 in. per year with June (16.5 in.) as the wettest month of the year (WRCC 2008). Precipitation predominantly comes in the form of snow in the winter months, as snow and rain in the spring and fall, and as rain in the summer.

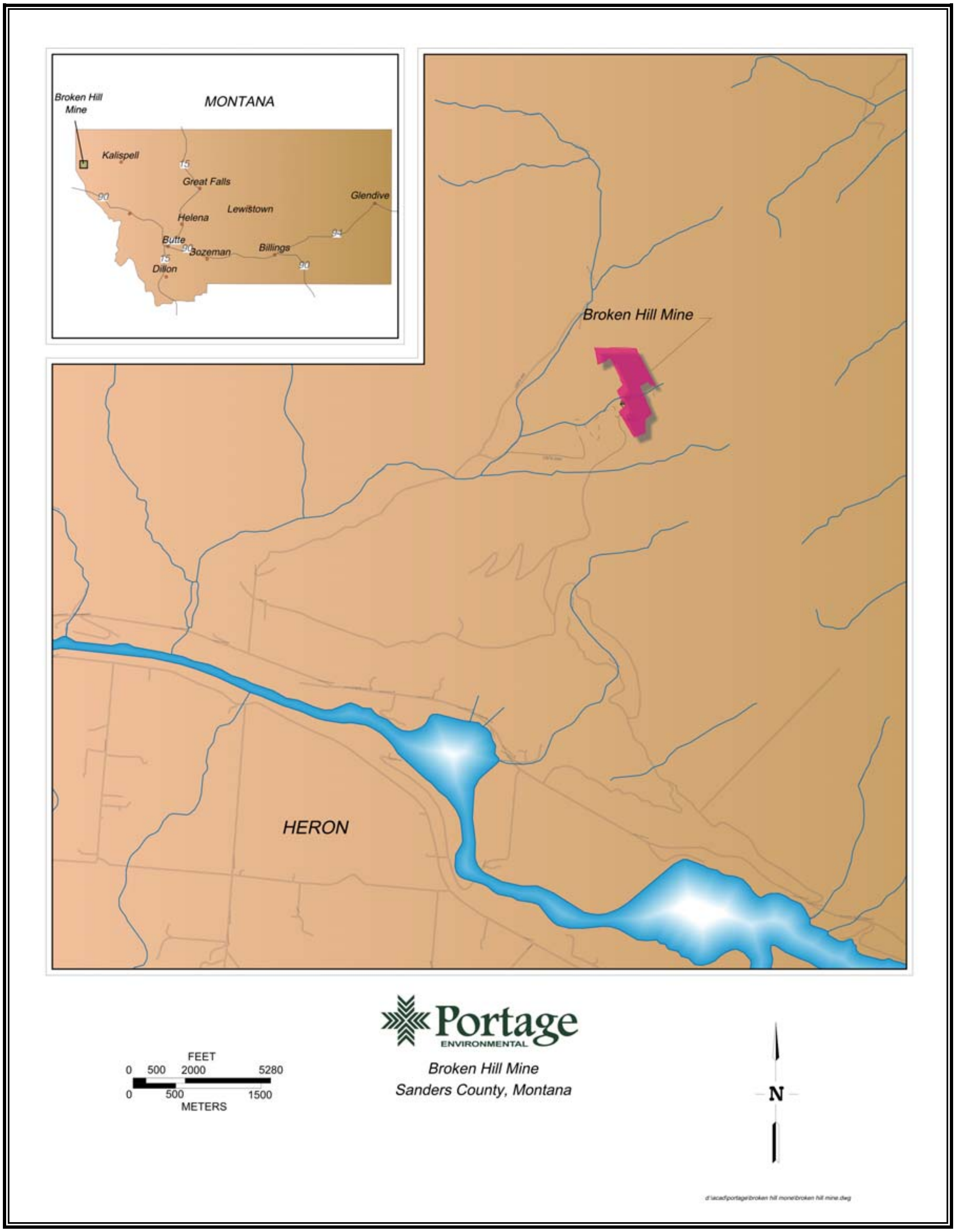

Figure 1. BHMS location map.

2.1 Site Description

The BHMS is oriented on the southwest slope of Billiard Table Mountain northwest of Noxon, Montana. An unnamed, ephemeral tributary of the East Fork of Blue Creek lies to the north of the BHMS. The unnamed tributary enters the East Fork of Blue Creek 0.75 mile below the BHMS. The Scotchman No. 7 claim, Patent#: 10568, is also in proximity.

The following summarizes the major BHMS features:

- Small excavation above Forest Service Road 2290
- Collapsed adit (opening of a tunnel) on Forest Service Road 2290
- Upper waste rock dump (500 cubic yards) below the road (upper adit and waste rock dump)
- Collapsed adit with discharging water
- Lower waste rock dump (3,600 cubic yards) located downslope of the upper adit and waste rock dump.

The early history of the BHMS includes conflicting accounts. Early mine inspector reports state the first period of significant operations for the Broken Hill Mine began in 1906, when there was intermittent small-scale production. However, later sources put the development of the mine in the early 1920s, which is consistent with the original patent filing in 1920 (FHC 2002). During this initial period, the mine was worked by varying owners and operators until 1930, when it became inactive.

The 1920 patent survey recorded two tunnels, seven drifts, two crosscuts, and a raise. The mine was worked through a series of tunnels. The ore was iron oxide carrying as much as 80% excess iron, which made it desirable for fluxing applications. The Federal Bureau of Mining production records indicate 273 tons of ore were produced from 1925 to 1927, as well as 942 oz of silver, 53,057 lb of lead, and 176,632 lb of zinc. The Federal Bureau of Mining reported two adits: one 350 ft long and another 108 ft long with a raise connecting the two adits (MBMG 1963).

The mine remained inactive from 1930 to 1965, when other owners and operators renewed interest in mining at the Broken Hill Mine. Approximately 94 tons of ore were shipped in 1966. Road improvements, tunnel repair, and ore removal were performed; however, in 1973, the mine was inactive again and remains so today. Less than 400 tons of ore were recorded as being shipped from the Broken Hill Mine since its original discovery (RTI 2002).

2.2 Environmental Setting

2.2.1 Geology and Soils

During the Proterozoic Era, a shallow subsiding marine basin formed in northwestern Montana where great thicknesses of homogeneous sand, silt, clay, and carbonate sediments accumulated. Low-grade regional metamorphism later indurated these sediments into a mixture of resistant quartzites, siltites, argillites, and limestones; this thick sequence of fine-grained, quartzite-rich calcareous and non-calcareous rocks is the Belt Series. The Belt Series is subdivided into four general groups in ascending order: Lower Belt or Pre-Ravalli, Ravalli, Middle Belt Carbonate, and Missoula Groups (Montana Agricultural Experiment Station and USDA 1980). The BHMS is in the Ravalli Group. The Montana Bureau of Mines and Geology (MBMG) reported that selected dump samples at the BHMS contained pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, and arsenopyrite. They are present in a gangue of quartz, tourmaline, and tremolite. The dominant geologic feature of the district is the Hope fault, a large northwest-trending transverse fault that extends from at least Hope, Idaho, to Heron, Montana (MBMG 1963).

Hard, fine-grained Belt Series rocks typically weather to fine sandy or loamy soils with high percentages of coarse fragments. Most soils are weakly developed. These Sharrott series soils consist of shallow residual or colluvial soils developed on the moderately sloping to steep ridges and mountain slopes of hard thinly-bedded argillite at an elevation of 3,000 to 4,500 ft. They are well-drained soils with medium runoff and moderate permeability ranging from 0.6 to 2.0 in./hour. Depth to bedrock is typically 4 to 20 in., and coarse fragment content is 50 to 80%. Clay content is usually 5 to 20%. They are slightly sticky (after pressure, soil adheres to both thumb and finger and tends to stretch somewhat before pulling apart) to slightly plastic (moderate pressure is required to deform soil mass) when wet. Soils may be classified as a loamy-skeletal, mixed Lithic Ustocrept (Montana Agricultural Experiment Station and USDA 1980).

2.2.2 Hydrogeology

The MBMG Groundwater Information Center (GWIC) database lists one well log within a 1-mile radius of the BHMS. The well is located 1 mile to the northwest in Section 2 of Township 27 North and Range 34 West. The well has a static water level of 92 ft below ground surface and a yield of 5 gal per minute and is used for domestic purposes (GWIC 2008). There are no lithologic details available for this well. The GWIC database lists 35 well logs within a 4-mile radius of the BHMS.

2.2.3 Hydrology

The BHMS is located within the watershed of an unnamed, ephemeral tributary to the East Fork of Blue Creek. The unnamed tributary lies 100 ft to the north of the BHMS and reaches its confluence with the East Fork of Blue Creek approximately 0.75 mile downstream from the BHMS. The East Fork of Blue Creek reaches its confluence with Blue Creek 2 miles from there.

Blue Creek empties into Cabinet Gorge Reservoir of the Clark Fork River 0.5 mile from the confluence of the East Fork with Blue Creek proper. The unnamed tributary begins approximately 4,000 ft above the BHMS (USGS 1997). All previous site visits noted the tributary as being dry; however, all previous site visits occurred during traditionally low flow periods (August or October).

2.2.4 Vegetation and Wildlife

The BHMS is characterized by native plants growing on undisturbed areas around the site; little or no vegetation is currently growing on the waste rock piles. Dominant trees onsite include Douglas fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), and Sitka alder. Shrubs and other vegetative species include thimbleberry (MNHP 2008). Other trees, shrubs, and forbs are found across and around the site in lower densities. There is regrowth of the forest in some mining-impacted areas, particularly on the lower haul road used for mining operations. Knapweed is widespread in all areas of relatively recent disturbance, with the exception of the waste rock dumps.

The habitat type supports a variety of wildlife—deer, elk, bobcat, black bear, potentially lynx and wolverine, and miscellaneous smaller mammals such as rabbits, squirrels, mice, and voles (MNHP 2008). Many species of birds are found around the site throughout the year, including various songbirds, owls, and raptors.

2.2.5 Land Use and Population

The BHMS is located on private land and the Kootenai National Forest. The primary land use in the vicinity of the site is commercial (logging) and recreational. The population in Sanders County is 10,227 people, with four persons per square mile (USCB 2000).

2.3 Land Ownership

The following details the land ownership for the discrete elements of the BHMS (RTI 2002):

- The upper adit and waste rock dump are located on the patented Broken Hill claim, Patent #: 10572. The Broken Hill claim is currently owned by Sanders Mtn. Development, LLC, Kalispell, Montana.

- The lower adit and waste rock dump are located on the unpatented Tuesday Lode, Patent#: 10572. These and the surrounding lands are administered by the Kootenai National Forest.

3. INVESTIGATION OBJECTIVES

To support development of the RI report, Portage developed a work plan on behalf of the MDEQ (Portage 2009). The work plan included a field sampling plan that detailed the sampling objectives for the RI field visit. Field sampling activities focused on the collection of additional data to support the human health and ecological risk assessments and to fill data gaps from previous sampling efforts. The sampling objectives were designed to determine:

- The magnitude and extent of soil contamination

- The levels of dissolved and total metals in groundwater

- The concentration of metals in background soil.

As part of the field sampling effort, Portage also completed preliminary field inspections of the BHMS and the surrounding area to aid in identifying possible waste repository sites and soil borrow areas. Additional inspection by engineering staff likely will be needed to further refine these areas.

3.1 Summary of RI Field Activities

Field sampling activities at the BHMS were planned for and completed between July 6 and 8, 2009. To access the site, Portage first met with representatives from the United States Forest Service (USFS) Trout Creek Ranger Station to obtain the necessary permissions and a key to open the access closure on Forest Service Route 2290. A gate serves as a year-round closure after crossing Blue Creek and serves to protect grizzly and black bear habitat.

Once past the gate, and at the direction of the MDEQ and the Trout Creek Ranger, Portage personnel began clearing Route 2290. A chainsaw was used to clear fallen trees on the road to approximately 0.5 mile beyond the closure. At this point, a large overhead tree blocked the route and was beyond the capabilities of field personnel to cut and remove. A large seep also surfaces at this location, further limiting full-sized vehicle travel. Therefore, Portage personnel chose to travel the remainder of the road to the BHMS on foot.

At or near the private property boundary for the BHMS, a second locked gate was noted. During October 2008 field reconnaissance, this gate was observed to have been pulled from its hinges and was lying on the ground. In July of 2009, the gate had been repaired and replaced. Having received prior written permission to access the private property (Appendix A), Portage personnel proceeded to the site on foot. Upon arrival at the historic mine workings, field personnel began locating and collecting samples. In total, 15 samples were collected. Figure 2 presents the sample locations, Appendix H presents a topographic survey map of the site which illustrates the sample locations, and Table 1 lists specific details (e.g., depth and analyses) for the samples. A summary follows:

- Three background soil samples were collected approximately 300 ft above the upper waste rock dump, starting at the southeastern sample (BG-1) and traversing the mountain to the northwestern most sample (BG-3).

- Using visual inspection, two soil samples were collected from the lateral and lower boundaries of the upper waste rock dump (SS-1 and SS-2).

- One waste rock sample was collected from the deepest portion of the upper waste rock dump (WR-1).

- Next, two water samples (GW-1 and GW-2) and one field duplicate (GW-3) were collected from the discharging adit that divides the upper and lower waste rock dumps. These included filtered and unfiltered samples.

- Proceeding to the lower waste rock dump, four soil samples and a soil field duplicate were collected from the lateral and lower boundaries of the lower waste rock dump (SS-3 through SS-7).

- Lastly, one waste rock sample was collected from the deepest portion of the lower waste rock dump (WR-2).

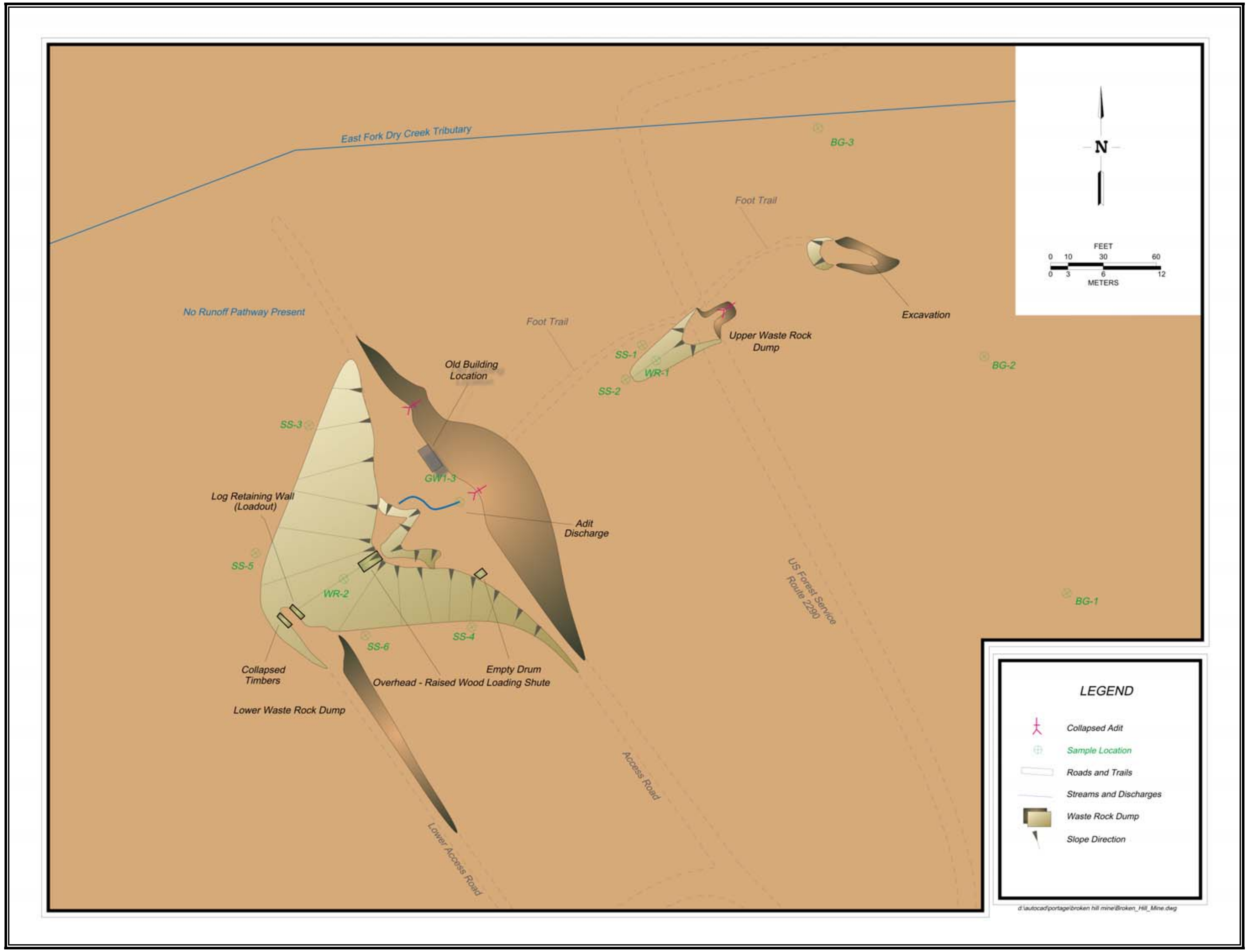

Figure 2. Sample location map.

Table 1. BHMS soil, waste rock, and water samples.

Sample Location	Laboratory Analysis	Sample Number	Sample Depth (in.)
Background	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-BG-1	0–3
Background	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-BG-2	0–3
Background	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-BG-3	0–3
Upper Waste Rock Dump	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-SS-1	0–3
Upper Waste Rock Dump	TAL metals	BHMS-SS-2	0–3
Upper Waste Rock Dump	SPLP	BHMS-WR-1	0–3
Adit Discharge	TAL total metals plus water quality parameters	BHMS-GW-1	Not applicable
Adit Discharge	TAL dissolved metals	BHMS-GW-2	Not applicable
Adit Discharge	TAL dissolved metals	BHMS-GW-3 Duplicate of GW-2	Not applicable
Lower Waste Rock Dump	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-SS-3	0–3
Lower Waste Rock Dump	TAL metals	BHMS-SS-4	0–3
Lower Waste Rock Dump	TAL metals	BHMS-SS-5	0–3
Lower Waste Rock Dump	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-SS-6	0–3
Lower Waste Rock Dump	TAL metals plus particle size (texture), CEC, agricultural analyses, ABA	BHMS-SS-7 Duplicate of SS-6	0–3
Lower Waste Rock Dump	SPLP	BHMS-WR-2	0–3

ABA = acid base accounting (total sulfur, sulfate sulfur, pyretic sulfur, and organic sulfur).

Agricultural analyses = pH, conductivity, nitrogen, phosphorus, potassium, organic matter, and lime, including a fertilizer requirement.

CEC = cation exchange capacity.

SPLP = synthetic precipitation leaching procedure.

TAL = target analyte list (antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc).

Water quality parameters = chloride, sulfate, nitrate/nitrite, forms of alkalinity/acidity, and total dissolved solids.

Sample collection activities were completed on July 7, 2009. On July 8, Portage personnel traveled with USFS personnel to the Scotchman Mine Site located on USFS land (also in Blue Creek Watershed) to inspect the condition of the site. The joint visit was arranged and completed to evaluate the possibility of a joint repository site for waste located at the Broken Hill and Scotchman sites, should removal be deemed the preferred treatment alternative at each. Following this visit, USFS personnel concluded a joint repository is not a cost-effective/feasible option (see Section 5.4 for more information).

During the inspection, several prospective repository sites were visited along the Blue Creek Road. An additional location was also identified along USFS Route 2294 to the east. Appendix I contains a map that highlights the possible repository locations. Following short stops to view possible repository locations, Portage personnel accompanied by USFS representatives traveled back to the BHMS to complete surveying of sample locations and placement of control points. In accordance with the work plan, each of the USFS employees was quizzed concerning the status of their Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response Training. Each indicated they had recently completed their 8-hour refresher courses.

All of the sample and control point locations were field surveyed using a hand-held global positioning system (GPS), and survey tape was placed at each location to aid in the land surveyor’s ability to find them during the formal civil survey. Coordinates for all of the locations were provided to the MDEQ on July 9, 2009, to further aid in locating the sample and control points. The formal land survey was completed from July 27 through July 29, 2009, by DJ&A of Missoula, Montana. The field survey provided volume and spatial estimates of the impacted area at the BHMS.

Table 2 presents the GPS data collected by Portage personnel during field sampling activities. Photographs for each location are provided in Appendix B. Pages from the field logbook are presented in Appendix C.

Table 2. BHMS sample location coordinates.

Sample Number	Latitude	Longitude
BHMS-SS-1	North 48° 07’ 170”	West 115° 57’ 807”
BHMS-SS-2	North 48° 07’ 161”	West 115° 57’ 815”
BHMS-WR-1	North 48° 07’ 162”	West 115° 57’ 810”
BHMS-SS-3	North 48° 07’ 147”	West 115° 57’ 869”
BHMS-SS-4	North 48° 07’ 133”	West 115° 57’ 852”
BHMS-SS-5	North 48° 07’ 137”	West 115° 57’ 877”
BHMS-SS-6	North 48° 07’ 123”	West 115° 57’ 860”
BHMS-SS-7	North 48° 07’ 123”	West 115° 57’ 860”
BHMS-WR-2	North 48° 07’ 139”	West 115° 57’ 863”
BHMS-BG-1	North 48° 07’ 174”	West 115° 57’ 760”
BHMS-BG-2	North 48° 07’ 154”	West 115° 57’ 767”

Table 2. (continued).

BHMS-BG-3	North 48° 07’ 139”	West 115° 57’ 786”
BHMS-GW-1	North 48° 07’ 142”	West 115° 57’ 838”
BHMS-GW-2	North 48° 07’ 142”	West 115° 57’ 838”
BHMS-GW-3	North 48° 07’ 142”	West 115° 57’ 838”

NOTE: *Portage was issued a special use permit by the Trout Creek Ranger Station to access the BHMS. The permit included a daily activity log used by the USFS to document the number of personnel accessing the habitat protection area yearly. The original sheet was returned to Gary Kedish of the Trout Creek Ranger Station upon completion of surveying. A copy is on file at the Ranger Station.*

3.2 Summary of Solid Sample Collection

The following sections provide a synopsis of the samples collected and in-field observations for soil and waste rock samples collected from the BHMS during the July 2009 RI field sampling effort. The total estimated waste rock volume for the BHMS is 4,100 cubic yards. This equates to conservative estimates each for the upper and lower waste rock dumps of: 500 cubic yards (upper) and 3,600 cubic yards (lower).

3.2.1 Background Soils

Three background soil samples were collected in keeping with the provisions of the work plan[a] (Portage 2009). Each sample was composed of dark-brown loam with course materials. Site preparation (pre-sampling) included scraping of duff/decomposing plant material from the surface to expose actual soil. All of the background samples contained approximately 10% coarse fragments and 90% loamy soil. Each background sample was submitted for target analyte list (TAL) metals, texture, cation exchange capacity (CEC), acid base accounting (ABA), and agricultural analyses.

3.2.2 Upper Waste Rock Dump

Also in keeping with the BHMS work plan, three samples were collected from the upper waste rock dump. Two samples (BHMS-SS-1 and BHMS-SS-2) were collected from natural soil adjacent to the waste rock dump to acquire data bounding the spatial extent of contamination. One sample (BHMS-WR-1) was collected from the deepest portion of the waste rock. BHMS-SS-1 was a dark-brown loam and was submitted for TAL metals, texture, CEC, ABA, and agricultural analyses. BHMS-SS-1 and BHMS-SS-2 consisted of dark-brown loam with 10% coarse fragments. Each was submitted for TAL metals. BHMS-WR-1 was composed of tan, coarse sand. It was submitted for synthetic precipitation leaching procedure (SPLP) extraction and metals analysis.

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[a] All solid matrix samples were collected using sterile, disposable, polyethylene scoops. Sampling equipment was not reused during the RI sampling effort. As a result, decontamination of sampling equipment was not necessary.

3.2.3 Lower Waste Rock Dump

Six samples were collected from the lower waste rock dump per the provisions of the work plan.[b] Five samples (BHMS-SS-3, -4, -5, -6, and its duplicate -7) were collected from natural soil adjacent to waste rock dump. One sample (BHMS-WR-2) was collected in the deepest portion of the waste rock. BHMS-SS-3 and BHMS-SS-4 consisted of dark-brown loams with approximately 20% coarse fragments. BHMS-SS-5, BHMS-SS-6, and its duplicate, BHMS-SS-7, were a lighter brown loam containing approximately 10% coarse fragments. BHMS-WR-2 was brown coarse sand. BHMS-SS-3 and BHMS-SS-4 were submitted for TAL metals only. BHMS-SS-5, BHMS-SS-6, and BHMS-SS-7 were submitted for TAL metals, texture, CEC, ABA, and agricultural analyses. BHMS-WR-2 was submitted for SPLP extraction and metals analyses.

Other than the noted labeling issue, no deviations from the work plan took place during the RI fieldwork.

3.3 Water Sampling

Prior to collection of water from the BHMS discharging adit, field parameters were collected to support examination of water quality. The results of these measurements are presented in Table 3. Following field measurements, three water samples were collected from the discharging adit. BHMS-GW-1 was submitted for TAL metals and water quality parameters. TAL metals were submitted in a 250-mL polyethylene bottle preserved with nitric acid. Water quality parameters, including chloride, sulfate, alkalinity/acidity, and total dissolved solids (TDS), were submitted in a 500-mL polyethylene bottle. Water quality parameter nitrate/nitrite was submitted in a 250-mL polyethylene bottle and preserved with sulfuric acid. BHMS-GW-2 and its duplicate, BHMS-GW-3, were filtered through a 0.45-micron filter prior to filling the 250-mL polyethylene bottle and then preserved with nitric acid. Filtered samples were submitted for TAL metals.

The BHMS work plan (Portage 2009) stated that all the water samples would include water quality parameters (chloride, sulfate, nitrate/nitrite, forms of alkalinity/acidity, and total dissolved solids). Filtered samples BHMS-GW-2 and BHMS-GW-3 were not submitted for these analyses, because filtration exposes the water to excess oxygen during the filtration process, essentially voiding the accuracy of the associated results. Water quality parameters are analyzed on unpreserved/unfiltered samples for this reason, and results for the adit discharge were obtained in this manner for BHMS-GW-1. While this is a slight deviation from the sampling plan, the analytical request is in keeping with the analytical methods and therefore does not impact the ability of the MDEQ to evaluate adit water quality.

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[b] The work plan proposed sample BHMS-SS-3 to be analyzed for TAL metals, texture, CEC, ABA, and agricultural analyses. BHMS-SS-5 was to be analyzed for TAL metals only. Because of a clerical error in completing sample labels (prior to sampling), the analyses for these samples are reversed.

Table 3. BHMS field water quality parameters.

Sample Number	Temperature (°C)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (ppm)	Oxidation Reduction potential (mV)	pH (s.u.)
BHMS-GW-1	8.6	102.3	16.2	18	6.20

ppm = parts per million.
mV = millivolt.
umhos/cm = micromoles per centimeter.
s.u. = standard unit.

3.4 Post-Sampling Activities

While in the field, both solid and liquid samples were logged in the field logbook and on chain-of-custody forms. The samples were maintained on ice in sealed coolers and were in the custody of Portage samplers or secured in a locked vehicle throughout the fieldwork. Soil, waste rock, and water samples were shipped to Energy Laboratories in Helena, Montana, for the analyses prescribed in the BHMS work plan. On July 9, 2009, samples were shipped to the laboratory, which received them on July 10, 2009.

4. SITE AND WASTE CHARACTERIZATION RESULTS

This section describes the analytical results for the samples collected from the BHMS. Included in this section is information on the various waste types, the locations, and other physical properties of the waste. Characterization of the waste types is used to assess (1) the potential risk to human health and the environment and (2) the specific waste material volumes associated with the reclamation alternatives for the site.

In accordance with MDEQ guidance, the solid matrix data were compared to both risk-based cleanup guidelines (RBCGs) for abandoned mine sites (MDEQ 1996) and to U.S. Environmental Protection Agency (EPA) Region 9 regional screening levels (RSLs) for residential soil (EPA 2010a). The solid and water RBCGs used for this site are for receptors (gold panner/rock hound) exposed through a maximum use scenario (50-day gold panner/rock hound scenario).

Adit water results were compared to both the RBCGs and the acute aquatic life standard in the “Montana Numeric Water Quality Standards,” Circular DEQ-7 (MDEQ 2008). The chronic value and the human health standard are also reported for information purposes only.

4.1 Data Validation Summary

Preliminary data validation was conducted on August 28, 2009, and, following receipt of Level IV data packages, was completed on September 24, 2009. The data were validated according to the *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994). The complete data validation reports are presented in Appendix D. The following summarizes the findings of data validation:

- All samples were analyzed within required holding times.

- All Analytical Quantitation System calibration results demonstrated a correlation coefficient greater than 0.995.

- All initial calibration verification and continuing calibration verification were within the acceptance criteria.

- Positive detections were noted in the method blank(s) for neutralization potential analysis for phosphorus, potassium, manganese, nickel, and zinc. However, all results were greater than the instrument detection limit (IDL) and less than five times the blank value. Only phosphorus was affected in sample BHMS-BG-2. It was qualified as a false positive and assigned a "U" validation flag (non-detect).

- All initial calibration blanks, continuing calibration blanks, and the remaining preparation/method blanks were non-detect.

- The interference check sample associated with samples BHMS-WR-1 and BHMS-WR-2 was below the acceptance criteria for iron. This resulted in the assignment of a 'UJ' qualifier, indicating the result may be biased low.

- The matrix spike (MS) and matrix spike duplicate (MSD) samples for mercury (high recovery), antimony (low recovery), and barium (one low and one high) in soil were outside control limits. Mercury data required no qualification, because all results were less than the IDL. All soil antimony results are flagged 'J' (estimated); however, only BHMS-BG-3 had a result above the IDL. All barium results are flagged 'J' (estimated).

- All MSD results were within required criteria.

- All laboratory control samples were within the required limits.

- All serial dilution sample results were within the required limits.

In summary, the water data required no qualification. All solid matrix sample data are unqualified except the following:

- Iron in samples BHMS-WR-1 and BHMS-WR-2 (UJ) because of low interference check sample recovery

- Antimony in sample BHMS-BG-3 (J) because of low MS/MSD recovery

- Barium in all solid samples (J) because of poor MS/MSD recoveries.

4.2 Background Soil Samples

Three soil samples were collected to evaluate the background concentration of metals in surface soils at the BHMS. Soil samples BHMS-BG-1, BHMS-BG-2, and BHMS-BG-3 were collected above the upper waste rock dump and its associated adit, in naturally occurring soil. The metals concentrations are presented in Tables 4 and 5. Table 4 presents the metals concentrations compared to EPA Region 9 RSLs for residential soil (EPA 2010a). Table 5 presents the metals concentrations compared to MDEQ RBCGs (MDEQ 1996).

Table 4. BHMS background soil concentrations (ppm) compared to EPA RSLs.

Analyte	EPA RSL[a]	Mean Background	BHMS-BG-1	BHMS-BG-2	BHMS-BG-3
Antimony	310	12	5UJ	5UJ	12J
Arsenic	0.39 (40)[b]	**44**	28	**67**	36
Barium	15,000	241	304J	199J	220J
Cadmium	70	1	1U	1U	1U
Chromium	280	6	7	5	6
Copper	3,100	13	12	14	24
Iron	55,000	14,833	13,300	13,300	17,900
Lead	400	**560**	350	309	**1,020**
Manganese	Not applicable	1,720	2,510	1,430	1,220
Mercury	6.7	0.50U	0.50U	0.50U	0.50U
Nickel	14,000	7	7	8	6
Silver	390	7	5U	5U	7
Zinc	23,000	257	205	162	404

a. Regional screening level table, residential soil values (EPA 2010a).

b. 0.39 ppm is the arsenic residential soil RSL for the carcinogenic endpoint. MDEQ uses a soil screening value of 40 ppm for arsenic based on background arsenic values for Montana soils (MDEQ 2005).

UJ–The material was analyzed for but not detected. The sample quantitation limit is an estimated quantity.

J–The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the sample.

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

Bold–Value exceeds the EPA RSL or in the case of arsenic the MDEQ soil screening value.

Table 5. BHMS background soil concentrations (ppm) compared to MDEQ RBCGs.

Analyte	MDEQ RBCG	Mean Background	BHMS-BG-1 Background	BHMS-BG-2 Background	BHMS-BG-3 Background
Antimony	586	12	5UJ	5UJ	12J
Arsenic	323	44	28	67	36
Barium	103,000	241	304J	199J	220J
Cadmium	1,750	1U	1U	1U	1U
Chromium	1,470,000	6	7	5	6
Copper	54,200	13	12	14	24
Iron	Not Applicable	14,833	13,300	13,300	17,900
Lead	2,200	560	350	309	1,020
Manganese	7,330	1,720	2,510	1,430	1,220
Mercury	440	0.50U	0.50U	0.50U	0.50U
Nickel	29,300	7	7	8	6
Silver	Not Applicable	7	5U	5U	7
Zinc	440,000	257	205	162	404

RBCG = risk based cleanup guideline (MDEQ 1996).

UJ–The material was analyzed for but not detected. The sample quantitation limit is an estimated quantity.

J–The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the sample.

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

Metals in background soils are below the MDEQ RBCGs. The arsenic value in soil sample BHMS-BG-2 (67 ppm) exceeds the EPA RSL (0.39 ppm) and the MDEQ soil screening value (40 ppm). The mean arsenic concentration for background soils (44 ppm) also exceeds the EPA RSL and MDEQ soil screening value. Lead in BHMS-BG-3 (1,020 ppm) exceeds the EPA RSL (400 ppm). The mean lead concentration (560 ppm) also exceeds the EPA RSL.

4.3 Solid Matrix Samples

As noted previously, there are two waste rock piles at the BHMS: upper and lower waste rock. In 2009, seven soil samples (two from the upper and five from the lower) were collected from the periphery of the waste rock piles to establish the spatial boundaries of contamination. Each was analyzed for total metals. Previous investigations sufficiently characterized total metals concentrations in waste rock (Pioneer 1993). Appendix E presents the 1993 data. To better understand waste rock, samples from each of the dumps were collected to evaluate the mobility of metals they contain under environmental conditions. To support this effort, one waste rock sample was collected from each dump and submitted for SPLP extraction.[c]

Analytical results for the soil and waste rock samples are presented in Tables 6, 7, and 8. In Table 6, the metals concentrations are compared to EPA Region 9 RSLs for residential soil. In Table 7, the metals are compared to MDEQ RBCGs (MDEQ 1996). In Table 8, the metals concentrations are compared to mean background values. The following summarizes these comparisons:

- Lead exceeded the EPA RSLs in all samples except BHMS-SS-2 (adjacent to upper waste rock dump)
- Lead exceeded the MDEQ RBCG in both waste rock samples and BHMS-SS-1 (adjacent to the upper waste rock dump)
- Arsenic exceeded the EPA RSL in both waste rock samples and BHMS-SS-5 (lower waste rock dump)
- Arsenic exceeded the MDEQ RBCG in both waste rock samples
- The EPA RSL for antimony, iron, and mercury was exceeded in the upper waste dump only
- Zinc exceeded background concentrations in all nine samples
- Lead exceeded background concentrations in eight of nine samples
- Copper exceeded background concentrations in six of nine samples.

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c. The two waste rock samples collected in 1993 (Pioneer) for total metals analysis are included in the tables.

Table 6. BHMS solid matrix total metals analytical results (ppm) compared to EPA RSLs.

Analyte	EPA RSL[a]	WR-1 Upper Waste Rock Dump[c]	WR-2 Lower Waste Rock Dump[c]	BHMS-SS-1 Upper Waste Rock Dump	BHMS-SS-2 Upper Waste Rock Dump	BHMS-SS-3 Lower Waste Rock Dump	BHMS-SS-4 Lower Waste Rock Dump	BHMS-SS-5 Lower Waste Rock Dump	BHMS-SS-6 Lower Waste Rock Dump	BHMS-SS-7 Duplicate of SS-6
Antimony	310	**344**	61.3	5UJ	5UJ	5UJ	5UJ	5UJ	5UJ	5UJ
Arsenic	0.39 (40)[b]	**1,140**	**508**	21	13	32	11	**171**	22	20
Barium	15,000	27.9	19.8	186J	188J	28J	48J	65J	154J	102J
Cadmium	70	15.2	26	4	1U	4	1U	26	1U	1U
Chromium	280	5.25	4.5	8	5	5U	6	5	6	5U
Copper	3,100	342J	140J	18	13	17	19	29	22	14
Iron	55,000	**94,400**	44,200	22,300	12,500	8,410	14,200	9,690	14,700	13,000
Lead	400	**55,900J**	**18,700**	**2,540**	355	**1,160**	**642**	**2,110**	**1,130**	**737**
Manganese	Not applicable	992	426	1,680	1,050	322	283	1,170	738	466
Mercury	6.7	**27.2J**	2.53J	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U
Nickel	14,000	3.84	6.23	10	7	7	8	8	8	5
Silver	390	NA	NA	5U	5U	5U	5U	5U	5U	5U
Zinc	23,000	9,600	11,400	926	1,050	1,680	751	4,410	866	535

a. EPA regional screening level table, residential soil values (EPA 2010a).

b. 0.39 ppm is the arsenic residential soil RSL for the carcinogenic endpoint. The MDEQ uses a soil screening value of 40 ppm for arsenic based on background arsenic values for Montana soils (MDEQ 2005).

c. Total metals analytical results from 1993 AMRB Hazardous Materials Inventory (Pioneer 1993).

UJ–The material was analyzed for but not detected. The sample quantitation limit is an estimated quantity.

J-–The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the sample.

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

Bold– Value exceeds the EPA RSL or for arsenic the MDEQ soil screening value.

NA–Not analyzed.

Table 7. BHMS solid matrix total metals analytical results (ppm) compared to MDEQ RBCGs.

Analyte	MDEQ RBCG[a]	WR-1 Upper Waste Rock Dump[b]	WR-2 Lower Waste Rock Dump[b]	BHMS-SS-1 Upper Waste Rock Dump	BHMS-SS-2 Upper Waste Rock Dump	BHMS-SS-3 Lower Waste Rock Dump	BHMS-SS-4 Lower Waste Rock Dump	BHMS-SS-5 Lower Waste Rock Dump	BHMS-SS-6 Lower Waste Rock Dump	BHMS-SS-7 Duplicate of SS-6
Antimony	586	344	61.3	5UJ	5UJ	5UJ	5UJ	5UJ	5UJ	5UJ
Arsenic	323	**1,140**	**508**	21	13	32	11	171	22	20
Barium	103,000	27.9	19.8	186J	188J	28J	48J	65J	154J	102J
Cadmium	1,750	15.2	26	4	1U	4	1U	26	1U	1U
Chromium	1,470,000	5.25	4.5	8	5	5U	6	5	6	5U
Copper	54,200	342J	140J	18	13	17	19	29	22	14
Iron	Not applicable	94,400	44,200	22,300	12,500	8,410	14,200	9,690	14,700	13,000
Lead	2,200	**55,900J**	**18,700**	**2,540**	355	1,160	642	2,110	1,130	737
Manganese	7,330	992	426	1,680	1,050	322	283	1,170	738	466
Mercury	440	27.2J	2.53J	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U
Nickel	29,300	3.84	6.23	10	7	7	8	8	8	5
Silver	Not applicable	NA	NA	5U	5U	5U	5U	5U	5U	5U
Zinc	440,000	9,600	11,400	926	1,050	1,680	751	4,410	866	535

a. MDEQ risk based cleanup guideline (MDEQ 1996).

b. Total metals analytical results from 1993 AMRB Hazardous Materials Inventory (Pioneer 1993).

UJ–The material was analyzed for but not detected. The sample quantitation limit is an estimated quantity.

J– The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the sample.

U– The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

Bold– Value exceeds the MDEQ RBCG.

NA–Not analyzed.

Table 8. BHMS solid matrix total metals analytical results (ppm) compared to mean background.

Analyte	Mean Background	WR-1 Upper Waste Rock Dump[a]	WR-2 Lower Waste Rock Dump[a]	BHMS-SS-1 Upper Waste Rock Dump	BHMS-SS-2 Upper Waste Rock Dump	BHMS-SS-3 Lower Waste Rock Dump	BHMS-SS-4 Lower Waste Rock Dump	BHMS-SS-5 Lower Waste Rock Dump	BHMS-SS-6 Lower Waste Rock Dump	BHMS-SS-7 Duplicate of SS-6
Antimony	12J	**344**	**61.3**	5UJ	5UJ	5UJ	5UJ	5UJ	5UJ	5UJ
Arsenic	44	**1,140**	**508**	21	13	32	11	**171**	22	20
Barium	241	27.9	19.8	186J	188J	28J	48J	65J	154J	102J
Cadmium	1U	**15.2**	**26**	**4**	1U	**4**	1U	**26**	1U	1U
Chromium	6	5.25	4.5	**8**	5	5U	6	5	6	5U
Copper	17	**342J**	**140J**	**18**	13	17	**19**	**29**	**22**	14
Iron	14,833	**94,400**	**44,200**	**22,300**	12,500	8,410	14,200	9,690	14,700	13,000
Lead	560	**55,900J**	**18,700**	**2,540**	355	**1,160**	**642**	**2,110**	**1,130**	**737**
Manganese	1,720	992	426	1,680	1,050	322	283	1,170	738	466
Mercury	0.5U	**27.2J**	**2.53J**	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U
Nickel	7	3.84	6.23	**10**	7	7	**8**	**8**	**8**	5
Silver	7	NA	NA	5U	5U	5U	5U	5U	5U	5U
Zinc	257	**9,600**	**11,400**	**926**	**1,050**	**1,680**	**751**	**4,410**	**866**	**535**

a Total metals analytical results from 1993 AMRB Hazardous Materials Inventory (Pioneer 1993).
UJ–The material was analyzed for but not detected. The sample quantitation limit is an estimated quantity.
J–The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the sample.
U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
Bold –Value exceeds the mean background level.
NA–Not analyzed.

- Cadmium exceeded background concentrations in five of nine samples
- Arsenic and iron exceeded background concentrations in three of nine samples
- Antimony and mercury exceeded background concentrations in two of nine samples (both waste rock samples)
- Chromium exceeded background concentrations in one of nine samples
- Nickel exceeded background concentrations in four of nine samples
- Zinc exceeded background concentrations in nine of nine samples.

As noted, two waste rock samples underwent SPLP extraction and metals analysis. This method determines the total metals that would be leached under simulated environmental conditions. The leaching is performed with a dilute acid extraction fluid to reflect the pH of the acidic precipitation in the geographic region, to evaluate environmental mobility of metals. The SPLP results are presented in Table 9.

Table 9. BHMS laboratory SPLP total metals analytical results (ppm).

	Sb	Cu	Fe	Hg	Mn	Ni	Zn	As	Ba	Cd	Cr	Pb	Ag
WR-1 Upper Waste Rock Dump	0.5U	0.5U	1UJ	.02U	0.5U	0.5U	1U	0.5U	10U	0.1U	0.5U	9.0	0.5U
WR-2 Lower Waste Rock Dump	0.5U	0.5U	1UJ	.02U	0.5U	0.5U	1U	0.5U	10U	0.1U	0.5U	0.5U	0.5U

UJ–The material was analyzed for but not detected. The sample quantitation limit is an estimated quantity.
U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

With only one exception, none of the samples showed detectable levels of target metals, indicating limited mobility of these metals in the environment. This is a reasonable outcome, considering the overwhelming majority of the mine waste is waste rock, with very little fines found at the site (i.e., no milling/size reduction took place at the site). The metals being bound in the natural rock of the region limits their contact with surface waters and reduces the amount of metals available for leaching. The rock form also significantly reduces the risk of large sedimentation events due to contact with surface water.

The SPLP extract for lead in sample BHMS-WR-1 (upper waste rock dump) was measured at 9 ppm (9,000 ppb). The human health standard for lead in water from the “Montana Numeric Water Quality Standards” is 15 ppb (MDEQ 2008). The acute aquatic life standard from the “Montana Numeric Water Quality Standards” is 13.98 ppb (MDEQ 2008). Given the high levels of lead found in the upper waste rock, this value, while not indicative of excessive mobility, is a reasonable outcome.

At the request of MDEQ, Portage personnel traveled to the BHMS in November 2009 to acquire waste rock samples from both the upper and lower dumps. The data was collected to confirm 1993 results and to ensure that no sificnat changes had occurred since the previous sampling effort. To support this effort, one composite waste rock sample was collected from each of the waste rock dumps (upper and lower). The November 2009 data is presented in Table 10.

Table 10. Additional 2009 BHMS solid matrix total metals (ppm) analytical results

	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
WR-1 Upper Waste Rock Dump	34	743	17	2	6	171	55,800	14,100	634	4	5U	26	1,800
WR-2 Lower Waste Rock Dump	12	117	42	3	6	61	18,300	2,760	524	0.83	10	5	1,480

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

The 1993 waste rock data was generated by collecting multiple sub-samples from individual areas within each dump and combining subsamples from that dump into a single composite sample (e.g., WR-1 subsamples combined with other WR-1 subsamples). The stakes/markers used to identify where subsamples were collected were not evident in 2009. As a result, the supplemental samples collected in November of 2009 are not from these locations. However, the 2009 composite samples were collected from multiple locations at each dump, similar to prior sampling.

In comparing the results of the two sampling efforts, it is clear that the waste rock has a relatively high degree of heterogeneity. Relative percent differences (RPDs) between the 1993 and 2009 results were rather high (> 35%). However, field dupulicates collected during 2009 showed similar variability, indicating the spread in the data has more to do with the sample matrix than sampling precision. In general, the results from the 1993 sampling were higher for the majority of constituents. In particular, the primary contaminant of potential concern (arsenic) was higher. Results for metals with lesser human and/or ecological toxicity were slightly higher in the 2009 data. These included: chromium in WR-1 and barium and manganese in WR-2. For purposes of examining site conditions, the 1993 data has been retained in this report, as the results generally represent the maximum concentrations found at the site and, therefore, their use is more protective of human health and the environment. Additional detail is provided in Section 6, Risk Assessment.

4.4 Water

Water at the BHMS originates from the collapsed adit that divides the upper and lower waste rock dumps (Figure 2). To better understand the composition of the discharge, three water samples were collected. The first was an unfiltered sample collected for total metals and water quality parameters and to confirm the results of the 1993 sampling effort. The other two samples were filtered and preserved to determine if the metals found in the 1993 unfiltered samples reflect natural conditions or if sediment loading led to the elevated concentrations observed in the water.

The data are presented in a series of tables that follow to provide context to the results. The following describes the data presentation:

- Table 11 presents the water-dissolved metals and a comparison to the MDEQ RBCG
- Table 12 presents the water dissolved metals and a comparison to the “Montana Numeric Water Quality Standards” (MDEQ 2008) for aquatic life (acute values), aquatic life (chronic levels), and the human health values (surface water) for reference
- Table 13 presents the water total metals data and a comparison to the MDEQ RBCGs
- Table 14 presents the water total metals data compared to the “Montana Numeric Water Quality Standards” for aquatic life (acute levels), aquatic life (chronic levels), and human health values (surface water) for reference[d]
- Table 15 presents the water quality parameter data.

Table 11. BHMS water dissolved metals (ppb) vs. MDEQ RBCG.

	MDEQ RBCG[a]	BHMS-GW-2	BHMS-GW-3 Duplicate of GW-2
Antimony	204	5U	5U
Arsenic	153	31	31
Barium	35,800	100U	100U
Cadmium	256	1	1
Calcium	None	9,000	9,000
Chromium	511,000 (as Cr III)	10U	10U
Copper	18,900	10U	10U
Iron	None	30U	30U
Lead	220	10U	10U
Magnesium	None	1,000U	1,000U
Manganese	2,560	10U	10U
Mercury	153	1U	1U
Nickel	10,200	10U	10U
Silver	None	4U	5U
Zinc	153,000	420	480

ppb = parts per billion.

a. MDEQ risk-based recreational cleanup guidelines (MDEQ 1996).

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

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[d] The adit discharge results from 1993 are also included in Tables 12 and 13.

12. BHMS water dissolved metals (ppb) vs. “Montana Numeric Water Quality Standards.”

	HHS[a]	Acute Aquatic Life Standard	Chronic Aquatic Life Standard	BHMS-GW-2	BHMS-GW-3 Duplicate of GW-2
Antimony	5.6[b]	None	None	5U	5U
Arsenic	10[b]	340 [b]	150[b]	**31**	**31**
Barium	2,000[c]	None	None	100U	100U
Cadmium	5[c]	0.52 @ 25ppm hardness	0.097 @ 25ppm hardness	**1**	**1**
Calcium	None	None	None	9,000	9,000
Chromium	100[c]	None	None	10U	10U
Copper	1,300[b]	3.79 @ 25ppm hardness	2.85 @ 25ppm hardness	10U	10U
Iron	300[d]	None	1,000[b]	30U	30U
Lead	15[b]	13.98 @ 25ppm hardness	0.545 @ 25ppm hardness	10U	10U
Magnesium	None	None	None	1,000U	1,000U
Manganese	50[d]	None	None	10U	10U
Mercury	0.05[b]	1.7[b]	0.91[b]	1U	1U
Nickel	100[e]	145 @ 25ppm hardness	16.1 @ 25ppm hardness	10U	10U
Silver	100[e]	0.374 @ 25ppm hardness	None	5U	5U
Zinc	2,000[e]	37 @ 25ppm hardness	37 @ 25ppm hardness	**420**	**480**

ppb = parts per billion.
a. Human Health Standards for Surface Water, Circular DEQ-7, “Montana Numeric Water Quality Standards” (MDEQ 2008).
b. Priority Pollutant, Circular DEQ-7, “Montana Numeric Water Quality Standards” (MDEQ 2008).
c. Maximum contaminant level (MDEQ 2008).
d. Secondary maximum contaminant level based on aesthetic properties (MDEQ 2008).
e. Health advisory (MDEQ 2008).
U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
Bold–Value exceeds the human health standard (HHS) or Montana acute aquatic life standard.

The comparison of dissolved metals values from the BHMS adit discharge to MDEQ RBCGs reveals metals in the adit discharge do not exceeded associated recreational cleanup guidelines. Arsenic exceeded the HHS and both cadmium and zinc exceeded the aquatic life standards listed in the “Montana Numeric Water Quality Standards” (MDEQ 2008).

Table 13. BHMS water total metals (ppb) vs. MDEQ RBCGs.

	MDEQ RBCG[a]	BHMS-GW-1	GW-1 1993 Level[b]
Antimony	204	5U	30.7U
Arsenic	153	31	30.4
Barium	35,800	100U	2.01U
Cadmium	256	2	2.57U
Calcium	None	9,000	NA
Chromium	511,000 (as Cr III)	10U	6.83U
Copper	18,900	10U	2.97
Iron	None	30U	69.6
Lead	220	20	107
Magnesium	None	1,000U	NA
Manganese	2,560	10U	15.2
Mercury	153	1U	0.044J
Nickel	10,200	10U	12.7U
Silver	None	5U	Not analyzed
Zinc	153,000	580	867

ppb = parts per billion.

a. MDEQ risk-based recreational cleanup guidelines (MDEQ 1996).

b. Analytical results from 1993 AMRB Hazardous Materials Inventory (Pioneer 1993).

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

NA–Not analyzed.

Table 14. BHMS water total metals (ppb) vs. "Montana Numeric Water Quality Standards."

	HHS[a]	Acute Aquatic Life Standard	Chronic Aquatic Life Standard	BHMS-GW-1	GW-1 1993 Level[f]
Antimony	5.6[b]	None	None	5U	30.7U
Arsenic	10[b]	340[b]	150[b]	**31**	30.4
Barium	2,000[c]	None	None	100U	2.01U
Cadmium	5[c]	0.52 @ 25 ppm hardness	0.097 @ 25 ppm hardness	**2**	2.57U
Chromium	100[c]	None	None	10U	6.83U
Copper	1,300[b]	3.79 @ 25 ppm hardness	2.85@ 25 ppm hardness	10U	2.97
Iron	300[d]	None	1,000[b]	30U	69.6
Lead	15[b]	13.98 @ 25 ppm hardness	0.545 @ 25 ppm hardness	**20**	107
Manganese	50[d]	None	None	10U	15.2
Mercury	0.05[b]	1.7[b]	0.91[b]	1U	0.044J
Nickel	100[e]	145 @ 25 ppm hardness	16.1 @ 25 ppm hardness	10U	12.7U
Silver	100[e]	0.374 @ 25 ppm hardness	None	5U	Not analyzed
Zinc	2,000[e]	37 @ 25 ppm hardness	37 @ 25 ppm hardness	**580**	867

ppb = parts per billion.

a. Human Health Standards For Surface Water, Circular DEQ-7, "Montana Numeric Water Quality Standards" (MDEQ 2008).

b. Priority Pollutant, Circular DEQ-7, "Montana Numeric Water Quality Standards" (MDEQ 2008).

c. Maximum contaminant level (MDEQ 2008).

d. Secondary maximum contaminant level based on aesthetic properties (MDEQ 2008).

e. Health advisory (MDEQ 2008).

f. Analytical results from 1993 AMRB Hazardous Materials Inventory (Pioneer 1993).

U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

Bold–Values exceed either the HHS and/or the Aquatic Life Standard.

As the results show, none of the total metals in the adit discharge exceeded their associated RBCG. The HHS for arsenic and lead were exceeded. Cadmium, lead, and zinc all exceed aquatic life standards from the "Montana Numeric Water Quality Standards."

Table 15. Water quality parameter analytical results (ppm) for the BHMS.

	Chloride	Carbonate as CO_3	Sulfate	Hardness	Nitrate /Nitrite	Alkalinity as $CaCO_3$	Total Acidity as $CaCO_3$	TDS	Bicarbonate as HCO_3
BHMS -GW-1	1U	4U	3	25	0.11	24	4U	42	29
GW-2	NA	NA	NA	25	NA	NA	NA	NA	NA
GW-3	NA	NA	NA	25	NA	NA	NA	NA	NA

TDS = total dissolved solids.
U–The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
NA–Not analyzed.

The water quality parameters indicate limited nutrient loading in the adit discharge. This result is consistent with observed conditions, as the discharge emerges from underground without contacting a large area at the site before returning to groundwater. The water clarity at the discharge is high, with no observable loading in the water or staining on the gravel at the discharge point.

4.5 Field Quality Assurance/Quality Control Samples

Two quality assurance/quality control (QA/QC) samples were collected during this RI: (a) a soil field duplicate (BHMS-SS-7) and (b) a water field duplicate (BHMS-GW-3). The soil total metals results for which duplicates were collected are presented in Tables 6, 7, and 8. The water analyses results for which duplicates were collected are presented in Tables 11 and 12.

Precision is the measure of variance occurring between two samples from the same location, undergoing the same analyses, and using the same analytical method(s). One measure of duplicate precision is relative percent difference (RPD). The EPA has established benchmarks for evaluating the levels of precision in solid and water matrices. These include +/−20% RPD for waters and +/−35% for soils (EPA 1994). While these benchmarks provide context to decision-makers in evaluating the general quality of their data, field duplicate results aid in quantifying the uncertainty or the spread in field duplicate measurements. This spread should be evaluated by end data users to provide a sense of how well the results represent site conditions.

For solid samples collected at the BHMS in 2009, the RPD for barium (41%), copper (44%), lead (42%), manganese (45%), nickel (46%), and zinc (47%) exceeded the 35% benchmark slightly. The RPD was met for arsenic (9%) and iron (12%). All soil agronomy analyses fell within the +/−35% RPD except sulfate (50%). Given that soil is a very heterogeneous material, field duplicate precision tends to be considered qualitative in terms of data quality. The better use of these results is in examining the uncertainty (or lack thereof) in the representativeness of the two values. For BHMS solid samples, the relative spread is rather small and would indicate that metals data reasonably reflect site conditions.

For the BHMS adit discharge samples, all of the field duplicate RPDs fell below 20% RPD.

5. RECLAMATION AND LAND USE CHARACTERIZATION RESULTS

The physical, agricultural, and geochemical properties of soil and waste rock were evaluated by collecting samples from the BHMS in 2009. This information was acquired to support a better understanding of the condition of solid materials at the site and to support future decision-making concerning a possible remedy. Table 16 provides a summary of the noted analyses for soil samples collected from the BHMS. Also included in the table is a fertilizer recommendation from Neal Fehringer, Certified Professional Agronomist for Energy Laboratories based on the associated analytical data.

5.1 Physical Analyses

Physical analyses included texture and CEC. Texture is the relative proportions of the various soil separates (sand, silt, and clay) in a soil. Naturally occurring soil at the BHMS is mostly silt-loam with one background sample consisting of loam. Equal amounts of sand, silt, and clay make a clay loam. A silt loam is a higher percentage of silt, which is a coarser fragment allowing good water-holding capacity and adequate drainage.

CEC is the expression of cation adsorption sites per unit weight of soil. The higher the cation exchange sites the better plant nutrients are absorbed by local vegetation. Samples at the BHMS had a CEC ranging from 46.1/100 g to 72.7 meq/100 g. On average, organic matter found in mineral soils have CEC levels of around 200 meq/100 g (Kabata-Pendias and Pendias 1992). The CEC of the soil samples at BHMS shows a fair amount of exchangeable cations, although soils at the site are relatively thinly deposited in most areas.

5.2 Agricultural Analyses

Agricultural analyses include pH, conductivity, nitrate, phosphorus, potassium, organic matter, and lime. The following provides a summary of the agricultural analyses and how they may affect current and future plant growth:

- pH is the measure of the acidity/alkalinity of soils and provides a general look at the ability of soils to establish and maintain vegetation. pH is considered netural at 7.0 standard units (s.u.). The pH of the seven soil samples collected at the BHMS ranged from 4.3 to 6.2 s.u.. For plant nutrients as a whole, good nutrient availability is found at pH 6.5 s.u. The optimum pH range for Douglas fir growth is 6.0 to 7.0 (Kabata-Pendias and Pendias 1992).

- Conductivity measures the salinity of the soil. When found at high enough concentrations, conductivity can predict when soil conditions may either limit existing plant growth or impede re-vegetation. The conductivity of soils collected from the BHMS ranged from 0.12 to 0.24 mmhos/cm. This is within a good working range needed for establishing vegetation (Bohn 1979).

- Nitrogen and nitrogen forms such as nitrate and nitrite are essential nutrients in establishing and maintaining vegetative cover. The nitrate levels in soil collected at the BHMS ranged from not detected to 3 mg/kg. This is relatively low when compared to the high levels of organic matter found in BHMS soils and some amendment of nitrogen is likely needed. It is important to note that local vegetation is well established along the periphery of the waste rock dumps and throughout the watershed.

- Like nitrate, phosphorous is a key nutrient needed for maintaining existing vegetation and for establishing and maintaining vegetative cover. The phosphate form of phosphorous is most often used by plants for growth (USDA 2009). The phosphorus levels found in soil at the BHMS ranged from not detected to 22 mg/kg. Phosphorous/phosphate levels greater than 22 mg/kg are considered sufficient for growth of most species. The phosphorous levels found in BHMS soils are at or above this concentration. Again, it is also important to note that vegetation in and around the BHMS is well established, despite these levels.

- Potassium is another essential nutrient which facilitates vegetative growth. The potassium levels in soil at the BHMS ranged from 104 to 276 mg/kg. Soils containing potassium at or above 120 mg/kg will typically support vegetation (USDA 2009). The levels noted at BHMS are likely sufficient to support re-vegetation.

- Organic matter stores anions, buffers the soil against rapid changes due to acidity or alkalinity, increases water-holding capacity, etc. The organic matter levels in soil at the BHMS ranged from 15.4% to 19.6%. This is a relatively high percentage of organic matter and will easily support vegetative re-growth at the site (Bohn 1979).

- Natural lime in soils will buffer or neutralize acid-producing elements often found in mine waste (e.g., sulfur) while facilitating plant uptake of nitrogen. Soils with a pH below 5 typically have lime applied prior to fertilizer to achieve maximum fertilizer efficiency. The lime levels in the soil at the BHMS ranged from 0.3% to 2%, which is relatively low (Follett 1981). This coupled with slightly lower than netural pH of the soils at BHMS, suggest addition of lime is advised to support vegetative re-growth.

- As part of the 2009 sampling and analysis effort, fertilizer and lime recommendations were requested for the BHMS soils, in the event essential nutrients were found to be absent or too low to support vegetation. As noted above, several essential nutrients were found to be on the low end of the recommended requirements to support establishment of vegetation at the BHMS. As a result, amendments are recommended to ensure timely establishment of vegetative cover.

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

  - Phosphorous = 0 to 50 pounds per acre based on a crop of grass yielding 1.5 tons per acre

  - Potassium = 0 to 50 pounds per acre based on a crop of grass yielding 1.5 tons per acre

  - Lime = 0 to 5 tons based on a crop of grass yielding 1.5 tons per acre.

Table 16. BHMS solid matrix physical, agricultural, and acid/base accounting results.

		BHMS-BG-1 Background	BHMS-BG-2 Background	BHMS-BG-3 Background	BHMS-SS-1 Upper Waste Rock Dump	BHMS-SS-5 Lower Waste Rock Dump	BHMS-SS-6 Lower Waste Rock Dump	BHMS-SS-7 Duplicate of SS-6
Physical Analyses	Texture	Silt Loam	Loam	Silt Loam	Silt Loam	Silt Loam	Silt Loam	Silt Loam
	Cation exchange capacity (meq/100g)	51.8	46.1	49.6	53.5	72.7	53.3	49.7
Agricultural Analyses	pH (s.u.)	5.2	4.3	5.2	5.2	6.2	5.5	5.5
	Conductivity (mmhos/cm)	0.24	0.12	0.14	0.13	0.33	0.22	0.20
	Nitrate as nitrogen (mg/kg)	Non-detect	Non-detect	Non-detect	1	2	3	3
	Fertilizer recommendation (lb/ac)	30	30	30	30	25	25	25
	Phosphorus (mg/kg)	22	1.1U	4.9	9.1	5.2	4.2	3.9
	Phosporus recommendation (lb/ac)	0	50	35	0	50	50	50
	Potassium (mg/kg)	228	104	150	105	276	256	216
	Potassium recommendation (lb/ac)	0	50	40	50	0	0	0
	Organic matter (%)	18.8	19.5	17	15.4	19.5	19.6	19
	Lime (%)	1.2	0.3	0.5	0.4	2	0.9	0.8
	Lime recommendation (tons)	3	5	3	3	0	3	3

Table 16. (continued).

	Sulfur recommendation (lb/ac)	10	10	10	10	10	10	10
Acid Base Accounting	Total sulfur (%)	0.02	0.01	0.02	0.02	0.02	0.03	0.03
	Pyritic sulfur %	0.02	<0.01	0.02	0.01	0.02	0.02	0.02
	Organic sulfur %	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate sulfur (meq/L)	0.095	0.10	0.076	0.17	0.25	0.25	0.15
	Neutralization potential (t/kt)	12	3	5	4	20	9	8
	Acid potential(t/kt)	0.53	0.41	0.67	0.69	0.78	1	0.93
	Acid/base potential (t/kt)	11	3	4	4	20	8	7

5.3 Acid/Base Accounting Analyses

Like the lime requirement, ABA provides a more sophisticated means of examining the naturally occurring levels of basic material in soils (e.g., lime) versus the amount of acid generating species it contains (e.g., sulfur) and how the two may interact over time. ABA analyses evaluates the amount of sulfur, pyritic sulfur, organic sulfur, sulfate sulfur to determine the ability of the soil/waste to generate acidity when it contacts water.

ABA also examines how much lime is required to neutralize all acid that could be formed by the waste. This is done by evaluating the acid potential and the acid/base potential to determine if the waste contains sufficient buffering capacity to offset the sulfur it contains. Together, they provide a measure of whether mine waste is likely to generate acid when exposed to water over time, or if the natural buffering capacity (e.g., lime equivalent) of the waste will offset its effects. When acid generating materials encounter equal amounts of acid neutralizing material, generally the material is able to neutralize its own acidity. Often, the sulfur content of mine wastes exceeds its buffering capacity due to weathering or leaching of the material. In these cases, excess lime must be added to counteract the acid potential, and/or the material must be prevented from contacting water over time to interrupt its acid generating potential (engineered repository). If left untreated, the waste acidity will eventually lead to leaching and release of metals. The following summarizes the ABA analysis and recommended treatments for BHMS soils:

- The sulfur levels in soil at the BHMS ranged from 0.0%1 to 0.03%
- The sulfate sulfur levels in the soils at the BHMS ranged from 0.076 to 0.25 meq/L
- The acid potential ranged from 0.41 to 1 t/kt
- The neutralization potential (lime required to neutralize acid species in the waste) ranged from 3 to 20 t/kt
- The acid/base potential (natural buffering capacity of the waste itself) ranged from 3 to 20 t/kt.

These results suggest that the soils at BHMS contain nearly as much buffering capacity as they do acid-forming sulfur. As a result, lime amendments to counteract their ability are likely to be somewhat limited. Depending on the selected remedy for the site, some lime amendment may be warranted to be protective of vegetative cover and to prevent migration of metals into the watershed. The examination of possible soil amendments will be further examined in the expanded engineering evaluation/cost analysis (EEE/CA) for the BHMS and will be contingent upon the remedy identified for the site.

5.4 Potential Repository and Borrow Soil Locations

As part of work plan implementation, Portage personnel visited potential repository locations in the event that waste rock dumps require removal from the watershed. Because of the proximity of the Scotchman Mine to the BHMS and relative timing under which the USFS is working at the Scotchman, a joint location for waste from both sites was being considered.

On Wednesday, July 8, USFS personnel, Gary Kedish and Nancy Rusho, identified potential repository locations. Photographs are presented in Appendix B. Approximately 2,000 ft from the turnoff for Forest Service Road 2290 and 2,500 ft prior to the Scotchman site, Forest Service Road 409 moves away from the East Fork of Blue Creek. This widening in the road is approximately 500 to 600 ft long and 100 to 200 ft wide.

Current access to the BHMS is via Forest Service Road 2290. An alternate route to the BHMS could be achieved on Forest Service Road 2294, with some site preparation. Forest Service personnel report this road is locked at the bottom (also monitored for grizzly and black bear habitat) and has some discontinuous areas. However, there is a saddle on Forest Service Road 2294 approximately 4,000 ft from the intersection of Forest Service roads 2292 and 2294. This saddle could only be investigated from a distance, because Portage personnel did not have a special use permit to access the area. However, the saddle has a large flat area that may allow a repository and offer borrow soil material. Additional inspection by engineering staff is recommended to determine the feasibility of this location. A map of repository locations identified during the RI is presented in Appendix I.

Information on Forest Service Road 2290 was presented earlier in Section 3. Some clearing and grubbing would likely be needed for annual blowdown episodes. Additionally, if 2290 is the preferred route, two seeps on the road would likely require installation of best management techniques (e.g., culverts), and areas of the road would likely require widening. Route 2290 is also much steeper than what is now typically allowed on Forest Service land. Based on a review of the contours and general lay of the land, Route 2294 may be a more suitable haul road if waste requires removal, particularly if the saddle near its shoulder proves a viable repository location.

Per USFS determination, after examining the two sites, a joint repository was determined not to be feasible based on the site locations. The USFS determined that two separate repositories, one for each site, would be a better option.

6. HUMAN HEALTH RISK ASSESSMENT

Field samples were collected from the BHMS and analyzed for heavy metals, nutrients, and physical/geochemical characteristics. These results were used to conduct a screening level human health risk analysis to meet RI objectives. The analysis was conducted using current guidance set forth in the following:

- *Risk-Based Cleanup Guidelines for Abandoned Mine Sites: Final Report* (TetraTech 1996)
- Standardized risk assessment spreadsheets developed by MDEQ/MWCB
- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Interim Final)* (RAGS) (EPA 1989a).

The risk assessment involved five steps: (1) hazard identification, (2) exposure assessment, (3) toxicity assessment, (4) risk characterization, and (5) calculation of risk-based cleanup goals. The following sections discuss these steps in detail. The information and calculations used to develop the human health risk analysis are provided in Appendix F.

6.1 Hazard Identification

Hazard identification is conducted to identify contaminants of potential concern (COPCs). Each COPC must meet four criteria established by the EPA (EPA 1989a): (1) the constituent is present at the site, (2) the concentrations of the constituent are significantly above background concentrations (generally 3x), (3) 20% of the concentrations must be above the method detection limit, and (4) the analytical results for each constituent must meet QA/QC criteria outlined by the *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994).

COPC determination also includes screening against MDEQ/MWCB RBCGs for the gold panner/rock hound scenario; the basis for choosing this exposure scenario is discussed further in Section 6.1.3. All metals identified as COPCs, either by meeting the EPA criteria and/or exceeding the MDEQ/MWCB recreational cleanup guidelines, were used to conduct the exposure assessment and determine human health risk through recreational use of the site.

Twelve solid samples and two adit water samples have been collected at the BHMS. Solid samples consist of three background surface soil samples, seven surface soil samples, and two waste rock samples.

6.1.1 Solid Samples

Metal concentrations in surface soil and waste rock samples were evaluated against the four EPA COPC criteria outlined above. Seven metals met these criteria in solid samples:

- Antimony
- Arsenic

- Cadmium
- Iron
- Lead
- Mercury
- Zinc.

These metals were also screened against the MDEQ/MWCB RBCG for the gold panner/rock hound scenario. Only arsenic and lead exceeded the RBCG.

6.1.2 Water Samples

Metal concentrations in the adit water samples were evaluated against the four EPA COPC criteria outlined above. Eight metals met these criteria in water samples:

- Arsenic
- Cadmium
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Zinc.

These metals were screened against the MDEQ/MWCB RBCG for the gold panner/rock hound scenario as well as the Montana state water quality standards (WQB-7) acute aquatic life standards (MDEQ 2008). None of the metals exceeded the RBCGs; only cadmium, lead, and zinc exceeded WQB-7 standards.

6.1.3 Exposure Assessment

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

As stated, the gold panner/rock hound scenario was selected as the exposure scenario for this assessment. The fisherman exposure scenario was not selected, because no continuous surface water is present to support this activity. The hunter and ATV/motorcycle rider exposure scenarios are plausible; however, with the exception of inhalation exposure to barium, cadmium, and manganese for the ATV/motorcycle ride exposure scenario, the gold panner/rock hound has the most conservative exposure parameters, and therefore bounds (protective) the other exposure scenarios presented in the *Risk-Based Cleanup Guidelines for Abandoned Mine Sites: Final Report* (TetraTech 1996). As outlined in Section 6.2 of this document, *de minimus* risk and hazard values are exceeded using the gold panner/rock hound exposure parameters; therefore, assessing any additional risk and hazard due to fugitive dust inhalation of barium, cadmium, and manganese for ATV/motorcycle riders is unwarranted.

In examining the site data, a determination of "moderate" was made, using the Abandoned and Inactive Mines Scoring System (AIMSS) for potential recreational use. This determination is based on limited site access (the site is accessible by a Forest Service road with a locked gate at the base year-round) and lack of surface water resources. The ranking is used to determine the exposure frequency used in risk and hazard calculations. A moderate ranking corresponds to an exposure frequency of 25 days per year for the gold panner/rock hound scenario. In addition, relatively restrictive land use requirements, remote location, and small size of the nearby population demonstrate the 25 days per year exposure frequency is likely more representative of actual use patterns at the BHMS.

Exposure point concentrations (EPCs) for use in risk and hazard calculations are generally either (a) the 95% upper confidence limit (UCL) generated from the data set or (b) the maximum concentration for each COPC. Both EPA's risk assessment guidance for Superfund (EPA 1989a) and TetraTech's risk-based cleanup guidelines for abandoned mine sites (TetraTech 1996) recommend using the 95% UCL as the EPC for a sufficiently large number of samples. However, insufficient samples were available to compute 95% UCLs (i.e., less than 12 detections for each matrix type); therefore, the maximum concentration for each COPC was used as the EPC in all cases. Uncertainties associated with use of the maximum concentration as the EPC are further discussed in Section 6.2.2 of this document. Table 17 presents the EPCs used in the risk and hazard calculations.

Table 17. Exposure point concentrations for the BHMS, total metals.

Exposure Media	Antimony	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Mercury	Zinc
Solid (mg/kg)	344	1,140	26	342	94,400	55,900	NA	27.2	11,400
Water (µg/L)	NA	31	2.57	2.97	69.6	107	15.2	0.044	867

Notes:
mg/kg = milligrams per kilogram.
µg/L = micrograms per liter.
NA = Not included as a COPC for the media shown; metal did not meet EPA COPC criteria.

6.1.4 Toxicity Assessment

The toxicity assessment summarizes the potential for each COPC to cause adverse effects in exposed populations. These effects can be categorized as carcinogenic or non-carcinogenic and are measured in terms of cancer risk and hazard index (HI). Arsenic and lead exhibited either hazard levels greater than 1.0 or risk levels greater than 1×10^{-6} individually; these COPCs are the major contributors to risk and hazard levels at the BHMS. The following sections summarize the acute, chronic, carcinogenic, and other known toxic effects of these two COPCs from toxicological summaries prepared for the Oak Ridge Reservation Environmental Restoration Program (DOE 2009). The other COPCs do not pose a significant risk to potential human receptors and their toxicological profiles were therefore excluded.

6.1.4.1 Arsenic. The toxicity of inorganic arsenic (As) depends on its valence state (−3, +3, or +5) and also on the physical and chemical properties of the compound in which it occurs. Trivalent (As+3) compounds are generally more toxic than pentavalent (As+5) compounds, and the more water soluble compounds are usually more toxic and more likely to have systemic effects than the less soluble compounds, which are more likely to cause chronic pulmonary effects if inhaled. One of the most toxic inorganic arsenic compounds is arsine gas (AsH3). It should be noted that laboratory animals are generally less sensitive than humans to the toxic effects of inorganic arsenic. In addition, in rodents the critical effects appear to be immunosuppression and hepato-renal dysfunction, whereas in humans the skin, vascular system, and peripheral nervous system are the primary target organs.

Water-soluble inorganic arsenic compounds are absorbed through the gastrointestinal tract (>90%) and lungs; distributed primarily to the liver, kidney, lung, spleen, aorta, and skin; and excreted mainly in the urine at rates as high as 80% in 61 hours following oral dosing. Pentavalent arsenic is reduced to the trivalent form and then methylated in the liver to less toxic methylarsinic acids.

Symptoms of acute inorganic arsenic poisoning in humans are nausea, anorexia, vomiting, epigastric and abdominal pain, and diarrhea. Dermatitis (exfoliative erythroderma), muscle cramps, cardiac abnormalities, hepatotoxicity, bone marrow suppression and hematologic abnormalities (anemia), vascular lesions, and peripheral neuropathy (motor dysfunction, paresthesia) have also been reported. Oral doses as low as 20 to 60 g/kg/day have been reported to cause toxic effects in some individuals. Severe exposures can result in acute encephalopathy, congestive heart failure, stupor, convulsions, paralysis, coma, and death. The acute lethal dose to humans has been estimated to be about 0.6 mg/kg/day. General symptoms of chronic arsenic poisoning in humans are weakness, general debility and lassitude, loss of appetite and energy, loss of hair, hoarseness of voice, loss of weight, and mental disorders. Primary target organs are the skin (hyperpigmentation and hyperkeratosis), nervous system (peripheral neuropathy), and vascular system. Anemia, leukopenia, hepatomegaly, and portal hypertension have also been reported. In addition, possible reproductive effects include a high male to female birth ratio.

In animals, acute oral exposures can cause gastrointestinal and neurological effects. Oral LD50 values range from about 10 to 300 mg/kg. Low subchronic doses can result in immunosuppression and hepato-renal effects. Chronic exposures have also resulted in mild hyperkeratosis and bile duct enlargement with hyperplasia, focal necrosis, and fibrosis. Reduction in litter size, high male to female birth ratios, and fetotoxicity without significant fetal abnormalities occur following oral exposures; however, parenteral dosing has resulted in exencephaly, encephaloceles, skeletal defects, and urogenital system abnormalities.

Acute inhalation exposures to inorganic arsenic can damage mucous membranes; cause rhinitis, pharyngitis, and laryngitis; and result in nasal septum perforation. Chronic inhalation exposures, as occurring in the workplace, can lead to rhino-pharyno-laryngitis, tracheobronchitis; dermatitis, hyperpigmentation, and hyperkeratosis; leukopenia; peripheral nerve dysfunction as indicated by abnormal nerve conduction velocities; and peripheral vascular disorders as indicated by Raynaud's syndrome and increased vasospastic reactivity in fingers when exposed to low temperatures. Higher rates of cardiovascular disease have also been reported in some arsenic-exposed workers. Possible reproductive effects include a high frequency of spontaneous abortions and reduced birth weights. Arsine gas (AsH3), at concentrations as low as 3 to 10 ppm for several hours, can cause toxic effects. Hemolysis, hemoglobinuria, jaundice, hemolytic anemia, and necrosis of the renal tubules have been reported in exposed workers.

Animal studies have shown that inorganic arsenic, by intratracheal instillation, can cause pulmonary inflammation and hyperplasia, lung lesions, and immunosuppression. Long-term inhalation exposures have resulted in altered conditioned reflexes and central nervous system damage. Reductions in fetal weight and in the number of live fetuses and increases in fetal abnormalities due to retarded osteogenesis have been observed following inhalation exposures.

The reference dose (RfD) for chronic oral exposures, 3.00×10^{-4} mg/kg/day, is based on a no observed effects level (NOAEL) of 0.0008 mg/kg/day and a lowest observed adverse effects level (LOAEL) of 0.014 mg/kg/day for hyperpigmentation, keratosis, and possible vascular complications in a human population consuming arsenic-contaminated drinking water. Because of uncertainties in the data, the EPA states that "strong scientific arguments can be made for various values within a factor of 2 or 3 of the currently recommended RfD value." The dermal RfD of 3.00×10^{-4} is equivalent to the oral RfD, in accordance with Exhibit 4-1 of the EPA RAGS for Superfund (EPA 2004). Subchronic and chronic reference concentration (RfC) for inorganic arsenic has not been derived.

Epidemiological studies have revealed an association between arsenic concentrations in drinking water and increased incidences of skin cancers (including squamous cell carcinomas and multiple basal cell carcinomas) and cancers of the liver, bladder, and respiratory and gastrointestinal tracts. Occupational exposure studies have shown a clear correlation between exposure to arsenic and lung cancer mortality. The EPA has placed inorganic arsenic in Weight-of-Evidence Group A (known human carcinogen). The oral slope factor listed in the EPA's Integrated Risk Information System database is $1.50 \times 10^{+0}$. The dermal slope factor of $1.50 \times 10^{+0}$ is equivalent to the oral slope factor, in accordance with Exhibit 4-1 of the EPA RAGS for Superfund (EPA 2004). The inhalation slope factor of $1.51 \text{ x } 10^{+01}$ was calculated from the inhalation unit risk, per *Supplemental Guidance from RAGS: Region 4 Bulletins*, Human Health Risk Assessment (EPA 2009).

6.1.4.2 *Lead.* Lead occurs naturally as a sulfide in galena. Lead is a soft, bluish-white, silvery gray, malleable metal with a melting point of 327.5°C. Elemental lead reacts with hot boiling acids and is attacked by pure water. The solubility of lead salts in water varies from insoluble to soluble depending on the type of salt.

Lead is a natural element that is persistent in water and soil. Most of the lead in environmental media is of anthropogenic sources. The mean concentration is 3.9 µg/L in surface water and 0.005 µg/L in sea water. River sediments contain about 20,000 µg/g and costal sediments about 100,000 µg/g. Soil content varies with location, ranging up to 30 µg/g in rural areas, 3,000 µg/g in urban areas, and 20,000 µg/g near point sources. Human exposure occurs primarily through diet, air, drinking water, and ingestion of dirt and paint chips.

The efficiency of lead absorption depends on the route of exposure, age, and nutritional status. Adult humans absorb about 10 to 15% of ingested lead, whereas children may absorb up to 50%, depending on whether lead is in the diet, dirt, or paint chips. More than 90% of lead particles deposited in the respiratory tract are absorbed into systemic circulation. Inorganic lead is not efficiently absorbed through the skin; consequently, this route does not contribute considerably to the total body lead burden.

Lead absorbed into the body is distributed to three major compartments: blood, soft tissue, and bone. The largest compartment is the bone, which contains about 95% of the total body lead burden in adults and about 73% in children. The half-life of bone lead is more than 20 years. The concentration of blood lead changes rapidly with exposure, and its half-life of only 25 to 28 days is considerably shorter than that of bone lead. Blood lead is in equilibrium with lead in bone and soft tissue. The soft tissues that take up lead are liver, kidneys, brain, and muscle. Lead is not metabolized in the body but may be conjugated with glutathione and excreted primarily in the urine. Exposure to lead is evidenced by elevated blood lead levels.

The systemic toxic effects of lead in humans have been well documented by the EPA and Agency for Toxic Substances and Disease Registry (ATSDR), which extensively reviewed and evaluated data reported in the literature up to 1991. The evidence shows that lead is a multitargeted toxicant, causing effects in the gastrointestinal tract, hematopoietic system, cardiovascular system, central and peripheral nervous systems, kidneys, immune system, and reproductive system. Overt symptoms of subencephalopathic central nervous system effects and peripheral nerve damage occur at blood lead levels of 40 to 60 µg/dL, and nonovert symptoms, such as peripheral nerve dysfunction, occur at levels of 30 to 50 µg/dL in adults; no clear threshold is evident. Cognitive and neuropsychological deficits are not usually the focus of studies in adults, but there is some evidence of neuropsychological impairment and cognitive deficits in lead workers with blood levels of 41 to 80 µg/dL.

Although similar effects occur in adults and children, children are more sensitive to lead exposure than are adults. Irreversible brain damage occurs at blood lead levels greater than or equal to 100 µg/dL in adults and at 80 to100 µg/dL in children; death can occur at the same blood levels in children. Children who survive these high levels of exposure suffer permanent, severe mental retardation.

As discussed previously, neuropsychological impairment and cognitive deficits are sensitive indicators of lead exposure; both neuropsychological impairment and intelligence quotient (IQ) deficits have been the subject of cross-sectional and longitudinal studies in children. One of the early studies reported IQ score deficits of four points at blood lead levels of 30 to 50 µg/dL and one to two points at levels of 15 to 30 µg/dL among 75 black children of low socioeconomic status.

Very detailed longitudinal studies have been conducted on children (starting at the time of birth) living in Port Pirie, Australia; Cincinnati, Ohio; and Boston, Massachusetts. Various measures of cognitive performance have been assessed in these children. Studies of the Port Pirie children up to 7 years of age revealed IQ deficits in 2-year-old children of 1.6 points for each 10-µg/dL increase in blood lead, deficits of 7.2 points in 4-year-old children, and deficits of 4.4 to 5.3 points in 7-year-old children as blood lead increased from 10 to 30 µg/dL. No significant neurobehavioral deficits were noted for children 5 years or younger who lived in the Cincinnati, Ohio, area. In 6.5-year-old children, performance IQ was reduced by 7 points in children whose lifetime blood level exceeded 20 µg/dL. Children living in the Boston, Massachusetts, area have been studied up to the age of 10 years. Cognitive performance scores were negatively correlated with blood lead in the younger children in the high lead group (greater than or equal to 10 µg/dL), and improvements were noted in some children at 57 months as their blood lead levels became lower. However, measures of IQ and academic performance in 10-year-old children showed a 5.8-point deficit in IQ and an 8.9-point deficit in academic performance as blood lead increased by 10 µg/dL within the range of 1 to 25 µg/dL. Because of the large database on subclinical neurotoxic effects of lead in children, only a few of the studies have been included. However, EPA concluded that there is no clear threshold for neurotoxic effects of lead in children.

In adults, the cardiovascular system is a very sensitive target for lead. Hypertension (elevated blood pressure) is linked to lead exposure in occupationally exposed subjects and in the general population. Three large population-based studies have been conducted to study the relationship between blood lead levels and high blood pressure. The British Regional Heart Study (BRHS), the National Health and Nutrition Examination Survey (NHANES) II study, and the Welsh Heart Programme comprise the major studies for the general population. The BRHS showed that systolic pressure greater than 160 mm Hg and diastolic pressure greater than 100 mm Hg were associated with blood lead levels greater than 37 µg/dL. An analysis of 9,933 subjects in the NHANES study showed positive correlations between blood pressure and blood lead among 12- to 74-year-old males but not females, 40- to 59-year-old white males with blood levels ranging from 7 to 34 µg/dL, and males and females greater than 20 years old. In addition, left ventricular hypertrophy was also positively associated with blood lead. The Welsh study did not show an association among men and women with blood lead of 12.4 and 9.6 µg/dL, respectively. Other smaller studies showed both positive and negative results. The EPA concluded that increased blood pressure is positively correlated with blood lead levels in middle-aged men, possibly at concentrations as low as 7 µg/dL. In addition, the EPA estimated that systolic pressure is increased by 1.5 to 3.0 mm Hg in males and 1.0 to 2.0 mm Hg in females for every doubling of blood lead concentration.

The hematopoietic system is a target for lead as evidenced by frank anemia occurring at blood lead levels of 80 µg/dL in adults and 70 µg/dL in children. The anemia is due primarily to reduced heme synthesis, which is observed in adults having blood levels of 50 µg/dL and in children having blood levels of 40 µg/dL. Reduced heme synthesis is caused by inhibition of key enzymes involved in the synthesis of heme. Inhibition of erythrocyte-aminolevulinic acid dehydrase (ALAD) activity (catalyzes formation of porphobilinogen from erythrocyte -aminolevulinic acid) has been detected in adults and children having blood levels of less than 10 µg/dL. ALAD activity is the most sensitive measure of lead exposure, but erythrocyte zinc protoporphyrin is the most reliable indicator of lead exposure, because it is a measure of the toxicologically active fraction of bone lead. The activity of another erythrocyte enzyme, pyrimidine-5-nucleotidase, is also inhibited by lead exposure. Inhibition has been observed at levels below 5 µg/dL; no clear threshold is evident.

Other organs or systems affected by exposure to lead are the kidneys, immune system, reproductive system, gastrointestinal tract, and liver. These effects usually occur at high blood levels, or the blood levels at which they occur have not been sufficiently documented.

The EPA has not developed an RfD for lead, because it appears that lead is a nonthreshold toxicant, and it is not appropriate to develop RfDs for these types of toxicants. Instead, the EPA has developed the Integrated Exposure Uptake Biokenetic Model to estimate the percentage of the population of children up to 6 years of age with blood lead levels above a critical value, 10 µg/dL. The model determines the contribution of lead intake from multimedia sources (diet, soil and dirt, air, and drinking water) on the concentration of lead in the blood. Site-specific concentrations of lead in various media are used when available; otherwise, default values are assumed. However, guidance from MDEQ/MWCB uses back-calculation methods to derive lead RfDs using the EPA residential soil screening level of 400 mg/kg, the EPA drinking water action level of 15 μg/L, and the National Ambient Air Quality Standard of 1.5 μg/m^3. The RfDs calculated using this approach are 1.5×10^{-3} for soil ingestion and 4.3×10^{-4} for water ingestion and inhalation (TetraTech 1996).

Inorganic lead and lead compounds have been evaluated for carcinogenicity by the EPA. The data from human studies are inadequate for evaluating the potential carcinogenicity of lead. Data from animal studies, however, are sufficient based on numerous studies showing that lead induces renal tumors in experimental animals. A few studies have shown evidence for induction of tumors at other sites (cerebral gliomas and testicular, adrenal, prostate, pituitary, and thyroid tumors). A slope factor was not derived for inorganic lead or lead compounds.

6.2 Risk Characterization

Risk characterization combines the evaluations in the exposure and toxicity assessments to calculate quantitative carcinogenic risk and non-carcinogenic hazards for the gold panner/rock hound recreational exposure scenario. The following sections detail the quantitative human health risk assessment.

6.2.1 Risk Calculations

The risks and hazards to potential human receptors from the COPCs were calculated for the BHMS. Data from the BHMS were evaluated using the gold panner/rock hound exposure scenario for both an adult and child recreational user. Complete soil/waste rock exposure pathways for the gold panner/rock hound scenario evaluated in risk and hazard calculations are as follows:

- Incidental ingestion
- Dermal contact
- Particulates inhalation.

Complete adit water exposure pathways for the gold panner/rock hound scenario included:

- Incidental ingestion
- Dermal contact.

The inhalation pathway was not included in risk and hazard calculations for adit water, because the COPCs identified for this site are not volatile, making it an incomplete exposure pathway. Pathway-specific formulas used for calculating chronic daily intake values and default values used in these formulas are from Figure 4-2 and Table 4-2, respectively, of the *Risk-Based Cleanup Guidelines for Abandoned Mine Sites: Final Report* (TetraTech 1996). The risk assessment spreadsheets used to perform all risk and hazard calculations are located in Appendix F.

Contaminants of concern (COCs) are those COPCs with an individual hazard quotient (HQ) greater than 1.0 or an individual risk greater than 1×10^{-6}. Tables 18, 19, and 20 summarize the adult hazard, child hazard, and total estimated lifetime cancer risk (ELCR) values for all COPCs, respectively.

Table 18. Adult gold panner/rock hound hazard summary for the BHMS.

COPC	Soil/Waste Rock HQ[a]	Adit Water HQ[a]	Combined HQ[b]	% Contribution[c]
Antimony	5.27E-01	NA[d]	0.527	3.9%
Arsenic	**1.54E+00**	1.03E-01	**1.64**	12.2%
Cadmium	1.20E-02	3.13E-03	0.0151	0.1%
Copper	2.49E-03	7.37E-05	0.002567	0.0%
Iron	3.93E-02	9.87E-05	0.0394	0.3%
Lead	**1.09E+01**	2.47E-01	**11.1**	83.1%
Manganese	NA[d]	8.52E-04	0.000852	0.0%
Mercury	2.64E-02	1.46E-04	0.0266	0.2%
Zinc	1.11E-02	2.85E-03	0.0139	0.1%
Total HI			**13.4**	100.0%

a. An exposure frequency of 25 days per year exposure frequency is more representative of actual use patterns at the BHMS and was used in all risk and hazard calculations.

b. The combined HQ represents the hazard across all complete exposure pathways for both solid and liquid matrices for each COPC; it is unitless.

c. The percent contribution represents the contribution of each COPC to the total HI.

d. NA indicates the metal is not a COPC for the matrix listed.

Table 19. Child gold panner/rock hound hazard summary for the BHMS.

COPC	Soil/Waste Rock HQ[a]	Adit Water HQ[a]	Combined HQ[b]	% Contribution[c]
Antimony	8.64E-01	NA[d]	0.864	3.4%
Arsenic	**2.67E+00**	4.74E-01	**3.15**	12.4%
Cadmium	2.04E-02	1.08E-02	0.0312	0.1%
Copper	4.61E-03	3.41E-04	0.00495	0.0%
Iron	7.27E-02	4.56E-04	0.0731	0.3%
Lead	**2.01E+01**	**1.14E+00**	**21.2**	83.5%
Manganese	NA[d]	3.22E-03	0.00322	0.0%
Mercury	4.89E-02	6.73E-04	0.0495	0.2%
Zinc	2.05E-02	1.32E-02	0.0337	0.1%
Total HI			**25.4**	100.0%

a. An exposure frequency of 25 days per year exposure frequency is more representative of actual use patterns at the BHMS and was used in all risk and hazard calculations.

b. The combined HQ represents the hazard across all complete exposure pathways for both solid and liquid matrices for each COPC; it is unitless.

c. The percent contribution represents the contribution of each COPC to the total HI.

d. NA indicates the metal is not a COPC for the matrix listed.

Table 20. Gold panner/rock hound risk summary for the BHMS.

COPC	Soil ELCR[a]	Water ELCR[a]	Combined ELCR[b]	% Contribution[c]
Arsenic	**2.74E-04**	**3.41E-05**	**3.08E-04**	100.0%
Cadmium	3.62E-10	NA[c]	3.62E-10	0.0%
Total ELCR			**3E-04**	

a. An exposure frequency of 25 days per year exposure frequency is more representative of actual use patterns at the BHMS and was used in all risk and hazard calculations.

b. The combined Adult and Child ELCR represents the risk across all complete exposure pathways for both solid and liquid matrices for each COPC; it is unitless.

c. The percent contribution represents the contribution of each COPC to the total ELCR.

As noted, EPA-established benchmarks for evaluating the need for a remedy are 1 × 10^{-6} for carcinogenic risk and 1.0 for non-carcinogenic hazards. As shown in the above tables, the gold panner/rock hound exposure scenario resulted in a total ELCR of 3 × 10^{-4} and HIs for the adult and child recreational user of 13.4 and 25.4, respectively. These values are well above EPA benchmark values. Arsenic accounts for all of the cancer risk at the site and approximately 20% of the hazard for both the child and adult exposure scenarios. Lead is responsible for the majority of the hazard at the site (74% each for an adult and a child).

6.2.2 Uncertainty Assessment

A degree of uncertainty always exists when performing risk assessments. The following discusses elements of uncertainty associated with the assessment of potential human health risks and hazards associated with recreational use of the BHMS.

1. *Adit water samples.* Two adit water samples were used in developing hazard and risk numbers for water. One of these samples was collected during a 1993 hazardous material inventory. Results between the data sets are comparable, with some exceptions. In the 2009 data set, copper, iron, manganese, and mercury were not detected, but all were detected in the 1993 sample. This may be because of the differing times of year when samples were collected, variations in laboratory instrument sensitivity, or simply natural variation in the water. In any case, these four metals contribute only 0.5% of the total HI for both the adult or child receptors, with no contribution to carcinogenic risks. Inclusion of the metals in this assessment results in a slightly more conservative evaluation of HIs. The impact of including the additional COPCs in hazard calculations is considered very low.
2. *Exposure point concentrations.* Maximum concentrations were used to compute human health risks and HIs, rather than 95% UCLs. UCLs were not employed due to insufficient numbers of of detected results to compute them. This is standard industry practice and is used because extremely small sets of detections (e.g., <12) can greatly increase the uncertainty in estimating the mean/UCL. Use of the maximum value is in keeping with EPA accepted guidance. The impact of using maximum values from the 1993 waste rock data in the assessment is also considered low.

   To illustrate, results from the 2009 composite waste rock samples were evaluated versus the generally higher maximum values found in the 1993 data set. Because both sets of samples are composites, the results for each incorporate the variability of the waste rock (subsamples were included from all portions of the dump). November 2009 results are shown in Table 10. When hazard quotient and human health risk values are computed using the 2009 results and are compared with the 1993 values, the risk and hazard values for the the 2009 data are lower with the adult HI = 3.84, child HI = 6.97, and combined adult and child ELCR = 2E-04. However, this comparison also illustrates that using the lower values in lieu of the maximum values (1993 data set) results in risks and hazards well above *de minimus* levels. Ultimately, both data sets indicate that an action is warranted to reduce potential risks to human health.

3. *Lead toxicity values.* Toxicity values for lead used in hazard calculations were derived as described in the *Risk-Based Cleanup Guidelines for Abandoned Mine Sites: Final Report* (TetraTech 1996). These RfDs were determined by back-calculating EPA published residential screening levels. This approach infers the screening levels are safe concentrations (i.e., without adverse effects). However, the EPA has concluded that developing lead RfDs using screening levels as the basis is not appropriate, because health effects have been shown to occur at essentially all blood lead levels (EPA 2004). The impact of using these RfDs in determining HIs is moderate.

6.2.3 Risk-Based Cleanup Goals

Risk-based cleanup goals are calculated to allow for the design and implementation of reclamation alternatives. Table 21 lists the cleanup goals for soil and water based on the gold panner/rock hound recreational user scenario. These cleanup goals are taken from Table 7-1 of the *Risk-Based Cleanup Guidelines for Abandoned Mine Sites: Final Report* (TetraTech 1996), with the exposure frequency adjusted from 50 days/year to 25 days/year to be consistent with the moderate use ranking and site-specific use factors for the BHMS. Cleanup goals are based on an HI = 1 and an ELCR = 1 × 10^{-6} for each COC.

Table 21. Recreational risk-based cleanup goals for the BHMS.

COC	Soil (mg/kg)[a]	Water (µg/L)[b]
Arsenic[c]	2.78	1.32
Lead	4,400	440

a. Soil cleanup goals include both ingestion and dermal contact pathways.
b. Water cleanup goals shown are for water ingestion, because they are more conservative than dermal contact values.
c. Cleanup values listed for arsenic are for the carcinogenic endpoint, because they were more conservative than noncarcinogenic endpoint goals.

6.2.4 Risk Characterization Summary

The risk values summarized for the BHMS in Tables 19, 20, and 21 indicate the site poses a potential risk to recreational users with both non-carcinogenic and carcinogenic endpoints. As discussed earlier, arsenic accounts for all of the carcinogenic risk for the 25-day gold panner exposure frequency. The ELCR for this site (3 × 10^{-4}) exceeds the EPA threshold value of 1 × 10^{-6} for assessing the need for contaminant cleanup.

The HIs for both the adult (13.4) and child (25.4) gold panner/rock hound also exceed *de minimus* levels, with both computed to be above the EPA threshold level of 1.0. These risk and hazard values indicate that contaminants at the BHMS are present at concentrations that could potentially cause adverse human health effects for a recreational user. Therefore, corrective measures to reduce human health risks and hazards in and around the BHMS are recommended.

7. ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment was conducted for the BHMS and considers terrestrial plant communities, aquatic life communities, and terrestrial wildlife exposure scenarios using contaminant concentrations measured during the RI conducted in the summer of 2009. The assessment involved initial identification of COCs, development of an exposure assessment, an ecological effects assessment, and a risk characterization. The ecological risk assessment was carried out for the BHMS using several key federal guidance documents, including:

- *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (Interim Final)* (EPA 1989b)
- *Framework for Ecological Risk Assessment, Risk Assessment Forum* (EPA 1992)
- *Wildlife Exposure Factors Handbook* (EPA 1993)
- EPA's RAGS: *Process for Designing and Conducting Ecological Risk Assessment (Interim Final)* (EPA 1997).

Mine waste at the BHMS poses a potential risk not only to humans but also to plants and animals that come into contact with the waste. Ecological risk assessments exclude the potential for effects on people and domesticated species such as livestock. However, the health of people and domesticated species is inextricably linked to the quality of the environment shared with other species. The ecological evaluation that follows is intended to be a qualitative screening-level ecological risk assessment because of the limited and indirect nature of the data available.

The ecological risk assessment estimates the effects of the "no action" alternative at the site and involves four steps: (1) identification of COCs, ecological receptors, and ecological effects of concern; (2) exposure assessment; (3) ecological effects assessment; and (4) risk characterization. These four tasks are accomplished by evaluating data and selecting contaminants, receptors, and exposure routes of concern; estimating EPCs from the data; assessing the ecological toxicity of each COC; and characterizing the overall risk by integrating the results of the toxicity and exposure assessments.

Environmental contaminants at the BHMS potentially affecting ecological receptors include high concentrations of metals in soil, waste rock, and metals found in adit discharge water. The lack of vegetation on the waste rock piles is evidence of the effect of metals concentrations on the vegetative community. The waste materials and vegetation in the area are easily accessible to wildlife and could result in significant ecological effects. The objective of this ecological risk assessment is to estimate current and future effects of the "no action" alternative at the site.

7.1 Contaminants and Receptors of Concern

The screening for ecological COCs is similar to the human health COPC screening discussed earlier and includes the following: (1) the constituent is present at the site, (2) the analytical results for each constituent must meet QA/QC criteria outlined by the *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), and (3) the concentrations of the constituent are above background concentrations. The seven metals that met these criteria in solid (soil and waste rock) samples were antimony, arsenic, cadmium, iron, lead, mercury, and zinc. Of these metals, the recreational human health risk assessment analysis (Section 6) identified arsenic and lead as COCs for the BHMS. Eight metals that met the COC for the ecological risk assessment were detected in adit water: arsenic, cadmium, copper, iron, lead, manganese, mercury, and zinc.

Data tables in Section 4 summarize the detectable concentrations for metals in samples of soil, waste rock, and adit water. These concentrations are characteristic of hard rock wastes and should reliably represent contamination associated with mining at the BHMS. However, no ecological toxicity data are available for several of these contaminants to evaluate potential effects. The following toxicological data are from EPA's Region 5 ecological toxicity profile (EPA 2010b) and pertain to the primary COCs identified for the ecological risk assessment (arsenic, cadmium, copper, lead, and zinc) (BLM 2002).

7.1.1 Arsenic

In plants, arsenic has been shown to cause wilting, chlorosis, browning, dehydration, mortality, and inhibition of light activation (Eisler 1988a). Arsenic is a carcinogen, teratogen, and possible mutagen (causing mutations in genes/DNA) in mammals (ATSDR 1993a). Chronic exposure can result in fatigue, gastrointestinal distress, anemia, neuropathy, and skin lesions that can develop into skin cancer in mammals. It can cause death in soil microbiota and earthworms. Cancer-causing and genetic mutation-causing effects occur in aquatic organisms, with those effects including behavioral impairments, growth reduction, appetite loss, and metabolic failure. Aquatic bottom feeders are more susceptible to arsenic. In birds, tolerance to arsenic varies among species, but effects include destruction of gut blood vessels, blood-cell damage, muscular incoordination, debility, slowness, jerkiness, falling, hyperactivity, fluffed feathers, drooped eyelids, immobility, seizures, and systemic growth, behavioral, and reproductive problems (Stanley et al. 1994; Whitworth et al. 1991; Camardese et al. 1990).

7.1.2 Cadmium

Cadmium is highly toxic to wildlife; it is cancer-causing, teratogenic, and potentially mutation-causing, with severe sublethal and lethal effects at low environmental concentrations (Eisler 1985). Cadmium is associated with increased mortality, and it affects respiratory functions, enzyme levels, muscle contractions, growth rates, and reproduction. It bioaccumulates at all trophic levels, accumulating in the livers and kidneys of fish (Sindayigaya et al. 1994; Sadiq 1992). Crustaceans appear to be more sensitive to cadmium than fish and mollusks (Sadiq 1992). Cadmium can be toxic to plants at lower soil concentrations than other heavy metals and is more readily taken up than other metals (EPA 1981). However, some insects can accumulate high levels of cadmium without adverse effects (Jamil and Hussain 1992).

7.1.3 Copper

Copper is a micronutrient and toxin. It strongly adsorbs to organic matter, carbonates, and clay, which reduces its bioavailability. Copper is highly toxic in aquatic environments and causes effects in fish, invertebrates, and amphibians (including mortality and sodium loss), with adverse effects in tadpoles and embryos (Horne and Dunson 1995; Owen 1981). Copper will bioconcentrate in many different organs in fish and mollusks (Owen 1981). There is low potential for bioconcentration in fish but high potential in mollusks. Copper sulfate and other copper compounds are effective algaecides (free copper ions are the lethal agent). Single-cell and filamentous algae and cyanobacteria are particularly susceptible to acute effects, which include reductions in photosynthesis and growth, loss of photosynthetic pigments, disruption of potassium regulation, and mortality. Sensitive algae may be affected by free copper at low (parts per billion) concentrations in freshwater.

There is a moderate potential for bioaccumulation in plants and no biomagnifications. Toxic effects in birds include reduced growth rates, lowered egg production, and developmental abnormalities. While mammals are not as sensitive to copper toxicity as aquatic organisms, toxicity in mammals includes a wide range of animals and effects, such as liver cirrhosis, necrosis in kidneys and the brain, gastrointestinal distress, lesions, low blood pressure, and fetal mortality (ATSDR 1990; Kabata-Pendias and Pendias 1992; Ware 1983; Vymazal 1995).

7.1.4 Lead

Lead is cancer-causing and adversely affects reproduction, liver and thyroid function, and disease resistance (Eisler 1988b). The main potential ecological impacts of wetland contaminants result from direct exposure of algae, benthic invertebrates, and embryos and fingerlings of freshwater fish and amphibians to lead. It can be bioconcentrated from water but does not bioaccumulate and tends to decrease with increasing trophic levels in freshwater habitats (Eisler 1988b). Lead adversely affects algae, invertebrates, and fish. There are also limited adverse effects in amphibians, including loss of sodium, reduced learning capacity, and developmental problems (Horne and Dunson 1995). Fish exposed to high levels of lead exhibit a wide range of effects, including muscular and neurological degeneration and destruction, growth inhibition, mortality, reproductive problems, and paralysis (Eisler 1988b; EPA 1976). Lead adversely affects invertebrate reproduction; algal growth is affected. Lead partitions primarily to sediments but becomes more bioavailable under low pH, hardness, and organic matter content (among other factors). Lead bioaccumulates in algae, macrophytes, and benthic organisms, but the inorganic forms of lead do not biomagnify.

At elevated levels in plants, lead can cause reduced growth, photosynthesis, mitosis, and water absorption (Eisler 1988b). Birds and mammals suffer effects such as damage to the nervous system, kidneys, and liver; sterility; growth inhibition; developmental retardation; and detrimental effects in blood (Eisler 1988b; Amdur et al. 1991). Lead poisoning in higher organisms has been associated with lead shot and organolead compounds but not with food chain exposure to inorganic lead (other than lead shot, sinkers, or paint) (Eisler 1988b). There are complex interactions with other contaminants and diet. Lead poisoning in higher organisms primarily affects hematologic and neurologic processes.

7.1.5 Zinc

In many types of aquatic plants and animals, growth, survival, and reproduction can all be adversely affected by elevated zinc levels (Eisler 1993). Zinc in aquatic systems tends to be partitioned into sediment and less frequently dissolved as hydrated zinc ions and organic and inorganic complexes (MacDonald 1993). Zinc is toxic to plants at elevated levels, causing adverse effects on growth, survival, and reproduction (Eisler 1993). Terrestrial invertebrates show sensitivity to elevated zinc levels, with reduced survival, growth, and reproduction. Elevated zinc levels can cause mortality, pancreatic degradation, reduced growth, and decreased weight gain in birds (Eisler 1993; NAS 1980). Elevated zinc levels can also cause a wide range of problems in mammals, including cardiovascular, developmental, immunological, liver and kidney, neurological, hematological, pancreatic, and reproductive problems (Eisler 1993; Domingo 1994).

7.1.6 Ecological Receptors of Concern

A variety of plants, birds, amphibians, and mammals are part of the general food web at the BHMS, and many more species could be included in a more extensive ecological assessment. This assessment has identified three groups of receptors potentially affected by metal contamination at the BHMS. The first group of potential receptors is the terrestrial plant communities. Native plants are growing on undisturbed areas around the site, but little or no vegetation is currently growing on the waste rock piles (Portage 2009). This may be caused by toxic and inhibitory levels of metals in the plant root zone, along with other detrimental physical and chemical properties of the soil. Plant communities are a concern, because they represent the first trophic level in the food chain and are consumed by many higher trophic level animals.

The second group of potential ecological receptors is the terrestrial wildlife, including elk and mule deer, that may use the area as part of a home range. Grazing by wildlife species at this site is a concern because of the potential to consume contaminated vegetation, soil, and evaporative salts. The only terrestrial wildlife receptors evaluated quantitatively in this assessment are deer, because they are assumed to represent the highest level of exposure to site contamination, and the effects on deer are representative of other potential receptors.

The third group of potential receptors is the aquatic life communities. Although only adit water is present at the BHMS, it is located within the watershed of an unnamed, ephemeral tributary to the East Fork of Blue Creek. The tributary lies 100 ft north of the BHMS and reaches its confluence with the East Fork of Blue Creek approximately 0.75 mile downstream from the site. The East Fork of Blue Creek provides suitable habitat for aquatic life.

7.2 Exposure Assessment

The exposure assessment evaluates the risk to the identified ecological receptors of concern identified above using various contaminant concentrations from samples collected at the site. The risk to terrestrial plant communities was evaluated using the EPCs for the recreational user identified in Table 17. As discussed in Section 6, the EPCs for both solid and water samples are the maximum concentrations for each of the COCs.

7.2.1 Terrestrial Plant – Phytotoxicity Scenario

This scenario involves the limited ability of various plant species to grow in soils or wastes with high concentrations of arsenic, cadmium, copper, lead, and zinc. Plant sensitivity to certain arsenic compounds is so great that these compounds were used as herbicides for many years. Phytotoxic criteria reported in the literature for total arsenic in soils ranged from 15 to 50 mg/kg; the 50-mg/kg hazard level was considered appropriate for the Helena Valley, Montana (CH2M Hill 1987). Cadmium is toxic to plants at concentrations greater than 8 mg/kg. Lead is also considered toxic to plants. Numerous phytotoxic concentrations are reported in the literature and generally range from 100 mg/kg to 1,000 mg/kg (Kabata-Pendias and Pendias 1992; CH2M Hill 1987). A moderate concentration of 400 mg/kg was chosen for the ecological risk analysis. Zinc is only moderately toxic to plants at concentrations more than 300 mg/kg (Kabata-Pendias and Pendias 1992). A tolerable concentration of 200 mg/kg of zinc in soil has been previously cited for the Helena Valley (CH2M Hill 1987). The upper end of the range for zinc (400 mg/kg) was used in the ecological risk analysis.

7.2.2 Terrestrial Wildlife – Ingestion by Deer Scenario

Estimates of total intake dosage for deer are based on reported literature values and the following assumptions: (a) the currently unvegetated areas do not provide habitat for deer, (b) native vegetation is growing across most areas of the site and would be available to deer that graze in the area, and (c) the average weight of an individual adult deer is 68.04 kg (150 lb).

The daily salt uptake for deer is based on data in *Elk of North America*, which reported an average of 6 lb in one month for an average sized herd of 63 elk.[e] Assuming deer require 50% of the salt intake of an elk, a median salt intake exposure approach would equate to an average of 3 lb per month. Using the average herd size of 63, the average individual salt uptake would equal 0.0016 lb per day (0.00072 kg/day). Beyer et al. (1994) estimated that soil ingestion accounts for less than 2% of the average Wyoming mule deer's diet of 1.39 kg/day of vegetation, which equals 0.0278 kg/day of soil.

The maximum values for metal COCs from surface soil and waste rock were used for both the salt and soil levels. No vegetation samples were collected for analysis during this investigation. The concentrations listed in Tables 6 through 8 were used in calculating ecological risks to terrestrial wildlife. The concentration for copper was estimated based on data from the Kabata-Pendias and Pendias study (1992); the remaining metal concentrations were based on tolerable levels in vegetation (the lowest phytotoxic tissue levels) from the East Helena assessment (CH2M Hill 1987). Approximately 1.5 acres at the BHMS are impacted by metal mining; this would represent 0.4% of an average mule deer's home range of 345 acres (average range is 90 to 600 acres) (Beyer et al. 1994).

7.2.3 Aquatic Life Scenario

This scenario involves the limited ability of aquatic organisms to survive in waters contaminated with metals mining waste. Toxicity of metals to aquatic organisms depends on the concentration in the surface water and sediment as well as other conditions such as water hardness, temperature, and pH. Surface water criteria for the ecological risk assessment were derived from the Montana DEQ-7 acute aquatic life standards (MDEQ 2008).

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[e] Personal communication with USFS, Helena National Forest personnel. Salt ingestion data taken from *Elk of North America*.

7.2.4 Ecological Effects Assessment

Site-specific toxicity tests were not performed to support this risk assessment. Instead, only existing and proposed toxicity-based criteria and standards were used for this assessment. The following sections detail the specific standards and data used for comparison to the analytical results of the field sampling investigation.

7.2.4.1 Terrestrial Plant – Phytotoxicity Scenario. A summary of the phytotoxicity for the primary COCs is provided in Table 22. These concentrations were used for comparison to concentrations of metals in surface soil and waste rock. The availability of contaminants to plants and the potential for plant toxicity depend on many factors, including soil pH, soil texture, nutrients, and plant species.

Table 22. Summary of tolerable and phytotoxic soil concentrations at the BHMS.

COC	Tolerable Soil Level[a] (mg/kg)	Phytotoxic Soil Concentration Range[b] (mg/kg)	Maximum Soil Concentration[c] (mg/kg)
Arsenic	50	15 to 50	344
Cadmium	NA[d]	4 to 8	26
Copper	NA[d]	60 to 125	342
Lead	25	100 to 400	55,900
Zinc	50	70 to 400	11,400

a. Concentrations from CH2M Hill (1987).
b. Concentrations from Kabata-Pendias and Pendias (1992).
c. Maximum concentration from 1993 soil and waste rock samples.
d. Not available/not determined.

7.2.4.2 Terrestrial Wildlife – Ingestion by Deer Scenario. Adverse effects data for test animals were obtained from the ATSDR toxicological profiles (1990, 1993a, 1993b) and from other literature sources (Eisler 1988a, 1988b). The data consist of dose levels at either no NOAELs or LOAELs in laboratory animals. The lethal arsenic dose of 34 mg/kg × day for deer (Eisler 1988a) is included, along with other dose levels from other species. Data for laboratory animals (primarily rats) have been adjusted for increased body weight only. These data are listed in Table 23.

Table 23. Mammalian toxicological data for inorganic metals at the BHMS.

Dose	Arsenic	Cadmium	Copper	Lead	Zinc
NOAEL[a]	3.2[b]	0.271[c]	22.5[d]	0.005[e]	55[f]
LOAEL[a]	6.4[b]	2.706[c]	90[d]	0.05[e]	571[f]
Lethal	34[g]	NA	NA	NA	NA

a. Based on studies on laboratory rats; units are (mg/kg × day).
b. From ATSDR toxicological profile (1993a).
c. From Sample et al. (1996).
d. From NAS (1980).
e. From ATSDR toxicological profile (1993b) and Eisler (1988b).
f. From Maita et al. (1981).
g. Based on 1988 deer study (Eisler 1988a); units are (mg/kg × day).

7.2.4.3 Aquatic Life Scenario. Montana water quality standards were compared with analytical data from adit water samples. Analytical results were adjusted for conditions such as water hardness, temperature, and pH, which can affect the toxicity of metals to aquatic organisms in surface water. Montana water quality standards for aquatic life (MDEQ 2008) are presented in Table 24. Appendix G contains ecological risk assessment spreadsheets.

Table 24. Montana surface water quality aquatic life standards.[a]

Metal	Acute Toxicity	Chronic Toxicity	Broken Hill Adit Water Concentration[b]
Arsenic	340	150	31[g]
Cadmium	1.7[c]	0.2[c]	2[g]
Copper	11.3[c]	7.7[c]	2.97
Iron	NA[d]	1,000	69.6
Lead	61.5[c]	2.4[c]	107
Manganese	50[e]	NA[d]	15.2
Mercury	2.4[f]	0.012[f]	0.044
Zinc	99[f]	99[f]	867

a. Toxicity values are from WQB-7 (MDEQ 2008); all concentrations are in units of µg/L.
b. Maximum adit water concentration. Unless otherwise noted, concentrations are from 1993 sampling event.
c. Concentration at hardness of 80 mg/L.
d. Standard currently not available.
e. Ambient water quality standard for protection of human health for fish consumption.
f. Concentration at hardness of 25 mg/L.
g. Result is from the 2009 sampling event.

7.2.5 Risk Characterization and Summary

This section combines the ecological exposure estimates and concentrations presented in preceding sections and the ecological effects data presented in Section 7.2.4 to provide a screening level estimate of potential adverse ecological impacts. This estimate was achieved by generating ecological impact quotients (EQs) analogous to the HQs calculated for human exposure to noncarcinogenic metals. EQs were calculated for each COC by exposure scenario or receptor type and are summarized in Table 25; they were generated by dividing the specific intake estimate by available ecological effect values. Tables summarizing the risk calculations are provided in Appendix G. As with HIs, adverse ecological impacts are expected if the EQs are greater than 1.0.

Table 25. Ecological impact quotients for the BHMS.

Receptor	Arsenic	Cadmium	Copper	Lead	Zinc	Total EQ by Receptor
Plant Phytotoxicity	22.8	3.25	0	140	28.5	194
Deer Ingestion	0.0035	0.0003	0.0168	181	0.0005	181
Aquatic Life – Surface Water	0.0912	3.84	18.4	1.09	23.4	46.8
Total EQ by COC	22.9	7.09	18.4	322	51.9	-

7.2.5.1 Terrestrial Plant – Phytotoxicity Scenario. Maximum concentrations of metals collected from the BHMS were compared with maximum values of the plant phytotoxicity ranges listed in Table 22. One limitation of this comparison is that the phytotoxicity ranges are not species specific and may not represent toxicity to species at this site. Additionally, other physical characteristics of the waste materials may create microenvironments that limit growth and survival of terrestrial plants directly or in combination with substrate toxicity. Concentrations of metals are likely to be elevated in waste material at the site. Further, organic content is low, nutrients are limited, and the materials may harden enough to resist root penetration.

The results of the EQ calculations for plant phytotoxicity are presented in Table 25. EQs for this exposure scenario were greater than 1.0 for arsenic, cadmium, lead, and zinc. The non-conservative assumption of using the high end of the phytotoxicity range to derive the EQs may underestimate the potential phytotoxic effects to some plant communities. However, several other factors combine to adversely affect plant establishment and successful reestablishment on waste materials. In addition, the maximum metals concentrations from soil and waste rock samples were used as the plant dosage value in the EQ calculation, which adds conservatism to the EQ value.

7.2.5.2 Terrestrial Wildlife – Ingestion by Deer Scenario. Estimated deer ingestion doses were compared with LOAELs discussed earlier. This comparison is limited because of the use of effects data from rat studies that were adjusted only for increased body weight. Extrapolating these effects from rats to deer introduces some uncertainty, because each metal may be metabolized differently between these two species, making one more or less susceptible to effects than the other.

The results of the EQ calculations for deer ingestion are also presented in Table 25. The EQs for this scenario exceeded 1.0 for lead and indicate a potential risk to deer and other wildlife as a result of lead in surface soils and waste rock.

7.2.5.3 Aquatic Life Scenario. Maximum concentrations in adit water collected at the BHMS were compared with acute aquatic quality criteria and other toxicity standards derived from Long and Morgan (1991). Acute aquatic water quality criteria were more appropriate than chronic criteria for use in this scenario because of the limited data set. It is important to note, however, that using adit water results to compare to aquatic life standards overestimates risk to aquatic life. The adit water drainage is very shallow and seeps into the ground after leaving the mine adit, making it unsuitable to sustain aquatic life. However, as discussed earlier, the site is within the watershed of an unnamed, ephemeral tributary to the East Fork of Blue Creek. Concentrations of metals are likely lower in Blue Creek than the adit water, and using adit water results adds conservatism to these EQ calculations.

The results of the EQ calculations for the aquatic life scenario are presented in Table 25 and indicate potential for adverse ecological impacts from adit water. The acute EQs for this scenario exceeded 1.0 for cadmium, copper, lead, and zinc.

7.2.5.4 Risk Characterization Summary. The calculated EQs can be used to evaluate whether ecological receptors are potentially exposed to toxic doses of site-related metals contamination via the three ecological scenarios evaluated. The EQs calculated for the BHMS indicate that lead is the primary driver for ecological risk (EQ = 322 or 76% of the overall ecological risk). The risk from lead is split among plant phytotoxicity (EQ = 140), deer ingestion (EQ = 181), and aquatic life (EQ = 1.09); lead contributes 100% of the risk to the deer ingestion scenario and 72% of the risk to plants. The primary drivers for aquatic life risks are copper and zinc (39 and 50%, respectively). The overall EQ for all COCs over all pathways is 419, indicating that contaminants at the site constitute probable adverse ecological effects for plants, terrestrial wildlife, and aquatic life.

8. RECLAMATION OBJECTIVES AND GOALS

The overall objective of the BHMS RI is to protect human health and the environment in accordance with the guidelines set forth by the MDEQ/MWCB. Specifically, site reclamation must limit human and ecological exposure to mine-related contaminants and reduce the mobility of those contaminants through associated solid media and surface water exposure pathways.

Currently, there are no promulgated standards for metal concentrations in soil. The MDEQ has developed a conservative set of RBCGs that are calculated for different contaminants using a recreational visitor exposure pathway scenario. The guidelines take into account the possibility of exposure through multiple exposure routes. Action levels for the BHMS have been determined based on the RBCGs.

While this RI report is not intended to govern reclamation, the information it contains can be used by decision-makers to determine whether remedial action is needed to reduce risks in the Blue Creek Watershed. Data users should use the human health and ecological risk assessments in concert with the other information/observations contained herein as the basis for developing a path forward for the BHMS. The following sections provide additional interpretation of project data by placing them in context with site conditions and the regulatory framework under which future site actions are likely to take place.

9. PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are categorized as either contaminant-specific requirements that define acceptable exposure limits, as location-specific requirements that may set restrictions on activities within a specific location, or as action-specific requirements that may set controls or restrictions for a particular treatment or disposal activity for the proposed response. ARARs assist in the development and selection of reclamation remedies. The State of Montana has the authority, delegated by the U.S. Office of Surface Mining, Reclamation and Enforcement, to administer the Abandoned Mines Reclamation Program in accordance with the State of Montana’s Reclamation Plan.

The two State of Montana agencies that implement reclamation of hard rock mine sites are the MDEQ/Hazardous Waste Site Cleanup Bureau under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC 6901 et seq.) and the state Comprehensive Environmental Cleanup and Responsibility Act (Montana Code 75-10-705 through 724) and the MDEQ/MWCB under the Federal Abandoned Mined Lands Reclamation program. The federal CERCLA statute requires a state ARAR to be consistently applied, or a remedy that does attain that ARAR may be selected by the federal government. Although the MWCB is not governed under CERCLA, the MWCB consistently applies ARARs and incorporates both federal and state cleanup requirements.

ARARs are either applicable or relevant and appropriate. Applicable requirements address a specific hazardous substance, pollutant, or contaminant; remedial action; location; or other circumstance. Relevant and appropriate requirements address problems or situations sufficiently similar to those encountered at another site. The MDEQ/MWCB has developed a summary of federal and state ARARs for reclamation projects that apply to the BHMS. Table 26 is a list of these ARARs and indicates whether the ARAR is likely to be applicable, possibly applicable, or not likely applicable to the BHMS reclamation project.

ARARs listed here are generic and will be further defined in the EEE/CA process. In addition, the preamble to the National Oil and Hazardous Substances Pollution Contingency Plan (more commonly known as the National Contingency Plan [NCP] [40 CFR 300]), a document that provides a procedure for evaluating alternative cleanup methods for hazardous wastes, provides a list of “To be Considered” documents. The NCP is found in 55 Federal Register 8765 (March 8, 1990). Those documents will also be considered during the reclamation design and construction.

Table 26. Preliminary identification of applicable or relevant and appropriate requirements.

ARARs	Likely ARAR	Possible ARAR	Not Likely ARAR
Federal Contaminant-Specific ARARs			
Safe Drinking Water Act, 42 USC 300f et seq.			X
Clean Water Act, 33 USC 1251 et seq. (applicable)	X		
National Ambient Air Quality Standards, 40 CFR 50.6 (applicable)	X		
State Contaminant-Specific ARARs			
Groundwater Protection, ARM 17.301005, 1006, 1011 (applicable)		X	
Montana Water Quality Act, MCA 75-5-10116 et seq. (applicable)	X		
Montana Ambient Air Quality Regulations, ARM 17.8, 206, 222, 220, 233 (applicable)	X		
Federal Location-Specific ARARs			
National Historic Preservation, 16 USC 470 et seq. (applicable)			X
Archaeological and Historic Preservation Act, 16 USC 469 et seq. (applicable)	X		
Historic Sites Act of 1935, 16 USC 461 et seq. (applicable)	X		
Protection and Enhancement of the Cultural Environment, 16 USC 470 et seq. (applicable)	X		
The Archeological Resources Protection Act of 1979, 16 USC 47 et seq. (applicable)	X		
American Indian Religious Freedom Act, 42 USC 1996 (applicable)		X	
Native American Graves Protection and Repatriation Act, 25 USC 3001 et seq. (applicable)		X	
Fish and Wildlife Coordination Act ,16 USC 661 et seq. (applicable)		X	
Endangered Species Act, 16 USC 1531−1544 (applicable)		X	
Floodplain Management Act, 40 CFR Part 6 Appendix A; Executive Order No. 11988 (applicable)		X	

Table 26. (continued)

ARARs	Likely ARAR	Possible ARAR	Not Likely ARAR
Protection of Wetlands Regulations 40 CFR 6, Appendix A; Executive Order 11990 (applicable)	X		
Clean Water Act, 33 USC 121 et seq. (applicable)	X		
Migratory Bird Treaty Act, 16 USC 703 et seq. (applicable)		X	
Bald Eagle Protection Act, 16 USC 668 et seq. (applicable)		X	
Resource Conservation and Recovery Act, 42 USC 6901−6991	X		
State Location-Specific ARARs			
Montana Antiquities Act, 22-3-421 et seq., MCA		X	
Montana Human Skeletal Remains and Burial Site Protection Act, 22-3-801 et seq., MCA (applicable)	X		
Montana Floodplain and Floodway Management Act, Section 76-5-401 et seq., MCA (applicable)		X	
Montana Stream Protection Requirements, 75-7-101 et seq., MCA and 36.2.401 et seq., ARM (applicable)	X		
Montana Solid Waste Management Act, 75-10-201 et seq., MCA (applicable)	X		
Endangered Species and Wildlife Act, 36.2240 et seq., ARM (applicable)		X	
Action-Specific ARARs			
Federal and State Water Protection Requirements	X		
Clean Water Act, 33 USC 1342 et seq. (applicable)	X		
Montana Pollutant Discharge Elimination System Requirements ARM 17.30.1342−1344 and 1203 and 1344 (applicable)		X	
Water Quality Statutes and Regulations, MCA 75-5-303, 605, 637, 705 (applicable)	X		
Stormwater Runoff Control Requirements, ARM 17.24.633 (applicable)	X		
Federal and State RCRA Subtitle C Requirements, 42 USC 6921 et seq. and 40 CFR 264	X		
Federal and State RCRA Subtitle D and Solid Waste Management Requirements, 40 CFR 257	X		
Federal Requirements, 40 CFR 257 (applicable)		X	
State of Montana Solid Waste Requirements, ARM 17.50.505, 506, 511, 523, 530, 531 (applicable)	X		
Federal and State Mine Reclamation Requirements	X		
Surface Mining Control and Reclamation Act, 30 USC 1201−1326	X		
Montana Statutory and Regulatory Requirements, MCA 82-4-201, 231, 233, 336 et seq. and ARM 17.24.501, 519, 631, 633-641, 643-646, 701-703, 711, 713, 714. 716-718, 721, 723, 724, 726, 731, 751, 824	X		
Air Requirements ARM 17.8.304, 308, 604, 761 (applicable)	X		
Noxious Weeds MCA 7-22-2101	X		

10. PRELIMINARY IDENTIFICATION OF RECLAMATION ALTERNATIVES

Reclamation alternatives must be evaluated with respect to the overall site objective as well as the specific reclamation goals. The evaluation will be completed through an alternative screening process under the framework of an EEE/CA. The EEE/CA process explores various feasible reclamation alternatives and evaluates each in terms of effectiveness, implementability, and cost. Likely alternatives for the EEE/CA and possible future reclamation actions for the BHMS could include the following:

- No action (evaluated as a baseline for other alternatives)
- Institutional controls with hazardous mine opening (HMO) mitigation
- Stabilize waste in place
- Partial removal and stabilization of remaining waste
- Complete removal and surface stabilization
  - Transport waste to an onsite or nearby repository
  - Transport waste to an offsite disposal facility.

All removal actions (except the no action alternative) would include HMO mitigation and management of the adit discharge water (Appendix H). Stabilization, partial removal, and total removal alternatives include regrading, amending topsoil as needed, and establishing a vegetative cover.

The total estimated waste rock volume for the BHMS is 4,100 cubic yards. This equates to conservative estimates each for the upper and lower waste rock dumps of: 500 cubic yards (upper) and 3,600 cubic yards (lower). The aerial extent of each waste rock pile was determined from the land survey, and the extent of contamination based on the available analytical results. Waste rock pile depths were estimated from the topographic survey map by comparing the existing surface to the inferred original ground surface elevation contours.

Groundwater discharging from the BHMS adit may also require corrective action. Based on comparisons with water quality standards and human health and ecological benchmarks, exposure pathways that currently exist will likely require a remedy. This remedy could range from an in-adit treatment that stops water flow to closure of the adit, which would prevent access to the discharge. As of 2009, the discharge is only visible for approximately 6 ft at the surface, and then the discharge appears to reenter the groundwater. If removal of waste rock is the preferred alternative, this may upset current conditions such that an in-adit treatment is necessary. However, if discharge continues to return to local groundwater following excavation, a more passive and less expensive treatment may prove effective.

All of the noted treatment alternatives for waste rock, the HMOs, and the adit discharge will be explored in greater detail in the EEE/CA.

11. SUMMARY AND CONCLUSIONS

The following sections summarize the findings from the BHMS reclamation investigation completed in July of 2009.

11.1 Solid Waste

A total of nine solid samples and one solid field duplicate were collected from the upper and lower waste rock dumps and their periphery. In addition, three background samples were collected from areas upgrade and upwind of the historic mine workings. The following summarizes the findings of the sample data acquired for these samples:

- Elevated metals concentrations were noted in background soil samples, consistent with the mineralized nature of the BHMS
- Lead exceeded the EPA RSLs in all samples except BHMS-SS-2 (adjacent to upper waste rock dump)
- Lead exceeded the MDEQ RBCG in both waste rock samples and BHMS-SS-1 (adjacent to the upper waste rock dump)
- Arsenic exceeded the EPA RSL for arsenic in both waste rock samples and BHMS-SS-5 (lower waste rock dump)
- Arsenic exceeded the MDEQ RBCG in both waste rock samples
- The EPA RSL for antimony, iron, and mercury was exceeded in the upper waste dump only
- Zinc exceeded background concentrations in all nine samples
- Lead exceeded background concentrations in eight of nine samples
- Copper exceeded background concentrations in six of nine samples
- Cadmium exceeded background concentrations in five of nine samples
- Arsenic and iron exceeded background concentrations in three of nine samples
- Antimony and mercury exceeded background concentrations in two of nine samples
- The lead concentration in the SPLP extract exceeded the human health standard for water and the acute aquatic life standard as found in MDEQ 2008.

The results of this screening effort suggest that metals found at the BHMS may result in negative impacts to the Blue Creek Watershed if left in place, without treatment. Coupled with total metals values acquired from waste rock in 2003, the results suggest that lead and arsenic values, in particular, require some level of treatment in order to prevent long-term releases of heavy metals to the environment.

The results of the human health and ecological risk assessments support and further clarify the results of the initial screening effort. EPA-established benchmarks for human health risks and evaluating the need for a remedy are 1×10^{-6} for carcinogenic risk and 1.0 for non-carcinogenic hazards. The gold panner/rock hound exposure scenario resulted in a total ELCR from contact with soil/waste rock of 3×10^{-4} and HIs for the adult and child recreational user of 13 and 24, respectively. These values are well above EPA benchmark values. Arsenic accounts for all of the cancer risk at the site and approximately 20% of the hazard for both the child and adult exposure scenarios. Lead is responsible for the remainder of the hazard at the site (74% each for an adult and a child).

The ecological risk assessment also points toward conditions in waste rock that may require action. Qualitatively, conditions on the waste rock dumps and in and around the adit discharge suggest the lack of organic matter in the material, coupled with the phytotoxicity of the material and limited plant growth, has resulted in an extended period when waste rock has been exposed to the environment without naturally revegetating.

Quantitatively, the ecological assessment indicates that negative impacts to plant regrowth and animal species could result if the waste rock is left as it is at the BHMS. A comparison of phytotoxicity levels for the waste rock to published benchmarks indicates the metals in BHMS will strongly impede revegetation. As the assessment notes, an EQ greater than 1 represents a phytotoxicity level that is likely to impede plant growth. The analytical results from the BHMS find a phytotoxicity EQ of 194.

Similarly, the potential for health effects to deer that ingest soils/waste rock and water from the site as part of normal browsing is significantly elevated. With an EQ greater than 1 considered elevated, the computed EQ for deer browsing and drinking from the site is 181.

11.2 Adit Discharge

The results of sampling conducted at the BHMS adit discharge also indicate elevated levels of metals that may require treatment in order to prevent continued release. The human health risk assessment for water acquired from the BHMS adit discharge indicates that elevated human health risks would occur if visitors to the site were to come into contact with, or consume, adit discharge.

For the gold panner/rock hound exposure scenario, the total ELCR from contact and ingestion of adit water is 3×10^{-5} and HIs for the adult and child recreational user of 0.4 and 1.6, respectively. While the adult recreationist is below EPA benchmark values, the ELCR and child hazard exceed these levels. Arsenic accounts for all of the cancer risk in adit water and approximately 12% of the hazard for both the child and adult exposure scenarios. Lead is responsible for approximately 83% of the hazard, with antimony contributing approximately 4%.

The ecological assessment finds similar results for the discharging adit water. Elevated hazards to deer that consume water from the site are described above. Computed aquatic toxicity due to contact with the discharge is also elevated; where an EQ greater than 1 suggests a possible ecological effect, the EQ calculated for the BHMS adit water is 46.8.

12. REFERENCES

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APPENDIX A
BHMS LANDOWNER ACCESS AGREEMENT

NOTICE AND CONSENT FOR ENTRY

I, Tyson Jerald, am an owner(s), claimant(s), lessee(s), renter(s) of record of the following described properties:

- **Broken Hill, MS #10572, legal description: PAR 2, COS 2088 Plat S1 22.954 AC 00 DESC SPLIT BNDY CHANGE COS 2088, located in Section 10, Township 27N, Range 34W, Sanders County, Montana**

- **Bobby, MS #10572, legal description: PLAT S PAT 1039654 MINING CLAIMS 20.05 AC IN W2E2, located in Section 10, Township 27N, Range 34W, Sanders County, Montana**

I understand that, although it is not required, written consent is the preferred means for carrying out reclamation activities. I understand that Montana law provides that the Department of Environmental Quality (DEQ) may enter my property for the purpose of conducting studies or exploratory work to determine whether my property has been mined and not reclaimed and rehabilitated and, if so, to determine the feasibility of restoration or reclamation or abatement, control or prevention of adverse effects of past mining practices. I understand further that if the DEQ makes a finding that my land or water resources upon my land have been adversely affected by past mining practices and that it is in the public interest to take action, the DEQ may give notice and enter upon my property to do all things necessary or expedient to restore, reclaim, abate, control or prevent the adverse effects of past mining practices.

Entry and exploratory or reclamation and abatement work, if any, performed by the DEQ, the Office of Surface Mining Reclamation and Enforcement, U. S. Department of the Interior, their agents, employee, or contractors, is pursuant to the authority granted in Title IV of the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231 et seq. and Title 82, Chapter 4, Part 3 of the Montana Code Annotated.

CONSENT FOR ENTRY

I hereby grant consent to the Montana Department of Environmental Quality and the Office of Surface Mining Reclamation and Enforcement of the U.S. Department of the Interior, their agents, employees or contractors to enter my property as described above. This consent is granted for the length of time necessary to complete the necessary investigative work, including sampling, surveying and reclamation activities. Should my ownership or use of this property be transferred to another owner, I will provide the DEQ with the name and address of the new owner.

In giving my consent to this entry, I do not waive any rights conferred upon me by virtue of the language contained Title IV of the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq. or Title 82, Chapter 4 of the Montana Code Annotated.

Dated this 20th day of October, 20 09 PL

Owner of Record

Owner of Record

Owner of Record

Owner of Record

RECEIVED
OCT 22 2009
Dept. of Environmental Quality
Remediation Division

APPENDIX B
PHOTOGRAPH LOG

131.jpg
BHMS-BG-3

BHMS-BG-2

BHMS-BG-1

BHMS-SS-1

BHMS-SS-2

BHMS-WR-1

BHMS-SS-3

BHMS-SS-5

BHMS-SS-6

BHMS-WR-2

GW-1

Repository Location #1 (Blue Creek Road)

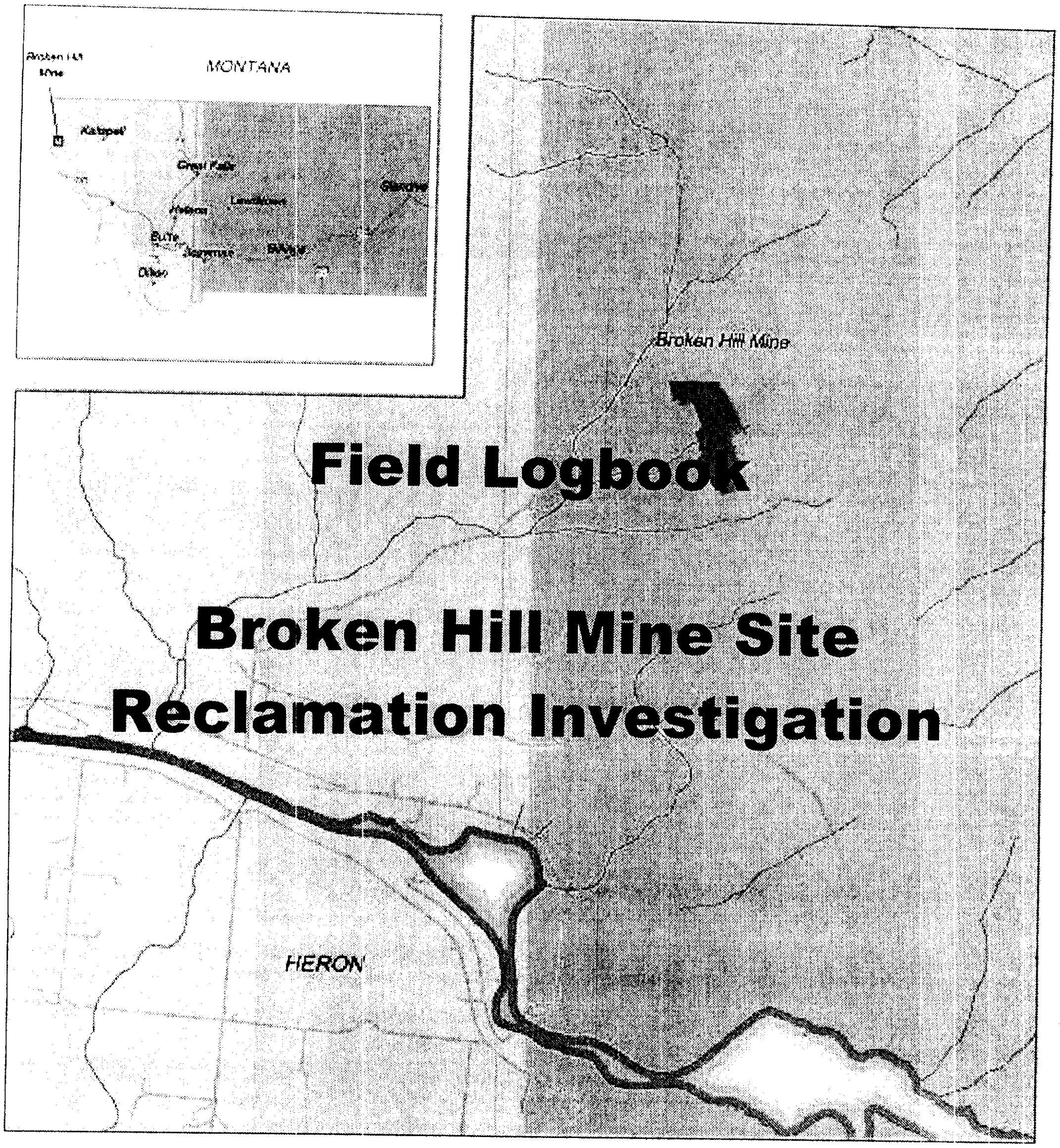
Potential Repository Location #1 (Blue Creek Road)

Potential Repository Location#2 Route 2294

APPENDIX C
FIELD LOGBOOK

Field Logbook

Broken Hill Mine Site Reclamation Investigation



Portage
ENVIRONMENTAL

Broken Hill Mine
Sanders County, Montana

Site Access Form

Portage Samplers: Meg Babitz
Pat Seccomb

Visitor Name: Signature: Date:
Visitor 40-Hour Training Records Available: (Y / N)

Visitor Name: Signature: Date:
Visitor 40-Hour Training Records Available: (Y / N)

Visitor Name: Signature: Date:
Visitor 40-Hour Training Records Available: (Y / N)

Visitor Name: Gary Kedish Signature: Date: 7/8/09
Visitor 40-Hour Training Records Available: ([✓ Y] / N) Renewed 09

Visitor Name: Nancy Rusho Signature: Date: 7-8-2009
Visitor 40-Hour Training Records Available: ([✓ Y] / N) Renewed 09

Visitor Name: Signature: Date:
Visitor 40-Hour Training Records Available: (Y / N)

Visitor Name: Signature: Date:
Visitor 40-Hour Training Records Available: (Y / N)

Visitor Name: Signature: Date:
Visitor 40-Hour Training Records Available: (Y / N)

Daily Contractor Quality Control Summary

Date: 7-7-09

Samples packed on ice? [✓ Y] / N
Chain of custody complete? [✓ Y] / N
Is sample custody secured? [✓ Y] / N
Sampling procedures used properly? [✓ Y] / N

Describe any deviations that occurred during field activities due to site conditions:

- Analyses for Samples BHMS-SS-3 and 5 were switched
- Water Quality parameters were switched
- No H_2O Rinsate was collected

Were these deviations detrimental to sampling (explain)?

Other observations:

arrived @ gate 0745 cleared trees til 0946
stopped by H_2O + large tree
hiked up to site + arrived @ site 1020

left site @ 1600
got to truck 1630

Sampling Collection Summary

Date: BHMS - BG-1 7-7-09
Time: 1030
Sampler(s): M. Babits + P. Seccomb
Field Sample Id#: BHMS-BG-1
Preservative(s): ice
Number / Type of Containers this Sample: 2 ziplock bags
Sampling Method Used: sterile scoop
Photo Id# (s): #1

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP MB (~~Y~~ / [✓ N])
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Specific Conductance__________umhos/cm

Temperature__________°F / °C

Dissolved Oxygen__________ppm

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

DK brn loam MB

Sample Location (latitude / longitude in *deg/min/sec*):
~~48 07 139 115 57 786~~ 48 07 174 PES 115 57 760

Weather Conditions at the time of Sample Collection:
overcast 65°

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09
Time: 1100
Sampler(s): M. Babits /P. Seccomb
Field Sample Id#: BHMS-BG-2
Preservative(s): ice
Number / Type of Containers this Sample: 2 ziplock bags
Sampling Method Used: strile scoop
Photo Id# (s): #2

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (~~Y~~ / [✓ N]) MB
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Temperature_________°F / °C

Specific Conductance_________umhos/cm

Dissolved Oxygen___________ppm

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)

DK br loam. w/ 10% C.F.

Sample Location (latitude / longitude in *deg/min/sec*):
48 07 154 11557767

Weather Conditions at the time of Sample Collection:
overcast 65°F

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09

Time:

Sampling Collection Summary

Date: 7-7-09
Time: 1130
Sampler(s): M. Babitz / P. Secomb
Field Sample Id#: BHMS-BG-3
Preservative(s): ice
Number / Type of Containers this Sample: 2 ziplocks
Sampling Method Used: disposable sterile scoop
Photo Id# (s): #3

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (~~Y~~ / [✓ N]) MB
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.
Specific Conductance_________umhos/cm
Temperature_________°F / °C
Dissolved Oxygen____________ppm
NA

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

DK br loam w/ 10% C.F

Sample Location (latitude / longitude in *deg/min/sec*):

48 07 139 115 57 786

Weather Conditions at the time of Sample Collection:

pt. cloudy 68°F

Chain of Custody Form Number & Shipping Information:

Sampling Collection Summary

Date: 7-7-09

Time: 1200

Sampler(s): M. Babits / P. Seccomb

Field Sample Id#: BHMS-~~S~~ MB WR-1

Preservative(s): ice

Number / Type of Containers this Sample: 1 ziplock bag

Sampling Method Used: disposable sterile poly scoop

Photo Id# (s): #5

Soil Analyses:

- Target Analyte List Metals (Y / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP ([✓ Y] / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

~~SPLP~~ MB MB

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Specific Conductance__________umhos/cm

Temperature__________°F / °C

Dissolved Oxygen__________ppm

N/A

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

tan coarse sand

Sample Location (latitude / longitude in *deg/min/sec*):

48 07 16 2 115 57 810'

Weather Conditions at the time of Sample Collection:

pt. cloudy 70°F breeze @ 5-10 mph

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09

Time: 1130

Sampler(s): M. Babitz / P. Secomb

Field Sample Id#: BHMS-BG-3

Preservative(s): ice

Number / Type of Containers this Sample: 2 ziplocks

Sampling Method Used: disposable sterile scoop

Photo Id# (s): #3

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (~~Y~~ / [✓ N]) MB
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Specific Conductance________umhos/cm

Temperature________°F / °C

Dissolved Oxygen________ppm

NA

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)

Dk br loam w/ 10% C.F

Sample Location (latitude / longitude in *deg/min/sec*):

48 07 139 115 57 786

Weather Conditions at the time of Sample Collection:

pt. cloudy 68°F

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09

Time: 1215

Sampler(s): M. Babitz / M. Beccomb

Field Sample Id#: BHMS-SS-1

Preservative(s): ice

Number / Type of Containers this Sample: 2 ziplocks

Sampling Method Used: sterile disp. poly scoops

Photo Id# (s): #4

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (Y / N)
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Specific Conductance_________umhos/cm

Temperature__________°F / °C

Dissolved Oxygen___________ppm

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

decomposing wood on top of dk brn loam

Sample Location (latitude / longitude in *deg/min/sec*):

48 07 170 115 57 807

Weather Conditions at the time of Sample Collection:

ptly. cloudy 70°F sl. breeze 0-5 mph

Chain of Custody Form Number & Shipping Information:

Other Observations:

Control Point #3 IS BHMS-SS-1

Sampling Collection Summary

Date: 7-7-09
Time: 1230
Sampler(s): M. Babits / B. Seccomb
Field Sample Id#: BHMS-SS-2
Preservative(s): ice
Number / Type of Containers this Sample: 1 ziplock
Sampling Method Used: disp sterile poly scoop
Photo Id# (s): #6

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP (Y / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Specific Conductance__________umhos/cm

Temperature__________°F / °C

Dissolved Oxygen__________ppm

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)
dk br loam w/ 10% coarse fragment

Sample Location (latitude / longitude in *deg/min/sec*):
46 07 161 115 57 915

Weather Conditions at the time of Sample Collection:
ptly cloudy slight breeze 0 5mph
70°F

Chain of Custody Form Number & Shipping Information:

Other Observations:
#7 photo empty barrels in dry Trib of east Fork Blue CK
#8 photo possible adit NW of lower WR dump

Sampling Collection Summary

Date: 7-7-09
Time: 1315
Sampler(s): M. Babits / P. Seccomb
Field Sample Id#: BHMS-GW-1
Preservative(s): H_2SO_4 Nitrate Nitric Metals
Number / Type of Containers this Sample: 1 500 ml 2 250 ml
Sampling Method Used: direct
Photo Id# (s): #9

Soil Analyses:

- Target Analyte List Metals (Y / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP (Y / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity ([✓ Y] / N)
- Acidity ([✓ Y] / N)
- Sulfate ([✓ Y] / N)
- Chloride ([✓ Y] / N)
- Nitrate/Nitrite ([✓ Y] / N)
- TDS ([✓ Y] / N)
- Metals ~~(field blank)~~ total ([✓ Y] / N)

Field Measurements: oRP: 18 mV

pH 6.20 s.u.

Specific Conductance 102.3 umhos/cm → 1643 us actual
17.4 °C
1413 us standard

Temperature 8.6 °F / [✓ °C]

Dissolved Oxygen 16.2 ppm

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)
NA

Sample Location (latitude / longitude in *deg/min/sec*):
48°07' 142" 115°57' 838"

Weather Conditions at the time of Sample Collection:
65°F, cloudy, Slight breeze 0-5 mph

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09
Time: 1350
Sampler(s): M Babits / P. Seccomb
Field Sample Id#: BHMS-WR-2
Preservative(s): ice
Number / Type of Containers this Sample: 1 ziplock
Sampling Method Used: disp sterile scoop
Photo Id# (s): #12

Soil Analyses:

- Target Analyte List Metals (Y / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP ([✓ Y] / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.
Temperature__________°F / °C
Specific Conductance__________umhos/cm
Dissolved Oxygen__________ppm
NA

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)

Brown Coarse Sand

Sample Location (latitude / longitude in *deg/min/sec*):

Weather Conditions at the time of Sample Collection:

partly cloudy slight breeze 0-5mph 65°F

Chain of Custody Form Number & Shipping Information:

4807 139

Other Observations: 115° 57' 863

Sampling Collection Summary

Date: 7-7-09

Time: 1400

Sampler(s): M. Babits / P. Seccomb

Field Sample Id#: BHMS-SS-3

Preservative(s): ice

Number / Type of Containers this Sample: 1 ziplock

Sampling Method Used: disp sterile scoop

Photo Id# (s): #11

Soil Analyses:

- ➢ Target Analyte List Metals ([✓ Y] / N)
- ➢ Soil Texture (Y / N)
- ➢ Cation Exchange Capacity (Y / N)
- ➢ Acid-Base Accounting (Y / N)
- ➢ SPLP (Y / N)
- ➢ Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- ➢ Alkalinity (Y / N)
- ➢ Acidity (Y / N)
- ➢ Sulfate (Y / N)
- ➢ Chloride (Y / N)
- ➢ Nitrate/Nitrite (Y / N)
- ➢ TDS (Y / N)
- ➢ Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Temperature__________°F / °C

Specific Conductance__________umhos/cm

Dissolved Oxygen__________ppm

NA

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)

Brn loam 20% CF

Sample Location (latitude / longitude in *deg/min/sec*):

Weather Conditions at the time of Sample Collection:

ptly cloudy slight breeze
65°F

Chain of Custody Form Number & Shipping Information:

Other Observations: N 48.07.147 Control pt 1
W 115 57 869 10'

Sampling Collection Summary

Date: 7-7-09

Time: 1330

Sampler(s): M Babits / P Seccomb

Field Sample Id#: BHMS-GW-2

Preservative(s): Nitric (Metals)

Number / Type of Containers this Sample: 250 ml

Sampling Method Used: direct

Photo Id# (s): #9

Soil Analyses:

- Target Analyte List Metals (Y / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP (Y / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals ~~(field blank)~~ dissolved ([✓ Y]/ N)

Field Measurements:

pH__________s.u.

Specific Conductance_________umhos/cm

see GW-1

Temperature_________°F / °C

Dissolved Oxygen__________ppm

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

NA

Sample Location (latitude / longitude in *deg/min/sec*):

Same as GW-1

Weather Conditions at the time of Sample Collection:

65°F cloudy slight breeze

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09

Time: 1335

Sampler(s): M. Babitz / P. Seccomb

Field Sample Id#: BHMS-GW-3

Preservative(s): Nitric (metals)

Number / Type of Containers this Sample: 1 250ml

Sampling Method Used: direct

Photo Id# (s): #9

Soil Analyses:

- Target Analyte List Metals (Y / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP (Y / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (~~field blank~~) dissolved ([✓ Y] / N)

Field Measurements:

pH__________s.u.

Specific Conductance_________umhos/cm

See GW-1

Temperature_________°F / °C

Dissolved Oxygen__________ppm

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)

NA

Sample Location (latitude / longitude in *deg/min/sec*):

Same as GW-1

Weather Conditions at the time of Sample Collection:

Cloudy slight breeze 65°F

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09
Time: 1440
Sampler(s): M Babits P Seccomb
Field Sample Id#: BHMS-SS-4
Preservative(s): ice
Number / Type of Containers this Sample: 1 ziplock
Sampling Method Used: disp sterile scoop
Photo Id# (s): #14

Soil Analyses:

- ➢ Target Analyte List Metals ([✓ Y] / N)
- ➢ Soil Texture (Y / N)
- ➢ Cation Exchange Capacity (Y / N)
- ➢ Acid-Base Accounting (Y / N)
- ➢ SPLP (Y / N)
- ➢ Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- ➢ Alkalinity (Y / N)
- ➢ Acidity (Y / N)
- ➢ Sulfate (Y / N)
- ➢ Chloride (Y / N)
- ➢ Nitrate/Nitrite (Y / N)
- ➢ TDS (Y / N)
- ➢ Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.
Specific Conductance________umhos/cm
Temperature________°F / °C
Dissolved Oxygen__________ppm

NA

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

DK brn loam 20% CF

Sample Location (latitude / longitude in *deg/min/sec*):
48°07' 133" 115°57'852"

Weather Conditions at the time of Sample Collection:
ptly cloudy, sl. breeze, 65°F
0-5mph

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09
Time: 1415
Sampler(s): M. Babits / P. Seccomb
Field Sample Id#: BHMS-SS-5
Preservative(s): ice
Number / Type of Containers this Sample: 2 ziplocks
Sampling Method Used: disp sterile scoop
Photo Id# (s): #10

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (~~Y~~ / [✓ N])
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u. Specific Conductance________umhos/cm

Temperature________°F / °C Dissolved Oxygen__________ppm NA

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)
brown loam

Sample Location (latitude / longitude in *deg/min/sec*):
48°07'037" 115°57'877"

Weather Conditions at the time of Sample Collection:
65°F slightly cloudy sl. breeze-0-5mph

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7-7-09

Time: 1430

Sampler(s): M. Babits / P. Seccomb

Field Sample Id#: BHMS-SS-6

Preservative(s): ice

Number / Type of Containers this Sample: 2 ziplocks

Sampling Method Used: disp sterile scoop

Photo Id# (s): #13

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (Y / N)
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u. Specific Conductance________umhos/cm

Temperature_________°F / °C Dissolved Oxygen___________ppm NA

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

br. loam 10% CF.

Sample Location (latitude / longitude in *deg/min/sec*):

48°07'123" 115°57'860"

Weather Conditions at the time of Sample Collection:

partly cloudy, 65°F, sl. breeze (0-5mph),

Chain of Custody Form Number & Shipping Information:

Other Observations:

CP2
4807131
11557854

Sampling Collection Summary

Date: 7-7-09
Time: 1430
Sampler(s): MB / PS
Field Sample Id#: BHMS-SS-7 (dup of 6)
Preservative(s): ice
Number / Type of Containers this Sample: 2 ziplocks
Sampling Method Used: disp sterile scoop
Photo Id# (s):

Soil Analyses:

- Target Analyte List Metals ([✓ Y] / N)
- Soil Texture ([✓ Y] / N)
- Cation Exchange Capacity ([✓ Y] / N)
- Acid-Base Accounting ([✓ Y] / N)
- SPLP (Y / N)
- Agricultural ([✓ Y] / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.
Specific Conductance________umhos/cm
Temperature________°F / °C
Dissolved Oxygen__________ppm

NA

Identify the soil type and other pertinent observations for this sample:
(e.g. brown, silty sand containing small quantity of wood debris)

Same as SS-6

Sample Location (latitude / longitude in *deg/min/sec*):

Weather Conditions at the time of Sample Collection:

Same as SS-6

Chain of Custody Form Number & Shipping Information:

Other Observations:

Sampling Collection Summary

Date: 7/8/09
Time: 1120
Sampler(s): MB P&S
Field Sample Id#: Control Point #4 Upper WR
Preservative(s):
Number / Type of Containers this Sample:
Sampling Method Used:
Photo Id# (s):

Soil Analyses:

- Target Analyte List Metals (Y / N)
- Soil Texture (Y / N)
- Cation Exchange Capacity (Y / N)
- Acid-Base Accounting (Y / N)
- SPLP (Y / N)
- Agricultural (Y / N)
  (pH, N-P-K, OM, lime and fertilizer requirement

Water Analyses:

- Alkalinity (Y / N)
- Acidity (Y / N)
- Sulfate (Y / N)
- Chloride (Y / N)
- Nitrate/Nitrite (Y / N)
- TDS (Y / N)
- Metals (field blank) (Y / N)

Field Measurements:

pH__________s.u.

Specific Conductance__________umhos/cm

Temperature__________°F / °C

Dissolved Oxygen__________ppm

Identify the soil type and other pertinent observations for this sample:
(*e.g. brown, silty sand containing small quantity of wood debris*)

Sample Location (latitude / longitude in *deg/min/sec*):
48 07 155   115 57 802

Weather Conditions at the time of Sample Collection:

Chain of Custody Form Number & Shipping Information:

Other Observations:

APPENDIX D
DATA VALIDATION REPORTS

Broken Hill Mine Site

SDG#:	**H09070123, Rev 1**
Number of Samples:	**(3)**
Sample Matrix:	**(3) Aqueous**
Applicable Analytes:	**Target Analyte List (TAL) for Metals (Sb, As, Ba, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, Ag, and Zn), Hardness, Total Dissolved Solids (TDS), Total Acidity, Alkalinity (Total, Carbonate, & Bicarbonate), Anions (Chloride and Sulfate), and Nitrate.**
Reporting Tier:	**Level IV**
Applicable TOS#:	**N/A**
Laboratory:	**Energy Laboratories**
Validation Level:	**'B'**
Validator Affiliation:	**Portage, Inc.**
Project#:	**Broken Hill Mine Site Inorganics**

Validator:__________________ **Date Completed:** 08/26/09; 01/06/09

Portage Review:__________________ **Date Completed:** 08/26/09; 01/06/09

REPORT ORGANIZATION:

Limitations & Validation (L&V) Report is organized into the following sections:

- Glossary of Terms & Method References
- Data Quality Statement
- L&V Report
- Attachment A: Laboratory Report Forms Corrected for Qualification
- Attachment B: Laboratory Case Narrative
-

GLOSSARY OF VALIDATION TERMS & METHOD VALIDATION REFERENCES

Terms:

CRDL	Contract Required Detection Limit
IDL	Instrument Detection Limit
SOW	Statement of Work
SOP	Standard Operating Procedure
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ICP-ICS	Inductively Coupled Plasma-Interference Check Sample
ICV	Initial Calibration Verification
CCV	Continuing Calibration Verification
ICB	Initial Calibration Blank
CCB	Continuing Calibration Blank
PB	Preparation Blank
LCS	Laboratory Control Sample
SDS	Serial Dilution Sample
SDG	Sample Delivery Group

Qualifiers:

U - The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
Note: This detection limit may be elevated to a level greater than the IDL due to a detection of a target compound in the method blank, and as a result, the sample value, which was less than ten times the blank result, has been qualified 'U' as a non-detect.

J - The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the environmental sample. The data should be seriously considered for decision-making and are usable for many purposes.

R - The data are unusable (may or may not be present). Resampling and reanalysis are necessary for verification.

UJ - The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Reference:

The validation of this data was performed according to:

1. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 540-R-04-004, October 2004.*
2. *USEPA Contract Laboratory Program Statement of Work For Inorganic Analysis, Multi-Media, Multi-Concentration, Document Number ILM04.0*, *January 2000.*

LIMITATIONS AND VALIDATION REPORT

INTRODUCTION:

The Broken Hill Mine Site metals and inorganic results were received by Portage Inc. on August 24, 2009. The laboratory analytical request provided for a full deliverable and a summary data package attached for total metals. The samples were analyzed in accordance with approved methods as outlined in PLN-5005, Table 9. Data validation was performed utilizing the USEPA Functional Guidelines for Inorganic Data Review, 2004. The following cross-reference has been provided to assist data users in comparing field identifications to the corresponding laboratory numbers.

Cross-Reference for SPRU Soil for Metals Samples

Field Id#:	Lab Id#:	Matrix:	Analysis Request:	Date of Collection:	Date of Laboratory Receipt:
BHMS-GW-1	H09070123-001	Aqueous	Metals and Inorganics	07/07/09	07/10/09
BHMS-GW-2	H09070123-002	Aqueous	Metals and Hardness	07/07/09	07/10/09
BHMS-GW-3	H09070123-003	Aqueous	Metals and Hardness	07/07/09	07/10/09

CONTRACT AND TECHNICAL REVIEW

1. The laboratory case narrative contains all of the elements outlined in the USEPA Functional Guidelines.
2. All analytes were analyzed within their prescribed holding times..
3. All AQS calibration results demonstrated a correlation coefficient greater than 0.995 as prescribed.
4. All initial calibration verification (ICV) and continuing calibration verification (CCV) sample results were within the 90-110%acceptance criteria.
5. Positive detections were noted in the preparation blank for acidity, TDS, antimony, cadmium, iron, manganese, silver, and zinc. All acidity, TDS, antimony, cadmium, iron, manganese, silver, and zinc results were either less than the IDL or greater than five times the blank value. No qualification is warranted.

   All initial calibration blank (ICB), continuing calibration blank (CCB), and remaining PB results were non-detect.

6. All ICP-interference check sample (ICS) results were within the 80-120% acceptance criteria.
7. The matrix spike (MS) and matrix spike duplicate (MSD) results were within the 75-125% recovery criteria.

8. All matrix spike duplicate (MSD) results were within the +/-20% RPD acceptance criteria.
9. All aqueous laboratory control sample (LCS) results were within the 80-120% acceptance limits.
10. All serial dilution sample (SDS) results exhibited a %D less than 10%.
11. The revised data package delivered on September 11, 2009 contained a lower reporting limit for silver (4 ppb) and calcium and magnesium data.

OVERALL ASSESSMENT OF DATA:

All field sample data points have been assessed and remain unqualified.

	Target Analyte and Assigned Qualification: SDG#: H09070123							
Field Sample Id#:	**TDS**	**Acidity**	**Total Alkalinity**	**Carbonate**	**Bicarbonate**	**Chloride**	**Sulfate**	**Nitrate**
BHMS-GW-1								

	Target Analyte and Assigned Qualification: SDG#: H09070123															
Field Sample Id#:	**Sb**	**As**	**Ba**	**Cd**	**Ca**	**Cr**	**Cu**	**Fe**	**Pb**	**Mg**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**	**Hardness**
BHMS-GW-1																
BHMS-GW-2																
BHMS-GW-3																

Attachment A: Laboratory Report Forms

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-GW-1
Project: Broken Hill Mine Site
Matrix: Aqueous

Lab ID: H09070123-001
Collection Date: 07/07/09 13:15
DateReceived: 07/10/09
Report Date: 07/23/09 **Revised Date:** 09/11/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
PHYSICAL PROPERTIES												
Solids, Total Dissolved TDS @ 180 C	42	mg/L		10		A2540 C	07/10/09 14:22 / WB			SOLIDS_090710B :	14	090710A-SLDS-TDS-W
INORGANICS												
Acidity, Total as CaCO3	ND	mg/L		4.0		A2310 B	07/17/09 11:00 / hm			MISC WC_090717A :	2	090717A
Alkalinity, Total as CaCO3	24	mg/L		4		A2320 B	07/14/09 10:44 / JG			TITTR_090714A :	10	090714A-ALK-W
Bicarbonate as HCO3	29	mg/L		4		A2320 B	07/14/09 10:44 / JG			TITTR_090714A :	10	090714A-ALK-W
Carbonate as CO3	ND	mg/L		4		A2320 B	07/14/09 10:44 / JG			TITTR_090714A :	10	090714A-ALK-W
Chloride	ND	mg/L		1		E300.0	07/15/09 08:13 / hm			IC101-H_090714A :	79	R55050
Sulfate	3	mg/L		1		E300.0	07/15/09 08:13 / hm			IC101-H_090714A :	79	R55050
Hardness as CaCO3	25	mg/L		1		A2340 B	09/11/09 13:22 / jdh			WATERCALC_090911A :	1	R56543
NUTRIENTS												
Nitrogen, Nitrate+Nitrite as N	0.11	mg/L		0.05		E353.2	07/13/09 15:28 / stp			NUTRIENTS_090913B :	43	A2009-07-13_5_NO3_01
METALS, TOTAL												
Antimony	ND	mg/L		0.005		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Arsenic	0.031	mg/L		0.005		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Barium	ND	mg/L		0.1		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Cadmium	0.002	mg/L		0.001		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Calcium	9	mg/L		1		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Chromium	ND	mg/L		0.01		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Copper	ND	mg/L		0.01		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Iron	ND	mg/L		0.03		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Lead	0.02	mg/L		0.01		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Magnesium	ND	mg/L		1		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Manganese	ND	mg/L		0.01		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Mercury	ND	mg/L		0.001		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Nickel	ND	mg/L		0.01		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Silver	ND	mg/L		0.004		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864
Zinc	0.58	mg/L		0.01		E200.8	07/16/09 21:45 / eli-b			SUB-B132864 :	1	B_R132864

Report Definitions: RL - Analyte reporting limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-GW-2
Project: Broken Hill Mine Site
Matrix: Aqueous

Lab ID: H09070123-002
Collection Date: 07/07/09 13:30
DateReceived: 07/10/09
Report Date: 07/23/09 **Revised Date:** 09/11/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
INORGANICS												
Hardness as CaCO3	25	mg/L		1		A2340 B	09/11/09 13:22 / jdh			WATERCALC_090911A : 2		R56543
METALS, DISSOLVED												
Antimony	ND	mg/L		0.005		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Arsenic	0.031	mg/L		0.005		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Barium	ND	mg/L		0.1		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Cadmium	0.001	mg/L		0.001		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Calcium	9	mg/L		1		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Chromium	ND	mg/L		0.01		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Copper	ND	mg/L		0.01		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Iron	ND	mg/L		0.03		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Lead	ND	mg/L		0.01		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Magnesium	ND	mg/L		1		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Manganese	ND	mg/L		0.01		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Mercury	ND	mg/L		0.001		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Nickel	ND	mg/L		0.01		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Silver	ND	mg/L		0.004		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864
Zinc	0.42	mg/L		0.01		E200.8	07/16/09 22:12 / eli-b			SUB-B132864 : 2		B_R132864

Report Definitions: RL - Analyte reporting limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-GW-3
Project: Broken Hill Mine Site
Matrix: Aqueous

Lab ID: H09070123-003
Collection Date: 07/07/09 13:35
DateReceived: 07/10/09
Report Date: 07/23/09 **Revised Date:** 09/11/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
INORGANICS												
Hardness as CaCO3	25	mg/L		1		A2340 B	09/11/09 13:22 / jdh			WATERCALC_090911A : 3		R56543
METALS, DISSOLVED												
Antimony	ND	mg/L		0.005		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Arsenic	0.031	mg/L		0.005		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Barium	ND	mg/L		0.1		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Cadmium	0.001	mg/L		0.001		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Calcium	9	mg/L		1		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Chromium	ND	mg/L		0.01		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Copper	ND	mg/L		0.01		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Iron	ND	mg/L		0.03		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Lead	ND	mg/L		0.01		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Magnesium	ND	mg/L		1		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Manganese	ND	mg/L		0.01		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Mercury	ND	mg/L		0.001		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Nickel	ND	mg/L		0.01		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Silver	ND	mg/L		0.004		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864
Zinc	0.48	mg/L		0.01		E200.8	07/16/09 22:19 / eli-b			SUB-B132864 : 3		B_R132864

Report Definitions: RL - Analyte reporting limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

Attachment B: Laboratory Case Narrative

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
Toll Free 877.472.0711 * 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

CLIENT: MT DEQ
Project: Broken Hill Mine Site
Sample Delivery Group: H09070123

Date: *11-Sep-09*

CASE NARRATIVE

Client called and requested Calcium and Magnesium be added to the list of metals and Silver be reported to 4 ppb. Client also requested a level IV QC package.

Samples received from Helena under their WO # H09070123 were subcontracted to Billings, received 7/14/09, and assigned Billings WO # B09071200.

Comments: Included with the analysis reports are instrument data reports for all analysis associated with the instrument calibration, QC sample analysis, and sample analysis. Copies of the detailed laboratory records for the analyses are sorted by method, instrument, and then analysis time. For the metals analyses by ICP-AES, instrument raw data summaries for initial calibration, continuing calibration, method blanks, blank matrix spike, matrix spike, and sample results are included with this sample analyses set. Other methods, are reported similarly, as appropriate. All analytical data is within method QA/QC specifications except as noted on analyses and/or QC summary reports, or in this narrative. The analytical report identifies which QC batch ID and sequence QC is associated with each analysis result for a sample.

Inclusion of the raw data will be found on the attached CD. The results of this Analytical Report relate only to the items submitted for analysis. Only the raw data associated with parameters listed on this report should be validated.

Jonathan Dee Hager
Assistant Laboratory Manager
Energy Laboratories, Inc., - Helena, MT

Broken Hill Mine Site

SDG#: H09070134

Number of Samples: (6)

Sample Matrix: (6) Soil

Applicable Analytes: Target Analyte List (TAL) for Metals (Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, and Zn), Cation Exchange Capacity (CEC), Acid/Base Potential, Conductivity, Sulfur, Organic Matter, Lime as $CaCO_3$, Neutralization Potential, Acid Potential, Phosphorus, Nitrate, pH, and Soil Composition.

Reporting Tier: Level IV

Applicable TOS#: N/A

Laboratory: Energy Laboratories

Validation Level: 'B'

Validator Affiliation: Portage, Inc.

Project#: Broken Hill Mine Site Inorganics

Validator: ______________ **Date Completed:** 8/26/09

Portage Review: ______________ **Date Completed:** 8/26/09

REPORT ORGANIZATION:

Limitations & Validation (L&V) Report is organized into the following sections:

- Glossary of Terms & Method References
- Data Quality Statement
- L&V Report
- Attachment A: Laboratory Report Forms Corrected for Qualification
- Attachment B: Laboratory Case Narrative
- Attachment C: Chain of Custody Forms & Sample Receipt Checklist

GLOSSARY OF VALIDATION TERMS & METHOD VALIDATION REFERENCES

Terms:

CRDL	Contract Required Detection Limit
IDL	Instrument Detection Limit
SOW	Statement of Work
SOP	Standard Operating Procedure
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ICP-ICS	Inductively Coupled Plasma-Interference Check Sample
ICV	Initial Calibration Verification
CCV	Continuing Calibration Verification
ICB	Initial Calibration Blank
CCB	Continuing Calibration Blank
PB	Preparation Blank
LCS	Laboratory Control Sample
SDS	Serial Dilution Sample
SDG	Sample Delivery Group

Qualifiers:

U - The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
Note: This detection limit may be elevated to a level greater than the IDL due to a detection of a target compound in the method blank, and as a result, the sample value, which was less than ten times the blank result, has been qualified 'U' as a non-detect.

J - The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the environmental sample. The data should be seriously considered for decision-making and are usable for many purposes.

R - The data are unusable (may or may not be present). Resampling and reanalysis are necessary for verification.

UJ - The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Reference:

The validation of this data was performed according to:

1. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 540-R-04-004, October 2004.*
2. *USEPA Contract Laboratory Program Statement of Work For Inorganic Analysis, Multi-Media, Multi-Concentration, Document Number ILM04.0, January 2000.*

LIMITATIONS AND VALIDATION REPORT

INTRODUCTION:

The Broken Hill Mine Site metals and inorganic results were received by Portage Inc. on August 17, 2009. The laboratory analytical request provided for a full deliverable and a summary data package attached for total metals. The samples were analyzed in accordance with approved methods as outlined in PLN-5005, Table 9. Data validation was performed utilizing the USEPA Functional Guidelines for Inorganic Data Review, 2004. The following cross-reference has been provided to assist data users in comparing field identifications to the corresponding laboratory numbers.

Cross-Reference for SPRU Soil for Metals Samples

Field Id#:	Lab Id#:	Matrix:	Analysis Request:	Date of Collection:	Date of Laboratory Receipt:
BHMS-WR-2	H09070134-001	Soil	SPLP Metals	07/07/09	07/10/09
BHMS-SS-3	H09070134-002	Soil	Metals	07/07/09	07/10/09
BHMS-SS-4	H09070134-003	Soil	Metals	07/07/09	07/10/09
BHMS-SS-5	H09070134-004	Soil	Metals and Inorganic	07/07/09	07/10/09
BHMS-SS-6	H09070134-005	Soil	Metals and Inorganic	07/07/09	07/10/09
BHMS-SS-7	H09070134-006	Soil	Metals and Inorganic	07/07/09	07/10/09

CONTRACT AND TECHNICAL REVIEW

1. The laboratory case narrative contains all of the elements outlined in the USEPA Functional Guidelines.
2. All analytes were analyzed within their prescribed holding times..
3. All AQS calibration results demonstrated a correlation coefficient greater than 0.995 as prescribed.
4. All initial calibration verification (ICV) and continuing calibration verification (CCV) sample results were within the 90-110%acceptance criteria.
5. Positive detections were noted in the neutralization potential, phosphorus, potassium, manganese, nickel, and zinc. All neutralization potential, phosphorus, potassium, manganese, nickel, and zinc results were greater than five times the blank value. No qualification is warranted.

   All initial calibration blank (ICB), continuing calibration blank (CCB), and remaining PB results were non-detect.

6. The iron (74%) ICP-interference check sample (ICS) result associated with BHMS-WR-2 was below the 80-120% acceptance criteria. It has been qualified with a "UJ" validation flag due to a sample result less than the IDL.

   All remaining ICP-ICS results were within the 80-120% acceptance criteria.

7. The mercury (153% and 149%), antimony (45% and 48%) and barium (48% and 126%) associated with USEPA 6010B/7471A analysis matrix spike (MS) and matrix spike duplicate (MSD) results were outside the 75-125% recovery criteria. Qualification is as follows:

   - Mercury warrants no qualification due to sample results less than the IDL.
   - Antimony has been qualified with a "UJ" validation flag due to low MS/MSD recovery and sample results less than the IDL.
   - Barium has been qualified with a "J" validation flag due to poor MS/MSD recovery and sample results greater than the IDL.

   The remaining soil and all SPLP extracted MS and MSD results were within the 75-125% recovery criteria.

8. All matrix spike duplicate (MSD) results were within the +/-35% RPD acceptance criteria.
9. All solid laboratory control sample (LCS) results were within the manufacturer's prescribed acceptance limits.
10. All serial dilution sample (SDS) results exhibited a %D less than 10%.

OVERALL ASSESSMENT OF DATA:

The iron result for BHMS-WR-2 has been qualified with a "UJ" validation flag to denote that the data is non-detect at the reported value, and the reported value is an estimate due to low ICP-ICS recovery *(See CTR Comment #6).*

All antimony results, **excluding** BHMS0WR-2, have has been qualified with a "UJ" validation flag to denote that the data is non-detect at the reported value, and the reported value is an estimate due to low MS/MSD recovery *(See CTR Comment #7).*

All barium results, **excluding** BHMS-WR-2, have been qualified with a "J" validation flag to denote that the data is detectable at the reported value, but the reported value is an estimate due to poor MS/MSD recovery *(See CTR Comment #7).*

All remaining field sample data points have been assessed and remain unqualified.

	Target Analyte and Assigned Qualification: SDG#: H09070134									
Field Sample Id#:	**pH**	**Conductivity**	**Ca (Sat paste)**	**Mg(Sat paste)**	**Na (sat paste)**	**Sand**	**Silt**	**Clay**	**Texture**	**K**
BHMS-SS-5										
BHMS-SS-6										
BHMS-SS-7										

	Target Analyte and Assigned Qualification: SDG#: H09070134									
Field Sample Id#:	**S**	**CEC**	**Organic Matter**	**Lime**	**Neutralization Potential**	**Acid Potential**	**Acid/Base Potential**	**P**	**Nitrate**	**Sulfate**
BHMS-SS-5										
BHMS-SS-6										
BHMS-SS-7										

	Target Analyte and Assigned Qualification: SDG#: H09070134												
Field Sample Id#:	**Sb**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**
BHMS-WR-2							**UJ**						
BHMS-SS-3	**UJ**		**J**										
BHMS-SS-4	**UJ**		**J**										
BHMS-SS-5	**UJ**		**J**										
BHMS-SS-6	**UJ**		**J**										
BHMS-SS-7	**UJ**		**J**										

Attachment A: Laboratory Report Forms

ENERGY LABORATORIES

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
*Toll Free 877.472.0711 * 406.442.0711 * FAX 406.442.0712 * helena@energylab.com*

LABORATORY ANALYTICAL REPORT

Client:	MT DEQ
Client Sample ID:	BHMS-WR-2
Project:	Broken Hill Mine Site
Matrix:	Soil

Lab ID:	H09070134-001
Collection Date:	07/07/09 13:50
DateReceived:	07/10/09
Report Date:	08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SPLP METALS												
Mercury	ND	mg/L		0.020		SW7470A	07/22/09 13:39 / eli-b	07/22/09 11:00		SUB-B133145	1	B_40274
SPLP EXTRACTABLE CONSTITUENTS												
Antimony	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Copper	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Iron	UJ ND	mg/L		1		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Manganese	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Nickel	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Zinc	ND	mg/L		1		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Arsenic	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Barium	ND	mg/L		10		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Cadmium	ND	mg/L		0.1		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Chromium	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Lead	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324
Silver	ND	mg/L		0.5		SW6020	07/25/09 11:14 / eli-b	07/23/09 09:30		SUB-B133304	1	B_40324

JAH
08-21-09

Report Definitions: RL - Analyte reporting limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-3
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-002
Collection Date: 07/07/09 14:00
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Arsenic	32	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Barium	J 28	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Cadmium	4	mg/kg		1		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Chromium	ND	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Copper	17	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Iron	8410	mg/kg	D	10		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Lead	1160	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Manganese	322	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:20 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	6	6648
Nickel	7	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194
Zinc	1680	mg/kg		5		SW6010B	07/21/09 20:23 / eli-b	07/20/09 10:22		SUB-B133081	3	B_40194

JAN
08-21-09

Report Definitions:
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
D - RL increased due to sample matrix interference.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-4
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-003
Collection Date: 07/07/09 14:40
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Arsenic	11	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Barium	J 48	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Chromium	6	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Copper	19	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Iron	14200	mg/kg	D	10		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Lead	642	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Manganese	283	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:42 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	12	6648
Nickel	8	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194
Zinc	751	mg/kg		5		SW6010B	07/21/09 20:27 / eli-b	07/20/09 10:22		SUB-B133081	4	B_40194

JAM
08-21-09

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-5
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-004
Collection Date: 07/07/09 14:15
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	6.2	s.u.		0.1		ASAM10-3.2	07/22/09 07:12 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722C : 5		6637
Conductivity, sat. paste	0.33	mmhos/cm		0.01		ASA10-3	07/22/09 11:38 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722D : 5		6637
Calcium, sat. paste	1.08	meq/l		0.05		SW6010B	07/27/09 10:11 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 9		6637
Magnesium, sat. paste	0.18	meq/l		0.08		SW6010B	07/27/09 10:11 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 9		6637
Sodium, sat. paste	0.42	meq/l		0.04		SW6010B	07/27/09 10:11 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 9		6637
PHYSICAL CHARACTERISTICS												
Sand	37	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 1		6645
Silt	55	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 1		6645
Clay	8	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 1		6645
Texture	SiL	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 9		6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	276	mg/kg		1		ASA13-3	07/27/09 08:59 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A : 23		6644
Sulfur, Total	0.02	%		0.01		E3.2.3	07/23/09 15:31 / ejp			LECO632_090723C : 4		R55311
Cation Exchange Capacity	72.7	meq/100g		0.09		SW6010B	07/31/09 09:20 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A : 19		6639
Organic Matter	19.5	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A : 1		6642
Lime as CaCO3	2.0	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D : 6		6641
Neutralization Potential	20	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D : 4		6641
Acid Potential	0.78	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723H : 1		6641
Acid/Base Potential	20	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723H : 1		6641
Phosphorus	5.2	mg/kg		0.1		ASA24-5	08/07/09 11:38 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A : 22		6643
Nitrate as N, KCL Extract	2	mg/kg		1		ASA33-8	07/27/09 13:04 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A : 9		6638
INORGANICS												
Sulfate, sat. paste	0.25	meq/L		0.021		E300.0	07/29/09 16:52 / hm	07/17/09 10:26	USDA2	IC101-H_090729A : 19		6637
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Arsenic	171	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Barium	J 65	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Cadmium	26	mg/kg		1		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Chromium	5	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Copper	29	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Iron	9690	mg/kg	D	10		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194
Lead	2110	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081 : 5		B_40194

JAH
08-21-09

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-5
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-004
Collection Date: 07/07/09 14:15
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Manganese	1170	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081	5	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:44 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	13	6648
Nickel	8	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081	5	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081	5	B_40194
Zinc	4410	mg/kg		5		SW6010B	07/21/09 20:37 / eli-b	07/20/09 10:22		SUB-B133081	5	B_40194

Report Definitions:
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-6
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-005
Collection Date: 07/07/09 14:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	5.5	s.u.		0.1		ASAM10-3.2	07/22/09 07:13 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722C	6	6637
Conductivity, sat. paste	0.22	mmhos/cm		0.01		ASA10-3	07/22/09 11:39 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722D	6	6637
Calcium, sat. paste	0.66	meq/l		0.05		SW6010B	07/27/09 10:14 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	10	6637
Magnesium, sat. paste	0.22	meq/l		0.08		SW6010B	07/27/09 10:14 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	10	6637
Sodium, sat. paste	0.43	meq/l		0.04		SW6010B	07/27/09 10:14 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	10	6637
PHYSICAL CHARACTERISTICS												
Sand	39	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	2	6645
Silt	51	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	2	6645
Clay	10	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	2	6645
Texture	SiL	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	10	6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	256	mg/kg		1		ASA13-3	07/27/09 09:01 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A	24	6644
Sulfur, Total	0.03	%		0.01		E3.2.3	07/23/09 15:33 / ejp			LECO632_090723C	5	R55311
Cation Exchange Capacity	53.3	meq/100g		0.09		SW6010B	07/31/09 09:34 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A	22	6639
Organic Matter	19.6	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A	2	6642
Lime as CaCO3	0.9	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	8	6641
Neutralization Potential	9	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	7	6641
Acid Potential	1.0	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723H	2	6641
Acid/Base Potential	8	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723H	2	6641
Phosphorus	4.2	mg/kg		0.1		ASA24-5	08/07/09 11:39 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A	23	6643
Nitrate as N, KCL Extract	3	mg/kg		1		ASA33-8	07/27/09 13:06 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A	10	6638
INORGANICS												
Sulfate, sat. paste	0.25	meq/L		0.021		E300.0	07/29/09 17:08 / hm	07/17/09 10:26	USDA2	IC101-H_090729A	20	6637
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Arsenic	22	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Barium	J 154	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Chromium	6	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Copper	22	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Iron	14700	mg/kg	D	9		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Lead	1130	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194

JAN 08-27-09

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-6
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-005
Collection Date: 07/07/09 14:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Manganese	738	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:47 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	14	6648
Nickel	8	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194
Zinc	866	mg/kg		5		SW6010B	07/21/09 20:41 / eli-b	07/20/09 10:22		SUB-B133081	6	B_40194

Report Definitions:
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-7
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-006
Collection Date: 07/07/09 14:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	5.5	s.u.		0.1		ASAM10-3.2	07/22/09 07:13 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722C	7	6637
Conductivity, sat. paste	0.20	mmhos/cm		0.01		ASA10-3	07/22/09 11:39 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722D	7	6637
Calcium, sat. paste	0.58	meq/l		0.05		SW6010B	07/27/09 10:16 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	11	6637
Magnesium, sat. paste	0.20	meq/l		0.08		SW6010B	07/27/09 10:16 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	11	6637
Sodium, sat. paste	0.34	meq/l		0.04		SW6010B	07/27/09 10:16 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	11	6637
PHYSICAL CHARACTERISTICS												
Sand	33	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	3	6645
Silt	57	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	3	6645
Clay	10	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	3	6645
Texture	SiL	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	11	6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	216	mg/kg		1		ASA13-3	07/27/09 09:04 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A	25	6644
Sulfur, Total	0.03	%		0.01		E3.2.3	07/23/09 15:35 / ejp			LECO632_090723C	6	R55311
Cation Exchange Capacity	49.7	meq/100g		0.09		SW6010B	07/31/09 09:37 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A	23	6639
Organic Matter	19.0	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A	3	6642
Lime as CaCO3	0.8	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	10	6641
Neutralization Potential	8	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	9	6641
Acid Potential	0.93	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723H	3	6641
Acid/Base Potential	7	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723H	3	6641
Phosphorus	3.9	mg/kg		0.1		ASA24-5	08/07/09 11:40 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A	24	6643
Nitrate as N, KCL Extract	3	mg/kg		1		ASA33-8	07/27/09 13:08 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A	11	6638
INORGANICS												
Sulfate, sat. paste	0.15	meq/L		0.021		E300.0	07/29/09 17:24 / hm	07/17/09 10:26	USDA2	IC101-H_090729A	21	6637
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Arsenic	20	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Barium	J 102	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Chromium	ND	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Copper	14	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Iron	13000	mg/kg	D	10		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Lead	737	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194

JAN
08-21-09

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-7
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070134-006
Collection Date: 07/07/09 14:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Manganese	466	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:49 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	15	6648
Nickel	5	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194
Zinc	535	mg/kg		5		SW6010B	07/21/09 20:45 / eli-b	07/20/09 10:22		SUB-B133081	7	B_40194

Report Definitions:
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

Attachment B: Laboratory Case Narrative

ENERGY LABORATORIES

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ANALYTICAL SUMMARY REPORT

August 12, 2009

Pebbles Clark
MT DEQ
PO Box 200901
Helena, MT 59620-

Workorder No.: H09070134 Quote ID: H373 - Broken Hill Mine

Project Name: Broken Hill Mine Site

Energy Laboratories Inc received the following 6 samples for MT DEQ on 7/10/2009 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H09070134-001	BHMS-WR-2	07/07/09 13:50	07/10/09	Soil	Metals by ICP/ICPMS, Total Mercury, SPLP SPLP Extraction, Regular
H09070134-002	BHMS-SS-3	07/07/09 14:00	07/10/09	Soil	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H09070134-003	BHMS-SS-4	07/07/09 14:40	07/10/09	Soil	Same As Above
H09070134-004	BHMS-SS-5	07/07/09 14:15	07/10/09	Soil	Metals by ICP/ICPMS, Total Cation Exchange Capacity Cations, Saturated Paste Acid/Base Potential Conductivity Mercury in Solid By CVAA Anions by Ion Chromatography Potassium Lime as CaCO3, % Nitrate as N, CaCL2 Extract Organic Matter-Walkley/Black Saturated Paste pH Phosphorus-Olsen Digestion, Total Metals CaCl2 Hot Water Soil Extraction CEC NH4AC Soil Extraction Digestion, Mercury by CVAA Lime Percentage NaHCO3 Soil Extract NH4AC Soil Extraction Particle Size Analysis / Texture Prep Saturated Paste Extraction Total Organic Matter Prep Particle Size Analysis / Texture Sulfur Forms Particle Size Analysis / Texture
H09070134-005	BHMS-SS-6	07/07/09 14:30	07/10/09	Soil	Same As Above
H09070134-006	BHMS-SS-7	07/07/09 14:30	07/10/09	Soil	Same As Above

This is a preliminary report that contains incomplete data or data that has not been fully validated. Caution should be exercised in the use of any data presented as final reported results may not reflect the values presented.

If you have any questions regarding these tests results, please call 406-442-0711 or 877-472-0711.

Report Approved By:

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
Toll Free 877.472.0711 * 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

CLIENT: MT DEQ

Project: Broken Hill Mine Site

Sample Delivery Group: H09070134

Date: *12-Aug-09*

CASE NARRATIVE

Samples received from Helena under their WO # H09070134 were subcontracted to Billings, received 7/17/09, and assigned Billings WO # B09071607.

Comments: Included with the analysis reports are instrument data reports for all analysis associated with the instrument calibration, QC sample analysis, and sample analysis. Copies of the detailed laboratory records for the analyses are sorted by method, instrument, and then analysis time. For the metals analyses by ICP-AES, instrument raw data summaries for initial calibration, continuing calibration, method blanks, blank matrix spike, matrix spike, and sample results are included with this sample analyses set. Other methods, are reported similarly, as appropriate. All analytical data is within method QA/QC specifications except as noted on analyses and/or QC summary reports, or in this narrative. The analytical report identifies which QC batch ID and sequence QC is associated with each analysis result for a sample. Soil results for total metals are reported on a as-received basis and not corrected for soil moisture.

Inclusion of the raw data will be found on the attached CD. The results of this Analytical Report relate only to the items submitted for analysis. Only the raw data associated with parameters listed on this report should be validated.

Jonathan Hager
Assistant Laboratory Manager
Energy Laboratories, Inc., - Helena, MT

Attachment C: Chain of Custody Forms and Sample Receipt Checklist

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page 1 of 1

PLEASE PRINT- Provide as much information as possible.

Company Name: Portage Env / MDEQ/MWCB

Project Name, PWS, Permit, Etc. Broken Hill Mine Site

Sample Origin State: MT

EPA/State Compliance: Yes ☐ No ☐

Report Mail Address:
Pebbles Clark
MDEQ/MWCB
POB 200901
Helena MT 59620

Pat Seccomb
Portage
103 N. Main St.
Butte MT 59701

Contact Name: Pebbles Clark / Pat Seccomb

Phone/Fax: 841-5028 / 782-2822

Email: pclark2@mt.gov / pat-seccomb@qwest.net

Sampler: (Please Print) Meg Babits / Pat Seccomb

Invoice Address: see MDEQ/MWCB

Invoice Contact & Phone: PEBBLES CLARK 841-5028

Purchase Order:

Quote/Bottle Order: H373

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW
☐ GSA
☐ POTW/WWTP
☐ State: ______
☐ Other: ______

☐ A2LA
☑ EDD/EDT (Electronic Data)
Format: ______
☑ LEVEL IV
☐ NELAC

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: UPS ATS

Cooler ID(s):

Receipt Temp 7.6 °C

On Ice: [✓ Yes] ~~No~~ SQ

Custody Seal [✓ Y] N

Bottles/Coolers B [✓ C]

Intact [✓ Y] N

Signature Match [✓ Y] N

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	Number of Containers Sample Type: A W S V B O Air Water Soils/Solids Vegetation Bioassay Other MATRIX	ANALYSIS REQUESTED Total Metals	Texture	ABA, CEC, AG	SPLP						SEE ATTACHED	Normal Turnaround (TAT)	RUSH	LABORATORY USE ONLY
1	BHMS-WR-2 ✓	7-7-09	1352	S				✓							✓		H09070134
2	BHMS-SS-3 ✓	7-7-09	1400	S	✓										✓		002
3	BHMS-SS-4 ✓	7-7-09	1440	S	✓										✓		003
4	BHMS-SS-5 ✓	7-7-09	1415	S	✓	✓	✓								✓		004
5	BHMS-SS-6 ✓	7-7-09	1430	S	✓	✓	✓								✓		005
6	BHMS-SS-7 ✓	7-7-09	1430	S	✓	✓	✓								✓		006
7																	
8																	
9																	
10																	

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
M. Babits	7/9/09 1200	Meg Babits	Steve Dui	7-10-09 10:00	
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory:	Date/Time:	Signature:

Sample Disposal: Return to Client: ______ Lab Disposal: ✓

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.

Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Broken Hill Mine Site

SDG#: H09070135

Number of Samples: (6)

Sample Matrix: (6) Soil

Applicable Analytes: Target Analyte List (TAL) for Metals (Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, and Zn), Cation Exchange Capacity (CEC), Acid/Base Potential, Conductivity, Sulfur, Organic Matter, Lime as $CaCO_3$, Neutralization Potential, Acid Potential, Phosphorus, Nitrate, pH, and Soil Composition.

Reporting Tier: Level IV

Applicable TOS#: N/A

Laboratory: Energy Laboratories

Validation Level: 'B'

Validator Affiliation: Portage, Inc.

Project#: Broken Hill Mine Site Inorganics

Validator: ______ **Date Completed:** 8/26/09

Portage Review: ______ **Date Completed:** 8/26/09

REPORT ORGANIZATION:

Limitations & Validation (L&V) Report is organized into the following sections:

- Glossary of Terms & Method References
- Data Quality Statement
- L&V Report
- Attachment A: Laboratory Report Forms Corrected for Qualification
- Attachment B: Laboratory Case Narrative
- Attachment C: Chain of Custody Forms & Sample Receipt Checklist

GLOSSARY OF VALIDATION TERMS & METHOD VALIDATION REFERENCES

Terms:

CRDL	Contract Required Detection Limit
IDL	Instrument Detection Limit
SOW	Statement of Work
SOP	Standard Operating Procedure
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ICP-ICS	Inductively Coupled Plasma-Interference Check Sample
ICV	Initial Calibration Verification
CCV	Continuing Calibration Verification
ICB	Initial Calibration Blank
CCB	Continuing Calibration Blank
PB	Preparation Blank
LCS	Laboratory Control Sample
SDS	Serial Dilution Sample
SDG	Sample Delivery Group

Qualifiers:

U - The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
Note: This detection limit may be elevated to a level greater than the IDL due to a detection of a target compound in the method blank, and as a result, the sample value, which was less than ten times the blank result, has been qualified 'U' as a non-detect.

J - The analyte was positively identified in the sample, but the associated numerical value may not be an accurate representation of the amount actually present in the environmental sample. The data should be seriously considered for decision-making and are usable for many purposes.

R - The data are unusable (may or may not be present). Resampling and reanalysis are necessary for verification.

UJ - The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Reference:

The validation of this data was performed according to:

1. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 540-R-04-004, October 2004.*
2. *USEPA Contract Laboratory Program Statement of Work For Inorganic Analysis, Multi-Media, Multi-Concentration, Document Number ILM04.0, January 2000.*

LIMITATIONS AND VALIDATION REPORT

INTRODUCTION:

The Broken Hill Mine Site metals and inorganic results were received by Portage Inc. on August 17, 2009. The laboratory analytical request provided for a full deliverable and a summary data package attached for total metals. The samples were analyzed in accordance with approved methods as outlined in PLN-5005, Table 9. Data validation was performed utilizing the USEPA Functional Guidelines for Inorganic Data Review, 2004. The following cross-reference has been provided to assist data users in comparing field identifications to the corresponding laboratory numbers.

Cross-Reference for SPRU Soil for Metals Samples

Field Id#:	Lab Id#:	Matrix:	Analysis Request:	Date of Collection:	Date of Laboratory Receipt:
BHMS-BG-1	H09070135-001	Soil	Metals and Inorganic	07/07/09	07/10/09
BHMS-BG-2	H09070135-002	Soil	Metals and Inorganic	07/07/09	07/10/09
BHMS-BG-3	H09070135-003	Soil	Metals and Inorganic	07/07/09	07/10/09
BHMS-WR-1	H09070135-004	Soil	SPLP Metals	07/07/09	07/10/09
BHMS-SS-1	H09070135-005	Soil	Metals and Inorganic	07/07/09	07/10/09
BHMS-SS-2	H09070135-006	Soil	Metals	07/07/09	07/10/09

CONTRACT AND TECHNICAL REVIEW

1. The laboratory case narrative contains all of the elements outlined in the USEPA Functional Guidelines.
2. All analytes were analyzed within their prescribed holding times.
3. All AQS calibration results demonstrated a correlation coefficient greater than 0.995 as prescribed.
4. All initial calibration verification (ICV) and continuing calibration verification (CCV) sample results were within the 90-110%acceptance criteria.
5. Positive detections were noted for neutralization potential, phosphorus, potassium, manganese, nickel, and zinc in the preparation blank (PB).

   The phosphorus result for BHMS-BG-2 has been qualified with a “U” validation flag due to a sample result greater than the IDL but less than five times the blank value.

   All neutralization potential, remaining, phosphorus, potassium, manganese, nickel, and zinc results were greater than five times the blank value. No qualification is warranted.

All initial calibration blank (ICB), continuing calibration blank (CCB), and remaining PB results were non-detect.

6. The iron (74%) ICP-interference check sample (ICS) result associated with BHMS-WR-1 was below the 80-120% acceptance criteria. It has been qualified with a "UJ" validation flag due to a sample result less than the IDL.

   All remaining ICP-ICS results were within the 80-120% acceptance criteria.

7. The mercury (153% and 149%), antimony (45% and 48%) and barium (48% and 126%) associated with USEPA 6010B/7471A analysis matrix spike (MS) and matrix spike duplicate (MSD) results were outside the 75-125% recovery criteria. Qualification is as follows:

   - Mercury warrants no qualification due to sample results less than the IDL.
   - The antimony result for BHMS-BG-3 has been qualified with a "J-" validation flag due to low MS/MSD recovery and a sample result greater than the IDL. The remaining antimony results have been qualified with a "UJ" validation flag due to low MS/MSD recovery and sample results less than the IDL.
   - Barium has been qualified with a "J" validation flag due to poor MS/MSD recovery and sample results greater than the IDL.

   The remaining soil and all SPLP extracted MS and MSD results were within the 75-125% recovery criteria.

8. All matrix spike duplicate (MSD) results were within the +/-35% RPD acceptance criteria.
9. All solid laboratory control sample (LCS) results were within the manufacturer's prescribed acceptance limits.
10. All serial dilution sample (SDS) results exhibited a %D less than 10%.

OVERALL ASSESSMENT OF DATA:

The iron result for BHMS-WR-1 has been qualified with a "UJ" validation flag to denote that the data is non-detect at the reported value, and the reported value is an estimate due to low ICP-ICS recovery *(See CTR Comment #6).*

The antimony result for sample BHMS-BG-3 has been qualified with a "J-" validation flag to denote that the data is detectable at the reported value, but the reported value is an estimate due to poor MS/MSD recovery. All remaining antimony results, **excluding** BHMS-WR-1, have has been qualified with a "UJ" validation flag to denote that the data is non-detect at the reported value, and the reported value is an estimate due to low MS/MSD recovery *(See CTR Comment #7).*

All barium results, **excluding** BHMS-WR-1, have been qualified with a “J” validation flag to denote that the data is detectable at the reported value, but the reported value is an estimate due to poor MS/MSD recovery *(See CTR Comment #7).*

The phosphorus result for BHMS-BG-2 has been qualified with a “U” validation flag to denote the data is non-detect at the reported value due to a positive blank detection *(See CTR Comment #5).*

All remaining field sample data points have been assessed and remain unqualified.

	Target Analyte and Assigned Qualification: SDG#: H09070135									
Field Sample Id#:	**pH**	**Conductivity**	**Ca (Sat paste)**	**Mg(Sat paste)**	**Na (sat paste)**	**Sand**	**Silt**	**Clay**	**Texture**	**K**
BHMS-BG-1										
BHMS-BG-2										
BHMS-BG-3										
BHMS-SS-1										

	Target Analyte and Assigned Qualification: SDG#: H09070135									
Field Sample Id#:	**S**	**CEC**	**Organic Matter**	**Lime**	**Neutralization Potential**	**Acid Potential**	**Acid/Base Potential**	**P**	**Nitrate**	**Sulfate**
BHMS-BG-1										
BHMS-BG-2								**U**		
BHMS-BG-3										
BHMS-SS-1										

	Target Analyte and Assigned Qualification: SDG#: H09070135												
Field Sample Id#:	**Sb**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**
BHMS-BG-1	**UJ**		**J**										
BHMS-BG-2	**UJ**		**J**										
BHMS-BG-3	**J-**		**J**										
BHMS-WR-1							**UJ**						
BHMS-SS-1	**UJ**		**J**										
BHMS-SS-2	**UJ**		**J**										

Attachment A: Laboratory Report Forms

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-BG-1
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-001
Collection Date: 07/07/09 10:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	5.2	s.u.		0.1		ASAM10-3.2	07/22/09 07:15 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722E	5	6637
Conductivity, sat. paste	0.24	mmhos/cm		0.01		ASA10-3	07/22/09 11:40 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722F	5	6637
Calcium, sat. paste	1.00	meq/l		0.05		SW6010B	07/27/09 10:19 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	12	6637
Magnesium, sat. paste	0.40	meq/l		0.08		SW6010B	07/27/09 10:19 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	12	6637
Sodium, sat. paste	0.38	meq/l		0.04		SW6010B	07/27/09 10:19 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	12	6637
PHYSICAL CHARACTERISTICS												
Sand	31	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	4	6645
Silt	59	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	4	6645
Clay	10	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	4	6645
Texture	SiL	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	12	6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	228	mg/kg		1		ASA13-3	07/27/09 09:06 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A	26	6644
Sulfur, Total	0.02	%		0.01		E3.2.3	07/23/09 15:46 / ejp			LECO632_090723D	4	R55313
Cation Exchange Capacity	51.8	meq/100g		0.09		SW6010B	07/31/09 09:45 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A	26	6639
Organic Matter	18.8	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A	4	6642
Lime as CaCO3	1.2	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	12	6641
Neutralization Potential	12	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	11	6641
Acid Potential	0.53	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I	1	6641
Acid/Base Potential	11	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I	1	6641
Phosphorus	22	mg/kg		0.1		ASA24-5	08/07/09 11:43 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A	27	6643
Nitrate as N, KCL Extract	ND	mg/kg		1		ASA33-8	07/27/09 13:11 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A	12	6638
INORGANICS												
Sulfate, sat. paste	0.095	meq/L		0.021		E300.0	07/29/09 17:41 / hm	07/17/09 10:26	USDA2	IC101-H_090729A	22	6637
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Arsenic	28	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Barium	J 304	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Chromium	7	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Copper	12	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Iron	13300	mg/kg	D	9		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194
Lead	350	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	16	B_40194

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

JAM 08-24-09

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-BG-1
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-001
Collection Date: 07/07/09 10:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Manganese	2510	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	: 16	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:52 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	: 16	6648
Nickel	7	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	: 16	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	: 16	B_40194
Zinc	205	mg/kg		5		SW6010B	07/21/09 20:52 / eli-b	07/20/09 10:22		SUB-B133081	: 16	B_40194

Report Definitions:
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MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-BG-2
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-002
Collection Date: 07/07/09 11:00
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	4.3	s.u.		0.1		ASAM10-3.2	07/22/09 07:16 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722E : 6		6637
Conductivity, sat. paste	0.12	mmhos/cm		0.01		ASA10-3	07/22/09 11:40 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722F : 6		6637
Calcium, sat. paste	0.24	meq/l		0.05		SW6010B	07/27/09 10:22 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 13		6637
Magnesium, sat. paste	0.16	meq/l		0.08		SW6010B	07/27/09 10:22 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 13		6637
Sodium, sat. paste	0.37	meq/l		0.04		SW6010B	07/27/09 10:22 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 13		6637
PHYSICAL CHARACTERISTICS												
Sand	39	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 5		6645
Silt	47	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 5		6645
Clay	14	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 5		6645
Texture	L	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 13		6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	104	mg/kg		1		ASA13-3	07/27/09 09:09 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A : 27		6644
Sulfur, Total	0.01	%		0.01		E3.2.3	07/23/09 15:48 / ejp			LECO632_090723D : 5		R55313
Cation Exchange Capacity	46.1	meq/100g		0.09		SW6010B	07/31/09 09:47 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A : 27		6639
Organic Matter	19.5	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A : 5		6642
Lime as CaCO3	0.3	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D : 14		6641
Neutralization Potential	3	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D : 13		6641
Acid Potential	0.41	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I : 2		6641
Acid/Base Potential	3	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I : 2		6641
Phosphorus	U 1.1	mg/kg		0.1		ASA24-5	08/07/09 11:45 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A : 28		6643
Nitrate as N, KCL Extract	ND	mg/kg		1		ASA33-8	07/27/09 13:12 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A : 13		6638
INORGANICS												
Sulfate, sat. paste	0.10	meq/L		0.021		E300.0	07/29/09 17:57 / hm	07/17/09 10:26	USDA2	IC101-H_090729A : 23		6637
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Arsenic	67	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Barium	J 199	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Chromium	5	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Copper	14	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Iron	13300	mg/kg	D	10		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194
Lead	309	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081 : 17		B_40194

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

JAN
08-24-09

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-BG-2
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-002
Collection Date: 07/07/09 11:00
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS. TOTAL												
Manganese	1430	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081	: 17	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 12:57 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	: 18	6648
Nickel	8	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081	: 17	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081	: 17	B_40194
Zinc	162	mg/kg		5		SW6010B	07/21/09 20:55 / eli-b	07/20/09 10:22		SUB-B133081	: 17	B_40194

Report Definitions:
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MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-BG-3
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-003
Collection Date: 07/07/09 11:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	5.2	s.u.		0.1		ASAM10-3.2	07/22/09 07:17 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722E	7	6637
Conductivity, sat. paste	0.14	mmhos/cm		0.01		ASA10-3	07/22/09 11:40 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722F	7	6637
Calcium, sat. paste	0.48	meq/l		0.05		SW6010B	07/27/09 10:24 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	14	6637
Magnesium, sat. paste	0.20	meq/l		0.08		SW6010B	07/27/09 10:24 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	14	6637
Sodium, sat. paste	0.22	meq/l		0.04		SW6010B	07/27/09 10:24 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B	14	6637
PHYSICAL CHARACTERISTICS												
Sand	29	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	6	6645
Silt	59	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	6	6645
Clay	12	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	6	6645
Texture	SiL	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X	14	6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	150	mg/kg		1		ASA13-3	07/27/09 09:12 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A	28	6644
Sulfur, Total	0.02	%		0.01		E3.2.3	07/23/09 15:50 / ejp			LECO632_090723D	6	R55313
Cation Exchange Capacity	49.6	meq/100g		0.09		SW6010B	07/31/09 09:50 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A	28	6639
Organic Matter	17.0	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A	6	6642
Lime as CaCO3	0.5	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	16	6641
Neutralization Potential	5	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D	15	6641
Acid Potential	0.67	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I	3	6641
Acid/Base Potential	4	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I	3	6641
Phosphorus	4.9	mg/kg		0.1		ASA24-5	08/07/09 11:46 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A	29	6643
Nitrate as N, KCL Extract	ND	mg/kg		1		ASA33-8	07/27/09 13:14 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A	14	6638
INORGANICS												
Sulfate, sat. paste	0.076	meq/L		0.021		E300.0	07/29/09 18:14 / lmm	07/17/09 10:26	USDA2	IC101-H_090729A	24	6637
METALS, TOTAL												
Antimony	J 12	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Arsenic	36	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Barium	J 220	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Chromium	6	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Copper	24	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Iron	17900	mg/kg	D	10		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Lead	1020	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

JAM
08-24-09

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-BG-3
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-003
Collection Date: 07/07/09 11:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Manganese	1220	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 13:13 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	21	6648
Nickel	6	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Silver	7	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194
Zinc	404	mg/kg		5		SW6010B	07/21/09 20:59 / eli-b	07/20/09 10:22		SUB-B133081	18	B_40194

Report Definitions: RL - Analyte reporting limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-WR-1
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-004
Collection Date: 07/07/09 12:00
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SPLP METALS												
Mercury	ND	mg/L		0.020		SW7470A	07/22/09 13:43 / eli-b	07/22/09 11:00		SUB-B133145	8	B_40274
SPLP EXTRACTABLE CONSTITUENTS												
Antimony	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Copper	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Iron	UJ ND	mg/L		1		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Manganese	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Nickel	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Zinc	ND	mg/L		1		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Arsenic	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Barium	ND	mg/L		10		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Cadmium	ND	mg/L		0.1		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Chromium	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Lead	9.0	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324
Silver	ND	mg/L		0.5		SW6020	07/25/09 12:02 / eli-b	07/23/09 09:30		SUB-B133304	10	B_40324

JAH
08-24-09

Report Definitions: RL - Analyte reporting limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
Toll Free 877.472.0711 * 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-1
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-005
Collection Date: 07/07/09 12:15
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
SATURATED PASTE												
pH, sat. paste	5.2	s.u.		0.1		ASAM10-3.2	07/22/09 07:17 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722E : 8		6637
Conductivity, sat. paste	0.13	mmhos/cm		0.01		ASA10-3	07/22/09 11:41 / sah	07/17/09 10:26	USDA2	MISC SOILS_090722F : 8		6637
Calcium, sat. paste	0.45	meq/l		0.05		SW6010B	07/27/09 10:37 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 19		6637
Magnesium, sat. paste	0.18	meq/l		0.08		SW6010B	07/27/09 10:37 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 19		6637
Sodium, sat. paste	0.31	meq/l		0.04		SW6010B	07/27/09 10:37 / sld	07/17/09 10:26	USDA2	ICP1-HE_090727B : 19		6637
PHYSICAL CHARACTERISTICS												
Sand	27	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 7		6645
Silt	61	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 7		6645
Clay	12	%		1		ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 7		6645
Texture	SiL	unitless				ASA15-5	07/27/09 15:00 / sah	07/17/09 10:45	ASA15-5	MISC SOILS_090727X : 15		6645
CHEMICAL CHARACTERISTICS												
Potassium, NH4OAc Extractable	105	mg/kg		1		ASA13-3	07/27/09 09:14 / sld	07/17/09 10:34	ASA13-3	ICP1-HE_090727A : 29		6644
Sulfur, Total	0.02	%		0.01		E3.2.3	07/23/09 15:52 / ejp			LECO632_090723D : 7		R55313
Cation Exchange Capacity	53.5	meq/100g		0.09		SW6010B	07/31/09 09:58 / sld	07/17/09 10:27	USDA19	ICP1-HE_090731A : 31		6639
Organic Matter	15.4	%		0.02		ASA29-3	07/27/09 08:14 / sah	07/17/09 10:30	ASA29-3	MISC SOILS_090727A : 7		6642
Lime as CaCO3	0.4	%		0.1		USDA23c	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D : 18		6641
Neutralization Potential	4	t/kt				Sobek Modified	07/23/09 00:00 / sah	07/17/09 10:29	USDA23c	MISC SOILS_090723D : 17		6641
Acid Potential	0.69	t/kt	D	0.01		Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I : 4		6641
Acid/Base Potential	4	t/kt				Sobek Modified	07/23/09 00:00 / ejp	07/17/09 10:29	USDA23c	MISC SOILS_090723I : 4		6641
Phosphorus	9.1	mg/kg		0.1		ASA24-5	08/07/09 11:47 / stp	07/17/09 10:31	ASA24-5	FIA202-HE_090807A : 30		6643
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	07/27/09 13:20 / stp	07/17/09 10:26	ASA25-9	NUTRIENTS_090727A : 17		6638
INORGANICS												
Sulfate, sat. paste	0.17	meq/L		0.021		E300.0	07/29/09 18:30 / hm	07/17/09 10:26	USDA2	IC101-H_090729A : 25		6637
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Arsenic	21	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Barium	J 186	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Cadmium	4	mg/kg		1		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Chromium	8	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Copper	18	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Iron	22300	mg/kg	D	10		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194
Lead	2540	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081 : 19		B_40194

Report Definitions:
RL - Analyte reporting limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

JKH
08-24-09

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-1
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-005
Collection Date: 07/07/09 12:15
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Manganese	1680	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081	19	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 13:15 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	22	6648
Nickel	10	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081	19	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081	19	B_40194
Zinc	926	mg/kg		5		SW6010B	07/21/09 21:02 / eli-b	07/20/09 10:22		SUB-B133081	19	B_40194

Report Definitions:
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Client Sample ID: BHMS-SS-2
Project: Broken Hill Mine Site
Matrix: Soil

Lab ID: H09070135-006
Collection Date: 07/07/09 12:30
DateReceived: 07/10/09
Report Date: 08/12/09

Analyses	Result	Units	QUAL	RL	MCL	Method	Analysis Date / By	Prep Date	Prep Method	RunID	Run Order	BatchID
METALS, TOTAL												
Antimony	UJ ND	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Arsenic	13	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Barium	J 188	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Cadmium	ND	mg/kg		1		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Chromium	5	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Copper	13	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Iron	12500	mg/kg	D	9		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Lead	355	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Manganese	1050	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Mercury	ND	mg/kg		0.50		SW7471A	07/22/09 13:18 / eau	07/21/09 10:30	SW7471A	HGCV201-H_090722A	23	6648
Nickel	7	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Silver	ND	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194
Zinc	1050	mg/kg		5		SW6010B	07/21/09 21:06 / eli-b	07/20/09 10:22		SUB-B133081	20	B_40194

JAH
08-24-09

Report Definitions:
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
D - RL increased due to sample matrix interference.

Attachment B: Laboratory Case Narrative

ENERGY LABORATORIES, INC. * 1120 S 27th St * PO Box 30916 * Billings, MT 59107-0916
Toll Free 800.735.4489 * 406.252.6325 * FAX 406.252.6069 * eli@energylab.com

ANALYTICAL SUMMARY REPORT

July 30, 2009

Pebbles Clark
Energy Laboratories Helena
3161 E Lyndale (59604)
Helena, MT 59601

Workorder No.: B09071608

Project Name: Broken Hill Mine Site

Energy Laboratories Inc received the following 6 samples for Energy Laboratories Helena on 7/17/2009 for analysis.

Sample ID	**Client Sample ID**	**Collect Date**	**Receive Date**	**Matrix**	**Test**
B09071608-001	H09070135-001A	07/07/09 10:30	07/17/09	Soil	Metals by ICP/ICPMS, Total or Soluble Digestion, Total Metals
B09071608-002	H09070135-002A	07/07/09 11:00	07/17/09	Soil	Same As Above
B09071608-003	H09070135-003A	07/07/09 11:30	07/17/09	Soil	Same As Above
B09071608-004	H09070135-004A	07/07/09 12:00	07/17/09	Soil	Metals by ICP/ICPMS, SPLP Mercury, SPLP Digestion, Mercury by CVAA SPLP Extraction, Mercury SPLP Extraction, Regular Digestion, Total Metals
B09071608-005	H09070135-005A	07/07/09 12:15	07/17/09	Soil	Metals by ICP/ICPMS, Total or Soluble Digestion, Total Metals
B09071608-006	H09070135-006A	07/07/09 12:30	07/17/09	Soil	Same As Above

Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

If you have any questions regarding these tests results, please call.

Report Approved By:____

CLIENT: Energy Laboratories Helena
Project: Broken Hill Mine Site
Sample Delivery Group: B09071608

Date: *30-Jul-09*

CASE NARRATIVE

Samples received from Helena under their WO # H09070135 were subcontracted to Billings, received 7/17/09, and assigned Billings WO # B09071608.

Comments: Included with the analysis reports are instrument data reports for all analysis associated with the instrument calibration, QC sample analysis, and sample analysis. Copies of the detailed laboratory records for the analyses are sorted by method, instrument, and then analysis time. For the metals analyses by ICP-AES, instrument raw data summaries for initial calibration, continuing calibration, method blanks, blank matrix spike, matrix spike, and sample results are included with this sample analyses set. Other methods, are reported similarly, as appropriate. All analytical data is within method QA/QC specifications except as noted on analyses and/or QC summary reports, or in this narrative. The analytical report identifies which QC batch ID and sequence QC is associated with each analysis result for a sample. Soil results for total metals are reported on a as-received basis and not corrected for soil moisture.

Inclusion of the raw data will be found on the attached CD. The raw data is contained in files provided with WO H09070134 The results of this Analytical Report relate only to the items submitted for analysis. Only the raw data associated with parameters listed on this report should be validated.

Cornelius A. Valkenburg Ph.D.
Corporate Quality Assurance Officer
Energy Laboratories, Inc., - Billings, MT

Attachment C: Chain of Custody Forms and Sample Receipt Checklist

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page 1 of 1

PLEASE PRINT- Provide as much information as possible.

Company Name: Portage Environmental MDEQ/MWCB

Project Name, PWS, Permit, Etc.: Broken Hill Mine Site

Sample Origin State: MT

EPA/State Compliance: Yes ☑ No ☐

Report Mail Address:
Pebbles Clark
MDEQ/MWCB
POB 200901
Helena MT 59620

Pat Seccomb
Portage
103 N. Main
Butte, MT 59701

Contact Name:	Phone/Fax:	Email:
Pat Seccomb	841-5028	pclark2@mt.gov
Pebbles Clark	782-2822	pat-seccomb@qwest.net

Sampler: (Please Print) Meg Babits, Pat Seccomb

Invoice Address: See DEQ above

Invoice Contact & Phone: Pebbles Clark 841-5028

Purchase Order:

Quote/Bottle Order: H 373

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW
☐ GSA
☐ POTW/WWTP
☐ State: ____
☐ Other: ____

☐ A2LA
☑ EDD/EDT (Electronic Data)
Format: ____
☑ LEVEL IV
☐ NELAC

Number of Containers
Sample Type: A W S V B O
Air Water Soils/Solids Vegetation Bioassay Other

ANALYSIS REQUESTED

R U S H

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by:

Cooler ID(s):

Receipt Temp 10.8 °C

On Ice: [✓ Yes] [✓ No] SD

Custody Seal [✓ Y] N

Bottles/Coolers B [✓ C]

Intact [✓ Y] N

Signature Match [✓ Y] N

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	Total Metals	Texture	CEC, ABA, AG	SPLP						SEE ATTACHED	Normal Turnaround (TAT)	LABORATORY USE ONLY
1	BHMS-BG-1	7-7-09	1030	S	✓	✓	✓								✓	H09070135-001
2	BHMS-BG-2	7-7-09	1100	S	✓	✓	✓								✓	002
3	BHMS-BG-3	7-7-09	1130	S	✓	✓	✓								✓	003
4	BHMS-WR-1	7-7-09	1200	S				✓							✓	004
5	BHMS-SS-1	7-7-09	1215	S	✓	✓	✓								✓	005
6	BHMS-SS-2	7-7-09	1230	S	✓										✓	006
7																
8																
9																
10																

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Meg Babits	7-9-09 1200	Meg Babits	Steve Dull	7-10-09 10:00	
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory:	Date/Time:	Signature:

Sample Disposal: Return to Client: ____ Lab Disposal: ✓

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

SUPPLEMENTAL DATA
BROKEN HILL MINE SITE

ENERGY LABORATORIES
ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

TO: Montana DEQ
ADDRESS:

LAB NO.: H09070135-001-006
DATE: 10/31/09

Broken Hill Mine Site
FERTILIZER RECOMMENDATIONS
Fertilizer Suggested in Actual Pounds per Acre

FIELD	BG-1	BG-2	BG-3	WR-1	SS-1	SS-2
CROP	Grass	Grass	Grass	Grass	Grass	Grass
PROJECTED YIELD	1.5T	1.5T	1.5T	1.5T	1.5T	1.5T
Nitrogen						
Total	30	30	30	n/a	30	n/a
Preplant	30	30	30	n/a	30	n/a
Sidedress	0	0	0	0	0	0
Phosphorus (P_2O_5)						
Broadcast	0	50	35	n/a	0	n/a
Banded						
Potassium (K_2O)						
Broadcast	0	50	40	n/a	50	n/a
Banded						
Sulphur (S)	10	10	10	n/a	10	n/a
Zinc (Zn)						
Iron (Fe)						
Copper (Cu)						
Boron (B)						
Lime	3T	5T	3T	n/a	3T	n/a

COMMENTS ______________________________

PREPARED BY: Neal Fehringer, Certified Professional Agronomist, C.C.A., (406) 860-3647.

ENERGY LABORATORIES

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877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

TO: Montana DEQ
ADDRESS:

LAB NO H09070134-001-006
DATE: 10/31/09

Broken Hill Mine Site
FERTILIZER RECOMMENDATIONS
Fertilizer Suggested in Actual Pounds per Acre

FIELD	WR-2	SS-3	SS-4	SS-5	SS-6	SS-7
CROP	Grass	Grass	Grass	Grass	Grass	Grass
PROJECTED YIELD	1.5T	1.5T	1.5T	1.5T	1.5T	1.5T
Nitrogen						
Total	n/a	n/a	n/a	25	25	25
Preplant	n/a	n/a	n/a	25	25	25
Sidedress	0	0	0	0	0	0
Phosphorus (P_2O_5)						
Broadcast	n/a	n/a	n/a	50	50	50
Banded						
Potassium (K_2O)						
Broadcast	n/a	n/a	n/a	0	0	0
Banded						
Sulphur (S)	n/a	n/a	n/a	10	10	10
Zinc (Zn)						
Iron (Fe)						
Copper (Cu)						
Boron (B)						
Lime	n/a	n/a	n/a	0T	3T	3T

COMMENTS: ______________________

PREPARED BY: Neal Fehringer, Certified Professional Agronomist, C.C.A., (406) 860-3647.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: Broken Hill Mine Site
Workorder: H09070135

Report Date: 09/15/09
Date Received: 07/10/09

		Analysis		Sulfur, Pyritic	Sulfur, Organic	CEC	OM-WB	Lime	Neut Potential	Acid Potential	Acid/Base Potential	P-Olsen	NO3	SO4-SatPst
		Units		%	%	meq/100g	%	%	t/kt	t/kt	t/kt	mg/kg	mg/kg	meq/L
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H09070135-001	BHMS-BG-1	0	0	0.02	< 0.01	51.8	18.8	1.2	12	0.52	11	22	< 1	0.095
H09070135-002	BHMS-BG-2	0	0	< 0.01	< 0.01	46.1	19.5	0.3	3	0.27	3	1.1	< 1	0.10
H09070135-003	BHMS-BG-3	0	0	0.02	< 0.01	49.6	17.0	0.5	5	0.58	4	4.9	< 1	0.076
H09070135-004	BHMS-WR-1	0	0											
H09070135-005	BHMS-SS-1	0	0	0.01	< 0.01	53.5	15.4	0.4	4	0.36	4	9.1	1	0.17
H09070135-006	BHMS-SS-2	0	0											

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: Broken Hill Mine Site
Workorder: H09070134

Report Date: 09/15/09
Date Received: 07/10/09

		Analysis		Sulfur, Pyritic	Sulfur, Organic	CEC	OM-WB	Lime	Neut Potential	Acid Potential	Acid/Base Potential	P-Olsen	NO3	SO4-SatPst
		Units		%	%	meq/100g	%	%	t/kt	t/kt	t/kt	mg/kg	mg/kg	meq/L
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H09070134-001	BHMS-WR-2	0	0											
H09070134-002	BHMS-SS-3	0	0											
H09070134-003	BHMS-SS-4	0	0											
H09070134-004	BHMS-SS-5	0	0	0.02	< 0.01	72.7	19.5	2.0	20	0.61	20	5.2	2	0.25
H09070134-005	BHMS-SS-6	0	0	0.02	< 0.01	53.3	19.6	0.9	9	0.73	9	4.2	3	0.25
H09070134-006	BHMS-SS-7	0	0	0.02	< 0.01	49.7	19.0	0.8	8	0.69	7	3.9	3	0.15

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP1-HE_091124B
Sample ID: ICSAB	11	Interference Check Sample AB								11/24/09 20:14
Arsenic		0.985	mg/L	0.020	**99**	80	120			
Barium		0.503	mg/L	0.10	**101**	80	120			
Cadmium		0.891	mg/L	0.0020	**89**	80	120			
Chromium		0.478	mg/L	0.010	**96**	80	120			
Copper		0.526	mg/L	0.010	**105**	80	120			
Iron		177	mg/L	0.030	**89**	80	120			
Lead		0.943	mg/L	0.010	**94**	80	120			
Manganese		0.523	mg/L	0.010	**105**	80	120			
Nickel		0.953	mg/L	0.010	**95**	80	120			
Silver		0.989	mg/L	0.0050	**99**	80	120			
Zinc		0.845	mg/L	0.010	**85**	80	120			
Method: E200.7										Analytical Run: ICP1-HE_091125C
Sample ID: ICV	2	Initial Calibration Verification Standard								11/25/09 17:43
Antimony		0.774	mg/L	0.050	**97**	90	110			
Iron		4.01	mg/L	0.030	**100**	90	110			
Sample ID: ICSA	2	Interference Check Sample A								11/25/09 17:56
Antimony		0.0515	mg/L	0.050		0	0			
Iron		186	mg/L	0.030	**93**	80	120			
Sample ID: ICSAB	2	Interference Check Sample AB								11/25/09 17:59
Antimony		1.15	mg/L	0.050	**115**	80	120			
Iron		197	mg/L	0.030	**98**	80	120			
Sample ID: ICSA	2	Interference Check Sample A								11/25/09 19:59
Antimony		0.0571	mg/L	0.050		0	0			
Iron		195	mg/L	0.030	**98**	80	120			
Sample ID: ICSAB	2	Interference Check Sample AB								11/25/09 20:02
Antimony		1.13	mg/L	0.050	**113**	80	120			
Iron		192	mg/L	0.030	**96**	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: Broken Hill Mine
Lab ID: H09110259-001
Client Sample ID: BHMS-WR-1 (11/13/09)

Report Date: 12/08/09
Collection Date: 11/13/09 10:12
DateReceived: 11/19/09
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, TOTAL							
Antimony	34	mg/kg		5		SW6010B	12/02/09 11:02 / sld
Arsenic	743	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Barium	17	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Cadmium	2	mg/kg		1		SW6010B	11/24/09 19:43 / sld
Chromium	6	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Copper	171	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Iron	55800	mg/kg	D	60		SW6010B	11/25/09 18:29 / sld
Lead	14100	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Manganese	634	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Mercury	4.0	mg/kg		1.0		SW7471A	12/04/09 12:49 / eli-b2
Nickel	ND	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Silver	26	mg/kg		5		SW6010B	11/24/09 19:43 / sld
Zinc	1800	mg/kg		5		SW6010B	11/24/09 19:43 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7							Analytical Run: ICP1-HE_091124B			
Sample ID: ICSAB	11	Interference Check Sample AB								11/24/09 15:11
Manganese		0.543	mg/L	0.010	**109**	80	120			
Nickel		1.11	mg/L	0.010	**110**	80	120			
Silver		1.05	mg/L	0.0050	**105**	80	120			
Zinc		1.01	mg/L	0.010	**101**	80	120			
Sample ID: ICSA	11	Interference Check Sample A								11/24/09 16:51
Arsenic		0.0244	mg/L	0.020		0	0			
Barium		ND	mg/L	0.10		0	0			
Cadmium		0.00100	mg/L	0.0020		0	0			
Chromium		-0.00210	mg/L	0.010		0	0			
Copper		0.0122	mg/L	0.010		0	0			
Iron		176	mg/L	0.030	88	80	120			
Lead		0.0646	mg/L	0.010		0	0			
Manganese		0.0297	mg/L	0.010		0	0			
Nickel		0.0601	mg/L	0.010		0	0			
Silver		0.000300	mg/L	0.0050		0	0			
Zinc		-0.00330	mg/L	0.010		0	0			
Sample ID: ICSAB	11	Interference Check Sample AB								11/24/09 16:54
Arsenic		1.01	mg/L	0.020	**101**	80	120			
Barium		0.512	mg/L	0.10	**102**	80	120			
Cadmium		0.948	mg/L	0.0020	**95**	80	120			
Chromium		0.488	mg/L	0.010	**98**	80	120			
Copper		0.537	mg/L	0.010	**107**	80	120			
Iron		182	mg/L	0.030	**91**	80	120			
Lead		1.07	mg/L	0.010	**107**	80	120			
Manganese		0.525	mg/L	0.010	**105**	80	120			
Nickel		1.05	mg/L	0.010	**104**	80	120			
Silver		1.01	mg/L	0.0050	**101**	80	120			
Zinc		0.923	mg/L	0.010	**92**	80	120			
Sample ID: ICSA	11	Interference Check Sample A								11/24/09 20:11
Arsenic		0.0374	mg/L	0.020		0	0			
Barium		-0.000400	mg/L	0.10		0	0			
Cadmium		0.000800	mg/L	0.0020		0	0			
Chromium		-0.00190	mg/L	0.010		0	0			
Copper		0.0134	mg/L	0.010		0	0			
Iron		179	mg/L	0.030	**89**	80	120			
Lead		0.0454	mg/L	0.010		0	0			
Manganese		0.0290	mg/L	0.010		0	0			
Nickel		0.0536	mg/L	0.010		0	0			
Silver		-0.000200	mg/L	0.0050		0	0			
Zinc		-0.00480	mg/L	0.010		0	0			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: Broken Hill Mine
Lab ID: H09110259-002
Client Sample ID: BHMS-WR-2 (11/13/09)

Report Date: 12/08/09
Collection Date: 11/13/09 10:41
DateReceived: 11/19/09
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, TOTAL							
Antimony	12	mg/kg		5		SW6010B	11/25/09 18:35 / sld
Arsenic	117	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Barium	42	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Cadmium	3	mg/kg		1		SW6010B	11/24/09 19:46 / sld
Chromium	6	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Copper	61	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Iron	18300	mg/kg	D	20		SW6010B	11/24/09 19:46 / sld
Lead	2760	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Manganese	524	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Mercury	0.83	mg/kg		0.50		SW7471A	12/04/09 12:27 / eli-b2
Nickel	10	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Silver	5	mg/kg		5		SW6010B	11/24/09 19:46 / sld
Zinc	1480	mg/kg		5		SW6010B	11/24/09 19:46 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP1-HE_091124B
Sample ID: ICV	9	Initial Calibration Verification Standard								11/24/09 13:50
Arsenic		0.802	mg/L	0.020	**100**	95	105			
Barium		0.833	mg/L	0.10	**104**	95	105			
Chromium		0.809	mg/L	0.010	**101**	95	105			
Iron		4.02	mg/L	0.030	**100**	95	105			
Lead		0.826	mg/L	0.010	**103**	95	105			
Manganese		4.01	mg/L	0.010	**100**	95	105			
Nickel		0.824	mg/L	0.010	**103**	95	105			
Silver		0.404	mg/L	0.0050	**101**	95	105			
Zinc		0.819	mg/L	0.010	**102**	95	105			
Sample ID: ICV	11	Initial Calibration Verification Standard								11/24/09 14:51
Arsenic		0.831	mg/L	0.020	**104**	90	110			
Barium		0.861	mg/L	0.10	**108**	90	110			
Cadmium		0.430	mg/L	0.0020	**108**	90	110			
Chromium		0.851	mg/L	0.010	**106**	90	110			
Copper		0.827	mg/L	0.010	**103**	90	110			
Iron		4.20	mg/L	0.030	**105**	90	110			
Lead		0.879	mg/L	0.010	**110**	90	110			
Manganese		4.25	mg/L	0.010	**106**	90	110			
Nickel		0.868	mg/L	0.010	**108**	90	110			
Silver		0.403	mg/L	0.0050	**101**	90	110			
Zinc		0.879	mg/L	0.010	**110**	90	110			
Sample ID: ICSA	11	Interference Check Sample A								11/24/09 15:07
Arsenic		0.0180	mg/L	0.020		0	0			
Barium		0.00140	mg/L	0.10		0	0			
Cadmium		0.00110	mg/L	0.0020		0	0			
Chromium		-0.00220	mg/L	0.010		0	0			
Copper		0.0159	mg/L	0.010		0	0			
Iron		199	mg/L	0.030	**99**	80	120			
Lead		0.0804	mg/L	0.010		0	0			
Manganese		0.0279	mg/L	0.010		0	0			
Nickel		0.0798	mg/L	0.010		0	0			
Silver		0.00100	mg/L	0.0050		0	0			
Zinc		-0.00260	mg/L	0.010		0	0			
Sample ID: ICSAB	11	Interference Check Sample AB								11/24/09 15:11
Arsenic		1.08	mg/L	0.020	**108**	80	120			
Barium		0.539	mg/L	0.10	**108**	80	120			
Cadmium		1.01	mg/L	0.0020	**101**	80	120			
Chromium		0.530	mg/L	0.010	**106**	80	120			
Copper		0.562	mg/L	0.010	**112**	80	120			
Iron		197	mg/L	0.030	**98**	80	120			
Lead		1.12	mg/L	0.010	**112**	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: **E200.7**										Analytical Run: ICP1-HE_091202A
Sample ID: ICV		Initial Calibration Verification Standard								12/02/09 09:03
Antimony		0.836	mg/L	0.050	**104**	90	110			
Sample ID: ICSA		Interference Check Sample A								12/02/09 09:21
Antimony		0.0805	mg/L	0.050		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/02/09 09:24
Antimony		1.10	mg/L	0.050	**110**	80	120			
Sample ID: ICSA		Interference Check Sample A								12/02/09 12:26
Antimony		0.0756	mg/L	0.050		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/02/09 12:29
Antimony		1.08	mg/L	0.050	**108**	80	120			
Sample ID: ICSA		Interference Check Sample A								12/02/09 13:32
Antimony		0.0603	mg/L	0.050		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/02/09 13:35
Antimony		1.10	mg/L	0.050	**110**	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 7454
Sample ID: MB-7454	10	Method Blank				Run: ICP1-HE_091124B				11/24/09 18:26
Arsenic		0.6	mg/kg	0.5						
Barium		ND	mg/kg	0.03						
Cadmium		ND	mg/kg	0.02						
Chromium		ND	mg/kg	0.1						
Copper		0.4	mg/kg	0.2						
Iron		4	mg/kg	3						
Lead		ND	mg/kg	0.4						
Manganese		ND	mg/kg	0.1						
Nickel		ND	mg/kg	0.2						
Silver		ND	mg/kg	0.10						
Sample ID: LFB-7454	10	Laboratory Fortified Blank				Run: ICP1-HE_091124B				11/24/09 18:29
Arsenic		86.4	mg/kg	5.0	**86**	70	130			
Barium		93.8	mg/kg	5.0	**94**	70	130			
Cadmium		89.1	mg/kg	1.0	**89**	70	130			
Chromium		95.3	mg/kg	5.0	**95**	70	130			
Copper		94.5	mg/kg	5.0	**94**	70	130			
Iron		105	mg/kg	5.0	**100**	70	130			
Lead		91.5	mg/kg	5.0	**92**	70	130			
Manganese		91.3	mg/kg	5.0	**91**	70	130			
Nickel		94.3	mg/kg	5.0	**94**	70	130			
Silver		88.6	mg/kg	5.0	**89**	70	130			
Sample ID: LCS-7454	10	Laboratory Control Sample				Run: ICP1-HE_091124B				11/24/09 18:32
Arsenic		149	mg/kg	5.0	**86**	81	119			
Barium		315	mg/kg	5.0	**88**	82	118			
Cadmium		46.9	mg/kg	1.0	**85**	82	118			
Chromium		104	mg/kg	5.0	**92**	81	119			
Copper		75.2	mg/kg	5.0	**93**	83	117			
Iron		14400	mg/kg	5.0	**105**	53	147			
Lead		109	mg/kg	5.0	**88**	81	119			
Manganese		233	mg/kg	5.0	**90**	82	118			
Nickel		144	mg/kg	5.0	**88**	82	118			
Silver		57.2	mg/kg	5.0	**87**	66	134			
Sample ID: H09110239-005AMS	10	Sample Matrix Spike				Run: ICP1-HE_091124B				11/24/09 19:00
Arsenic		82.8	mg/kg	5.0	**76**	75	125			
Barium		297	mg/kg	5.0	**94**	75	125			
Cadmium		74.4	mg/kg	1.0	**76**	75	125			
Chromium		94.6	mg/kg	5.0	**80**	75	125			
Copper		97.7	mg/kg	5.0	**85**	75	125			
Iron		10900	mg/kg	5.0		75	125			A
Lead		106	mg/kg	5.0	**80**	75	125			
Manganese		340	mg/kg	5.0	**91**	75	125			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 7454
Sample ID: H09110239-005AMS	10 Sample Matrix Spike					Run: ICP1-HE_091124B				11/24/09 19:00
Nickel		102	mg/kg	5.0	81	75	125			
Silver		79.2	mg/kg	5.0	81	75	125			
Sample ID: H09110239-005AMSD	10 Sample Matrix Spike Duplicate					Run: ICP1-HE_091124B				11/24/09 19:03
Arsenic		80.8	mg/kg	5.0	75	75	125	2.4	20	
Barium		314	mg/kg	5.0	111	75	125	5.3	20	
Cadmium		78.7	mg/kg	1.0	81	75	125	5.5	20	
Chromium		101	mg/kg	5.0	87	75	125	6.4	20	
Copper		101	mg/kg	5.0	89	75	125	2.9	20	
Iron		11800	mg/kg	5.0		75	125	8	20	A
Lead		112	mg/kg	5.0	87	75	125	6	20	
Manganese		351	mg/kg	5.0	103	75	125	3.2	20	
Nickel		106	mg/kg	5.0	86	75	125	4.1	20	
Silver		79.6	mg/kg	5.0	82	75	125	0.5	20	
Sample ID: H09110239-010ADUP	11 Sample Duplicate					Run: ICP1-HE_091124B				11/24/09 19:28
Arsenic		6.54	mg/kg	5.0				2.7	30	
Barium		121	mg/kg	5.0				2.5	30	
Cadmium		ND	mg/kg	1.0					30	
Chromium		13.8	mg/kg	5.0				9.2	30	
Copper		10.5	mg/kg	5.0				11	30	
Iron		10400	mg/kg	5.0				1.5	30	
Lead		9.96	mg/kg	5.0				5.5	30	
Manganese		262	mg/kg	5.0				10	30	
Nickel		21.5	mg/kg	5.0				3.9	30	
Silver		ND	mg/kg	5.0					30	
Zinc		38.6	mg/kg	5.0				8.9	30	
Sample ID: MB-7454	12 Method Blank					Run: ICP1-HE_091125C				11/25/09 18:17
Antimony		ND	mg/kg	1						
Arsenic		ND	mg/kg	0.5						
Barium		ND	mg/kg	0.03						
Cadmium		ND	mg/kg	0.02						
Chromium		0.2	mg/kg	0.1						
Copper		0.2	mg/kg	0.2						
Iron		4	mg/kg	3						
Lead		ND	mg/kg	0.4						
Manganese		ND	mg/kg	0.08						
Nickel		ND	mg/kg	0.1						
Silver		ND	mg/kg	0.10						
Zinc		0.3	mg/kg	0.1						
Sample ID: LFB-7454	12 Laboratory Fortified Blank					Run: ICP1-HE_091125C				11/25/09 18:22
Antimony		100	mg/kg	5.0	100	70	130			
Arsenic		94.4	mg/kg	5.0	94	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine

Report Date: 12/08/09
Work Order: H09110259

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 7454
Sample ID: LFB-7454	12	Laboratory Fortified Blank				Run: ICP1-HE_091125C				11/25/09 18:22
Barium		108	mg/kg	5.0	108	70	130			
Cadmium		107	mg/kg	1.0	107	70	130			
Chromium		104	mg/kg	5.0	104	70	130			
Copper		99.6	mg/kg	5.0	99	70	130			
Iron		110	mg/kg	5.0	105	70	130			
Lead		104	mg/kg	5.0	104	70	130			
Manganese		99.4	mg/kg	5.0	99	70	130			
Nickel		102	mg/kg	5.0	102	70	130			
Silver		97.7	mg/kg	5.0	98	70	130			
Zinc		101	mg/kg	5.0	101	70	130			
Sample ID: LCS-7454	12	Laboratory Control Sample				Run: ICP1-HE_091125C				11/25/09 18:26
Antimony		48.7	mg/kg	5.0	73	2.18	211			
Arsenic		152	mg/kg	5.0	88	81	119			
Barium		335	mg/kg	5.0	94	82	118			
Cadmium		51.5	mg/kg	1.0	94	82	118			
Chromium		109	mg/kg	5.0	96	81	119			
Copper		77.3	mg/kg	5.0	96	83	117			
Iron		13600	mg/kg	5.0	99	53	147			
Lead		110	mg/kg	5.0	89	81	119			
Manganese		243	mg/kg	5.0	94	82	118			
Nickel		150	mg/kg	5.0	91	82	118			
Silver		60.6	mg/kg	5.0	92	66	134			
Zinc		152	mg/kg	5.0	91	79	121			
Method: SW7471A										Batch: B_43109
Sample ID: MB-43109		Method Blank				Run: SUB-B140041				12/04/09 11:39
Mercury		ND	mg/kg	0.05						
Sample ID: LCS3-43109		Laboratory Control Sample				Run: SUB-B140041				12/04/09 11:41
Mercury		4.8	mg/kg	1.0	96	70	130			
Sample ID: H09110259-002A		Serial Dilution				Run: SUB-B140041				12/04/09 12:30
Mercury		0.84	mg/kg	1.0		0	0		20	
Sample ID: H09110259-002A		Sample Matrix Spike				Run: SUB-B140041				12/04/09 12:37
Mercury		11	mg/kg	1.0	105	70	130			
Sample ID: H09110259-002A		Sample Matrix Spike Duplicate				Run: SUB-B140041				12/04/09 12:39
Mercury		12	mg/kg	1.0	109	70	130	3.6	30	
Method: SW7471A										Analytical Run: SUB-B140041
Sample ID: QCS		Initial Calibration Verification Standard								12/04/09 11:32
Mercury		0.0019	mg/kg	1.0	97	85	115			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

APPENDIX E
1993 INVENTORY DATA
BROKEN HILL MINE SITE

LABORATORY ANALYTICAL DATA

BROKEN HILL
PA NO. 45-005

Broken Hill PA# 45–005
AMRB HAZARDOUS MATERIALS INVENTORY
INVESTIGATOR: PIONEER – BULLOCK
INVESTIGATION DATE: 08/03/93

SOLID MATRIX ANALYSES

Metals in soils
Results per dry weight basis

FIELD ID	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Co (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)	CYANIDE (mg/Kg)
45–005–WR–1	1140	27.9	15.2	7.25	5.25	342 J	94400	27.2 J	992	3.84	55900 J	344	9600	NR
45–005–WR–2	508	19.8	26	5.86	4.5	140 J	44200	2.53 J	426	6.23	18700 J	61.3	11400	NR
BACKGROUND	8.68	142	0.6 U	10.4	10.5	21.2 J	22100	0.059 J	710	14.4	33.8 J	6.84 U	78.2	NR

U – Not Detected; J – Estimated Quantity; X – Outlier for Accuracy or Precision; NR – Not Requested

Acid/Base Accounting

FIELD ID	TOTAL SULFUR %	TOTAL SULFUR ACID BASE t/1000t	NEUTRAL. POTENT. t/1000t	SULFUR ACID BASE POTENT. t/1000t	SULFATE SULFUR %	PYRITIC SULFUR %	ORGANIC SULFUR %	PYRITIC SULFUR ACID BASE t/1000t	SULFUR ACID BASE POTENT. t/1000t
45–005–WR–1	2.80	87.5	–5.78	–93.3	1.86	0.08	0.86	2.50	–8.28
45–005–WR–2	2.46	76.9	–4.12	–81.0	0.59	0.15	1.72	4.69	–8.81

WATER MATRIX ANALYSES

Metals in Water
Results in ug/L

FIELD ID	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Zn	HARDNESS CALC. (mg CaCO3/L)
45–005–GW–1	30.4	2.01 U	2.57 U	9.7 U	6.83 U	2.97	69.6	0.044 J	15.2	12.7 U	107	30.7 U	867	23.4

U – Not Detected; J – Estimated Quantity; X – Outlier for Accuracy or Precision; NR – Not Requested

Wet Chemistry
Results in mg/l

FIELD I.D.	TOTAL DISSOLVED SOLIDS	CHLORIDE	SULFATE	NO3/NO2–N	CYANIDE
45–005–GW–1	52	6.7	< 5	< 0.05	NR

LEGEND

WR1 – Composite of subsamples WR1A, 1B, 1C, and 3.
WR2 – Composite of subsamples WR2A and 2B.
BACKGROUND – From the Holliday Mine (45–009–SS–1).
GW1 – From the flow out of adit #2.

XRF ANALYSIS RESULTS

BROKEN HILL
PA NO. 45-005

MDSL AMRB/PIONEER 4/9/93

Mine Name: Broken Hill PA# 45-005
XRF Field Analyses
Results in PPM

XRF SAMPLE ID	CrHI	K	Ca	Ti	CrLO	Mn	Fe	Co	Cu	Zn	As	Sr
45-005-SS-1		8954.69	8324.01	2567.26		3780.19	25954.6			369.353	52.8292 *	177.798
45-005-WR1-A	365.038 *	14752.2	1300.84	1259.48	203.588 *	1568.44	94982.8	550.725 *	98.4646 *	8067.61		27.5093 *
45-005-WR1-B	621.981 *	6090.21	997.152	437.957			89196.9	674.602	400.884	5482.23		38.6474 *
45-005-WR1-C		26241.3	1398.52	2106.73	174.768 *	4204.74	32126.4		86.1975 *	2979.45	230.7 *	18.1062 *
45-005-WR2-A		18830.4	945.541	1544.67		1060.29 *	65176.6		173.514 *	4655.63		21.7083 *
45-005-WR2-B		16079.5	2994.29	2090.41		1134.57 *	51254.8		142.261 *	2030.36		54.2273
45-005-WR-1-COMP		10866.8	2195.92	1180.72		1529.46 *	110745	918.133 *	406.608	5352.95		64.3026
45-005-WR-2-COMP	383.543 *	17142.4	2159.34	1725.75		663.145 *	65835.8		171.66 *	5517.7		39.3539
45-005-WR-2-COMP-DUP		16466.6	2236.71	1724.56		891.663 *	68796.6	432.031 *	175.765 *	3046.92		37.4987
45-005-WR-3	482.43 *	5549.98	3732.81	1165.8			181063	1455.75 *	597.114	5064.06		98.72

	Zr	Hg	Mo	Pb	Rb	Cd	Sb	Ba	Ag	U	Th
45-005-SS-1	186.205			455.401	74.2341			270.072			10.1168 *
45-005-WR1-A	198.968			16486.4	125.755		128.867 *	140.934	180.738 *		
45-005-WR1-B	130.446			43946.3	83.04 *	255.897 *	201.859	48.8326 *			
45-005-WR1-C	229.568			1158.45	197.226			304.392			21.5592 *
45-005-WR2-A	217.387			11575.7	181.219		76.9297 *	174.889			33.8282 *
45-005-WR2-B	244.608			12926.9	170.8		69.382 *	413.322			28.4652 *
45-005-WR-1-COMP	187.831			34122.8	99.3553 *	251.935 *	636.824	125.317	231.406 *		
45-005-WR-2-COMP	239.503			15142.1	175.841		100.177 *	257.347			33.586 *
45-005-WR-2-COMP.	251.803			14008.6	167.834		155.472 *	296.306			24.3571 *
45-005-WR-3	136.79			47270.2			1911.44	89.8487 *	616.526 *		

* – Estimated Quantity
$ – Unvalidated Data

ABANDONED AND INACTIVE MINES SCORING SYSTEM (AIMSS) SCORESHEET

BROKEN HILL
PA NO. 45-005

MDSL AMRB/PIONEER 4/9/93

AIMSS SCORESHEET

SITE NAME: BLUEBIRD
PA NUMBER: 41-009

LINE NO.				
		GROUNDWATER PATHWAY		
1		OBSERVED RELEASE		0
2		EXCEEDENCES		0
3A	GW - LIKELIHOOD OF RELEASE	CONTAINMENT		20
3B		GW DEPTH		10
3C		POTENTIAL TO RELEASE	LINES 3A x 3B	200
4		LIKELIHOOD SCORE	LINES 1 + 2 + 3C	200
5	GW - WASTE CHAR.	CALCULATED SCORE	(SEE WORKSHEET)	0.050
6		WELLS - 1 MI. x 2.5		287.5
7	GW - TARGETS	WELLS - 1 TO 4 MI		991
8		NEAREST WELL		5
9		TARGETS SCORE	LINES 6 + 7 + 8	1283.5
10		**GROUNDWATER SCORE**	LINES 4 x 5 x 9	12835
		SURFACE WATER PATHWAY		
11		OBSERVED RELEASE		300
12	SW - LIKELIHOOD OF RELEASE	EXCEEDENCES		0
13A		CONTAINMENT		20
13B		DISTANCE TO SW		20
13C		POTENTIAL TO RELEASE	LINES 13A x 13B	400
14		LIKELIHOOD SCORE	LINES 11 + 12 + 13C	700
15	SW - WASTE CHAR.	CALCULATED SCORE	(SEE WORKSHEET)	0.057
16		DRINKING WATER POP'N		0
17		IMPACTED DRAINAGE		0
18		WETLANDS		10
19	SW - TARGETS	FISHERY		0
20		RECREATION		5
21		IRRIGATION/STOCK		2
22		T & E SPECIES HABITAT		0
23		TARGETS SCORE	SUM LINES 16 THRU 22	17
24		**SURFACE WATER SCORE**	LINES 14 x 15 x 23	678
		AIR PATHWAY		
25		OBSERVED RELEASE		0
26A	AIR - LIKELIHOOD OF RELEASE	CONTAINMENT		10
26B		DISTANCE TO POPULATION		10
26C		POTENTIAL TO RELEASE	LINES 26A x 26B	100
27		LIKELIHOOD SCORE	LINES 25 + 26C	100
28	AIR - WASTE CHAR.	CALCULATED SCORE	(SEE WORKSHEET)	0.006
29		POPULATION - 4 MILES		300
30		NEAREST RESIDENCE		5
31	AIR - TARGETS	WETLANDS		0
32		PARKS / WILDERNESS		0
33		T & E SPECIES HABITAT		0
34		TARGETS SCORE	SUM LINES 29 THRU 33	305
35		**AIR PATHWAY SCORE**	LINES 27 x 28 x 34	183
		DIRECT CONTACT PATHWAY		
36		OBSERVED EXPOSURE		200
37A	LIKELIHOOD OF EXPOSURE	ACCESSIBILITY		5
37B		DISTANCE TO POPULATION		10
37C		POTENTIAL EXPOSURE	LINES 37A x 37B	50
38		LIKELIHOOD SCORE	LINES 36 + 37C	250
39	D. C. WASTE CHAR.	CALCULATED SCORE	(SEE WORKSHEET)	0.005
40	DIRECT CONTACT TARGETS	POPULATION - 1 MILE		30
41		NEAREST RESIDENCE		5
42		RECREATIONAL USE		0
43		TARGETS SCORE	SUM LINES 40 THRU 42	35
44		**DIRECT CONTACT SCORE**	LINES 38 x 39 x 43	44
45	**TOTAL SITE HUMAN & ENVIRONMENTAL HAZARD SCORE**	(LINES 10 + 24 + 35 + 44) / 100,000		**0.14**

SITE NAME: BLUEBIRD
PA NUMBER: 41-009

LINE NO.		SITE SAFETY		
1	THREAT	ACCESSIBILITY		5
2	HAZARDS	OPEN SHAFTS	100 EA.	20[illegible]
3		OPEN ADITS	50 EA.	0
4		UNSTAB. HIWALLS / PITS	75 EA.	75
5		HAZ. STRUCTURES	40 EA.	0
6		EXPLOSIVES		0
7		HAZ. MATERIALS		0
8		HAZARDS SCORE	SUM LINES 2 THRU 7	275
9	TARGETS	POPULATION - 1 MILE		30
10		NEAREST RESIDENCE		5
11		RECREATIONAL USE		0
12		TARGETS SCORE	SUM LINES 9 THRU 11	35
13		SITE SAFETY SCORE	(LINES 1 x 8 x 12) / 1,000	48.13

APPENDIX F
BROKEN HILL MINE SITE
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS

RECREATIONAL RISK ASSESSMENT CALCULATION SHEETS
Broken Hill Mine Site

<u>SOIL EXPOSURE</u>

Hazard Index – Adult Gold Panner/Rock Hound

COPC	EPC	CDIs (mg/kg/day)			RfDs (mg/kg/day)			HQs			
	(mg/kg)	Soil Ingestion	Dermal Contact	Inhalation	Oral[a]	Dermal[b]	Inhalation[c]	Oral	Dermal	Inhalation	Total
Antimony	344	8.08E-05	1.95E-05	1.12E-09	4.00E-04	6.00E-05	NA	2.02E-01	3.25E-01	NA	5.27E-01
Arsenic	1140	2.68E-04	1.94E-04	3.71E-09	3.00E-04	3.00E-04	NA	8.92E-01	6.47E-01	NA	1.54E+00
Cadmium	26	6.11E-06	1.48E-07	8.46E-11	1.00E-03	2.50E-05	NA	6.11E-03	5.90E-03	NA	1.20E-02
Copper	342	8.03E-05	1.94E-05	1.11E-09	4.00E-02[d]	4.00E-02	NA	2.01E-03	4.85E-04	NA	2.49E-03
Iron	94400	2.22E-02	5.36E-03	3.07E-07	7.00E-01[d]	7.00E-01	NA	3.17E-02	7.65E-03	NA	3.93E-02
Lead	55900	1.31E-02	3.17E-03	1.82E-07	1.50E-03[e]	1.50E-03	4.30E-04	8.75E+00	2.11E+00	4.23E-04	1.09E+01
Mercury	27.2	6.39E-06	1.54E-06	8.85E-11	3.00E-04	3.00E-04	NA	2.13E-02	5.15E-03	NA	2.64E-02
Zinc	11400	2.68E-03	6.47E-04	3.71E-08	3.00E-01	3.00E-01	NA	8.92E-03	2.16E-03	NA	1.11E-02
							Total Hazard	9.92E+00	3.11E+00	4.23E-04	**1.30E+01**
							% of Total Hazard	76.1%	23.9%	0.0%	100.0%

Notes:

[a] All oral RfDs are from EPA's IRIS (2009) unless otherwise noted.

[b] All dermal RfDs were calculated by multiplying the oral RfD by the GI ABS value from EPA's RAGS Part E (2004).

[c] The inhalation RfD for lead is from DEQ (TetraTech 1996). Inhalation RfDs are not available for the remaining COPCs.

[d] RfD source: RAIS (2009)

[e] RfD source: DEQ (TetraTech 1996)

Hazard Index – Child Gold Panner/Rock Hound

COPC	EPC	CDIs (mg/kg/day)			RfDs (mg/kg/day)			HQs			
	(mg/kg)	Soil Ingestion	Dermal Contact	Inhalation	Oral[a]	Dermal[b]	Inhalation[c]	Oral	Dermal	Inhalation	Total
Antimony	344	1.57E-04	2.83E-05	4.40E-09	4.00E-04	6.00E-05	NA	3.93E-01	4.71E-01	NA	8.64E-01
Arsenic	1140	5.21E-04	2.81E-04	1.46E-08	3.00E-04	3.00E-04	NA	1.74E+00	9.37E-01	NA	2.67E+00
Cadmium	26	1.19E-05	2.14E-07	3.32E-10	1.00E-03	2.50E-05	NA	1.19E-02	8.55E-03	NA	2.04E-02
Copper	342	1.56E-04	2.81E-05	4.37E-09	4.00E-02[d]	4.00E-02	NA	3.90E-03	7.03E-04	NA	4.61E-03
Iron	94400	4.31E-02	7.76E-03	1.21E-06	7.00E-01[d]	7.00E-01	NA	6.16E-02	1.11E-02	NA	7.27E-02
Lead	55900	2.55E-02	4.59E-03	7.15E-07	1.50E-03[e]	1.50E-03	4.30E-04	1.70E+01	3.06E+00	2.33E-07	2.01E+01
Mercury	27.2	1.24E-05	2.24E-06	3.48E-10	3.00E-04	3.00E-04	NA	4.14E-02	7.45E-03	NA	4.89E-02
Zinc	11400	5.21E-03	9.37E-04	1.46E-07	3.00E-01	3.00E-01	NA	1.74E-02	3.12E-03	NA	2.05E-02
						Total Hazard		1.93E+01	4.50E+00	2.33E-07	**2.38E+01**
						% of Total Hazard		81%	19%	0%	100%

Notes:

[a] All oral RfDs are from EPA's IRIS (2009) unless otherwise noted.

[b] All dermal RfDs were calculated by multiplying the oral RfD by the GI ABS value from EPA's RAGS Part E (2004).

[c] The inhalation RfD for lead is from DEQ (TetraTech 1996). Inhalation RfDs are not available for the remaining COPCs.

[d] RfD source: RAIS (2009)

[e] RfD source: DEQ (TetraTech 1996)

Excess Lifetime Cancer Risk – Gold Panner/Rock Hound Scenario

COPC	**EPC**	**CDIs (mg/kg/day)**			**SFs $(mg/kg/day)^{-1}$**			**Risk**			
	(mg/kg)	**Soil Ingestion**	**Dermal Contact**	**Inhalation**	**Oral[a]**	**Dermal[b]**	**Inhalation[c]**	**Oral**	**Dermal**	**Inhalation**	**Total**
Arsenic	1140	1.36E-04	4.63E-05	2.52E-09	1.50E+00	1.50E+00	1.51E+01	2.E-04	7.E-05	4.E-08	3.E-04
Cadmium	26	3.11E-06	1.06E-06	5.75E-11	NA	NA	6.30E+00	NA	NA	4.E-10	4.E-10
						ELCR		2.E-04	7.E-05	0.E+00	**3.E-04**
						% of ELCR		74.7%	25.3%	0.0%	100.0%

Notes:

[a] Oral SFs are from EPA’s IRIS (2009).

[b] Dermal SFs were calculated by multiplying the oral RfD by the GI ABS value from EPA’s RAGS Part E (2004).

[c] Inhalation SFs were calculated from the inhalation unit risk as specified by EPA’s RAGS (1995).

WATER EXPOSURE

Hazard Index – Adult Gold Panner/Rock Hound

COPC	**EPC**	**CDIs (mg/kg/day)**		**RfDs (mg/kg/day)**		**HQs**		
	(ug/L)	**Water Ingestion**	**Dermal Contact**	**Oral[a]**	**Dermal[b]**	**Oral**	**Dermal**	**Total**
Arsenic	31	3.03E-05	4.55E-07	3.00E-04	3.00E-04	1.01E-01	1.52E-03	1.03E-01
Cadmium	2	1.96E-06	2.94E-08	1.00E-03	2.50E-05	1.96E-03	1.17E-03	3.13E-03
Copper	2.97	2.91E-06	4.36E-08	4.00E-02[c]	4.00E-02	7.27E-05	1.09E-06	7.37E-05
Iron	69.6	6.81E-05	1.02E-06	7.00E-01[c]	7.00E-01	9.73E-05	1.46E-06	9.87E-05
Lead	107	1.05E-04	1.57E-06	4.30E-04[d]	4.30E-04	2.43E-01	3.65E-03	2.47E-01
Manganese	15.2	1.49E-05	2.23E-07	2.40E-02	9.60E-04	6.20E-04	2.32E-04	8.52E-04
Mercury	0.044	4.31E-08	6.46E-10	3.00E-04	3.00E-04	1.44E-04	2.15E-06	1.46E-04
Zinc	867	8.48E-04	7.64E-06	3.00E-01	3.00E-01	2.83E-03	2.55E-05	2.85E-03
				Total Hazard		3.50E-01	6.61E-03	**3.57E-01**
				% of Total Hazard		98.1%	1.9%	**100.0%**

Notes:

[a] All oral RfDs are from EPA's IRIS (2009) unless otherwise noted.

[b] All dermal RfDs were calculated by multiplying the oral RfD by the GI ABS value from EPA's RAGS Part E (2004).

[c] RfD source: RAIS (2009)

[d] RfD source: DEQ (TetraTech 1996)

Hazard Index – Child Gold Panner/Rock Hound

COPC	**EPC**	**CDIs (mg/kg/day)**		**RfDs (mg/kg/day)**		**HQs**		
	(ug/L)	**Water Ingestion**	**Dermal Contact**	**Oral[a]**	**Dermal[b]**	**Oral**	**Dermal**	**Total**
Arsenic	31	1.42E-04	6.37E-07	3.00E-04	3.00E-04	4.72E-01	2.12E-03	4.74E-01
Cadmium	2	9.13E-06	4.11E-08	1.00E-03	2.50E-05	9.13E-03	1.64E-03	1.08E-02
Copper	2.97	1.36E-05	6.10E-08	4.00E-02[c]	4.00E-02	3.39E-04	1.53E-06	3.41E-04
Iron	69.6	3.18E-04	1.43E-06	7.00E-01[c]	7.00E-01	4.54E-04	2.04E-06	4.56E-04
Lead	107	4.89E-04	2.20E-06	4.30E-04[d]	4.30E-04	1.14E+00	5.11E-03	1.14E+00
Manganese	15.2	6.94E-05	3.12E-07	2.40E-02	9.60E-04	2.89E-03	3.25E-04	3.22E-03
Mercury	0.044	2.01E-07	9.04E-10	3.00E-04	3.00E-04	6.70E-04	3.01E-06	6.73E-04
Zinc	867	3.96E-03	1.07E-05	3.00E-01	3.00E-01	1.32E-02	3.56E-05	1.32E-02
				Total Hazard		1.63E+00	9.25E-03	**1.64E+00**
				% of Total Hazard		99.4%	0.6%	**100.0%**

Notes:

[a] All oral RfDs are from EPA's IRIS (2009) unless otherwise noted.

[b] All dermal RfDs were calculated by multiplying the oral RfD by the GI ABS value from EPA's RAGS Part E (2004).

[c] RfD source: RAIS (2009)

[d] RfD source: DEQ (TetraTech 1996)

Excess Lifetime Cancer Risk – Gold Panner/Rock Hound Scenario

COPC	EPC	CDIs (mg/kg/day)		SFs $(mg/kg/day)^{-1}$		Risk		
	(ug/L)	Water Ingestion	Dermal Contact	Oral[a]	Dermal[b]	Oral	Dermal	Total
Arsenic	31	2.25E-05	2.11E-07	1.50E+00	1.50E+00	3.E-05	3.E-07	3.E-05
					ELCR	3.E-05	3.E-07	**3.E-05**
					% of ELCR	99.1%	0.9%	**100.0%**

Notes:

[a] Oral SF is from EPA's IRIS (2009).

[b] Dermal SF was calculated by multiplying the oral RfD by the GI ABS value from EPA's RAGS Part E (2004).

APPENDIX G
ECOLOGICAL RISK ASSESSMENT
BROKEN HILL MINE SITE

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 1 - SITE SPECIFIC INFORMATION

SITE NAME: **Broken Hill Mine Site**

	Aquatic Life Maximum Surface Water Conc. ug/L	Assoc. Surface Water Hardness* mg/L	Deer Ingestion Water Conc. ug/L	Deer Ingestion/ Phytotoxicity Surface Conc. mg/Kg
Antimony	NA	25	NA	344
Arsenic	31	25	31	1140
Cadmium	2	25	2	26
Copper	2.97	25	2.97	0
Iron	69.6	25	69.6	94400
Lead	107	25	107	55900
Manganese	15.2	25	15.2	0
Mercury	0.044	25	0.044	27.2
Zinc	867	25	867	11400

Note: Minimum hardness=25 mg/L; Maximum=400 mg/L
nhd = not hardness dependent COCs

All site specific data are entered on page 1; pages 2 through 5 are lookup tables and page 6 presents the resultant EQs.

Enter media concentrations for the site, either areal averages or site maximum concentrations. If a contaminant does not meet the criteria for "contaminant of concern", enter 0 as the concentration or leave it blank (don't leave hardness blank). These criteria are listed below:

1) contaminants associated with and present at the site;
2) contaminants with concentrations significantly above background (generally 3 times higher);
3) contaminants with at least 20% of the measured concentrations above the detection limit; and,
4) contaminants with acceptable QA/QC results applied to the data.

Column B are surface water concentrations for comparison to aquatic life standards. Enter the maximum concentration measured in "real" surface water at the site (i.e. not adit discharges or intermittent water) that aquatic life might live in.

Column C are hardness measurements for the corresponding surface water concentration in column B in mg/L. Note that the minimum hardness for AWQC calculation is 25 mg/L and the maximum is 400 mg/L. Don't leave blank.

Column D are the maximum sediment concentrations measured at the site in "real" surface water (not adit discharges or intermittent drainages) for aquatic life impacts.

Column E are surface water concentrations that deer might drink at the site. This includes adit discharges, intermittent drainages, and ponded water, as long as it is accessible by deer.

Column F are surface waste concentrations for both the deer ingestion (salt) scenario and the phytotoxicity scenario. Enter the mean surface concentration of the highest concentration source at the site (generally tailings).

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 2 - AQUATIC LIFE CRITERIA EQ

SITE NAME: **Broken Hill Mine Site**

	Acute Criteria ug/L	Chronic Criteria ug/L	Acute AWQC EQ	Chronic AWQC EQ
Arsenic	340	150	0.0912	0.2067
Cadmium	0.5	0.1	3.8376	20.6411
Copper	3.8	2.9	18.3557	24.3915
Iron	NA	1000	NA	0.1070
Lead	14.0	0.5	1.0873	27.9011
Manganese	50.0	NA	0.0009	NA
Mercury	2.4	0.012	0.0183	3.6667
Zinc	37	37	23.4222	23.4222
TOTAL			46.8131	100.3362

This page calculates AWQC for the hardness values supplied on page 1, column C. Both chronic and acute are calculated in the table; however, the chronic values are for reference only. Chronic criteria are not applicable unless surface water has been sampled over the entire range of hydrologic conditions at the site, and a statistically significant number of samples at each station are averaged to determine the chronic concentrations over time.

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 3 - DEER INGESTION EQ

SITE NAME: **Broken Hill Mine Site**

	Deer Intake Dose Est. Soil + water mg/Kg-day	Deer Ingestion EQ	
Arsenic	0.0227	0.0035	Toxicological effects from ATSDR, 1991a
Cadmium	0.0007	0.0003	Toxicological effects from Sample et. al, 1996
Copper	1.5112	0.0168	Toxicological effects from NAS, 1980
Lead	0.9045	180.9099	Toxicological effects from ATSDR, 1991c
Zinc	0.3088	0.0005	Toxicological effects from Maita et al, 1981
TOTAL		180.9311	

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 4 - PHYTOTOXICITY EQ

SITE NAME: **Broken Hill Mine Site**

	Phytotoxic Soil Conc.* mg/Kg	Phytotoxicity EQ
Arsenic	50	22.8000
Cadmium	8	3.2500
Copper	125	0.0000
Lead	400	139.7500
Zinc	400	28.5000
TOTAL		194.3000

*Upper end of range, from Kabata-Pendias and Pendias, 1989

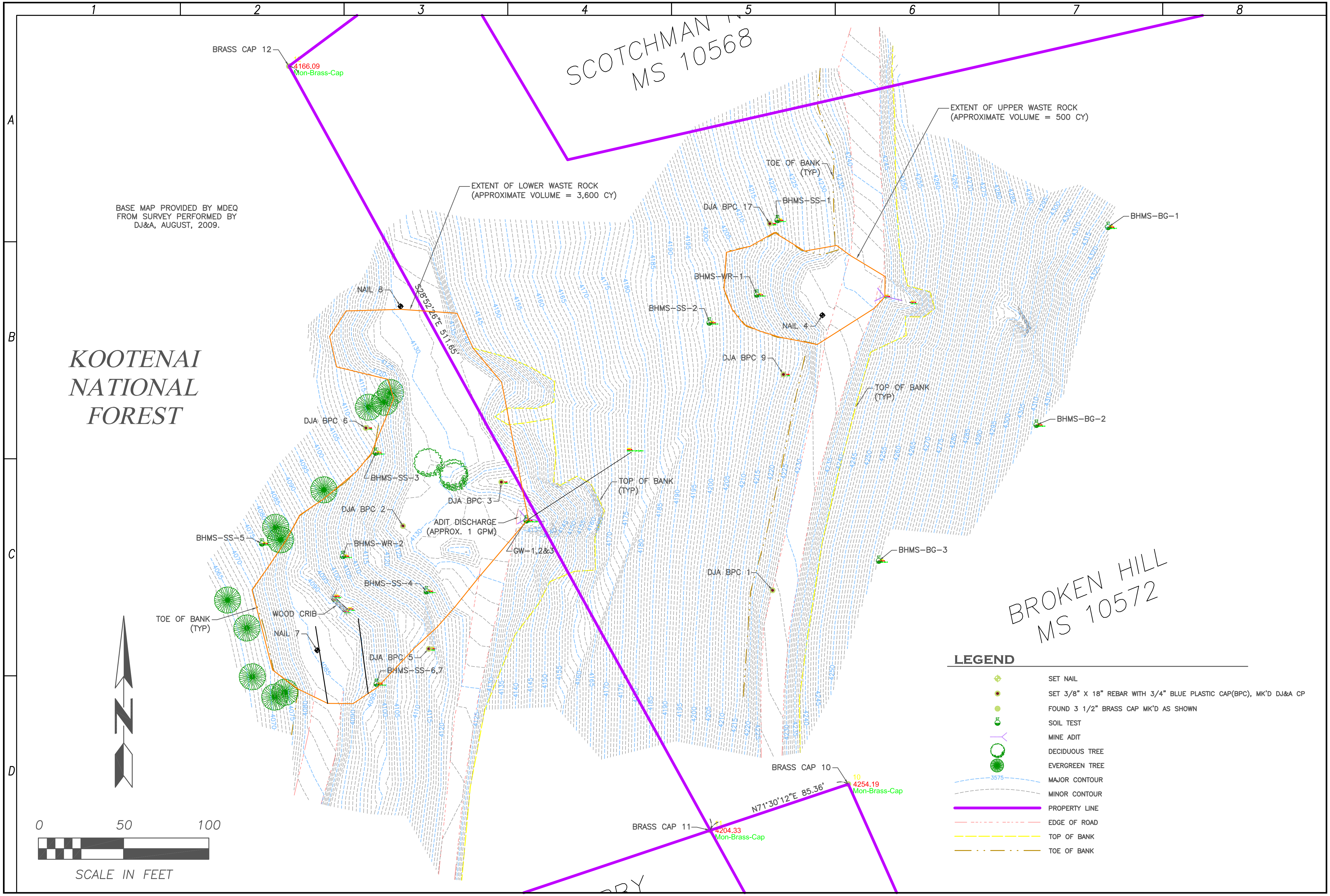
ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 5 - COMBINATION OF ECOLOGIC IMPACT QUOTIENTS (EQs)

SITE NAME: **Broken Hill Mine Site**

	Aquatic Life-Surface Water EQ (Acute)	Deer Ingestion EQ	Plant Phytotoxicity EQ	Total EQ by COC
Arsenic	0.0912	0.0035	22.8000	22.8947
Cadmium	3.8376	0.0003	3.2500	7.0878
Copper	18.3557	0.0168	0.0000	18.3725
Iron	NA	NA	NA	0.0000
Lead	1.0873	180.9099	139.7500	321.7472
Manganese	0.0009	NA	NA	0.0009
Mercury	0.0183	NA	NA	0.0183
Zinc	23.4222	0.0005	28.5000	51.9228
TOTAL	46.8131	180.9311	194.3000	422.0442

APPENDIX H
ESTIMATES OF WASTE ROCK VOLUME AND SURVEYED SITE MAP BROKEN HILL MINE SITE



DESIGNED BY:	RGS	10/08/09
DRAWN BY:	DCB	10/08/09
CHECKED BY:	RGS	10/08/09
APPROVED BY:	PES	10/08/09

CONTRACT NUMBER: MDEQ 407025

BROKEN HILL MINE SITE

SANDERS COUNTY
MONTANA

DATE	REVISIONS	BY

Portage

BUTTE MONTANA OFFICE
103 N. MAIN, SUITE 103, BUTTE MT 59701
PHONE 406.782.2822 FAX: 406.782.2466

DRAWING NO.
DWG-2194 07-E1

SHEET NO.
1

OF 1

Broken Hill Mine Site
Waste Rock Volume Estimates

Totals	Upper	423.6	CY
	Lower	3,015.7	
Contingency		20.0%	
REVISED	Upper	508.4	CY
	Lower	3,618.8	CY

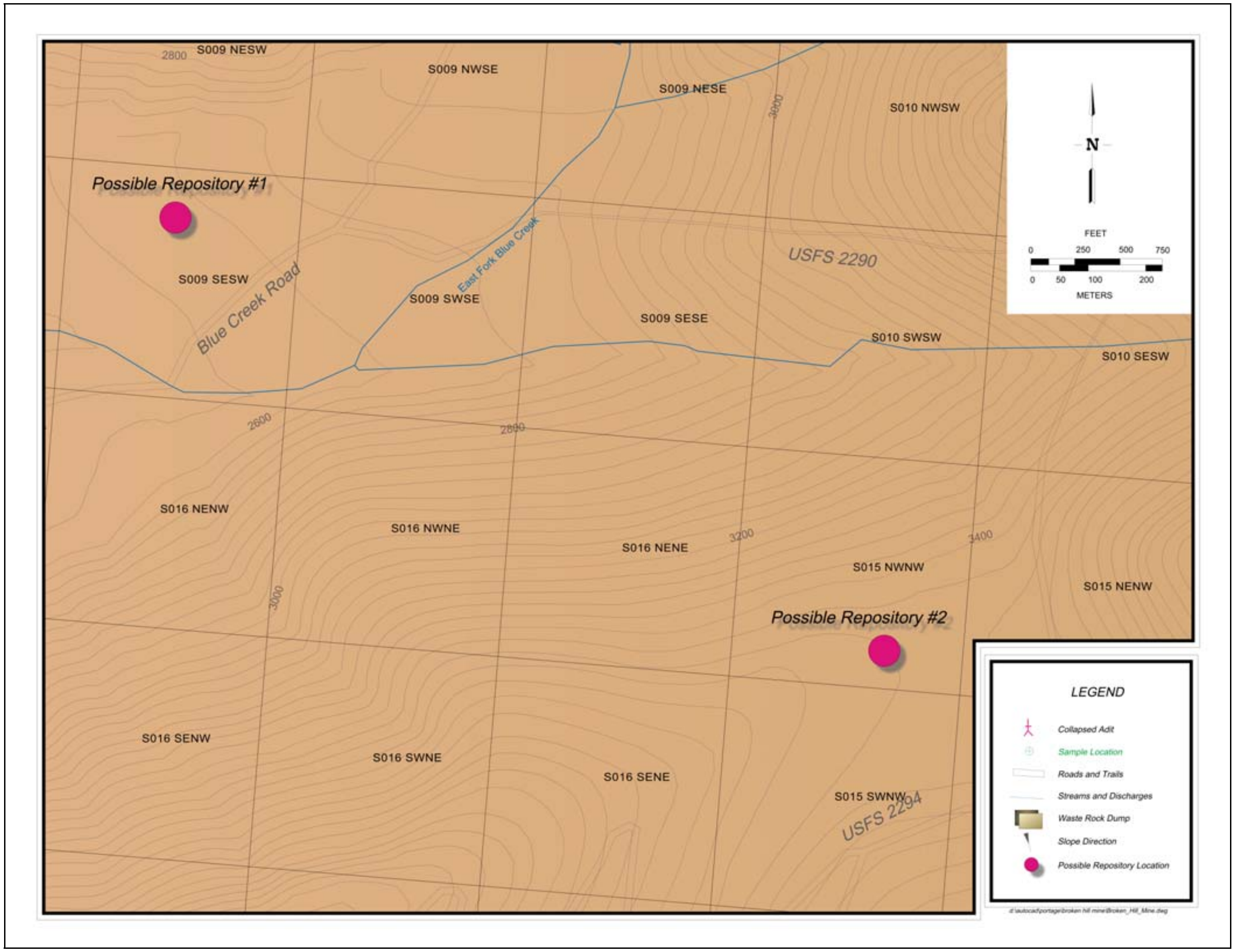
Upper Pile

Outline	Depth (ft)		Area (sq ft)	Area Between Outlines (sq ft)	Subtotal Volume (CY)	
0	0.0		4,260.85			
		0.5		1,576.94	29.2	
1	1.0		2,683.91			
		1.5		654.41	36.4	
2	2.0		2,029.50			
		2.5		495.05	45.8	
3	3.0		1,534.45			
		3.5		380.03	49.3	
4	4.0		1,154.42			
		4.5		326.25	54.4	
5	5.0		828.17			
		5.5		270.09	55.0	
6	6.0		558.08			
		6.5		231.82	55.8	
7	7.0		326.26			
		7.5		168.21	46.7	
8	8.0		158.05			
		8.5		123.19	38.8	
9	9.0		34.86			
		9.5		34.86	12.3	
				TOTAL	423.6	CY

Lower Pile

Outline	Depth (ft)		Outline Area 1 (sq ft)	Outline Area 1 (sq ft)	Total Area of Outlines (sq ft)	Area Between Outlines (sq ft)	Subtotal Volume (CY)	
0	0.0		21,482.61		21,482.61			
		0.5				11064.35	204.9	
1	1.0		1,050.71	9,367.55	10,418.26			
		1.5				1649.29	91.6	
2	2.0		819.14	7,949.83	8,768.97			
		2.5				1813.06	167.9	
3	3.0		543.08	6,412.83	6,955.91			
		3.5				1599.24	207.3	
4	4.0		197.00	5,159.67	5,356.67			
		4.5				1122.48	187.1	
5	5.0		32.66	4,201.53	4,234.19			
		5.5				723.49	147.4	
6	6.0			3,510.70	3,510.70			
		6.5				477.16	114.9	
7	7.0			3,033.54	3,033.54			
		7.5				510.81	141.9	
8	8.0			2,522.73	2,522.73			
		8.5				473.9	149.2	
9	9.0			2,048.83	2,048.83			
		9.5				2048.83	720.9	
10	10.0			1,656.96	1,656.96			
		10.5				265.25	103.2	
11	11.0			1,391.71	1,391.71			
		11.5				260.88	111.1	
12	12.0			1,130.83	1,130.83			
		12.5				220.44	102.1	
13	13.0			910.39	910.39			
		13.5				313.25	156.6	
14	14.0			597.14	597.14			
		14.5				488.65	262.4	
15	15.0			108.49	108.49			
		15.5				108.49	62.3	
						Additional Pile (north)	70.0	
						Additional Pile (south)	15.0	
						TOTAL	3,015.7	CY

APPENDIX I
MAP OF POTENTIAL REPOSITORY LOCATIONS
BROKEN HILL MINE SITE



Possible Repository Locations - BHMS