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HUMAN HEALTH RISK ASSESSMENT REPORT

Almeda Mine
Josephine County, Oregon

Prepared for:
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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Site Location and Geology 1
1.2 Site Conditions 2
2.0 SITE CHARACTERIZATION 3
2.1 Surface Discharge Seep at A520 3
2.2 Waste Piles 3
3.0 CHEMICALS OF POTENTIAL CONCERN (COPC) 6
4.0 CONCEPTUAL SITE MODEL 6
5.0 RISK EVALUATION APPROACH 8
6.0 TOXICITY ASSESSMENT 9
6.1 Lead 10
7.0 CALCULATION OF SITE-SPECIFIC RBCS 11
7.1 Lead 11
8.0 RISK-CHARACTERIZATION 11
8.1 Excess Cancer Risk from Exposure to Surface Water Drainage 13
8.2 Excess Cancer Risk from Exposure to Surface Waste Piles 13
8.3 Cumulative Excess Cancer Risk 13
8.4 Hazard Index from Exposure to Surface Water Drainage 14
8.5 Hazard Index from Exposure to Surface Waste Piles 14
8.6 Cumulative Hazard Index 14
9.0 HUMAN HEALTH RISK ASSESSMENT UNCERTAINTIES 14
10.0 SUMMARY AND DISCUSSION 15
11.0 LIMITATIONS 17
12.0 SIGNATURES 17
13.0 REFERENCES 18
14.0 LIST OF ABBREVIATIONS AND ACRONYMS 19

FIGURES

Figure 1 – Site Vicinity Map
Figure 2 – Site Plan
Figure 3 – Enlarged Plan A
Figure 4 – Enlarged Plans B and C
Figure 5 – Conceptual Site Model – Potential Pathways of Exposure

TABLES

Table 1 – Quarterly Water-Quality Monitoring Results
Table 2 – Summary of Soil Analyses of Select Total Metals
Table 3 – Summary Statistics for Selected Total Metals
Table 4 – Summary Statistics for Selected Total Metals in Soil
Table 5 – Summary of Exposure Modifications and Calculated RBCs
Table 6 – Carcinogenic Risk Characterization
Table 7 – Non-Carcinogenic Risk Characterization

APPENDICES

Appendix A Soil Laboratory Report and Data Quality Review
Appendix B Raw Data Statistics
Appendix C RBDM Spreadsheets

1.0 INTRODUCTION

PBS Engineering and Environmental (PBS) was retained by NRC Environmental Services, Inc. (NRC) to perform a Human Health Risk Assessment (HHRA) of the Almeda Mine site (Site) in Josephine County, Oregon. The risk assessment is being conducted for the US Bureau of Land Management (BLM) following various site activities to assess how the previous mining activities may affect likely human users of the Site. This evaluation delineates the most likely exposure pathways and characterizes the potential for human health impacts from the Site. Analytical data from the ongoing surface water monitoring of the mine discharge water was used in this evaluation. After initial review of the Site, PBS recommended the collection of samples from select waste piles at the Site so that the HHRA could include this potential source of risk in the evaluation. A summary of the soil sampling activities and analytical results and findings are presented in Section 2.1 of this report.

1.1 Site Location and Geology

The Almeda Mine is located in Josephine County, within the BLM Medford District, Grants Pass Resource Area, approximately one river mile north of the town of Rand and three miles north of Galice in Township 34 South, Range 7 West, Section 18 and Range 8 West, Section 13 of the Willamette Meridian (Figure 1). The Site is located near the north bank of the Rogue River within the Hellgate Recreation Area. The Site can be accessed via boat or alternatively via more than ten miles of logging and four-wheel drive jeep roads which are frequently impassable during the winter months. The Site is primarily accessed by river users since there are no roads on the north/east bank of that stretch of the river. The south/west bank of the river in the vicinity of the Site is accessed by river users and the Merlin-Galice Road.

The Site is located within the recreational ection of the National Rogue Wild and Scenic River and three miles upstream of the Wild Section (starts three miles downstream at Grave Creek). The river is protected for its outstanding Remarkable values of recreation, scenery and fisheries. The average flow of the Rogue River ranges from 1,400 to 5,954 cubic feet per second (CFS), with the lowest flows occurring in September and the highest flows in January. The Site's location, within a federally designated recreation corridor and within the County's Forest Commercial (FC) zoning, suggests that the existing land uses will remain for the foreseeable future and no new development will occur.

The Almeda County Park (boat access, day use, and camping facilities) and the Rand day use area are located within a mile upstream of the Site. Additional boat access and designated camping are offered at Argo, approximately 1.5 miles downstream of the Site. The majority of the shoreline in the immediate vicinity of the Site is publicly owned under BLM management as part of the Recreation corridor.

A review of groundwater uses in the area of the Almeda Mine indicate one well in Section 18 and five wells in Section 24. The wells in Section 24 appear to be connected to the shallow aquifer located on the opposite side of the Rogue River from the Site. All of the wells are located in the presumed upgradient direction of the Site. There are no known uses of surface water for domestic purposes in the presumed downgradient direction of the Site.

1.2 Site Conditions

The Almeda Mine consists of a series of adits and stopes, connected by crosscuts and raises drilled into the hillside from elevations up to 300 feet above and reportedly over 400 feet below the Rogue River level (BLM, 2003). The ore body of the Almeda Mine is located in a volcanic sulfide deposit of the Rogue Formation. The mine has a flood plain level adit (520 Adit or A520) at an elevation of approximately 685 feet above mean sea level (AMSL). Above A520 is a collapsed adit (the 0 Adit) and the 620 Adit located at an elevation of 776 AMSL, near the access road and overburden rock piles. A520 discharges adit seeps between 8 and 20 gallons per minute (gpm) and flows across the rocky flood plain to the Rogue River located at an elevation of about 660 feet AMSL (Figure 2).

Initial groundwater sampling conducted in 2001 by BLM indicated the discharge from A520 consisted of acidic (i.e. low pH) water with elevated metals, typical of acid mine drainage (AMD). Naturally occurring metals appear to be primarily released into solution by the oxidation of the sulfide minerals carried in groundwater and exposed to oxygen.

In order to increase the pH and reduce the leaching of metals from A520, a pilot test using an Aquafix treatment unit was installed in 2002 to add calcium oxide lime to the discharge water to raise the pH levels so that the metals in water would precipitate into the settling basin near the unit. The results of the pilot project demonstrated that the Aquafix unit is capable of reducing the major loading of metals by raising the pH. However, the distribution of the lime product to match the relatively low flow rates (9 to 20 gpm) from the adit discharge was difficult to achieve, especially given the Site's remote location.

A limestone treatment channel was installed as a second pilot test to remove metals as the discharge water passes through the limestone-filled channel (Figure 3). Over a relatively short time the limestone became coated with iron hydroxides and the neutralization effects were reduced, thereby requiring replacement. Due to the remote location of the Site, maintenance and replacement is problematic.

The BLM retained Saguaro GeoServices, Inc. to conduct a surface and underground assessment of the abandoned mine for the purposes of evaluating the feasibility of plugging portions of the mine contributing to releases of impacted groundwater (Saguaro, 2002). The study concluded that there were several investigative steps necessary to determine if plugging of A520 would be successful. The study also indicated that several additional measures would be needed in combination with plugging the adit to redirect flow to a higher level away from the river flood plain. The heterogeneity of the rock formation's permeability and variable hydrostatic pressures could complicate any attempt to control the A520 discharge.

The mine Site also has two primary waste piles: a smelter slag pile (Slag Pile) adjacent to the former mine furnace and a waste rock dump (Rock Dump) that is situated on the canyon wall below A620 and extending down slope to the floodplain (see Figure 3). The Rock Dump covers an area of approximately 50,000 sq. ft. and averages about 3 feet thick (BLM, 2003). The Slag Pile is located just west of A520 adjacent to the access road and extends into the floodplain in close proximity to the Almeda Riffle. There are also a few remnant mining structures, including concrete foundations and scrap metal at the Site. These two waste piles were previously analyzed using a portable X-ray

fluorescence analyzer. The analysis indicated that arsenic, iron, lead, and zinc were the primary metals detected with mean concentrations of 410mg/l, 127,000 mg/l, 537 mg/l, and 462 mg/l, respectively (BLM, 2003).

A repository consisting of approximately 155 cubic yards of waste material from the A520 adit opening was constructed at the Site in November 2009. The Repository consists of an unlined excavated area located east of A620 that was filled with the A520 material and capped with the excavated material, geotextile fabric, a single layer of 50-millimeter thick high density polyethylene (HDPE) liner. The liner is covered with approximately 2 feet of Site soils (Figure 3).

2.0 SITE CHARACTERIZATION

2.1 Surface Discharge Seep at A520

The BLM has contracted with Katalyst, Inc. of Medford to conduct water sampling of the groundwater seeping out of A520 and other select locations since the winter of 2009 (Katalyst, 2012). Samples have been collected from the A520 discharge, the discharge from the limestone treatment channel effluent (LSCE), the Galice Road culvert outfall (GRCO) on the south bank of the river, and at locations upstream (RRRA), downstream (RRAR) and within 100 feet of the discharge to the Rogue River (RRMX). A total of twelve quarterly sampling events have occurred at A520 and at LSCE, while the Rogue River samples have been collected annually during the summer for the past one or two years. The GRCO sampling has been conducted when there is water flowing out of the culvert.

The samples have been analyzed for both dissolved and total metals (aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc) utilizing U.S. Environmental Protection Agency (EPA) Method 200.7/200.8 and mercury utilizing EPA Method 245.1. Mercury was not detected in any of the samples at or above the method reporting limit. The other eight metals were detected at A520 and the LSCE at relatively comparable concentrations since the quarterly sampling began in February 2009, suggesting the limestone channel is coated and not providing any significant ongoing treatment. Since the LSCE concentrations are very similar, the A520 data was used in the risk assessment calculations.

Total concentrations are generally slightly higher than dissolved concentrations. Samples representing the Rogue River water upgradient and downgradient of the Site detected these same metals at concentrations two to three orders of magnitude lower than those detected in A520 and the LSCE. A summary of the surface water sampling analyses is provided in Table 1.

2.2 Waste Piles

In order to improve the quality of the data for risk assessment purposes, PBS conducted surface soil sampling of the Slag Pile (SL), Rock Dump (RD), and background (BG) samples for selected total metals. Each area was grided into approximate equal areas to achieve a minimum of ten (10) sample locations. The number of sample locations was increased to 24 to accommodate the larger surface area of the RD Area. Background samples were collected from road cuts located topographically above any known former mining activity according to BLM personnel on site during the sampling event. Half of the BG samples were collected from soil within the Rogue Fm (BG-1 thru BG-5) and the

remaining half of the BG samples (BG-6 thru BG-10) were collected from soil within the Galice Fm (BLM, 2003, see Figure 4). The waste rock material within the Repository was not sampled as originally planned due to the presence of the plastic liner capping the material. Samples were collected from the former furnace area (FR) adjacent to the Slag Pile to assess whether the residual surface soils had similar concentrations to the Slag Pile. Sample locations are shown in Figure 3

Sampling Protocol

Discrete samples were collected from within each grid using clean disposable nitrile gloves and plastic trowels. Soil was directly placed into clean laboratory supplied jars with Teflon-lined lids. The sample containers were stored on ice in a cooler during the collection period. The coolers were sealed at the end of the sampling event and transported under a formal chain-of-custody to Test America Laboratory in Beaverton for analysis. The samples were analyzed for total aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), and zinc (Zn) using EPA Method 6020. Approximately 20 percent of the samples were also analyzed for mercury (Hg) using EPA Method 7471A.

Laboratory Analyses

The laboratory results were reviewed by a PBS chemist to verify the data quality objectives were met and summarized in the data quality report (DQR) in Appendix A. The only data quality issue that resulted in qualified data was the analyses of background samples for arsenic and copper. The reported results may be low based on the below-acceptable matrix spike/matrix spike duplicate recoveries. This is most likely due to sample matrix interference. Except as noted above and noted in the DQR, the data is considered complete and the usefulness of this data is based on EPA guidance documents referenced in the DQR. Upon consideration of the information presented above, the data is considered usable. A summary of the data is presented in Table 2 and the complete laboratory report is also included in Appendix A.

Results

Ten background samples (BG-) were collected to represent typical soil types originating from both the Rogue and Galice Fm. Less than 10% of samples detected cadmium, selenium, or silver and only 30% contained detectable for chromium and nickel. Aluminum ranged from 3,770 to 30,700 mg/kg, arsenic ranged from 12.7 to 305 mg/kg, copper ranged from 33 to 365 mg/kg, iron ranged from 31,900 to 138,000 mg/kg, Lead ranged from 13 to 719 mg/kg, manganese ranged from 357 to 2,590 mg/kg, and zinc ranged from 115 to 579 mg/kg. Mercury was detected in one of two samples at 0.2 mg/kg.

Ten smelter slag pile samples (SL-) were collected across the Slag Pile area. No cadmium, chromium, nickel, or selenium, were detected in the SL samples. Aluminum ranged from 5,420 to 52,000 mg/kg, arsenic ranged from 50.3 to 301 mg/kg, copper ranged from 287 to 4,620 mg/kg, iron ranged from 52,100 to 188,000 mg/kg, lead ranged from 36.7 to 254 mg/kg, manganese ranged from 119 to 279 mg/kg, silver ranged from 14.6 to 419 mg/kg and zinc ranged from 36.7 to 5,680 mg/kg. Mercury was detected in one of two samples at 0.2 mg/kg.

Two samples (FR-) were collected in the immediate vicinity of the former furnace area adjacent to the SL samples. Aluminum ranged from 7,120 to 8,180 mg/kg, arsenic ranged from 138 to 251 mg/kg, cadmium was detected in one sample at 3.4 mg/kg,

chromium ranged from 31.9 to 37.3 mg/kg, copper ranged from 258 to 575 mg/kg, iron ranged from 37,400 to 92,800 mg/kg, lead ranged from 430 to 861 mg/kg, manganese ranged from 152 to 234 mg/kg, nickel ranged from 26.3 to 28.3 mg/kg, selenium ranged from 7.6 to 13.4 mg/kg, silver ranged from 16.6 to 42.9 mg/kg and zinc ranged from 167 to 388 mg/kg. Mercury was detected in one of two samples at 1.3 mg/kg.

Twenty-four samples were collected from the rock dump area (RD-). Aluminum ranged from 675 to 15,100 mg/kg, arsenic ranged from 5.3 to 628 mg/kg, cadmium ranged from 0.57 to 1.96 mg/kg, chromium ranged from 1.15 to 23.5 mg/kg, copper ranged from 6.61 to 328 mg/kg, iron ranged from 2,900 to 103,000 mg/kg, lead ranged from 17.6 to 2,960 mg/kg, manganese ranged from 1.32 to 368 mg/kg, nickel ranged from 1.15 to 25.1 mg/kg, selenium ranged from 3.84 to 56.1 mg/kg, silver ranged from 3.6 to 174 mg/kg and zinc ranged from 13 to 535 mg/kg. Mercury was detected in all five of the samples submitted for mercury analysis, ranging from 1.36 to 6.14 mg/kg.

Discussion

A few generalizations can be made about the surface sampling conducted within select waste piles at the Almeda Mine Site in comparison with background samples.

- The background samples contained few detectable concentrations of cadmium, chromium, nickel, selenium, and silver. Concentrations of arsenic, iron, and lead appeared to be elevated when compared to generic risk based concentrations. Background concentrations of manganese and nickel were higher than in samples from the waste piles.
- The Slag Pile samples did not contain detectable cadmium, chromium, nickel and selenium at or above the method reporting limit. However, silver was present in most samples. Concentrations of aluminum, arsenic, copper, iron, and zinc were greater than the mean background samples while lead and manganese concentrations were lower than the background concentrations for those metals.
- The FR samples contained concentrations of metals that were within the range of the concentrations detected with the Slag Pile results. One exception is lead which was detected at a higher mean concentration in the FR samples compared to the mean of the SL samples, but lower than the mean of the RD samples. Additionally, chromium, nickel, and Selenium were not detected in the SL samples, but were detected in both FR samples. It should be noted that only two samples were collected from the furnace area so caution should be used in drawing any conclusions based on the limited data.
- The majority of Rock Dump samples contained detectable concentrations of all of the compounds of interest (COI) with concentrations of arsenic, cadmium, lead, selenium and silver, being greater than background mean concentrations and aluminum, chromium, iron, manganese, nickel and zinc being lower than the mean background concentrations.
- The SL sample group contained higher concentrations of aluminum, copper, iron, silver, and zinc than the RD or BG sample groups.
- The RD sample group overall contained the higher mean concentrations of arsenic, lead, and selenium than the SL or BG groups.
- The sampling in each sample group contained very low concentrations of mercury which is consistent with the A520 water sampling.
- It appears that the eastern third of the RD samples (RD-17 through RD-24 on Fig. 3) generally contained lower concentrations of metals, including two COI

with very few detections (manganese and zinc) and three COI with no detections above the method reporting limit (cadmium, chromium, nickel).

3.0 CHEMICALS OF POTENTIAL CONCERN (COPC)

Surface Water Discharge Seep

The COI were identified as the following total trace metals: aluminum, arsenic, cadmium, copper, iron, lead, manganese, mercury and zinc. Maximum detected concentrations from the A520 samples representing untreated water were screened against the most conservative Oregon Risk Based Concentrations (RBCs) for groundwater ingestion from tapwater (DEQ, 2011). If an RBC was not available for a specific chemical, the EPA Regional Screening Levels (RSLs; EPA, 2011) were used. RSLs were used for aluminum, iron and zinc. All of the chemicals of interest except mercury were considered a COPC. Mercury was eliminated as a COPC because the maximum detected concentration was significantly below the most conservative RBC. A summary of the COPC screening is presented on Table 3. All of the maximum detected values of COPCs exceed their respective RBC or RSL. The mean detected values for aluminum and zinc were below their respective RSL. The mean of the detected concentrations for the other COPCs exceeded their respective screening level.

Waste Piles

The COI were identified as the following trace metals: aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc. Maximum detected concentrations from the SL and RD samples representing surface soils were screened against the most conservative RBC for direct ingestion, dermal contact and inhalation. If an RBC was not available for a specific compound (i.e. iron), the RSLs were used. Lead concentrations were initially compared with RBCs derived using the Integrated Exposure Uptake Biokinetic (IEUBK) model (see Section 6.1). The COPCs for the waste piles were identified as arsenic, copper, iron, lead and silver. All of the maximum detected values and many of the mean values of COPCs exceed their respective RBC or RSL in either the Slag Pile or the Rock Dump samples. It should be noted that maximum detected concentrations of arsenic, iron, lead and manganese in the background (BG) sample group exceed the respective RBCs/RSLs. Additionally, mean arsenic and iron concentrations in background samples exceed their respective RBC/RSL. A summary of the COPC screening is presented on Table 4. All of the maximum detected values of COPCs exceed their respective RBC or RSL. The mean detected values of copper and silver were below their RBC in both SL and RD sample groups.

4.0 CONCEPTUAL SITE MODEL

The Conceptual Site Model (CSM) describes potential chemical sources, release mechanisms, environmental transport processes, exposure routes, and receptors. The primary purpose of the CSM is to describe pathways by which human receptors may be exposed to COPCs. According to the EPA (1989), a complete exposure pathway consists of four necessary elements: (1) a source and mechanism of chemical release to the environment, (2) an environmental transport medium for a released chemical, (3) a point of potential contact with the impacted medium (referred to as the exposure point), and (4) an exposure route (e.g., water ingestion) to the exposure point.

Processes that structure the fate and transport of COPCs in the environment and potential exposure scenarios are discussed below and are graphically depicted in Figure 5.

Primary Sources
The majority of chemical impacts to the surface water at the Site result from discharges of acidic groundwater containing sulfide minerals from A520. The primary chemical impact to the surface soils is from the waste piles from the former mining operation and processing activities.

Fate and Transport
The primary mechanism that affects fate and transport of released COPCs from groundwater discharges from A520 is the oxidation of the water as it discharges across the rocky flood plain to the discharge point into the Rogue River. The primary mechanism that affects the fate and transport of released COPCs from the waste piles are direct contact with particles of the waste material.

Exposure Routes
The primary exposure routes for the groundwater discharge from A520 are through dermal contact and ingestion of the water. The inhalation pathway is unlikely because the discharge is open to ambient air and the COPCs are not volatile. The primary exposure routes for the waste piles are dermal contact, ingestion and inhalation of soil particles from being in close proximity to the Slag Pile and the Rock Dump.

Potential Receptors
The primary current and likely future receptors are recreationalists accessing the Site as they float down the Rogue River. The potential for current and future construction/excavation workers conducting maintenance at the Site was also considered in the evaluation.

Exposure Scenario
The Site is currently a former mine and is unlikely to be reopened as an active mine due to its location within a recreational corridor of a Wild and Scenic River. The primary current and likely future receptors are recreationalists accessing from the river as they float past the Site. The seasonal changes in river flows and climate limit river use to approximately six (6) months per year (late spring to late fall). Although there are more preferable take-out locations with designated camping upstream (Rand) and downstream (Argo) of the Site, recreationalists have been known to pull-out on the rocky floodplain adjacent to A520 and the waste piles of the Site. It is unlikely that recreationalists will stay for more than a couple of hours because the floodplain consists of gravel and is less preferable compared to other nearby sites (Almeda County Park at Rand or at Argo Camp Site) for extended periods of time or for overnight camping. The daily exposure duration was adjusted down from the default 24 hours to a four (4) hour/day period. Furthermore, the recreationalists will tend to be adolescents and adults rather than children under the age of six, due to the nature of the sport and the inherent risks for infants.

If the public does stop at the Site, the most obvious remaining features from the river level is the A520 opening and the water seeping out across the flood plain. Additionally, the Slag Pile and the lower portions of the Rock Dump are more likely to be accessed than the upper portion of the Rock Dump or other adits because of their proximity to the river. Access to other parts of the Site is less likely due to the relatively steep terrain away from the flood plain. River recreationalists typically are not prepared to hike/climb on rocky and unstable hillsides. If recreationalists stopover at the Site for a few hours, it is unlikely that they will consume a full daily intake of water.

The other access to the Site is on land via approximately ten (10) miles of jeep and four-wheel drive roads, behind a locked gate and across private property. Therefore, Site access via land is

not reasonably likely for users or trespassers either on vehicle or on foot due to the restricted access and the distance to the Site from the locked gate and a public road.

There is also a potential that a construction/excavation worker would conduct activities at the Site. Due to the unlikely redevelopment of the Site, it is reasonable to assume that the primary reason for construction/excavation work would be to perform maintenance at one of the adits or waste piles. Based on past activity at the Site, it is reasonable to assume a reduction in the exposure duration would also be appropriate.

Site Specific Exposure Modifications

Based on the scenario described above, the recreationalist will likely exclude young children and will most closely resemble a modified residential scenario. The exposure frequency and water intake would need to be modified for these potential pathways. Because it is unlikely that a river enthusiast would visit this Site on a regular basis, it was assumed that the average recreationalist would visit the Site up to six (6) times per year which equates to one visit per month during the recreational season on the river. It is unlikely that a user would visit the Site during each river trip, however, the modified scenario accounts for this possibility. The water intake values for the residential scenario were reduced to account for the user only visiting the Site for one-half of a day (i.e. 4 hours). This time estimate is twice the highest estimate reported by BLM river recreation staff for the Site. In addition, the vast majority of river users on this stretch of the river are day users and this would tend to limit time on land. Furthermore, if users were camping, there are more preferable camping locations upstream and downstream of the Site. Based on Site use, the water intake volume was reduced to four (4) hours to account for this reduced exposure. All other exposure parameters for the residential scenario were kept the same. This includes the child exposure rates of the residential scenario which were retained in the Recreational user scenario using the proportional reduction in exposure time and ingestion. As described above it is unlikely that children under six years of age would be able to visit the Site, however, their exposure route was left into account for the remote possibility that adults would include children in the river rafting experience.

The construction/excavation worker scenario was also modified to account for reasonable likely exposures given the likely activities that could be performed at the Site. In the Risk Based Decision Making (RBDM) guidance (DEQ, 2003), DEQ presents a default exposure duration for an excavation worker of nine (9) days per year while the exposure duration for a construction worker is 250 days/year. There is a limited amount of work potentially required to maintain mine adit access control and potential future maintenance; however, there are no other reasonably likely activities anticipated at the Site. Therefore, the exposure frequency for both the construction and excavation worker scenarios was reduced to one week (5 days) per year. The limited exposure to groundwater for the excavation worker scenario appears to be comparable with a remediation worker performing activities around the surface water discharges from the adit. It is anticipated that the only construction/excavation work would be related to the mining activity and would be under a remediation or maintenance plan that identifies the hazards and the appropriate personal protective equipment. None of the other default exposure parameters were changed. A summary of both the Reasonable Maximum Exposure (RME) and the Central Tendency Exposure (CTE) parameter modifications are shown on Table 5.

5.0 RISK EVALUATION APPROACH

Exposure Point Concentrations (EPCs) are conservative estimates of the average concentrations of COPCs in environmental media that may be contacted by human receptors in a particular exposure unit. It is assumed that recreationalists will focus their activity near the

Rogue River and expose themselves though surface water ingestion from the discharge from A520 and direct contact (i.e. ingestion, inhalation, dermal contact) with the upper surfaces of the waste piles.

The 90-percent upper confidence limit of the mean (90% UCL) is used to conservatively represent the concentration of a chemical in soil (DEQ, 2000) for Reasonable Maximum Exposures (RME). The 90% UCL is a statistical calculation that is generally accepted as an upper-bound, conservative estimate of the mean of a select, randomly sampled statistical population. The 90% UCL accounts for the uncertainty introduced by extrapolating from a sample to the population. If the calculated 90% UCL was found to be higher than the maximum value actually detected, the maximum detected concentration of the COPC was used as the EPC in RME risk calculations.

ProUCL is a software program developed by the EPA that can estimate UCLs using a variety of different statistical methods (EPA, 2004). This software program was used to calculate and select the 90% UCLs used as RME EPCs for the recreationist surface water exposure and soil contact pathways.

Prior to calculating the UCL, an outlier test was conducted for each COPC in a given sample group to determine if the minimum or maximum concentration of a particular group is considered an outlier at a significance level of five percent. The A520 sample group contained upper-tail outliers for four of the eight metals. The soil sample groups SL and RD contained two and seven upper-tail outliers, respectively. No upper-tail outliers identified for the BG soil sample group. There were no lower-tail outliers identified for any of the surface water or soil sample groups.

The UCL for each COPC in each sample group that contained more than 30 percent detectable concentrations was calculated excluding any identified outliers. Each of the sample groups fit either a normal or lognormal distribution. The raw statistical data (i.e. mean, median, etc.) includes the outlier values, so in some cases the mean value is slightly greater than the 90% UCL. A summary of this data is presented in Table 3 for the water data and Table 4 for the soil data. The ProUCL output is included in Appendix B.

Risk estimates based on RME assumptions are used to evaluate if risk management actions may be needed for a site. RME assumptions are designed to estimate an exposure that is conservative (health-protective). RME values for intake rates and other exposure assumptions are often based on a 90% UCL or other similar upper bounds from the population.

In addition to estimating risks associated with the RME, DEQ recommends estimating risks associated with a CTE. CTE assumptions are often based on estimates of mean intake rates and exposure durations for a particular exposure scenario. The arithmetic mean of the surface water and soil data was used as the EPC for CTE risk calculations. DEQ's acceptable risk levels are based on RME assumptions and risk management decisions are typically made after evaluating RME risk estimates. Risk estimates based on the both CTE and RME assumptions were calculated for this assessment for comparison purposes. The input values presented in the RBDM guidance (DEQ, 2003) were used to estimate CTE risk (Table 5).

6.0 TOXICITY ASSESSMENT

In order to characterize potential carcinogenic and non-carcinogenic risks associated with all significant human exposure pathways, toxicity information for each COPC was evaluated. The

HHRA used information from the DEQ RBDM spreadsheet for individual chemicals (DEQ, 2003, rev. 2011). For some of the COPCs there was no toxicological data available in the RBDM spreadsheet so critical values were obtained from EPA's Regional Screening Level Table (EPA, June 2011).

Two general types of health effects were evaluated separately in the HHRA: cancer effects and adverse non-cancer health effects. This distinction is made because the EPA generally assumes that a dose threshold exists for non-carcinogens, and that compensatory processes prevent the expression of adverse effects if humans are exposed to chemical doses below the threshold. No such threshold is generally assumed for carcinogens. Instead, it is generally assumed that there is a finite probability of developing cancer associated with any exposure to a carcinogen.

Cancer slope factors (SFs) are chemical-specific potency values used to calculate the risk of cancer resulting from exposure to carcinogenic chemicals. A higher value implies a more potent carcinogen. Arsenic and cadmium are two COPCs with associated known or suspected carcinogenic risks.

Reference doses (RfDs) are estimated dose thresholds for non-carcinogenic effects. A chronic RfD is an estimate of a lifetime (70 years) daily chemical dose that is likely to result in no appreciable deleterious non-carcinogenic effects. Although cancer risks are only relevant for carcinogens, non-cancer risks are estimated for both carcinogens and non-carcinogens if sufficient toxicity data are available.

6.1 Lead

The evaluation of risk from lead exposures utilizes different risk modeling than the other compounds. This is because lead exposure is evaluated using a biokinetic model and risk is interpreted in terms of blood lead concentration rather than a Hazard Quotient. Young children (aged 6-84 months) are usually the sub-population of chief concern for lead exposure. This is because: 1) young children tend to have higher intakes of environmental media per unit body weight than adults (especially for soil and dust), 2) young children tend to absorb a higher fraction of ingested lead than adults, and 3) young children are inherently more susceptible to the adverse effects of lead, since their nervous systems are still developing.

In residential locations and other areas where children are exposed to lead, EPA recommends the use of the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) model to evaluate exposures from lead-contaminated media and to predict the likely effects of those exposures on blood lead levels. When young children are not expected to be present at a site such as the subject Site, then the population of concern is the adult (e.g., a worker). While both males and females are susceptible to adverse effects from excess lead exposure, the female of child-bearing age is the sub-population of chief concern, since exposure of the pregnant female can result in exposure of the fetus in utero. The EPA has developed the Adult Lead Methodology (ALM) for evaluating the potential risks from lead in pregnant females (EPA, 2003).

The ALM model is mathematically simpler than the IEUBK model, but the basic concept is the same: information on lead exposure from all environmental sources is used to predict the blood lead level in a typical adult female, and this is converted into a lognormal distribution based on a specified geometric standard deviation (GSD). Based

on studies of maternal/fetal blood lead ratios, the blood lead of the fetus is assumed to be 90% of the value in the mother. Decision criteria for the ALM are usually similar to that for young children (i.e. no more than a 5% chance that the blood lead level in a fetus will exceed a value of 5 µg/dL). The blood lead level of 5 ug/dL is based on the EPA guidance (EPA, 2009a).

7.0 CALCULATION OF SITE-SPECIFIC RBCS

The calculation of site specific RBCs was performed using the Oregon DEQ spreadsheet entitled *Risk-Based Concentrations for Individual Chemicals* (DEQ, Nov. 2011). The spreadsheet derives its formulas and resulting RBCs from equation in the RBDM Guidance (DEQ, 2003) and the EPA Risk Assessment Guidance for Superfund; Volume I (US EPA, 2009b). The spreadsheet allows the user to alter various parameters used in calculating an RBC for a particular compound. It also allows the user to add compounds and their chemical and toxicological properties to be able to calculate an RBC for that compound. Only the exposure factors described above (exposure frequency, exposure duration and water ingestion rate) were altered to reflect the current and reasonably likely site exposures for users of the Site. The RBC for lead was not calculated using the spreadsheet because of the different method of determining risk from exposure to this compound as described above in Section 6.1 of this report. A summary of the site specific RBCs are presented in Table 5 and the spreadsheets for both RME and CTE exposure assumptions are included in Appendix C.

7.1 Lead

An RBC for lead was not calculated for the surface water pathway because the risk of lead in tapwater is determined by evaluation of the effects on children under the age of six (6) in the EPA Integrated Exposure Uptake Bio-Kinetic (IEUBK) model and the ALM does not include ingestion of lead in tapwater as a significant exposure pathway. Since it is assumed that children under 7 years of age are not likely to visit the Site, there is not a readily available risk evaluation model to consider adult ingestion of lead in water. The IEUBK model is used to generate the generic RBC values used by DEQ and they are very conservative, especially for this Site's completed exposure pathways.

Considering that adult recreationalists and construction/excavation workers are the primary receptor at the Site, the EPA ALM (EPA, 2009c) was used to evaluate risk to adults from exposures to lead in soil and dust. The only modification to the model was to reduce the exposure frequency to 10 days per year. The site specific RBC for lead in soil using the ALM is provided in Table 5. The modified ALM spreadsheets used to calculate a recreational RBC are included in Appendix C.

8.0 RISK-CHARACTERIZATION

Risk characterization elements of the HHRA were performed consistent with the DEQ risk evaluation framework for petroleum-contaminated sites outlined in the RBDM (DEQ, 2003). The risk characterization process for the HHRA is discussed below.

In general, risk is a function of the amount or dose of a chemical that a receptor may be exposed to, and the toxicity of the chemical. The primary determinants of chemical exposure include concentrations of chemicals in the environment, chemical contact rates (e.g., water ingestion rates, soil ingestion rates), and the duration of potential exposure. The general equation for estimating risk is as follows:

Risk = Concentration x Intake x Toxicity

A chemical specific risk-based concentration (RBC) is an estimate of the concentration of a chemical in soil, groundwater, or air that would not pose unacceptable risks to humans with a RME to the impacted medium. Site-specific RBCs are estimated by rearranging the above equation used to estimate risks in a deterministic assessment. Instead of solving for risks, the risk term is set to the DEQ acceptable risk level and the equation is solved for the concentration term as follows:

$$Risk-based\ Concentration = \frac{Acceptable\ Risk\ Level}{Intake \times Toxicity}$$

The DEQ acceptable risk level for exposure to a single carcinogen is a lifetime excess cancer risk of one in a million (1.0E-06). The acceptable risk level for exposure to a non-carcinogen is a hazard index of less than or equal to one (DEQ, 2003).

In the RBDM guidance, the DEQ has developed generic RBCs for the most common pathways by which humans may contact individual chemicals at a site (DEQ, 2003). Initial risk screening was made by comparing EPCs of COPCs in soil and groundwater with relevant generic RBCs.

Chemical-specific risk estimates were determined for carcinogens as follows:

$$ECR_i = \frac{EPC}{RBC} \times 10E-06$$

Where:
ECR_i = Lifetime excess cancer risk associated with exposure to a particular chemical (unitless)
EPC = Concentration of the chemical at the exposure point
RBC = Risk-based concentration for the chemical
10*E*-06= One in one million

For noncarcinogens, risks are expressed as hazard quotients and are calculated as follows:

$$HQi = \frac{EPC}{RBC}$$

Where:
HQ_i = Hazard quotient associated with exposure to a particular chemical (unitless)

Risks associated with exposure to multiple chemicals in a medium were evaluated separately for carcinogens and non-carcinogens as follows:

$$C-ECR = \Sigma ECR_i$$

Where:
C-ECR =Cumulative lifetime excess cancer risk for carcinogens and,

$$HI = \sum HQ_i$$

Where:
HI = Hazard Index for non-carcinogens

If the Hazard Index (HI) for non-carcinogens is less than one, it is inferred that potential exposure to multiple chemicals will not result in unacceptable risks. The DEQ acceptable risk level associated with exposure to multiple carcinogens is a lifetime excess cancer risk greater than one in one hundred thousand (1.0E-05) (DEQ, 2003). Therefore, if C-ECR is less than 1.0E-05, it is inferred that potential exposure to multiple carcinogens will not result in unacceptable risks.

Tables 6 and 7 show cancer and non-cancer risk associated with the exposure of recreational and construction/excavation workers to surface water and soil COPCs due to direct contact with the media through ingestion or dermal contact. All of the COPCs are considered non-volatile and therefore the inhalation pathway is unlikely to be complete or contribute in a significant way to the overall risk.

8.1 Excess Cancer Risk from Exposure to Surface Water Drainage

The excess lifetime cancer risk (ECR) was calculated for the two water COPCs with known or suspected carcinogenic effects, arsenic and cadmium. The cumulative water ECR associated with RME and CTE of a recreationalist exposed to surface water at the Site is 7.0E-06 (7 in one million) and 3.7E-06 (3.7 in one million), respectively. The cumulative water ECR associated with RME and CTE of a construction/excavation worker exposed to surface water was calculated to be 9.1E-09 (9.1 in one billion) and 7.1E-09 (7.1 in one billion) for RME and CTE assumptions, respectively. The predominant risk from the surface water is associated with arsenic (Table 6).

8.2 Excess Cancer Risk from Exposure to Surface Waste Piles

The ECR was calculated for arsenic, the only soil COPC with known or suspected carcinogenic effects that exceed default RBCs or background concentrations. The ECR was calculated for both the SL sample group and the RD sample group. The soil ECR associated with RME and CTE of a recreationalist exposed to the SL waste pile (SL-ECR) is 1.3E-06 (1.3 in one million) and 9.8E-07 (9.8 in ten million), respectively. The soil ECR associated with RME and CTE of a recreationalist exposed to RD waste piles (RD-ECR) is 1.7E-06 (1.7 in one million) and 2.0E-06 (2 in one million), respectively. The ECR associated with RME and CTE of a construction/excavation worker exposed to the SL waste pile is 3.7E-07 (3.7 in ten million) and 5.9E-08 (5.9 in one hundred million), respectively. The ECR associated with RME and CTE of a construction/excavation worker exposed to the RD waste pile is 4.8E-07 (4.8 in ten million) and 1.2E-07 (1.2 in ten million), respectively.

Using the RME criteria and averaging the risk evenly between the two waste pile areas, the soil ECR for the recreational scenario is 1.5E-06 (1.5 in one million) and the resulting ECR for the construction worker is 4.2E-07 (4.2 in ten million).

8.3 Cumulative Excess Cancer Risk

The cumulative carcinogenic ECR was determined using the cumulative water ECR. The average soil ECR values to represent the soil exposures assuming that users would be just as likely to visit the rock dump as the slag pile. The cumulative carcinogenic ECR associated with a RME and CTE of a recreationalist exposed to both adit water and the waste piles is 8.5E-06 (8.5 in one million) and 5.2E-06 (5.2 in one million), respectively. The cumulative carcinogenic ECR associated with a RME and CTE of a construction/excavation worker exposed to both water and the waste piles is 4.3E-07

(4.7 in ten million) and 9.6E-08 (9.6 in ten million), respectively. The site specific recreational exposure scenario under both RME and CTE criteria exceed an ECR of 1.0 in one million. The individual and cumulative ECR for the COPC with carcinogenic effects are presented in Table 6.

8.4 Hazard Index from Exposure to Surface Water Drainage

The Hazard Index (HI) was calculated for the seven water COPCs with known or suspected non-carcinogenic human health effects, including aluminum, arsenic, cadmium, copper, iron, manganese, and zinc (Table 7). The cumulative water-HI for the RME and CTE of a recreationalist exposed to surface water at the Site is 6.7E-02 (0.067) and 4.2E-02 (0.042), respectively. The cumulative water-HI for the RME and CTE of a construction/excavation worker exposed to surface water at the Site is 2.7E-03 (0.0027) and 2.4E-03 (0.0024), respectively.

8.5 Hazard Index from Exposure to Surface Waste Piles

The HI was calculated for the five soil COPCs with known or suspected non-carcinogenic human health effects, including arsenic, copper, iron, lead and silver (Table 7). The waste pile with the higher EPC was used in the calculation to be more conservative. As a result EPC values for arsenic and lead are derived from the RD sample group and the EPC values for copper and iron are derived from the SL sample group. The cumulative soil-HI for the RME and CTE of a recreationalist exposed to the waste piles at the Site is 2.9E-01 (0.29) and 1.2E-01 (0.21), respectively. The cumulative soil-HI for the RME and CTE of a construction/excavation worker exposed to soil at the Site is 9.9E-02 (0.099) and 3.4E-02 (0.034), respectively.

8.6 Cumulative Hazard Index

The cumulative HI for the RME and CTE of a recreationalist exposed to the surface water and waste piles at the Site is 0.36 and 0.16, respectively. The cumulative HI for the RME and CTE of a construction/excavation worker exposed to the surface water and waste piles at the Site is 0.1 and 0.036, respectively. All of the cumulative HI values are less than an HI of 1.0. The individual chemical hazard quotients and cumulative HIs are presented on
Table 7.

9.0 HUMAN HEALTH RISK ASSESSMENT UNCERTAINTIES

Estimating and evaluating human health risks from exposure to environmental chemicals is a complex process with inherent uncertainties. Uncertainty reflects limitations in knowledge and simplifying assumptions that must be made in order to quantify health risks and can be assessed by formal analysis or described qualitatively. The choice of qualitative or quantitative approaches depends on the completeness of the database and the purposes of the risk analysis. Because of the amount of available data and the nature of the uncertainties involved, a qualitative discussion of uncertainty is provided for this analysis.

Uncertainties reflect specific limitations in knowledge. In this assessment, uncertainties relate to (i) the development of media concentrations that Site users are exposed to, (ii) the assumptions about exposure and toxicity, and (iii) the characterization of health risks. Uncertainty in the development of media concentrations is due to the inability to sample a site in its entirety. Practically, a limited number of samples must be obtained to represent the contaminant characteristics of a medium in a larger area. Uncertainty in concentrations and spatial

distributions of contaminants is evident at this Site due to the limited amount of sampling undertaken.

There is also uncertainty associated with the analytical data collected that are used to characterize human health risks at the Site. The use of the 90% UCLs as soil EPCs for COPCs also contributes some uncertainty to the risk assessment. Calculation of the 90% UCL, which is an upper estimate of the true mean of a sampled population, is meant to provide assurance that there is only a 10% chance that the true mean is greater than the 90% UCL. Due to a number of statistical factors and especially sample size, there is some uncertainty as to how representative the 90% UCLs are of actual site conditions.

Default exposure parameters were used extensively in this evaluation. These default parameters are meant to broadly represent typical exposure scenarios at the Site and may differ from actual site exposures. In addition, there was one chemical, lead, which had no readily available toxicity factors for one of the potentially complete pathways. As a result, this compound could not be fully evaluated quantitatively for its potential contribution to total risk. Lead is evaluated based on the concentration of lead in one's bloodstream. The most conservative lead model, EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK), only considers a drinking water ingestion exposure for a child (up to six years old). EPA's Adult Lead Model does not include the drinking water pathway in evaluating an adult workplace exposure. Therefore lead was the one COPC which was not included in risk from surface water ingestion evaluation. It should be noted that the RBC/RSL tapwater screening value for lead is based on a child's exposure under the IEUBK and would overestimate risk based on the current or likely future users at the Site. Although the risk from lead was not evaluated for the surface water discharges on Site, any remedial action that reduced the unacceptable long-term risk posed by one of the other metals in the discharge water would likely reduce the lead concentrations as well.

10.0 SUMMARY AND DISCUSSION

Potential human health risks associated with select uses of the Site were evaluated using DEQ and USEPA protocols. Chemicals of potential concern (COPCs) at the Site were selected on the basis of measured concentrations in surface water and in surface samples of select waste piles, inherent toxicity, and frequency of detection. Conservative estimates of the average concentrations of COPCs detected in samples collected by others were calculated for the entire site and the nature and magnitude of actual or potential exposures to site COPCs were characterized for specific exposure scenarios. These potential exposure scenarios include:

- Recreational Boaters exposed to surface water and waste piles via direct ingestion, dermal contact, and inhalation exposure routes.
- Construction and Excavation Workers exposed to surface water and waste piles via direct ingestion, dermal contact, and inhalation exposure routes.

Due to the current land use restrictions and no current and likely future land use changes, default residential and occupational use scenarios were not evaluated.

Non-Cancer Effects

The non-carcinogenic human health effects from Site COPCs do not exceed the site-specific acceptable levels for both the recreational user and construction/excavation worker scenarios. All of the individual metals considered to be COPCs have Hazard Index (HI) values less than

one (1.0) and the cumulative HI considering both the surface water discharge water from the A520 adit and the waste piles are also less than one (1.0).

Cancer Effects

Individual cancer risks were evaluated for arsenic and cadmium in the surface water discharge and for arsenic in the waste piles based on site specific sampling data. According to Oregon Administrative Rule (OAR) 340-122-115(2)(a), the DEQ acceptable risk level for excess lifetime cancer risk (ECR) associated with potential exposures to individual compounds is 10E-06 (one in one million). The ECRs for arsenic and cadmium under the construction/excavation worker scenario are below the 1.0E-06 or one in one million threshold (Table 6). Under the recreational user scenario the ECR is exceeded for arsenic in both the surface water media (7.0E-06 or 7 in one million) and in the waste pile media (1.5E-06 or 1.5 in one million).

The DEQ acceptable risk level for ECR associated with potential exposures to multiple carcinogenic compounds is 10E-05 (one in one hundred thousand; OAR 340-122-115(3)(a)). The cumulative site ECR for the recreational user exposed to multiple carcinogens is 8.5E-06 (8.5 in one million). The cumulative site ECR for the construction/excavation user scenario ECR for multiple carcinogens is 4.3E-07 (4.3 in ten million). Therefore, both the recreational user and construction/excavation worker scenarios do not exceed the acceptable risk level for multiple carcinogens.

The exposure pathway for recreational exposure to site COPCs is through direct contact (i.e., ingestion and dermal contact) with the surface water discharge. Contact with the COPCs in adit discharge water results in an ECR for the recreational user scenario of 7.0E-06 (7 in one million). The majority of this risk is attributed to the concentrations of arsenic.

Direct contact (i.e. ingestion, dermal contact) with the waste piles is a secondary contributor to risk with an average ECR for the recreational user of 1.5E-06 (1.5 in one million) based on the ECR associated with the Slag Pile (1.3E-06 or 1.3 in one million) and the Rock Dump (1.7E-06 or 1.7 in one million). All of the ECR associated with the waste piles is attributed to the concentrations of arsenic in the waste piles. The ECR from the waste piles represents about 20 percent of the cumulative excess cancer risk at the Site. The calculated ECR of the waste piles has been adjusted to account for the elevated arsenic concentrations detected in background soil samples.

Cleanup Goals

Based on this HHRA, the primary compound driving human health risk levels above acceptable levels is the presence of arsenic in the surface water discharge and in the waste piles. Based on the exposure assumptions used in this analysis the individual cleanup goal for arsenic in the surface water discharge, based on an ECR of 10E-06 (one in a million), is 13 ug/l. Previous sampling events over the last three years at the A520 adit indicate that arsenic levels have ranged from 19 to 1,480 ug/l, with an average of 71 ug/l. There were no background groundwater concentrations of arsenic available to consider for this evaluation.

The cleanup goal for arsenic in the waste piles is 184 mg/kg based on the background concentrations of arsenic in soil. The Slag Pile soil samples ranged from 50 to 301 mg/kg (average of 129 mg/kg) and the Rock Dump soil samples ranged from 5.3 to 628 mg/kg (average of 263 mg/kg). It should be noted that the analytical results for arsenic in the background samples were affected by the elevated metals in the background soil and the values are estimated. This may cause the results to underestimate the actual concentrations of

arsenic in the background samples. Additional sampling may be warranted to try to further define background concentrations of metals in soils, especially arsenic.

Concentrations of arsenic that exceed the site specific risk-based cleanup goals are subject to further study to determine an appropriate remedial response action. An Engineering Evaluation/Cost Analysis (EE/CA) is typically conducted to evaluate a range of remedial alternatives (i.e. institutional controls, engineering controls, treatment technologies, and/or removal actions) using specified evaluation criteria to determine a cost effective remedy that is protective of human health and the environment.

Some uncertainty exists regarding this risk assessment because of chemicals for which no toxicity factors are available to evaluate the surface water pathway, including lead. Exposure to these chemicals could have a limited contribution to overall risk estimates and are not likely to affect the overall findings.

11.0 LIMITATIONS

The findings and conclusions of this work are not scientific certainties but, rather, probabilities based on professional judgment concerning the significance of data gathered during the course of this investigation and subsequent data evaluation. PBS is not able to represent conditions regarding the Site beyond those conditions detected or observed by PBS.

The data and information contained in this document is for the exclusive use of the client and is not to be relied upon by other parties. The report shall not be duplicated, used or disclosed, in whole or in part, to other parties without written consent of the client and PBS.

12.0 SIGNATURES

PBS ENGINEERING AND ENVIRONMENTAL

07/18/12

N. Toby Scott, R.G. — Date
Project Manager/Hydrogeologist

07/18/12

Reviewed by: Dulcy Berri — Date
Principal Geologist

13.0 REFERENCES

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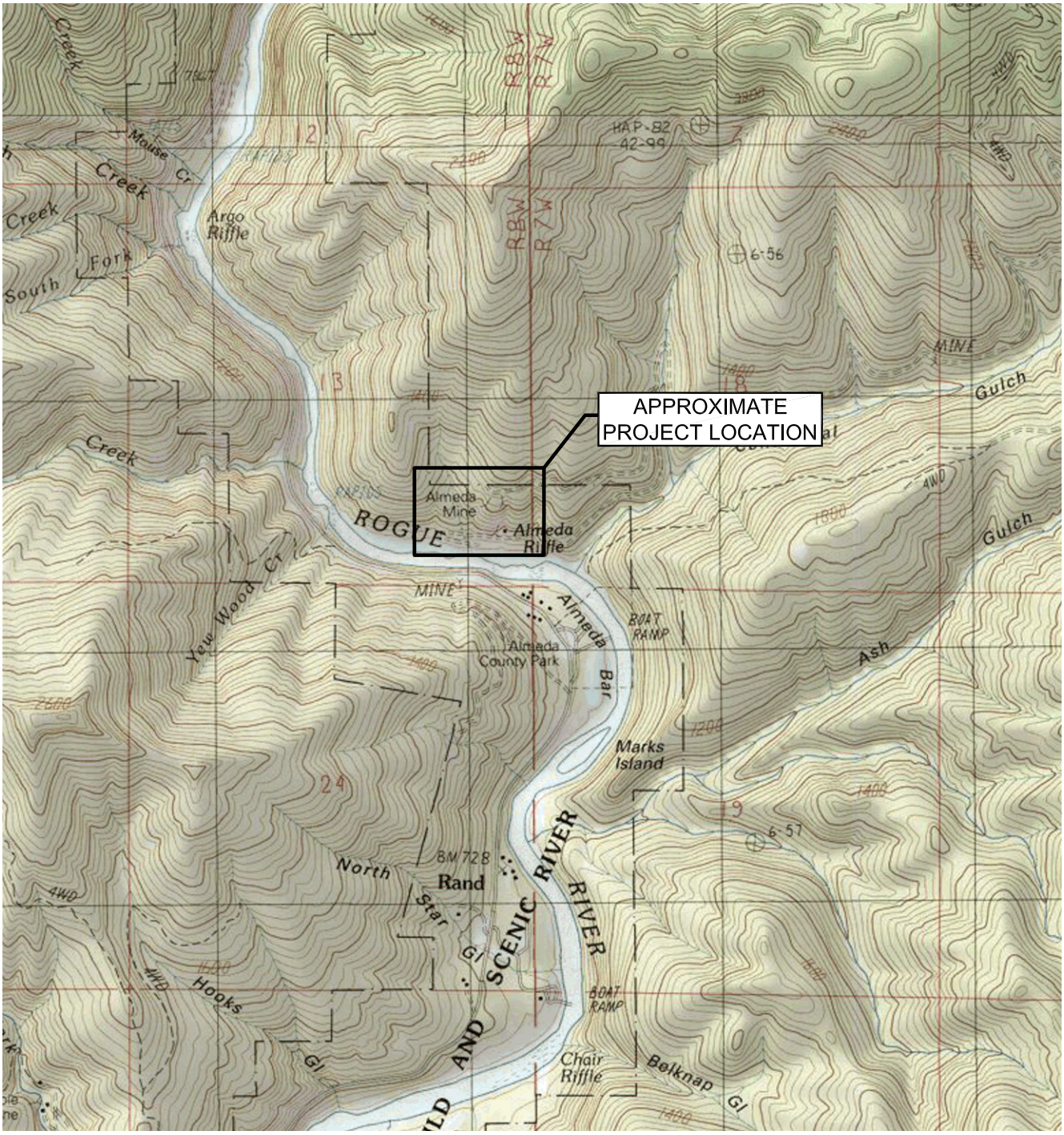
14.0 LIST OF ABBREVIATIONS AND ACRONYMS

UCL	upper confidence limit of the mean
A520	adit number location
Ag	silver
Al	aluminum
ALM	Adult Lead Methodology
AMD	acid mine drainage
AMSL	above mean sea level
As	arsenic
BLM	US Bureau of Land Management
BG	background
BG-	background sample
Cd	cadmium
CFS	cubic feet per second
COI	compounds of interest
COPC	contaminates of potential concern
Cr	chromium
Cu	copper
CSM	conceptual site model
CTE	central tendency exposure
DQR	data quality report
ECRi	lifetime excess cancer risk associated with exposure to a particular chemical
EPC	exposure point concentration
FC	forest commercial zoning
Fe	iron
FR	former furnace area
FR-	former furnace area samples
GRCO	Galice Road culvert outfall sample location
GSD	geometric standard deviation
HDPE	high density polyethylene
Hg	mercury
HHRA	human health risk assessment
HI	hazard index for non-carcinogens
HQi	hazard quotient associated with exposure to a particular chemical
IEUBK	Integrated Exposure Uptake Biokinetic Model
LSCE	limestone treatment channel effluent
Mn	manganese
Ni	nickel
NRC	NRC Environmental Services, Inc.
Pb	lead
RBC	Oregon Risk-Based Concentrations for Individual Chemicals
RBDM	Oregon Risk-Based Decision Making for Petroleum-Contaminated Sites
RD	rock dump
RD-	rock dump samples

RfDs	reference doses
RME	reasonable maximum exposure
RRAR	Rogue River near Argo Riffle (downstream)
RRMX	Rogue River 100 feet downstream of Adit 520 outflow
RRRA	Rogue River near Rand (upstream)
RSLs	EPA Regional Screening Levels
Se	selenium
SFs	cancer slope factors
SL	slag pile
SL-	slag pile samples
Soil-ECR	excess lifetime cancer risk in soil
Water-ECR	excess lifetime cancer risk in water
USEPA	US Environmental Protection Agency
Zn	zinc

FIGURES



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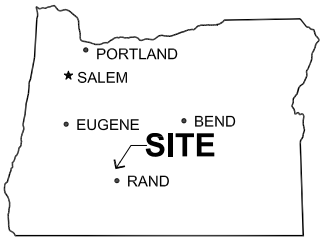

OREGON

0' 1000' 2000' 4000'

SCALE: 1" = 2,000'

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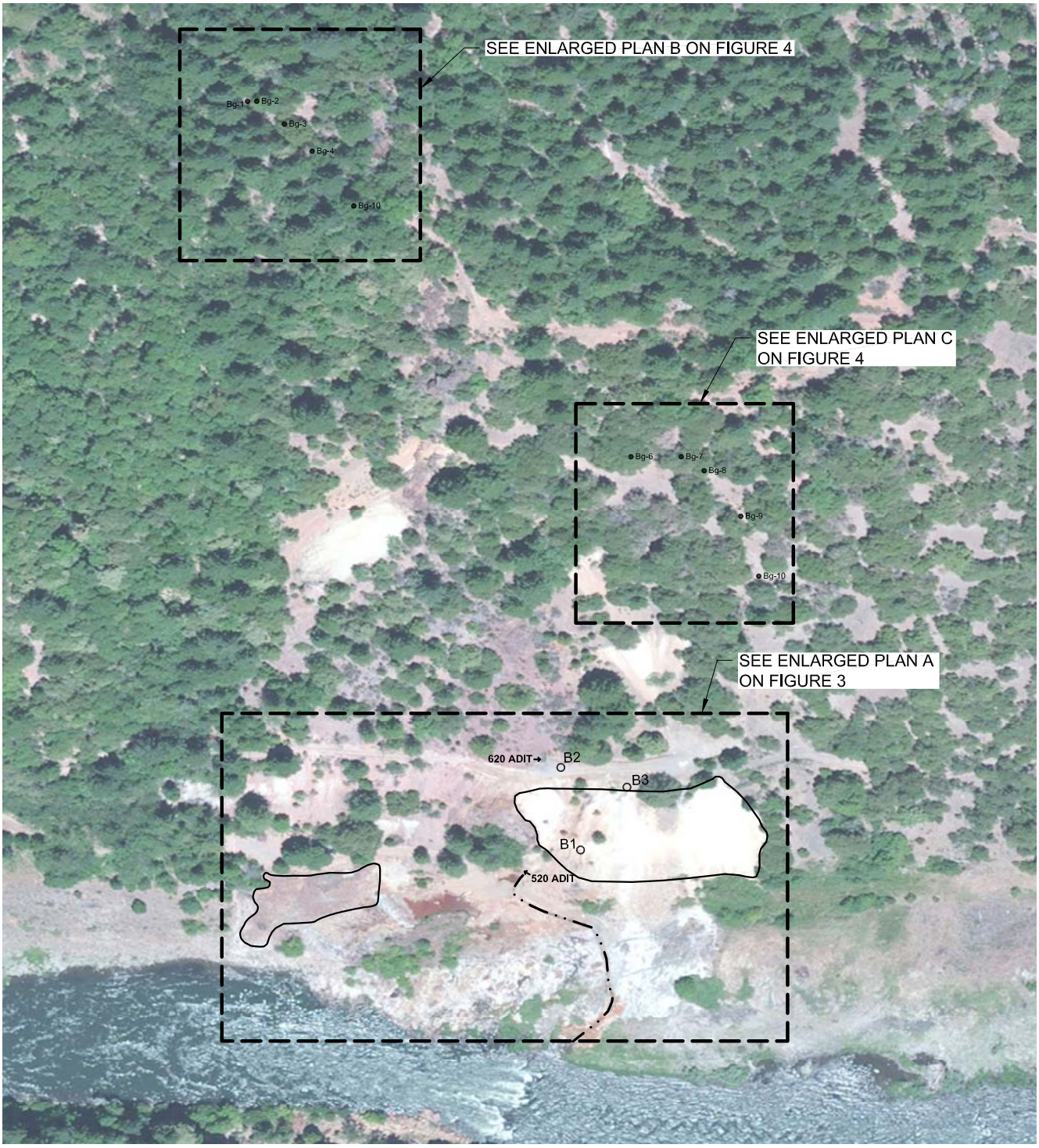
PROJECT #	SITE VICINITY MAP	FIGURE
80523.000	T34S R7W S18 AND T34S R7W S13 JOSEPHINE COUNTY, OREGON	1
DATE JUNE 2012		

L:\Projects\80000\80500-80599\80523_NRC Environmental_AlmedaMine\DWG\FROM DON\80523.000_FIG-1-2-FINAL.dwg Jun 08, 2012 09:50am brendam



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SCALE: 1" = 200'

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PROJECT # 80523.000

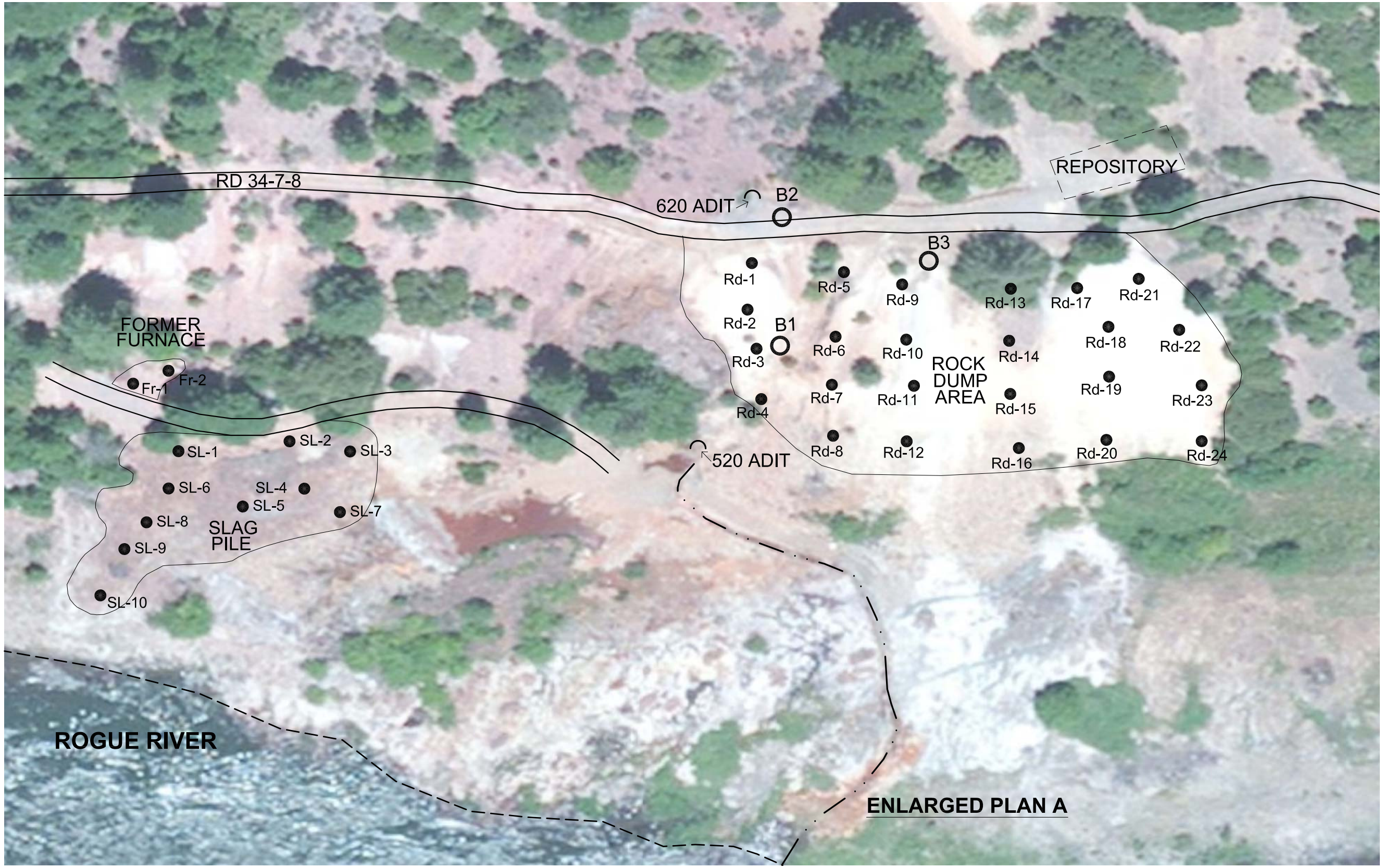
DATE JUNE 2012

SITE PLAN

T34S R7W S18 AND T34S R7W S13
JOSEPHINE COUNTY, OREGON

FIGURE 2

L:\Projects\80000\80500-80599\80523_NRC Environmental_AlmedaMine\DWG\FROM DON\80523.000_FIG-1-2-FINAL.dwg Jun 08, 2012 09:49am brendam



LEGEND

- SL10 — SHALLOW SOIL SAMPLE LOCATION
- B2 — EXISTING MONITORING WELL LOCATION
- APPROXIMATE SHORELINE
- DRAINAGE DITCH

0' 30' 60' 120'

APPROXIMATE SCALE: 1" = 60'

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ENLARGED PLAN A

T34S R7W S18 AND T34S R7W S13
JOSEPHINE COUNTY, OREGON

SAMPLE LOCATIONS

PROJECT:	80523.000
DATE:	JUNE 2012
FIGURE:	3

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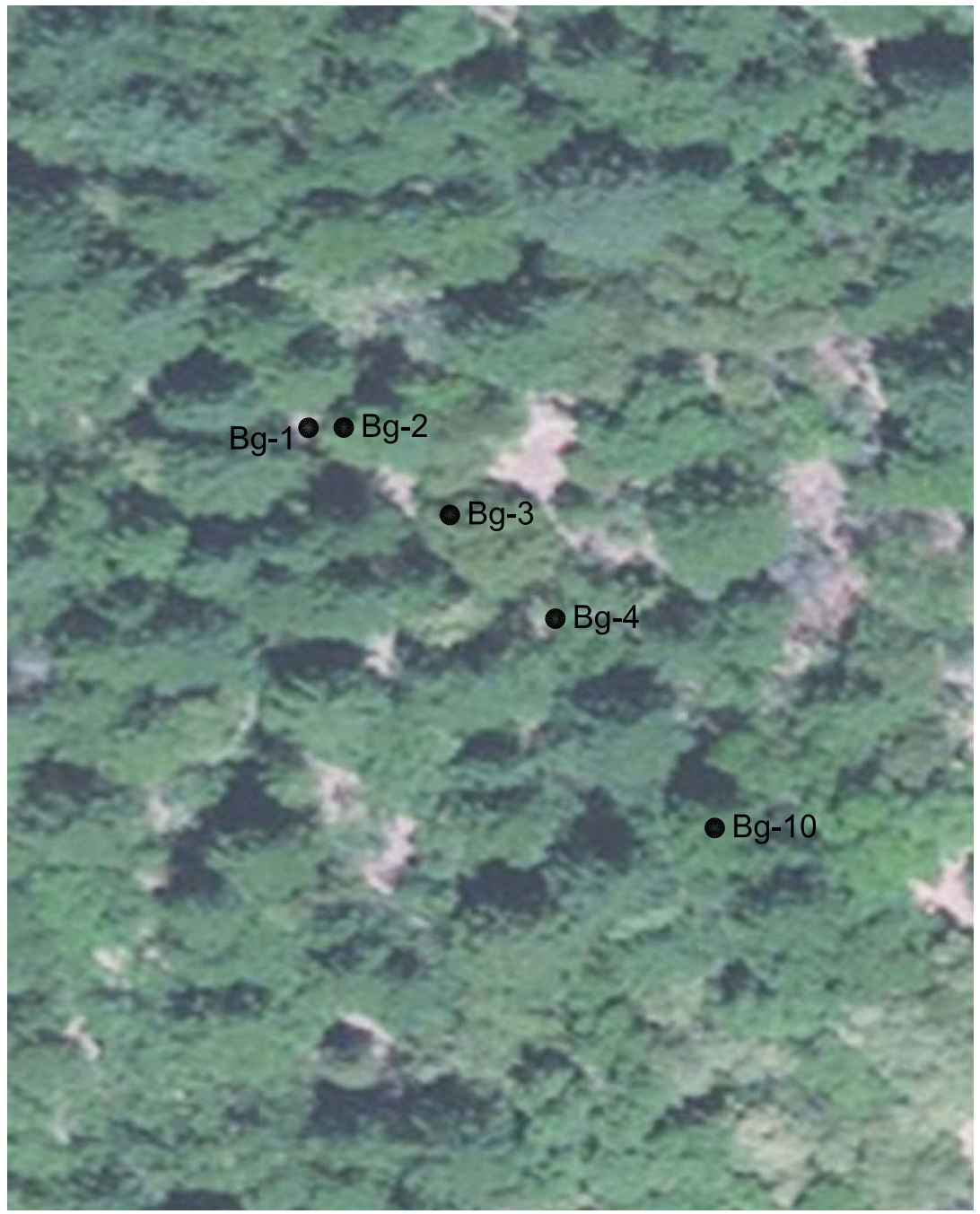

ENLARGED PLAN B

APPROXIMATE SCALE: 1" = 60'

BACKGROUND SAMPLES - ROGUE FM.

ENLARGED PLAN C

APPROXIMATE SCALE: 1" = 60'

BACKGROUND SAMPLES - GALICE FM.

0' 30' 60' 120'

APPROXIMATE SCALE: 1" = 60'

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ENLARGED PLANS B AND C

T34S R7W S18 AND T34S R7W S13
JOSEPHINE COUNTY, OREGON

SAMPLE LOCATIONS

PROJECT:	80523.000
DATE:	JUNE 2012
FIGURE:	4

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TABLES

Table 1
Quarterly Water-Quality Monitoring Results
Almeda Mine, Josephine County, OR

PBS Project No: 80523.000
Report Date: June 2012

ID	Event	Date	Field Parameters				Metals (total and dissolved in milligrams per liter)																		Comments
			pH	Conductivity (uS/cm)	Temperature (C)	Flow Rate (gpm)	Aluminum (tot)	Aluminum (dis)	Arsenic (tot)	Arsenic (dis)	Cadmium (tot)	Cadmium (dis)	Copper (tot)	Copper (dis)	Iron (tot)	Iron (dis)	Lead (tot)	Lead (dis)	Manganese (tot)	Manganese (dis)	Mercury (tot)	Mercury (dis)	Zinc (tot)	Zinc (dis)	
A520	Winter 2009	02/27/09	3.55	--	--	--	NA	NA	0.0705	NA	0.035	NA	2.59	NA	115	NA	0.0532	NA	1.47	NA	NA	NA	7.95	NA	
	Summer 2009	08/13/09	--	--	--	--	15.4	15.8	0.0588	0.0248	0.047	0.0445	2.69	2.19	107	110	0.0602	0.0546	1.46	1.6	<0.002	<0.002	8.4	8.58	
	Fall 2009	11/17/09	3.23	1337	13.5	8.7	17.9	15.2	1.48	0.00565	0.053	0.0528	2.67	2.38	196	65.1	0.646	0.0245	1.60	1.55	0.0015	<0.002	8.7	8.64	flow turbid due to
	Winter 2010	01/28/10	3.19	1400	13.8	11.2	18.2	17.9	0.0379	0.023	0.049	0.0491	4.16	4.1	54.6	51.8	0.0424	0.0424	1.6	1.57	<0.002	<0.002	7.83	7.85	BLM3&4 on COC
	Spring 2010	04/26/10	2.93	1655	14	15.0	23.0	22.8	0.108	0.0127	0.060	0.0597	5.04	5.03	100	78.3	0.12	0.118	1.79	1.81	<0.002	<0.002	10.8	10.4	BLM3&4 on COC
	Summer 2010	07/22/10	3.00	1436	14.9	12.4	20.8	20.6	0.063	0.0137	0.051	0.0512	3.07	3.25	99.1	79.7	0.068	0.0687	1.68	1.71	<0.002	<0.002	10.7	11.2	AM3&4 on COC
	Fall 2010	10/12/10	3.03	1424	14.9	9.3	16.9	16.8	0.019	0.0175	0.044	0.0435	2.39	2.40	69.0	68.4	0.0485	0.0481	1.59	1.59	<0.002	<0.002	9.10	8.83	AM3&4 on COC
	Winter 2011	01/20/10	2.89	1516	13.8	13.1	21.7	21.1	0.0822	0.117	0.054	0.0563	5.05	5.16	118.0	102	0.0784	0.0816	1.9	1.87	<0.002	<0.002	10.40	11.2	AM4&5 on COC
	Spring 2011	04/20/11	3.01	1991	14.1	21.5	41.8	36.9	0.185	0.126	0.085	0.084	7.94	7.90	169.0	116	0.181	0.171	2.04	1.86	<0.002	<0.002	16.8	15.7	AM3&4 on COC
	Summer 2011	08/08/11	3.93	1551	14.6	14.2	24.0	24.5	0.0794	0.0276	0.059	0.059	4.83	4.69	95.9	94.8	0.0974	0.0968	1.62	1.55	NA	NA	11.8	11.5	AM5&6 on COC
	Fall 2011	10/26/11	3.03	1482	13.4	11.77	22.1	20.3	0.0587	0.0536	0.051	0.0503	3.80	3.88	94.4	86.3	0.0851	0.0849	1.54	1.54	NA	NA	10.9	11.2	AM4&5 on COC
	Winter 2012	01/17/12	3.08	1496	10.7	9.7	19.1	19.2	0.0352	0.0351	0.046	0.0472	3.07	3.04	82.9	80.6	0.0692	0.0702	1.44	1.42	NA	NA	9.56	9.5	AM3&4 on COC
LSCE	Winter 2009	02/27/09	3.25	--	--	--			0.0111		0.034		2.52		52.1		0.0394		1.80		NA		7.76		
	Summer 2009	08/13/09	--	--	--	--	15.3	15.1	0.00724	0.00377	0.044	0.0432	2.43	2.58	42.4	38.6	0.0518	0.0487	1.62	1.67	<0.002	<0.002	7.9	7.55	
	Fall 2009	11/17/09	3.34	1585	11.3	7.1	27.4	26.2	0.211	0.00131	0.046	0.0449	2.4	2.4	32.7	16.8	0.152	0.0159	2.57	2.61	0.0003	<0.002	7.6	7.79	see lab narrative
	Winter 2010	01/28/10	3.26	1625	11.1	na	31.1	28.1	0.013	0.0103	0.047	0.0474	4.19	4.03	31.7	31.7	0.0311	0.0323	2.30	2.15	<0.002	<0.002	7.09	6.93	BLM1&2 on COC
	Spring 2010	04/26/10	3.00	1735	16.4	na	28.0	27.9	0.084	0.0176	0.060	0.0589	5.01	4.93	87.3	70.4	0.11	0.106	2.09	2.18	<0.002	<0.002	10.7	10.3	BLM6&7 on COC
	Summer 2010	07/22/10	2.83	1690	23.9	na	20.8	21	0.029	0.00942	0.052	0.0518	3.11	3.30	63.2	58.1	0.0668	0.0669	1.68	1.72	<0.002	<0.002	10.9	9.77	AM1&2 on COC
	Fall 2010	10/12/10	2.93	1521	20.3	na	19.2	19.1	0.007	0.00674	0.038	0.0378	2.41	2.37	49.3	48.8	0.0385	0.0377	1.81	1.80	<0.002	<0.002	8.95	8.92	AM1&2 on COC
	Winter 2011	01/20/11	2.89	1544	13.8	na	21.2	21.2	0.069	0.0874	0.054	0.0617	5.06	5.11	97.7	93.9	0.0758	0.0805	1.82	1.88	<0.002	<0.002	10.2	11.2	AM1&2 on COC
	Spring 2011	04/20/11	2.94	2033	15.0	na	41.0	39.0	0.164	0.123	0.083	0.0841	7.95	7.96	159.0	116	0.176	0.172	2.03	2.00	<0.002	<0.002	15.8	17.2	
	Summer 2011	08/08/11	3.44	1626	23.9	na	25.3	26.5	0.049	0.0231	0.0580	0.0586	4.74	4.82	79.4	81.8	0.0952	0.0942	1.7	1.73	NA	NA	11.4	11.7	AM3&4 on COC
	Fall 2011	10/26/11	2.98	1536	13.2	na	22.7	21.3	0.04	0.045	0.0500	0.05	3.71	3.84	82.4	77.4	0.083	0.08	1.58	1.59	NA	NA	10.7	11.2	AM1&2 on COC
	Winter 2012	01/17/12	3.1	1430	12.5	na	20.8	20.3	0.029	0.027	0.0470	0.05	3.09	3.14	73.4	73.4	0.068	0.07	1.52	1.53	NA	NA	9.63	9.81	AM3 on COC
GRCO	Fall 2009	11/17/09	Dry																						No Flow
	Winter 2010	01/28/10	3.74	331	10.3	24.6	4.47	4.22	0.00217	<0.0005	0.001	0.00072	0.215	0.22	6.34	1.17	0.00033	0.00028	0.12	0.122	<0.002	<0.002	0.189	0.177	BLM5&6 on COC
	Spring 2010	04/26/10	5.44	195	10.9	18.5	1.37	0.0461	0.00146	<0.0005	0.00031	0.00032	0.108	0.08	3.26	0.372	0.00021	<0.0001	0.0465	0.0482	<0.002	<0.002	0.0699	0.0617	BLM1&2 on COC
	Summer 2010	07/22/10	6.08	199	26.3	2.2	0.0931	0.0454	<0.0005	<0.0005	<0.0001	<0.0001	0.0093	0.00766	0.0826	0.025	<0.0001	<0.0001	0.017	0.0183	<0.002	<0.002	0.0448	0.017	AM5&6 on COC
	Fall 2010	10/12/10	Dry																						No Flow
	Winter 2011	01/02/11	4.51	165	9.3	23.7	1.79	0.804	0.0018	<0.0005	0.00032	0.00034	0.119	0.107	5.81	1.22	0.00014	<0.0001	<0.1	<0.1	<0.002	<0.002	0.0634	0.074	AM6&7 on COC
	Spring 2011	04/20/11	5.95	180	10.5	48.2	0.926	0.022	0.0009	<0.0005	0.00017	0.00022	0.0583	0.015	2.03	0.0621	0.00011	<0.0001	0.0211	0.0205	<0.002	<0.002	<0.05	<0.05	AM6&7 on COC
	Summer 2011	08/08/11	Dry																						No Flow
	Fall 2011	10/26/11	Dry																						
	Winter 2012	01/17/12	Dry																						
RRRA	Summer 2010	07/23/10	6.98	82	20.8	--	0.244	0.0157	<0.0005	<0.0005	<0.0001	<0.0001	0.00121	0.00276	0.258	0.0389	0.00024	<0.0001	0.0168	<0.005	<0.0002	<0.0002	0.0294	<0.0001	AM7&8 on COC
	Summer 2011	08/08/11	7.98	68	16.7	--	0.199	0.0281	<0.0005	<0.0005	<0.0001	<0.0001	0.0008	0.00152	0.196	0.331	<0.0001	<0.0001	0.0113	<0.005	NA	NA	<0.001	0.00152	AM1&2 on COC
RRMX	Summer 2011	08/08/11	7.95	68	17.7	--	0.248	0.0309	0.00063	<0.0005	<0.0001	<0.0001	0.00168	0.00119	0.264	0.0339	0.00019	<0.0001	0.0122	<0.005	NA	NA	0.0173	0.00311	AM7&8 on COC
RRAR	Summer 2010	07/23/10	7.01	79	20.9	--	0.212	0.0177	0.00085	<0.0005	<0.0001	<0.0001	0.00112	0.00267	0.240	0.040	0.00011	<0.0001	0.0168	<0.005	<0.0002	<0.0002	0.0469	<0.0001	AM9&10 on COC
	Summer 2011	08/08/11	7.99	69	17.6	--	0.22	0.028	<0.0005	<0.0005	<0.0001	<0.0001	0.00119	0.00704	0.211	0.033	0.00013	<0.0001	0.0122	<0.005	NA	NA	0.00535	<0.0001	AM10&11 on COC

Notes:

Data collected by Katalyst, Inc. for BLM.
A520 = Flume outlet from adit 520
LSCE = terminus of limestone treatment channel
GRCO = Galice Road culvert outlet
RRRA = Rogue River near Rand (upstream). Summer only.
RRAR = Rogue River near Argo Riffle (downstream). Summer only.
RRMX = Rogue River 100 feet downstreem of LSCE discharge

gpm = gallons per minute
uS/cm = microsiemens per centimeter
C = degrees Celsius
D = a 'D' at the end of a location ID means a duplicate sample was collected at that location
"-" = not sampled, not applicable
ND = not detected above the laboratory method detection limit for that compound.
NA = not analyzed

1.48 Value identified as Outlier at a 5 percent significance level

Table 2
Summary of Soil Analyses of Select Total Metals
Almeda Mine, Josephine County, OR

PBS Project No.: 80523.000
Report Date: June 2012

Sample ID	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Zinc	Mercury
	EPA Method 6020 -Total Metals Per EPA 6000/7000 Series Methods												EPA Method 7471A
BG-1	**11,700**	**105 J**	<15.7	<31.5	**93.3 J**	**49,900**	**180**	**1,750**	<31.5	<15.7	<15.7	**157**	
BG-2	**3,770**	**174 J**	<29.2	<58.4	**107 J**	**96,600**	**374**	**357**	<58.4	<29.2	<29.2	**292**	
BG-3	**4,530**	**305 J**	<57.9	<116	**116 J**	**138,000**	**719**	**736**	<116	<57.9	<57.9	< 579	**0.202**
BG-4	**28,400**	**211 J**	<32.5	<65.1	**236 J**	**85,300**	**519**	**563**	<65.1	<32.5	**7.25**	**325**	
BG-5	**30,500**	**183 J**	<57.2	<114	**365 J**	**87,900**	**493**	**847**	<114	<57.2	<57.2	<572	
BG-6	**30,700**	<33.0 J	<33.0	<66.1	**108 J**	**49,800**	**50.9**	**2,590**	<66.1	<33.0	<33.0	<330	
BG-7	**22,300**	**15.7 J**	<14.2	**33.7**	**55.9 J**	**38,800**	**29.9**	**1,910**	**35.9**	<14.2	<14.2	**182**	
BG-8	**19,500**	<12.6 J	<12.6	<25.2	**33.5 J**	**31,900**	<12.6	**921**	<25.2	<12.6	<12.6	<126	<0.111
BG-9	**24,200**	**47.5 J**	<0.631	**36.2**	**96.2 J**	**59,400**	**27.3**	**960**	**33.3**	**2.93**	<0.631	**120**	
BG-10	**24,100**	**12.7 J**	<0.583	**43.7**	**69.6 J**	**45,600**	**17.7**	**1,100**	**36.2**	<0.583	<0.583	**115**	
SL-1	**25,100**	<55.9	<55.9	<112	**4,620**	**188,000**	**71.0**	**159**	<112	<55.9	**27.9**	**4,590**	
SL-2	**14,300**	**276**	<65.0	<130	**3,620**	**171,000**	**227**	<130	<130	<65.0	**419**	<650	
SL-3	**5,420**	**301**	<69.2	<138	**463**	**98,000**	<69.2	<138	<138	<69.2	**44.5**	**711**	
SL-4	**27,100**	50.3	<31.2	<62.4	**4,440**	**52,100**	**78.3**	**279**	<62.4	<31.2	**50.0**	**401**	**0.272**
SL-5	**17,600**	**140**	<58.2	<116	**2,500**	**129,000**	**254**	**119**	<116	<58.2	**131**	**3,150**	
SL-6	**27,800**	<55.7	<55.7	<111	**2,500**	**156,000**	**78.0**	**136**	<111	<55.7	**37.3**	**4,800**	
SL-7	**11,300**	**235**	<36.7	<73.4	**287**	**67,000**	<36.7	**184**	<73.4	<36.7	<36.7	<367	
SL-8	**51,700**	**70.7**	<54.8	<110	**3,690**	**152,000**	**68.5**	**198**	<110	<54.8	**14.6**	**4,680**	<0.0984
SL-9	**52,000**	<53.5	<53.5	<107	**3,050**	**168,000**	<53.5	**179**	<107	<53.5	**14.7**	**2,750**	
SL-10	**33,900**	<54.7	<54.7	<109	**3,050**	**173,000**	**63.4**	**148**	<109	<54.7	**28.3**	**4,540**	
FR-1	**8,180**	**138**	<3.42	**31.9**	**258**	**37,400**	**430**	**152**	**26.6**	**7.56**	**42.9**	**167**	
FR-2	**7,160**	**251**	**3.41**	**37.3**	**575**	**92,800**	**861**	**234**	**28.3**	**13.4**	**16.6**	**388**	**1.29**
RD-1	**3,220**	**536**	<0.609	**3.30**	**106**	**45,300**	**653**	**61.7**	1.92	**23.5**	**14.4**	**64.9**	
RD-2	**1,120**	**178**	<0.586	**1.29**	**46.6**	**23,700**	**355**	**10.1**	<1.17	**11.4**	**4.82**	**25.6**	
RD-3	**4,150**	**266**	<0.574	**2.55**	**63.8**	**31,600**	**380**	**92.1**	1.86	**9.55**	**12.2**	**63.9**	**1.36**
RD-4	**2,960**	**465**	**0.572**	**3.75**	**205**	**85,300**	**807**	**39.7**	**1.69**	**23.4**	**24.6**	**108**	
RD-5	**8,330**	**308**	**1.79**	**11.5**	**182**	**63,500**	**834**	**166**	**8.48**	**26.1**	**45.6**	**535**	
RD-6	**5,280**	**270**	**0.706**	**3.36**	**117**	**61,000**	**475**	**148**	**1.89**	**36.6**	**18.9**	**136**	
RD-7	**5,620**	**277**	**0.634**	**4.78**	**176**	**72,000**	**528**	**110**	**2.32**	**25.4**	**13.5**	**129**	**2.56**
RD-8	**6,230**	**479**	**0.702**	**8.12**	**242**	**103,000**	**694**	**163**	**3.37**	**34.6**	**32.1**	**155**	
RD-9	**15,100**	**108**	<0.590	**23.5**	**183**	**76,300**	**486**	**368**	**25.1**	**8.71**	**19.9**	**170**	**2.46**
RD-10	**3,390**	**180**	<0.605	**4.06**	**112**	**33,500**	**553**	**179**	**2.92**	**20.1**	**16.9**	**106**	
RD-11	**1,930**	**112**	<0.636	**2.66**	**94.2**	**27,200**	**691**	**26.6**	**2.43**	**22.0**	**25.2**	**101**	
RD-12	**2,290**	**170**	**1.96**	**4.56**	**181**	**41,400**	**2,960**	**33.1**	**1.79**	**56.1**	**96.8**	**322**	
RD-13	**6,790**	**628**	**1.08**	**3.82**	**328**	**88,900**	**1,050**	**140**	**3.25**	**40.8**	**35.9**	**185**	
RD-14	**6,630**	**566**	0.772	**3.97**	**267**	**86,400**	**1,090**	**119**	**2.82**	**41.1**	**93.0**	**204**	
RD-15	**10,800**	**494**	**1.18**	**4.72**	**244**	**73,800**	**740**	**253**	**3.78**	**19.2**	**47.6**	**243**	
RD-16	**7,370**	**531**	**0.738**	**4.51**	**241**	**71,600**	**1,360**	**129**	**2.95**	**36.4**	**174**	**228**	**6.14**
RD-17	**801**	**20.9**	<0.584	<1.17	**9.09**	**7,550**	**164**	**3.32**	<1.17	**3.86**	**3.79**	**13.0**	
RD-18	**952**	**15.4**	<0.573	<1.15	**6.61**	**10,900**	**170**	**1.32**	<1.15	**6.14**	**4.11**	<5.73	
RD-19	**675**	**5.34**	<2.95	<5.90	<5.90	**2,900**	**17.6**	<5.90	<5.90	**8.88**	**3.60**	<29.5	
RD-20	**1,190**	**71.1**	<2.81	<5.62	**39.1**	**21,100**	**464**	<5.62	<5.62	**7.81**	**15.0**	<28.1	
RD-21	**928**	**284**	<2.72	<5.45	**85.0**	**33,500**	**1,050**	<5.45	<5.45	**6.73**	**36.7**	<27.2	
RD-22	**1,290**	**40.0**	<2.93	<5.87	**94.4**	**18,900**	**1,090**	<5.87	<5.87	**3.84**	**29.5**	**51.4**	**4.18**
RD-23	**1,010**	**180**	<3.17	<6.33	**78.4**	**50,200**	**776**	<6.33	<6.33	**7.50**	**38.5**	<31.7	
RD-24	**1,940**	**130**	<2.98	<5.96	**39.5**	**21,400**	**395**	**10.8**	<5.96	**5.84**	**14.4**	<29.8	

Notes: Samples collected on 01/18/12 by PBS.
All results in milligrams per kilogram (mg/kg). Detections are shown in **bold.**
J= The associated numerical value is an estimated value based on laboratory QA/QC.
23.5 = Value identified an an Outlier at a 5 percent significance Level.
BG = Background samples BG-1 thru BG-5 Rogue Fm.; BG-6 thru BG-10 Gallice Fm.; SL = Slag Pile, FR = Furnace Area RD = Rock Dump.

Table 3
Summary Statistics for Selected Total Metals
Alemda Mine, Josephine County, OR

PBS Project No: 80523.000
Report Date: June 2012

ID	Raw Full Data Sets	Total Trace Metals (milligrams per liter)								
		Aluminum	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Zinc	
A520	NumObs	11	12	12	12	12	12	12	12	
	Minimum	15.4	0.019	0.035	2.39	54.6	0.0424	1.44	7.83	
	Maximum	41.8	1.48	0.085	7.94	196	0.65	2.04	16.80	
	Mean	21.9	0.071	0.053	3.942	108.4	0.129	1.656	10.25	
	Median	20.8	0.067	0.051	3.435	99.55	0.0738	1.6	9.98	
	Variance	50.77	0.167	1.476E-04	2.565	1554	0.0279	0.0305	5.91	
	Standard Deviation	7.12	0.409	0.012	1.602	39.4	0.167	0.175	2.43	
	Outlier Test (upper/lower)	41.8/N	1.48/N	0.085/N	N/N	N/N	0.646/N	N/N	N/N	4 outliers (upper tail) identified
	90% UCL of the Mean	**21.15**	**0.09**	**0.053**	**4.008**	**123.7**	**0.10**	**1.73**	**10.2**	Excluding outliers
	SL-Residential RBC/RSL	37	3.80E-05	0.018	1.5	26	0.015	0.88	11	
	BLM-Human Risk Management Criteria	NA	0.081	0.553	20.5	41.03	0.05	5.53	3.32	
	DEQ WQ NGQGL				1	0.3				
	Mean Conc. Exceeds SL	N	Y	Y	Y	Y	Y	Y	N	
	UCL Conc. Exceeds SL	N	Y	Y	Y	Y	Y	Y	N	
	Max Conc. Exceeds SL	Y	Y	Y	Y	Y	Y	Y	Y	
LSCE	NumObs	11	12	12	12	12	12	12	12	
	Minimum	15.3	0.007	0.034	2.4	31.7	0.0311	1.52	7.09	
	Maximum	41	0.211	0.083	7.95	159	0.176	2.57	15.80	
	Mean	24.8	0.0595	0.051	3.885	70.88	0.0823	1.88	9.89	
	Median	22.7	0.035	0.049	3.41	68.3	0.0719	1.805	9.915	
	Variance	49.04	0.004	1.577E-04	2.693	1241	0.00203	0.0994	5.652	
	Standard Deviation	7	0.065	0.013	1.641	35.22	0.0451	0.315	2.377	
	Outlier Test (upper/lower)	41/N	0.211/N	0.083/N	N/N	159/N	N/N	N/N	15.8/N	5 outliers (upper tail) identified
	90% UCL of the Mean	**25.3**	**0.073**	**0.052**	**4.59**	**72.29**	**0.1**	**2**	**9.98**	Excluding outliers
	SL-Residential RBC/RSL	37.0	3.80E-05	0.018	1.5	26	0.015	0.88	11	
	BLM-Human Risk Management Criteria	NA	0.081	0.553	20.5	41.03	0.05	5.53	3.32	
	DEQ WQ NGQGL				1	0.3				
	Mean Conc. Exceeds SL	N	Y	Y	Y	Y	Y	Y	N	
	UCL Conc. Exceeds SL	N	Y	Y	Y	Y	Y	Y	N	
	Max Conc. Exceeds SL	Y	Y	Y	Y	Y	Y	Y	Y	

A520=Flume outlet from Adit 520
LSCE=terminus of limestone treatment channel
Outlier Test - Dixon's Outlier Test for upper / lower tail (outlier value or 'N' for no outlier)
90%UCL of the Mean=90 percent upper confidencelimit of the mean excluding outliers.
SL-Screen Level
Residential Tapwater Oregon Risk Based Concentration or EPA Preliminary Remediation Goal

BLM-HRMC-Human Risk Management Criteria, BLM Technical Note 390, Oct. 2004

Table 4
Summary Statistics for Selected Total Metals in Soil
Almeda Mine, Josephine County, OR

PBS Project No: 80523.000
Report Date: June 2012

ID	Raw Full Data Sets	Total Trace Metals (milligrams per kilogram)													Comments
		Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Zinc	Mercury	
Background (BG) Samples	Num Detections/Num Samples	10/10	8/10	0/10	3/10	10/10	10/10	9/10	10/10	3/10	1/10	1/10	6/10	1/2	
	Minimum	3,770	12.7	N/A	34	33.5	31,900	17.7	357	33.30	2.93	7.25	115	0.2	
	Maximum	30,700	305	N/A	44	365	138,000	719	2,590	36.20	2.93	7.25	325	0.2	
	Mean	19,970	132	N/A	38	128.1	68,320	267.9	1,173	35.13	2.93	7.25	198.5	0.2	
	Median	23200	139.5	N/A	36	101.1	54,650	180	940.5	35.9	2.93	7.25	169.5	0.2	
	Variance	1.E+08	1.1E+04	N/A	27.1	9.8E+03	1.1E+09	7.0E+04	4.8E+05	2.54	N/A	N/A	8.0E+03	N/A	
	Standard Deviation	10,038	102.9	N/A	5	99.2	33003.0	264.7	693.9	1.59	N/A	N/A	89.3	N/A	
	Outlier Test (upper/lower)	N/N	N/N	N/A	N/N	N/N	N/N	N/N	N/N	N/N	N/A	N/A	N/N	N/A	no outliers (upper tail) identified
	90% UCL of the Mean	**24,360**	**184**	N/A	N/A	**180**	**82,754**	**391**	**1,477**	N/A	N/A	N/A	**252**[1]	N/A	UCL Excluding outliers, NDs
	SL-Residential RBC/RSL	77,000	0.39	39	120,000	3,100	55,000	400	1,800	1,500	390	390	23,000	23	
	BLM-HRMA	N/A	20	70	N/A	5,000	N/A	1,000	19,000	2,700	700	700	40,000	40	
	Mean Conc. Exceeds SL	N	Y	N/A	N	N	Y	N	N	N	N	N	N	N	
	UCL Conc. Exceeds SL	N	Y	N/A	N/A	N	Y	N	N	N/A	N/A	N/A	N	N/A	
	Max Conc. Exceeds SL	N	Y	N/A	N	N	Y	Y	Y	N	N	N	N	N	
Slag Pile (SL) Samples	Num Detections/Num Samples	10/10	6/10	0/10	0/10	10/10	10/10	7/10	10/10	0/10	0/10	9/10	8/10	1/2	
	Minimum	5,420	50.3	N/A	N/A	287	52100	36.7	119	N/A	N/A	15	36.7	0.27	
	Maximum	52,000	301	N/A	N/A	4,620	188000	254	279	N/A	N/A	419	5,680	0.27	
	Mean	26,622	129.3	N/A	N/A	2,822	135410	99.96	167	N/A	N/A	80	2,731	0.27	
	Median	26,100	63.3	N/A	N/A	3,050	154000	70.1	153.5	N/A	N/A	37	2950	0.27	
	Variance	2.5E+08	1.0E+04	N/A	N/A	2.2E+06	2.3E+09	5.7E+03	2.2E+03	N/A	N/A	1.5E+04	4.6E+06	N/A	
	Standard Deviation	15,802	102	N/A	N/A	1,474	47455	75.34	46.95	N/A	N/A	123.5	2,134	N/A	
	Outlier Test (upper/lower)	N/N	N/N	N/A	N/A	N/N	N/N	N/N	279/N	N/A	N/A	419/N	N/N	N/A	2 outliers (upper tail) identified
	90% UCL of the Mean	**33,533**	**243**[1]	N/A	N/A	**3,466**	**156,165**	**180**	**167**	N/A	N/A	**73**	**4,302**	N/A	UCL Excluding outliers, NDs
	SL-Residential RBC/RSL	77,000	0.39	39	120,000	3,100	55,000	400	1,800	1,500	390	390	23,000	23	
	BLM-HRMA	N/A	20	70	N/A	5,000	N/A	1,000	19,000	2,700	700	700	40,000	40	
	Mean Conc. Exceeds SL	N	Y	N	N	N	Y	N	N	N/A	N/A	N	N	N	
	UCL Conc. Exceeds SL	N	Y	N	N	Y	Y	N	N	N/A	N/A	N	N	N/A	
	Max Conc. Exceeds SL	N	Y	N	N	Y	Y	N	N	N/A	N/A	Y	N	N	
Furnace Samples	Num Detections/Num Samples	2/2	2/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	1/2	
	Minimum	7,160	138	3.4	31.9	258	37,400	430	152	26.6	7.6	16.6	167	1.3	
	Maximum	8,180	251	3.4	37.3	575	92,800	861	234	28.3	13.4	42.9	388	1.3	
	Mean	7,670	194.5	3.4	34.6	416.5	65,100	645.5	193	27.5	10.5	29.8	277.5	1.3	
Rock Dump (RD) Samples	Num Detections/Num Samples	24/24	24/24	10/24	16/24	23/24	24/24	24/24	19/24	15/24	24/24	24/24	18/24	5/5	
	Minimum	675	5.34	0.572	1.15	6.6	2,900	17.6	1.32	1.15	3.84	3.6	13	1.36	
	Maximum	15,100	628	1.96	23.5	328	103,000	2,960	368	25.1	56.1	174	535	6.14	
	Mean	4,167	263.1	1.01	5.329	131.1	47,856	740.9	108.1	4.23	20.23	34.21	164.1	3.34	
	Median	3,090	223	0.755	4.535	109	43,350	672	110	2.63	19.65	22.25	136	2.56	
	Variance	1.34E+08	3.8E+04	0.244	20.1	8.4E+03	8.6E+08	3.3E+05	9.1E+03	33.7	211.4	1.5E+03	1.6E+04	3.46	
	Standard Deviation	3,664	195.8	0.494	4.48	91.66	29,241	576.5	95.4	5.81	14.54	38.39	124.8	1.86	
	Outlier Test (upper/lower)	15100/N	N/N	N/N	23.5/N	N/N	N/N	2960/N	368/N	25.1/N	N/N	174/N	535/N	N/N	7 outliers (upper tail) identified
	90% UCL of the Mean	**5,347**	**316**	**1.27**	**5.5**	**161**	**55,832**	**737**	**117**	**3.4**	**28**	**36**	**169**	**4.6**[1]	UCL Excluding outliers, NDs
	SL-Residential RBC/RSL	77,000	0.39	39	120,000	3,100	55,000	400	1,800	1,500	390	390	23,000	23	
	BLM-HRMA	N/A	20	70	N/A	5,000	N/A	1,000	19,000	2,700	700	700	40,000	40	
	Mean Conc. Exceeds SL	N	Y	N	N	N	N	Y	N	N	N	N	N	N	
	UCL Conc. Exceeds SL	N	Y	N	N	N	Y	Y	N	N	N	N	N	N	
	Max Conc. Exceeds SL	N	Y	N	N	N	Y	Y	N	N	N	N	N	N	

Notes:
Outlier Test-Dixon's Outlier Test for upper / lower tail (outlier value or 'N' for no outlier)
90%UCL of the Mean=90 percent upper confidencelimit of the mean excluding outliers.
SL-Screening Level using DEQ Risk-Based Concentrations (11/2011) or EPA Regional Screening Levels (06/2011)
BLM HRMA - Human Risk Management Criteria for a Camper Scenario (BLM, Tech. Memo 390, rev. 4, 2004)
1 - UCL determined with fewer than 8 data points.

Table 5
Summary of Exposure Modifications and Calculated RBCs **PBS Project No.: 80523.000**
Almeda Mine, Josephine County, OR **Report Date: June 2012**

Exposure Parameter		Residential		**Site Specific Changes To Exposure Parameters**		Construction/Excavation Worker		**Site Specific Changes To Exposure Parameters**	
		RME	CTE	RME	CTE	RME	CTE	RME	CTE
Exposure Duration - Adult (yrs)		30	9	**NC**	**NC**	1	0.5	**NC**	**NC**
Exposure Duration - Child (yrs)		6	6	**NC**	**NC**	NA	NA	**NC**	**NC**
Exposure Frequency (days/yr)		350	350	**10**	**10**	250/9	250/9	**5/5**	**5/5**
Water Ingestion - Adult (liters/day)		2	1.4	**0.35**	**0.25**	NA	NA	**NA**	**NA**
Water Ingestion - Child (liters/day)		1.5	0.9	**0.25**	**0.15**	NA	NA	**NA**	**NA**
Water RBCs (ug/l)	Aluminium (Al)	37,000	52,000	**1.2 E+07**	**1.7 E+07**	NA	NA	**NA**	**NA**
	Arsenic (As)	(0.038) 11	(0.058) 16	**(13) 3,700**	**(19) 5,100**	(0.27) 44	(1.6) 61	**(10,000) 67,000**	**(10,000) 67,000**
	Cadmium (Cd)	(5.7 E+10) 18	(8.7 E+10) 26	**(1.9 E+13) 6,100**	**(2.9 E+13) 8,500**	(4.1 E+11) 73	(2.4 E+12) 100	**(1.4 E +16) 100,000**	**(2.9 E+19) 100,000**
	Copper (Cu)	1,500	2,100	**4.9 E+05**	**6.8 E+05**	5,800	8,200	**9.0 E+06**	**9.0 E+06**
	Iron (Fe)	26,000	37,000	**8.5 E+06**	**1.2 E+07**	NA	NA	**NA**	**NA**
	Lead[1] (Pb)	15	15	**NA**	**NA**	15	15	**NA**	**NA**
	Manganese (Mn)	880	1,300	**2.9 E+05**	**4.1 E+05**	3,500	4,900	**6.4 E+06**	**6.40E+06**
	Zinc (Zn)	11,000	16,000	**3.7 E+06**	**5.1 E+06**	44,000	61,000	**1.1 E+08**	**1.1 E+08**
Soil RBCs (mg/kg)	Arsenic (As)	(0.39) 22	(0.82) 45	**(23) 1300**	**(48) 2,600**	(13) 85	(87) 560	**(660) 4,300**	**(2200) 14,000**
	Copper (Cu)	3,100	6,300	**1.8 E+05**	**3.6 E+05**	12,000	81,000	**6.2 E+05**	**2.0 E+06**
	Iron (Fe)	55,000	1.1 E+05	**3.2 E+06**	**6.4 E+06**	2.2 E +05	1.4 E+06	**1.1 E+07**	**3.6 E+07**
	Lead[2] (Pb)	400	400	**28,000**	**28,000**	800	800	**28,000**	**28,000**
	Silver (Ag)	390	780	**23,000**	**46,000**	1,500	10,000	**77,000**	**2.6 E+05**

Notes:
RME= Reasonable Maximum Exposure
CTE= Central Tendency Exposure
Bold Values are site
NA=Not Applicable
NC=No Change
Risk-based concentrations indicated for non cacinogenic effects and (carcinogenic effects)
1 = Site specific Lead RBCs for water not calculated because there are no anticipated young child (< 6 yrs.) exposures.
2= Site specific Lead RBC for soil calculated by adjusting exposure frequency in EPA adult lead model.

Table 6
Carcinogenic Risk Characterization **PBS Project No.: 80523.000**
Almeda Mine, Josephine County, OR **Report Date: June 2012**

Carcinogenic Effects by Compound	Modified Residential (Recreational)		Construction/Excavation	
	RME	CTE	RME	CTE
Water				
Arsenic				
EPC (ppb)	91	71	91	71
Calculated RBC (ppb)	13	19	10,000	10,000
ECR (ppb)	*7.0E-06*	*3.7E-06*	*9.1E-09*	*7.1E-09*
ECR >10^{-6}	Yes	Yes	Yes	No
ECR >10^{-5}	No	No	No	No
Cadmium				
EPC (ppb)	53	53	53	53
Calculated RBC (ppb)	1.9E+13	2.9E+13	1.4E+16	2.9E+16
ECR (ppb)	*2.8E-18*	*1.8E-18*	*3.8E-21*	*1.8E-21*
ECR >10^{-6}	No	No	No	No
Water- ECR	***7.0E-06***	***3.7E-06***	***9.1E-09***	***7.1E-09***
Soil (Waste Pile)				
Arsenic - Slag Pile				
EPC (ppm)	243	129	243	129
Calculated/Bkgd. RBC (ppm)	(23) 184[1]	(48) 132[2]	660	2,200
SL-ECR	*1.30E-06*	*9.80E-07*	*3.7E-07*	*5.9E-08*
ECR >10^{-6}	Yes	No	No	No
ECR >10^{-5}	No	No	No	No
Arsenic - Rock Dump				
EPC (ppm)	316	263	316	263
Calculated /Bkgd. RBC (ppm)	(23) 184[1]	(48) 132[2]	660	2,200
RD-ECR	*1.70E-06*	*2.00E-06*	*4.8E-07*	*1.2E-07*
ECR >10^{-6}	Yes	Yes	No	No
ECR >10^{-5}	No	No	No	No
Average Soil ECR[3]	***1.5E-06***	***1.5E-06***	***4.2E-07***	***8.9E-08***
ECR >10^{-6}	Yes	Yes	No	No
ECR >10^{-5}	No	No	No	No
Cumulative Carcinogenic Risk[4]	**8.5E-06**	**5.2E-06**	**4.3E-07**	**9.6E-08**
>1 X 10^{-6}	Yes	Yes	No	No
>1 X 10^{-5}	No	No	No	No

Notes:

EPC: Exposure Point Concentration based on 90% Upper Confidence Limit of the Mean

RME: Reasonable Maximum Exposure

CTE: Central Tendency Exposure

RBC: Risked Based Concentration

ECR: Excess Cancer Risk (*shown in italics*)

1 = RBC is based on 90% of the UCL of Background sample group results (Calculated site specific RBC in parentheses).

2 = RBC is based on mean of Background sample group results.

3 = Soil-ECR is the average arsenic ECR(SL-ECR+RD-ECR/2)

4 = Cumulative Risk includes the sum of Water-ECR and the average Soil ECR.

Table 7
Non-Carcinogenic Risk Characterization **PBS Project No.: 80523.000**
Almeda Mine, Josephine County, OR **Report Date: June 2012**

Non-Carcinogenic Effects by Compound	Modified Residential (Recreational)		Construction/Excavation Worker	
	RME	CTE	RME	CTE
Water				
Aluminum				
EPC (ppb - ug/l)	2.1E+04	2.2E+04	2.1E+04	2.2E+04
RBC (ppb - ug/l))	1.2E+07	1.7E+07	NA	NA
HQ	*1.8E-03*	*1.3E-03*	--	--
Arsenic				
EPC (ppb - ug/l)	91	71	91	71
RBC (ppb - ug/l))	3.7E+03	5.1E+03	6.7E+04	6.7E+04
HQ	*2.5E-02*	*1.4E-02*	*1.4E-03*	*1.1E-03*
Cadmium				
EPC (ppb - ug/l)	53	53	53	53
RBC (ppb - ug/l))	6.1E+03	8.5E+03	1.0E+05	1.0E+05
HQ	*8.7E-03*	*6.2E-03*	*5.3E-04*	*5.3E-04*
Copper				
EPC (ppb - ug/l)	4.0E+03	3.9E+03	4.0E+03	3.9E+03
RBC (ppb - ug/l))	4.9E+05	6.8E+05	9.0E+06	9.0E+06
HQ	*8.2E-03*	*5.8E-03*	*4.5E-04*	*4.4E-04*
Iron				
EPC (ppb - ug/l)	1.2E+05	1.1E+05	1.2E+05	1.1E+05
RBC (ppb - ug/l))	8.5E+06	1.2E+07	NA	NA
HQ	*1.5E-02*	*9.0E-03*	--	--
Manganese				
EPC (ppb - ug/l)	1.7E+03	1.7E+03	1.7E+03	1.7E+03
RBC (ppb - ug/l))	2.9E+05	4.1E+05	6.4E+06	6.4E+06
HQ	*6.0E-03*	*4.0E-03*	*2.7E-04*	*2.6E-04*
Zinc				
EPC (ppb - ug/l)	1.0E+04	1.0E+04	1.0E+04	1.0E+04
RBC (ppb - ug/l))	3.7E+06	5.1E+06	1.1E+08	1.1E+08
HQ	*2.8E-03*	*2.0E-03*	*9.3E-05*	*9.3E-05*
Water Hazard Index (water-HI)	***6.7E-02***	***4.2E-02***	***2.7E-03***	***2.4E-03***
Soil				
Arsenic				
EPC[1] (ppm)	280	196	280	196
RBC (ppm)	1300	2,600	4,300	14,000
HQ	*2.2E-01*	*7.5E-02*	*6.5E-02*	*1.4E-02*
Copper				
EPC[1] (ppm)	1.8E+03	1.5E+03	1.8E+03	1.5E+03
RBC (ppm)	1.8E+05	3.6E+05	6.2E+05	2.0E+06
HQ	*1.0E-02*	*4.1E-03*	*2.9E-03*	*7.4E-04*
Iron				
EPC[1] (ppm)	1.6E+05	1.4E+05	1.6E+05	1.4E+05
RBC (ppm)	3.2E+06	6.4E+06	1.1E+07	3.6E+07
HQ	*4.9E-02*	*2.1E-02*	*1.4E-02*	*3.8E-03*
Lead				
EPC[1] (ppm)	459	420	459	420
RBC[2] (ppm)	2.8E+04	2.8E+04	2.8E+04	2.8E+04
HQ	*1.6E-02*	*1.5E-02*	*1.6E-02*	*1.5E-02*
Silver				
EPC[1] (ppm)	55	57	55	57
RBC (ppm)	2.3E+04	4.6E+04	7.7E+04	2.6E+05
HQ	*2.4E-03*	*1.2E-03*	*7.1E-04*	*2.2E-04*
Soil Hazard Index (soil-HI)	***2.9E-01***	***1.2E-01***	***9.9E-02***	***3.4E-02***
Cumulative Hazard Index (HI)	***0.36***	***0.16***	***0.10***	***0.04***
HI > 1.0 (1.0E+00)	**No**	**No**	**No**	**No**

EPC=Exposure Point Concentration based on 90% Upper Confidence Limit of the Mean
RME=Reasonable Maximum Exposure; CTE=Central Tendency Exposure
RBC=Risked Based Concentration
[1] =EPC is based on UCL /mean of RD and SL samples.
[2] =Lead RBC established using EPA Adult Lead Model