GEODESIGN INC

FOCUSED SITE INSPECTION

Ruth Mine - Opal Creek Scenic and Recreation Area

Willamette National Forest

Marion County, Oregon

For
Opal Creek Ancient Forest Center
c/o Perkins Coie LLP
June 14, 2006

GeoDesign Project: OpalCreek-1-01

GEODESIGN INC

June 14, 2006

Opal Creek Ancient Forest Center
c/o Perkins Coie LLP
1120 NW Couch Street, Tenth Floor
Portland, OR 97201

Attention: Mr. Chris Rich

Focused Site Inspection
Ruth Mine - Opal Creek Scenic and Recreation Area
Willamette National Forest
Marion County, Oregon
GeoDesign Project: OpalCreek-1-01

GeoDesign, Inc. is pleased to submit our Focused Site Inspection report for the Ruth Mine site, located in the Opal Creek Scenic and Recreation Area in Marion County, Oregon.

Please call if you have questions concerning this submittal.

Sincerely,

GeoDesign, Inc.

Craig W. Ware, R.G.
Principal Geologist

cc: Mr. Stephen Feldman, Perkins Coie, LLP (one copy submitted)
Mr. Aaron Courtney, Perkins Coie, LLP (one copy submitted)
Mr. Brian Windrope, Opal Creek Ancient Forest Center (one copy submitted)
Mr. Jim Brown, James C. Brown and Associates, PC (six copies submitted)
Mr. Chris Reive, Jordon Schrader, PC (one copy submitted)
Mr. Dennis Boles, Ochoco N.F. (one copy submitted)
Mr. James E. Alexander, U.S. Department of Agriculture (one copy submitted)

SCN:CWW:kt
Attachments
One copy submitted
Document ID: OpalCreek-1-01-061406-envr-FSI.doc
© 2006 GeoDesign, Inc. All rights reserved.

15575 SW Sequoia Pkwy - Suite 100 | Portland, OR 97224 | Off 503.968.8787 | Fax 503.968.3068

ACRONYMS

APA	Abbreviated Preliminary Assessment
BGS	below the ground surface
BS	blank spike
BSD	blank spike duplicate
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	chain of custody
COI	contaminant of interest
COPC	contaminant of potential concern
CPEC	contaminant of potential ecological concern
CTE	central tendency exposure
DEQ	Oregon Department of Environmental Quality
EC	environmental concentrations
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FSI	Focused Site Inspection
HHRE	Human Health Risk Evaluation
I.D.	identification
IEUBK	Integrated Exposure Uptake BioKinetic
MCL	maximum contaminant level
mg/day	milligrams per day
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
NA	not applicable
ND	not detected
OAR	Oregon Administrative Rule
OWRD	Oregon Water Resources Department
PRG	preliminary remediation goal
RME	reasonable maximum exposure
SI	Site Inspection
SLV	screening level value
SPLP	Synthetic Precipitation Leaching Procedure
SRMC	Shiny Rock Mining Company
µg/dL	micrograms per deciliter
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
WQC	Water Quality Criteria
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

The Ruth #1 Mine (Ruth Mine) is an historic hard rock mine in the Opal Creek Scenic Recreation Area of the Willamette National Forest in Marion County, Oregon, that operated primarily during the 1930s and 1940s and again in the 1970s and 1980s. It is located in a remote, mineral enriched, and rugged section of the Oregon Cascade Mountain range at elevations ranging from approximately 2,360 to 2,660 feet above mean seal level (MSL). The nearest residents are employees of the Opal Creek Ancient Forest Center located at Jawbone Flats, approximately 1 mile to the west of the Ruth Mine. There are no other residents within approximately 4 miles of the Ruth Mine site. Visitors to the site are primarily occasional day hikers.

Surface water runoff from the Ruth Mine site flows into Ruth Creek from Adit 4 and directly into Battle Ax Creek from Adit 5. Ruth Creek is also a tributary to Battle Ax Creek, which is located a short distance away and approximately 60 and 360 feet below Ruth Mine Adits 5 and 4, respectively. Battle Ax Creek flows through a steep-sloped ravine between Whetstone Mountain and the north-facing hillside where the Ruth Mine is located. Additional mining sites, the Morningstar Mine and other unnamed mine adits, as well as the Amalgamated Mill site are located on the same north-facing slope. The southern slope of Whetstone Mountain is the southern edge of the Opal Creek Wilderness Area. Battle Ax Creek flows generally east to west from an elevation of approximately 2,420 feet above MSL at the confluence of Blue Jay Creek and Battle Ax Creek to 2,320 feet above MSL at the confluence of Ruth Creek and Battle Ax Creek (approximately 0.4 mile downstream of the Blue Jay Creek confluence). The elevation of Battle Ax Creek at the former Amalgamated Mill site, located approximately 1 mile downstream of the Ruth Creek confluence, is approximately 2,160 feet above MSL. This is a drop in elevation of over 250 feet in less than 1.5 miles.

In October 2004, the U.S. Forest Service (USFS) completed an *Abbreviated Preliminary Assessment* for the historic Ruth Mine. Based upon field results from a Niton® hand-held X-ray fluorescence (XRF) instrument, used by USFS to test for total metals concentrations in the waste rock dumps at the Ruth Mine site, USFS concluded that the total metals concentrations of naturally occurring metals in the waste rock (including arsenic, chromium, iron, lead, manganese, and nickel) might be elevated above U.S. Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goals for industrial soils. USFS also concluded that the waste rock was potentially eroding and that hazardous substances (i.e., total metals) from the waste rock or leachate from the waste rock might enter Battle Ax Creek and cause a threat to human health or the environment. USFS recommended that a Site Inspection (SI) be completed for the Ruth Mine site.

On December 1, 2004, USFS decided that the Shiny Rock Mining Company (SRMC), as a former operator of the Ruth Mine, was liable as a responsible party under the Comprehensive Environmental Response, Compensation and Liability Act and requested that SRMC participate in the completion of the SI at the Ruth Mine site.

The Opal Creek Ancient Forest Center retained GeoDesign to complete further site assessment work. GeoDesign completed a site reconnaissance at the Ruth Mine in August 2005 and presented a September 2005 Work Plan to further assess the USFS findings and to complete a

Focused Site Inspection (FSI) at the Ruth Mine site. The proposed scope of work was developed to: (1) further evaluate total metals concentrations obtained using the XRF field instrument using standard chemical analytical methods; (2) conduct appropriate sampling and analysis to evaluate metals concentrations in waste rock/soil, sediments, and surface water; and (3) conduct appropriate risk assessment to determine whether the Ruth Mine site poses an actual threat to human health or the environment requiring further action. The Work Plan was presented to USFS for review prior to conducting the field activities.

On November 8 and 9, 2005, GeoDesign representatives (accompanied by USFS personnel on November 8) conducted field activities at the Ruth Mine area, which included the collection of surface water, mine adit water, sediment pore water, stream sediment, waste rock/soil, and background rock/soil samples for chemical analyses. GeoDesign used a Niton® XL-722 XRF detector to analyze the waste rock/soil and background rock/soil samples for total metals as well as submitting the samples to the laboratory for standard total metals analysis. The waste rock/soil samples, in some cases, were collected at or near the locations where USFS collected XRF samples in 2004. The respective XRF data were compared to laboratory analytical data. These comparisons indicated that in several samples there was over 50 percent difference between the XRF total metals concentrations and the laboratory detected total metals concentrations using standard analytical protocols.

The Synthetic Precipitation Leaching Procedure (SPLP) was used to assess the potential for the waste rock to leach metals to the environment under naturally occurring conditions at the Ruth Mine. The SPLP results for the waste rock/soil indicate that 9 of the 13 metals did not leach at detectable concentrations. The detected metal concentrations of the four remaining metals in the waste rock (i.e., iron, lead, manganese, and zinc) were generally equivalent to or less than the concentrations of these metals found in the SPLP results for the background soil samples and were only slightly elevated above the Oregon Department of Environmental Quality (DEQ), ecological screening criteria, Level II Screening Level Values (SLVs) for fresh surface water. Subsequent risk analysis indicates that leachate from the waste rock does not pose a threat to human health or the environment.

Historical information, provided by USFS, the Oregon Water Resources Department, DEQ, and EPA, as well as analytical data, was also used to complete a Human Health Risk Evaluation (HHRE) and Screening Ecological Risk Assessment (ERA) for the Ruth Mine site. To complete the HHRE, exposure scenarios for the Ruth Mine site were determined based on the USFS designation of "Low Use" for the Ruth Mine portion of the Opal Creek Scenic Recreation Area and information provided by the Opal Creek Ancient Forest Center personnel. Several conservative factors were built into the HHRE calculations, including exposure frequency and duration to the site by adults and children, ingestion rates based on DEQ and/or EPA guidance, and basing contaminant of potential concern concentrations exclusively on the waste rock/soil analytical results rather than including background concentrations.

The HHRE indicates that there are no unacceptable cancer or non-cancer health risks to adults or children from exposure to surface water, sediments, waste rock/soil, or air related to the Ruth Mine. The Screening ERA showed that some metals were elevated in waste rock/soil, surface water, and sediment samples. In some cases, those levels exceeded the DEQ Level II SLVs, which

are exposure concentrations that are deemed acceptable for ecological receptors (i.e., plants, invertebrates, and wildlife). A number of conservative factors were built into the risk calculations for determining contaminants of potential ecological concern (CPECs). Based on the results of the risk calculations for the selected CPECs, some limited risk was initially predicted for various receptors to different media. However, further evaluation indicates that risks are not substantial due to habitat constraints and the environmental concentrations. The size of the Ruth Mine site is relatively small in area compared to the surrounding vicinity of similar physical and biological characteristics, which provides more suitable habitat and food sources to the ecological receptors in the environment. Accordingly, the Ruth Mine site does not pose a significant ecological risk to local ecological receptors and communities.

Based on the information gathered for the FSI and the results of the HHRE and the Screening ERA, it is our professional opinion that no further environmental assessment or planned remedial action is warranted at the Ruth Mine site.

TABLE OF CONTENTS — PAGE NO.

1.0	INTRODUCTION AND OBJECTIVES		1
2.0	SITE DESCRIPTION AND OPERATIONAL HISTORY		2
	2.1	Description and Location	2
	2.2	Historical Operations and Ownership	2
	2.3	Climate	4
3.0	GROUNDWATER EXPOSURE PATHWAY		4
	3.1	Geologic Setting	4
	3.2	Site-Specific Mining Geology	4
	3.3	Hydrogeology	5
	3.4	Targets	5
4.0	SURFACE WATER EXPOSURE PATHWAY		5
	4.1	Hydrologic Setting	5
	4.2	Targets	6
	4.3	Sample Locations	6
	4.4	Analytical Results	8
	4.5	Conclusions - Surface Water	9
5.0	SOIL AND AIR EXPOSURE PATHWAYS		10
	5.1	Physical Conditions	10
	5.2	Targets	11
	5.3	Waste Rock/Soil Sample Locations	11
	5.4	Analytical Results	11
	5.5	Conclusions - Soil and Air	12
6.0	SUMMARY		13

FIGURES

Battle Ax and Opal Creeks Drainage Basin	Figure 1
Vicinity Map	Figure 2
Ruth Mine Camp in 1935	Figure 3
Site Plan	Figure 4
Proposed Recreation Management Intensity Zones	Figure 5
Adit 4 Area	Figure 6
Adit 5 Area	Figure 7
Site Photographs	Figures 8 - 10

TABLES

Summary of XRF Comparison Data Including FSI and USFS Sample Results	Table 1
Summary of Chemical Analytical Data for Surface Water and Sediment	Table 2
Summary of Chemical Analytical Data for Waste Rock/Soil and Background Rock/Soil (Total Metals)	Table 3A
Summary of Chemical Analytical Data for Waste Rock/Soil and Background Rock/Soil (SPLP Metals)	Table 3B
Summary of Non-Cancer Hazard Quotients	Table 4
Summary of Cancer Risks	Table 5

APPENDICES
Appendix A
Human Health Risk Evaluation
Appendix B
Screening Ecological Risk Assessment
Appendix C
Sampling Activities C-1
Appendix D
Chemical Analytical Program D-1
Analytical Laboratory Data Reports

1.0 INTRODUCTION AND OBJECTIVES

This report presents the results of GeoDesign's Focused Site Inspection (FSI) that was conducted for the Ruth Mine area in the Opal Creek Scenic and Recreation Area of the Willamette National Forest in Marion County, Oregon. The proposed scope of work was developed to: (1) further evaluate total metals concentrations obtained using the X-ray fluorescence (XRF) field instrument compared to standard chemical analytical methods; (2) conduct appropriate sampling and analysis to evaluate metals concentrations in waste rock/soil, sediments, and surface water; and (3) conduct appropriate risk assessment to determine whether the Ruth Mine site poses an actual threat to human health or the environment requiring further action.
In August 2004, USFS conducted field screening of waste rock piles near Adit 4 and Adit 5 of the Ruth Mine. The field screening utilized a Niton® XL-722 XRF detector to gather data regarding the metals content of the waste rock. The results of the XRF screening were incorporated into a USFS report entitled *Abbreviated Preliminary Assessment for Ruth Mine #1, Willamette National Forest, Marion County, OR* (hereinafter referred to as the "USFS APA"), with a revised date of October 2004. The XRF screening indicated that certain metals (i.e., arsenic, chromium, iron, lead, nickel, and manganese) were present at concentrations exceeding applicable U.S. Environmental Protection Agency (EPA) Region 9 preliminary remediation goals (PRGs) for industrial sites. Based on this information, USFS determined that a Site Investigation (SI) needed to be completed to further assess the waste materials and their potential for adverse environmental impact(s).

On December 1, 2004, USFS decided that Shiny Rock Mining Company (SRMC), as a former operator of the Ruth Mine, was potentially liable as a responsible party under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for the release of hazardous substances (i.e., total metals) from the waste rock at the Ruth Mine site. USFS proposed that SRMC participate in the completion of the SI for the Ruth Mine site.

SRMC and the Opal Creek Ancient Forest Center discussed concerns regarding this decision with USFS and raised the need for confirmatory analysis of the underlying USFS APA XRF data. Opal Creek Ancient Forest Center subsequently retained GeoDesign to complete further site assessment work. GeoDesign completed a site reconnaissance at the Ruth Mine site in August 2005 and presented a September 2005 Work Plan to further assess the USFS findings and to complete an FSI at the Ruth Mine site. The Work Plan was presented to USFS for review prior to conducting the field activities. USFS reviewed the Work Plan; however, they declined to either approve or disapprove it. GeoDesign completed field activities for the work at the Ruth Mine site on November 8 and 9, 2006.

The scope of work for the FSI included the collection of samples of waste rock/soil, background rock/soil, stream surface water, stream sediment, sediment pore water, and mine adit water from the areas around the Ruth Mine, Ruth Creek, and Battle Ax Creek.

Rock/soil samples were analyzed using a Niton® XL-722 XRF detector by GeoDesign prior to submittal to the analytical laboratory using EPA 6000/7000 Series Methods. The collected field samples were analyzed for total metals content by an analytical laboratory. The GeoDesign XRF data was compared to the USFS XRF data collected on site, where applicable, as well as to the

laboratory analytical data. The XRF data and laboratory analytical data are presented in Table 1. The respective XRF data was compared to laboratory analytical data. In these comparisons, there is a 50 percent or greater differences between XRF results and laboratory results in several samples. The laboratory results for nickel and chromium concentrations compared to XRF results indicate differences of several orders of magnitude. Guidance for the use of XRF as a screening tool for metals in the field is set forth in EPA Method 6200, which specifies that it is to be used with confirmatory analysis using EPA-approved laboratory methods.

In addition, a Human Health Risk Evaluation (HHRE) and Screening Ecological Risk Assessment (ERA) were completed using the collected analytical data for evaluating the potential for a risk to human health and ecological receptors and for purposes of determining the need for remedial response, if any. The FSI was conducted in general conformance with the EPA's *Guidance for Performing Site Inspections Under CERCLA; EPA/540-R-92-021 Directive 9345.1-05 September 1992.*

2.0 SITE DESCRIPTION AND OPERATIONAL HISTORY

2.1 DESCRIPTION AND LOCATION

The Ruth Mine site is located on the south side of Battle Ax Creek in a rugged and remote area, Section 27 of Township 8 South, Range 5 East of the Willamette Meridian in Marion County, Oregon, at Latitude 44° 51' 11"N and Longitude 122°11' 23"W, U.S. Geological Survey quadrangle Battle Ax. The site lies within the Opal Creek Scenic and Recreation Area of the Willamette National Forest that is administered by USFS. The Ruth Mine is approximately 1 mile east-northeast of Jawbone Flats, an historic mining camp. The elevation of the Ruth Mine area varies from approximately 2,360 feet above mean sea level (MSL) near Battle Ax Creek to approximately 2,660 feet above MSL at the Adit 4 level. The Ruth Mine site is shown relative to the surrounding vicinity on Figures 1 and 2. Whetstone Mountain forms the north steep slope of this portion of Battle Ax Creek drainage (Figures 1 and 2). Whetstone Mountain is also the southern boundary of the Opal Creek Wilderness area of the Cascade Mountain range.

The Ruth Mine area includes the Adit 4 and Adit 5 areas. Adit 5 is approximately 60 feet up slope from Battle Ax Creek (2,320 feet above MSL) and includes the adit, a collapsed historic building, and small waste rock piles in the area (including waste rock built up for ore cart track ballast). Based on GeoDesign's field measurements, the volume of waste material at Adit 5 is approximately 675 cubic yards. The Adit 4 area is located at a greater elevation (2,660 feet above MSL) than the Adit 5 area above Battle Ax Creek along Ruth Creek, a tributary to Battle Ax Creek. The Adit 4 area has two openings to the mine tunnel. Included at the Adit 4 area are pieces of ore cart track, some miscellaneous historic mine machinery, and a waste rock pile that slopes down to Ruth Creek. Based on GeoDesign's field measurements, there is approximately 3,000 cubic yards of waste rock/soil at the Adit 4 area. Figure 3 illustrates the layout of the Ruth Mine Camp as it existed in 1935.

2.2 HISTORIC OPERATIONS AND OWNERSHIP

The Ruth Mine is located in the North Santiam Mining District. Based on information presented in *The Santiam Mining District of the Oregon Cascades: A Cultural Property Inventory and Historical Survey,* by Anthony J. George, P.E., the Ruth Group claims can be traced back to the

1860s. The Ruth Mine site claims were located in 1896 and were sold to the Lewis & Clark Mining & Milling Company in 1903. The Ruth Mine was operated and/or leased by several mining companies (including the Lewis & Clark Mining & Milling Company, the Amalgamated Mining & Milling Company, the Columbia Mines Development Company, Amcol [a joint venture of the Amalgamated and Columbia Mines Development Company], the Pacific Smelting & Refining Company, and the SRMC). Mining operations at the Ruth Mine site did not include the processing of mined ore. Ore processing occurred at either the Amalgamated Mill in the 1930s and 1940s or the Starvation Mill between 1973 and the late 1980s. Both of these mill sites were located down stream along Battle Ax Creek. The Ruth vein was mined primarily for lead and zinc, although small amounts of gold, silver, and copper were also present.

Based on a review of documents and on discussions with persons knowledgeable of the mining history of the area, including representatives of SRMC, the following is a general summary of historical ownership and previous investigations:

- 1972: SRMC acquired the patented and unpatented mining claims and mill site rights of the Amalgamated Mining and Milling Company, The Columbia Mines Development Company, and The Gold Creek Mining and Milling Company for the area between Jawbone Flats and the Ruth Mine from Mr. J. P. Hewitt.
- 1992: SRMC donated its patented and unpatented mining claims and mill sites to the Friends of Opal Creek (now known as the Opal Creek Ancient Forest Center). In order for the Opal Creek Wilderness and the Opal Creek Scenic Recreation Area to be established, it was necessary for the Friends of Opal Creek to donate to the United States "all right, title and interest in the following patented parcels of land," which included the Santiam Number 1, Ruth Quartz Mine Number 2, and Morning Star Lode mining claims. Additionally, the Friends of Opal Creek's interest in the lode mining claims known as Princess Lode, Black Prince Lode, King Number 4 Lode, and Ruth Quartz Mine Number 1 were also transferred to the United States.
- 1992 to 1994: SRMC cleaned up residual mill tailings contamination at the Starvation Mill site.
- 1995 to 1998: SRMC worked with USFS to clean up the residual mill tailings at the Amalgamated Mill site.
- 1996 and 1997: USFS' District Geologist completed the *Preliminary Site Assessments* for the Santiam No. 1, the Morning Star Lode, the "Hockey Stick" claim block (which included the Princess, Black Prince, and King No. 4 mining claims), Ruth Quartz Mine No. 2, and Ruth Quartz Mine No. 1 mining claims. Except for some additional cleanup at the Santiam No. 1 and the Ruth Quartz Mine No. 1 that required some additional cleanup, the remainder of the properties were transferred as is.
- 1997: On October 9, 1997 letter from USFS to the Friends of Opal Creek regarding USFS' inspection of the cleanup of the Ruth Mine No. 1, which stated in part, "In summary, Friends has completed the cleanup of the Ruth 1 claim as described in the Preliminary Site Assessment. No further action is required at this time."
- 1998: On July 29, 1998 the U.S. Department of Agriculture (USDA) Forest Service entered into a *Lands, Waters, or Interests in Land or Waters Purchase Option and Contract* with the Friends of Opal Creek and acquired ownership of the Black Prince, King No. 4, Princess Lode, and Ruth Quartz Mine No. 1 mining claims. The claims were transferred to the USFS by

Warranty Deed on October 23, 1998. The Friends of Opal Creek conveyed by *Donation Deed*, to the United States the Santiam No. 1, Morning Star Lode, and Ruth Quartz Mine No. 1 mining claims also on October 23, 1998.

- 2001: In January 2001, USFS issued its *Decision Memo for the Abandoned Mine Closure Project*, for the Black Eagle, Golden Bear, Santiam #1, Ruth #4 Discovery Cut, Ruth #1 - 4th Level, Ruth #1 - 5th Level, and Morning Star mines, which stated that the project was completed for "the USDA Forest Service to address the public safety problems associated with these abandoned mines. These mines do not contain any hazardous materials or pollutants that would qualify them for CERCLA or RCRA cleanup actions. These mines do not exist on active mining claims."
- 2004: In October 2004, USFS issued the revised *Abbreviated Preliminary Assessment of the Ruth Mine #1*. USFS recommended that an SI be completed for the Ruth Mine #1.
- 2005: On February 23, 2005, USFS issued the *Ruth Mine Initiation of CERCLA Investigation Memorandum.*

2.3 CLIMATE

The site is located in the western Cascades. Based on data from the Western Regional Climate Center, approximately one-half of the annual precipitation falls between the months of December and February, approximately one-fourth in the spring and fall, and very little during the summer months. The average total precipitation on the western slopes of the Cascades increases with elevation. The Detroit, Oregon, weather monitoring station was used to obtain the following data based on the distance from the Ruth Mine. The Detroit, Oregon, monitoring station is located approximately 8 miles southeast of the Ruth Mine site at approximately 1,590 feet above MSL. Since the Ruth Mine site is approximately 700 to 1,000 feet higher in elevation than the Detroit monitoring station, it receives more total precipitation and has lower minimum and maximum temperatures than the Detroit monitoring station. For the Detroit monitoring station, total precipitation is approximately 82.51 inches per year. The average minimum temperature is 26.9 degrees F and occurs in January. The average maximum temperature is 81.7 degrees F and occurs in July. Temperature extremes range between -10 degrees F in the winter and 107 degrees F in the summer.

3.0 GROUNDWATER EXPOSURE PATHWAY

3.1 GEOLOGIC SETTING

Based on information provided in the *Geology of Oregon* (by Orr and Orr), the Ruth Mine is located in the Western Cascades subdivision of the Cascades physiographic province. The geology in the Western Cascades is largely of volcanic origin and varies in age from 40 to 10 million years old. Geology in the North Santiam area consists of basalt and basaltic andesite.

3.2 SITE-SPECIFIC MINING GEOLOGY

The Ruth Mine is located in the mineral enriched North Santiam Mining District. The Ruth Mine is within the Battle Ax drainage basin that meets Opal Creek and forms the Little North Santiam River at the confluence of these two creeks. Deposits of lead and zinc are found in pyrite, galena, sphalerite, and chalcopyrite. The ores are found in veins or porphyry deposits formed in volcanic fractures. Lead and zinc were the primary ores mined at the Ruth Mine with copper, gold, and silver present in trace quantities.

3.3 HYDROGEOLOGY

The Ruth Mine site is located in the North Santiam River watershed. A review of the Oregon Water Resources Department (OWRD) well log database indicates that water wells are not located within a 4-mile radius of the project site. Well logs from monitoring wells MARI 17649 through MARI 17654 (installed approximately 4 miles southwest of the Ruth Mine site in the southeast quarter of the southwest quarter of Section 31 in Township 8 South, Range 5 East of the Willamette Meridian) were reviewed, and based on the logs, the subsurface was described as gravel, cobbles, and boulders to depths ranging between 15 and 100 feet below the ground surface (BGS), underlain by basalt bedrock. The approximate elevation of these monitoring wells is 2,200 feet above MSL. Groundwater was encountered in the monitoring wells at depths ranging between 47 and 60 feet BGS. None of the wells were observed or sampled during the field reconnaissance.

3.4 TARGETS

Targets are receptors for a particular pathway within a target distance. For the groundwater pathway, the target distance was defined as 4 miles and targets include drinking water wells and wellhead protection areas. Based on information obtained from the OWRD database, drinking water wells are not located within 4 miles of the Ruth Mine. Wellhead protection areas were not noted within 4 miles of the Ruth Mine. Employees of the nearby Opal Creek Ancient Forest Center (the only residents within 4 miles) rely on surface water from Opal Creek for drinking water.

Based on this information, groundwater within 4 miles of the Ruth Mine is not used for drinking water. The groundwater pathway appears to be incomplete and no further assessment is necessary.

4.0 SURFACE WATER EXPOSURE PATHWAY

4.1 HYDROLOGIC SETTING

The Ruth Mine site is located up slope of Battle Ax Creek. Ruth Creek (a tributary to Battle Ax Creek) flows north-northwest, passing by Adit 4 to its confluence to Battle Ax Creek approximately 400 feet upstream of the Adit 5 location. Blue Jay Creek flows into Battle Ax Creek approximately ½ mile upstream of the Adit 5 location. Blue Jay Creek also flows by the Morningstar Mine.

Battle Ax Creek flows generally east to west through a steep-sloped ravine between Whetstone Mountain and the north-facing hillside where the Ruth Mine is located. Battle Ax Creek is at an approximate elevation of 2,420 feet above MSL at the confluence of Blue Jay Creek and Battle Ax Creek to 2,320 feet above MSL at the confluence of Ruth Creek and Battle Ax Creek (approximately 0.4 mile downstream of the Blue Jay Creek confluence). The elevation of Battle Ax Creek at the former Amalgamated Mill site, approximately 1 mile downstream of the Ruth Creek confluence, is approximately 2,160 feet above MSL. This is a drop in elevation of over 250 feet in less than 1.5 miles. Several small tributaries, other than Blue Jay Creek and Ruth Creek, also flow into Battle Ax Creek along this stretch before its confluence with Opal Creek.

Opal Creek and Battle Ax Creek converge to form the Little North Santiam River. Farther downstream, the Little North Santiam River converges with the North Santiam River, then the Santiam River to the Willamette River.

4.2 TARGETS

The target distance for exposure to potential elevated metals concentrations in the surface water was defined as 12 miles and includes residences withdrawing surface waters for domestic usage. Based on information obtained from the OWRD database, a point of diversion water rights for domestic use of the Little North Santiam River water was issued to one family located approximately 12 miles downstream of the confluence of Ruth Creek and Battle Ax Creek. Since numerous tributary creeks flow into the Little North Santiam River downstream of the confluence of Battle Ax Creek and Opal Creek, this point of diversion was not considered a target. Residents and guests of the Jawbone Flats area use surface water from Opal Creek (rather than Battle Ax Creek) for domestic use and, therefore, were not selected as a target for drinking water.

Residents and guests of the Jawbone Flats area, as well as recreational users (including campers, hikers, fisherman, and hunters), are assumed to be exposed to surface waters in the area of the Ruth Mine. USFS has proposed that the Ruth Mine site be included within a "Low Use" management intensity zone for the Opal Creek Scenic Recreation Area, as presented on Figure 5.

In completing the HHRE portion of the FSI, conservative exposure duration and frequency scenarios were utilized. The human targets selected for the various exposure scenarios include adult and child recreational users. Adult men and women between the ages of 18 and 70 years old were assumed to be exposed 4 hours a day for between 5 and 20 days per year. The 20-day value is the reasonable maximum exposure (RME), which is an estimate of worst case conditions, while the 5-day value is the central tendency exposure (CTE), which is an estimate of more typical adult exposure. Children between the ages of 0 and 6 years old were assumed to be exposed between 4 and 14 days per year, also for 4 hours each day, establishing the children's CTE and RME, respectively. The adult exposure is assumed to occur every year for 9 to 30 years while the child exposure is assumed to occur every year for 2 to 6 years. These exposure scenarios are believed to represent significantly higher rates of use than has been observed by the Opal Creek Ancient Forest Center. The exposure scenarios are discussed in greater detail in the HHRE.

The exposure routes for adults and children at the site include ingestion of waste rock and soil, surface water, and sediments; direct skin contact with rock and soil, surface water, and sediments; and inhalation of dust comprised of waste rock soil. The results of the HHRE are discussed in more detail below, and the complete HHRE is presented as Appendix A.

A Screening ERA was completed for the Ruth Mine site. Various ecological receptors (including terrestrial plants and wildlife as well as birds, invertebrates, and aquatic organisms) were considered. The results of the Screening ERA are discussed, as applicable, below. The complete Screening ERA is presented as Appendix B.

4.3 SAMPLE LOCATIONS

Samples of surface water, pore water, mine adit water, and stream sediment were collected in the vicinity of the Ruth Mine based on site reconnaissance performed by GeoDesign and on

recommendations set forth in the USFS APA. Samples were collected from various media because the potential human and ecological receptors have various exposures to each media. Possible contaminants affect receptors differently depending on exposure frequency and duration, as well as the method of chemical intake and the size or age of the receptor. The exposure and toxicity models use specific exposure parameters to determine uptake and effects. Sample locations are presented on Figures 4, 6 and 7 and include 10 surface water samples, 2 pore water samples, 2 adit water samples, 6 sediment samples, 10 waste rock/soil samples, and 10 background rock/soil samples. The samples of surface water, mine adit water, and sediments were collected because each medium has viable exposure potential for both human and ecological receptors and have different uptake characteristics for the receptor. Samples were collected upstream and downstream of the mine adit locations in both creeks to provide data for comparison of metals concentrations above and below the former mining operations. The locations are described as follows:

- Two surface water samples in Battle Ax Creek downstream of the Adit 5 area and downstream of the confluence of Ruth Creek and Battle Ax Creek (SW-1 and SW-2).
- Three surface water samples (SW-3, SW-4, and SW-5) in Ruth Creek, including one upstream of Adit 4 (SW-3) and two downstream of Adit 4 (SW-4 and SW-5).
- One surface water sample (SW-7) at the confluence of Ruth Creek and Battle Ax Creek.
- One surface water sample (SW-6) in Battle Ax Creek upstream of the confluence of Ruth Creek and Battle Ax Creek.
- One adit water sample for each adit (AW-4 and AW-5).
- Pore water samples in Battle Ax Creek downstream (PW-1) and upstream (PW-2) of its confluence with Ruth Creek.
- Sediment samples from Battle Ax Creek downstream of the confluence (SED-1 and SED-2), upstream of the confluence (SED-6), at the confluence of Battle Ax Creek and Ruth Creek (SED-7), and the Ruth Creek locations (SED-3, SED-4, and SED-5).
- In addition, surface water samples SW-8, SW-9, and SW-10 were collected from Battle Ax Creek upstream of the confluence with Blue Jay Creek, at the confluence with Blue Jay Creek, and downstream of the confluence with Blue Jay Creek, respectively. Although data from these latter samples was not used in the data set for the HHRE or the Screening ERA for the Ruth Mine, analytical results are provided in the general data tables, and sample locations are presented on Figure 4.

Surface water samples were collected from approximately 6 inches below the stream surface and were collected in laboratory-supplied containers with a peristaltic pump using dedicated tubing for each sample. Mine adit water samples were collected in laboratory-supplied containers using a peristaltic pump using dedicated tubing approximately 1 inch into the water because of the limited surface water depth.

Pore water samples were collected within sediment in the stream using a stainless steel probe with an approximate 4-inch screen located approximately 4 to 8 inches below the sediment surface, along with a peristaltic pump and dedicated tubing. Pore water is the water within the sediments in the stream rather than the surface water flowing over the sediments. The pore water typically is exposed to the sediment for a longer duration, allowing a higher concentration

of solids to dissolve in the water. Pore water samples were collected using the peristaltic pump set at a low pumping rate to ensure water uptake was from within the sediment pore space.

Sediment collection was attempted with a Wildco® Instruments sediment sampler with sample sleeve and sand catcher; however, the sediment in both Battle Ax Creek and Ruth Creek was generally limited in depth and consisted of coarse-grained material that would not fill the sample sleeve. Sediment sample locations in the creek beds were also limited in availability. Many locations in Battle Ax Creek had little to no sediment deposition. Sediment samples were collected by hand using the laboratory-supplied, wide-mouth glass jars to directly scoop sediments from the stream. All field samples were stored in coolers on ice pending laboratory submittal.

4.4 ANALYTICAL RESULTS

Samples were submitted to North Creek Analytical of Beaverton, Oregon, under chain of custody (COC) documentation. Surface water, adit water, and sediment samples were submitted for chemical analysis of total metals using EPA 6000/7000 Series Methods. Pore water samples were submitted for chemical analysis of dissolved metals using EPA 6000/7000 Series Methods. Laboratory results for surface water, pore water, and sediment samples are provided in Table 2. Sample collection methods are described in Appendix C. Photographs of selected sample locations are provided on Figures 8 through 10. The laboratory reports, COC documentation, and our review of the laboratory quality control data are provided in Appendix D.

The analytical results for the collected samples were used in the completion of the HHRE and the Screening ERA. Detected metal concentrations were screened against applicable regulatory screening values. For human health purposes, the soil and sediment concentrations of contaminants of interest (COIs) were screened against industrial soil PRGs, which are risk-based concentrations because they are considered conservative in comparison to a recreational exposure scenario. The surface water concentrations of COIs were compared to the industrial tap water PRGs because the PRGs are considered conservative for exposure to surface waters. For the Screening ERA, the Oregon Department of Environmental Quality (DEQ) Level II Screening Level Values (SLVs) were used based on the 2001 DEQ *Guidance for Ecological Risk Assessment: Level II Screening.* DEQ Water Quality Criteria (WQC) was also referenced as conservative screening values where applicable (Oregon Administrative Rules [OAR] 340-041-0033 Tables 20, 33A, 33B, and 33C). The WQC are criteria for waters of the State of Oregon that are not to be exceeded in order to protect aquatic life and human health.

The total metals analytical results for the surface water samples SW-1 through SW-10 were either not detected above method reporting limits or were below the Level II SLVs for fresh surface waters and WQC with the exception of lead (Table 2). There were four detected concentrations of lead exceeding the Level II SLV (SW-1, SW-4, SW-5, and SW-9) with the greatest exceedence in SW-5 at 0.00194 milligrams per liter (mg/L). Lead concentrations slightly exceeded the WQC only in samples SW-4 and SW-5.

Analytical results indicate that the concentrations of barium, cadmium, copper, lead, and zinc slightly exceed either or both of the Level II SLVs for fresh surface water and the most conservative WQC in the mine adit water sample AW-4. The laboratory results indicate that the

AW-5 sample had concentrations of cadmium, lead, and zinc slightly exceeding the Level II SLVs with only zinc also exceeding the WQC. Several metals (including arsenic, chromium, iron, manganese, mercury, nickel, and selenium) were either not detected above method reporting limits or were detected at concentrations below regulatory screening values.

Dissolved metals were not detected above method reporting limits or were less than the Level II SLVs in pore water samples PW-1 and PW-2 with the exception of zinc in PW-1 (Table 2). At PW-1, the furthest downstream sample location from the confluence of Ruth Creek and Battle Ax Creeks, the zinc concentration of 0.277 mg/L exceeded the Level II SLV of 0.12 mg/L.

The waste rock/soil and background rock/soil samples were analyzed for both total metals, as well as Synthetic Precipitation Leaching Procedure (SPLP) metals. Total metals concentrations indicate the total amount by weight of a given metal is in the rock/soil sample, and the SPLP concentration indicates how much of each metal would leach from the rock/soil under naturally occurring conditions. The total metals concentrations in the waste rock/soil samples and background rock/soil samples exceeded the Level II SLVs for soil and/or the EPA Region 9 PRGs for industrial soil for each of the 13 metals (Table 3A). SPLP results showed that metals were not detected above method reporting limits for 8 of the 13 metals (Table 3B). Detections of iron, lead, manganese, and zinc occurred in both waste rock/soil and background rock/soil samples.

4.5 CONCLUSIONS - SURFACE WATER

In the HHRE, cadmium and lead in surface water were identified as non-carcinogenic contaminants of potential concern (COPCs). No carcinogenic COPCs were identified for surface water. Arsenic was identified as a non-carcinogenic, as well as a carcinogenic COPC for stream sediments. The surface water concentrations that were used to determine the applicability of the COPCs included the mine adit water samples, which were considerably higher in concentration compared to surface water samples collected from Ruth Creek and Battle Ax Creek. Mine adit water samples were included in the HHRE because the potential receptors have equal opportunity for exposure to stream surface water or mine adit water.

The HHRE risk calculation results indicated that there were no unacceptable non-carcinogenic risk from incidental ingestion or dermal contact from the elevated cadmium and lead in surface water and arsenic in sediments. These calculations also indicate that the excess cancer risk from arsenic in sediments was below regulatory thresholds for adults and children. Non-cancer risks are expressed numerically as compared to the hazard quotient of 1.0. If the calculated risk is below 1.0, then there is no concern that adverse health effects will be observed in the exposed population. If the hazard quotient is 1.0 or greater, risk of adverse health effects exists. For cancer risks, the probability of an individual developing cancer over a lifetime as a result of exposure to a contaminant is used for expressing risk. If the probability of developing cancer is more than 1 in 1,000,000 (1.0 E-6), an excess cancer risk exists. The results of the HHRE determined that there were no unacceptable cancer human health risks due to dermal contact or incidental ingestion of surface water or sediments at the Ruth Mine site. The HHRE results also determined there were no unacceptable non-cancer human health risks due to dermal contact or incidental ingestion of surface water or sediments at the Ruth Mine site. Tables 4 and 5 summarize the results of the non-cancer hazard quotients and the cancer risks, respectively. The HHRE is presented in Appendix A.

The results of the Screening ERA indicate that cadmium and zinc were elevated above the applicable Level II SLVs for the mine adit water only and were determined to be contaminants of potential ecological concern (CPECs) for aquatic organism exposure to surface water. The concentrations of cadmium, lead, and zinc in both stream surface water samples and mine adit water samples were below the applicable Level II SLVs for birds and mammals exposed to the surface water. Table 2 presents the surface water analytical results. Lead was the only CPEC for stream surface waters and exceedences of the aquatic organism Level II SLV were reported in six samples. Surface water samples SW-8, SW-9, and SW-10 were collected from the area around the confluence of Blue Jay Creek and Battle Ax Creek and were not included in the HHRE or the Screening ERA because they were not relevant to the Ruth Mine site risk assessment. Of the remaining five samples with elevated lead concentrations, two were from mine adit water and two were collected from the Ruth Creek, neither of these locations provide suitable habitat for aquatic wildlife. In addition, all of the detected concentrations of lead were less than two-fold greater than the Level II SLV for aquatic organisms of 0.0025 mg/L. The concentration of lead in surface water exceeded the fresh water chronic criteria WQC value in one mine adit water sample (AW-4) and stream surface water samples SW-4 and SW-5 from Ruth Creek. The cadmium and copper concentrations were also elevated in samples AW-4 and AW-5. These mine adit water and Ruth Creek surface water sample locations do not provide quality habitat for fresh water organisms and, therefore, the WQC value is not applicable.

The Screening ERA indicated that several metals were selected as CPECs in the sediment from Ruth Creek. Tables A-1 through A-4 in the Screening ERA present the CPECs for each medium. The risks were predicted for freshwater sediment benthos and wildlife bioaccumulation. Ruth Creek does not provide adequate habitat or food source due to its lack of organic sedimentary material, intermittent flows (including dry periods), and steep gradient; therefore, sediment benthos are not a realistic population to be encountered in Ruth Creek and wildlife bioaccumulation is not applicable. CPECs in sediment from Battle Ax Creek included cadmium, copper, lead, and zinc. These metals may pose a risk to sediment invertebrates in Battle Ax Creek, although cadmium and lead concentrations were less than 10 percent over the Level II SLVs. Ecological risk for the slightly elevated metals is not well defined because the native soils in the area have elevated metals concentrations that also contribute to sediments in the creeks. The Screening ERA is presented as Appendix B.

5.0 SOIL AND AIR EXPOSURE PATHWAYS

5.1 PHYSICAL CONDITIONS

The Ruth Mine site is approximately 1 mile from the Jawbone Flats area, which is approximately 3 miles from a locked gate on USFS Road 2209 that limits most public access to foot, bicycle, or horse traffic. USFS Road 2209 passes by the Ruth Mine site above Adit 5 and below Adit 4. The Adit 5 area includes the open adit, a collapsed structure, some abandoned equipment, and small waste rock piles approximately 675 cubic yards in volume visible on photograph A on Figure 9. The Adit 4 area includes the adit openings, some abandoned equipment, and a waste rock pile approximately 3,000 cubic yards in volume visible on photographs B and A on Figures 9 and 10, respectively.

5.2 TARGETS

There are no workers or residents near the Ruth Mine site. The nearest resident is a full-time employee of the Opal Creek Ancient Forest Center approximately 1 mile away at Jawbone Flats. Public use of the area is not currently restricted, although access is limited to foot, bicycle, or horse traffic. The distance from public vehicle access to the Ruth Mine site is approximately 4 miles. Recreational users are the most likely receptors, and the exposure assumptions were previously discussed in Section 4.2. The exposure scenarios are discussed in detail in the HHRE.

5.3 WASTE SOIL/ROCK SAMPLE LOCATIONS

Waste rock/soil samples were collected in the direct vicinity of the Adit 4 and Adit 5 areas as shown on Figures 4 and 5, based on the results of the USFS APA prepared for the Ruth Mine as well as GeoDesign's exercise of professional judgment during the field activities. Photographs of selected sample locations are provided on Figures 8 through 10. Rock/soil samples were collected using a stainless steel trowel and digging approximately 6 to 8 inches below the soil surface as presented on photograph B on Figure 8. Ten waste rock/soil samples were collected and placed in laboratory-supplied glass jars with Teflon® lined lids.

In addition, 10 background rock/soil samples were collected from areas around the Ruth Mine area, which appeared to have not been affected by the mining activities. The background samples were taken generally from areas at greater elevation than Adit 4 or in areas further east than the former Ruth Mine complex. Background rock/soil samples analytical results were not used while completing the HHRE as recreational users were assumed to be exposed only to waste rock/soil at the Ruth Mine site.

5.4 ANALYTICAL RESULTS

Based on the USFS APA, the initial characterization of the waste rock/soil in the adit areas was completed by USFS using a Niton® hand-held XRF detector. The APA did not indicate that waste rock/soil samples were analyzed at an analytical laboratory. The waste rock/soil samples and background rock/soil samples collected during the FSI field work on November 8 and 9, 2005 were brought back to the GeoDesign soils laboratory and were analyzed by GeoDesign using a hand-held Niton® XL-722 XRF analyzer. The samples were analyzed ex situ based on the Niton recommended EPA Method 6200 protocol and taking the average value of three analyzing shots for each sample.

The waste rock/soil samples and background rock/soil samples were submitted under COC to North Creek Analytical of Beaverton, Oregon, for analysis of total arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, and zinc using EPA 6000/7000 Series Methods, total mercury using EPA Method 7471A, and hexavalent chromium using EPA Method 3060A. The samples were also analyzed for SPLP using EPA 1312/6000/7000 Series Methods and SPLP mercury using EPA Methods 1312/7470A. Analytical results are summarized in Tables 3A and 3B. Table 1 shows the waste rock/soil and background rock/soil analytical results, as well as the XRF results collected by GeoDesign and, at applicable sample locations, the corresponding USFS sample collected in a similar location. Laboratory reports and COC documentation are provided in Appendix D. Air samples were not collected during the field activities.

Based on the analytical results, arsenic and lead were detected in waste rock/soil samples at concentrations greater than the EPA Region 9 PRG for industrial soil. Concentrations of the other metals analyzed in the waste rock/soil samples did not exceed the EPA Region 9 PRGs for industrial soil. The concentration of arsenic in all background samples was greater than the EPA Region 9 PRG for industrial soil. Arsenic was detected at a concentration greater than the Level II SLV in three of the background rock/soil samples. Lead was detected above the Level II SLV in nine of the background samples and above the EPA Region 9 PRG for lead in industrial soil in three samples (BG-4, BG-5, and BG-7). The concentrations of barium, cadmium, chromium, copper, iron, manganese, mercury, nickel, selenium, silver, and zinc were also greater than the SLVs in many waste rock/soil samples, as well as background rock/soil samples as shown in Table 2A. The SPLP results of these samples, which are indicative of the leaching potential, were not detected above method reporting limits for 8 of 13 the metals (Table 3B). Detections of iron, lead, manganese, and zinc occurred in the waste rock. The SPLP concentrations in the waste rock/soil samples were frequently less than the background rock/soil sample SPLP concentrations.

5.5 CONCLUSIONS - SOIL AND AIR

Arsenic and lead were determined to be COPCs for waste rock/soil. The results of the HHRE indicate that there is no unacceptable excess cancer risk or non-cancer health risk for incidental ingestion, dermal contact, or inhalation of dust particles for arsenic. The risk calculations used conservative factors for exposure frequency and duration as well as assuming that those receptors exposed would be exposed only to waste rock/soil rather than general soil and rock in the area of the Ruth Mine site to simulate worst case conditions. The exposure scenarios are discussed previously in Section 4.2. Air exposure inhalation rates were taken from EPA 1997 *Exposure Factors Handbook*. These results are discussed in the HHRE presented as Appendix A.

The risk from lead was evaluated using EPA models to predict blood lead levels based on exposure frequency, duration, as well as pathways (such as inhalation or ingestion). The exposure to Ruth Mine site waste rock/soil was considered an additional "alternate source" of lead to the EPA guidance default levels for lead exposure. Conservative estimates of exposure of 4 hours per day for 14 days per year for the first 7 years of a child's life were used for the HHRE, which given the actual usage of the Ruth Mine site by day hikers is very conservative. Based on the results of the HHRE completed using various EPA guidance documents for the Integrated Exposure Uptake BioKinetic (IEUBK) Model, it was determined that when ingestion rates of waste rock is 100 milligrams per day (mg/day), the predicted blood lead levels in children are below the EPA threshold of 10 micrograms per deciliter (µg/dL). Lower ingestion rates predict lower blood lead levels. In adults, even relatively high ingestion rates (25 mg/day) of waste rock resulted in predicted blood lead levels below the EPA threshold of 10 µg/dL.

The screening ERA indicated that CPECs included several metals that represented potential risk for terrestrial plants, invertebrates, birds, and mammals. A majority of the samples were collected from waste piles or road bed locations. These locations represent the greatest concentration of waste rock/soil with elevated metals concentrations. The waste piles and road bed do not provide a quality habitat or food source for plants and animals because of the hard

surface and minimal organic content. In addition, the small area is surrounded by more suitable habitat. The risks from the waste rock/soil are considered to be insignificant due to limited exposure.

6.0 SUMMARY

The Ruth Mine field assessment and FSI were completed to collect appropriate analytical data and assess the potential risk to human and ecological receptors and to determine whether the Ruth Mine site presents a threat to human health or the environment. A field visit was conducted on November 8 and 9, 2005 that included observation of the layout of the Ruth Mine site and the local vicinity; collection of waste rock/soil samples; and collection of surface water, pore water, mine adit water, and stream sediment samples. Additionally, background rock/soil samples were collected.

These environmental media samples were submitted for chemical analysis, the results of which are presented in Tables 1, 2, 3A, and 3B along with laboratory reports included in Appendix D. These analytical results were used to determine the total and/or SPLP metals concentrations in the various media, as well as assessing the relative risk to human health and the environment presented by these materials.

The Ruth Mine site is located in a "Low Use" area of the Opal Creek Scenic Recreation Area and has limited access. There are no residents or workers within 1 mile of the site. Risks to human and ecological receptors were evaluated by screening contaminant concentrations against applicable regulatory criteria and using various conservative exposure factors to complete an HHRE and a Screening ERA.

Groundwater is not used for drinking purposes within 4 miles of the Ruth Mine; therefore, the groundwater pathway is considered incomplete and further assessment is not warranted.

Based on analytical results, it appears that metals concentrations are somewhat elevated in surface waters and sediments in Ruth Creek, the tributary to Battle Ax Creek, and slightly elevated in select locations in Battle Ax Creek. Surface water in Ruth Creek is intermittent seasonally and, therefore, not consistently available for exposure. Sediment in Battle Ax Creek is limited in availability and, therefore, not easily available for exposure. Using conservative environmental concentrations, exposure frequencies, and exposure duration scenarios, the HHRE calculations were performed to assess the potential risk from these surface waters and sediments. It was determined that there were no unacceptable cancer human health risks and no unacceptable non-cancer human health risks in children or adults due to dermal contact or incidental ingestion of surface water or sediments at the Ruth Mine site.

Waste rock/soil samples collected at the Ruth Mine site were analyzed using a Niton® XRF instrument and standard laboratory methods for total metals. SPLP analysis was also completed for the waste rock/soil samples to determine whether leachate from the waste rock/soil contained elevated metals concentrations. Laboratory analytical results of total metals concentrations were compared to total metals concentrations gathered using the XRF and the results varied significantly. Total metals concentrations are, in some cases, elevated above

certain regulatory screening criteria. The waste rock/soil SPLP results indicate that 9 of the 13 metals were not detected above method reporting limits in the samples. The concentrations of iron, lead, and zinc exceeded the Level II SLVs slightly in some of the SPLP samples. The SPLP results for the detected metals were within the range of the background rock/soil sample SPLP results.

Based on the results of the HHRE, there were no unacceptable excess cancer risks or non-cancer health risks associated with waste rock/soil related to the Ruth Mine site samples. The HHRE calculated risks related to lead using the EPA IEUBK guidance. Based on the results of the calculations using conservative exposure frequency and ingestion rates, blood lead levels were not expected to exceed regulatory thresholds in adults or children.

Ecological receptors were evaluated by completing a Screening ERA. The results of the Screening ERA indicate slight risks to certain receptors based on exceedances of metals (such as zinc) in certain media. Concentrations of metals above Level II SLVs in the Ruth Creek samples do not appear to represent significant ecological risk based on the lack of quality habitat due to the creek's steep gradient, intermittent flows, and lack of food source. Ecological risk for terrestrial receptors appears minimal again based on habitat quality being of greater quality in the surrounding vicinity and the general small area of the waste rock/soil compared to available habitat. Ecological risk in Battle Ax Creek appears very limited with concentrations only slightly exceeding regulatory criteria in part of the sample set.

Based on the information gathered during the FSI for the Ruth Mine site and the results of the HHRE and the Screening ERA, it is our professional opinion that no further environmental assessment is recommended and environmental remedial action is not warranted. These findings are generally consistent with the findings of the previous investigations completed at the Ruth Mine site.

◊ ◊ ◊

Please call if you have any questions regarding this report.

Sincerely,

GeoDesign, Inc.

Stephen C. Nelson
Project Manager

Craig W. Ware, R.G.
Principal Geologist

REFERENCES

George, Anthony J. P.E. and Weber, Joseph E. 1985. *The Santiam Mining District of the Oregon Cascades, A Cultural Property Inventory and Historical Survey.* The Solo Press, Salem, Oregon. May.

Orr, E.L., Orr, W.N. and Baldwin, E.M. 1999, *Geology of Oregon.* Kendall/Hunt Publishing, Dubuque, Iowa: p. 141-152.

USEPA. 1991. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part B, Development of Risk-base Preliminary Remediation Goals).* Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C. NTIS PB-92-96333.

USEPA. 1992. *Guidance for Performing Site Inspections under CERCLA.* Interim Final. Report No. EPA/540-R-92-021/Directive 9345.1-05. USEPA, Hazardous Site Evaluation Division, Office of Solid Waste and Emergency Response, Washington, D.C. September.

USEPA. 1997. *Exposure Factors Handbook.* Volumes I, II and III. Report No. EPA/600/P-95/002Fa, b & c. USEPA, Exposure Assessment Group, Office of Health and Environment, Washington, D.C. August.

USEPA. 1998. *Draft Update IVA of SW-846 Method 6200.* Federal Register Volume 63, #89 p. 25430-25438. May.

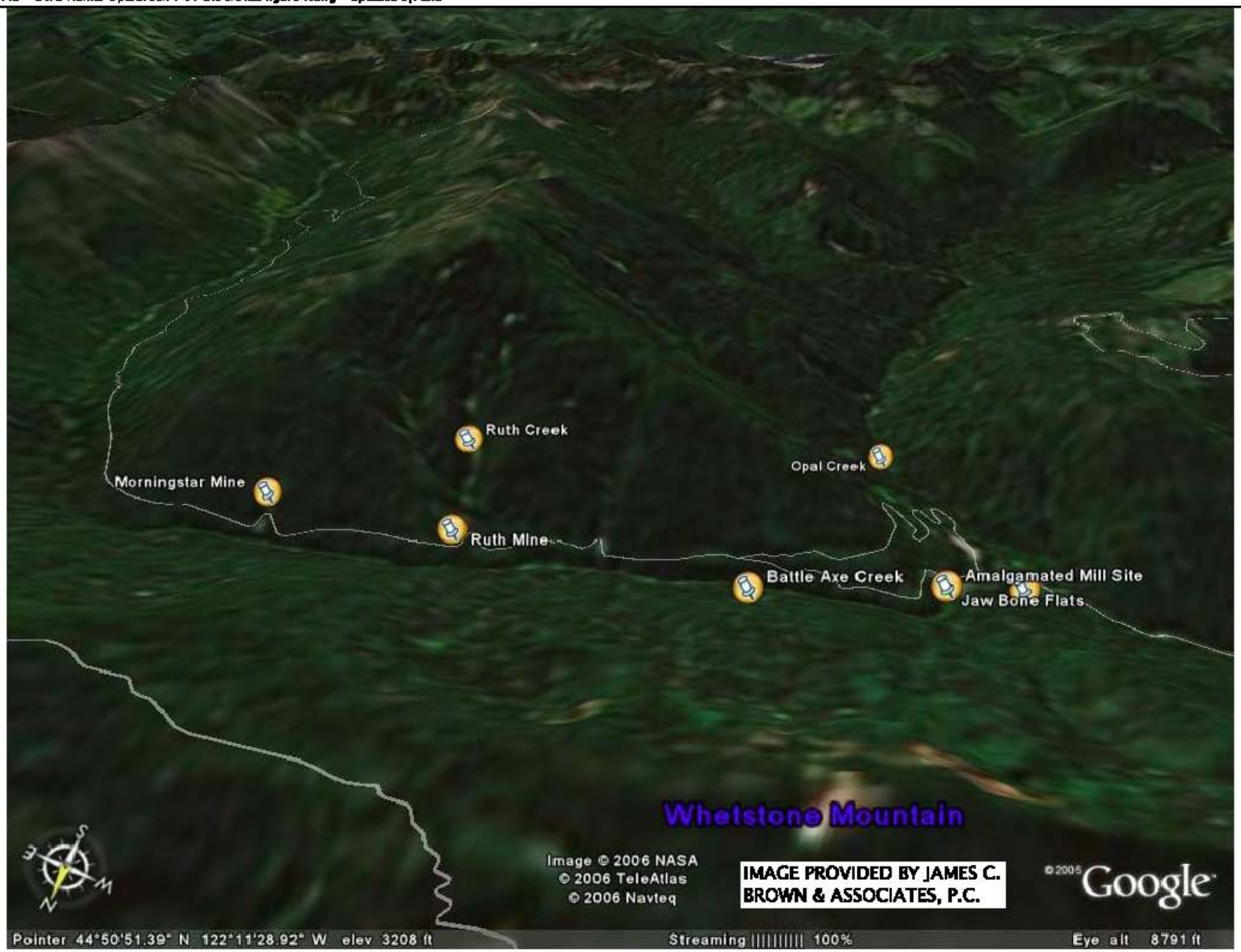
USFS. 1997. *Preliminary Site Assessment, Ruth Quartz Mine No. 1.* January

USFS. 2001. *Decision Memo for the Abandoned Mine Closure Project.* January.

USFS. 2004. *Abbreviated Preliminary Assessment Ruth #1 Mine, Willamette National Forest, Marion County, Oregon.* October.

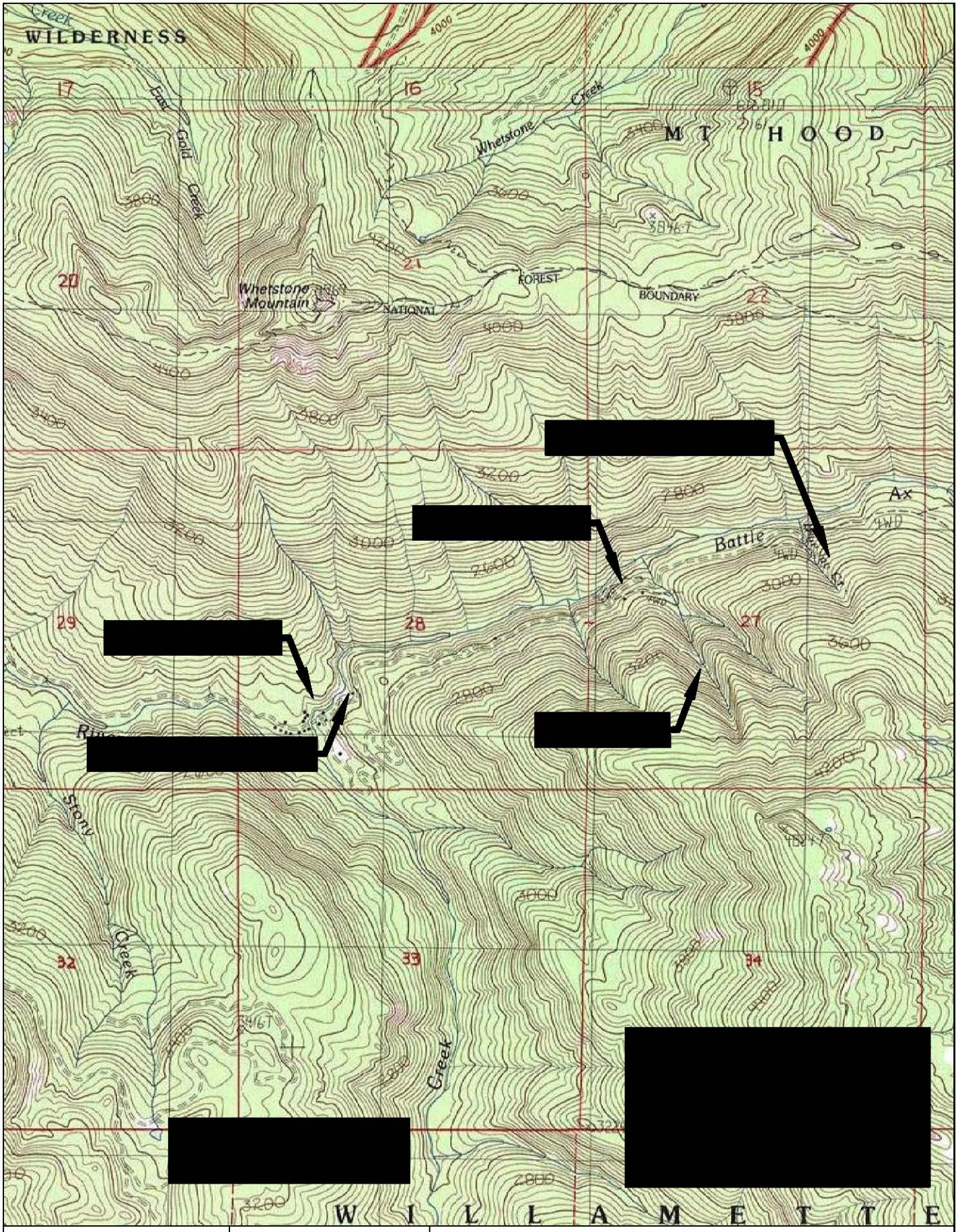
FIGURES

Jun 13, 2006 - 09:40:42 DWG Name: OpalCreek-1-01-DRAINAGE-figure-1.dwg Updated By: akd



GEODESIGN INC
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3089

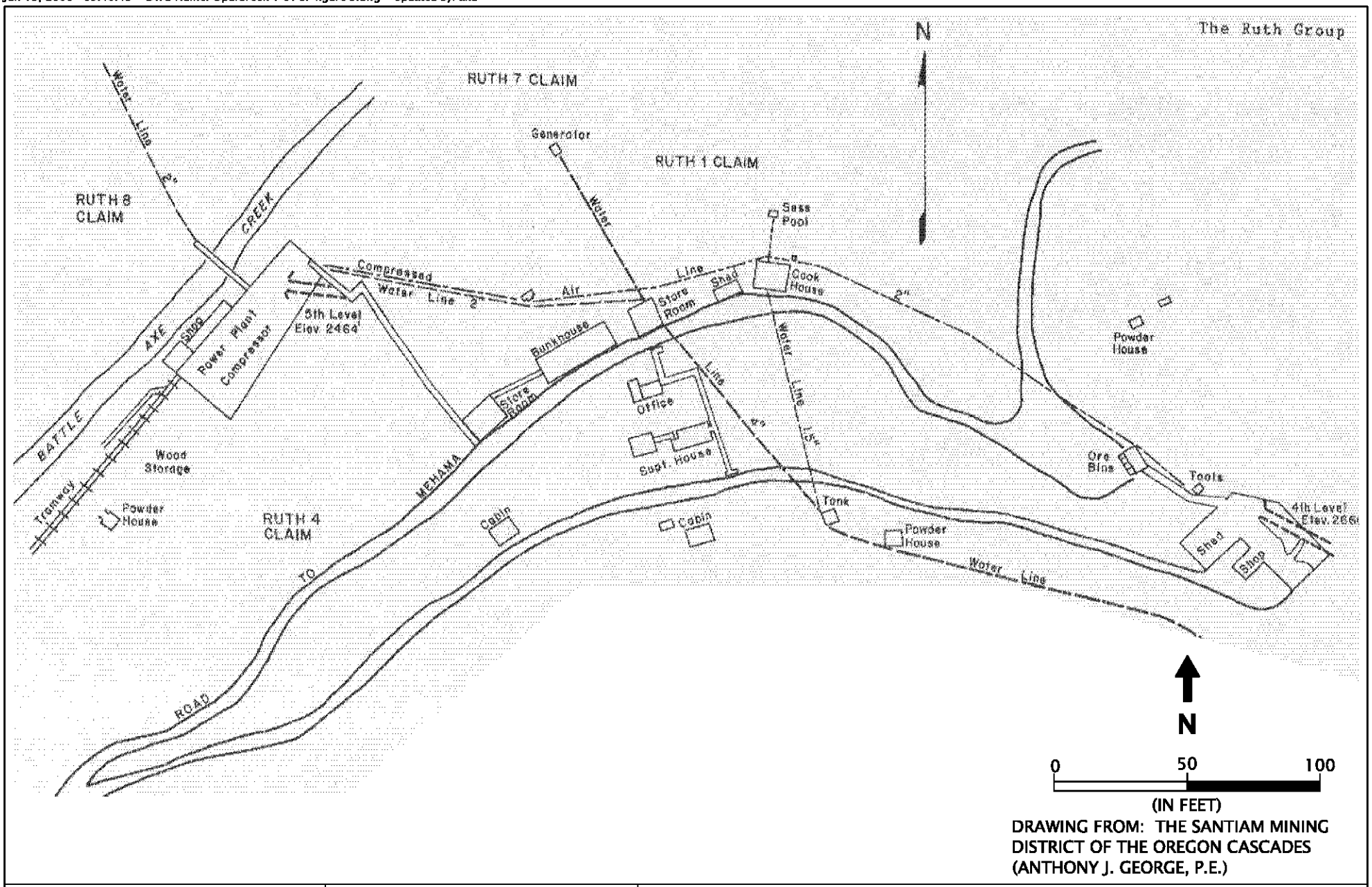
OPALCREEK-1-01	BATTLE AX AND OPAL CREEK DRAINAGE BASIN	
JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	FIGURE 1



Jun 13, 2006 - 09:40:41 DWG Name: OpalCreek-1-01-vm-figure-2.dwg Updated By: akd

GEODESIGN INC 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068	OPALCREEK-1-01	**VICINITY MAP**
	JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	**FIGURE 2**

Jun 13, 2006 - 09:40:43 DWG Name: OpalCreek-1-01-SP-figure-3.dwg Updated By: akd

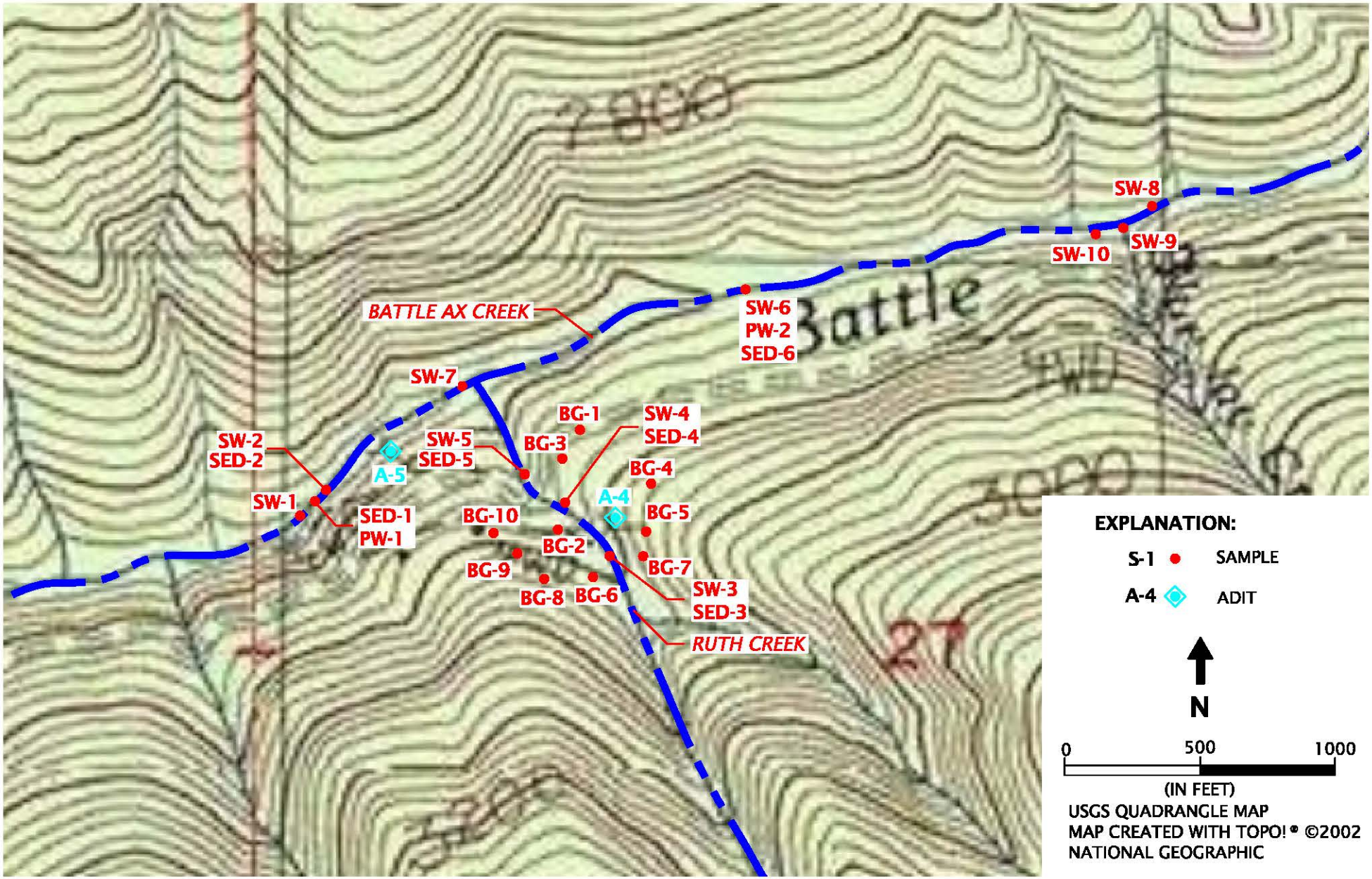


DRAWING FROM: THE SANTIAM MINING DISTRICT OF THE OREGON CASCADES (ANTHONY J. GEORGE, P.E.)

GEODESIGN INC
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

OPALCREEK-1-01	RUTH MINE CAMP IN 1935	
JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	FIGURE 3

Jun 13, 2006 - 09:40:44 DWG Name: OpalCreek-1-01-SP-figure-4.dwg Updated By: akd

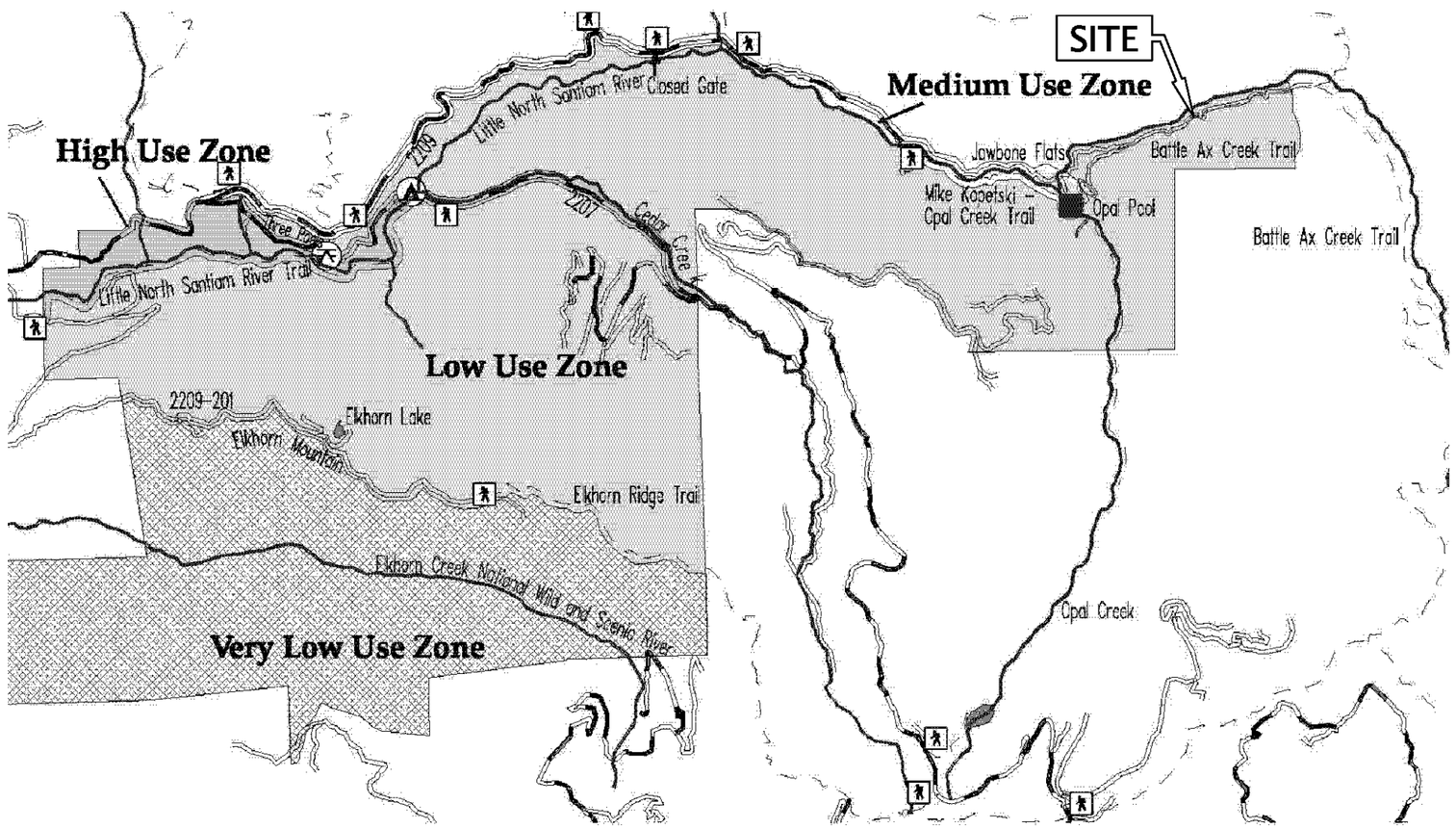


GEODESIGN INC 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068	OPALCREEK-1-01	SITE PLAN	
	JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	FIGURE 4

Opal Creek Scenic Recreation Area
Proposed Recreation Management Intensity Zones

ATTENTION
Features represented on this map may not be in an accurate geographic location. The Forest Service makes no expressed or implied warranty of this data nor of the appropriateness for any user's purposes. The Forest Service reserves the right to correct, update, modify, or replace the geospatial information on which this map is based without notification. For more information, contact
Detroit Ranger District GIS shop (503) 845-3366

Legend
High Use
Medium Use
Low Use
Legend
Very Low Use
Improved Gravel Road
Low Maintenance Road
Trails
Streams
Day Use
Campground
Trailheads
Peaks



Willamette National Forest

N

0 1 2
(IN MILES)

FIGURE BASED ON DRAWING PROVIDED BY THE WILLAMETTE NATIONAL FOREST

PROPOSED RECREATION MANAGEMENT INTENSITY ZONES

FIGURE 5

RUTH MINE SITE AT OPAL CREEK
MARION COUNTY, OR

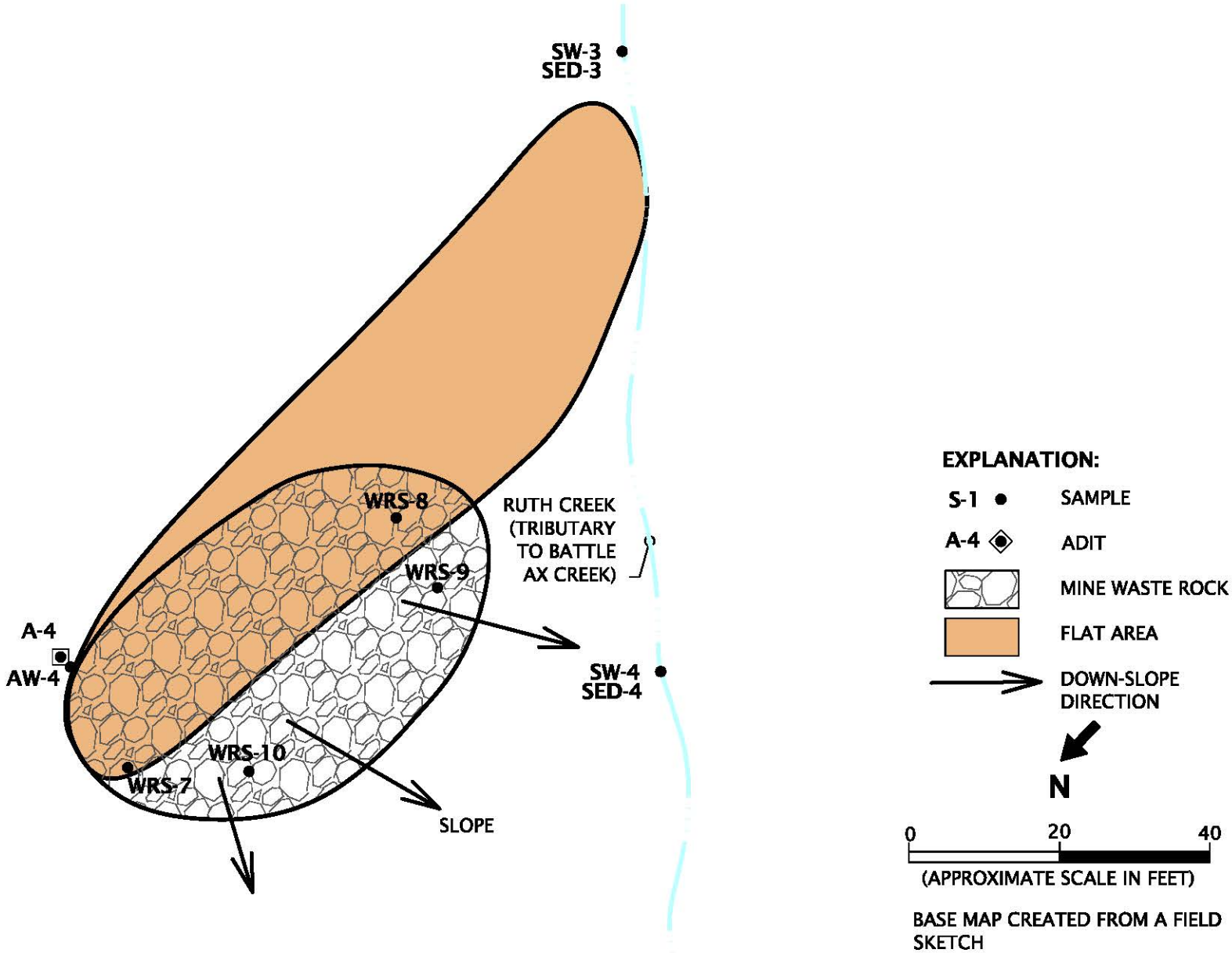
OPALCREEK-1-01

JUNE 2006

GEODESIGN NW
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

Jun 13, 2006 - 09:40:46 DWG Name: OpalCreek-1-01-SP-figure-5-ZONES.dwg Updated By: akd

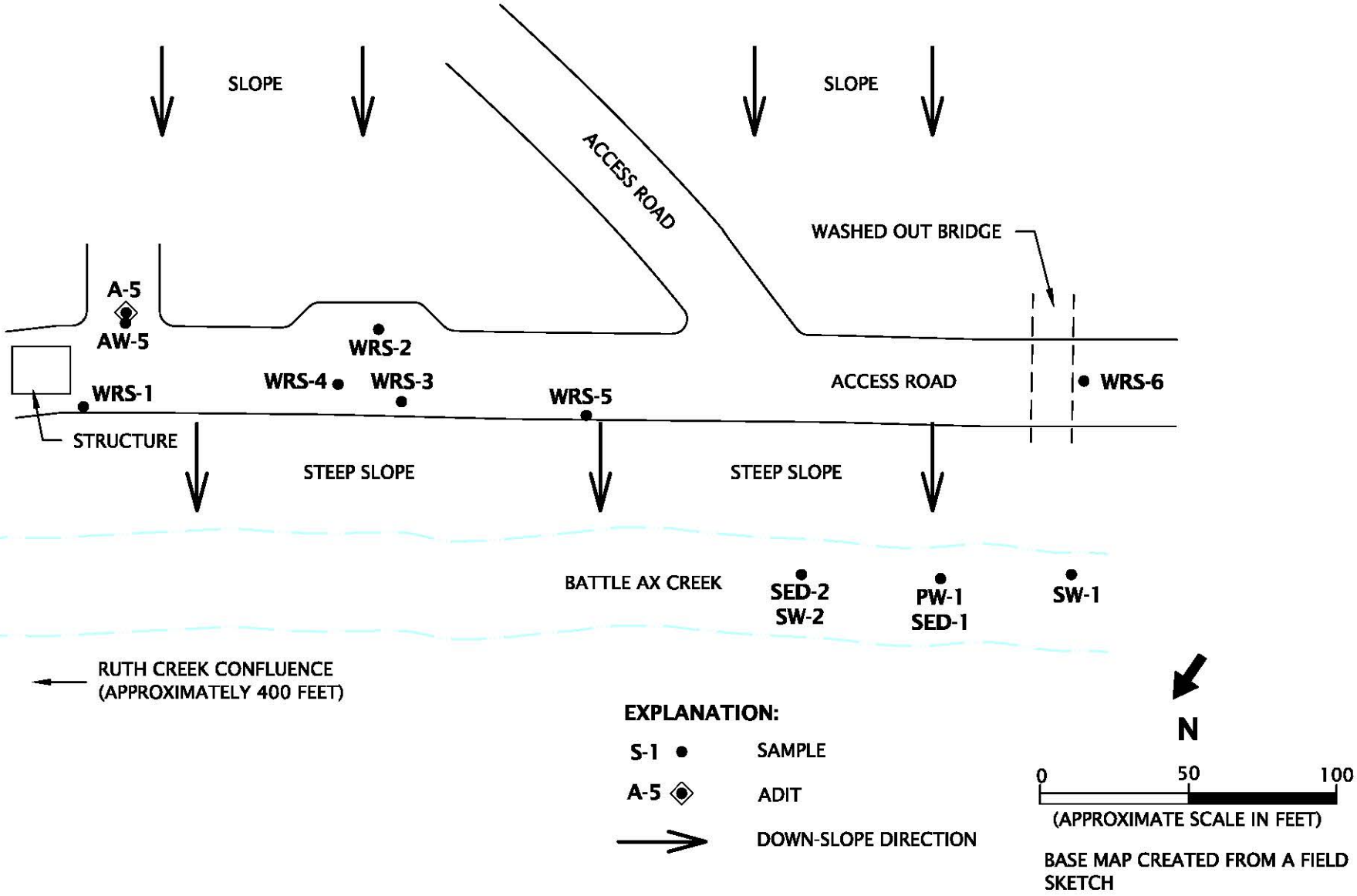
Jun 13, 2006 - 09:40:47 DWG Name: OpalCreek-1-01-SP-figure-6-ADIT4.dwg Updated By: akd



GEODESIGN INC
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

OPALCREEK-1-01	ADIT 4 AREA	
JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	FIGURE 6

Jun 13, 2006 - 09:40:48 DWG Name: OpalCreek-1-01-SP-figure-7-ADIT5.dwg Updated By: akd



GEODESIGN INC 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068	OPALCREEK-1-01	**ADIT 5 AREA**	
	JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	**FIGURE 7**

A. BATTLE AX CREEK. PORE WATER SAMPLE LOCATION PW-1. PHOTOGRAPH TAKEN FACING NORTHWEST.

B. WASTE ROCK/SOIL SAMPLE LOCATION WRS-3. PHOTOGRAPH TAKEN FACING WEST.

GEODESIGN INC
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

OPALCREEK-1-01	**PROJECT SITE PHOTOGRAPHS**	
JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	**FIGURE 8**

A. WASTE ROCK/SOIL SAMPLE WRS-5 LOCATION SHOWN IN FOREGROUND. THE ADIT 5 BUILDING AND ROAD BED ARE VISIBLE. PHOTOGRAPH TAKEN FACING NORTHEAST.

B. RUTH MINE ADIT 4 AREA. PHOTOGRAPH TAKEN FACING NORTH.

GEODESIGN INC
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

OPALCREEK-1-01	**PROJECT SITE PHOTOGRAPHS**	
JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	**FIGURE 9**

A. WASTE ROCK/SOIL SAMPLE LOCATION WRS-8. RUTH CREEK IS VISIBLE IN BACKGROUND. PHOTOGRAPH TAKEN FACING SOUTH.

B. SURFACE WATER SAMPLE LOCATION SW-3, WITH ADIT 4 AREA IN BACKGROUND. PHOTOGRAPH TAKEN FACING NORTH.

GEODESIGN INC
15575 SW Sequoia Parkway - Suite 100
Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

OPALCREEK-1-01	**PROJECT SITE PHOTOGRAPHS**	
JUNE 2006	RUTH MINE SITE AT OPAL CREEK MARION COUNTY, OR	**FIGURE 10**

TABLES

TABLE 1
Summary of XRF Comparison Data including FSI and USFS Sample Results (mg/Kg)
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Sample I.D.	Arsenic			Copper			Chromium			Iron			Lead			Manganese			Nickel			Zinc		
	XRF	Lab	USFS	XRF	Lab	USFS	XRF	Lab	USFS	XRF	Lab	USFS	XRF	Lab	USFS	XRF	Lab	USFS	XRF	Lab	USFS	XRF	Lab	USFS
WRS-1	--	7.88	--	<218	94.5	--	<1,700	23.1	--	53,800	30,300	78,592	351	346	106.0	1,549	1,220	11,296	<346	19.2	14,989	996	918	733
WRS-2	<528	46.2	--	4,996	7,600	--	--	16.6	--	144,667	77,000	160,973	970	2,050	4,810	18,100	10,200	28,288	<1,600	17.6	26,394	59,867	64,900	38,886
WRS-3	<1,838	22.8	--	<1,417	1,120	--	--	37.6	--	135,400	68,200	175,923	5,153	14,000	2,939	--	15,900	26,099	<1,634	23.7	30,976	35,267	43,600	48,077
WRS-4	<1,228	23.7	--	--	2,780	2,450	--	19.6	--	61,478	77,000	104,960	4,170	34,000	3,667	20,633	12,900	12,896	<2,012	18.7	31,898	30,767	98,900	35,891
WRS-5	<735	22.0	372	--	5,480	--	<882	23.2	4,339	102,533	74,000	118,998	3,677	10,800	6,490	22,133	13,000	19,290	<1,063	22.9	--	23,967	54,800	43,878
WRS-6	<742	26.9	237	<661	541	--	<2,316	18.0	3,798	67,133	35,100	77,875	4,940	4,030	2,570	7,321	5,480	9,286	<856	23.1	--	12,267	17,100	15,296
WRS-7	<162	10.8	--	<247	134	--	<714	26.5	--	40,900	26,800	38,477	852	2,440	886	5,005	5,300	4,000	<402	31.6	18,394	4,130	4,370	3,968
WRS-8	<528	15.4	--	<770	363	--	<2,600	32.9	--	56,467	33,500	--	1,465	2,670	--	9,656	7,730	--	<1,140	40.6	--	5,417	14,800	--
WRS-9	<442	17.9	--	<677	202	--	<1,230	34.6	--	89,567	36,800	83,763	1,195	1,480	2,450	13,500	6,360	12,397	<1,198	35.7	24,896	5,545	7,630	9,446
WRS-10	<158	26.9	--	<227	462	--	<2,075	13.8	1,120	28,367	24,200	63,488	855	2,410	495	2,855	4,640	4,640	<404	22.7	27,494	4,096	15,200	2,869
BG-1	<74	2.55	--	<295	42.9	--	<486	17.0	--	30,667	17,700	--	--	26.0	--	<1,500	516	--	<492	22.2	--	--	126	--
BG-2	--	2.41	--	--	48.7	--	<4,233	18.4	--	--	16,200	--	--	25.1	--	--	807	--	--	24.2	--	--	469	--
BG-3	<53	3.23	--	<198	57.4	--	<957	18.8	--	33,433	19,100	--	<63	2.9	--	1,234	450	--	<377	25.6	--	436	86.7	--
BG-4	<47	30.5	--	<187	868	--	<1,200	20.5	--	29,600	47,700	--	--	5,450	--	--	7,700	--	<251.8	23.8	--	<163	24,600	--
BG-5	<382	17.3	--	<380	365	--	<974	38.5	--	38,000	29,200	--	2,242	2,020	--	4,342	5,340	--	<503	30.9	--	2,614	1,700	--
BG-6	<228	2.48	--	<1,039	40.0	--	--	18.0	--	27,967	16,700	--	--	16.7	--	<3,033	722	--	<1172	25.4	--	<782	83.0	--
BG-7	<131	12.0	--	<264	506	--	--	28.3	--	29,067	24,000	--	553	936	--	2,340	3,620	--	<377	31.0	--	1,187	4,160	--
BG-8	<105	2.54	--	<599	51.9	--	--	14.9	--	27,433	17,600	--	<166	27.3	--	<3,150	648	--	<1,013	23.8	--	<609	107	--
BG-9	<59	3.43	--	<397	196	--	--	21.4	--	32,267	15,400	--	225	146	--	<1,454	893	--	<550	27.7	--	2,348	2,470	--
BG-10	<80	8.45	--	<230	73.5	--	--	16.7	--	25,233	16,900	--	<251	68.2	--	<2,091	959	--	<1,050	21.9	--	<547	268	--

Notes:
--: not applicable
<: less than method reporting limit
All results reported in mg/Kg.
BG: background rock/soil sample
Lab: Denotes total metals analysis using EPA 6000/7000 Series Methods, conducted by North Creek Analytical.
USFS: Denotes USFS XRF analysis of sample in similar location.
XRF: Denotes GeoDesign XRF average of three analyses of sample.
WRS: waste rock/soil sample

TABLE 2
Summary of Chemical Analytical Data for Surface Water and Sediment[1]
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Sample I.D.	Date	Media	Total Metals using EPA Method 6000/7000 Series (mg/L)												
			Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
AW-4	11/8/05	adit water	ND<0.0010	0.00694	0.0221	ND<0.0010	0.0148	0.0475	0.0377	0.0235	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	3.08
AW-5	11/8/05	adit water	ND<0.0010	0.00322	0.00539	ND<0.0010	0.0046	0.0739	0.00262	0.0309	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	1.27
SW-1	11/8/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	0.0117	0.00295	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.0193
SW-2	11/8/05	surface water	ND<0.0010	0.00104	ND<0.0010	ND<0.0010	ND<0.0020	0.0258	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.00775
SW-3	11/8/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.0186
SW-4	11/8/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	0.0434	0.00392	0.004	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.0516
SW-5	11/8/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	0.00444	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.0856
SW-6	11/9/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	ND<0.0050
SW-7	11/9/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.0174
SW-8	11/9/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	ND<0.0050
SW-9	11/9/05	surface water	0.00133	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	0.00252	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.0724
SW-10	11/9/05	surface water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	ND<0.0050

Sample I.D.	Date	Media	Dissolved Metals using EPA Method 6000/7000 Series (mg/L)												
			Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
PW-1	11/8/05	pore water	ND<0.0010	0.00201	0.00149	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	0.277
PW-2	11/9/05	pore water	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0010	ND<0.0020	ND<0.010	ND<0.0010	ND<0.0020	ND<0.00020	ND<0.0020	ND<0.0020	ND<0.0010	ND<0.0050
Level II SLVs Surface Water Fresh (mg/L)			0.15	0.004	0.0022	0.074	0.009	1	0.0025	0.12	0.05	0.052	0.005	0.00012	0.12
EPA Region 9 Tap Water (mg/L)			0.000045	2.6	0.018	0.11*	1.5	11	NS	0.88	0.011	0.73	0.18	0.18	11
Water Quality Criteria[2] (mg/L)			0.01	1	0.0011	0.011	0.012	0.3	0.0032	0.05	0.00002	0.0134	0.01	0.00012	0.11

TABLE 2
Summary of Chemical Analytical Data for Surface Water and Sediment[1]
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Sample I.D.	Date	Media	Total Metals using EPA Method 6000/7000 Series (mg/Kg)												
			Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
SED-1	11/8/05	sediment	1.08	22.9	0.66	12.9	29.1	11,700	35.6	339	ND<0.0927	27.9	ND<0.588	ND<0.588	246
SED-2	11/8/05	sediment	1.95	30.4	ND<0.657	11.2	20.4	13,100	38.1	948	ND<0.107	23.7	ND<0.657	ND<0.657	290
SED-3	11/8/05	sediment	2.00	35.7	1.06	14.6	63.9	16,500	244	1,440	ND<0.0643	15.7	ND<0.618	ND<0.618	648
SED-4	11/8/05	sediment	3.68	34.6	1.87	13.8	465	20,800	265	2,280	ND<0.0633	18.8	ND<0.652	0.745	953
SED-5	11/8/05	sediment	11.7	12.2	0.989	9.86	39.6	23,100	278	4,290	ND<0.102	17.4	ND<0.706	ND<0.706	577
SED-6	11/9/05	sediment	2.60	82.3	ND<0.661	14.0	35.9	15,200	12.8	768	ND<0.0748	30.6	ND<0.661	ND<0.661	119
Level II SLVs Fresh Water Sediments (mg/Kg)			6	NA	0.6	37	36	NA	35	1,100	0.2	18	NA	4.5	123

Notes:
1. Chemical analyses performed by North Creek Analytical of Beaverton, Oregon.
2. The most conservative value among Fresh Acute Criteria, Fresh Chronic Criteria, Water and Fish Consumption, and Drinking Water MCL.
* The Chromium VI value was used because it is more conservative

TABLE 3A
Summary of Chemical Analytical Data for Waste Rock/Soil and Background Rock/Soil [1] (Total Metals)
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Sample I.D.	Date	Total Metals using EPA Method 6000/7000 Series and Total Mercury using EPA Method 7471A (mg/Kg)													Hexavalent Chromium using EPA Method 3060A (mg/Kg)
		Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc	
WRS-1	11/08/05	7.88	56.6	3.95	23.1	94.5	30,300	346	1,220	0.135	19.2	ND<0.545	ND<0.545	918	ND<1.12
WRS-2	11/08/05	46.2	7.94	307	16.6	7,600	77,000	2,050	10,200	1.87	17.6	9.98	9.19	64,900	ND<1.09
WRS-3	11/08/05	22.8	10.2	171	37.6	1,120	68,200	14,000	15,900	0.548	23.7	6.56	7.62	43,600	ND<1.06
WRS-4	11/08/05	23.7	10.0	422	19.6	2,780	77,000	34,000	12,900	0.431	18.7	16.5	7.1	98,900	ND<1.05
WRS-5	11/08/05	22.0	11.5	227	23.2	5,480	74,000	10,800	13,000	0.378	22.9	6.67	9.66	54,800	ND<1.17
WRS-6	11/08/05	26.9	17.5	76.8	18.0	541	35,100	4,030	5,480	1.11	23.1	3.03	10.0	17,100	ND<0.758
WRS-7	11/08/05	10.8	28.1	17.2	26.5	134	26,800	2,440	5,300	ND<0.0880	31.6	2.97	4.98	4,370	ND<0.689
WRS-8	11/08/05	15.4	34.7	66.1	32.9	363	33,500	2,670	7,730	0.126	40.6	2.05	5.51	14,800	ND<0.637
WRS-9	11/08/05	17.9	16.3	33.3	34.6	202	36,800	1,480	6,360	0.37	35.7	1.02	3.63	7,630	ND<0.671
WRS-10	11/08/05	26.9	28.2	68.4	13.8	462	24,200	2,410	4,640	0.341	22.7	2.06	6.49	15,200	ND<0.715
BG-1	11/08/05	2.55	92.3	ND<0.657	17.0	42.9	17,700	26.0	516	ND<0.0876	22.2	ND<0.657	ND<0.657	126	ND<1.27
BG-2	11/09/05	2.41	40.7	ND<0.570	18.4	48.7	16,200	25.1	807	ND<0.0891	24.2	ND<0.570	ND<0.570	469	ND<1.16
BG-3	11/09/05	3.23	75.7	ND<0.595	18.8	57.4	19,100	2.9	450	ND<0.0972	25.6	ND<0.595	ND<0.595	86.7	NA
BG-4	11/09/05	30.5	21.4	98.4	20.5	868	47,700	5,450	7,700	ND<0.0593	23.8	3.56	9.09	24,600	ND<1.15
BG-5	11/09/05	17.3	66.7	3.28	38.5	365	29,200	2,020	5,340	0.121	30.9	1.3	3.33	1,700	ND<1.21
BG-6	11/09/05	2.48	42.1	ND<0.608	18.0	40.0	16,700	16.7	722	ND<0.0627	25.4	ND<0.608	ND<0.608	83.0	ND<1.24
BG-7	11/09/05	12.0	22.2	23.5	28.3	506	24,000	936	3,620	0.123	31.0	1.18	2.39	4,160	ND<1.12
BG-8	11/09/05	2.54	63.3	ND<0.581	14.9	51.9	17,600	27.3	648	ND<0.103	23.8	ND<0.581	ND<0.581	107	ND<1.19
BG-9	11/09/05	3.43	69.6	1.16	21.4	196	15,400	146	893	ND<0.0879	27.7	ND<0.586	ND<0.586	2,470	ND<1.19
BG-10	11/09/05	8.45	110	ND<0.599	16.7	73.5	16,900	68.2	959	ND<0.0659	21.9	ND<0.599	ND<0.599	268	ND<1.16
Level II SLVs Soil (mg/Kg)		10	85	4	0.4	50	10	16	100	0.1	30	1	2	50	410
EPA Region 9 PRGs Industrial Soil (mg/Kg)		1.6	67,000	450	450	41,000	100,000	800	19,000	310	20,000	5,100	5,100	100,000	64

Notes:
1. Chemical analyses performed by North Creek Analytical of Beaverton, Oregon.
BG: background rock/soil sample
NA: The data for this sample was compromised during the laboratory extraction.
WRS: waste rock/soil sample

TABLE 3B
Summary of Chemical Analytical Data for Waste Rock/Soil and Background Rock/Soil[1] (SPLP Metals)
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Sample I.D.	Date	SPLP Metals using EPA Method 1312/6000/7000 Series and SPLP Mercury using EPA Method 1312/7470A (mg/L)												
		Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
WRS-1	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	1.3	ND<0.0250	0.0447	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-2	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	ND<0.0500	ND<0.0250	0.0158	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-3	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	ND<0.0500	ND<0.0250	0.201	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-4	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	ND<0.0500	ND<0.0250	0.202	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-5	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	0.121	ND<0.0250	0.0154	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-6	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	0.815	0.0291	0.0661	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-7	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	1.79	0.108	0.235	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	0.368
WRS-8	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	0.165	ND<0.0250	0.0278	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-9	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	0.238	ND<0.0250	0.0358	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
WRS-10	11/08/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	1.25	0.0848	0.199	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	0.273
BG-1	11/08/05	ND<0.0250	0.0472	ND<0.0250	ND<0.0250	ND<0.250	1.03	ND<0.0250	0.055	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-2	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	0.391	ND<0.0250	0.0132	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-3	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	ND<0.0500	ND<0.0250	ND<0.0100	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-4	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	4.25	ND<0.0250	0.0264	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-5	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	4.47	0.237	0.665	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	0.146
BG-6	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	4.24	ND<0.0250	0.143	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-7	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	3.88	ND<0.0250	0.149	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-8	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	3.76	ND<0.0250	0.132	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
BG-9	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	1.50	ND<0.0250	0.0588	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	0.176
BG-10	11/09/05	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.250	1.33	ND<0.0250	0.0380	ND<0.0002	ND<0.0250	ND<0.0250	ND<0.0250	ND<0.125
Level II SLVs Surface Water Fresh (mg/L)		0.15	0.004	0.0022	0.074	0.009	1	0.0025	0.12	0.05	0.052	0.005	0.00012	0.12

Notes:
1. Chemical analyses performed by North Creek Analytical of Beaverton, Oregon.
BG: background rock/soil sample
WRS: waste rock/soil sample

TABLE 4
Summary of Non-Cancer Hazard Quotients[1]
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Route of Exposure	Children		Adults	
	CTE[2]	RME[2]	CTE[2]	RME[2]
Incidental Ingestion of Surface Soil	0.002	0.02	0.0003	0.002
Dermal Contact with Surface Soil	0.0004	0.01	0.0003	0.001
Inhalation of Particles from Surface Soil	0	0	0	0
Incidental Ingestion of Surface Water	0.0001	0.0005	0.00003	0.0002
Dermal Contact with Surface Water	0.0007	0.005	0.0003	0.002
Incidental Ingestion of Sediment	0.000	0.006	0.0001	0.001
Dermal Contact with Sediment	0.0001	0.004	0.0001	0.0001

Notes:

1. Risk calculations completed by Pascoe Environmental Consulting, Port Townsend, Washington.
2. A CTE or RME Hazard Quotient that is less than 1.0 indicates that there is no unacceptable risk that adverse health effects will be observed in the exposed population.

TABLE 5
Summary of Cancer Risks[1]
Ruth Mine and Battle Ax Creek
Opal Creek Scenic Recreation Area
Marion County, Oregon

Route of Exposure	Children		Adults	
	CTE[2]	RME[2]	CTE[2]	RME[2]
Incidental Ingestion of Surface Soil	2.1E-08	8.8E-07	1.7E-08	3.5E-07
Dermal Contact with Surface Soil	4.8E-09	5.5E-07	1.9E-08	2.5E-07
Inhalation of Particles from Surface Soil	3.1E-11	3.2E-10	6.5E-11	6.5E-10
Incidental Ingestion of Surface Water	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dermal Contact with Surface Water	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Incidental Ingestion of Sediment	5.8E-09	2.4E-07	4.7E-09	9.8E-08
Dermal Contact with Sediment	1.3E-09	1.5E-07	5.1E-09	6.8E-08

Notes:

1. Risk calculations performed by Pascoe Environmental Consulting of Port Townsend, Washington.
2. A CTE or RME Cancer Risk that is 1.0 E-06 or less indicates that there is 1 in 1,000,000 or less excess chance of the individual developing cancer from the exposure and the cancer risk is acceptable.

APPENDIX A

Human Health Risk Evaluation

Ruth Mine Site

Willamette National Forest, Oregon

March 2006

Prepared for

GeoDesign, Inc.
Portland, Oregon

TABLE OF CONTENTS

Table of Contents i

List of Tables ii

List of Figures ii

1. Introduction 3

2. Identification of Contaminants of Concern 4

3. Exposure Assessment 5

3.1 Identification of Potentially Exposed Populations 5

3.2 Exposure Scenarios 6

3.3 Exposure Assumptions 7

3.4 Exposure Point Concentrations 10

3.5 Intake Estimation 12

3.5.1 Incidental Ingestion of Soil or Sediment 13

3.5.2 Dermal Contact with Soil or Sediment 13

3.5.3 Inhalation of Soil Particles 14

3.5.4 Ingestion of Surface Water 14

3.5.5 Dermal Contact with Surface Water 14

4. Toxicity Assessment 15

4.1 Non-Carcinogenic Toxicity Values 16

4.2 Carcinogenic Toxicity Values 16

4.3 Chemical Factors 18

5. Risk Characterization 18

5.1 Method for Noncarcinogenic Risks 19

5.2 Method for Cancer Risks 20

5.3 Non-Cancer and Cancer Risk Estimates for Recreational Users *20*

5.3.1 Noncarcinogenic Risks *22*

5.3.2 Carcinogenic Risks *22*

5.3.3 Risks from Lead Exposures *23*

5.4 Summary of Human Health Risks *26*

6. Uncertainty Analysis 27

6.1 Sampling and Analysis *27*

6.2 Exposure Point Concentrations *27*

6.3 Exposure Factors *28*

6.4 Toxicology *29*

7. References 29

APPENDIX A - RISK CALCULATION TABLES 31

APPENDIX B – PRINTOUTS OF CHILD AND ADULT LEAD MODEL RUNS 47

LIST OF TABLES

Table 1. Contaminants of Potential Concern 5

Table 2. Exposure Point Concentrations 12

Table 3. Toxicity Values 17

Table 4. Chemical-Specific Parameters 18

Table 5. Summary of NonCancer Hazard Quotients 21

Table 6. Summary of Cancer Risks 21

LIST OF FIGURES

Figure 1. Recreation Management Intensity Zones for Opal Creek Area 8

1. INTRODUCTION

A screening-level human health risk evaluation was performed for the Ruth Mine Site, Opal Creek Scenic Recreation Area, Willamette National Forest, Marion County, Oregon. The human health risk evaluation analyzes the potential for health risks associated with recreational activities at the mine site that might occur by members of the public. The evaluation addresses present and future health risks due to the presence of metals at the site, in the absence of any removal or remediation of the sources of metals. The evaluation does not address other types of risks that may be associated with the mine.

The evaluation incorporates analytical data collected from environmental media at the mine with information on potential exposure pathways to provide an understanding of the potential human health risks. The evaluation follows guidance on performing risk assessments by the Oregon Department of Environmental Quality (ODEQ) and the US Environmental Protection Agency (USEPA). It consists of four components:

- *Identification of Chemicals of Potential Concern*. Site data are evaluated by a screening process to determine chemicals of potential concern (COPC). COPCs are evaluated further for non-cancer and cancer risks.
- *Exposure Assessment*. Activities through which humans may be exposed to elevated metals at the mine area are identified and quantified. Exposure activities are incorporated with COPC concentrations in environmental media to quantify exposures.
- *Toxicity Assessment*. The toxicity of the COPCs is quantified for relating human exposures to potential adverse health effects.
- *Risk Characterization*. Information from the exposure and toxicity assessments is integrated into a quantitative estimate of non-cancer and cancer risks. Uncertainties in the characterization are discussed.

The evaluation is considered screening-level because it relies on readily available information for exposure modeling, toxicology of metals, and risk modeling. All exposure and risk estimates are based on exposure modeling from data on metals collected from waste rock piles, background soils, surface water in mine adits, and surface water and sediments in Battle Ax Creek and a tributary at the mine site.

2. IDENTIFICATION OF CONTAMINANTS OF CONCERN

This section describes the methodology used to identify COPCs in various environmental media at the mine site. All chemical data were screened against criteria following guidelines of ODEQ (1998). Initially, 13 metals were analyzed and identified as chemicals of interest (COI):

- Arsenic
- Barium
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Manganese
- Nickel
- Selenium
- Silver
- Zinc.

These COIs were screened to select COPCs based on the following criteria:

- *USEPA Region 9 Preliminary Remediation Goals (PRGs)* – Maximum concentrations of COIs in soils, surface waters, and sediments are compared with PRGs for industrial exposures. Both soil and sediment concentrations of COIs are compared with industrial soil PRGs, and surface water COIs are compared with industrial tap water PRGs. Industrial PRGs developed by USEPA Region 9 are considered conservative criteria for screening COIs that humans may contact through recreational activities. The industrial soil criteria are designed for evaluating continuous exposures to industrial workers over a standard working time period, which entails exposures higher than would be likely for intermittent exposures under a recreational scenario. Industrial tap water criteria are designed for screening drinking water uses and are conservative for application to surface waters. Industrial soil criteria are conservative screens for exposures to recreational exposures to sediment. Screening criteria specifically for recreational exposures are not available.
- *Frequency of Detection* – COIs detected in less than 5% of the samples of a given medium were excluded from COPCs. No COIs that passed the Region 9 PRG screen were excluded based on frequency of detection.

- *Background* – COIs that are at background concentrations are typically not selected as COPCs. Comparison of the concentration of each COI in soil samples against the 95 percent upper confidence limit of the mean of background soil concentrations did not exclude any COIs that had passed the PRG screen. No data on background levels are available for surface water or sediment at the site.

Tables A-1 through A-3 in Appendix A presents the results of the screening against PRGs. As per ODEQ guidance, the screen identifies multiple COPCs in multiple media. Table 1 summarizes the result of the selection of COPCs.

Table 1. Contaminants of Potential Concern

Exposure Media	Results of Screen
Waste rock soil	Arsenic exceeded the PRG by a factor of 29 Lead exceeded the PRG by a factor of 43
Surface water	Cadmium exceeded the PRG by a factor of 1.2 Lead exceeded the PRG by a factor of 2.5
Sediment	Arsenic exceeded the PRG by a factor of 7

COIs were screened against EPA Region 9 Industrial Preliminary Remediation Goals.

3. EXPOSURE ASSESSMENT

The Exposure Assessment identifies the populations that may be exposed to COPCs at the site, develops the exposure scenarios and exposure pathways, and quantifies the concentrations of COPCs in the exposure media that humans may contact.

3.1 Identification of Potentially Exposed Populations

There are no residences at the mine site; the nearest residence is located approximately 1.5 miles down a US Forest Service access road at the Opal Creek Ancient Forest Center in Jawbone Flats. Because of the remoteness of the mine and the steep grades, there is little likelihood of full-time residents at the site in the future. Since the mine is abandoned, there are no on-site workers at the site. Only US Forest Service vehicles and Opal Creek Ancient Forest Center vehicles are allowed to use the access road.

The mine site is located on Battle Ax Creek approximately 1.5 miles from the Opal Creek Ancient Forest Center at Jawbone Flats, which contains several public accommodations and on-site residences. The access road from Jawbone Flats to Ruth Mine encompasses the Battle Ax Creek trail; with the entire mine site and portions of the access road and trail located in the Opal Creek Scenic Recreation Area. The access road and trail pass immediately below the historical mining operations at Adit 4. Hence recreational users of the area, primarily for hiking but also fishing, hunting, and horseback riding, are assumed to have the highest potential exposures to COPCs at the mine site.

3.2 Exposure Scenarios

The estimation of exposure and risk depends on the identification of exposure pathways, scenarios, and exposure routes. Complete exposure pathways consist of four elements: a source of chemical release into the environment, an environmental medium for transport of the chemical (e.g., soil, surface water, air), a point of potential human exposure, and an exposure route by which the chemical can get into the body.

Exposure scenarios were developed for complete exposure pathways for recreational exposures to COPCs at the mine site.

Adult Recreational Scenario

- Adults who may come in contact with waste rock soil during recreational activities at the mine site, through the following exposure routes:
  - Inadvertent ingestion of dirt particles that consist only of waste rock soil
  - Direct skin contact with waste rock soil
  - Inhalation of dust particles comprised solely of waste rock soil.
- Adults who may contact surface water and sediment at the site, through the following exposure routes:
  - Ingestion of surface water
  - Dermal contact with surface water
  - Ingestion of sediment
  - Dermal contact with sediment.

Child Recreational Scenario

- Children who may come in contact with waste rock soil during recreational activities at the mine site, through the following exposure routes:
  - Inadvertent ingestion of dirt particles that consist only of waste rock soil
  - Direct skin contact with waste rock soil
  - Inhalation of dust particles comprised solely of waste rock soil.
- Children who may play in the surface waters at the site, exposed through the following routes:
  - Ingestion of surface water
  - Dermal contact with surface water
  - Ingestion of sediment
  - Dermal contact with sediment.

For both the adult and child exposure scenarios, risks under reasonable maximum exposure (RME) conditions and central tendency exposure (CTE) conditions are estimated. The RME exposure conditions are designed to estimate a reasonable worst case type of exposure at the site, whereas the CTE conditions represent a more typical exposure.

3.3 Exposure Assumptions

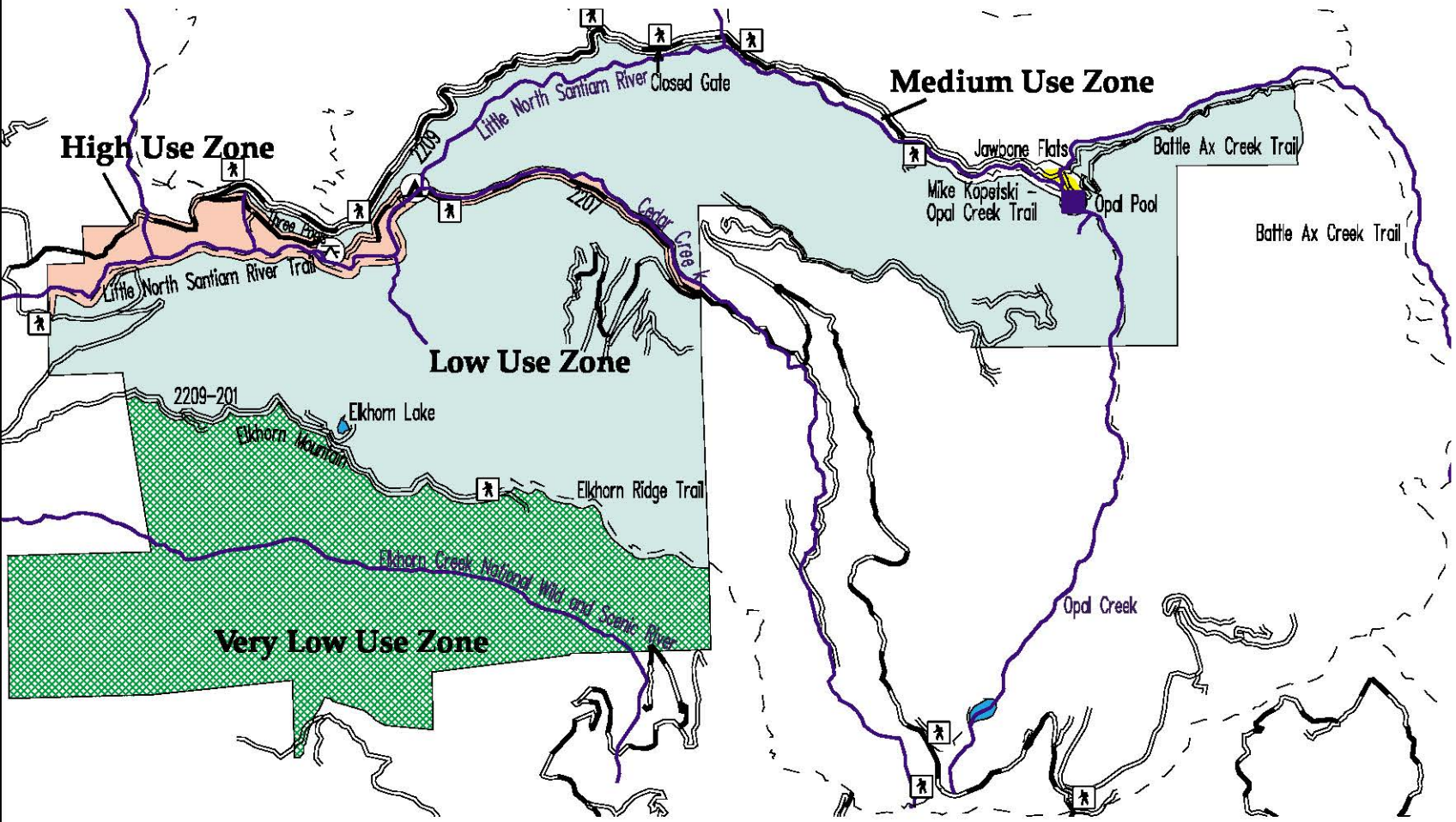
The parameters that are used to quantify exposures for the scenarios described above include many assumptions. Some parameters are quantified following ODEQ (1998) or USEPA (1989) guidance, and some parameters that are specific to the site, such as the amount of time that recreational users may spend at the site, are based on best professional judgment or information from the managers of the Opal Creek Ancient Forest Center at Jawbone Flats. The US Forest Service has identified the Battle Ax Creek portion of the Opal Creek Scenic Recreation Area as a "Low Use" zone in its recreation management plan for the area (Figure 1). The durations and frequencies of exposures that are assumed for this risk evaluation are considered reasonably conservative given the current and future anticipated use of the site for recreational purposes.

Opal Creek Scenic Recreation Area
Proposed Recreation Management Intensity Zones

Figure 1.

ATTENTION
Features represented on this map may not be in an accurate geographic location. The Forest Service makes no expressed or implied warranty of this data nor of the appropriateness for any user's purposes. The Forest Service reserves the right to correct, update, modify, or replace the geospatial information on which this map is based without notification. For more information, contact
Detroit Ranger District GIS shop (503) 845-3366

Legend
High Use
Medium Use
Low Use
Legend
Very Low Use
Improved Gravel Road
Low Maintenance Road
Trails
Streams
Day Use
Campground
Trailheads
Peaks



Willamette National Forest

1" = 1.14 miles
0 miles 1 2

Scale 1:72240
Request #20186
07/24/01

The following assumptions were made for recreational exposures at the site. Exposure parameters are developed for both the CTE and RME conditions. The parameters and their values are also listed in Table A-4 of Appendix A.

- Body Weight – A body weight of 15 kg for child represents the mean weight of children between the ages of 0 and 6. A body weight of 70 kg for adults is the mean weight of men and women between the ages of 18 and 70. Both values are taken from ODEQ (1998) guidance.
- Exposure Duration – The exposure duration is the number of years over which exposures may occur. For children, values of 2 and 6 years are used for the CTE and RME conditions, respectively. For adults, the values of 9 and 30 years are assumed for CTE and RME conditions, respectively, based on ODEQ (1998) guidance on lengths of residence in a given area.
- Exposure Frequency – Exposure frequency is number of days per year that a person may spend at the site, engaged in recreational activities. Frequencies for child exposures are assumed to be 2 weekends in summer, for 2 days each weekend, for a total of 4 days per year for CTE; and 14 days for the RME (i.e., assuming a two-week vacation during summer months when the soils are accessible) for each of 6 years. For adults, 5 and 20 days per year are used for the CTE and RME conditions, respectively.
- Exposure Time – It is assumed that young children are accompanied by adults to the mine site, and both children and adults spend 4 hours exposed to contaminated media during each of the visits to the site. In other words, the exposure time assumes that the child and adult visitors spend all 4 hours actively engaged in activities that result in continuous direct exposure to COPCs in waste rock soils, surface water, and sediment at the site. The child and adult are also assumed to be actively exposed during the 4-hour visit to both waste rock soils and to contaminated surface waters.
- Surface Area – Values for body surface areas for dermal contact for exposures to soil, surface water, and sediment are taken from ODEQ (1998) guidance on soil contact. Swimmable water bodies are not available at the site.
- Pathway Specific Parameters:

  Soil Ingestion – Children are assumed to ingest waste rock pile soils at rates of 25 and 100 mg/day during each 4-hour visit, for CTE and RME conditions, respectively. Adults are assumed to ingest waste rock pile soils at rates of 12 and 25 mg/day during each visit, for CTE and RME conditions, respectively. Ingestion rates are one-quarter the values recommended in ODEQ (1998) and USEPA (1997) for combined

ingestion of house dust and soil under continuous exposures in a residential setting. The selected ingestion rates are assumed to be representative of activities that would occur throughout the exposure time of 4 hours per day at the waste rock soils.

Soil Adherence Factor – Adherence factors for determining the amount of soil and sediment that may stick to skin are taken from USEPA (2004a) guidance on dermal risk assessment.

Inhalation of Fugitive Particulate Dust – Inhalation rates of 1.2 m^3/hr and 1.5 m^3/hr, for children and adults, respectively, for the 4 hours during each visit to the site, are taken from USEPA (1997) guidance.

Surface Water Ingestion – The rate of surface water ingestion is taken from USEPA (1997) guidance. The amounts of time spent exposed to surface water are assumed at 0.5 and 1 hour per visit, for both children and adults, under CTE and RME conditions, respectively.

Sediment Ingestion – Rates of sediment ingestion are assumed to be one-quarter the rates of soil ingestion.

Slightly different values for some of these parameters, such as exposure duration for children, are assumed by USEPA for evaluating risks from child exposure to lead, as described in the lead risk section (Section 5.3).

3.4 Exposure Point Concentrations

Exposure point concentrations (EPCs) are those concentrations of COPCs in environmental media that humans may be exposed to. For the Ruth Mine site, COPC concentration data are available for soils, surface waters, and sediments. From those data, EPCs are developed for soils, surface waters, sediments, and air. Air EPCs are developed for particulate dust that is modeled as releases from waste rock soils. For each environmental medium, EPCs are developed as the upper 90 percent confidence limit (90UCL) on the mean concentration, following ODEQ (1998) guidance. The 90UCL concentrations are used to quantify exposures with the assumption that they best represent the concentrations of COPCs that a person would contact over chronic time periods, assuming that a person moves randomly throughout the exposure area.

The USEPA ProUCL program was used for statistical analyses and to develop the 90UCL values (USEPA 2004b). For each COPC, the distribution characteristics of the sampling data were first determined. Sampling data consisted of concentrations in soils (mg/kg waste rock soil), surface waters (mg/L), and sediments (mg/kg whole

sediment). Statistical analyses for soil and sediment were performed on the original dry weight data. The Shapiro-Wilk test was used to test for normal distributions, consistent with Gilbert (1987), and the Anderson-Darling and Kolmogorov-Smirnov test statistics were used to test for gamma distribution. Based on these tests, each COPC was assigned a normal distribution, a log-normal distribution, a gamma distribution, or a non-parametric distribution. The type of distribution was found to vary for different COPCs within the same media and across media types. Descriptive statistics for each COPC were compiled using the distributions of the data that were assigned by the ProUCL software.

EPCs are developed for each COPC in each of the environmental media that receptors may contact.

- *Soils* – Recreational users are assumed to be exposed only to waste rock soils for the duration of their soil exposures at the site. The EPC is based on the 10 waste rock soil samples. Exposures to background soils are not included.
- *Surface Water* – Recreational users are assumed to be exposed to surface waters that were sampled at the site. Surface waters consist of two samples of adit water from Adits 4 and 5, three samples collected from the tributary that runs past the adits, and 4 samples from Battle Ax Creek. The EPC does not include samples from Battle Ax Creek at the Blue Jay Creek confluence, upstream of Blue Jay Creek, or Blue Jay Creek itself. It was assumed that visitors to the site could have equal access to all environmental media at the site; e.g., exposures could occur to waters in Battle Ax Creek and the tributary of equal accessibility under future conditions.
- *Sediments* – Recreational users are assumed to be exposed to sediment in the same surface waters as under the surface water exposures.
- *Air* – Recreational users are assumed to breathe particulates that have been released only from the waste rock soils. It is assumed that the particulates derive from the waste rock soils and do not include particulates that may derive from nearby background soils.

Metals concentrations in air are modeled from the waste rock soil samples by the following equation:

$$C_{air} = \left(\frac{C_{soil}}{PEF} \times F_c \right)$$

where:

C_{air} = concentration in air (mg/m^3)
C_{soil} = 90UCL in waste rock soil
PEF = Particulate emission factor, set at 1.32E+09 m^3/kg as per ODEQ (1998) guidance
F_c = Fraction of soil that is contaminated; assumed to be 100%.

Air particulate modeling results are displayed in Table A-33 of Appendix A.

Table 2 presents the EPCs for the COPCs at the Ruth Mine site.

Table 2. Exposure Point Concentrations

Chemical of Potential Concern	Soil CTE/RME (90% UCLM) (mg/kg)	Surface Water CTE/RME (90% UCLM) (mg/L)	Sediment CTE/RME (90% UCLM) (mg/kg)	Air CTE/RME (modeled) (mg/m3)
Inorganics				
Arsenic	2.67E+01	NA	7.39E+00	2.02E-08
Cadmium	NA	1.06E-02	NA	NA
Lead	1.38E+04	1.38E-02	NA	1.05E-05

CTE/RME = central tendency exposures/reasonable maximum exposures
90% UCLM = 90% upper confidence limit on the mean concentration
NA = Not a COPC for that medium.

3.5 Intake Estimation

The final step in the exposure assessment is the estimation of chemical intake and resulting dose for each chemical and each of the pathways considered in the assessment. The extent of potential intake received through the various pathways is dependent on an individual's location and behavior. A series of simplifying assumptions are made to calculate chemical intakes that yield conservatively high estimates of potential exposures.

For long-term (i.e., chronic) exposures to noncarcinogenic chemicals, intakes are averaged over the period of exposure (i.e., the averaging time, AT), and are referred to as the average daily dose (ADD) (USEPA 1989). For carcinogens, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily dose (LADD) (USEPA 1989).

The equations used to estimate intakes for each of the exposure pathways follow USEPA (1989, 2004a) guidance:

3.5.1 Incidental Ingestion of Soil or Sediment

$$(L)ADD = \frac{C_s \ x \ IR_s \ x \ EF \ x \ ED}{BW \ x \ AT} \ x \ CF$$

where:

(L)ADD	=	(Lifetime) Average Daily Dose (mg/kg-day)
C_s	=	Concentration of chemical in soil or sediment (mg/kg)
IR_s	=	Ingestion Rate of soil or sediment (mg/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)
CF	=	Conversion Factor (10^{-6} kg/mg).

For noncarcinogens, intakes are calculated by averaging the daily doses over the averaging time (AT), which is set equal to the exposure duration (ED). For carcinogens, AT is an average upper bound duration of human lifetime, which is assumed by ODEQ (1998) to be 70 years (25,550 days).

3.5.2 Dermal Contact with Soil or Sediment

$$(L)ADD = \frac{C_s \ x \ SA \ x \ AF \ x \ DAF \ x \ EF \ x \ ED}{BW \ x \ AT} \ x \ CF$$

where:

(L)ADD	=	(Lifetime) Average Daily Dose (mg/kg-day)
C_s	=	Concentration in soil or sediment (mg/kg)
SA	=	Surface Area of skin contact (cm^2/event)
AF	=	Adherence Factor for soil or sediment to skin (mg/cm^2)
DAF	=	Dermal Absorption Factor (unitless)
EF	=	Exposure Frequency (events/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)
CF	=	Conversion Factor (10^{-6} kg/mg).

3.5.3 Inhalation of Soil Particles

$$(L)ADD = \frac{C_s \ x \ IR_p \ x \ ET \ x \ EF \ x \ ED}{BW \ x \ AT}$$

where:

(L)ADD	=	(Lifetime) Average Daily Dose (mg/kg-day)
C_s	=	Concentration in soil particulates (mg/kg)
IR_p	=	Inhalation Rate of particulates (m^3/hour)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days).

3.5.4 Ingestion of Surface Water

$$(L)ADD = \frac{C_{sw} \ x \ IR_{sw} \ x \ ET \ x \ EF \ x \ ED}{BW \ x \ AT}$$

where:

(L)ADD	=	(Lifetime) Average Daily Dose from ingestion of surface water (mg/kg-day)
C_{sw}	=	Concentration of chemical in surface water (mg/L)
IR_{sw}	=	Ingestion Rate of surface water (L/day)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days).

3.5.5 Dermal Contact with Surface Water

$$(L)ADD = \frac{C_{sw} \ x \ SA \ x \ PC \ x \ ET \ xEF \ x \ ED}{BW \ x \ AT} \ x \ CF$$

where:

(L)ADD	=	(Lifetime) Average Daily Dose (mg/kg-day)
C_{sw}	=	Concentration in surface water (mg/kg)

SA	=	Surface Area of skin contact (cm^2/event)
PC	=	Permeability Coefficient of chemical (cm/hour)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)
CF	=	Conversion Factor (10^{-3} L/cm^3).

Calculated doses, or intakes, of all COPCs in soil, sediment, and surface water are displayed in the risk calculation tables presented in Tables A-5 through A-32 of Appendix A.

4. TOXICITY ASSESSMENT

The Toxicity Assessment presents the toxicity information and criteria for the COPCs that are used with the exposure intake doses to quantify risks. Toxicity criteria are based on the types of potential adverse health affects associated with exposures to the COPC; the relationship between magnitude of exposure and potential adverse effects; and related uncertainties, such as the weight of evidence of a particular chemical's carcinogenicity in humans. The toxicity criteria rely on existing toxicity information developed for specific chemical constituents. USEPA has evaluated existing toxicity information and characterized the relationship between the dose of the chemical administered or received and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity criteria were derived that can be used to estimate the incidence of potentially adverse effects at different exposure levels (USEPA 1989). These toxicity criteria are called reference doses (RfDs) for non-carcinogens and slope factors (SFs) for potential carcinogens.

Of the COPCs at the site, US EPA has identified arsenic as carcinogenic via ingestion and inhalation, and cadmium as carcinogenic by inhalation, for which slope factors have been derived (Table 3). US EPA quantifies non-carcinogenic effects for arsenic via ingestion and for cadmium via ingestion and inhalation, for which reference doses are derived (Table 3). For lead, USEPA does not recommend the use of a reference dose, but instead provides models to estimate the contribution of the site to blood lead levels in children and fetus through maternal exposures (see Section 5.3).

4.1 Non-Carcinogenic Toxicity Values

Reference doses are expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-bw/day). They are derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies), and include uncertainty factors to account for specific types of uncertainty inherent in extrapolation from the available data, and modifying factors to account for the confidence in the scientific studies. The use of these factors is a conservative approach to the protection of human health and is likely to overestimate the risks associated with chemical exposure.

The primary source for toxicity values for non-carcinogens was the USEPA Integrated Risk Information Systems (IRIS) database. If toxicity values were not available from IRIS, the USEPA Region 3 Risk-Based Concentrations tables were consulted (USEPA 2005), which provides a compilation of values from the USEPA Health Effects Assessment Summary Tables (HEAST) and the USEPA National Center for Exposure Assessment (NCEA).

Toxicity values used for exposures that involve dermal contact with chemicals may require adjustment of the oral toxicity values (oral RfDs) to allow for the difference between the daily intake dose through absorption via dermal contact and the amount that is ingested in the toxicity study used to derive the oral RfD (i.e., the administered dose). Most toxicity values are based on the administered dose, and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to their use in dermal contact risk assessment (USEPA 1989, 2004a). Ingestion route toxicity values were adjusted by absorption factors in USEPA (2004a) guidance to account for the differences between the administered dose and the absorbed dose across the skin. This adjustment lowers the reference doses for use in dermal exposures.

The toxicity values used for non-carcinogenic chemicals are presented in Table 3.

4.2 Carcinogenic Toxicity Values

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold, that is, there is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept is based on the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. US EPA has quantified cancer

toxic potency concentrations, *i.e.,* the slope factor, which reflects the dose-response data for the carcinogenic endpoint (USEPA 1989).

The slope factor is determined by US EPA as the upper 95th percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. Typically, the slope factor is used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. Slope factors are generally based on experimental animal data, unless suitable epidemiologic studies are available. Due to the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, slope factors are typically developed by using a model to fit the available high-dose, experimental animal data, and then extrapolating downward to the low-dose range to which humans are typically exposed. The models used by US EPA are conservative and provide an upper bound estimate of excess lifetime cancer risk. Thus, the actual risk may be lower and could be zero (USEPA 1989). The toxicity values used for carcinogenic metals are presented in Table 3.

Table 3. Toxicity Values

Carcinogenicity					
Chemical of Potential Concern	**Cancer Slope Factor**			**Weight-of-Evidence Classification**	**Basis of Slope Factor**
	Oral (mg/kg-day)-1	Dermal (mg/kg-day)-1	Inhalation (mg/kg-day)-1		
Arsenic	1.50E+00	1.58E+00	1.51E+01	A Known Human Carcinogen	Skin cancer, human epidemiology studies (drinking water)
Cadmium	NA	NA	6.30E+00	B1 Probable Human Carcinogen	Lung, trachea, human occupational exposure
Non-Carcinogenicity					
Chemical of Potential Concern	**Reference Dose**			**Basis of RfD**	**Target Endpoint Effects**
	Oral (mg/kg-day)	Dermal (mg/kg-day)	Inhalation (mg/kg-day)		
Arsenic	3.00E-04	2.85E-04	NA	Human epidemiology studies, drinking water	Skin, vascular effects

Cadmium	5.0E-04	2.50E-05	--	Model of human renal cortex	Proteinuria
Cadmium	--	--	5.7E-05	NA (USEPA NCEA)	--
Lead	NA	NA	NA	See text	Blood lead

Sources: USEPA IRIS database; USEPA HEAST; USEPA NCEA; USEPA 2004a
Dermal RfDs are derived from oral RfDs (USEPA 2004a).

4.3 Chemical Factors

Other chemical factors for calculating exposures include the gastrointestinal absorption factor and the dermal absorption factor. Chemical parameters are listed in Table 4. Gastrointestinal and dermal absorption factors were taken from US EPA (1989, 1994b, 2004a) guidance.

Table 4. Chemical-Specific Parameters

Chemical of Potential Concern	GI Absorption Factor GI ABS Unitless	Dermal Absorption Factor DAF Unitless	Dermal Permeability Coefficient PC cm/hr
Inorganics			
Arsenic	0.95	0.03	1.00E-03
Cadmium	0.05	0.001	1.00E-03
Lead	0.3	0.01	1.00E-03

Sources: USEPA 1989, 1994b, 2004a

5. RISK CHARACTERIZATION

Risk characterization is the final step of the risk assessment process. In this step, the toxicity values were combined with the estimated chemical intakes for the receptor populations to quantitatively estimate health risks associated with carcinogen and non-carcinogen exposures. Human health risks are deliberately characterized in a conservative manner in order to determine an upper range of potential risks for exposures to chemicals at the site. The characterization is considered screening level because it is based on limited sampling data and conservative simplifying

assumptions about how much a recreational user is exposed to metals in the waste rock and surface waters of the site.

The methodologies used to estimate cancer risks and chronic and subchronic risks for non-carcinogens for conventional chemicals are described below.

5.1 Method for Noncarcinogenic Risks

The potential human health risks associated with exposures to non-carcinogenic COPCs were estimated by comparing ADDs with established RfDs, as per ODEQ (1998) and US EPA (1989) guidance. A hazard quotient (HQ) was derived for each chemical, as shown in the following equation:

$$HQ = \frac{ADD}{RfD}$$

where:

HQ	=	Hazard Quotient (unitless); ratio of average daily dose or intake level (ADD) to acceptable daily intake level or reference dose (RfD)
ADD	=	Average Daily Dose (mg/kg-day)
RfD	=	Reference Dose (mg/kg-day).

If the ADD exceeds the RfD, the HQ will exceed 1.0 and there may be concern that potential adverse systemic health effects could be observed in the exposed populations. If the ADD does not exceed the RfD, the HQ will not exceed 1.0 and there is no concern that potential adverse systemic health effects will be observed in the exposed populations. However, if the sum of several HQs exceeds 1.0, and the chemicals affect the same target organ, there may be concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of the HQ above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual chemical HQs are summed to provide an exposure pathway Hazard Index (HI). If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures via that pathway at the site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on a toxic endpoint of concern or target organ (*e.g.*, HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-

specific HI is greater than one is there reason for concern about potential health effects for that endpoint.

5.2 Method for Cancer Risks

Carcinogenic risk was estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical estimate of excess lifetime cancer risk was calculated by multiplying the lifetime average daily dose (ADD) by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = ADD \times SF$$

where:

Risk	=	The unitless probability of an exposed individual developing cancer
ADD	=	Average Daily Dose over a lifetime (mg/kg-day)
SF	=	Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$.

Because the slope factor is the statistical 95th percent upper confidence limit on the slope of the dose-response curve, this method provides a conservative, upper-bound estimate of risk.

5.3 Non-Cancer and Cancer Risk Estimates for Recreational Users

Estimates of potential cancer and noncancer health risks under CTE and RME conditions at the mine site are presented in the following subsections. Estimates are presented for adult and children for each of the exposure pathways.

Noncancer hazard quotients and excess cancer risks under CTE and RME conditions are summarized for adults and children under various exposure scenarios in Tables 5 and 6. Summary tables of risk estimates are presented for each COPC in Tables A-5 through A-32 in Appendix A. Within each summary table, risks are presented for exposure to waste rock soils, surface waters, sediments, and waste rock soils resuspended as particulates in breathable air.

Table 5. Summary of NonCancer Hazard Quotients

Route of Exposure	Children		Adults	
	CTE	RME	CTE	RME
Incidental Ingestion of Surface Soil	0.002	0.02	0.0003	0.002
Dermal Contact with Surface Soil	0.0004	0.01	0.0003	0.001
Inhalation of Particles from Surface Soil	0	0	0	0
Incidental Ingestion of Surface Water	0.0001	0.0005	0.00003	0.0002
Dermal Contact with Surface Water	0.0007	0.005	0.0003	0.002
Incidental Ingestion of Sediment	0.000	0.006	0.0001	0.001
Dermal Contact with Sediment	0.0001	0.004	0.0001	0.0001

Table 6. Summary of Cancer Risks

Route of Exposure	Children		Adults	
	CTE	RME	CTE	RME
Incidental Ingestion of Surface Soil	2.1E-08	8.8E-07	1.7E-08	3.5E-07
Dermal Contact with Surface Soil	4.8E-09	5.5E-07	1.9E-08	2.5E-07
Inhalation of Particles from Surface Soil	3.1E-11	3.2E-10	6.5E-11	6.5E-10
Incidental Ingestion of Surface Water	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dermal Contact with Surface Water	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Incidental Ingestion of Sediment	5.8E-09	2.4E-07	4.7E-09	9.8E-08
Dermal Contact with Sediment	1.3E-09	1.5E-07	5.1E-09	6.8E-08

5.3.1 Noncarcinogenic Risks

Calculations of exposures as daily doses, and noncarcinogenic risks for adult and child recreational users, are presented in Appendix A.

Waste rock soils – Arsenic and lead were identified as noncarcinogenic COPCs for waste rock soils. All of the arsenic HQs for ingestion of soil and dermal contact with soil were below 1.0. Risks associated with lead exposures are discussed in a following subsection.

*Surface wate*r – Surface water consisted of #4 and #5 adit waters, the tributary running past adits 4 and 5, and Battle Ax Creek at and down stream of the confluence with the tributary. Cadmium and lead were identified as noncarcinogenic COPCs for surface waters. All of the cadmium HQs for incidental ingestion and dermal contact with surface waters were below 1.0. Risks associated with lead exposures are discussed in a following subsection.

Sediment – Sediment consisted of sediments from the same sources as the surface waters. Arsenic was identified as a noncarcinogenic COPC for sediment. All of the arsenic HQs for ingestion and dermal contact with sediment were below 1.0.

Inhalation of soil particulates – Arsenic and lead were identified as noncarcinogenic COPCs for soil particles. All of the HQs for children and adults were below 1.0.

The risk characterization of noncarcinogenic hazards for recreational exposures at the Ruth Mine site suggests that the potential for noncarcinogenic health effects are negligible.

5.3.2 Carcinogenic Risks

Calculations of exposures as daily doses, and carcinogenic risks for adult and child recreational users, are presented in Appendix A.

Waste rock soils – Arsenic was identified as the only carcinogenic COPC for waste rock soils. The highest excess cancer risk was estimated for the child ingestion of waste rock soil under RME conditions, at 8.8E-07. The RME conditions for child ingestion of waste rock soil assumes that the child plays on the waste rock for 14 days every year from the ages of 1 through 6, and that they can ingest waste rock soil at the rate of 100 mg during the 4 hour visit. The EPC for arsenic in waste rock soil associated with the 8.8E-07 cancer risk estimate is 26.7 mg/kg. Excess cancer risk estimates for all of the other exposure pathways for child and adult were also below 1E-06.

*Surface wate*r – No carcinogenic COPCs were identified for surface water.

Sediment – Arsenic was identified as the only carcinogenic COPC for sediment. Excess cancer risk estimates for all exposure pathways for children and adults were below 1E-06.

Inhalation of soil particulates – Arsenic was the only carcinogenic COPC identified for soil particles. All excess cancer risk estimates for children and adults were less than 1E-06.

The risk characterization for cancer risks for recreational exposures at the Ruth Mine site suggests that estimated excess cancer risks for children and adults are negligible.

5.3.3 Risks from Lead Exposures

Risks from exposures to lead in the environment are not evaluated by the methods used for the other COPCs. Regulatory agencies do not provide toxicity criteria for lead, and instead recommend evaluating lead by use of a model to predict blood levels of lead. Lead effects on neurological development of children are best related to blood lead levels rather than to doses or intake levels. USEPA has developed models that predict blood lead levels in children and in the developing fetus from maternal exposures based on multiple sources of lead in the environment. The contribution of lead in site-related media to the total blood lead levels in a child or developing fetus exposed to the site is modeled, and the resultant total blood levels are compared with a health-based criterion for lead in blood.

For the Ruth Mine site, it was assumed that both children and adults are exposed to lead in waste rock soils and air at the site. The upper 95% confidence level of the mean concentration in waste rock soil (16,573 mg/kg) was used as the exposure point concentration for site-related exposures, as per USEPA (1994a) guidance for the lead model. For the child modeling, the lead level in air was assumed to be the default value in the model, at 0.1 $\mu g/m^3$; the lower concentration of 0.011 $\mu g/m^3$ that was modeled from the waste rock soils was not used. Model parameterization for the child and adult lead models are described separately below.

Child Exposures

The model developed for estimating child blood levels is the Integrated Exposure Uptake BioKinetic (IEUBK) model, available as a downloadable model from USEPA (http://www.epa.gov/superfund/programs/lead/products.htm#ieubk). The child model was developed for exposures of young children to lead in a residential

environment. The default parameters of the model assume that the child is exposed to lead through multiple environmental media typical of a residential location, including yard soil, house dust, air, food sources, drinking water, and perinatal exposures (i.e., fetal and nursing) from the mother. The ingestion of soil pathway in the model assumes that house dust is comprised partly of outside yard soil that is contaminated with lead. The model assumes that the child is exposed continuously to the above sources from a developing fetus through 7 years of age, with varying rates of exposure to different media for each year of age.

The IEUBK model is not designed specifically to predict blood lead levels for recreational exposures that occur on an intermittent basis, nor is it designed for exposures away from the residential location. However, the IEUBK model contains an "alternate source data" component for including sources of lead intake that are outside of the typical residential setting that are used to define default residential exposures (USEPA 1994a). The alternate source component provides model input fields for adding a daily intake of lead in μg/day for each of the seven years of child exposure. This component was used to include the lead intake associated with recreational activities at the Ruth Mine site. In general, the daily lead intake from the exposure to waste rock soils at the Ruth Mine site was calculated and input to the yearly fields under the "alternative source data" component of the model. With this added exposure component, lead intake due to activities while visiting the Ruth Mine site are added to the exposures included in the model as default residential exposures.

For the inclusion of the alternate source modeling, all default exposure pathways and parameters in the IEUBK model were retained. These include default values for lead levels in food and drinking water, lead in outdoor and indoor air, lead in soil and house dust, the relative amounts of yard soil and house dust that a child is assumed to ingest, maternal contribution of lead to the fetus, and absorption of lead from soils and other sources. Within the model, only the alternate source data field was altered by inclusion of a daily intake rate for lead from the alternate source for each of the seven years of child exposure. The gastrointestinal absorption of lead from the alternative source was set at the same absorption that the model uses for soils (i.e., 30 percent).

A daily intake rate for lead due to the exposure at the mine site was calculated as follows. The alternate source was assumed to be the waste rock soils at the mine site, with a concentration of lead at 16,573 mg/kg, set at the upper 95% confidence level of the mean concentration. The ingestion of waste rock soil was assumed to be the

RME value of 100 mg/day, which is assumed to occur during the 4 hours that the child visits the site each day, for 14 days per year. Under these exposure conditions, averaged over one year, the daily ingestion rate of lead from the waste rock soil is 63.6 μg/day. The absorption of lead from the ingested waste rock soil was assumed to be 30 percent.

The print-out from the IEUBK model run is presented in Appendix B, using the default residential exposure setting with the RME conditions as described above, and including the average daily lead ingestion from waste rock soil as the "alternate souce data". Under this alternative source scenario, blood lead levels for children at 7 years of age are predicted to be 7.1 μg/dL. This concentration is below the threshold of concern level for child blood lead that USEPA has set at 10 μg/dL. Running the model under the CTE waste rock soil ingestion rate of 25 mg/day results in substantially lower predicted blood lead levels.

The bioavailability of lead from soil decreases as the amount of lead ingested increases, due to saturation limitations of the uptake from the gastrointestinal tract (USEPA 1994). The IEUBK model was developed for soil lead concentrations generally around 200 mg/kg; the waste rock soil concentration of 16,573 mg/kg is substantially above that level. Lead in ingested soils that are at concentrations above the model range are absorbed at lower rates than the model assumes (USEPA 1994b). In addition, the absorption efficiency for lead from minerals such as galena, which is found in the Cascades mining districts in which the Ruth Mine site is located, are lower than the absorption assumed in the model (USEPA 1999). For these reasons, the 30 percent absorption efficiency for lead from ingested soil that is assumed in the model is likely an overestimate for the waste rock soils. In addition, the size of particles at hard rock mining sites are generally larger than the sizes of yard and dust particles that formed the basis for skin adherence that is assumed in the model, as recently reviewed for Superfund mining sites (NRC 2005). Thus, the model assumption for the ingestion of soil that adheres to skin is likely overestimated for waste rock soil. Both of these factors, the percent absorption and soil adherence factor, result in very conservative estimates of exposure in the model.

Adult Exposures

A separate model is available from the USEPA web page on estimating lead risks (http://www.epa.gov/superfund/programs/lead/products.htm#ieubk) that can be used to evaluate blood lead levels of a fetus in an exposed adult. The adult exposure model assumes that adults have a baseline level of lead in their blood, and then adds to that a contribution of lead from outside soil and house dust. The model then

predicts the blood levels of lead in a fetus of a pregnant adult at those exposures. The predicted blood levels of lead in the fetus are compared to the same criterion as with the IEUBK model.

The adult model was run using the same waste rock soil concentration as the child model, default blood lead levels from background sources, and an adult waste rock soil ingestion rate of 25 mg/day under RME conditions of 20 days per year exposure at the site. Results of the modeling of fetal blood lead levels from adult exposures predicted blood lead levels to range from 7.9 to 9.9 μg/dL (Appendix B). These concentrations are below the threshold of concern level for fetal and child blood lead that USEPA has set at 10 μg/dL. Under the CTE conditions, assuming an adult ingestion rate of waste rock soil at 12 mg/day results in blood lead levels in the fetus ranging from 6.2 to 7.9 μg/dL.

5.4 Summary of Human Health Risks

Of the 13 metals COIs identified at the site, arsenic, cadmium, and lead were identified as COPCs by the screening procedure. These three COPCs were evaluated quantitatively for human health risks following ODEQ guidance. Health risks were evaluated for people who would visit the site for recreational purposes. It was assumed that visitors would be exposed to COPCs in the waste rock soils and in the surface waters of the mine adits, the tributary that flows past the mine adits, and in Battle Ax Creek. The likelihood of exposure to COPCs in the surface waters was assumed to be similar across the site, assuming that both adults and children engaged in recreational activities, both presently and in the future, would have access to all contaminated areas. The exposure parameters used in the evaluation were assumed to be conservative for the expected future recreational exposures at the site. The US Forest Service has identified the Battle Ax Creek portion of the Opal Creek Scenic Recreation Area as a "Low Use" zone in its recreation management plan for the area.

Exposures and risks were evaluated for incidental ingestion of waste rock soil, dermal contact with waste rock soil, inhalation of waste rock soil particulates released to air; and ingestion and dermal contact with both surface water and sediments of the adits, tributary, and Battle Ax Creek at the site. Risks were not evaluated for potential exposures to background soils or to other creeks in the area.

Results of the risk evaluation indicate that noncarcinogenic risks for all exposure pathways for adults and children are below regulatory levels of concern. Risks to

young children for exposure to lead in waste rock soils are at acceptable levels under the assumptions of the RME exposure conditions.

Results of the evaluation of excess cancer risks above background risk levels indicate that the highest cancer risk is associated with child ingestion of waste rock soils, at 8.8E-07 cancer risk, associated with arsenic levels of 26.7 mg/kg in the waste rock. Excess cancer risks for all other pathways of exposure for both children and adults were also estimated to be below 1E-06.

6. UNCERTAINTY ANALYSIS

This section discusses some of the uncertainties in the risk evaluation described above. Some uncertainties are specific to the site conditions and some are inherent to the risk assessment process. An analysis of uncertainties provides the risk managers with information on the limitations and interpretation of the risk estimates and potential exposures for use in future decision making.

6.1 Sampling and Analysis

The sampling approach for the mine site was focused in design, with most samples of soils and surface waters located in areas of suspected contamination. The area was not sampled randomly and the results are not considered representative of average exposures to recreational users of the site. Only samples from the waste rock soils were used for the soil exposure pathways; data on lower contaminated background soils in the area were not used. Average exposures would typically result from varied movement throughout the site, with a mix of exposures to both contaminated and uncontaminated soils and waters.

Focusing on samples with high levels of contamination, such as soils that appear to consist primarily of waste rock, results in exposure point concentrations and subsequent risks to be overestimated compared to actual exposures encountered by random movement across the area. Since the soil samples collected were mostly biased toward contaminated areas, the measured concentrations and calculated health risks are overestimated.

6.2 Exposure Point Concentrations

Estimates of exposure to metals at the mine site were based on a limited number of samples to represent the various exposure media. For the waste rock soils, 10

samples were used, for surface water and sediment only nine and six samples were available, respectively. The low number of samples typically results in highly skewed data sets and high upper confidence limits on the mean values, frequently close to the maximum concentration. With the use of gamma distribution statistics, a 90UCL was calculatable for all samples regardless of the low number or the skewness of the data.

6.3 Exposure Factors

Soil and sediment ingestion - A major source of uncertainty in exposure factors is the selection of soil and sediment ingestion rates. Soil ingestion for children under the RME scenario was assumed to be 100 mg/day, with all of the ingestion consisting of waste rock and all occurring during the 4 hours each day that the child is assumed to be present on the waste rock soil. Uncertainty with the soil ingestion rate is high.

The sediment ingestion rate was directly taken from the soil ingestion rate. The sediment ingestion rate is considered sufficiently conservative by this approach. Also a major source of uncertainty for the soil and sediment ingestion pathways is the amount of lead and arsenic absorbed from the ingested material. Metals in waste rock are unlikely to be as bioavailable at the fractions recommended for soils by USEPA (1994a, 2004a). This uncertainty is considered moderate.

Dermal contact - A major source of uncertainty in the direct contact pathway is the absorption of metals across the skin and the resulting toxicity. The dermal absorption factors for the metals used in the modeling were taken from US EPA guidance. The dermal absorption factors are typically based on laboratory studies, and are not specific to the environment in which the metals are found. Specifically, the absorption of arsenic from weathered waste rock is unknown. Uncertainty in the dermal absorption factors is considered high.

Another factor in the dermal contact risk estimates is the adherence factor for soil and sediment adhering to skin. The adherence factor determines how much of the soil or sediment adheres to an area of the skin. The values used are taken from ODEQ and USEPA guidance and are derived from studies with children exposed to dry and wet soil, but not to sediment. The values are not specific to the site. The type of soils used to derive the adherence factors are more typical soil materials that contain organic material, to which metals may desorb from. However, the waste rock soil and sediment at the mine site are very grainy with likely low organic material present.

Also a factor in the dermal contact risk estimates is the frequency of exposures to the sediments. The frequency of exposure was assumed to be 14 days per year, every year, for the RME child recreational user. This value is assumed to be conservatively representative of exposures for an individual who may visit the mine area.

6.4 Toxicology

The toxicity values for metals in any risk assessment are considered uncertain because most of the values are extrapolated from laboratory studies or occupational studies performed elsewhere. The toxicity values used in this risk assessment are not specific to the site or conditions, but they have been generated, reviewed, and accepted by various regulatory agencies. Because resolution of the uncertainty in toxicity of metals to humans is considered difficult, the uncertainty is not considered major.

7. References

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold Company Inc. New York.

NRC. 2005. *Superfund and Mining Megasites. Lessons from the Coeur D'Alene River Basin.* National Research Council. National Academies Press, Washington, DC. http://www.epa.gov/superfund/reports/pdfs/coeur/ch6.pdf. Accessed Jan. 25, 2006.

ODEQ. 1998. *Guidance for ecological risk assessment: Levels I, II, III, IV. Final*. Updated 2000. Oregon Department of Environmental Quality, Waste Management and Cleanup Division, Portland, OR.

USEPA. 1989. *Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A) (Interim Final).* EPA/540/1-89002. US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

USEPA. 1994a. *Guidance Manual for the IEUBK model for Lead in Children*. PB93-963510, OSWER #9285.7-15-1. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. Available: http://www.epa.gov/superfund/programs/lead/products/. Accessed January, 2006.

USEPA. 1994b. *Technical Support Document: Parameters and Equations Used in the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (v 0.99d).* EPA/540/R-94/040. OSWER 9285.7-22. PB94-963505. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

Available: http://www.epa.gov/superfund/programs/lead/products/tsd.pdf. Accessed Jan. 25, 2006.

USEPA. 1997. *Exposure Factors Handbook.* Volumes I, II and III. Report No. EPA/600/P-95/002Fa,b, & c. USEPA, Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, DC. August.

USEPA. 1998. *Human Health Risk Assessment Protocol at Hazardous Waste Combustion Facilities*. EPA 530-D-98-001. Office of Solid Waste, US Environmental Protection Agency, Washington, DC. July.

USEPA. 1999. *IEUBK Model Bioavailability Variable*. Guidance Document. Technical Review Workgroup for Lead. U.S. Environmental Protection Agency, Washington, DC. Available: http://www.epa.gov/superfund/programs/lead/products/. Accessed February, 2006.

USEPA. 2004a. *Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (Final).* EPA/540/R/99/005. US Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, Washington, DC.

USEPA. 2004b. *ProUCL Version 3.0. User Guide. April 2004*. EPA/600/R04/079. Office of Research and Development. Prepared by Lockheed-Martin.

USFS. 2005. Opal Creek Scenic Recreation Area, Willamette National Forest. US Department of Agriculture, National Forest Service. Updated August 2005. Accessed January 2006. http://www.fs.fed.us/r6/willamette/manage/opalcreek/.

APPENDIX A - RISK CALCULATION TABLES

Table A-1. Waste Rock Soil PRG Screen

Chemical	Cancer/ Noncancer	Maximum Detected Concentration (mg/kg)	USEPA Region 9 Industrial Soil PRG (mg/kg)	Individual COI Risk Ratio (Ri)	Individual COPC?	Multiple COIs Ri/Rtotal	Multiple COPC in Soil?
Arsenic	C	46.2	1.6E+00	29	**Yes**	0.39	**Yes**
Barium	NC	56.6	6.7E+04	0.001	No	0.00001	No
Cadmium	NC	422	4.5E+02	0.93	No	0.012	No
Chromium	C	37.6	4.5E+02	0.08	No	0.001	No
Copper	NC	7600	4.1E+04	0.19	No	0.002	No
Iron	Max	77000	1.0E+05	0.8	No	0.010	No
Lead	NC	34000	8.0E+02	43	**Yes**	0.56	**Yes**
Manganese	NC	15900	1.9E+04	0.8	No	0.011	No
Mercury	NC	1.87	3.1E+02	0.01	No	0.0001	No
Nickel	NC	40.6	2.0E+04	0.002	No	0.00003	No
Selenium	NC	16.5	5.1E+03	0.003	No	0.00004	No
Silver	NC	10	5.1E+03	0.002	No	0.00003	No
Zinc	NC	98900	1.0E+05	0.99	No	0.013	No
Hexavalent Chromium	C	0	6.4E+01	0.00	No	0.0000	No
			Sum of Risk Ratios (Rtotal)	75			
			Number of COIs (N)	14			
			1/N	0.07			

Samples consist of all soil and waste rock samples on-site (N=10).

Table A-2. Surface Water PRG Screen

Chemical	Cancer/ Noncancer	Maximum Detected Concentration (ug/L)	USEPA Region 9 Industrial PRG (ug/L)	Individual COI Risk Ratio (Rwater)	Individual COPC?	Multiple COIs Rwater/Rwtotal	Multiple COPC in Surface Water?
Arsenic	C	0	4.5E-02	0	No	0.00	No
Barium	NC	6.94	2.6E+03	0.003	No	0.0007	No
Cadmium	NC	22.1	1.8E+01	1.2	**Yes**	0.30	**Yes**
Chromium	NC	0	5.5E+04	0.000	No	0.00	No
Copper	NC	14.8	1.5E+03	0.010	No	0.0025	No
Iron	NC	73.9	1.1E+04	0.007	No	0.00	No
Lead	NC	37.7	1.5E+01	2.5	**Yes**	0.62	**Yes**
Manganese	NC	30.9	8.8E+02	0.035	No	0.009	No
Mercury	NC	0	1.1E+01	0.000	No	0.00	No
Nickel	NC	0	7.3E+02	0.000	No	0.00	No
Selenium	NC	0	1.8E+02	0.000	No	0.00	No
Silver	NC	0	1.8E+02	0.000	No	0.00	No
Zinc	NC	3080	1.1E+04	0.28	No	0.07	No
			Sum of Risk Ratios (Rwtotal)	4			
			Number of COIs (N)	13			
			1/N	0.08			

Note - Region 9 has not published a PRG for lead; the criterion is an EPA action level for drinking water.

Surface water samples include all creek, tributary, and adit waters on-site (N=12).

Table A-3. Sediment PRG Screen

Chemical	Cancer/ Noncancer	Maximum Detected Concentration (mg/kg)	USEPA Region 9 Industrial Soil PRG (mg/kg)	Individual COI Risk Ratio (Rsed)	Individual COPC in Sediment?	Multiple COIs (Rsed/Rsedtotal)	Multiple COPC in Sediment?
Arsenic	C	11.7	1.6E+00	7	**Yes**	0.90	**Yes**
Barium	NC	82.3	6.7E+04	0.001	No	0.00	No
Cadmium	NC	1.87	4.5E+02	0.004	No	0.00	No
Chromium	C	14.6	4.5E+02	0.03	No	0.00	No
Copper	NC	465	4.1E+04	0.01	No	0.00	No
Iron	Max	23100	1.0E+05	0.23	No	0.03	No
Lead	NC	278	8.0E+02	0.35	No	0.04	No
Manganese	NC	4290	1.9E+04	0.22	No	0.03	No
Mercury	NC	0.00	3.1E+02	0.0000	No	0.00	No
Nickel	NC	30.6	2.0E+04	0.0015	No	0.00	No
Selenium	NC	0.00	5.1E+03	0.0000	No	0.00	No
Silver	NC	0.75	5.1E+03	0.0001	No	0.00	No
Zinc	NC	953	1.0E+05	0.0095	No	0.00	No
			Sum of Risk Ratios (Rsedtotal)	8			
			Number of COIs (N)	13			
			1/N	0.08			

Samples consist of all creek and tributary sediment samples on-site (N=6)

Table A-4. Exposure Parameters

Variable	Definition	Units	Child Recreational User			Adult Recreational User		
			CTE	RME	REFERENCE	CTE	RME	REFERENCE
	Ingestion of Surface Soil							
IR	Ingestion Rate	mg/day	25	100	ODEQ 1998, BPJ	12	25	ODEQ 1998, BPJ
EF	Exposure Frequency	day/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time - Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998
AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
CF	Conversion Factor	kg/mg	1.00E-06	1.00E-06		1.00E-06	1.00E-06	0
	Dermal Contact With Soil							0
SA	Surface Area for Contact	cm2/event	4,500	5,000	ODEQ 1998	5,200	6,900	ODEQ 1998
AF	Adherence Factor	mg/cm2	0.04	0.4	USEPA 2004	0.08	0.08	ODEQ 1998
EF	Exposure Frequency	event/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time - Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998
AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
CF	Conversion Factor	kg/mg	1.00E-06	1.00E-06		1.00E-06	1.00E-06	
	Inhalation from Soil							
IR	Inhalation Rate	m3/hr	1.2	1.2	EPA 1997	1.5	1.5	EPA 1997
ET	Exposure Time	hr/day	4	4	BPJ	4	4	BPJ
EF	Exposure Frequency	day/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time - Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998
AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
	Ingestion of Surface Water							
IR	Ingestion Rate	L/hr	0.01	0.01	EPA 1997	0.01	0.01	EPA 1997
ET	Exposure Time	hr/day	0.5	1	ODEQ 1998, BPJ	0.5	1	ODEQ 1998, BPJ
EF	Exposure Frequency	day/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time-Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998

AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
	Dermal Contact with Surface Water							
SA	Surface Area for Contact	cm2	4,500	5,000	ODEQ 1998	5,200	6,900	ODEQ 1998
ET	Exposure Time	hr/day	0.5	1.0	ODEQ 1998, BPJ	0.5	1.0	ODEQ 1998, BPJ
EF	Exposure Frequency	day/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time - Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998
AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
CF	Conversion Factor	L/cm3	1.00E-03	1.00E-03		1.00E-03	1.00E-03	
	Ingestion of Sediment							
IR	Ingestion Rate	mg/day	10	25	BPJ, EPA 1997	10	25	BPJ, EPA 1997
EF	Exposure Frequency	day/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time - Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998
AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
CF	Conversion Factor	kg/g	1.00E-06	1.00E-06		1.00E-06	1.00E-06	
	Dermal Contact with Sediment							
SA	Surface Area for Contact	cm2	4,500	5,000	ODEQ 1998	5,200	6,900	ODEQ 1998
AF	Adherence Factor	mg/cm2	0.2	1	USEPA 2004; ODEQ 1998	0.08	0.08	ODEQ 1998
EF	Exposure Frequency	day/yr	4	14	BPJ	5	20	BPJ
ED	Exposure Duration	yr	2	6	ODEQ 1998	9	30	ODEQ 1998
BW	Body Weight	kg	15	15	ODEQ 1998	70	70	ODEQ 1998
AT-NC	Averaging time - Noncancer	days	730	2,190	ODEQ 1998	3,285	10,950	ODEQ 1998
AT-C	Averaging Time - Cancer	days	25,550	25,550	ODEQ 1998	25,550	25,550	ODEQ 1998
CF	Conversion Factor	kg/mg	1.00E-06	1.00E-06		1.00E-06	1.00E-06	

Notes:

BPJ = Best Professional Judgment

CTE, RME = Central Tendency Exposure, Reasonable Maximum Exposure
Surface area for contact assumes arms, hands, leg, and feet (ODEQ 1998); for both soil and surface water.

Table A-5. Estimates of Cancer and Noncancer Risks for Child Recreational Users

CTE - Incidental Ingestion of Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	4.88E-07	1.39E-08	3.00E-04	1.50E+00	1.63E-03	2.09E-08
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	1.38E+04	2.53E-04	7.22E-06	NA	NA	--	--
Cumulative Risk						**1.63E-03**	**2.09E-08**

NA = Not applicable, or not available

Table A-6. Estimates of Cancer and Noncancer Risks for Child Recreational Users

RME- Incidental Ingestion of Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	6.83E-06	5.85E-07	3.00E-04	1.50E+00	2.28E-02	8.78E-07
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	1.38E+04	3.54E-03	3.03E-04	NA	NA	--	--
Cumulative Risk						**2.28E-02**	**8.78E-07**

NA = Not applicable, or not available

Table A-7. Estimates of Cancer and Noncancer Risks for Child Recreational Users

CTE- Dermal Contact with Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	1.05E-07	3.01E-09	2.85E-04	1.58E+00	3.70E-04	4.75E-09
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	1.38E+04	1.82E-05	5.20E-07	NA	NA	--	--
Cumulative Risk						**3.70E-04**	**4.75E-09**

NA = Not applicable, or not available

Table A-8. Estimates of Cancer and Noncancer Risks for Child Recreational Users
RME- Dermal Contact with Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	4.10E-06	3.51E-07	2.85E-04	1.58E+00	1.44E-02	5.55E-07
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	1.38E+04	7.07E-04	6.06E-05	NA	NA	--	--
Cumulative Risk						**1.44E-02**	**5.55E-07**

NA = Not applicable, or not available

Table A-9. Estimates of Cancer and Noncancer Risks for Child Recreational Users
CTE- Inhalation of Particles from Soil

Chemical of Potential Concern	EPC (mg/m3)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.02E-08	7.10E-11	2.03E-12	NA	1.51E+01	--	3.06E-11
Cadmium	NA	--	--	5.70E-05	6.30E+00	--	--
Lead	1.05E-05	3.67E-08	1.05E-09	NA	NA	--	--
Cumulative Risk						**0.00E+00**	**3.06E-11**

NA = Not applicable, or not available

Table A-10. Estimates of Cancer and Noncancer Risks for Child Recreational Users
RME- Inhalation of Particles from Soil

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.02E-08	2.48E-10	2.13E-11	NA	1.51E+01	--	3.21E-10
Cadmium	NA	--	--	5.70E-05	6.30E+00	--	--
Lead	1.05E-05	1.29E-07	1.10E-08	NA	NA	--	--
Cumulative Risk						**0.00E+00**	**3.21E-10**

NA = Not applicable, or not available

Table A-11. Estimates of Cancer and Noncancer Risks for Adult Recreational Users
CTE- Incidental Ingestion of Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	6.27E-08	8.06E-09	3.00E-04	1.50E+00	2.09E-04	1.21E-08
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	1.38E+04	3.25E-05	4.18E-06	NA	NA	--	--
Cumulative Risk						**2.09E-04**	**1.21E-08**

NA = Not applicable, or not available

Table A-12. Estimates of Cancer and Noncancer Risks for Adult Recreational Users
RME- Incidental Ingestion of Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	5.23E-07	2.24E-07	3.00E-04	1.50E+00	1.74E-03	3.36E-07
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	1.38E+04	2.71E-04	1.16E-04	NA	NA	--	--
Cumulative Risk						**1.74E-03**	**3.36E-07**

NA = Not applicable, or not available

Table A-13. Estimates of Cancer and Noncancer Risks for Adult Recreational Users
CTE- Dermal Contact with Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	6.52E-08	8.39E-09	2.85E-04	1.58E+00	2.29E-04	1.32E-08
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	1.38E+04	1.13E-05	1.45E-06	NA	NA	--	--
Cumulative Risk						**2.29E-04**	**1.32E-08**

NA = Not applicable, or not available

Table A-14. Estimates of Cancer and Noncancer Risks for Adult Recreational Users

RME- Dermal Contact with Soil

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.67E+01	3.46E-07	1.48E-07	2.85E-04	1.58E+00	1.21E-03	2.34E-07
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	1.38E+04	5.98E-05	2.56E-05	NA	NA	--	--
Cumulative Risk						**1.21E-03**	**2.34E-07**

NA = Not applicable, or not available

Table A-15. Estimates of Cancer and Noncancer Risks for Adult Recreational Users

CTE- Inhalation of Particles from Soil

Chemical of Potential Concern	EPC (mg/m3)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.02E-08	2.38E-11	3.05E-12	NA	1.51E+01	--	4.61E-11
Cadmium	NA	--	--	5.70E-05	6.30E+00	--	--
Lead	1.05E-05	1.23E-08	1.58E-09	NA	NA	--	--
Cumulative Risk						**0.00E+00**	**4.61E-11**

NA = Not applicable, or not available

Table A-16. Estimates of Cancer and Noncancer Risks for Adult Recreational Users

RME- Inhalation of Particles from Soil

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	2.02E-08	9.50E-11	4.07E-11	NA	1.51E+01	--	6.15E-10
Cadmium	NA	--	--	5.70E-05	6.30E+00	--	--
Lead	1.05E-05	4.92E-08	2.11E-08	NA	NA	--	--
Cumulative Risk						**0.00E+00**	**6.15E-10**

NA = Not applicable, or not available

Table A-17. Estimates of Cancer and Noncancer Risks for Child Recreational Users
CTE - Ingestion of Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	3.00E-04	1.50E+00	--	--
Cadmium	1.06E-02	3.88E-08	1.11E-09	5.00E-04	NA	7.76E-05	--
Lead	1.38E-02	5.02E-08	1.44E-09	NA	NA	--	--
Cumulative Risk						**7.76E-05**	**0.00E+00**

NA = Not applicable, or not available

Table A-18. Estimates of Cancer and Noncancer Risks for Child Recreational Users
RME- Ingestion of Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	3.00E-04	1.50E+00	--	--
Cadmium	1.06E-02	2.72E-07	2.33E-08	5.00E-04	NA	5.43E-04	--
Lead	1.38E-02	3.52E-07	3.01E-08	NA	NA	--	--
Cumulative Risk						**5.43E-04**	**0.00E+00**

NA = Not applicable, or not available

Table A-19. Estimates of Cancer and Noncancer Risks for Child Recreational Users
CTE- Dermal Contact with Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	2.85E-04	1.58E+00	--	--
Cadmium	1.06E-02	1.75E-08	4.99E-10	2.50E-05	NA	6.99E-04	--
Lead	1.38E-02	2.26E-08	6.46E-10	NA	NA	--	--
Cumulative Risk						**6.99E-04**	**0.00E+00**

NA = Not applicable, or not available

Table A-20. Estimates of Cancer and Noncancer Risks for Child Recreational Users RME- Dermal Contact with Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	2.85E-04	1.58E+00	--	--
Cadmium	1.06E-02	1.36E-07	1.16E-08	2.50E-05	NA	5.43E-03	--
Lead	1.38E-02	1.76E-07	1.51E-08	NA	NA	--	--
Cumulative Risk						**5.43E-03**	**0.00E+00**

NA = Not applicable, or not available

Table A-21. Estimates of Cancer and Noncancer Risks for Adult Recreational Users CTE - Ingestion of Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	3.00E-04	1.50E+00	--	--
Cadmium	1.06E-02	1.04E-08	1.34E-09	5.00E-04	NA	2.08E-05	--
Lead	1.38E-02	1.35E-08	1.73E-09	NA	NA	--	--
Cumulative Risk						**2.08E-05**	**0.00E+00**

NA = Not applicable, or not available

Table A-22. Estimates of Cancer and Noncancer Risks for Adult Recreational Users RME - Ingestion of Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	3.00E-04	1.50E+00	--	--
Cadmium	1.06E-02	8.32E-08	3.56E-08	5.00E-04	NA	1.66E-04	--
Lead	1.38E-02	1.08E-07	4.61E-08	NA	NA	--	--
Cumulative Risk						**1.66E-04**	**0.00E+00**

NA = Not applicable, or not available

Table A-23. Estimates of Cancer and Noncancer Risks for Adult Recreational Users CTE- Dermal Contact with Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	2.85E-04	1.58E+00	--	--
Cadmium	1.06E-02	5.41E-09	6.95E-10	2.50E-05	NA	2.16E-04	--
Lead	1.38E-02	7.00E-09	9.00E-10	NA	NA	--	--
Cumulative Risk						**2.16E-04**	**0.00E+00**

NA = Not applicable, or not available

Table A-24. Estimates of Cancer and Noncancer Risks for Adult Recreational Users RME- Dermal Contact with Surface Water

Chemical of Potential Concern	EPC (mg/L)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	NA	--	--	2.85E-04	1.58E+00	--	--
Cadmium	1.06E-02	5.74E-08	2.46E-08	2.50E-05	NA	2.30E-03	--
Lead	1.38E-02	7.43E-08	3.18E-08	NA	NA	--	--
Cumulative Risk						**2.30E-03**	**0.00E+00**

NA = Not applicable, or not available

Table A-25. Estimates of Cancer and Noncancer Risks for Child Recreational Users CTE - Incidental Ingestion of Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	1.35E-07	3.86E-09	3.00E-04	1.50E+00	4.50E-04	5.78E-09
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**4.50E-04**	**5.78E-09**

NA = Not applicable, or not available

Table A-26. Estimates of Cancer and Noncancer Risks for Child Recreational Users
RME- Incidental Ingestion of Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	1.89E-06	1.62E-07	3.00E-04	1.50E+00	6.30E-03	2.43E-07
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**6.30E-03**	**2.43E-07**

NA = Not applicable, or not available

Table A-27. Estimates of Cancer and Noncancer Risks for Child Recreational Users
CTE- Dermal Contact with Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	2.91E-08	8.33E-10	2.85E-04	1.58E+00	1.02E-04	1.31E-09
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**1.02E-04**	**1.31E-09**

NA = Not applicable, or not available

Table A-28. Estimates of Cancer and Noncancer Risks for Child Recreational Users
RME- Dermal Contact with Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	1.13E-06	9.71E-08	2.85E-04	1.58E+00	3.98E-03	1.53E-07
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**3.98E-03**	**1.53E-07**

NA = Not applicable, or not available

Table A-29. Estimates of Cancer and Noncancer Risks for Adult Recreational Users
CTE - Incidental Ingestion of Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	1.73E-08	2.23E-09	3.00E-04	1.50E+00	5.78E-05	3.35E-09
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**5.78E-05**	**3.35E-09**

NA = Not applicable, or not available

Table A-30. Estimates of Cancer and Noncancer Risks for Adult Recreational Users
RME- Incidental Ingestion of Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	1.45E-07	6.20E-08	3.00E-04	1.50E+00	4.82E-04	9.29E-08
Cadmium	NA	--	--	5.00E-04	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**4.82E-04**	**9.29E-08**

NA = Not applicable, or not available

Table A-31. Estimates of Cancer and Noncancer Risks for Adult Recreational Users
CTE- Dermal Contact with Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	1.80E-08	2.32E-09	2.85E-04	1.58E+00	6.33E-05	3.66E-09
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**6.33E-05**	**3.66E-09**

NA = Not applicable, or not available

Table A-32. Estimates of Cancer and Noncancer Risks for Adult Recreational Users

RME- Dermal Contact with Sediment

Chemical of Potential Concern	EPC (mg/kg)	NCADD (mg/kg-day)	CADD (mg/kg-day)	Chronic RfD (mg/kg-day)	SF per (mg/kg-day)	HQ	Risk
Arsenic	7.39E+00	9.58E-08	4.10E-08	2.85E-04	1.58E+00	3.36E-04	6.48E-08
Cadmium	NA	--	--	2.50E-05	NA	--	--
Lead	NA	--	--	NA	NA	--	--
Cumulative Risk						**3.36E-04**	**6.48E-08**

NA = Not applicable, or not available

Table A-33. Air Particulate Modeling

Chemical	C_{soil} mg/kg	PEF m3/kg	Fraction Contaminated 100%	C_{air}, Particulate g/cm3	mg/m3
Inorganics			(ODEQ 1998)		
Arsenic	2.67E+04	1.32E+09	100%	2.02E-17	2.02E-08
Lead	1.38E+04	1.32E+09	100%	1.05E-14	1.05E-05

C_{soil} = Exposure Point Concentration (90UCL) in waste rock soil

PEF = Particulate Emission Factor; default value from ODEQ (1998)

Cair = Csoil/PEF * Fraction contaminated

APPENDIX B – PRINTOUTS OF CHILD AND ADULT LEAD MODEL RUNS

LEAD MODEL FOR WINDOWS Version 1.0

==========
==

Model Version: 1.0 Build 263
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==========
==

The time step used in this model run: 2 - Daily (once a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 150.000 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	200.000	150.000
1-2	200.000	150.000
2-3	200.000	150.000
3-4	200.000	150.000
4-5	200.000	150.000
5-6	200.000	150.000
6-7	200.000	150.000

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	63.600
1-2	63.600
2-3	63.600
3-4	63.600
4-5	63.600
5-6	63.600
6-7	63.600

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	2.164	14.934	0.313
1-2	0.034	2.325	15.352	0.805
2-3	0.062	2.680	15.756	0.859
3-4	0.067	2.642	16.154	0.897
4-5	0.067	2.618	16.621	0.958
5-6	0.093	2.804	16.877	1.026
6-7	0.093	3.124	17.028	1.053

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	3.443	20.875	10.9
1-2	5.621	24.138	10.3
2-3	5.769	25.125	9.2
3-4	5.915	25.675	8.9
4-5	4.508	24.772	8.2
5-6	4.120	24.920	7.6
6-7	3.926	25.224	7.1

Adult Blood Lead Model Results

Exposure Variable	PbB Equation[1] 1*	2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1, GSDi = Hom	Using Equation 1, GSDi = Het	Using Equation 2, GSDi = Hom	Using Equation 2, GSDi = Het
PbS	X	X	Soil lead concentration	ug/g or ppm	16573	16573	16573	16573
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.1	2.3	2.1	2.3
PbB_0	X	X	Baseline PbB	ug/dL	1.5	1.7	1.5	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.025	0.025	--	--
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.000	0.000
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.0	0.0
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	20	20	20	20
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult worker, geometric mean**			**ug/dL**	**2.6**	**2.8**	**1.5**	**1.7**
$PbB_{fetal,0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**7.9**	**9.9**	**4.6**	**6.0**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**			**%**	**2.5%**	**4.9%**	**0.3%**	**1.2%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S.D}) + PbB_0$
$PbB_{fetal,0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

****Equation 2, alternate approach based on Eq. 1, 2, and A-19 in USEPA (1996).**

PbB_{adult} =	$PbS*BKSF*([(IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])/365+PbB_0$
$PbB_{fetal,0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

Version date 05/19/03

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

APPENDIX B

Screening Ecological Risk Assessment

Ruth Mine Site

Willamette National Forest, Oregon

March 2006

Prepared for

GeoDesign, Inc.
Portland, Oregon

TABLE OF CONTENTS

Table of Contents i

List of Tables ii

List of Figures ii

1. Introduction 1

2. Problem Formulation 2

2.1 Ecological Setting 2

2.1.1 Geology 2

2.1.2 Habitat 3

2.2 Contaminants of Interest (COI) 6

2.3 Conceptual Ecological Exposure Model 6

2.3.1 Sources of Contamination 8

2.3.2 Ecological Receptors and Exposure Pathways 8

2.4 Environmental Concentrations 10

3. Assessment Endpoints and Measures of Effect 11

4. Identification of Contaminants of Potential Ecological Concern 13

4.1 Initial Screening 13

4.1.1 Frequency of Detection 13

4.1.2 Background Concentration Screening 13

4.2 Risk-Based Screening 14

4.2.1 Risk-Based Screening Criteria 14

4.2.2 Exposure Concentrations 15

4.2.3 Screening Procedure 15

4.2.4 Screening Results 17

5. Risk Characterization....17

5.1 Risk Description....18

5.1.1 Waste Rock Soil....18

5.1.2 Surface Water....19

5.1.3 Sediment....20

5.2 Uncertainty Analysis....21

5.2.1 Sampling and Analysis....21

5.2.2 Exposure Concentrations....21

5.2.3 Toxicology....22

6. Conclusions....22

7. References....24

APPENDIX A - RISK RATIO CALCULATION TABLES....26

APPENDIX B - SAMPLE SCREENING TABLES....35

LIST OF TABLES

Table 1. Threatened and Endangered Species at Opal Creek....5

Table 2. Ecological Receptors of Concern and Exposures....9

Table 3. Environmental Concentrations....11

Table 4. Assessment Endpoints and Measures of Effect and Exposure....12

Table 5. Initial Screening of COIs....14

LIST OF FIGURES

Figure 1. Plant Association Group at Ruth Mine Site....4

Figure 2. Conceptual Ecological Exposure Model for Ruth Mine Site....7

1. INTRODUCTION

A screening-level ecological risk assessment was performed for the Ruth Mine Site, Opal Creek Scenic Recreation Area, Marion County, Oregon. The ecological risk assessment analyzes the potential for adverse effects to local ecological receptors and communities that may be exposed to chemicals at the mine site. The assessment follows Oregon Department of Environmental Quality (ODEQ) guidance on performing a Level II ecological risk assessment (ODEQ 2001). The risk assessment is also consistent with USEPA guidance (1998) on performing screening level risk assessments, and follows the general report format in USEPA guidance while presenting the information requested in ODEQ guidance for Level II ecological risk assessment.

The components of this assessment consist of the following:

- Description of the ecological elements and habitats of the site.
- Identification of site-specific ecological receptors, potential exposure pathways, and chemicals of interest (COIs).
- Identification of assessment and measurement endpoints for the ecological receptors, and risk-based screening criteria consistent with those endpoints.
- Selection of chemicals of potential ecological concern (CPECs) based on screening against risk-based ecological criteria.
- Description of potential links between the CPECs and ecological receptors at the site.
- Evaluation of the potential for site-related ecological risk.

The assessment is considered screening-level because it relies on readily available information for exposure assessment, toxicology of metals, and screening against risk-based criteria. All potential exposures are based on metals data from samples collected of waste rock soils, background soils, surface water in mine adits, and surface water and sediments in Battle Ax Creek and a tributary at the mine site. The site was visited in November 2005 during the collection of sample data. Description of the site ecology is based on pubalically available information and on the site visit.

2. PROBLEM FORMULATION

The Problem Formulation step presents a description of the site and the ecological habitats, ecological receptors, and contamination. This information is used to construct a conceptual ecological exposure model, which describes the potential exposures of ecological receptors to contaminants of interest (COIs) at the site.

2.1 Ecological Setting

Information on regional and site-specific ecology is summarized to provide an understanding of the environment and the wildlife, fish, plants, invertebrates, and birds that may be exposed at the site. In general, an ecological risk assessment assumes that local species are resident on the site or use the site in sufficient abundance such that exposure to site contaminants could potentially affect the species population. Species populations and communities of populations are the critical ecological components that are evaluated for risks, with the understanding that impacts to individual organisms do not necessarily indicate that populations are at risk.

2.1.1 Geology

The Ruth Mine site is located in the Western Cascades in central Oregon. The mine site is located in the Battle Ax Creek drainage, which flows west to join with Opal Creek to form the Little North Santiam River, which continues west to the Willamette River valley. Most of the valleys in the higher elevations, including the Battle Ax Creek/Opal Creek valleys, were formed during the last glacial period 15,000 years ago.

The Western Cascades range is composed almost entirely of volcanic rocks, the remnant of a volcanic range that shifted east to form the High Cascades, which forms the present active Cascade volcanic range. The Western Cascades range is a low elevation eroded volcanic range that runs north-south, parallel to the Pacific coast. The Western Cascades receive 60 to 100 inches of precipitation annually which causes deep weathering of geologic features.

Gold and silver deposits have been found to exist in a 25-30 mile wide, north-south belt in the Western Cascades (Orr et al. 1992). Deposits of lead, zinc, and copper in the forms of pyrite, galena, sphalerite, and chalcopyrite, in addition to gold and silver, are found in this region. These ores are found in either veins or porphyry

deposits formed when fractured areas of volcanic rock were invaded by mineral rich hydrothermal solutions at temperatures of 250 to 350 degrees F.

Weathering processes have deeply eroded the Western Cascades exposing the ore-bearing rocks near the valley floors. The North Santiam mining district, which includes the Ruth Mine site, contains the most rugged terrain of all the five mining districts of the Cascades. In the early 1900's, the Ruth Mine was the largest producer in the North Santiam district. Most of the Ruth Mine ore produced lead and zinc, although small amounts of gold and silver were also recovered.

2.1.2 Habitat

A thorough study of the site ecology is not available. Information on the ecological setting is taken from available sources and observations during the 2005 sampling event.

The mine site is located in an old growth hemlock-dominated montane habitat transitioning into a higher elevation Pacific Silver Fir-dominated habitat (Figure 1). Typical vegetation in the western hemlock habitat (NPS 1998) consists of western hemlock (*Tsuga heterophylla*), with a mix of Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and Pacific yew (*Taxus brevifolius*). Undergrowth is characterized by salal, Oregon grape, and shade-tolerant hemlock and red cedar saplings. Open spaces are characterized by red alder (*Alnus rubra*), bigleaf maple (*Acer macrophylum*), and vine maple (*Acer circinatum*). Small mammals in the hemlock-dominant forest typically include Douglas squirrel (*Tamiasciurus douglasii*) and red tree voles (*Phenacomys longicaudus*).

The Opal Creek Ancient Forest Center maintains a list of plant, fish, amphibian, mammal, and invertebrate species in the area (http://www.opalcreek.org/eco/all-list.html). Threatened and endangered species in the North Cascades are identified by the Oregon Natural Heritage Center (2004). Threatened and endangered species that may be present in the habitat of the Opal Creek area are presented in Table 1.

Figure 1. Plant Association Group at Ruth Mine Site

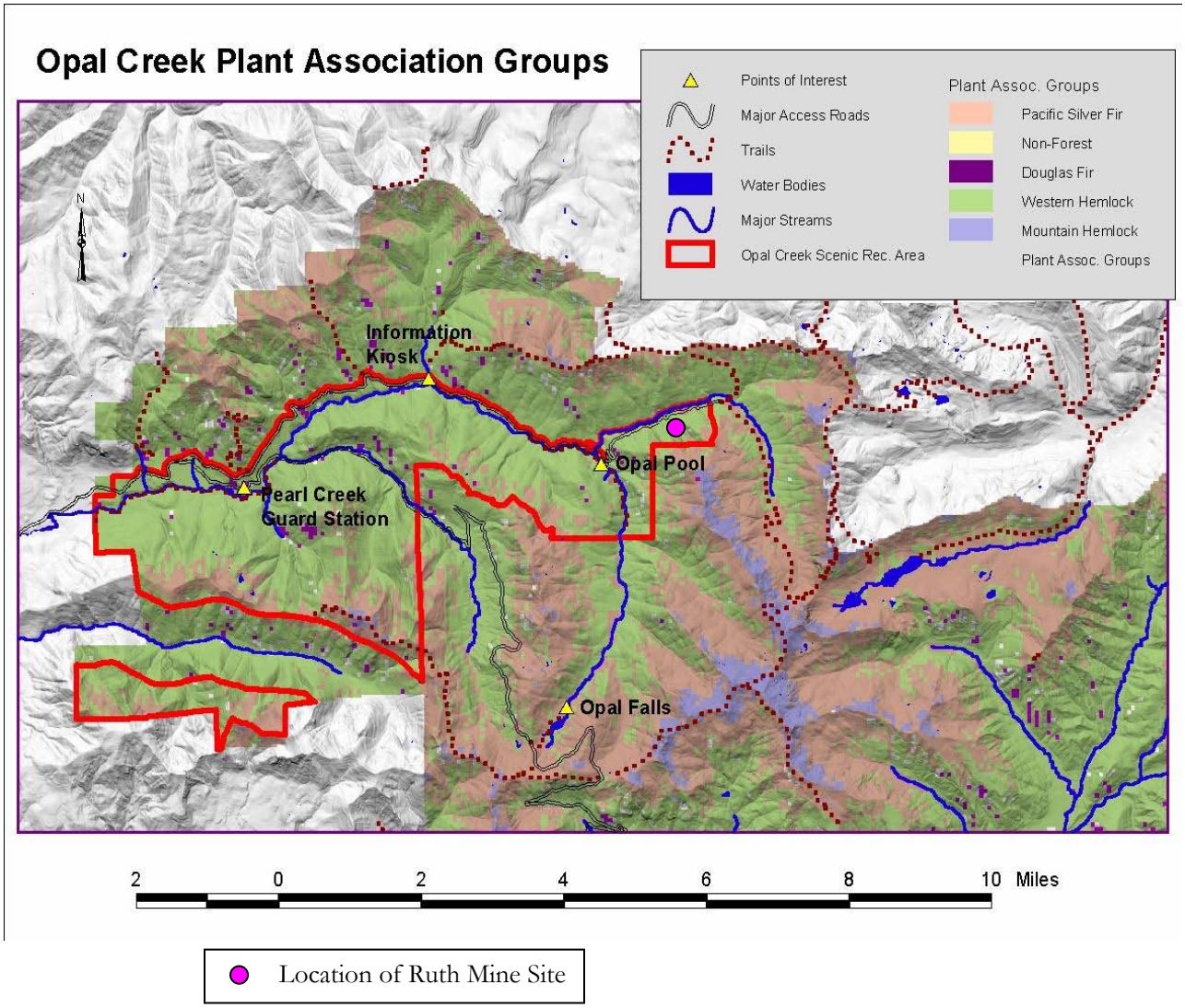


Table 1. Threatened and Endangered Species at Opal Creek

AMPHIBIANS			
Common Name	**Scientific Name**	**Federal Status**	**OR State Status**
Salamander, Cascade torrent	Rhyacotriton cascadae		Sensitive
Salamander, Clouded	Aneides ferreus		Sensitive
Salamander, Oregon slender	Batrachoseps wrighti		Sensitive
Frog, Tailed	Ascaphus truei	Species of Concern	Sensitive
Frog, Cascades	Rana cascadae	Species of Concern	Sensitive
Toad, Western	Bufo boreas		Sensitive
BIRDS			
Common Name	**Scientific Name**	**Federal Status**	**OR State Status**
Goshawk, Northern	Accipiter gentilis	Species of Concern	Sensitive
Woodpecker, Black-backed	Picoides arcticus		Sensitive
Nighthawk, Common	Chordeiles minor		Sensitive
Duck, Harlequin	Histrionicus histrionicus	Species of Concern	Sensitive
Quail, Mountain	Oreortyx pictus		Sensitive
Owl, Northern pygmy	Glaucidium gnoma		Sensitive
Owl, Northern spotted	Strix occidentalis caurina	Threatened	Threatened
Woodpecker, Pileated	Dryocopus pileatus		Sensitive
Bluebird, Western	Sialia mexicana		Sensitive
MAMMALS			
Common Name	**Scientific Name**	**Federal Status**	**OR State Status**
Marten, American	Martes americana		Sensitive
Long-eared Bat	Myotis evotis	Species of Concern	Sensitive
Lynx, North American	Lynx canadensis	Threatened	
Wolf, Gray	Canis lupus	Endangered	Endangered
Wolverine	Gulo gulo	Species of Concern	Threatened
FISH			
Common Name	**Scientific Name**	**Federal Status**	**OR State Status**
Salmon, Chinook	Oncorhynchus tshawytscha	Endangered & Threatened	Threatened
Salmon, Steelhead	Oncorhynchus mykiss	Endangered & Threatened	
Trout, Westslope cutthroat	Oncorhynchus clarki lewisi	Species of Concern	
PLANTS			
No plants on the Opal Creek list were found on the Federal or Oregon T&E list			

Lists of species observed at Opal Creek Ancient Forest Center were matched with the federal and Oregon T&E lists.

Sources:

Threatened and Endangered Species List: http://www.pacificbio.org/ESIN/Infopages/Oregonlist.html

Species List for Opal Creek: http://www.opalcreek.org/eco/all-list.html

2.2 Contaminants of Interest (COI)

Chemicals that may adversely affect ecological receptors, including populations of individual organisms and communities, are defined as chemical stressors on the environment. Stressors may also be biological, such as pathogens, or physical. Physical stressors at the mine site include alterations in the habitat such as mine and road construction, waste rock accumulation, removal of canopy cover, stream diversions and bed alterations, and physical blockages to fish movement. Physical barriers to fish movement are present in the Upper North Santiam River, and may impact fish populations in Battle Ax Creek. This risk assessment does not evaluate risk of impacts to ecological receptors due to biological or physical stressors.

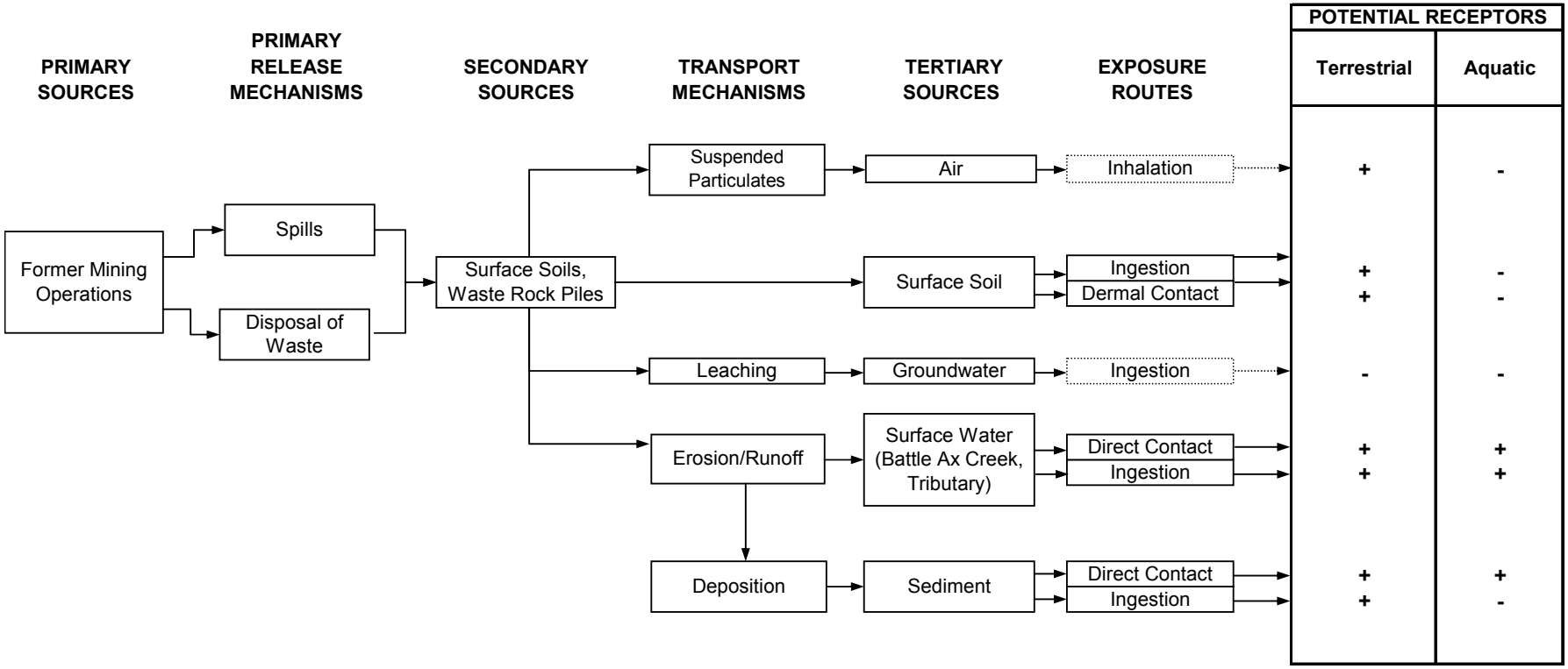
The COIs are identified as those metals that were analyzed and detected in environmental media at the site:

- Arsenic
- Barium
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Manganese
- Nickel
- Selenium
- Silver
- Zinc.

2.3 Conceptual Ecological Exposure Model

The conceptual ecological exposure model (CEEM) depicts the sources of contamination, contaminant release and possible transport mechanisms, impacted exposure media, and exposure routes for ecological receptors at the site. A graphical presentation of the CEEM is presented in Figure 2.

Figure 2. Conceptual Ecological Exposure Model for Ruth Mine Site



Notes:

- **+** Complete and potentially significant exposure
- **-** Insignificant or incomplete exposure pathway or medium

2.3.1 Sources of Contamination

The primary sources of contamination at the site are historical mining activities related to operations of the Ruth Mine. Ore was brought up from mines, with adits 4 and 5 located near the access roads and serving as the primary sources of ore wastes, processed to some extent at the site, and waste rock was deposited near the adits. Waste rock from adit 5 has been used as road bed material in the lower access road that was originally the rail line along Battle Ax Creek to Jawbone Flats.

Waste rock from mine activities at adit 4 was either directly deposited on or washed into the tributary that runs past the adits to Battle Ax Creek. Deposits in the tributary may have contributed sedimentary material that washed into Battle Ax Creek. Tributary water may have leached metals from the waste rock into surface water of the tributary and transported dissolved metals to Battle Ax Creek. Over time, rain and snow melt may have transported dissolved metals or waste rock particles, particulary from the area around adit 5, directly to Battle Ax Creek. Once in the creeks, contaminated sedimentary particles may deposit or transport downstream. Dissolved metals in the surface water may bind to particulates and deposit in the creek or transport downstream.

2.3.2 Ecological Receptors and Exposure Pathways

Based on the habitat types at the Ruth Mine site, expected wildlife in that habitat, and the species of wildlife that have been observed at the Opal Creek Ancient Forest Center, ecological receptors of potential concern and their possible site-related exposures are identified in Table 2.

Table 2. Ecological Receptors of Concern and Exposures

Ecological Receptor of Concern	Exposure Media and Pathway
Small mammals	Direct exposure to COIs in waste rock soils, surface water, sediments
	Ingestion of COIs in surface water
	Ingestion of COIs in waste rock soil is considered unlikely since the locations are primarily on existing access road bed or in piles of hard rock and not suitable habitat for small mammals nesting or burrowing.
Terrestrial forbs and grasses	Direct contact and root uptake of waste rock COIs is considered a marginal possibility since most of the waste rock is located on existing access road bed or in piles of hard rock and not suitable habitat for most plants.
Terrestrial trees and shrubs	Root uptake of COIs in waste rock soil may be considered an exposure pathway for trees located near the road bed.
Terrestrial invertebrates	Direct exposure to waste rock soil is considered not of ecological significance since the road bed and hard rock piles are not ideal habitat for soil invertebrates.
Wildlife (birds, mammals)	Birds and mammals may be exposed to COIs in waste rock soil through direct contact, and to COIs in surface water through ingestion. However, because of the extensive habitat in the surrounding landscape for birds and large mammals, the relatively limited amount of site soil habitat that is impacted by waste rock is considered to contribute negligible exposures to wildlife.
	Birds and large mammals may be exposed to bioaccumulative COIs through the ingestion of contaminated food sources, such as plants, invertebrates, or small mammals at the site.
Amphibians	Direct contact with COIs in surface water is considered a likely exposure pathway for Battle Ax Creek. Most of the tributary is not considered suitable aquatic habitat due to the steep gradient, high flow rate, intermittent flows, and apparent lack of organic material in much of the sediment that would provide substrate for adequate food sources.
Fish	Fish may be exposed to COIs in surface water and sediment of Battle Ax Creek. Fish barriers are present that prevent fish migration; rainbow trout may be present. The tributary is not considered suitable habitat for fish due to the steep gradient, high flow rate, and intermittent flows.
Aquatic invertebrates (benthic and water column)	Aquatic invertebrates may be exposed to COIs in surface water and sediment of Battle Ax Creek. Most of the tributary is not considered suitable aquatic habitat due to the steep gradient, high flow rate, intermittent flows, and apparent lack of organic material in much of the sediment.

2.4 Environmental Concentrations

Environmental concentrations (ECs) are those concentrations of chemicals in environmental media to which ecological receptors may be exposed. For the Ruth Mine site, data on concentrations of COIs are available for waste rock soils and background soils, and surface waters and sediments of local creeks. Analytical chemical data to develop ECs for the site were collected during the November 2005 site visit. For each environmental medium, ECs are developed as the upper 90 percent confidence limit (90UCL) on the mean concentration, following ODEQ (2001) guidance. The 90UCL concentrations are used to quantify exposures with the assumption that they best represent an upper bound of concentrations of COIs that an ecological receptor would contact.

The USEPA ProUCL program was used for statistical analyses and to develop the 90UCL values (USEPA 2004). For each COI, the distribution characteristics of the sampling data were first determined. Sampling data consisted of concentrations in soils (mg/kg waste rock soil), surface waters (mg/L), and sediments (mg/kg whole sediment). Statistical analyses for soil and sediment were performed on the original dry weight data. The Shapiro-Wilk test was used to test for normal distributions, consistent with Gilbert (1987), and the Anderson-Darling and Kolmogorov-Smirnov test statistics were used to test for gamma distribution. Based on these tests, each COI was assigned a normal distribution, a log-normal distribution, a gamma distribution, or a non-parametric distribution. The type of distribution was found to vary for different COIs within the same media and across media types. Descriptive statistics for each COI were compiled using the distributions of the data that were assigned by the ProUCL software.

ECs are developed for each COI in each of the environmental media that receptors may contact.

- *Waste Rock Soils* – The EC is based on the 10 waste rock soil samples. Terrestrial plants, invertebrates, birds, and mammals are assumed to be exposed only to waste rock soils for the duration of their soil exposures at the site. Exposures to background soils are not included.
- *Surface Water* – Aquatic organisms, birds, and mammals are assumed to be exposed to all surface waters that were sampled at the site. Surface waters consist of two samples of adit water from Adits 4 and 5, three samples from the tributary that runs past the adits, and four samples from Battle Ax Creek. The EC does not include samples from Battle Ax Creek at the Blue Jay Creek confluence, upstream of Blue Jay Creek, or Blue Jay Creek

itself. It was assumed that receptors could have equal access to all environmental media at the site; e.g., exposures could occur to waters in Battle Ax Creek and the tributary with equal accessibility.

- *Sediments* – Benthic invertebrates and wildlife are assumed to be exposed to sediment in the same surface waters as for the surface water exposures.

Table 3 summarizes the ECs for the COIs at the Ruth Mine site.

Table 3. Environmental Concentrations

Chemical of Interest (COI)	Waste Rock Soil 90 UCL Concentration (mg/kg)	Surface Water 90 UCL Concentration (mg/L)	Sediment 90 UCL Concentration (mg/kg)
Arsenic	26.7	0.0	7.4
Barium	28.7	0.005	50.9
Cadmium	200	0.011	1.2
Chromium	28.1	0.0	13.8
Copper	3842	0.008	206
Iron	58174	0.044	19401
Lead	13829	0.014	348
Manganese	10278	0.019	2546
Mercury	0.88	0.0	0.0
Nickel	29.0	0.0	26.0
Selenium	7.3	0.0	0.0
Silver	7.8	0.0	0.5
Zinc	46307	1.2	659

90% UCL = 90% upper confidence limit on the mean concentration

3. Assessment Endpoints and Measures of Effect

Assessment endpoints are defined as the explicit expression of an ecological value deemed important to protect, operationally defined by a receptor and one or more of that receptor's measurable attributes (ODEQ 2001). Assessment endpoints link the ecological risk assessment and risk management by highlighting ecological processes that are important to risk managers. Unless an ecological receptor is listed as a Threatened and Endangered (T&E) species, assessment endpoints are selected that are relevant to population-level rather than individual effects. For T&E species, risks to individuals are important to the evaluation.

Assessment endpoints are listed for each receptor of concern in Table 4, along with measures of effects and exposures used in the risk assessment. Survival, growth, and reproduction are the key endpoints for ecological receptors in this assessment.

Measures of effect and exposure for the screening level II ecological risk assessment under ODEQ (2001) guidelines consist of comparison of the ECs in various environmental media with the appropriate screening level value (SLV). The SLVs are intended to be protective of the key assessment endpoints. For chemicals for which SLVs are unaviable, surrogate risk-based screening criteria were identified. Ecological receptors, the assessment endpoints, and the environmental media and appropriate SLV types are identified in Table 4.

Table 4. Assessment Endpoints and Measures of Effect and Exposure

Ecological Receptor of Concern	Assessment Endpoint	Measures of Effect and Exposure
Small mammals	Survival, growth, reproduction	Comparison of waste rock soil ECs to soil screening criteria for mammals[a]
Terrestrial forbs and grasses	Survival, growth, development	Comparison of waste rock soil ECs to soil screening criteria for plants
Terrestrial trees and shrubs	Survival, growth, development	Comparison of waste rock soil ECs to soil screening criteria for plants
Terrestrial invertebrates	Survival, growth, reproduction	Comparison of waste rock soil ECs to soil screening criteria for invertebrates
Wildlife (birds, large mammals)	Survival, growth, reproduction	Comparison of waste rock soil ECs to soil screening criteria for birds and mammals Comparison of surface water ECs to surface water screening criteria for birds and mammals Comparison of sediment ECs to sediment screening criteria for bioaccumulation in wildlife
Amphibians	Survival, growth, reproduction	Comparison of surface water ECs to surface water screening criteria for aquatic organisms
Fish	Survival, growth, reproduction	Comparison of surface water ECs to surface water screening criteria for aquatic organisms
Aquatic invertebrates (benthic and water column)	Survival, growth, reproduction	Comparison of surface water ECs to surface water screening criteria for aquatic organisms Comparison of sediment ECs to sediment screening criteria for benthic organisms

a. Screening criteria are the SLVs provided by ODEQ (2001) or surrogate risk-based criteria.

4. Identification of Contaminants of Potential Ecological Concern

Contaminants of potential ecological concern (CPECs) are identified by screening of COIs on the basis of physiochemical properties and their toxicity and bioaccumulation potential (ODEQ 2001). The screening based on physiochemical properties of a COI is performed by consideration of frequency of detection and background concentrations. Screening does not include whether the COI is an essential nutrient.

4.1 Initial Screening

4.1.1 Frequency of Detection

COIs in each environmental medium were first screened on the basis of frequency of detection. If COIs were not detected above a frequency of five percent, they can be eliminated as a CPEC (ODEQ 2001). Results of the frequency screen are shown in Table 5. No COIs were screened from waste rock soils on the basis of frequency. In surface water, arsenic, chromium, mercury, nickel, selenium, and silver were not detected in any of the nine samples, which included the adit water of two mine shafts, tributary water, and surface water of Battle Ax Creek. In sediment, mercury and selenium were never detected in the six samples, which included tributary and Battle Ax Creek samples. For these COIs, ECs are shown as 0.0 in the screening tables.

4.1.2 Background Concentration Screening

COIs in site soils were screened against background soil concentrations, with results presented in Table 5. Background concentrations are set at the 95UCL of the mean concentration of background samples, and the maximum concentration in site soil is compared to this background value (ODEQ 2001). For the Ruth Mine site, 10 samples of soils in locations identified as unaffected by mining-related activities were collected as background. A set of background samples was not collected for surface water or sediment. Instead, samples were collected in Battle Ax Creek upstream of the confluence with the tributary, and upstream of the confluence of Blue Jay Creek, to represent surface waters not impacted by the mine site. Because of the limited number of these samples and the potential for impacts from other mining activities outside of the Ruth Mine site, they were not used to determine background concentrations. For background soils, one-half the detection limit was used for samples with non-detected values, which included cadmium, selenium, mercury, and silver. Only barium in waste rock soils did not exceed the soil background level.

Table 5. Initial Screening of COIs

Chemical of Interest (COI)	Frequency of Detection			Waste Rock Comparison to Soils Background		
	Soil	Surface Water[a]	Sediment[a]	Background (95UCL mg/kg)	Maximum Waste Rock (mg/kg)	Exceeds Background?
Arsenic	10/10	**0/9**	6/6	21.3	46.2	**Yes**
Barium	10/10	2/9[b]	6/6	77.2	56.6	No
Cadmium	10/10	2/9[b]	4/6	55.4	422	**Yes**
Chromium	10/10	**0/9**	6/6	25.5	37.6	**Yes**
Copper	10/10	2/9[b]	6/6	607	7600	**Yes**
Iron	10/10	5/9	6/6	28206	77000	**Yes**
Lead	10/10	5/9	6/6	4302	34000	**Yes**
Manganese	10/10	3/9	6/6	5658	15900	**Yes**
Mercury	9/10	**0/9**	**0/6**	0.1	1.87	**Yes**
Nickel	10/10	**0/9**	6/6	27.5	40.6	**Yes**
Selenium	9/10	**0/9**	**0/6**	2.2	16.5	**Yes**
Silver	9/10	**0/9**	1/6	5.6	10	**Yes**
Zinc	10/10	8/9	6/6	14461	98900	**Yes**

a = Bold values indicate that COIs were not detected in any samples; no EC was calculated for that medium

b = Detected in adit water only

4.2 Risk-Based Screening

Ecological risk-based screening consists of a comparison of ECs with risk-based screening criteria. ECs are identified for each COI in the previous section. Screening criteria are defined by ODEQ (2001) as the SLVs for each environmental medium at the site. The comparison of the ECs with the SLVs comprises a screening based on chemistry and toxicity. The result of the screening is a list of CPECs for each medium at the site that have the potential to pose risks to ecological receptors. The screening accounts for exposure to individual COIs, exposures to multiple COIs within a given media, and exposure to individual or multiple COIs within different media. The SLVs that are used in the comparison are considered applicable to the types of ecological receptors that may be present at the site.

4.2.1 Risk-Based Screening Criteria

Screening criteria are provided by ODEQ (2001) as SLVs for soils, surface water, and sediment. For those COIs for which SLVs are not available, surrogate risk-based screening criteria and their sources would be used. SLVs are available for exposures of terrestrial plants, invertebrates, birds, and mammals to soils; aquatic organisms,

birds, and mammals to surface waters; and benthic invertebrates to sediments and wildlife that may bioaccumulate COIs from sediments. SLVs are not available from ODEQ for a few COIs, specifically iron and silver for both birds and mammals exposed to either soil or surface water, and exposure of invertebrates to barium and iron in sediment. For those COIs, various sources of criteria were searched in order to identify surrogate values for the missing SLVs. Sources included soil and water screening benchmarks for wildlife developed by USEPA (2000, 2003) and Oak Ridge National Laboratory (Efroymson et al., 1997; Suter and Tsao, 1996; Jones et al., 1997; Sample et al., 1996), and NOAA and Washington Department of Ecology benchmarks for freshwater sediment (MacDonald et al., 2000; Ecology 2003). Surrogate screening values were not available from any of these sources for those COIs for which ODEQ SLVs are unavailable.

4.2.2 Exposure Concentrations

ECs are identified in Table 3 as the 90 UCL of concentrations of COIs in on-site environmental media. ECs were calculated for a variety of data distributions of the COIs. One-half the detection limits were used for all non-detected values where there was a mix of detects and non-detects. For environmental media with all non-detects of a COI, a value of 0.0 is listed in the screening tables for that COI. COIs that were not detected in a given medium are identified in Section 4.1.1. Environmental media consist of waste rock soils at the site; surface waters from adits, the tributary, and from Battle Ax Creek; and sediment from the tributary and Battle Ax Creek.

4.2.3 Screening Procedure

The screening procedure consists of the comparison of the ECs for each COI in each environmental medium with their respective SLVs or surrogate criteria for that medium. Results of each step of the screening calculations are displayed in the attached tables.

For each COI *i* in each medium *j*, a chemical-specific risk ratio is calculated (T_{ij}) as the ratio of the EC to the SLV or surrogate criterion, as per the following equation:

$$T_{ij} = \frac{C_{ij}}{SLV_{ij}}$$

where:

T_{ij}	=	Risk ratio
C_{ij}	=	90UCL in given medium

SLV = Screening level value or risk-based criterion.

The individual risk ratio T_{ij} is compared with the receptor designator *Q*, which is defined as Q=1 for listed threatened and endangered species, and Q=5 for non-T&E species. The following relationships select the COI as a CPEC:

- If the individual risk ratio T_{ij} is greater than 5, the COI is selected as a CPEC
- If T&E species are present and T_{ij} is greater than 1, the COI is selected as a CPEC
- For benthic invertebrates, if T_{ij} is greater than 1, the COI is selected as a CPEC.

Thus, for a given medium, a risk ratio greater than 5 indicates a potential for ecological risk to that non-T&E receptor type; whereas a risk ratio greater than 1 indicates a potential for ecological risk to the T&E receptor type. Those COIs for which ecological risks are indicated become the CPECs for that medium at the site. The predicted risks for those CPECs are discussed further in the risk characterization section.

Overall risk (T_j) for each medium *j* was calculated as the sum of the individual chemical risk ratio T_{ij} values. To account for the cumulative risk from multiple COIs in a medium, ODEQ (2001) provides the following equation, whereby if this relationship holds true, the COI is identified as a CPEC:

$$T_{ij} / T_j \geq \frac{1}{N_{ij}} xQ$$

where:

T_{ij}	=	Risk ratio for the individual chemical *i* in medium *j*
T_j	=	Sum of risk ratios for medium *j*
N_{ij}	=	Total number of COIs for medium *j*
Q	=	Value of 1 for T&E species, value of 5 for non-T&E species.

To account for COIs detected in multiple media, those detected COIs are selected as CPECs if the sum of the T_{ij} values is greater than Q. To account for potential bioaccumulation through aquatic food chains, ODEQ (2001) provides bioaccumulative SLVs for comparison with sediment concentrations.

4.2.4 Screening Results

Surface Soil – The waste rock soil screen and resultant CPECs are shown in Table A-1. Most of the COIs detected in waste rock soils were elevated above background and exceeded one or more of the soil SLVs: cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, and zinc. Of the COIs detected above background soil levels, arsenic, nickel, and silver were not selected as CPECs based on the screen. Risks were predicted to terrestrial plants for cadmium, chromium, copper, iron, lead, manganese, selenium, and zinc; to invertebrates for cadmium, chromium, copper, iron, lead, manganese, mercury, and zinc; to birds for cadmium, chromium, copper, lead, and zinc; and to mammals for cadmium, copper, lead, and zinc.

Surface Water - The surface water screen and resultant CPECs are shown in Table A-2. Three COIs that were detected in surface water were selected as CPECs: cadmium, lead, and zinc. Silver is also selected as a CPEC for surface water because all values were non-detects that exceeded the SLV for surface water. Risks were predicted to aquatic organisms for lead and zinc; to birds for zinc; and to mammals for cadmium and zinc.

Sediment - The sediment screen and resultant CPECs are shown in Table A-3. Many COIs were detected in sediment and selected as CPECs: arsenic, cadmium, copper, lead, manganese, nickel, and zinc. Risks were predicted to sediment benthos for arsenic, cadmium, copper, lead, manganese, nickel, and zinc; and to wildlife via bioaccumulation for arsenic, cadmium, copper, lead, and zinc.

Overall, many of the detected metals in waste rock soils were selected as CPECs, mostly with potential risks to plants, invertebrates, and birds, with iron, lead, and zinc showing the highest exceedances of SLVs. In surface waters, highest risks were identified for lead and zinc for aquatic receptors. In sediment, highest risks were identified for cadmium and zinc for potential bioaccumulation into wildlife.

5. RISK CHARACTERIZATION

Risk characterization is the step that describes the screening risk results that were calculated in the previous section, and includes an uncertainty analysis. The predicted risks are described in context of the exposure media, the receptor types present at the site, and the conservativeness of the risk screening procedure, and gives a general idea of the likelihood of actual risk. The uncertainty analysis discusses uncertainties in parameter values and assumptions associated with the

screening process, and their impact on whether risks may be over-estimated or under-estimated.

5.1 Risk Description

5.1.1 Waste Rock Soil

Numerous metals are identified as CPECs for risks to plants, invertebrates, and birds that may be exposed to waste rock soil at the site. All of the metals in waste rock soil except barium exceeded the background levels, as determined from 10 soil samples that were located in areas removed from impacts of activities at the mine site or other known local anthropogenic influences. Almost all of the 90 UCL concentrations of metals in the background soils, except barium and nickel, also exceeded one of the four soil screening criteria. The exceedance of soil screening criteria by background concentrations suggests that the levels of metals in the soils of the site are naturally enriched. Also, this comparison suggests that the screening criteria are based on levels that are lower than the natural levels in the soils of the local environment where the Ruth Mine is located. The ranges of background concentrations for most metals were very wide, and particularly for lead and zinc, they spanned two to three orders of magnitude.

The high concentrations of metals in background soils relative to screening criteria and the wide range of values may reflect discrete locations of highly mineralized soils in the area. This characteristic may be considered typical of the enriched veins of metals found in the Western Cascade mining districts. The highest elevated concentrations and consequent risk ratios are consistently associated with lead and zinc, which were the primary metals mined at the site. How much of a risk the elevated metals in the waste rock soils pose to receptors that may also be exposed to naturally high levels of background metals is unknown. Nonetheless, the waste rock soil metals concentrations are substantially higher than the background soils, up to 8-times higher for lead based on maximum concentrations, and are identified as posing risks associated with those high levels.

The locations of the waste rock soil samples were selected to characterize the areas of the site where waste rock was believed to either occur or to have been used. Six of the 10 waste rock samples were taken from around the access road bed that runs along Battle Ax Creek from adit 5 downstream towards Jawbone Flats. Sample locations include the ore cart track ballast (Station WRS-2), the waste pile on the downslope side of the road near the old pipes (Station WRS-3), the center of the road bed (Station WRS-4), and the road bed/waste pile further away from the adit (Station

WRS-5). The types of receptors that would be of concern for contacting soils in these locations are primarily mammals or insects that might traverse the area on occasion. Small mammals would not be expected to spend much time on the road bed due to lack of food resources or suitable burrowing material. Similarly, the presence of substantial rock and the occasional use of the road bed for hiking or vehicles would likely minimize the quality of habitat for plants or invertebrates, including their use as food sources.

The waste rock pile at adit 4 from which four of the 10 samples were taken does not present high quality habitat for plants or invertebrates due to the presence of hard surface and minimal organic material. Small mammals may use the rock piles as habitat and could be at risk from exposure at the piles; however the bioavailability of the waste rock metals to small mammals is uncertain, and the extent of the exposure would be limited to the area of the pile.

The highest concentrations of lead in waste rock samples were found at stations WRS-3 (the waste pile on the downslope side of the access road near the old pipes), WRS-4 (center of the road bed), and WRS-5 (road bed/waste pile further away from the adit). These samples are located in the approximate middle area of the access road, on the downslope side of the road, and also had the highest concentrations of iron and zinc if station WRS-2 (ore cart track ballast) is included. These three metals present the highest risk ratios of all the soil samples. The remaining samples of waste rock soil have concentrations of iron, lead, and zinc that are not much different from the range of background soil concentrations (see Table B-1 in Appendix B). Comparison of the data from these three locations with data from the remaining sample locations and with background soils data suggest that the majority of risks from soils may be localized to the central area of the road bed. Given the poor quality habitat of the road bed for plants and small mammals and their food sources, the actual risks from waste rock soil metals may be limited.

5.1.2 Surface Water

Surface water was found to pose risks from only a limited number of chemicals. Exceedances of SLVs for surface water were found for cadmium, lead, and zinc for aquatic organisms. The surface water screening included data from the adit water, since wildlife could be exposed to those waters. The cadmium and zinc exceedances were only found with adit waters, and not for exposures of birds or mammals. Surface water exceedances of SLV from non-adit water are found only for lead. Of the three samples with high lead, two of those were taken from the tributary downstream from adit 4. These two samples (stations SW-4 and SW-5) have elevated

lead concentrations compared with the sample taken in the tributary upstream of adit 4 (station SW-3 in Table B-2), suggesting that the adit is contributing to the dissolved lead in the tributary surface water. The elevation of the tributary lead concentration above the SLV is less than 2-fold. The tributary does not present suitable habitat for year round resident aquatic receptors, since it flows over a hard rock substrate and is dry part of the year. The tributary could present exposures to birds and mammals during times of the year with flow, but risk ratios for those receptor types were not elevated.

A single station in Battle Ax Creek presented an elevated risk ratio for lead (SW-1 in Table B-2), collected downstream of the adit 5 drainage. The exceedance of the aquatic organism criterion at that station suggests that aquatic receptors could be at risk from lead exposure. How frequently the concentration of lead in Battle Ax Creek surface water is elevated and whether it may present a chronic risk to aquatic organisms is unknown since only a single sampling event was performed. The finding that the surface water sample SW-2 taken just 100 feet or so upstream of SW-1 did not detect the presence of lead (see Table B-2), at a detection limit below the aquatic criterion, suggests that lead elevations in surface water may not be ubiquitous in that segment of Battle Ax Creek.

5.1.3 Sediment

Cadmium and zinc showed the highest exceedances of sediment SLVs. Because sediment benthos would generally be exposed to localized concentrations of CPECs, they are also evaluated on a single station basis. Exceedances of sediment SLVs were greatest at Stations SED-3, SED-4, and SED-5, all located in the tributary that runs past adit 4 (see Table B-3). Station SED-3 is upgradient of the adit, whereas the other two are downgradient of the adit. The highest exceedances among these three sediment stations were 8 to 9-fold greater than the SLV for lead and zinc, though there were no readily observable differences in the concentrations of those two metals among the three stations. The greatest sediment SLV exceedances in the tributary were for wildlife bioaccumulation, such that the sediment could pose risks to organisms if they used it for food sources. However, the habitat of the tributary is of poor quality as a food source because of the lack of sufficient sedimentary material over the hard rock substrate, and the intermittent lack of flow during dry seasons.

The sediment stations in Battle Ax Creek showed exceedances of the SLV for several metals, but in contrast to the tributary sediment, they were all less than 2-fold above the SLV. The likelihood that this exceedance of sediment SLVs would adversely affect benthic receptors is unknown given the apparently naturally enriched metals

concentrations in local soils, which would serve as a major contributing source to the general sediment load in Battle Ax Creek.

5.2 Uncertainty Analysis

This section discusses some of the uncertainties in the screening risk assessment described above. Some uncertainties are specific to the site conditions and some are inherent to the risk assessment process. An analysis of uncertainties provides the risk managers with information on the limitations and interpretation of the risk estimates and potential exposures for use in future decision making.

5.2.1 Sampling and Analysis

The sampling approach for the mine site was focused in design, with samples of waste rock soils and surface waters located in areas of suspected contamination. The data used to characterize ECs are not considered representative of average exposures to ecological receptors or wildlife that may reside or forage at the site. Only samples from the waste rock soils were used for the soil exposure pathways; data on lower contaminated background soils in the area were not used. For wildlife such as birds and large mammals, average exposures would typically result from varied movement throughout the site, with a mix of exposures to both contaminated and uncontaminated soils and waters.

Focusing on samples with high contamination, such as soils that consist primarily of waste rock, results in exposure concentrations and subsequent risk ratios to be overestimated compared to actual exposures encountered by random movement across the area.

5.2.2 Exposure Concentrations

Estimates of exposure to metals at the mine site were based on a limited number of samples to represent the various exposure media. For the waste rock soils, 10 samples were used; for surface water and sediment only nine and six samples were available, respectively. A low number of samples typically results in highly skewed data sets and high upper confidence limits on the mean values, frequently close to the maximum concentration. With the use of gamma distribution statistics, a 90UCL was calculatable for all samples regardless of the low number or the skewness of the data. Combining different types of sources into a single EC may also over-estimate overall risks. For example, combining surface water data from the tributary that may not present suitable habitat for aquatic organisms, with data from Battle Ax Creek

that does present suitable habitat leads to imprecision in the risk ratios for aquatic organisms. Evaluation of the specific locations where exceedances of SLVs were observed helps to place these exceedances in perspective with actual habitats and receptor types that may be exposed.

The screening criteria for bioaccumulative compounds and for wildlife are based on the assumption that a certain amount of chemical in the soil, water, or sediment will be transferred to relevant food sources at the site. The criteria do not take into account the differences between the conditions under which the tests and criteria were developed and conditions of the site. Refinements in the EC term of the risk ratio can be developed through the collection of data on chemical levels in food resources for higher trophic organisms and performance of a food web-based risk assessment.

5.2.3 Toxicology

The screening criteria are derived from a mix of sources identified in ODEQ (2001). The various sources present a variety of criteria that have not all been developed following the same methodology. Many of the criteria are based on observed no-effect-levels in laboratory studie on organisms and do not present levels where low frequency of effects might occur. Low frequency of effects on reproduction and survival of organisms in a test system may be adequately protective of populations and communities of the organisms. The screening criteria are considered to be substantially conservative for the protection of populations and communities.

The screening criteria are not based on toxicity values that are specific to the site or to the conditions at the site, although they have been generated, reviewed, and accepted by various regulatory agencies. Risk estimates can be refined through the use of site-specific toxicity tests that use actual media from the site and ecologically relevant organisms to more accurately determine the toxicity of the site environmental media.

6. CONCLUSIONS

Based on the ecological risk screening, waste rock soils pose a risk to plants and invertebrates that grow or reside in the soils due to the high levels of metals. However, the waste rock soils do not present high quality habitat for plants or invertebrates due to their location as road bed material or as hard rock piles. Also due to the lack of suitable habitat, small mammals are unlikely to use the waste rock soils in the road bed for burrowing or for much food resource. The hard rock piles could present habitat for small mammals but the surrounding terrain presents much

higher quality habitat and reliable food sources than the hard rock piles. It would be expected that small mammals would not use the waste rock soils to much extent. The road bed and hard rock piles also present poor quality habitat or food sources to birds or larger mammals, and they would be expected to have minimal exposures to the CEPCs in the waste rock soils.

Lead and zinc were screened as CPECs for surface waters. Surface waters of the tributary pose minimal risk to aquatic receptors because of the small size, intermittent flow with dry periods, and hard substrate that presents minimial food sources. Lead was identified as the only CPEC for Battle Ax Creek surface water at a station downstream of adit 5 drainage; however, Battle Ax Creek is unlikely to pose a significant chronic risk to aquatic receptors due to the lack of exceedance of the lead criterion at the second nearby station also downstream of adit 5 drainage.

Seven CPECs were identified for sediment in the tributary and Battle Ax Creek, with the highest exceedances of criteria found for the tributary sediment. Tributary sediment is unlikely to present a suitable habitat for freshwater sediment invertebrates due to the very small amount of sediment observed in the tributary and the intermittent flow.

Five CPECs are identified for the three sediment stations of Battle Ax Creek (Table A-4). These metals may pose a risk to sediment invertebrates of Battle Ax Creek, although cadmium, lead, and manganese concentrations were less than 10 percent over the SLV. For nickel and zinc, exceedances were around 2-fold. Cadmium and zinc exceeded the wildlife bioaccumulation SLV by about 200 and 100-fold, respectively.

Background concentrations of these metals in sediment are not available to determine how elevated the site samples may be relative to background. Concentrations in sediment upstream of the confluence of Battle Ax Creek with both the tributary that drains adit 4 and the adit 5 drainage are available from station SED-6 (Table B-4); however this station could be impacted by the drainage from Blue Jay Creek located further upstream in Battle Ax Creek. Concentations of most metals except lead and zinc at station SED-6 were greater than or similar to the concentrations at downstream stations. In comparison with the upstream station at SED-6, lead and zinc appear to be elevated at the two stations SED-1 and SED-2 in Battle Ax Creek downstream of the confluences of the tributary and the adit 5 drainage. These elevations may be due to the elevated concentrations of these metals in the local soils that characterize the location of Ruth Mine. The mines in this

mining district extracted primarily lead and zinc because of their enriched presence in specific hard rock locations. Whether the elevated lead and zinc in the sediments in Battle Ax Creek downstream of the mine site are at general background for locations downgradient of enriched soils is uncertain.

7. REFERENCES

Ecology. 2003. Development of Freshwater Sediment Quality Values for Use in Washington State. Phase II Report: Development and Recommendations of SQVs for Freshwater Sediments in Washington State. Publication Number 03-09-088. Prepared by Avocet Consulting, Kenmore, WA. Washington Department of Ecology, Toxics Cleanup Program, Sediment Management Unit, Olympia, WA. September.

Efroymson, R.A., G.W. Suter, B.E. Sample, and D.S. Jomes. 1997. Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2. Prepared for US Department of Energy. Oak Ridge National Laboratory, TN.

Gilbert, R. O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company Inc. New York.

Jones, D.S, G.W. Suter, and R.N. Hull. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. Prepared for the US Department of Energy by Lockheed Martin Energy Systems. Oak Ridge National Laboratory, TN.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater sediments. Archives of Environmental Contamination and Toxicology 39:20-31.

NPS. 1998. North Cascades Biodiversity: Montane forests. http://www.nps.gov/noca/biodiversity.htm. Accessed Jan. 2006.

NRC. 2005. Superfund and Mining Megasites. Lessons from the Coeur D'Alene River Basin. National Research Council. National Academies Press, Washington, DC. http://www.epa.gov/superfund/reports/pdfs/coeur/ch6.pdf. Accessed Jan. 25, 2006.

ODEQ. 2001. Guidance forEecological Risk Assessment: Level II Screening. Final. Oregon Department of Environmental Quality, Waste Management and Cleanup Division, Portland, OR.

ODFW. 1997. Sensitive Species. Oregon Endangered Species Rules (OAR 635-100-100 to 635-100-130). Oregon Department of Fish and Wildlife. December.

Oregon Natural Heritage. 2004. Rare, Threatened and Endangered Plants and Animals of Oregon. Wildlife Diversity Plan. Oregon Natural Heritage Program, Portland, Oregon. May. 84 pp. Also available on-line, accessed Jan. 2006, http://www.pacificbio.org/ESIN/Infopages/Oregonlist.html.

Orr, E.L., W.N. Orr, and E.M. Baldwin. 1992. *Geology of Oregon*, 4th Ed., Kendall/Hunt Publishing Co., Debuque, Iowa. Cited in Western Oregon University, Analysis of Jawbone Flats mine dump samples. http://www.wou.edu/las/physci//ch461/jawbone.htm.

Sample, B.E., D.M. Opresko, and G.W. Suter. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Prepared for the US Department of Energy by Lockheed Martin Energy Systems. Health Sciences Research Division, Oak Ridge National Laboratory, TN.

Suter, G.W., and C.L. Tsao. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. Prepared for US Department of Energy. Oak Ridge National Laboratory, TN. June.

USEPA. 1998. Guidelines for ecological risk assessment. EPA/630/R-95/002-F. Risk Assessment Forum, US Environmental Protection Agency, Washington, DC.

USEPA. 2000. Ecological Soil Screening Level Guidance. Draft. US Environmental Protection Agency, Office of Emergency and Remedial Response. July 10.

USEPA. 2003. Ecological Soil Screening Levels. U.S. Environmental Protection Agency, http://www.epa.gov/ecotox/ecossl/index.html

USEPA. 2004. *ProUCL Version 3.0. User Guide. April 2004*. EPA/600/R04/079. Office of Research and Development. Prepared by Lockheed-Martin.

APPENDIX A - RISK RATIO CALCULATION TABLES

Table A-1. Waste Rock Soil Screen

Chemical of Interest (COI)	90 UCL Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Screening Level Value			
			Plants (mg/kg)	Invertebrates (mg/kg)	Birds (mg/kg)	Mammals (mg/kg)
Arsenic	26.7	46.2	10	60	10	29
Barium	28.7	56.6	500	3000	85	638
Cadmium	200.3	422	4	20	6	125
Chromium	28.1	37.6	1	0.4	4	340000
Copper	3842	7600	100	50	190	390
Iron	58174	77000	10	200	NA	NA
Lead	13829	34000	50	500	16	4000
Manganese	10278	15900	500	100	4125	11000
Mercury	0.88	1.87	0.3	0.1	1.5	73
Nickel	29.0	40.6	30	200	320	625
Selenium	7.3	16.5	1	70	2	25
Silver	7.8	10	2	50	NA	NA
Zinc	46307	98900	50	200	60	20000

Samples consist of all soil and waste rock samples on-site (N=10).

90 UCL concentrations determined with ProUCL program (USEPA)

Table A-1. Waste Rock Soil Screen

Chemical of Interest (COI)	COI Risk Ratio			
	Plants (Tij)	Invertebrates (Tij)	Birds (Tij)	Mammals (Tij)
Arsenic	3	0.4	3	1
Barium	0.1	0.01	0.3	0.05
Cadmium	50	10	33	2
Chromium	28	70	7	0.0001
Copper	38	77	20	10
Iron	5,817	291	NA	NA
Lead	277	28	864	3
Manganese	21	103	2	1
Mercury	3	9	1	0.01
Nickel	1	0.1	0.1	0.05
Selenium	7	0.1	4	0.3
Silver	4	0.2	NA	NA
Zinc	926	232	772	2
Sum of Risk Ratios (Tj)	7,175	820	1,707	19
Number of COIs (Nij)	13	13	11	11
1/Nij	0.08	0.08	0.09	0.09

Risk Ratio (Tij) = (COI concentration)/SLV

Table A-1. Waste Rock Soil Screen

Chemical of Interest (COI)	Potential Risk to Non-Protected Species?				Potential Risk to Protected Mammals? (Tij>1)
	Plants (Tij>5)	Invertebrates (Tij>5)	Birds (Tij>5)	Mammals (Tij>5)	
Arsenic	No	No	No	No	No
Barium	No	No	No	No	No
Cadmium	**Yes**	**Yes**	**Yes**	No	**Yes**
Chromium	**Yes**	**Yes**	**Yes**	No	No
Copper	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Iron	**Yes**	**Yes**	NA	NA	NA
Lead	**Yes**	**Yes**	**Yes**	No	**Yes**
Manganese	**Yes**	**Yes**	No	No	No
Mercury	No	**Yes**	No	No	No
Nickel	No	No	No	No	No
Selenium	**Yes**	No	No	No	No
Silver	No	No	NA	NA	NA
Zinc	**Yes**	**Yes**	**Yes**	No	**Yes**

Potential Risk = Tij > Q

Q = 5 for non-T&E species

Q = 1 for T&E species

Table A-1. Waste Rock Soil Screen

Chemical of Interest (COI)	Risks to Non-Protected Species Due to Multiple Contaminants? (Tij/Tj>(1/Nij)*Q)				Risks to Protected Mammals Due to Multiple Contaminants? (Tij/Tj>(1/Nij)*Q)
	Plants	Invertebrates	Birds	Mammals	
Arsenic	No	No	No	No	No
Barium	No	No	No	No	No
Cadmium	No	No	No	No	No
Chromium	No	No	No	No	No
Copper	No	No	No	**Yes**	**Yes**
Iron	**Yes**	No	NA	NA	NA
Lead	No	No	**Yes**	No	**Yes**
Manganese	No	No	No	No	No
Mercury	No	No	No	No	No
Nickel	No	No	No	No	No
Selenium	No	No	No	No	No
Silver	No	No	NA	NA	NA
Zinc	No	No	No	No	**Yes**
	Q=5				Q=1

Table A-1. Waste Rock Soil Screen

Chemical of Interest (COI)	Selected as CPEC?				
	Plants	Invertebrates	Birds	Non-Protected Mammals	Protected Mammals
Arsenic	No	No	No	No	No
Barium	No	No	No	No	No
Cadmium	**Yes**	**Yes**	**Yes**	No	**Yes**
Chromium	**Yes**	**Yes**	**Yes**	No	No
Copper	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Iron	**Yes**	**Yes**	No	No	No
Lead	**Yes**	**Yes**	**Yes**	No	**Yes**
Manganese	**Yes**	**Yes**	No	No	No
Mercury	No	**Yes**	No	No	No
Nickel	No	No	No	No	No
Selenium	**Yes**	No	No	No	No
Silver	No	No	No	No	No
Zinc	**Yes**	**Yes**	**Yes**	No	**Yes**

Habitat suitability is not accounted for in the screening.

Table A-2. Surface Water SLV Screen

Chemical of Interest (COI)	90 UCL Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Screening Level Value		
			Aquatic (mg/L)	Birds (mg/L)	Mammals (mg/L)
Arsenic	0	0	0.15	18	6
Barium	0.005	0.007	0.004	150	39
Cadmium	0.011	0.022	0.0022	10	8
Chromium	0	0	0.074	7.2	21000
Copper	0.008	0.015	0.009	341	53
Iron	0.044	0.074	1	NA	NA
Lead	0.014	0.038	0.0025	28	323
Manganese	0.019	0.031	0.12	7242	676
Mercury	0	0	0.00077	3.3	10
Nickel	0	0	0.052	562	38
Selenium	0	0	0.005	3.6	1.5
Silver	0	0	0.00012	NA	NA
Zinc	1.21	3.08	0.12	105	1230

Surface water samples include Battle Ax Creek, tributary, and adit waters on-site (N=9).
90 UCL concentrations determined with ProUCL program (USEPA)

Table A-2. Surface Water SLV Screen

Chemical of Interest (COI)	COI Risk Ratio		
	Aquatic (Tij)	Birds (Tij)	Mammals (Tij)
Arsenic	--	--	--
Barium	1.2	0.00003	0.0001
Cadmium	4.8	0.001	0.001
Chromium	--	--	--
Copper	0.8	0.00002	0.0001
Iron	0.04	NA	NA
Lead	5.5	0.0005	0.00004
Manganese	0.2	0.000003	0.00003
Mercury	--	--	--
Nickel	--	--	--
Selenium	--	--	--
Silver	--	--	--
Zinc	10.1	0.01	0.001
Sum of Risk Ratios (Tj)	23	0.01	0.003
Number of COIs (Nij)	7	6	6
1/Nij	0.14	0.17	0.17

Risk Ratio (Tij) = (COI concentration)/SLV

Table A-2. Surface Water SLV Screen

Chemical of Interest (COI)	Potential Risk to Non-Protected Species?			Potential Risk to Protected Mammals? (Tij>1)
	Aquatic (Tij>5)	Birds (Tij>5)	Mammals (Tij>5)	
Arsenic	NA	NA	NA	NA
Barium	No	No	No	No
Cadmium	No	No	No	No
Chromium	NA	NA	NA	NA
Copper	No	No	No	No
Iron	No	NA	NA	NA
Lead	**Yes**	No	No	No
Manganese	No	No	No	No
Mercury	NA	NA	NA	NA
Nickel	NA	NA	NA	NA
Selenium	NA	NA	NA	NA
Silver	NA	NA	NA	NA
Zinc	**Yes**	No	No	No

Potential Risk = Tij > Q
Q = 5 for non-T&E species
Q = 1 for T&E species

Table A-2. Surface Water SLV Screen

Chemical of Interest (COI)	Risks to Non-Protected Species Due to Multiple Contaminants? (Tij/Tj>(1/Nij)*Q)			Risks to Protected Mammals Due to Multiple Contaminants? (Tij/Tj>(1/Nij)*Q)
	Aquatic	Birds	Mammals	
Arsenic	NA	NA	NA	NA
Barium	No	No	No	No
Cadmium	No	No	No	**Yes**
Chromium	NA	NA	NA	NA
Copper	No	No	No	No
Iron	No	NA	NA	NA
Lead	No	No	No	No
Manganese	No	No	No	No
Mercury	NA	NA	NA	NA
Nickel	NA	NA	NA	NA
Selenium	NA	NA	NA	NA
Silver	NA	NA	NA	NA
Zinc	No	**Yes**	No	**Yes**
	Q=5			Q=1

Table A-2. Surface Water SLV Screen

Chemical of Interest (COI)	Selected as CPEC?			
	Aquatic	Birds	Non-Protected Mammals	Protected Mammals
Arsenic	No	No	No	No
Barium	No	No	No	No
Cadmium	No	No	No	**Yes**
Chromium	No	No	No	No
Copper	No	No	No	No
Iron	No	No	No	No
Lead	**Yes**	No	No	No
Manganese	No	No	No	No
Mercury	No	No	No	No
Nickel	No	No	No	No
Selenium	No	No	No	No
Silver	No	No	No	No
Zinc	**Yes**	**Yes**	No	**Yes**

Habitat suitability is not accounted for in the screening.

Table A-3. Sediment Screen

Chemical of Interest (COI)	90 UCL Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Screening Level Value		COI Risk Ratio	
			Freshwater Sediment Benthos (mg/kg)	Wildlife Bioaccumulation (mg/kg)	Freshwater Sediment Benthos (Tij)	Wildlife Bioaccumulation (Tij)
Arsenic	7.4	11.7	6	4	1	1.8
Barium	50.9	82.3	NA	NA	NA	NA
Cadmium	1.2	1.9	0.6	0.003	2	407
Chromium	13.8	14.6	37	4200	0	0
Copper	205.9	465.0	36	10	6	21
Iron	19401.0	23100.0	NA	NA	NA	NA
Lead	348.1	278.0	35	128	10	3
Manganese	2546.3	4290.0	1100	NA	2	NA
Nickel	26.0	30.6	18	316	1	0.1
Silver	0.5	0.7	4.5	NA	0	NA
Zinc	659.3	953.0	123	3	5	220
				Sum of Risk Ratios (Tj):	29	652
				Number of COIs (Nij):	10	8
				1/Nij:	0.10	0.13

Samples consist of sediment samples on-site (N=6).

90 UCL concentrations determined with ProUCL program (USEPA)

Table A-3. Sediment Screen

Chemical of Interest (COI)	Potential Risk to Sediment-Exposed Species?		Risks Due to Multiple Contaminants? (Tij/Tj>(1/Nij)*Q)		Selected as CPEC?	
	Freshwater Sediment Benthos (Tij>1)	Wildlife Bioaccumulation (Tij>1)	Freshwater Sediment Benthos	Wildlife Bioaccumulation	Freshwater Sediment Benthos	Wildlife Bioaccumulation
Arsenic	**Yes**	**Yes**	No	No	**Yes**	**Yes**
Barium	NA	NA	NA	NA	No	No
Cadmium	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**
Chromium	No	No	No	No	No	No
Copper	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**
Iron	NA	NA	NA	NA	No	No
Lead	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**
Manganese	**Yes**	NA	No	NA	**Yes**	No
Nickel	**Yes**	No	No	No	**Yes**	No
Silver	No	NA	No	NA	No	No
Zinc	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Potential Risk = Tij > Q

Q = 1 for all sediment spieces (ODEQ 1998)

Table A-4. Battle Ax Creek Sediment Screen

Chemical of Interest (COI)	90 UCL Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Screening Level Value		COI Risk Ratio	
			Freshwater Sediment Benthos (mg/kg)	Wildlife Bioaccumulation (mg/kg)	Freshwater Sediment Benthos (Tij)	Wildlife Bioaccumulation (Tij)
Arsenic	1.3	2.6	6	4	0.2	0.3
Barium	54.5	82.3	NA	NA	NA	NA
Cadmium	0.32	0.66	0.6	0.003	0.5	107.6
Chromium	2.4	14	37	4200	0.1	0.0
Copper	13.1	36	36	10	0.4	1.3
Iron	2970	15200	NA	NA	NA	NA
Lead	23.5	38	35	128	0.7	0.2
Manganese	527	948	1100	NA	0.5	NA
Nickel	5.9	30.6	18	316	0.3	0.0
Zinc	150	290	123	3	1.2	49.9
				Sum of Risk Ratios (Tj):	4	159
				Number of COIs (Nij):	10	8
				1/Nij:	0.10	0.13

Samples consist of Battle Ax Creek sediment (N=3).

Table A-4. Battle Ax Creek Sediment Screen

Chemical of Interest (COI)	Potential Risk to Sediment-Exposed Species?		Risks Due to Multiple Contaminants? (Tij/Tj>(1/Nij)*Q)		Selected as CPEC?	
	Freshwater Sediment Benthos (Tij>1)	Wildlife Bioaccumulation (Tij>1)	Freshwater Sediment Benthos	Wildlife Bioaccumulation	Freshwater Sediment Benthos	Wildlife Bioaccumulation
Arsenic	No	No	No	No	No	No
Barium	NA	NA	NA	NA	No	No
Cadmium	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Chromium	No	No	No	No	No	No
Copper	No	**Yes**	No	No	No	**Yes**
Iron	NA	NA	NA	NA	No	No
Lead	No	No	**Yes**	No	**Yes**	No
Manganese	No	NA	**Yes**	NA	**Yes**	No
Nickel	No	No	No	No	No	No
Zinc	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Potential Risk = Tij > Q

Q = 1 for all sediment species (ODEQ 1998)

APPENDIX B - SAMPLE SCREENING TABLES

TABLE B-1. Soil Samples Screen

Background Soils

Sample I.D.	Total Metals (mg/kg)													Hexavalent Chromium
	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc	
BG-1	2.55	**92.3**	ND<0.657	**17.0**	42.9	**17700**	**26.0**	**516**	**ND<0.0876**	22.2	ND<0.657	ND<0.657	**126**	ND<1.27
BG-2	2.41	40.7	ND<0.570	**18.4**	48.7	**16200**	**25.1**	**807**	**ND<0.0891**	24.2	ND<0.570	ND<0.570	**469**	ND<1.16
BG-3	3.23	75.7	ND<0.595	**18.8**	**57.4**	**19100**	2.9	**450**	**ND<0.0972**	25.6	ND<0.595	ND<0.595	**86.7**	**442**
BG-4	**30.5**	21.4	**98.4**	**20.5**	**868**	**47700**	**5450**	**7700**	**ND<0.0593**	23.8	**3.56**	**9.09**	**24600**	ND<1.15
BG-5	**17.3**	66.7	3.28	**38.5**	**365**	**29200**	**2020**	**5340**	**0.121**	**30.9**	**1.3**	**3.33**	**1700**	ND<1.21
BG-6	2.48	42.1	ND<0.608	**18.0**	40.0	**16700**	**16.7**	**722**	**ND<0.0627**	25.4	ND<0.608	ND<0.608	**83.0**	ND<1.24
BG-7	**12.0**	22.2	**23.5**	**28.3**	**506**	**24000**	**936**	**3620**	**0.123**	**31.0**	**1.18**	**2.39**	**4160**	ND<1.12
BG-8	2.54	63.3	ND<0.581	**14.9**	**51.9**	**17600**	**27.3**	**648**	**ND<0.103**	23.8	ND<0.581	ND<0.581	**107**	ND<1.19
BG-9	3.43	69.6	1.16	**21.4**	**196**	**15400**	**146**	**893**	**ND<0.0879**	27.7	ND<0.586	ND<0.586	**2470**	ND<1.19
BG-10	8.45	**110**	ND<0.599	**16.7**	**73.5**	**16900**	**68.2**	**959**	**ND<0.0659**	21.9	ND<0.599	ND<0.599	**268**	ND<1.16
Maximum detected	**30.5**	**110**	**98.4**	**38.5**	**868**	**47700**	**5450**	**7700**	**0.123**	**31**	**3.56**	**9.09**	**24600**	**442**
Upper 95 UCL	**21.3**	77.2	**55.4**	**25.5**	**607**	**28206**	**4302**	**5658**	**0.11**	27.5	**2.25**	**5.58**	**14461**	

Waste Rock Soils

WRS-1	7.88	56.6	3.95	**23.1**	**94.5**	***30300***	**346**	**1220**	***0.135***	19.2	ND<0.545	ND<0.545	**918**	ND<1.12
WRS-2	***46.2***	7.94	***307***	**16.6**	***7600***	***77000***	**2050**	***10200***	***1.87***	17.6	***9.98***	***9.19***	***64900***	ND<1.09
WRS-3	***22.8***	10.2	***171***	***37.6***	***1120***	***68200***	***14000***	***15900***	***0.548***	23.7	***6.56***	***7.62***	***43600***	ND<1.06
WRS-4	***23.7***	10.0	***422***	**19.6**	***2780***	***77000***	***34000***	***12900***	***0.431***	18.7	***16.5***	***7.1***	***98900***	ND<1.05
WRS-5	***22.0***	11.5	***227***	**23.2**	***5480***	***74000***	***10800***	***13000***	***0.378***	22.9	***6.67***	***9.66***	***54800***	ND<1.17
WRS-6	***26.9***	17.5	***76.8***	**18.0**	**541**	***35100***	**4030**	**5480**	***1.11***	23.1	***3.03***	***10.0***	***17100***	ND<0.758
WRS-7	**10.8**	28.1	**17.2**	***26.5***	**134**	***26800***	**2440**	**5300**	**ND<0.0880**	***31.6***	***2.97***	**4.98**	**4370**	ND<0.689
WRS-8	**15.4**	34.7	***66.1***	***32.9***	**363**	***33500***	**2670**	***7730***	***0.126***	***40.6***	**2.05**	**5.51**	***14800***	ND<0.637
WRS-9	**17.9**	16.3	**33.3**	***34.6***	**202**	***36800***	**1480**	***6360***	***0.37***	***35.7***	**1.02**	**3.63**	**7630**	ND<0.671
WRS-10	***26.9***	28.2	***68.4***	**13.8**	**462**	**24200**	**2410**	**4640**	***0.341***	22.7	**2.06**	***6.49***	***15200***	ND<0.715
Max concentration	**46.2**	56.6	**422**	**37.6**	**7600**	**77000**	**34000**	**15900**	**1.9**	**40.6**	**16.5**	**10**	**98900**	0
Upper 90 UCL	**26.7**	**28.7**	**200.3**	**28.1**	**3842**	**58174**	**13829**	**10278**	**0.88**	**29.0**	**7.3**	**7.8**	**46307**	0
Upper 95 UCL		30.9	**220.2**	**29.3**	**4736**	**61551**	**16573**	**10931**	**1.0**	**30.1**	**8.0**	**8.2**	**50891**	0
Lowest SLV Soil (mg/kg)	10	85	4	0.4	50	10	16	100	0.0002	30	1	2	50	410
Max Concentration Exceed Background?	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N

95 UCL determined with ProUCL (USEPA xx); "ND" set at 1/2 displayed value.

Bold exceeds Screening Level; bold+italics exceed 95UCL background and Screening Level.

Background determined as 95 UCL of the mean of all BG samples

Table B-2. Surface Water Screen

Sample I.D.	Location	Total Metals (mg/L)												
		Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
AW-4	Adit 4	ND	**0.00694**	**0.0221**	ND	**0.0148**	0.0475	**0.0377**	0.0235	ND	ND	ND	**ND**	**3.08**
AW-5	Adit 5	ND	0.00322	**0.00539**	ND	0.0046	0.0739	**0.00262**	0.0309	ND	ND	ND	**ND**	**1.27**
SW-1	Battle Ax Cr., downstream of Adit 5	ND	ND	ND	ND	ND	0.0117	**0.00295**	ND	ND	ND	ND	**ND**	0.0193
SW-2	Battle Ax Cr., downstream of Adit 5	ND	0.00104	ND	ND	ND	0.0258	ND	ND	ND	ND	ND	**ND**	0.00775
SW-3	Tributary, above Adit 4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	0.0186
SW-4	Tributary, below Adit 4	ND	ND	ND	ND	ND	ND	**0.00392**	0.004	ND	ND	ND	**ND**	0.0516
SW-5	Tributary, below Adit 4	ND	ND	ND	ND	ND	ND	**0.00444**	ND	ND	ND	ND	**ND**	0.0856
SW-6	Battle Ax Cr., upstream of Adit 5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND
SW-7	Battle Ax Cr., confluence of tributary	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	0.0174
Maximum detected		0	**0.00694**	**0.0221**	0	**0.0148**	**0.0739**	**0.0377**	**0.0309**	0	0	0	0	**3.08**
Upper 90 UCL		0.000	**0.005**	**0.011**	0.000	**0.008**	**0.044**	**0.014**	**0.019**	0.000	0.000	0.000	0.000	**1.214**
Lowest Level II Screening Value Surface Water Fresh (mg/L)		0.15	0.004	0.0022	0.074	0.009	1	0.0025	0.12	0.05	0.052	0.005	0.00012	0.12

Bold values exceed Level II screening value

Table B-3. Sediment Screen

Sample I.D.	Location	Total Metals(mg/kg)												
		Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
SED-1	Battle Ax Cr., downstream of Adit 5	1.08	22.9	**0.66**	12.9	29.1	11700	**35.6**	339	ND<0.0927	**27.9**	ND<0.588	ND<0.588	**246**
SED-2	Battle Ax Cr., downstream of Adit 5	1.95	30.4	**ND<0.657**	11.2	20.4	13100	**38.1**	948	ND<0.107	**23.7**	ND<0.657	ND<0.657	**290**
SED-3	Tributary, above Adit 4	2.00	35.7	**1.06**	14.6	**63.9**	16500	**244**	**1440**	ND<0.0643	15.7	ND<0.618	ND<0.618	**648**
SED-4	Tributary, below Adit 4	3.68	34.6	**1.87**	13.8	**465**	20800	**265**	**2280**	ND<0.0633	**18.8**	ND<0.652	0.745	**953**
SED-5	Tributary, below Adit 4	**11.7**	12.2	**0.989**	9.86	**39.6**	23100	**278**	**4290**	ND<0.102	17.4	ND<0.706	ND<0.706	**577**
SED-6	Battle Ax Cr., upstream of Adit 5	2.60	82.3	**ND<0.661**	14.0	35.9	15200	12.8	768	ND<0.0748	**30.6**	ND<0.661	ND<0.661	119
	Maximum detected	**11.7**	82.3	**1.87**	14.6	**465**	23100	**278**	**4290**	0.00	**30.6**	0.00	0.75	**953**
	90 UCL	**7.39**	**50.9**	**1.22**	**13.8**	**206**	**19401**	**348**	**2546**	0.00	**26.0**	0.00	**0.50**	**659**
	95 UCL	**7.39**	56.2	**1.3**	**14.2**	**259**	20376	**251**	**2864**	0.0	**27.3**	0.0	0.5	**728**
Lowest Level II Screening Value Fresh Water Sediment (mg/kg)		6	NA	0.6	37	36	NA	35	1100	0.2	18	NA	4.5	123

Table B-4. Screening of Sediment of Battle Ax Creek.

Sample I.D.	Location	Total Metals(mg/kg)												
		Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
SED-1	Battle Ax Cr., downstream of Adit 5	1.08	22.9	**0.66**	12.9	29.1	11700	**35.6**	339	ND<0.0927	**27.9**	ND<0.588	ND<0.588	**246**
SED-2	Battle Ax Cr., downstream of Adit 5	1.95	30.4	**ND<0.657**	11.2	20.4	13100	**38.1**	948	ND<0.107	**23.7**	ND<0.657	ND<0.657	**290**
SED-6	Battle Ax Cr., upstream of Adit 5	2.60	82.3	**ND<0.661**	14.0	35.9	15200	12.8	768	ND<0.0748	**30.6**	ND<0.661	ND<0.661	119
	Maximum detected	2.6	82.3	**0.66**	14.0	36	15200	**38**	948	0.00	**30.6**	0.00	0.00	**290**
Level II Screening Values Fresh Water Sediment (mg/kg)		6	NA	0.6	37	36	NA	35	1100	0.2	18	NA	4.5	123

APPENDIX C

APPENDIX C

SAMPLING ACTIVITIES

Field sampling activities were completed at the Ruth Mine site on November 8 and 9, 2005. The sampling activities were completed by GeoDesign personnel and personnel from Pascoe Environmental Consulting of Port Townsend, Washington. The approximate sample locations are presented on Figures 3, 5, and 6.

WASTE ROCK/SOIL AND BACKGROUND ROCK/SOIL SAMPLING

Waste rock/soil samples and background rock/soil sampled were collected using a stainless steel trowel to dig approximately 6 inches below the soil surface. Rock/soil material was then collected and placed in laboratory-prepared glass jars with Teflon-lined lids. The soil samples were immediately placed in a cooler with ice for temporary storage.

The equipment used for soil sampling was cleaned between each sampling location with a tap water wash and a deionized water rinse. The GeoDesign representative wore new nitrile gloves during sample collection procedures.

SURFACE WATER SAMPLNG

Surface water samples were collected from the adit openings, Battle Ax Creek, Ruth Creek, and Blue Jay Creek. The GeoDesign field representative utilized a peristaltic pump and dedicated tubing for each sample. Samples from the stream locations were collected from approximately 6 inches below the stream surface while the adit water samples were collected from approximately 1 inch below the surface due to limited depth. Surface water samples were collected in laboratory-supplied and preserved containers. Samples were immediately placed in a cooler with ice for temporary storage pending analytical laboratory submittal.

PORE WATER SAMPLING

Pore water samples were collected from two locations in Battle Ax Creek. Pore water samples were collected using a stainless steel probe with approximately 4 inches of screened area. The probe was inserted with the screened area approximately 4 to 8 inches below the sediment surface and a peristaltic pump with dedicated tubing was used to collect the samples. A low flow pumping rate was used to ensure that pore water was collected.

SEDIMENT SAMPLING

Sediment samples were collected from Battle Ax Creek and Ruth Creek locations. Sediment sampling was originally attempted using a Wildco® Instruments sediment sampler. The sediment available for sampling was generally coarse-grained material that was not conducive to this type of sampling tool. GeoDesign personnel completed the sediment sampling by hand using the laboratory-supplied glass jars to scoop available sediment from the stream locations. Following collection, samples were immediately placed in a cooler with ice for temporary storage pending analytical laboratory submittal.

XRF SAMPLING

A Niton® XL-722 XRF detector was used by Niton® certified personnel at the GeoDesign soils laboratory to screen waste rock/soil and background rock/soil samples for metals content. Samples were somewhat homogenized; however, they were not oven-dried or ground. The samples were analyzed based on EPA Method 6200 by the XRF detector three times each. Each XRF analysis was completed between 30 and 300 seconds and an average of the three analyses were recorded as a concentration of each metal detected. Confirmatory analysis of each sample was conducted at an analytical laboratory using EPA 6000/7000 Series Methods.

ANALYTICAL LABORATORY TESTING

COC procedures were followed during the handling and transport of rock/soil, surface water, pore water, and sediment samples. All rock/soil, surface water, pore water, and sediment samples were submitted to North Creek Analytical of Beaverton, Oregon, for chemical analysis.

APPENDIX D

APPENDIX D

CHEMICAL ANALYTICAL PROGRAM

COC procedures were followed during handling and transport of the samples to the analytical laboratory. The laboratory holds the samples in cold storage pending extraction and/or analysis. The analytical results, analytical methods reference, and laboratory quality control records are included in this appendix. The analytical results also are summarized in the tables of this report.

REVIEW OF ANALYTICAL DATA

The analytical laboratory maintains an internal quality assurance program, consisting of a combination of the following:

Blanks - Blanks are laboratory prepared water samples that are free of contaminants. The blanks are carried through the analysis procedure along with the field samples to document that contaminants were not introduced to the samples during sample handling and analysis.

Surrogate Recoveries - Surrogates are organic compounds that are similar in nature to the analytes of concern, but are not normally found in nature. The surrogates are added to quality control and field samples prior to analysis. The percent recovery of the surrogate is calculated to demonstrate acceptable method performance.

Duplicates - Duplicates are obtained by splitting a sample into two parts. The two separate parts are carried through the analyses. The analytical results are then compared by calculating the relative percent difference between the samples.

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) Recoveries - An MS sample is a sample that has been split into a second portion. The MSD is obtained by further splitting the MS sample. A known concentration of the analyte of interest is added to the MS and MSD samples. The analytical results for both samples are then compared for relative percent difference and percent recovery to demonstrate acceptable method performance.

Blank Spike (BS)/Blank Spike Duplicate (BSD) Recoveries - BS and BSD samples are obtained and analyzed in the same procedure as the MS/MSD samples. However, the laboratory blank sample is used to obtain the BS/BSD samples. The percent recovery and relative percent difference of the known concentration of analyte of interest added to the BS/BSD sample is calculated after chemical analyses to demonstrate acceptable method performance.

SUMMARY OF ANALYTICAL DATA REVIEW

GeoDesign reviewed the attached analytical data reports for data quality exceptions and deviations from acceptable method performance criteria. In our opinion, the analytical data are acceptable for their intended use. During the waste rock/soil, background rock/soil, and sediment sample analyses, iron was detected in several method blank sample results at greater than one-half the method reporting limit for total metals and SPLP metals, but at concentrations less than one-tenth the concentration of the sample. Hexavalent chromium was run on Industry Coupled Plasma - Mass Spectrometery, and the reporting limits were based on total chromium.

The analytical laboratory noted a high bias in the hexavalent chromium analysis. The results for background rock/soil sample BG-3 was initially reported as above the total chromium value. The results for this sample were not able to be determined and therefore no value is presented in Table 3A. The remainder of the hexavalent chromium results were not affected. In some sediment samples, the reporting limit for manganese and/or zinc was raised due to high concentrations in the samples. In some cases, the MS recovery and/or the relative percent differences in some quality control samples were outside established control limits due to matrix interference or could not be accurately calculated due to high concentrations of the target analyte in the source sample.

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

December 30, 2005

Steve Nelson
GeoDesign
15575 SW Sequoia Parkway Ste.100
Portland, OR 97224

RE: Opal Creek-1-01

Enclosed are the results of analyses for samples received by the laboratory on 12/02/05 17:00.
The following list is a summary of the NCA Work Orders contained in this report.
If you have any questions concerning this report, please feel free to contact me.

Work	Project	ProjectNumber
P5L0118	Opal Creek-1-01	Opal Creek-1-01

Thank You,

Roxanne L. Clifton, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

North Creek Analytical, Inc.
Environmental Laboratory Network

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
BG-1	P5L0118-01	Soil	11/08/05 12:28	12/02/05 17:00
BG-2	P5L0118-02	Soil	11/09/05 10:55	12/02/05 17:00
BG-3	P5L0118-03	Soil	11/09/05 11:10	12/02/05 17:00
BG-4	P5L0118-04	Soil	11/09/05 11:15	12/02/05 17:00
BG-5	P5L0118-05	Soil	11/09/05 11:39	12/02/05 17:00
BG-6	P5L0118-06	Soil	11/09/05 11:45	12/02/05 17:00
BG-7	P5L0118-07	Soil	11/09/05 11:55	12/02/05 17:00
BG-8	P5L0118-08	Soil	11/09/05 12:02	12/02/05 17:00
BG-9	P5L0118-09	Soil	11/09/05 13:10	12/02/05 17:00
BG-10	P5L0118-10	Soil	11/09/05 13:15	12/02/05 17:00
WRS-1	P5L0118-11	Soil	11/08/05 10:33	12/02/05 17:00
WRS-2	P5L0118-12	Soil	11/08/05 10:38	12/02/05 17:00
WRS-3	P5L0118-13	Soil	11/08/05 10:51	12/02/05 17:00
WRS-4	P5L0118-14	Soil	11/08/05 11:05	12/02/05 17:00
WRS-5	P5L0118-15	Soil	11/08/05 11:15	12/02/05 17:00
WRS-6	P5L0118-16	Soil	11/08/05 11:25	12/02/05 17:00
WRS-7	P5L0118-17	Soil	11/08/05 11:56	12/02/05 17:00
WRS-8	P5L0118-18	Soil	11/08/05 12:02	12/02/05 17:00
WRS-9	P5L0118-19	Soil	11/08/05 12:08	12/02/05 17:00
WRS-10	P5L0118-20	Soil	11/08/05 12:13	12/02/05 17:00

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-01 Soil BG-1 Sampled: 11/08/05 12:28										
Arsenic	EPA 6020	**2.55**	-----	0.657	mg/kg dry	1x	5120483	12/12/05	12/14/05 05:39	
Barium	"	**92.3**	-----	0.657	"	"	"	"	"	
Cadmium	"	ND	-----	0.657	"	"	"	"	"	
Chromium	"	**17.0**	-----	1.31	"	2x	"	"	12/15/05 00:30	
Copper	"	**42.9**	-----	2.63	"	1x	"	"	12/14/05 05:39	
Iron	"	**17700**	-----	1040	mg/kg	200x	"	"	12/16/05 04:45	**B-17**
Lead	"	**26.0**	-----	0.657	mg/kg dry	1x	"	"	12/14/05 05:39	
Manganese	"	**516**	-----	2.63	"	2x	"	"	12/15/05 00:30	
Nickel	"	**22.2**	-----	1.31	"	1x	"	"	12/14/05 05:39	
Selenium	"	ND	-----	0.657	"	"	"	"	"	
Silver	"	ND	-----	0.657	"	"	"	"	"	
Zinc	"	**126**	-----	2.63	"	"	"	"	"	
P5L0118-02 Soil BG-2 Sampled: 11/09/05 10:55										
Arsenic	EPA 6020	**2.41**	-----	0.570	mg/kg dry	1x	5120483	12/12/05	12/14/05 05:47	
Barium	"	**40.7**	-----	0.570	"	"	"	"	"	
Cadmium	"	ND	-----	0.570	"	"	"	"	"	
Chromium	"	**18.4**	-----	1.14	"	2x	"	"	12/15/05 00:38	
Copper	"	**48.7**	-----	2.28	"	1x	"	"	12/14/05 05:47	
Iron	"	**16200**	-----	1000	mg/kg	200x	"	"	12/16/05 05:01	**B-17**
Lead	"	**25.1**	-----	0.570	mg/kg dry	1x	"	"	12/14/05 05:47	
Manganese	"	**807**	-----	2.28	"	2x	"	"	12/15/05 00:38	
Nickel	"	**24.2**	-----	1.14	"	1x	"	"	12/14/05 05:47	
Selenium	"	ND	-----	0.570	"	"	"	"	"	
Silver	"	ND	-----	0.570	"	"	"	"	"	
Zinc	"	**469**	-----	2.28	"	"	"	"	"	
P5L0118-03 Soil BG-3 Sampled: 11/09/05 11:10										
Arsenic	EPA 6020	**3.23**	-----	0.595	mg/kg dry	1x	5120484	12/12/05	12/14/05 06:25	
Barium	"	**75.7**	-----	0.595	"	"	"	"	"	
Cadmium	"	ND	-----	0.595	"	"	"	"	"	
Chromium	"	**18.8**	-----	0.595	"	"	"	"	12/15/05 06:29	
Copper	"	**57.4**	-----	2.38	"	"	"	"	12/14/05 06:25	
Iron	"	**19100**	-----	1020	mg/kg	200x	"	"	12/16/05 06:35	**B-17**
Lead	"	**20.9**	-----	0.595	mg/kg dry	1x	"	"	12/14/05 06:25	
Manganese	"	**450**	-----	1.19	"	"	"	"	12/15/05 06:29	
Nickel	"	**25.6**	-----	1.19	"	"	"	"	12/14/05 06:25	
Selenium	"	ND	-----	0.595	"	"	"	"	"	
Silver	"	ND	-----	0.595	"	"	"	"	"	
Zinc	"	**86.7**	-----	2.38	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-04 Soil BG-4 Sampled: 11/09/05 11:15										
Arsenic	EPA 6020	**30.5**	-----	0.558	mg/kg dry	1x	5120484	12/12/05	12/14/05 07:03	
Barium	"	**21.4**	-----	0.558	"	"	"	"	"	
Cadmium	"	**98.4**	-----	0.558	"	"	"	"	"	
Chromium	"	**20.5**	-----	2.79	"	5x	"	"	12/15/05 06:59	
Copper	"	**868**	-----	11.2	"	"	"	"	"	
Iron	"	**47700**	-----	962	mg/kg	200x	"	"	12/16/05 07:38	**B-17**
Lead	"	**5450**	-----	27.9	mg/kg dry	50x	"	"	12/15/05 04:19	
Manganese	"	**7700**	-----	55.8	"	"	"	"	"	
Nickel	"	**23.8**	-----	1.12	"	1x	"	"	12/14/05 07:03	
Selenium	"	**3.56**	-----	0.558	"	"	"	"	"	
Silver	"	**9.09**	-----	0.558	"	"	"	"	"	
Zinc	"	**24600**	-----	223	"	100x	"	"	12/15/05 10:01	
P5L0118-05 Soil BG-5 Sampled: 11/09/05 11:39										
Arsenic	EPA 6020	**17.3**	-----	0.598	mg/kg dry	1x	5120484	12/12/05	12/14/05 07:18	
Barium	"	**66.7**	-----	0.598	"	"	"	"	"	
Cadmium	"	**3.28**	-----	0.598	"	"	"	"	"	
Chromium	"	**38.5**	-----	2.99	"	5x	"	"	12/15/05 07:07	
Copper	"	**365**	-----	2.39	"	1x	"	"	12/14/05 07:18	
Iron	"	**29200**	-----	971	mg/kg	200x	"	"	12/16/05 08:09	**B-17**
Lead	"	**2020**	-----	12.0	mg/kg dry	20x	"	"	12/15/05 04:27	
Manganese	"	**5340**	-----	23.9	"	"	"	"	"	
Nickel	"	**30.9**	-----	1.20	"	1x	"	"	12/14/05 07:18	
Selenium	"	**1.30**	-----	0.598	"	"	"	"	"	
Silver	"	**3.33**	-----	0.598	"	"	"	"	"	
Zinc	"	**1700**	-----	47.8	"	20x	"	"	12/15/05 04:27	
P5L0118-06 Soil BG-6 Sampled: 11/09/05 11:45										
Arsenic	EPA 6020	**2.48**	-----	0.608	mg/kg dry	1x	5120484	12/12/05	12/14/05 07:25	
Barium	"	**42.1**	-----	0.608	"	"	"	"	"	
Cadmium	"	ND	-----	0.608	"	"	"	"	"	
Chromium	"	**18.0**	-----	3.04	"	5x	"	"	12/15/05 04:35	
Copper	"	**40.0**	-----	2.43	"	1x	"	"	12/14/05 07:25	
Iron	"	**16700**	-----	1030	mg/kg	200x	"	"	12/16/05 08:25	**B-17**
Lead	"	**16.7**	-----	0.608	mg/kg dry	1x	"	"	12/14/05 07:25	
Manganese	"	**722**	-----	6.08	"	5x	"	"	12/15/05 04:35	
Nickel	"	**25.4**	-----	1.22	"	1x	"	"	12/14/05 07:25	
Selenium	"	ND	-----	0.608	"	"	"	"	"	
Silver	"	ND	-----	0.608	"	"	"	"	"	
Zinc	"	**83.0**	-----	2.43	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-07 Soil BG-7 Sampled: 11/09/05 11:55										
Arsenic	EPA 6020	**12.0**	-----	0.521	mg/kg dry	1x	5120484	12/12/05	12/14/05 07:48	
Barium	"	**22.2**	-----	0.521	"	"	"	"	"	
Cadmium	"	**23.5**	-----	0.521	"	"	"	"	"	
Chromium	"	**28.3**	-----	1.04	"	2x	"	"	12/15/05 07:45	
Copper	"	**506**	-----	4.17	"	"	"	"	"	
Iron	"	**24000**	-----	962	mg/kg	200x	"	"	12/16/05 09:55	**B-17**
Lead	"	**936**	-----	10.4	mg/kg dry	20x	"	"	12/15/05 04:42	
Manganese	"	**3620**	-----	20.8	"	"	"	"	"	
Nickel	"	**31.0**	-----	1.04	"	1x	"	"	12/14/05 07:48	
Selenium	"	**1.18**	-----	0.521	"	"	"	"	"	
Silver	"	**2.39**	-----	0.521	"	"	"	"	"	
Zinc	"	**4160**	-----	41.7	"	20x	"	"	12/15/05 04:42	
P5L0118-08 Soil BG-8 Sampled: 11/09/05 12:02										
Arsenic	EPA 6020	**2.54**	-----	0.581	mg/kg dry	1x	5120484	12/12/05	12/14/05 07:55	
Barium	"	**63.3**	-----	0.581	"	"	"	"	"	
Cadmium	"	ND	-----	0.581	"	"	"	"	"	
Chromium	"	**14.9**	-----	2.91	"	5x	"	"	12/15/05 04:50	
Copper	"	**51.9**	-----	2.32	"	1x	"	"	12/14/05 07:55	
Iron	"	**17600**	-----	1010	mg/kg	200x	"	"	12/16/05 10:11	**B-17**
Lead	"	**27.3**	-----	0.581	mg/kg dry	1x	"	"	12/14/05 07:55	
Manganese	"	**648**	-----	5.81	"	5x	"	"	12/15/05 04:50	
Nickel	"	**23.8**	-----	1.16	"	1x	"	"	12/14/05 07:55	
Selenium	"	ND	-----	0.581	"	"	"	"	"	
Silver	"	ND	-----	0.581	"	"	"	"	"	
Zinc	"	**107**	-----	2.32	"	"	"	"	"	
P5L0118-09 Soil BG-9 Sampled: 11/09/05 13:10										
Arsenic	EPA 6020	**3.43**	-----	0.586	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:03	
Barium	"	**69.6**	-----	0.586	"	"	"	"	"	
Cadmium	"	**1.16**	-----	0.586	"	"	"	"	"	
Chromium	"	**21.4**	-----	2.93	"	5x	"	"	12/15/05 04:58	
Copper	"	**196**	-----	2.34	"	1x	"	"	12/14/05 08:03	
Iron	"	**15400**	-----	952	mg/kg	200x	"	"	12/16/05 10:27	**B-17**
Lead	"	**146**	-----	0.586	mg/kg dry	1x	"	"	12/14/05 08:03	
Manganese	"	**893**	-----	5.86	"	5x	"	"	12/15/05 04:58	
Nickel	"	**27.7**	-----	1.17	"	1x	"	"	12/14/05 08:03	
Selenium	"	ND	-----	0.586	"	"	"	"	"	
Silver	"	ND	-----	0.586	"	"	"	"	"	
Zinc	"	**2470**	-----	11.7	"	5x	"	"	12/15/05 04:58	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-10 Soil BG-10 Sampled: 11/09/05 13:15										
Arsenic	EPA 6020	**8.45**	-----	0.599	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:11	
Barium	"	**110**	-----	0.599	"	"	"	"	"	
Cadmium	"	ND	-----	0.599	"	"	"	"	"	
Chromium	"	**16.7**	-----	3.00	"	5x	"	"	12/15/05 05:05	
Copper	"	**73.5**	-----	2.40	"	1x	"	"	12/14/05 08:11	
Iron	"	**16900**	-----	1010	mg/kg	200x	"	"	12/16/05 10:43	**B-17**
Lead	"	**68.2**	-----	0.599	mg/kg dry	1x	"	"	12/14/05 08:11	
Manganese	"	**959**	-----	5.99	"	5x	"	"	12/15/05 05:05	
Nickel	"	**21.9**	-----	1.20	"	1x	"	"	12/14/05 08:11	
Selenium	"	ND	-----	0.599	"	"	"	"	"	
Silver	"	ND	-----	0.599	"	"	"	"	"	
Zinc	"	**268**	-----	2.40	"	"	"	"	"	
P5L0118-11 Soil WRS-1 Sampled: 11/08/05 10:33										
Arsenic	EPA 6020	**7.88**	-----	0.545	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:18	
Barium	"	**56.6**	-----	0.545	"	"	"	"	"	
Cadmium	"	**3.95**	-----	0.545	"	"	"	"	"	
Chromium	"	**23.1**	-----	2.72	"	5x	"	"	12/15/05 05:13	
Copper	"	**94.5**	-----	2.18	"	1x	"	"	12/14/05 08:18	
Iron	"	**30300**	-----	990	mg/kg	200x	"	"	12/16/05 10:58	**B-17**
Lead	"	**346**	-----	0.545	mg/kg dry	1x	"	"	12/14/05 08:18	
Manganese	"	**1220**	-----	5.45	"	5x	"	"	12/15/05 05:13	
Nickel	"	**19.2**	-----	1.09	"	1x	"	"	12/14/05 08:18	
Selenium	"	ND	-----	0.545	"	"	"	"	"	
Silver	"	ND	-----	0.545	"	"	"	"	"	
Zinc	"	**918**	-----	10.9	"	5x	"	"	12/15/05 05:13	
P5L0118-12 Soil WRS-2 Sampled: 11/08/05 10:38										
Arsenic	EPA 6020	**46.2**	-----	0.546	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:26	
Barium	"	**7.94**	-----	0.546	"	"	"	"	"	
Cadmium	"	**307**	-----	2.73	"	5x	"	"	12/15/05 07:52	
Chromium	"	**16.6**	-----	2.73	"	"	"	"	"	
Copper	"	**7600**	-----	437	"	200x	"	"	12/15/05 03:34	
Iron	"	**77000**	-----	980	mg/kg	"	"	"	12/16/05 11:14	**B-17**
Lead	"	**2050**	-----	109	mg/kg dry	"	"	"	12/15/05 03:34	
Manganese	"	**10200**	-----	218	"	"	"	"	"	
Nickel	"	**17.6**	-----	1.09	"	1x	"	"	12/14/05 08:26	
Selenium	"	**9.98**	-----	0.546	"	"	"	"	"	
Silver	"	**9.19**	-----	0.546	"	"	"	"	"	
Zinc	"	**64900**	-----	437	"	200x	"	"	12/15/05 03:34	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-13 Soil WRS-3 Sampled: 11/08/05 10:51										
Arsenic	EPA 6020	**22.8**	-----	0.522	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:33	
Barium	"	**10.2**	-----	0.522	"	"	"	"	"	
Cadmium	"	**171**	-----	0.522	"	"	"	"	"	
Chromium	"	**37.6**	-----	2.61	"	5x	"	"	12/15/05 08:00	
Copper	"	**1120**	-----	10.4	"	"	"	"	"	
Iron	"	**68200**	-----	952	mg/kg	200x	"	"	12/16/05 11:30	**B-17**
Lead	"	**14000**	-----	104	mg/kg dry	"	"	"	12/15/05 03:41	
Manganese	"	**15900**	-----	209	"	"	"	"	"	
Nickel	"	**23.7**	-----	1.04	"	1x	"	"	12/14/05 08:33	
Selenium	"	**6.56**	-----	0.522	"	"	"	"	"	
Silver	"	**7.62**	-----	0.522	"	"	"	"	"	
Zinc	"	**43600**	-----	418	"	200x	"	"	12/15/05 03:41	
P5L0118-14 Soil WRS-4 Sampled: 11/08/05 11:05										
Arsenic	EPA 6020	**23.7**	-----	0.532	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:41	
Barium	"	**10.0**	-----	0.532	"	"	"	"	"	
Cadmium	"	**422**	-----	2.66	"	5x	"	"	12/15/05 08:07	
Chromium	"	**19.6**	-----	2.66	"	"	"	"	"	
Copper	"	**2780**	-----	1060	"	500x	"	"	12/15/05 03:49	
Iron	"	**77000**	-----	980	mg/kg	200x	"	"	12/16/05 11:45	**B-17**
Lead	"	**34000**	-----	266	mg/kg dry	500x	"	"	12/15/05 03:49	
Manganese	"	**12900**	-----	532	"	"	"	"	"	
Nickel	"	**18.7**	-----	1.06	"	1x	"	"	12/14/05 08:41	
Selenium	"	**16.5**	-----	0.532	"	"	"	"	"	
Silver	"	**7.10**	-----	0.532	"	"	"	"	"	
Zinc	"	**98900**	-----	1060	"	500x	"	"	12/15/05 03:49	
P5L0118-15 Soil WRS-5 Sampled: 11/08/05 11:15										
Arsenic	EPA 6020	**22.0**	-----	0.575	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:48	
Barium	"	**11.5**	-----	0.575	"	"	"	"	"	
Cadmium	"	**227**	-----	28.7	"	50x	"	"	12/15/05 08:15	
Chromium	"	**23.2**	-----	2.87	"	5x	"	"	12/15/05 10:16	
Copper	"	**5480**	-----	115	"	50x	"	"	12/15/05 08:15	
Iron	"	**74000**	-----	1010	mg/kg	200x	"	"	12/16/05 12:32	**B-17**
Lead	"	**10800**	-----	28.7	mg/kg dry	50x	"	"	12/15/05 08:15	
Manganese	"	**13000**	-----	57.5	"	"	"	"	"	
Nickel	"	**22.9**	-----	1.15	"	1x	"	"	12/14/05 08:48	
Selenium	"	**6.67**	-----	0.575	"	"	"	"	"	
Silver	"	**9.66**	-----	0.575	"	"	"	"	"	
Zinc	"	**54800**	-----	460	"	200x	"	"	12/15/05 03:57	

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-16 Soil WRS-6 Sampled: 11/08/05 11:25										
Arsenic	EPA 6020	**26.9**	-----	0.612	mg/kg dry	1x	5120484	12/12/05	12/14/05 08:56	
Barium	"	**17.5**	-----	0.612	"	"	"	"	"	
Cadmium	"	**76.8**	-----	0.612	"	"	"	"	"	
Chromium	"	**18.0**	-----	3.06	"	5x	"	"	12/15/05 08:53	
Copper	"	**541**	-----	2.45	"	1x	"	"	12/14/05 08:56	
Iron	"	**35100**	-----	1020	mg/kg	200x	"	"	12/16/05 12:48	**B-17**
Lead	"	**4030**	-----	30.6	mg/kg dry	50x	"	"	12/15/05 05:20	
Manganese	"	**5480**	-----	61.2	"	"	"	"	"	
Nickel	"	**23.1**	-----	1.22	"	1x	"	"	12/14/05 08:56	
Selenium	"	**3.03**	-----	0.612	"	"	"	"	"	
Silver	"	**10.0**	-----	0.612	"	"	"	"	"	
Zinc	"	**17100**	-----	122	"	50x	"	"	12/15/05 05:20	
P5L0118-17 Soil WRS-7 Sampled: 11/08/05 11:56										
Arsenic	EPA 6020	**10.8**	-----	0.551	mg/kg dry	1x	5120484	12/12/05	12/14/05 09:18	
Barium	"	**28.1**	-----	0.551	"	"	"	"	"	
Cadmium	"	**17.2**	-----	0.551	"	"	"	"	"	
Chromium	"	**26.5**	-----	2.76	"	5x	"	"	12/15/05 09:00	
Copper	"	**134**	-----	2.21	"	1x	"	"	12/14/05 09:18	
Iron	"	**26800**	-----	1010	mg/kg	200x	"	"	12/16/05 13:03	**B-17**
Lead	"	**2440**	-----	11.0	mg/kg dry	20x	"	"	12/15/05 05:28	
Manganese	"	**5300**	-----	22.1	"	"	"	"	"	
Nickel	"	**31.6**	-----	1.10	"	1x	"	"	12/14/05 09:18	
Selenium	"	**2.97**	-----	0.551	"	"	"	"	"	
Silver	"	**4.98**	-----	0.551	"	"	"	"	"	
Zinc	"	**4370**	-----	44.1	"	20x	"	"	12/15/05 05:28	
P5L0118-18 Soil WRS-8 Sampled: 11/08/05 12:02										
Arsenic	EPA 6020	**15.4**	-----	0.526	mg/kg dry	1x	5120484	12/12/05	12/14/05 09:26	
Barium	"	**34.7**	-----	0.526	"	"	"	"	"	
Cadmium	"	**66.1**	-----	0.526	"	"	"	"	"	
Chromium	"	**32.9**	-----	2.63	"	5x	"	"	12/15/05 09:08	
Copper	"	**363**	-----	2.10	"	1x	"	"	12/14/05 09:26	
Iron	"	**33500**	-----	971	mg/kg	200x	"	"	12/16/05 13:19	**B-17**
Lead	"	**2670**	-----	26.3	mg/kg dry	50x	"	"	12/15/05 05:51	
Manganese	"	**7730**	-----	52.6	"	"	"	"	"	
Nickel	"	**40.6**	-----	1.05	"	1x	"	"	12/14/05 09:26	
Selenium	"	**2.05**	-----	0.526	"	"	"	"	"	
Silver	"	**5.51**	-----	0.526	"	"	"	"	"	
Zinc	"	**14800**	-----	105	"	50x	"	"	12/15/05 05:51	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-19 Soil WRS-9 Sampled: 11/08/05 12:08										
Arsenic	EPA 6020	**17.9**	-----	0.548	mg/kg dry	1x	5120484	12/12/05	12/14/05 09:34	
Barium	"	**16.3**	-----	0.548	"	"	"	"	"	
Cadmium	"	**33.3**	-----	0.548	"	"	"	"	"	
Chromium	"	**34.6**	-----	2.74	"	5x	"	"	12/15/05 09:15	
Copper	"	**202**	-----	2.19	"	1x	"	"	12/14/05 09:34	
Iron	"	**36800**	-----	990	mg/kg	200x	"	"	12/16/05 13:35	**B-17**
Lead	"	**1480**	-----	11.0	mg/kg dry	20x	"	"	12/15/05 05:59	
Manganese	"	**6360**	-----	21.9	"	"	"	"	"	
Nickel	"	**35.7**	-----	1.10	"	1x	"	"	12/14/05 09:34	
Selenium	"	**1.02**	-----	0.548	"	"	"	"	"	
Silver	"	**3.63**	-----	0.548	"	"	"	"	"	
Zinc	"	**7630**	-----	43.9	"	20x	"	"	12/15/05 05:59	
P5L0118-20 Soil WRS-10 Sampled: 11/08/05 12:13										
Arsenic	EPA 6020	**26.9**	-----	0.572	mg/kg dry	1x	5120484	12/12/05	12/14/05 09:41	
Barium	"	**28.2**	-----	0.572	"	"	"	"	"	
Cadmium	"	**68.4**	-----	0.572	"	"	"	"	"	
Chromium	"	**13.8**	-----	2.86	"	5x	"	"	12/15/05 09:23	
Copper	"	**462**	-----	2.29	"	1x	"	"	12/14/05 09:41	
Iron	"	**24200**	-----	1010	mg/kg	200x	"	"	12/16/05 13:51	**B-17**
Lead	"	**2410**	-----	5.72	mg/kg dry	10x	"	"	12/15/05 06:06	
Manganese	"	**4640**	-----	11.4	"	"	"	"	"	
Nickel	"	**22.7**	-----	1.14	"	1x	"	"	12/14/05 09:41	
Selenium	"	**2.06**	-----	0.572	"	"	"	"	"	
Silver	"	**6.49**	-----	0.572	"	"	"	"	"	
Zinc	"	**15200**	-----	114	"	50x	"	"	12/15/05 10:09	

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-01	**Soil**	**BG-1**	**Sampled: 11/08/05 12:28**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 14:31	
Barium		"	**0.0472**	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**1.03**	-----	0.0500	"	"	"	"	12/16/05 16:42	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/15/05 14:31	
Manganese		"	**0.0550**	-----	0.0100	"	"	"	"	"	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-02	**Soil**	**BG-2**	**Sampled: 11/09/05 10:55**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 15:09	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**0.391**	-----	0.0500	"	"	"	"	12/19/05 23:02	
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/15/05 15:09	
Manganese		"	**0.0132**	-----	0.0100	"	"	"	"	"	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-03	**Soil**	**BG-3**	**Sampled: 11/09/05 11:10**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 20:33	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	ND	-----	0.0500	"	"	"	"	12/16/05 18:00	**B-18**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 12:15	
Manganese		"	ND	-----	0.0100	"	"	"	"	12/15/05 20:33	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-04	**Soil**	**BG-4**	**Sampled: 11/09/05 11:15**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 20:41	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**4.25**	-----	0.0500	"	"	"	"	12/16/05 18:16	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 12:22	
Manganese		"	**0.0264**	-----	0.0100	"	"	"	"	12/15/05 20:41	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-05	**Soil**	**BG-5**	**Sampled: 11/09/05 11:39**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 20:49	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**4.47**	-----	0.0500	"	"	"	"	12/16/05 18:31	**B-17**
Lead		1312/6020	**0.237**	-----	0.0250	"	"	"	"	12/16/05 12:30	
Manganese		"	**0.665**	-----	0.0100	"	"	"	"	12/15/05 20:49	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	**0.146**	-----	0.125	"	"	"	"	"	
P5L0118-06	**Soil**	**BG-6**	**Sampled: 11/09/05 11:45**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 20:56	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**4.24**	-----	0.0500	"	"	"	"	12/16/05 19:18	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 12:38	
Manganese		"	**0.143**	-----	0.0100	"	"	"	"	12/15/05 20:56	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-07	**Soil**	**BG-7**	**Sampled: 11/09/05 11:55**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 21:19	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**3.88**	-----	0.0500	"	"	"	"	12/16/05 19:34	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 12:45	
Manganese		"	**0.149**	-----	0.0100	"	"	"	"	12/15/05 21:19	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-08	**Soil**	**BG-8**	**Sampled: 11/09/05 12:02**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 21:27	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**3.76**	-----	0.0500	"	"	"	"	12/16/05 19:49	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 12:53	
Manganese		"	**0.132**	-----	0.0100	"	"	"	"	12/15/05 21:27	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-09	**Soil**	**BG-9**	**Sampled: 11/09/05 13:10**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 21:34	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**1.50**	-----	0.0500	"	"	"	"	12/16/05 20:05	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 13:01	
Manganese		"	**0.0588**	-----	0.0100	"	"	"	"	12/15/05 21:34	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	**0.176**	-----	0.125	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-10	**Soil**	**BG-10**	**Sampled: 11/09/05 13:15**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 21:42	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**1.33**	-----	0.0500	"	"	"	"	12/16/05 20:20	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 13:08	
Manganese		"	**0.0380**	-----	0.0100	"	"	"	"	12/15/05 21:42	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-11	**Soil**	**WRS-1**	**Sampled: 11/08/05 10:33**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 21:50	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**1.30**	-----	0.0500	"	"	"	"	12/16/05 20:36	**B-17**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 13:16	
Manganese		"	**0.0447**	-----	0.0100	"	"	"	"	12/15/05 21:50	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-12	**Soil**	**WRS-2**	**Sampled: 11/08/05 10:38**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 21:57	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	ND	-----	0.0500	"	"	"	"	12/16/05 20:52	**B-18**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 13:24	
Manganese		"	**0.0158**	-----	0.0100	"	"	"	"	12/15/05 21:57	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-13	**Soil**	**WRS-3**	**Sampled: 11/08/05 10:51**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 22:05	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	ND	-----	0.0500	"	"	"	"	12/16/05 21:07	**B-18**
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 13:46	
Manganese		"	**0.201**	-----	0.0100	"	"	"	"	12/15/05 22:05	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-14	**Soil**	**WRS-4**	**Sampled: 11/08/05 11:05**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 22:13	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	ND	-----	0.0500	"	"	"	"	12/19/05 23:18	
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 13:54	
Manganese		"	**0.202**	-----	0.0100	"	"	"	"	12/15/05 22:13	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-15	**Soil**	**WRS-5**	**Sampled: 11/08/05 11:15**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 22:20	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**0.121**	-----	0.0500	"	"	"	"	12/19/05 23:34	
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 14:02	
Manganese		"	**0.0154**	-----	0.0100	"	"	"	"	12/15/05 22:20	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-16	**Soil**	**WRS-6**	**Sampled: 11/08/05 11:25**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 22:28	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**0.815**	-----	0.0500	"	"	"	"	12/16/05 22:25	**B-17**
Lead		1312/6020	**0.0291**	-----	0.0250	"	"	"	"	12/16/05 14:09	
Manganese		"	**0.0661**	-----	0.0100	"	"	"	"	12/15/05 22:28	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	"	
Silver		"	ND	-----	0.0250	"	"	"	"	"	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-17	**Soil**	**WRS-7**	**Sampled: 11/08/05 11:56**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 22:51	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**1.79**	-----	0.0500	"	"	"	"	12/16/05 22:41	**B-17**
Lead		1312/6020	**0.108**	-----	0.0250	"	"	"	"	12/16/05 14:17	
Manganese		"	**0.235**	-----	0.0100	"	"	"	"	12/15/05 22:51	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	12/16/05 14:17	
Silver		"	ND	-----	0.0250	"	"	"	"	12/15/05 22:51	
Zinc		"	**0.368**	-----	0.125	"	"	"	"	"	
P5L0118-18	**Soil**	**WRS-8**	**Sampled: 11/08/05 12:02**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 22:58	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**0.165**	-----	0.0500	"	"	"	"	12/19/05 23:49	
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 14:25	
Manganese		"	**0.0278**	-----	0.0100	"	"	"	"	12/15/05 22:58	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	12/16/05 14:25	
Silver		"	ND	-----	0.0250	"	"	"	"	12/15/05 22:58	
Zinc		"	ND	-----	0.125	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-19	**Soil**	**WRS-9**	**Sampled: 11/08/05 12:08**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 23:06	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**0.238**	-----	0.0500	"	"	"	"	12/20/05 00:05	
Lead		1312/6020	ND	-----	0.0250	"	"	"	"	12/16/05 14:32	
Manganese		"	**0.0358**	-----	0.0100	"	"	"	"	12/15/05 23:06	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	12/16/05 14:32	
Silver		"	ND	-----	0.0250	"	"	"	"	12/15/05 23:06	
Zinc		"	ND	-----	0.125	"	"	"	"	"	
P5L0118-20	**Soil**	**WRS-10**	**Sampled: 11/08/05 12:13**								
Arsenic		1312/6020	ND	-----	0.0250	mg/l	0.5x	5120530	12/13/05	12/15/05 23:13	
Barium		"	ND	-----	0.0250	"	"	"	"	"	
Cadmium		"	ND	-----	0.0250	"	"	"	"	"	
Chromium		"	ND	-----	0.0250	"	"	"	"	"	
Copper		"	ND	-----	0.250	"	"	"	"	"	
Iron		EPA 1312/6020	**1.25**	-----	0.0500	"	"	"	"	12/16/05 23:28	**B-17**
Lead		1312/6020	**0.0848**	-----	0.0250	"	"	"	"	12/16/05 14:40	
Manganese		"	**0.199**	-----	0.0100	"	"	"	"	12/15/05 23:13	
Nickel		"	ND	-----	0.0250	"	"	"	"	"	
Selenium		"	ND	-----	0.0250	"	"	"	"	12/16/05 14:40	
Silver		"	ND	-----	0.0250	"	"	"	"	12/15/05 23:13	
Zinc		"	**0.273**	-----	0.125	"	"	"	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Mercury per EPA Method 7471A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-01	**Soil**	**BG-1**	**Sampled: 11/08/05 12:28**								
Mercury		EPA 7471A	ND	-----	0.0876	mg/kg dry	1x	5120155	12/05/05	12/05/05 11:54	
P5L0118-02	**Soil**	**BG-2**	**Sampled: 11/09/05 10:55**								
Mercury		EPA 7471A	ND	-----	0.0891	mg/kg dry	1x	5120155	12/05/05	12/05/05 11:56	
P5L0118-03	**Soil**	**BG-3**	**Sampled: 11/09/05 11:10**								
Mercury		EPA 7471A	ND	-----	0.0972	mg/kg dry	1x	5120155	12/05/05	12/05/05 11:58	
P5L0118-04	**Soil**	**BG-4**	**Sampled: 11/09/05 11:15**								
Mercury		EPA 7471A	ND	-----	0.0593	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:00	
P5L0118-05	**Soil**	**BG-5**	**Sampled: 11/09/05 11:39**								
Mercury		EPA 7471A	**0.121**	-----	0.0832	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:08	
P5L0118-06	**Soil**	**BG-6**	**Sampled: 11/09/05 11:45**								
Mercury		EPA 7471A	ND	-----	0.0627	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:10	
P5L0118-07	**Soil**	**BG-7**	**Sampled: 11/09/05 11:55**								
Mercury		EPA 7471A	**0.123**	-----	0.0821	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:12	
P5L0118-08	**Soil**	**BG-8**	**Sampled: 11/09/05 12:02**								
Mercury		EPA 7471A	ND	-----	0.103	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:15	
P5L0118-09	**Soil**	**BG-9**	**Sampled: 11/09/05 13:10**								
Mercury		EPA 7471A	ND	-----	0.0879	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:17	
P5L0118-10	**Soil**	**BG-10**	**Sampled: 11/09/05 13:15**								
Mercury		EPA 7471A	ND	-----	0.0659	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:19	
P5L0118-11	**Soil**	**WRS-1**	**Sampled: 11/08/05 10:33**								
Mercury		EPA 7471A	**0.135**	-----	0.0671	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:21	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Mercury per EPA Method 7471A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-12	**Soil**	**WRS-2**	**Sampled: 11/08/05 10:38**								
Mercury		EPA 7471A	**1.87**	-----	0.268	mg/kg dry	5x	5120155	12/05/05	12/05/05 12:53	
P5L0118-13	**Soil**	**WRS-3**	**Sampled: 11/08/05 10:51**								
Mercury		EPA 7471A	**0.548**	-----	0.0783	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:28	
P5L0118-14	**Soil**	**WRS-4**	**Sampled: 11/08/05 11:05**								
Mercury		EPA 7471A	**0.431**	-----	0.0847	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:31	
P5L0118-15	**Soil**	**WRS-5**	**Sampled: 11/08/05 11:15**								
Mercury		EPA 7471A	**0.378**	-----	0.0547	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:38	
P5L0118-16	**Soil**	**WRS-6**	**Sampled: 11/08/05 11:25**								
Mercury		EPA 7471A	**1.11**	-----	0.0790	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:41	
P5L0118-17	**Soil**	**WRS-7**	**Sampled: 11/08/05 11:56**								
Mercury		EPA 7471A	ND	-----	0.0880	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:44	
P5L0118-18	**Soil**	**WRS-8**	**Sampled: 11/08/05 12:02**								
Mercury		EPA 7471A	**0.126**	-----	0.0602	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:46	
P5L0118-19	**Soil**	**WRS-9**	**Sampled: 11/08/05 12:08**								
Mercury		EPA 7471A	**0.370**	-----	0.0615	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:48	
P5L0118-20	**Soil**	**WRS-10**	**Sampled: 11/08/05 12:13**								
Mercury		EPA 7471A	**0.341**	-----	0.0976	mg/kg dry	1x	5120155	12/05/05	12/05/05 12:50	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Mercury per EPA Methods 1312/7470A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-01	**Soil**	**BG-1**	**Sampled: 11/08/05 12:28**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:15	
P5L0118-02	**Soil**	**BG-2**	**Sampled: 11/09/05 10:55**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:17	
P5L0118-03	**Soil**	**BG-3**	**Sampled: 11/09/05 11:10**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:20	
P5L0118-04	**Soil**	**BG-4**	**Sampled: 11/09/05 11:15**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:22	
P5L0118-05	**Soil**	**BG-5**	**Sampled: 11/09/05 11:39**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:24	
P5L0118-06	**Soil**	**BG-6**	**Sampled: 11/09/05 11:45**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:26	
P5L0118-07	**Soil**	**BG-7**	**Sampled: 11/09/05 11:55**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:28	
P5L0118-08	**Soil**	**BG-8**	**Sampled: 11/09/05 12:02**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:31	
P5L0118-09	**Soil**	**BG-9**	**Sampled: 11/09/05 13:10**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:33	
P5L0118-10	**Soil**	**BG-10**	**Sampled: 11/09/05 13:15**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:35	
P5L0118-11	**Soil**	**WRS-1**	**Sampled: 11/08/05 10:33**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:43	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name: **Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number: Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager: Steve Nelson	12/30/05 14:00

SPLP Mercury per EPA Methods 1312/7470A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-12	**Soil**	**WRS-2**	**Sampled: 11/08/05 10:38**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:45	
P5L0118-13	**Soil**	**WRS-3**	**Sampled: 11/08/05 10:51**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:47	
P5L0118-14	**Soil**	**WRS-4**	**Sampled: 11/08/05 11:05**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:50	
P5L0118-15	**Soil**	**WRS-5**	**Sampled: 11/08/05 11:15**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:52	
P5L0118-16	**Soil**	**WRS-6**	**Sampled: 11/08/05 11:25**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:54	
P5L0118-17	**Soil**	**WRS-7**	**Sampled: 11/08/05 11:56**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:56	
P5L0118-18	**Soil**	**WRS-8**	**Sampled: 11/08/05 12:02**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 14:59	
P5L0118-19	**Soil**	**WRS-9**	**Sampled: 11/08/05 12:08**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 15:01	
P5L0118-20	**Soil**	**WRS-10**	**Sampled: 11/08/05 12:13**								
Mercury		1312/7470A	ND	-----	0.000200	mg/l	1x	5120335	12/08/05	12/08/05 15:03	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Hexavalent Chromium per EPA Method 3060A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-01	**Soil**	**BG-1**	**Sampled: 11/08/05 12:28**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.27	mg/kg dry	1x	5120301	12/07/05	12/09/05 15:13	
P5L0118-02	**Soil**	**BG-2**	**Sampled: 11/09/05 10:55**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.16	mg/kg dry	1x	5120301	12/07/05	12/09/05 14:48	
P5L0118-03	**Soil**	**BG-3**	**Sampled: 11/09/05 11:10**								
Hexavalent Chromium		EPA 3060A	**442**	-----	2.46	mg/kg dry	2x	5120301	12/07/05	12/12/05 12:48	
P5L0118-04	**Soil**	**BG-4**	**Sampled: 11/09/05 11:15**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.15	mg/kg dry	1x	5120301	12/07/05	12/09/05 15:18	
P5L0118-05	**Soil**	**BG-5**	**Sampled: 11/09/05 11:39**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.21	mg/kg dry	1x	5120301	12/07/05	12/09/05 15:23	
P5L0118-06	**Soil**	**BG-6**	**Sampled: 11/09/05 11:45**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.24	mg/kg dry	1x	5120301	12/07/05	12/09/05 15:28	
P5L0118-07	**Soil**	**BG-7**	**Sampled: 11/09/05 11:55**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.12	mg/kg dry	1x	5120301	12/07/05	12/09/05 15:33	
P5L0118-08	**Soil**	**BG-8**	**Sampled: 11/09/05 12:02**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.19	mg/kg dry	1x	5120301	12/07/05	12/12/05 11:58	
P5L0118-09	**Soil**	**BG-9**	**Sampled: 11/09/05 13:10**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.19	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:03	
P5L0118-10	**Soil**	**BG-10**	**Sampled: 11/09/05 13:15**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.16	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:18	
P5L0118-11	**Soil**	**WRS-1**	**Sampled: 11/08/05 10:33**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.12	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name: **Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number: Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager: Steve Nelson	12/30/05 14:00

Hexavalent Chromium per EPA Method 3060A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-12	**Soil**	**WRS-2**	**Sampled: 11/08/05 10:38**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.09	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:28	
P5L0118-13	**Soil**	**WRS-3**	**Sampled: 11/08/05 10:51**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.06	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:33	
P5L0118-14	**Soil**	**WRS-4**	**Sampled: 11/08/05 11:05**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.05	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:38	
P5L0118-15	**Soil**	**WRS-5**	**Sampled: 11/08/05 11:15**								
Hexavalent Chromium		EPA 3060A	ND	-----	1.17	mg/kg dry	1x	5120301	12/07/05	12/12/05 12:43	
P5L0118-16	**Soil**	**WRS-6**	**Sampled: 11/08/05 11:25**								
Hexavalent Chromium		EPA 3060A	ND	-----	0.758	mg/kg dry	200x	5120369	12/08/05	12/14/05 22:48	**A-01, B-18**
P5L0118-17	**Soil**	**WRS-7**	**Sampled: 11/08/05 11:56**								
Hexavalent Chromium		EPA 3060A	ND	-----	0.689	mg/kg dry	200x	5120369	12/08/05	12/14/05 23:35	**A-01, B-18**
P5L0118-18	**Soil**	**WRS-8**	**Sampled: 11/08/05 12:02**								
Hexavalent Chromium		EPA 3060A	ND	-----	0.637	mg/kg dry	200x	5120369	12/08/05	12/14/05 23:51	**A-01, B-18**
P5L0118-19	**Soil**	**WRS-9**	**Sampled: 11/08/05 12:08**								
Hexavalent Chromium		EPA 3060A	ND	-----	0.671	mg/kg dry	200x	5120369	12/08/05	12/15/05 00:06	**B-18, A-01**
P5L0118-20	**Soil**	**WRS-10**	**Sampled: 11/08/05 12:13**								
Hexavalent Chromium		EPA 3060A	ND	-----	0.715	mg/kg dry	200x	5120369	12/08/05	12/15/05 00:22	**B-18, A-01**

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Percent Dry Weight (Solids) per Standard Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-01	**Soil**	**BG-1**	**Sampled: 11/08/05 12:28**								
% Solids		NCA SOP	**79.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-02	**Soil**	**BG-2**	**Sampled: 11/09/05 10:55**								
% Solids		NCA SOP	**87.7**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-03	**Soil**	**BG-3**	**Sampled: 11/09/05 11:10**								
% Solids		NCA SOP	**85.7**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-04	**Soil**	**BG-4**	**Sampled: 11/09/05 11:15**								
% Solids		NCA SOP	**86.1**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-05	**Soil**	**BG-5**	**Sampled: 11/09/05 11:39**								
% Solids		NCA SOP	**81.2**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-06	**Soil**	**BG-6**	**Sampled: 11/09/05 11:45**								
% Solids		NCA SOP	**84.8**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-07	**Soil**	**BG-7**	**Sampled: 11/09/05 11:55**								
% Solids		NCA SOP	**92.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-08	**Soil**	**BG-8**	**Sampled: 11/09/05 12:02**								
% Solids		NCA SOP	**86.9**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-09	**Soil**	**BG-9**	**Sampled: 11/09/05 13:10**								
% Solids		NCA SOP	**81.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-10	**Soil**	**BG-10**	**Sampled: 11/09/05 13:15**								
% Solids		NCA SOP	**84.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-11	**Soil**	**WRS-1**	**Sampled: 11/08/05 10:33**								
% Solids		NCA SOP	**90.9**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Percent Dry Weight (Solids) per Standard Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5L0118-12	**Soil**	**WRS-2**	**Sampled: 11/08/05 10:38**								
% Solids		NCA SOP	**89.8**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-13	**Soil**	**WRS-3**	**Sampled: 11/08/05 10:51**								
% Solids		NCA SOP	**91.2**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-14	**Soil**	**WRS-4**	**Sampled: 11/08/05 11:05**								
% Solids		NCA SOP	**92.2**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-15	**Soil**	**WRS-5**	**Sampled: 11/08/05 11:15**								
% Solids		NCA SOP	**87.9**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-16	**Soil**	**WRS-6**	**Sampled: 11/08/05 11:25**								
% Solids		NCA SOP	**83.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-17	**Soil**	**WRS-7**	**Sampled: 11/08/05 11:56**								
% Solids		NCA SOP	**91.6**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-18	**Soil**	**WRS-8**	**Sampled: 11/08/05 12:02**								
% Solids		NCA SOP	**92.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-19	**Soil**	**WRS-9**	**Sampled: 11/08/05 12:08**								
% Solids		NCA SOP	**90.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	
P5L0118-20	**Soil**	**WRS-10**	**Sampled: 11/08/05 12:13**								
% Solids		NCA SOP	**88.3**	-----	1.00	% by Weight	1x	5120235	12/06/05	12/07/05 11:46	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120483 **Soil Preparation Method: EPA 3050**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120483-BLK1)								Extracted: 12/12/05 12:42						
Arsenic	EPA 6020	ND	---	0.510	mg/kg	1x	--	--	--	--	--	--	12/14/05 02:37	
Barium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Cadmium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Chromium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Copper	"	ND	---	2.04	"	"	--	--	--	--	--	--	"	
Iron	"	16.9	---	1.02	"	0.2x	--	--	--	--	--	--	12/16/05 02:55	B
Lead	"	ND	---	0.510	"	1x	--	--	--	--	--	--	12/14/05 02:37	
Manganese	"	ND	---	1.02	"	"	--	--	--	--	--	--	"	
Nickel	"	ND	---	1.02	"	"	--	--	--	--	--	--	"	
Selenium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Silver	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Zinc	"	ND	---	2.04	"	"	--	--	--	--	--	--	"	
LCS (5120483-BS1)								Extracted: 12/12/05 12:42						
Arsenic	EPA 6020	10.6	---	0.526	mg/kg	1x	--	10.5	101%	(80-120)	--	--	12/14/05 02:29	
Barium	"	10.8	---	0.526	"	"	--	"	103%	"	--	--	"	
Cadmium	"	10.2	---	0.526	"	"	--	"	97.1%	"	--	--	"	
Chromium	"	10.3	---	0.526	"	"	--	"	98.1%	"	--	--	"	
Copper	"	10.7	---	2.11	"	"	--	"	102%	"	--	--	"	
Iron	"	103	---	2.63	"	0.5x	--	105	98.1%	(75-125)	--	--	12/16/05 09:40	
Lead	"	10.4	---	0.526	"	1x	--	10.5	99.0%	(80-120)	--	--	12/14/05 02:29	
Manganese	"	10.3	---	1.05	"	"	--	"	98.1%	"	--	--	"	
Nickel	"	10.5	---	1.05	"	"	--	"	100%	"	--	--	"	
Selenium	"	4.96	---	0.526	"	"	--	5.26	94.3%	"	--	--	"	
Silver	"	5.16	---	0.526	"	"	--	"	98.1%	"	--	--	"	
Zinc	"	9.52	---	2.11	"	"	--	10.5	90.7%	"	--	--	"	
Duplicate (5120483-DUP1)				QC Source: P5L0074-05				Extracted: 12/12/05 12:42						
Arsenic	EPA 6020	39.9	---	0.599	mg/kg dry	1x	39.4	--	--	--	1.26%	(40)	12/14/05 02:52	
Barium	"	95.5	---	0.599	"	"	138	--	--	--	36.4%	"	"	
Cadmium	"	ND	---	0.599	"	"	ND	--	--	--	NR	"	"	
Chromium	"	22.5	---	0.599	"	"	31.0	--	--	--	31.8%	"	"	
Copper	"	131	---	2.40	"	"	164	--	--	--	22.4%	"	"	
Iron	"	18600	---	1050	mg/kg	200x	32000	--	--	--	53.0%	"	12/16/05 03:27	Q-07
Lead	"	62.6	---	0.599	mg/kg dry	1x	95.0	--	--	--	41.1%	"	12/14/05 02:52	Q-14
Manganese	"	441	---	1.20	"	"	586	--	--	--	28.2%	"	"	Q-14
Nickel	"	13.9	---	1.20	"	"	57.8	--	--	--	122%	"	"	Q-14
Selenium	"	ND	---	0.599	"	"	ND	--	--	--	NR	"	"	
Silver	"	ND	---	0.599	"	"	ND	--	--	--	16.1%	"	"	
Zinc	"	384	---	2.40	"	"	497	--	--	--	25.7%	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120483 **Soil Preparation Method: EPA 3050**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5120483-MS1)				**QC Source: P5L0074-05**				**Extracted: 12/12/05 12:42**						
Arsenic	EPA 6020	66.5	---	0.547	mg/kg dry	1x	39.4	10.9	249%	(75-125)	--	--	12/14/05 03:07	Q-02
Barium	"	151	---	0.547	"	"	138	"	119%	"	--	--	"	
Cadmium	"	9.93	---	0.547	"	"	ND	"	91.1%	"	--	--	"	
Chromium	"	47.3	---	0.547	"	"	31.0	"	150%	"	--	--	"	Q-02
Copper	"	237	---	2.19	"	"	164	"	>300%	"	--	--	"	Q-02
Iron	"	29100	---	962	mg/kg	200x	32000	96.2	NR	"	--	--	12/16/05 03:43	Q-07
Lead	"	111	---	0.547	mg/kg dry	1x	95.0	10.9	147%	"	--	--	12/14/05 03:07	Q-02
Manganese	"	636	---	5.47	"	5x	586	"	>300%	"	--	--	12/14/05 03:00	Q-07
Nickel	"	42.0	---	1.09	"	1x	57.8	"	NR	"	--	--	12/14/05 03:07	Q-02
Selenium	"	5.40	---	0.547	"	"	ND	5.47	98.7%	"	--	--	"	
Silver	"	5.55	---	0.547	"	"	0.154	"	98.6%	"	--	--	"	
Zinc	"	586	---	10.9	"	5x	497	10.9	>300%	"	--	--	12/14/05 03:00	Q-07
Matrix Spike (5120483-MS2)				**QC Source: P5L0074-06**				**Extracted: 12/12/05 12:42**						
Arsenic	EPA 6020	18.8	---	0.548	mg/kg dry	1x	5.40	11.0	122%	(75-125)	--	--	12/14/05 03:45	
Barium	"	176	---	0.548	"	"	130	"	>300%	"	--	--	"	Q-02
Cadmium	"	8.16	---	0.548	"	"	ND	"	74.2%	"	--	--	"	Q-02
Chromium	"	41.9	---	0.548	"	"	14.3	"	251%	"	--	--	"	Q-02
Copper	"	111	---	2.19	"	"	72.3	"	>300%	"	--	--	"	Q-02
Iron	"	32900	---	1030	mg/kg	200x	29800	103	>300%	"	--	--	12/16/05 04:30	Q-07
Lead	"	118	---	0.548	mg/kg dry	1x	55.1	11.0	>300%	"	--	--	12/14/05 03:45	Q-02
Manganese	"	661	---	2.19	"	2x	562	"	>300%	"	--	--	12/15/05 00:08	Q-07
Nickel	"	23.4	---	1.10	"	1x	8.27	"	138%	"	--	--	12/14/05 03:45	Q-02
Selenium	"	4.97	---	0.548	"	"	ND	5.48	90.7%	"	--	--	"	
Silver	"	5.33	---	0.548	"	"	0.115	"	95.2%	"	--	--	"	
Zinc	"	536	---	4.38	"	2x	273	11.0	>300%	"	--	--	12/15/05 00:08	Q-07
Post Spike (5120483-PS1)				**QC Source: P5L0074-05**				**Extracted: 12/12/05 12:42**						
Arsenic	EPA 6020	1.20	---		ug/ml	1x	0.666	0.200	267%	(75-125)	--	--	12/14/05 03:30	Q-02
Barium	"	2.93	---		"	"	2.33	"	300%	"	--	--	"	Q-02
Cadmium	"	0.178	---		"	"	-0.00774	"	92.9%	"	--	--	"	
Chromium	"	1.11	---		"	"	0.523	"	294%	"	--	--	"	Q-02
Copper	"	4.91	---		"	"	2.77	"	>300%	"	--	--	"	Q-02
Iron	"	719	---		"	200x	615	2.00	>300%	"	--	--	12/16/05 03:58	Q-07
Lead	"	2.15	---		"	1x	1.60	0.200	275%	"	--	--	12/14/05 03:30	Q-02
Manganese	"	11.4	---		"	2x	9.89	"	>300%	"	--	--	12/14/05 23:52	Q-07
Nickel	"	0.721	---		"	1x	0.976	"	NR	"	--	--	12/14/05 03:30	Q-02
Selenium	"	0.0881	---		"	"	0.00132	0.100	86.8%	"	--	--	"	
Silver	"	0.0992	---		"	"	0.00260	"	96.6%	"	--	--	"	
Zinc	"	12.6	---		"	2x	8.38	0.200	>300%	"	--	--	12/14/05 23:52	Q-07

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120484 **Soil Preparation Method: EPA 3050**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120484-BLK1)								Extracted: 12/12/05 12:44						
Arsenic	EPA 6020	ND	---	0.515	mg/kg	1x	--	--	--	--	--	--	12/14/05 05:54	
Barium	"	ND	---	0.515	"	"	--	--	--	--	--	--	"	
Cadmium	"	ND	---	0.515	"	"	--	--	--	--	--	--	"	
Chromium	"	ND	---	0.515	"	"	--	--	--	--	--	--	12/15/05 09:45	
Copper	"	ND	---	2.06	"	"	--	--	--	--	--	--	12/14/05 05:54	
Iron	"	8.40	---	1.03	"	0.2x	--	--	--	--	--	--	12/16/05 06:03	B
Lead	"	ND	---	0.515	"	1x	--	--	--	--	--	--	12/14/05 05:54	
Manganese	"	ND	---	1.03	"	"	--	--	--	--	--	--	12/15/05 09:45	
Nickel	"	ND	---	1.03	"	"	--	--	--	--	--	--	12/14/05 05:54	
Selenium	"	ND	---	0.515	"	"	--	--	--	--	--	--	"	
Silver	"	ND	---	0.515	"	"	--	--	--	--	--	--	"	
Zinc	"	ND	---	2.06	"	"	--	--	--	--	--	--	"	
LCS (5120484-BS1)								Extracted: 12/12/05 12:44						
Arsenic	EPA 6020	10.1	---	0.495	mg/kg	1x	--	9.90	102%	(80-120)	--	--	12/14/05 06:17	
Barium	"	10.1	---	0.495	"	"	--	"	102%	"	--	--	"	
Cadmium	"	8.81	---	0.495	"	"	--	"	89.0%	"	--	--	"	
Chromium	"	9.16	---	0.495	"	"	--	"	92.5%	"	--	--	12/15/05 09:53	
Copper	"	10.8	---	1.98	"	"	--	"	109%	"	--	--	12/14/05 06:17	
Iron	"	87.9	---	0.990	"	0.2x	--	99.0	88.8%	(75-125)	--	--	12/16/05 06:19	
Lead	"	9.77	---	0.495	"	1x	--	9.90	98.7%	(80-120)	--	--	12/14/05 06:17	Q-23
Manganese	"	9.24	---	0.990	"	"	--	"	93.3%	"	--	--	12/15/05 09:53	Q-23
Nickel	"	10.3	---	0.990	"	"	--	"	104%	"	--	--	12/14/05 06:17	
Selenium	"	4.59	---	0.495	"	"	--	4.95	92.7%	"	--	--	"	
Silver	"	4.86	---	0.495	"	"	--	"	98.2%	"	--	--	"	
Zinc	"	9.56	---	1.98	"	"	--	9.90	96.6%	"	--	--	"	Q-23
Duplicate (5120484-DUP1)				QC Source: P5L0118-03				Extracted: 12/12/05 12:44						
Arsenic	EPA 6020	2.38	---	0.614	mg/kg dry	1x	3.23	--	--	--	30.3%	(40)	12/14/05 06:32	
Barium	"	56.9	---	0.614	"	"	75.7	--	--	--	28.4%	"	"	
Cadmium	"	ND	---	0.614	"	"	ND	--	--	--	NR	"	"	
Chromium	"	16.1	---	0.614	"	"	18.8	--	--	--	15.5%	"	12/15/05 06:36	
Copper	"	37.9	---	2.46	"	"	57.4	--	--	--	40.9%	"	12/14/05 06:32	Q-14
Iron	"	18400	---	1050	mg/kg	200x	19100	--	--	--	3.73%	"	12/16/05 06:50	
Lead	"	16.6	---	0.614	mg/kg dry	1x	20.9	--	--	--	22.9%	"	12/14/05 06:32	
Manganese	"	328	---	1.23	"	"	450	--	--	--	31.4%	"	12/15/05 06:36	
Nickel	"	24.1	---	1.23	"	"	25.6	--	--	--	6.04%	"	12/14/05 06:32	
Selenium	"	ND	---	0.614	"	"	ND	--	--	--	NR	"	"	
Silver	"	ND	---	0.614	"	"	ND	--	--	--	3.49%	"	"	
Zinc	"	72.0	---	2.46	"	"	86.7	--	--	--	18.5%	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120484 **Soil Preparation Method: EPA 3050**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5120484-MS1)				**QC Source: P5L0118-03**				**Extracted: 12/12/05 12:44**						
Arsenic	EPA 6020	13.5	---	0.578	mg/kg dry	1x	3.23	11.6	88.5%	(75-125)	--	--	12/14/05 06:47	
Barium	"	73.2	---	0.578	"	"	75.7	"	NR	"	--	--	"	Q-02
Cadmium	"	9.45	---	0.578	"	"	ND	"	81.5%	"	--	--	"	
Chromium	"	28.4	---	0.578	"	"	18.8	"	82.8%	"	--	--	12/15/05 06:44	
Copper	"	62.3	---	2.31	"	"	57.4	"	42.2%	"	--	--	12/14/05 06:47	Q-02
Iron	"	15300	---	990	mg/kg	200x	19100	99.0	NR	"	--	--	12/16/05 07:06	Q-07
Lead	"	29.8	---	0.578	mg/kg dry	1x	20.9	11.6	76.7%	"	--	--	12/14/05 06:47	
Manganese	"	369	---	1.16	"	"	450	"	NR	"	--	--	12/15/05 06:44	Q-02
Nickel	"	35.1	---	1.16	"	"	25.6	"	81.9%	"	--	--	12/14/05 06:47	
Selenium	"	5.07	---	0.578	"	"	ND	5.78	87.7%	"	--	--	"	
Silver	"	5.75	---	0.578	"	"	0.204	"	96.0%	"	--	--	"	
Zinc	"	90.0	---	2.31	"	"	86.7	11.6	28.4%	"	--	--	"	Q-02
Matrix Spike (5120484-MS2)				**QC Source: P5L0118-04**				**Extracted: 12/12/05 12:44**						
Arsenic	EPA 6020	47.5	---	0.581	mg/kg dry	1x	30.5	11.6	147%	(75-125)	--	--	12/14/05 07:10	Q-02
Barium	"	60.8	---	0.581	"	"	21.4	"	>300%	"	--	--	"	Q-02
Cadmium	"	91.1	---	0.581	"	"	98.4	"	NR	"	--	--	"	Q-02
Chromium	"	31.2	---	2.90	"	5x	20.5	"	92.2%	"	--	--	12/15/05 10:47	
Copper	"	712	---	11.6	"	"	868	"	NR	"	--	--	"	Q-07
Iron	"	46500	---	1000	mg/kg	200x	47700	100	NR	"	--	--	12/16/05 07:53	Q-07
Nickel	"	37.0	---	1.16	mg/kg dry	1x	23.8	11.6	114%	"	--	--	12/14/05 07:10	
Selenium	"	7.98	---	0.581	"	"	3.56	5.81	76.1%	"	--	--	"	
Silver	"	11.2	---	0.581	"	"	9.09	"	36.3%	"	--	--	"	Q-02
Post Spike (5120484-PS1)				**QC Source: P5L0118-03**				**Extracted: 12/12/05 12:44**						
Arsenic	EPA 6020	0.232	---		ug/ml	1x	0.0531	0.200	89.4%	(75-125)	--	--	12/14/05 06:55	
Barium	"	0.971	---		"	"	1.25	"	NR	"	--	--	"	Q-02
Cadmium	"	0.161	---		"	"	-0.0183	"	89.6%	"	--	--	"	
Chromium	"	0.489	---		"	"	0.309	"	90.0%	"	--	--	12/15/05 06:52	
Copper	"	0.852	---		"	"	0.945	"	NR	"	--	--	12/14/05 06:55	Q-02
Iron	"	470	---		"	200x	367	2.00	>300%	"	--	--	12/16/05 07:22	Q-07
Lead	"	0.484	---		"	1x	0.344	0.200	70.0%	"	--	--	12/14/05 06:55	Q-02
Manganese	"	7.78	---		"	"	7.40	"	190%	"	--	--	12/15/05 06:52	Q-02
Nickel	"	0.656	---		"	"	0.421	"	118%	"	--	--	12/14/05 06:55	
Selenium	"	0.0784	---		"	"	0.00384	0.100	74.6%	"	--	--	"	Q-02
Silver	"	0.0963	---		"	"	0.00336	"	92.9%	"	--	--	"	
Zinc	"	1.62	---		"	"	1.43	0.200	95.0%	"	--	--	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120530 **Soil Preparation Method: EPA 1312/3005 SPLP**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120530-BLK1)									**Extracted: 12/13/05 11:16**					
Arsenic	1312/6020	ND	---	0.0250	mg/l	0.5x	--	--	--	--	--	--	12/15/05 14:16	
Barium	"	ND	---	0.0250	"	"	--	--	--	--	--	--	"	
Cadmium	"	ND	---	0.0250	"	"	--	--	--	--	--	--	"	
Chromium	"	ND	---	0.0250	"	"	--	--	--	--	--	--	"	
Copper	"	ND	---	0.250	"	"	--	--	--	--	--	--	"	
Iron	EPA 1312/6020	0.0504	---	0.0500	"	"	--	--	--	--	--	--	12/16/05 16:11	B
Lead	1312/6020	ND	---	0.0250	"	"	--	--	--	--	--	--	12/15/05 14:16	
Manganese	"	ND	---	0.0100	"	"	--	--	--	--	--	--	"	
Nickel	"	ND	---	0.0250	"	"	--	--	--	--	--	--	"	
Selenium	"	ND	---	0.0250	"	"	--	--	--	--	--	--	"	
Silver	"	ND	---	0.0250	"	"	--	--	--	--	--	--	"	
Zinc	"	ND	---	0.125	"	"	--	--	--	--	--	--	"	
Blank (5120530-BLK2)									**Extracted: 12/13/05 11:16**					
Iron	EPA 1312/6020	ND	---	0.0500	mg/l	0.5x	--	--	--	--	--	--	12/19/05 22:31	
LCS (5120530-BS1)									**Extracted: 12/13/05 11:16**					
Arsenic	1312/6020	0.0962	---	0.0250	mg/l	0.5x	--	0.100	96.2%	(75-125)	--	--	12/15/05 14:24	
Barium	"	0.0939	---	0.0250	"	"	--	"	93.9%	"	--	--	"	
Cadmium	"	0.0936	---	0.0250	"	"	--	"	93.6%	"	--	--	"	
Chromium	"	0.0896	---	0.0250	"	"	--	"	89.6%	"	--	--	"	
Copper	"	0.0949	---	0.250	"	"	--	"	94.9%	"	--	--	"	
Iron	EPA 1312/6020	1.04	---	0.0500	"	"	--	1.00	104%	"	--	--	12/16/05 16:27	
Lead	1312/6020	0.0932	---	0.0250	"	"	--	0.100	93.2%	"	--	--	12/15/05 14:24	
Manganese	"	0.0880	---	0.0100	"	"	--	"	88.0%	(80-120)	--	--	"	
Nickel	"	0.0920	---	0.0250	"	"	--	"	92.0%	(75-125)	--	--	"	
Selenium	"	0.0439	---	0.0250	"	"	--	0.0500	87.8%	"	--	--	"	
Silver	"	0.0445	---	0.0250	"	"	--	"	89.0%	"	--	--	"	
Zinc	"	0.0958	---	0.125	"	"	--	0.100	95.8%	"	--	--	"	
LCS (5120530-BS2)									**Extracted: 12/13/05 11:16**					
Iron	EPA 1312/6020	1.09	---	0.0500	mg/l	0.5x	--	1.00	109%	(75-125)	--	--	12/19/05 22:47	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Metals per EPA 1312/6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120530 **Soil Preparation Method: EPA 1312/3005 SPLP**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5120530-MS1)				**QC Source: P5L0118-01**				**Extracted: 12/13/05 11:16**						
Arsenic	1312/6020	0.0971	---	0.0250	mg/l	0.5x	ND	0.100	97.1%	(75-125)	--	--	12/15/05 15:02	
Barium	"	0.148	---	0.0250	"	"	0.0472	"	101%	"	--	--	"	
Cadmium	"	0.0964	---	0.0250	"	"	ND	"	96.4%	"	--	--	"	
Chromium	"	0.0960	---	0.0250	"	"	ND	"	96.0%	"	--	--	"	
Copper	"	0.106	---	0.250	"	"	0.00568	"	100%	"	--	--	"	
Iron	EPA 1312/6020	3.28	---	0.0500	"	"	1.03	1.00	225%	"	--	--	12/16/05 16:58	Q-03
Lead	1312/6020	0.104	---	0.0250	"	"	0.00671	0.100	97.3%	"	--	--	12/15/05 15:02	
Manganese	"	0.172	---	0.0100	"	"	0.0550	"	117%	"	--	--	"	
Nickel	"	0.0996	---	0.0250	"	"	0.00550	"	94.1%	"	--	--	"	
Selenium	"	0.0429	---	0.0250	"	"	ND	0.0500	85.8%	"	--	--	"	
Silver	"	0.0466	---	0.0250	"	"	ND	"	93.2%	"	--	--	"	
Zinc	"	0.123	---	0.125	"	"	0.0159	0.100	107%	"	--	--	"	
Matrix Spike (5120530-MS2)				**QC Source: P5L0118-02**				**Extracted: 12/13/05 11:16**						
Arsenic	1312/6020	0.0964	---	0.0250	mg/l	0.5x	ND	0.100	96.4%	(75-125)	--	--	12/15/05 15:17	
Barium	"	0.0993	---	0.0250	"	"	0.00572	"	93.6%	"	--	--	"	
Cadmium	"	0.0930	---	0.0250	"	"	0.000495	"	92.5%	"	--	--	"	
Chromium	"	0.0928	---	0.0250	"	"	ND	"	92.8%	"	--	--	"	
Copper	"	0.0966	---	0.250	"	"	0.00213	"	94.5%	"	--	--	"	
Iron	EPA 1312/6020	1.32	---	0.0500	"	"	0.391	1.00	92.9%	"	--	--	12/16/05 17:45	
Lead	1312/6020	0.0937	---	0.0250	"	"	0.000935	0.100	92.8%	"	--	--	12/15/05 15:17	
Manganese	"	0.104	---	0.0100	"	"	0.0132	"	90.8%	"	--	--	"	
Nickel	"	0.0928	---	0.0250	"	"	ND	"	92.8%	"	--	--	"	
Selenium	"	0.0419	---	0.0250	"	"	ND	0.0500	83.8%	"	--	--	"	
Silver	"	0.0451	---	0.0250	"	"	ND	"	90.2%	"	--	--	"	
Zinc	"	0.114	---	0.125	"	"	0.0180	0.100	96.0%	"	--	--	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Total Mercury per EPA Method 7471A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120155 **Soil Preparation Method: EPA 7471A**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120155-BLK1)								**Extracted: 12/05/05 10:02**						
Mercury	EPA 7471A	ND	---	0.100	mg/kg	1x	--	--	--	--	--	--	12/05/05 11:38	
LCS (5120155-BS1)								**Extracted: 12/05/05 10:02**						
Mercury	EPA 7471A	1.01	---	0.100	mg/kg	1x	--	1.00	101%	(80-120)	--	--	12/05/05 11:40	
LCS Dup (5120155-BSD1)								**Extracted: 12/05/05 10:02**						
Mercury	EPA 7471A	1.00	---	0.100	mg/kg	1x	--	1.00	100%	(80-120)	0.995%	(20)	12/05/05 11:43	
Duplicate (5120155-DUP1)				**QC Source: P5L0118-01**				**Extracted: 12/05/05 10:02**						
Mercury	EPA 7471A	ND	---	0.0830	mg/kg dry	1x	ND	--	--	--	105%	(40)	12/05/05 11:46	Q-06
Matrix Spike (5120155-MS1)				**QC Source: P5L0118-01**				**Extracted: 12/05/05 10:02**						
Mercury	EPA 7471A	0.875	---	0.0830	mg/kg dry	1x	0.00929	0.830	104%	(75-125)	--	--	12/05/05 11:48	
Matrix Spike Dup (5120155-MSD1)				**QC Source: P5L0118-01**				**Extracted: 12/05/05 10:02**						
Mercury	EPA 7471A	0.915	---	0.0876	mg/kg dry	1x	0.00929	0.876	103%	(75-125)	4.47%	(40)	12/05/05 11:51	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Mercury per EPA Methods 1312/7470A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120335 **Soil Preparation Method: EPA 1311/7470A**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120335-BLK1)									**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	ND	---	0.000200	mg/l	1x	--	--	--	--	--	--	12/08/05 13:01	
LCS (5120335-BS1)									**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00507	---	0.000200	mg/l	1x	--	0.00500	101%	(75-125)	--	--	12/08/05 13:03	
LCS Dup (5120335-BSD1)									**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00509	---	0.000200	mg/l	1x	--	0.00500	102%	(75-125)	0.394%	(20)	12/08/05 13:06	
Matrix Spike (5120335-MS1)				**QC Source: P5L0118-01**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00500	---	0.000200	mg/l	1x	0.0000369	0.00500	99.3%	(75-125)	--	--	12/08/05 13:14	
Matrix Spike (5120335-MS2)				**QC Source: P5L0118-02**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00509	---	0.000200	mg/l	1x	ND	0.00500	102%	(75-125)	--	--	12/08/05 13:16	
Matrix Spike (5120335-MS3)				**QC Source: P5L0118-03**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00506	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 13:19	
Matrix Spike (5120335-MS4)				**QC Source: P5L0118-04**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00506	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 13:22	
Matrix Spike (5120335-MS5)				**QC Source: P5L0118-05**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00502	---	0.000200	mg/l	1x	ND	0.00500	100%	(75-125)	--	--	12/08/05 13:24	
Matrix Spike (5120335-MS6)				**QC Source: P5L0118-06**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00497	---	0.000200	mg/l	1x	ND	0.00500	99.4%	(75-125)	--	--	12/08/05 13:27	
Matrix Spike (5120335-MS7)				**QC Source: P5L0118-07**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00503	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 13:29	
Matrix Spike (5120335-MS8)				**QC Source: P5L0118-08**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00506	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 13:32	
Matrix Spike (5120335-MS9)				**QC Source: P5L0118-09**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00526	---	0.000200	mg/l	1x	ND	0.00500	105%	(75-125)	--	--	12/08/05 13:34	
Matrix Spike (5120335-MSA)				**QC Source: P5L0118-10**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00527	---	0.000200	mg/l	1x	0.0000394	0.00500	105%	(75-125)	--	--	12/08/05 13:37	
Matrix Spike (5120335-MSB)				**QC Source: P5L0118-11**					**Extracted: 12/08/05 08:47**					
Mercury	1312/7470A	0.00508	---	0.000200	mg/l	1x	0.0000390	0.00500	101%	(75-125)	--	--	12/08/05 13:44	
Matrix Spike (5120335-MSC)				**QC Source: P5L0118-12**					**Extracted: 12/08/05 08:47**					

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

SPLP Mercury per EPA Methods 1312/7470A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120335 **Soil Preparation Method: EPA 1311/7470A**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5120335-MSC)				**QC Source: P5L0118-12**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00510	---	0.000200	mg/l	1x	ND	0.00500	102%	(75-125)	--	--	12/08/05 13:47	
Matrix Spike (5120335-MSD)				**QC Source: P5L0118-13**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00503	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 13:49	
Matrix Spike (5120335-MSE)				**QC Source: P5L0118-14**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00506	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 13:52	
Matrix Spike (5120335-MSF)				**QC Source: P5L0118-15**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00500	---	0.000200	mg/l	1x	ND	0.00500	100%	(75-125)	--	--	12/08/05 13:55	
Matrix Spike (5120335-MSG)				**QC Source: P5L0118-16**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00507	---	0.000200	mg/l	1x	0.0000279	0.00500	101%	(75-125)	--	--	12/08/05 13:57	
Matrix Spike (5120335-MSH)				**QC Source: P5L0118-17**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00504	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 14:00	
Matrix Spike (5120335-MSI)				**QC Source: P5L0118-18**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00501	---	0.000200	mg/l	1x	ND	0.00500	100%	(75-125)	--	--	12/08/05 14:03	
Matrix Spike (5120335-MSJ)				**QC Source: P5L0118-19**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00510	---	0.000200	mg/l	1x	ND	0.00500	102%	(75-125)	--	--	12/08/05 14:05	
Matrix Spike (5120335-MSK)				**QC Source: P5L0118-20**				**Extracted: 12/08/05 08:47**						
Mercury	1312/7470A	0.00507	---	0.000200	mg/l	1x	ND	0.00500	101%	(75-125)	--	--	12/08/05 14:08	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Hexavalent Chromium per EPA Method 3060A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120301 **Soil Preparation Method: EPA 3060A Cr6**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120301-BLK1)									Extracted: 12/07/05 13:13					
Hexavalent Chromium	EPA 3060A	ND	---	0.990	mg/kg	1x	--	--	--	--	--	--	12/09/05 14:07	
LCS (5120301-BS1)									Extracted: 12/07/05 13:13					
Hexavalent Chromium	EPA 3060A	105	---	0.980	mg/kg	1x	--	98.0	107%	(80-120)	--	--	12/09/05 14:12	
Duplicate (5120301-DUP1)					QC Source: P5L0118-02				Extracted: 12/07/05 13:13					
Hexavalent Chromium	EPA 3060A	ND	---	1.15	mg/kg dry	1x	ND	--	--	--	NR	(40)	12/09/05 14:53	
Matrix Spike (5120301-MS1)					QC Source: P5L0118-02				Extracted: 12/07/05 13:13					
Hexavalent Chromium	EPA 3060A	130	---	1.19	mg/kg dry	1x	ND	119	109%	(75-125)	--	--	12/09/05 14:58	
Matrix Spike (5120301-MS2)					QC Source: P5L0118-03				Extracted: 12/07/05 13:13					
Hexavalent Chromium	EPA 3060A	525	---	2.43	mg/kg dry	2x	442	122	68.0%	(75-125)	--	--	12/12/05 12:54	Q-02

QC Batch: 5120369 **Soil Preparation Method: EPA 3060A Cr6**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5120369-BLK1)									Extracted: 12/08/05 14:52					
Hexavalent Chromium	EPA 3060A	1.58	---	0.632	mg/kg	200x	--	--	--	--	--	--	12/14/05 22:16	B, A-01
LCS (5120369-BS1)									Extracted: 12/08/05 14:52					
Hexavalent Chromium	EPA 3060A	108	---	0.619	mg/kg	200x	--	103	105%	(80-120)	--	--	12/14/05 22:32	B, A-01
Duplicate (5120369-DUP1)					QC Source: P5L0118-16				Extracted: 12/08/05 14:52					
Hexavalent Chromium	EPA 3060A	ND	---	0.693	mg/kg dry	200x	ND	--	--	--	58.5%	(40)	12/14/05 23:04	B, Q-14, A-01
Matrix Spike (5120369-MS1)					QC Source: P5L0118-16				Extracted: 12/08/05 14:52					
Hexavalent Chromium	EPA 3060A	126	---	0.750	mg/kg dry	200x	0.632	125	100%	(75-125)	--	--	12/14/05 23:19	B, A-01

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Percent Dry Weight (Solids) per Standard Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5120235 **Soil Preparation Method: Dry Weight**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Duplicate (5120235-DUP1)					**QC Source: P5L0073-68**				**Extracted: 12/06/05 12:53**					
% Solids	NCA SOP	72.8	---	1.00	% by Weight	1x	72.2	--	--	--	0.828%	(20)	12/07/05 11:46	
Duplicate (5120235-DUP2)					**QC Source: P5L0073-69**				**Extracted: 12/06/05 12:53**					
% Solids	NCA SOP	88.1	---	1.00	% by Weight	1x	88.6	--	--	--	0.566%	(20)	12/07/05 11:46	
Duplicate (5120235-DUP3)					**QC Source: P5L0073-71**				**Extracted: 12/06/05 12:53**					
% Solids	NCA SOP	74.1	---	1.00	% by Weight	1x	74.0	--	--	--	0.135%	(20)	12/07/05 11:46	
Duplicate (5120235-DUP4)					**QC Source: P5L0073-72**				**Extracted: 12/06/05 12:53**					
% Solids	NCA SOP	75.9	---	1.00	% by Weight	1x	75.3	--	--	--	0.794%	(20)	12/07/05 11:46	
Duplicate (5120235-DUP5)					**QC Source: P5L0073-74**				**Extracted: 12/06/05 12:53**					
% Solids	NCA SOP	74.8	---	1.00	% by Weight	1x	74.8	--	--	--	0.00%	(20)	12/07/05 11:46	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	Opal Creek-1-01	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/30/05 14:00

Notes and Definitions

Report Specific Notes:

A-01	-	Run on ICPMS3. Reporting limits are based on Total Chromium.
B	-	Analyte detected in the method blank.
B-17	-	Analyte was detected in the blank at greater than one-half of the MRL but less than 1/10 the concentration in the sample.
B-18	-	Analyte was detected in the blank at greater than one-half of the MRL, but samples are ND.
Q-02	-	The matrix spike recovery, and/or RPD, for this QC sample is outside of established control limits due to sample matrix interference.
Q-03	-	The matrix spike recovery, and/or RPD, for this QC sample cannot be accurately calculated due to the high concentration of analyte already present in the source sample.
Q-06	-	RPD is not applicable for analyte concentrations less than 5 times the MRL.
Q-07	-	The matrix spike recovery, and/or RPD, for this QC sample is outside control limits due to sample dilution required from high analyte concentration and/or matrix interferences.
Q-14	-	The matrix spike recovery, and/or RPD, for this QC sample is outside of control limits due to a non-homogeneous sample matrix.
Q-23	-	The matrix spike/duplicate for this batch could not be reported. Source sample contains high levels of target analyte, non-target analyte, and/or matrix interference requiring high dilution.

Laboratory Reporting Conventions:

DET	-	Analyte DETECTED at or above the Reporting Limit. Qualitative Analyses only.
ND	-	Analyte NOT DETECTED at or above the reporting limit (MDL or MRL, as appropriate).
NR / NA	-	Not Reported / Not Available
dry	-	Sample results reported on a dry weight basis. Reporting Limits have been corrected for %Solids.
wet	-	Sample results and reporting limits reported on a wet weight basis (as received).
RPD	-	Relative Percent Difference. (RPDs calculated using Results, not Percent Recoveries).
MRL	-	METHOD REPORTING LIMIT. Reporting Level at, or above, the lowest level standard of the Calibration Table.
MDL*	-	METHOD DETECTION LIMIT. Reporting Level at, or above, the statistically derived limit based on 40CFR, Part 136, Appendix B. *MDLs are listed on the report only if the data has been evaluated below the MRL. Results between the MDL and MRL are reported as Estimated results.
Dil	-	Dilutions are calculated based on deviations from the standard dilution performed for an analysis, and may not represent the dilution found on the analytical raw data.
Reporting limits	-	Reporting limits (MDLs and MRLs) are adjusted based on variations in sample preparation amounts, analytical dilutions and percent solids, where applicable.

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

December 02, 2005

Steve Nelson
GeoDesign
15575 SW Sequoia Parkway Ste.100
Portland, OR 97224

RE: Opal Creek-1-01

Enclosed are the results of analyses for samples received by the laboratory on 11/10/05 12:05.
The following list is a summary of the NCA Work Orders contained in this report.
If you have any questions concerning this report, please feel free to contact me.

Work	Project	ProjectNumber
P5K0485	Opal Creek-1-01	na

Thank You,

Roxanne L. Clifton, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

North Creek Analytical, Inc.
Environmental Laboratory Network

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
PW-1	P5K0485-01	Water	11/08/05 13:55	11/10/05 12:05
PW-2	P5K0485-02	Water	11/09/05 09:25	11/10/05 12:05
AW-4	P5K0485-03	Water	11/08/05 15:05	11/10/05 12:05
AW-5	P5K0485-04	Water	11/08/05 13:17	11/10/05 12:05
SW-1	P5K0485-05	Water	11/08/05 13:50	11/10/05 12:05
SW-2	P5K0485-06	Water	11/08/05 13:57	11/10/05 12:05
SW-3	P5K0485-07	Water	11/08/05 14:55	11/10/05 12:05
SW-4	P5K0485-08	Water	11/08/05 15:15	11/10/05 12:05
SW-5	P5K0485-09	Water	11/08/05 14:55	11/10/05 12:05
SW-6	P5K0485-10	Water	11/09/05 09:08	11/10/05 12:05
SW-7	P5K0485-11	Water	11/09/05 10:00	11/10/05 12:05
SW-8	P5K0485-12	Water	11/09/05 12:32	11/10/05 12:05
SW-9	P5K0485-13	Water	11/09/05 12:56	11/10/05 12:05
SW-10	P5K0485-14	Water	11/09/05 13:01	11/10/05 12:05
SED-1	P5K0485-15	Soil	11/08/05 13:40	11/10/05 12:05
SED-2	P5K0485-16	Soil	11/08/05 13:55	11/10/05 12:05
SED-3	P5K0485-17	Soil	11/08/05 15:20	11/10/05 12:05
SED-4	P5K0485-18	Soil	11/08/05 15:10	11/10/05 12:05
SED-5	P5K0485-19	Soil	11/08/05 14:55	11/10/05 12:05
SED-6	P5K0485-20	Soil	11/09/05 09:30	11/10/05 12:05

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-03	**Water**	**AW-4**	**Sampled: 11/08/05 15:05**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 06:02	
Barium		"	**0.00694**	-----	0.00100	"	"	"	"	"	
Cadmium		"	**0.0221**	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	**0.0148**	-----	0.00200	"	"	"	"	"	
Iron		"	**0.0475**	-----	0.0100	"	"	"	"	"	
Lead		"	**0.0377**	-----	0.00100	"	"	"	"	"	
Manganese		"	**0.0235**	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**3.08**	-----	0.0500	"	10x	"	"	11/17/05 13:39	
P5K0485-04	**Water**	**AW-5**	**Sampled: 11/08/05 13:17**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 06:15	
Barium		"	**0.00322**	-----	0.00100	"	"	"	"	"	
Cadmium		"	**0.00539**	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	**0.00460**	-----	0.00200	"	"	"	"	"	
Iron		"	**0.0739**	-----	0.0100	"	"	"	"	"	
Lead		"	**0.00262**	-----	0.00100	"	"	"	"	"	
Manganese		"	**0.0309**	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**1.27**	-----	0.0500	"	10x	"	"	11/17/05 13:48	
P5K0485-05	**Water**	**SW-1**	**Sampled: 11/08/05 13:50**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 06:28	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	**0.0117**	-----	0.0100	"	"	"	"	"	
Lead		"	**0.00295**	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.0193**	-----	0.00500	"	"	"	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-06	**Water**	**SW-2**	**Sampled: 11/08/05 13:57**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 07:43	
Barium		"	**0.00104**	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	**0.0258**	-----	0.0100	"	"	"	"	"	
Lead		"	ND	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.00775**	-----	0.00500	"	"	"	"	"	
P5K0485-07	**Water**	**SW-3**	**Sampled: 11/08/05 14:55**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 07:57	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	ND	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.0186**	-----	0.00500	"	"	"	"	"	
P5K0485-08	**Water**	**SW-4**	**Sampled: 11/08/05 15:15**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 08:10	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	**0.0434**	-----	0.0100	"	"	"	"	"	
Lead		"	**0.00392**	-----	0.00100	"	"	"	"	"	
Manganese		"	**0.00400**	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.0516**	-----	0.00500	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-09	**Water**	**SW-5**	**Sampled: 11/08/05 14:55**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 08:24	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	**0.00444**	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.0856**	-----	0.00500	"	"	"	"	"	
P5K0485-10	**Water**	**SW-6**	**Sampled: 11/09/05 09:08**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 08:38	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	ND	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	ND	-----	0.00500	"	"	"	"	"	
P5K0485-11	**Water**	**SW-7**	**Sampled: 11/09/05 10:00**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 08:51	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	ND	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.0174**	-----	0.00500	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-12	**Water**	**SW-8**	**Sampled: 11/09/05 12:32**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 09:05	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	ND	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	ND	-----	0.00500	"	"	"	"	"	
P5K0485-13	**Water**	**SW-9**	**Sampled: 11/09/05 12:56**								
Arsenic		EPA 6020	**0.00133**	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 09:41	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	**0.00252**	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	**0.0724**	-----	0.00500	"	"	"	"	"	
P5K0485-14	**Water**	**SW-10**	**Sampled: 11/09/05 13:01**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110749	11/15/05	11/17/05 10:20	
Barium		"	ND	-----	0.00100	"	"	"	"	"	
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	
Chromium		"	ND	-----	0.00100	"	"	"	"	"	
Copper		"	ND	-----	0.00200	"	"	"	"	"	
Iron		"	ND	-----	0.0100	"	"	"	"	"	
Lead		"	ND	-----	0.00100	"	"	"	"	"	
Manganese		"	ND	-----	0.00200	"	"	"	"	"	
Nickel		"	ND	-----	0.00200	"	"	"	"	"	
Selenium		"	ND	-----	0.00200	"	"	"	"	"	
Silver		"	ND	-----	0.00100	"	"	"	"	"	
Zinc		"	ND	-----	0.00500	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-15 Soil SED-1 Sampled: 11/08/05 13:40										
Arsenic	EPA 6020	**1.08**	-----	0.588	mg/kg dry	1x	5110619	11/13/05	11/18/05 13:32	
Barium	"	**22.9**	-----	0.588	"	"	"	"	11/22/05 12:56	
Cadmium	"	**0.660**	-----	0.588	"	"	"	"	11/18/05 13:32	
Chromium	"	**12.9**	-----	0.588	"	"	"	"	"	
Copper	"	**29.1**	-----	2.35	"	"	"	"	"	
Iron	"	**11700**	-----	48.1	mg/kg	10x	"	"	11/22/05 19:40	**B-17**
Lead	"	**35.6**	-----	0.588	mg/kg dry	1x	"	"	11/22/05 12:56	
Manganese	"	**339**	-----	1.18	"	"	"	"	11/18/05 13:32	
Nickel	"	**27.9**	-----	1.18	"	"	"	"	"	
Selenium	"	ND	-----	0.588	"	"	"	"	11/22/05 12:56	
Silver	"	ND	-----	0.588	"	"	"	"	11/18/05 13:32	
Zinc	"	**246**	-----	2.35	"	"	"	"	"	
P5K0485-16 Soil SED-2 Sampled: 11/08/05 13:55										
Arsenic	EPA 6020	**1.95**	-----	0.657	mg/kg dry	1x	5110619	11/13/05	11/18/05 13:39	
Barium	"	**30.4**	-----	0.657	"	"	"	"	11/22/05 13:03	
Cadmium	"	ND	-----	0.657	"	"	"	"	11/18/05 13:39	
Chromium	"	**11.2**	-----	0.657	"	"	"	"	"	
Copper	"	**20.4**	-----	2.63	"	"	"	"	"	
Iron	"	**13100**	-----	51.0	mg/kg	10x	"	"	11/23/05 12:13	**B-17**
Lead	"	**38.1**	-----	0.657	mg/kg dry	1x	"	"	11/22/05 13:03	
Manganese	"	**948**	-----	2.63	"	2x	"	"	11/22/05 21:18	**R-02**
Nickel	"	**23.7**	-----	1.31	"	1x	"	"	11/18/05 13:39	
Selenium	"	ND	-----	0.657	"	"	"	"	11/22/05 13:03	
Silver	"	ND	-----	0.657	"	"	"	"	11/18/05 13:39	
Zinc	"	**290**	-----	2.63	"	"	"	"	"	
P5K0485-17 Soil SED-3 Sampled: 11/08/05 15:20										
Arsenic	EPA 6020	**2.00**	-----	0.618	mg/kg dry	1x	5110619	11/13/05	11/18/05 13:47	
Barium	"	**35.7**	-----	0.618	"	"	"	"	11/22/05 13:11	
Cadmium	"	**1.06**	-----	0.618	"	"	"	"	11/18/05 13:47	
Chromium	"	**14.6**	-----	0.618	"	"	"	"	"	
Copper	"	**63.9**	-----	2.47	"	"	"	"	"	
Iron	"	**16500**	-----	49.0	mg/kg	10x	"	"	11/22/05 19:01	**B-17**
Lead	"	**244**	-----	0.618	mg/kg dry	1x	"	"	11/22/05 13:11	
Manganese	"	**1440**	-----	6.18	"	5x	"	"	11/22/05 21:26	**R-02**
Nickel	"	**15.7**	-----	1.24	"	1x	"	"	11/18/05 13:47	
Selenium	"	ND	-----	0.618	"	"	"	"	11/22/05 13:11	
Silver	"	ND	-----	0.618	"	"	"	"	11/18/05 13:47	
Zinc	"	**648**	-----	12.4	"	5x	"	"	11/22/05 21:26	**R-02**

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-18 Soil SED-4 Sampled: 11/08/05 15:10										
Arsenic	EPA 6020	**3.68**	-----	0.652	mg/kg dry	1x	5110619	11/13/05	11/18/05 13:54	
Barium	"	**34.6**	-----	0.652	"	"	"	"	11/22/05 13:18	
Cadmium	"	**1.87**	-----	0.652	"	"	"	"	11/18/05 13:54	
Chromium	"	**13.8**	-----	0.652	"	"	"	"	"	
Copper	"	**465**	-----	2.61	"	"	"	"	"	
Iron	"	**20800**	-----	50.5	mg/kg	10x	"	"	11/22/05 19:11	**B-17**
Lead	"	**265**	-----	0.652	mg/kg dry	1x	"	"	11/22/05 13:18	
Manganese	"	**2280**	-----	6.52	"	5x	"	"	11/22/05 21:33	**R-02**
Nickel	"	**18.8**	-----	1.30	"	1x	"	"	11/18/05 13:54	
Selenium	"	ND	-----	0.652	"	"	"	"	11/22/05 13:18	
Silver	"	**0.745**	-----	0.652	"	"	"	"	11/18/05 13:54	
Zinc	"	**953**	-----	13.0	"	5x	"	"	11/22/05 21:33	**R-02**
P5K0485-19 Soil SED-5 Sampled: 11/08/05 14:55										
Arsenic	EPA 6020	**11.7**	-----	0.706	mg/kg dry	1x	5110619	11/13/05	11/18/05 14:02	
Barium	"	**12.2**	-----	0.706	"	"	"	"	11/22/05 13:26	
Cadmium	"	**0.989**	-----	0.706	"	"	"	"	11/18/05 14:02	
Chromium	"	**9.86**	-----	0.706	"	"	"	"	"	
Copper	"	**39.6**	-----	2.82	"	"	"	"	"	
Iron	"	**23100**	-----	52.6	mg/kg	10x	"	"	11/22/05 19:21	**B-17**
Lead	"	**278**	-----	0.706	mg/kg dry	1x	"	"	11/22/05 13:26	
Manganese	"	**4290**	-----	14.1	"	10x	"	"	11/29/05 20:09	**R-02**
Nickel	"	**17.4**	-----	1.41	"	1x	"	"	11/18/05 14:02	
Selenium	"	ND	-----	0.706	"	"	"	"	11/22/05 13:26	
Silver	"	ND	-----	0.706	"	"	"	"	11/18/05 14:02	
Zinc	"	**577**	-----	2.82	"	"	"	"	"	
P5K0485-20 Soil SED-6 Sampled: 11/09/05 09:30										
Arsenic	EPA 6020	**2.60**	-----	0.661	mg/kg dry	1x	5110619	11/13/05	11/18/05 14:10	
Barium	"	**82.3**	-----	0.661	"	"	"	"	11/22/05 13:33	
Cadmium	"	ND	-----	0.661	"	"	"	"	11/18/05 14:10	
Chromium	"	**14.0**	-----	0.661	"	"	"	"	"	
Copper	"	**35.9**	-----	2.64	"	"	"	"	"	
Iron	"	**15200**	-----	52.6	mg/kg	10x	"	"	11/22/05 19:31	**B-17**
Lead	"	**12.8**	-----	0.661	mg/kg dry	1x	"	"	11/22/05 13:33	
Manganese	"	**768**	-----	2.64	"	2x	"	"	11/22/05 21:49	**R-02**
Nickel	"	**30.6**	-----	1.32	"	1x	"	"	11/18/05 14:10	
Selenium	"	ND	-----	0.661	"	"	"	"	11/22/05 13:33	
Silver	"	ND	-----	0.661	"	"	"	"	11/18/05 14:10	
Zinc	"	**119**	-----	2.64	"	"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name: **Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number: na	Report Created:
Portland, OR 97224	Project Manager: Steve Nelson	12/02/05 14:33

Dissolved Metals per EPA 6000/7000 Series Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-01	**Water**	**PW-1**	**Sampled: 11/08/05 13:55**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110644	11/14/05	11/15/05 16:14	**M-04**
Barium		"	**0.00201**	-----	0.00100	"	"	"	"	"	**M-04**
Cadmium		"	**0.00149**	-----	0.00100	"	"	"	"	"	**M-04**
Chromium		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Copper		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Iron		"	ND	-----	0.0100	"	"	"	"	"	**M-04**
Lead		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Manganese		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Nickel		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Selenium		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Silver		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Zinc		"	**0.277**	-----	0.00500	"	"	"	"	"	**M-04**
P5K0485-02	**Water**	**PW-2**	**Sampled: 11/09/05 09:25**								
Arsenic		EPA 6020	ND	-----	0.00100	mg/l	1x	5110644	11/14/05	11/15/05 16:30	**M-04**
Barium		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Cadmium		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Chromium		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Copper		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Iron		"	ND	-----	0.0100	"	"	"	"	"	**M-04**
Lead		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Manganese		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Nickel		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Selenium		"	ND	-----	0.00200	"	"	"	"	"	**M-04**
Silver		"	ND	-----	0.00100	"	"	"	"	"	**M-04**
Zinc		"	ND	-----	0.00500	"	"	"	"	"	**M-04**

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Dissolved Mercury per EPA Method 7470A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-01	**Water**	**PW-1**	**Sampled: 11/08/05 13:55**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110672	11/14/05	11/14/05 14:56	
P5K0485-02	**Water**	**PW-2**	**Sampled: 11/09/05 09:25**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110672	11/14/05	11/14/05 14:58	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Mercury per EPA Method 7470A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-03	**Water**	**AW-4**	**Sampled: 11/08/05 15:05**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:25	
P5K0485-04	**Water**	**AW-5**	**Sampled: 11/08/05 13:17**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:28	
P5K0485-05	**Water**	**SW-1**	**Sampled: 11/08/05 13:50**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:30	
P5K0485-06	**Water**	**SW-2**	**Sampled: 11/08/05 13:57**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:33	
P5K0485-07	**Water**	**SW-3**	**Sampled: 11/08/05 14:55**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:35	
P5K0485-08	**Water**	**SW-4**	**Sampled: 11/08/05 15:15**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:37	
P5K0485-09	**Water**	**SW-5**	**Sampled: 11/08/05 14:55**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:40	
P5K0485-10	**Water**	**SW-6**	**Sampled: 11/09/05 09:08**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:42	
P5K0485-11	**Water**	**SW-7**	**Sampled: 11/09/05 10:00**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:44	
P5K0485-12	**Water**	**SW-8**	**Sampled: 11/09/05 12:32**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:46	
P5K0485-13	**Water**	**SW-9**	**Sampled: 11/09/05 12:56**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:55	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Mercury per EPA Method 7470A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-14	**Water**	**SW-10**	**Sampled: 11/09/05 13:01**								
Mercury		EPA 7470A	ND	-----	0.000200	mg/l	1x	5110575	11/11/05	11/11/05 13:58	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name: **Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number: na	Report Created:
Portland, OR 97224	Project Manager: Steve Nelson	12/02/05 14:33

Total Mercury per EPA Method 7471A

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-15	**Soil**	**SED-1**	**Sampled: 11/08/05 13:40**								
Mercury		EPA 7471A	ND	-----	0.0927	mg/kg dry	1x	5110679	11/14/05	11/15/05 10:05	
P5K0485-16	**Soil**	**SED-2**	**Sampled: 11/08/05 13:55**								
Mercury		EPA 7471A	ND	-----	0.107	mg/kg dry	1x	5110679	11/14/05	11/15/05 10:07	
P5K0485-17	**Soil**	**SED-3**	**Sampled: 11/08/05 15:20**								
Mercury		EPA 7471A	ND	-----	0.0643	mg/kg dry	1x	5110679	11/14/05	11/15/05 10:10	
P5K0485-18	**Soil**	**SED-4**	**Sampled: 11/08/05 15:10**								
Mercury		EPA 7471A	ND	-----	0.0633	mg/kg dry	1x	5110679	11/14/05	11/15/05 10:12	
P5K0485-19	**Soil**	**SED-5**	**Sampled: 11/08/05 14:55**								
Mercury		EPA 7471A	ND	-----	0.102	mg/kg dry	1x	5110679	11/14/05	11/15/05 10:19	
P5K0485-20	**Soil**	**SED-6**	**Sampled: 11/09/05 09:30**								
Mercury		EPA 7471A	ND	-----	0.0748	mg/kg dry	1x	5110679	11/14/05	11/15/05 10:22	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Percent Dry Weight (Solids) per Standard Methods

North Creek Analytical - Portland

Analyte		Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
P5K0485-15	**Soil**	**SED-1**	**Sampled: 11/08/05 13:40**								
% Solids		NCA SOP	**81.7**	-----	1.00	% by Weight	1x	5110597	11/11/05	11/14/05 11:22	
P5K0485-16	**Soil**	**SED-2**	**Sampled: 11/08/05 13:55**								
% Solids		NCA SOP	**77.6**	-----	1.00	% by Weight	1x	5110597	11/11/05	11/14/05 11:22	
P5K0485-17	**Soil**	**SED-3**	**Sampled: 11/08/05 15:20**								
% Solids		NCA SOP	**79.3**	-----	1.00	% by Weight	1x	5110597	11/11/05	11/14/05 11:22	
P5K0485-18	**Soil**	**SED-4**	**Sampled: 11/08/05 15:10**								
% Solids		NCA SOP	**77.5**	-----	1.00	% by Weight	1x	5110597	11/11/05	11/14/05 11:22	
P5K0485-19	**Soil**	**SED-5**	**Sampled: 11/08/05 14:55**								
% Solids		NCA SOP	**74.6**	-----	1.00	% by Weight	1x	5110597	11/11/05	11/14/05 11:22	
P5K0485-20	**Soil**	**SED-6**	**Sampled: 11/09/05 09:30**								
% Solids		NCA SOP	**79.6**	-----	1.00	% by Weight	1x	5110597	11/11/05	11/14/05 11:22	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Roxanne L. Clifton, Project Manager

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110619 **Soil Preparation Method: EPA 3050**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5110619-BLK1)								Extracted: 11/13/05 12:46						
Arsenic	EPA 6020	ND	---	0.510	mg/kg	1x	--	--	--	--	--	--	11/18/05 10:05	
Barium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Cadmium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Chromium	"	ND	---	0.510	"	"	--	--	--	--	--	--	"	
Copper	"	ND	---	2.04	"	"	--	--	--	--	--	--	"	
Iron	"	ND	---	5.10	"	"	--	--	--	--	--	--	11/22/05 13:38	B
Lead	"	ND	---	0.510	"	"	--	--	--	--	--	--	11/18/05 10:05	
Manganese	"	ND	---	1.02	"	"	--	--	--	--	--	--	"	
Nickel	"	ND	---	1.02	"	"	--	--	--	--	--	--	"	
Selenium	"	ND	---	0.510	"	"	--	--	--	--	--	--	11/22/05 23:05	
Silver	"	ND	---	0.510	"	"	--	--	--	--	--	--	11/18/05 10:05	
Zinc	"	ND	---	2.04	"	"	--	--	--	--	--	--	"	
LCS (5110619-BS1)								Extracted: 11/13/05 12:46						
Arsenic	EPA 6020	10.5	---	0.515	mg/kg	1x	--	10.3	102%	(80-120)	--	--	11/18/05 10:13	
Barium	"	9.88	---	0.515	"	"	--	"	95.9%	"	--	--	"	
Cadmium	"	10.3	---	0.515	"	"	--	"	100%	"	--	--	"	
Chromium	"	10.4	---	0.515	"	"	--	"	101%	"	--	--	"	
Copper	"	10.6	---	2.06	"	"	--	"	103%	"	--	--	"	
Iron	"	91.5	---	5.15	"	"	--	103	88.8%	(75-125)	--	--	11/22/05 13:48	
Lead	"	9.85	---	0.515	"	"	--	10.3	95.6%	(80-120)	--	--	11/18/05 10:13	
Manganese	"	10.4	---	1.03	"	"	--	"	101%	"	--	--	"	
Nickel	"	10.3	---	1.03	"	"	--	"	100%	"	--	--	"	
Selenium	"	4.92	---	0.515	"	"	--	5.15	95.5%	"	--	--	11/22/05 20:10	
Silver	"	4.83	---	0.515	"	"	--	"	93.8%	"	--	--	11/18/05 10:13	
Zinc	"	10.0	---	2.06	"	"	--	10.3	97.1%	"	--	--	"	
Duplicate (5110619-DUP1)					QC Source: P5K0354-05			Extracted: 11/13/05 12:46						
Arsenic	EPA 6020	47.5	---	0.860	mg/kg dry	1x	43.0	--	--	--	9.94%	(40)	11/18/05 10:36	
Barium	"	338	---	0.860	"	"	239	--	--	--	34.3%	"	"	
Cadmium	"	ND	---	0.860	"	"	ND	--	--	--	NR	"	"	
Chromium	"	87.7	---	0.860	"	"	73.7	--	--	--	17.3%	"	"	
Copper	"	96.5	---	3.44	"	"	91.2	--	--	--	5.65%	"	"	
Iron	"	33500	---	505	mg/kg	100x	36600	--	--	--	8.84%	"	11/22/05 17:27	
Lead	"	49.6	---	0.860	mg/kg dry	1x	36.3	--	--	--	31.0%	"	11/18/05 10:36	
Manganese	"	4050	---	17.2	"	10x	3310	--	--	--	20.1%	"	11/18/05 15:03	
Nickel	"	123	---	1.72	"	1x	124	--	--	--	0.810%	"	11/18/05 10:36	
Selenium	"	ND	---	0.860	"	"	ND	--	--	--	NR	"	11/22/05 20:25	
Silver	"	ND	---	0.860	"	"	ND	--	--	--	NR	"	11/18/05 10:36	
Zinc	"	90.7	---	3.44	"	"	77.8	--	--	--	15.3%	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110619 **Soil Preparation Method: EPA 3050**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5110619-MS1)				**QC Source: P5K0354-05**					**Extracted: 11/13/05 12:46**					
Arsenic	EPA 6020	53.2	---	0.811	mg/kg dry	1x	43.0	16.2	63.0%	(75-125)	--	--	11/18/05 10:51	Q-02
Barium	"	300	---	0.811	"	"	239	"	>300%	"	--	--	"	Q-02
Cadmium	"	13.2	---	0.811	"	"	ND	"	81.5%	"	--	--	"	
Chromium	"	137	---	0.811	"	"	73.7	"	>300%	"	--	--	"	Q-02
Copper	"	95.6	---	3.24	"	"	91.2	"	27.2%	"	--	--	"	Q-02
Iron	"	31700	---	476	mg/kg	100x	36600	95.2	NR	"	--	--	11/22/05 17:37	Q-03
Lead	"	56.1	---	0.811	mg/kg dry	1x	36.3	16.2	122%	"	--	--	11/18/05 10:51	
Manganese	"	4540	---	16.2	"	10x	3310	"	>300%	"	--	--	11/18/05 15:11	Q-07
Nickel	"	146	---	1.62	"	1x	124	"	136%	"	--	--	11/18/05 10:51	Q-02
Selenium	"	6.41	---	0.811	"	"	ND	8.11	79.0%	"	--	--	11/22/05 20:33	
Silver	"	7.05	---	0.811	"	"	ND	"	86.9%	"	--	--	11/18/05 10:51	
Zinc	"	92.2	---	3.24	"	"	77.8	16.2	88.9%	"	--	--	"	
Matrix Spike (5110619-MS2)				**QC Source: P5K0354-06**					**Extracted: 11/13/05 12:46**					
Arsenic	EPA 6020	59.1	---	0.803	mg/kg dry	1x	40.9	16.1	113%	(75-125)	--	--	11/18/05 11:29	
Barium	"	346	---	0.803	"	"	493	"	NR	"	--	--	"	Q-02
Cadmium	"	14.4	---	0.803	"	"	ND	"	89.4%	"	--	--	"	
Chromium	"	123	---	0.803	"	"	93.9	"	181%	"	--	--	"	Q-02
Copper	"	127	---	3.21	"	"	121	"	37.3%	"	--	--	"	Q-02
Iron	"	35800	---	481	mg/kg	100x	33900	96.2	>300%	"	--	--	11/22/05 18:31	Q-03
Lead	"	52.3	---	0.803	mg/kg dry	1x	32.9	16.1	120%	"	--	--	11/18/05 11:29	
Manganese	"	5050	---	16.1	"	10x	6650	"	NR	"	--	--	11/18/05 15:34	Q-07
Nickel	"	149	---	1.61	"	1x	145	"	24.8%	"	--	--	11/18/05 11:29	Q-02
Selenium	"	7.02	---	0.803	"	"	ND	8.03	87.4%	"	--	--	11/22/05 20:55	
Silver	"	7.41	---	0.803	"	"	ND	"	92.3%	"	--	--	11/18/05 11:29	
Zinc	"	116	---	3.21	"	"	92.1	16.1	148%	"	--	--	"	Q-02
Post Spike (5110619-PS1)				**QC Source: P5K0354-05**					**Extracted: 11/13/05 12:46**					
Arsenic	EPA 6020	0.259	---		ug/ml	1x	0.515	0.200	NR	(75-125)	--	--	11/18/05 10:59	Q-02
Barium	"	2.45	---		"	"	2.87	"	NR	"	--	--	"	Q-02
Cadmium	"	0.175	---		"	"	-0.0124	"	93.7%	"	--	--	"	
Chromium	"	0.385	---		"	"	0.883	"	NR	"	--	--	"	Q-02
Copper	"	0.566	---		"	"	1.09	"	NR	"	--	--	"	Q-02
Iron	"	385	---		"	100x	748	2.00	NR	"	--	--	11/22/05 17:47	Q-03
Lead	"	0.214	---		"	1x	0.434	0.200	NR	"	--	--	11/18/05 10:59	Q-02
Manganese	"	9.70	---		"	2x	39.6	"	NR	"	--	--	11/18/05 15:19	Q-07
Nickel	"	0.358	---		"	1x	1.49	"	NR	"	--	--	11/18/05 10:59	Q-02
Selenium	"	0.0940	---		"	"	0.00502	0.100	89.0%	"	--	--	11/22/05 20:40	
Silver	"	0.0956	---		"	"	0.000569	"	95.0%	"	--	--	11/18/05 10:59	
Zinc	"	1.02	---		"	"	0.932	0.200	44.0%	"	--	--	"	Q-02

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110749 **Water Preparation Method: EPA 200/3005**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5110749-BLK1)								**Extracted: 11/15/05 14:45**						
Arsenic	EPA 6020	ND	---	0.00100	mg/l	1x	--	--	--	--	--	--	11/17/05 05:34	
Barium	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Cadmium	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Chromium	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Copper	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Iron	"	ND	---	0.0100	"	"	--	--	--	--	--	--	"	
Lead	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Manganese	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Nickel	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Selenium	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Silver	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Zinc	"	ND	---	0.00500	"	"	--	--	--	--	--	--	"	
LCS (5110749-BS1)								**Extracted: 11/15/05 14:45**						
Arsenic	EPA 6020	0.0968	---	0.00100	mg/l	1x	--	0.100	96.8%	(80-120)	--	--	11/17/05 13:57	
Barium	"	0.0986	---	0.00100	"	"	--	"	98.6%	"	--	--	"	
Cadmium	"	0.0943	---	0.00100	"	"	--	"	94.3%	"	--	--	"	
Chromium	"	0.0972	---	0.00100	"	"	--	"	97.2%	"	--	--	"	
Copper	"	0.0933	---	0.00200	"	"	--	"	93.3%	"	--	--	"	
Iron	"	1.03	---	0.0100	"	"	--	1.00	103%	(75-125)	--	--	"	
Lead	"	0.102	---	0.00100	"	"	--	0.100	102%	(80-120)	--	--	"	
Manganese	"	0.104	---	0.00200	"	"	--	"	104%	"	--	--	"	
Nickel	"	0.0963	---	0.00200	"	"	--	"	96.3%	"	--	--	"	
Selenium	"	0.0483	---	0.00200	"	"	--	0.0500	96.6%	"	--	--	"	
Silver	"	0.0507	---	0.00100	"	"	--	"	101%	"	--	--	"	
Zinc	"	0.0938	---	0.00500	"	"	--	0.100	93.8%	"	--	--	"	
Duplicate (5110749-DUP1)					**QC Source: P5K0485-05**			**Extracted: 11/15/05 14:45**						
Arsenic	EPA 6020	ND	---	0.00100	mg/l	1x	ND	--	--	--	NR	(20)	11/17/05 06:42	
Barium	"	0.00157	---	0.00100	"	"	ND	--	--	--	78.1%	"	"	Q-06
Cadmium	"	ND	---	0.00100	"	"	ND	--	--	--	2.35%	"	"	
Chromium	"	ND	---	0.00100	"	"	ND	--	--	--	NR	"	"	
Copper	"	ND	---	0.00200	"	"	ND	--	--	--	4.07%	"	"	
Iron	"	0.0104	---	0.0100	"	"	0.0117	--	--	--	11.8%	"	"	
Lead	"	0.00299	---	0.00100	"	"	0.00295	--	--	--	1.35%	"	"	
Manganese	"	ND	---	0.00200	"	"	ND	--	--	--	4.46%	"	"	
Nickel	"	ND	---	0.00200	"	"	ND	--	--	--	NR	"	"	
Selenium	"	ND	---	0.00200	"	"	ND	--	--	--	NR	"	"	
Silver	"	ND	---	0.00100	"	"	ND	--	--	--	NR	"	"	
Zinc	"	0.0200	---	0.00500	"	"	0.0193	--	--	--	3.56%	"	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name: **Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number: na	Report Created:
Portland, OR 97224	Project Manager: Steve Nelson	12/02/05 14:33

Total Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110749 **Water Preparation Method: EPA 200/3005**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5110749-MS1)				**QC Source: P5K0485-05**				**Extracted: 11/15/05 14:45**						
Arsenic	EPA 6020	0.0982	---	0.00100	mg/l	1x	ND	0.100	98.2%	(75-125)	--	--	11/17/05 07:08	
Barium	"	0.0972	---	0.00100	"	"	0.000688	"	96.5%	"	--	--	"	
Cadmium	"	0.0942	---	0.00100	"	"	0.0000949	"	94.1%	"	--	--	"	
Chromium	"	0.0944	---	0.00100	"	"	ND	"	94.4%	"	--	--	"	
Copper	"	0.0954	---	0.00200	"	"	0.000652	"	94.7%	"	--	--	"	
Iron	"	1.03	---	0.0100	"	"	0.0117	1.00	102%	"	--	--	"	
Lead	"	0.105	---	0.00100	"	"	0.00295	0.100	102%	"	--	--	"	
Manganese	"	0.102	---	0.00200	"	"	0.000642	"	101%	"	--	--	"	
Nickel	"	0.0923	---	0.00200	"	"	ND	"	92.3%	"	--	--	"	
Selenium	"	0.0490	---	0.00200	"	"	ND	0.0500	98.0%	"	--	--	"	
Silver	"	0.0506	---	0.00100	"	"	ND	"	101%	"	--	--	"	
Zinc	"	0.114	---	0.00500	"	"	0.0193	0.100	94.7%	"	--	--	"	
Matrix Spike (5110749-MS2)				**QC Source: P5K0485-12**				**Extracted: 11/15/05 14:45**						
Arsenic	EPA 6020	0.0962	---	0.00100	mg/l	1x	ND	0.100	96.2%	(75-125)	--	--	11/17/05 09:18	
Barium	"	0.0981	---	0.00100	"	"	0.000782	"	97.3%	"	--	--	"	
Cadmium	"	0.0946	---	0.00100	"	"	ND	"	94.6%	"	--	--	"	
Chromium	"	0.0939	---	0.00100	"	"	ND	"	93.9%	"	--	--	"	
Copper	"	0.0914	---	0.00200	"	"	0.000135	"	91.3%	"	--	--	"	
Iron	"	1.01	---	0.0100	"	"	0.00692	1.00	100%	"	--	--	"	
Lead	"	0.0996	---	0.00100	"	"	ND	0.100	99.6%	"	--	--	"	
Manganese	"	0.0995	---	0.00200	"	"	0.000371	"	99.1%	"	--	--	"	
Nickel	"	0.0913	---	0.00200	"	"	ND	"	91.3%	"	--	--	"	
Selenium	"	0.0472	---	0.00200	"	"	ND	0.0500	94.4%	"	--	--	"	
Silver	"	0.0508	---	0.00100	"	"	ND	"	102%	"	--	--	"	
Zinc	"	0.0969	---	0.00500	"	"	0.000552	0.100	96.3%	"	--	--	"	
Post Spike (5110749-PS1)				**QC Source: P5K0485-12**				**Extracted: 11/15/05 14:45**						
Arsenic	EPA 6020	0.0982	---		ug/ml	1x	0.0000767	0.100	98.1%	(75-125)	--	--	11/17/05 09:30	
Barium	"	0.0984	---		"	"	0.000782	"	97.6%	"	--	--	"	
Cadmium	"	0.0946	---		"	"	-4.50E-7	"	94.6%	"	--	--	"	
Chromium	"	0.0938	---		"	"	0.0000405	"	93.8%	"	--	--	"	
Copper	"	0.0945	---		"	"	0.000135	"	94.4%	"	--	--	"	
Iron	"	1.00	---		"	"	0.00692	1.00	99.3%	"	--	--	"	
Lead	"	0.101	---		"	"	9.57E-6	0.100	101%	"	--	--	"	
Manganese	"	0.101	---		"	"	0.000371	"	101%	"	--	--	"	
Nickel	"	0.0937	---		"	"	0.0000337	"	93.7%	"	--	--	"	
Selenium	"	0.0485	---		"	"	-0.0000630	0.0500	97.1%	"	--	--	"	
Silver	"	0.0513	---		"	"	5.30E-7	"	103%	"	--	--	"	
Zinc	"	0.0934	---		"	"	0.000552	0.100	92.8%	"	--	--	"	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Dissolved Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110644 **Water Preparation Method: EPA 200/3005 Diss**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5110644-BLK1)								**Extracted: 11/14/05 10:01**						
Arsenic	EPA 6020	ND	---	0.00100	mg/l	1x	--	--	--	--	--	--	11/15/05 14:23	
Barium	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Cadmium	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Chromium	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Copper	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Iron	"	ND	---	0.0100	"	"	--	--	--	--	--	--	"	
Lead	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Manganese	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Nickel	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Selenium	"	ND	---	0.00200	"	"	--	--	--	--	--	--	"	
Silver	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Zinc	"	ND	---	0.00500	"	"	--	--	--	--	--	--	"	
LCS (5110644-BS1)								**Extracted: 11/14/05 10:01**						
Arsenic	EPA 6020	0.104	---	0.0100	mg/l	10x	--	0.100	104%	(80-120)	--	--	11/15/05 14:39	
Barium	"	0.0981	---	0.0100	"	"	--	"	98.1%	"	--	--	"	
Cadmium	"	0.0941	---	0.0100	"	"	--	"	94.1%	"	--	--	"	
Chromium	"	0.0958	---	0.0100	"	"	--	"	95.8%	"	--	--	"	
Copper	"	0.100	---	0.0200	"	"	--	"	100%	"	--	--	"	
Iron	"	0.912	---	0.100	"	"	--	1.00	91.2%	(75-125)	--	--	"	
Lead	"	0.0973	---	0.0100	"	"	--	0.100	97.3%	(80-120)	--	--	"	
Manganese	"	0.0975	---	0.0200	"	"	--	"	97.5%	"	--	--	"	
Nickel	"	0.0973	---	0.0200	"	"	--	"	97.3%	"	--	--	"	
Selenium	"	0.0504	---	0.0200	"	"	--	0.0500	101%	"	--	--	"	
Silver	"	0.0501	---	0.0100	"	"	--	"	100%	"	--	--	"	
Zinc	"	0.0951	---	0.0500	"	"	--	0.100	95.1%	"	--	--	"	
Duplicate (5110644-DUP1)							**QC Source: P5J1126-11RE1**		**Extracted: 11/14/05 10:01**					
Arsenic	EPA 6020	0.00733	---	0.00100	mg/l	1x	0.00735	--	--	--	0.272%	(20)	11/15/05 15:10	
Barium	"	0.0193	---	0.00100	"	"	0.0191	--	--	--	1.04%	"	"	
Cadmium	"	0.00183	---	0.00100	"	"	0.00182	--	--	--	0.548%	"	"	
Chromium	"	0.0241	---	0.00100	"	"	0.0242	--	--	--	0.414%	"	"	
Copper	"	0.318	---	0.00200	"	"	0.321	--	--	--	0.939%	"	"	
Iron	"	13.2	---	1.00	"	100x	12.8	--	--	--	3.08%	"	11/19/05 11:18	
Lead	"	ND	---	0.00100	"	1x	ND	--	--	--	0.00%	"	11/15/05 15:10	
Manganese	"	2.55	---	0.0200	"	10x	2.71	--	--	--	6.08%	"	11/16/05 11:10	
Nickel	"	0.334	---	0.00200	"	1x	0.338	--	--	--	1.19%	"	11/15/05 15:10	
Selenium	"	0.00222	---	0.00200	"	"	0.00221	--	--	--	0.451%	"	"	
Silver	"	ND	---	0.00100	"	"	ND	--	--	--	4.14%	"	"	
Zinc	"	0.694	---	0.0500	"	10x	0.720	--	--	--	3.68%	"	11/16/05 11:10	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Dissolved Metals per EPA 6000/7000 Series Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110644 **Water Preparation Method: EPA 200/3005 Diss**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Matrix Spike (5110644-MS1)				**QC Source:**	**P5J1126-11RE1**			**Extracted:**	**11/14/05 10:01**					
Arsenic	EPA 6020	0.104	---	0.0100	mg/l	10x	0.00735	0.100	96.6%	(75-125)	--	--	11/15/05 15:26	
Barium	"	0.119	---	0.0100	"	"	0.0191	"	99.9%	"	--	--	"	
Cadmium	"	0.0940	---	0.0100	"	"	0.00182	"	92.2%	"	--	--	"	
Chromium	"	0.113	---	0.0100	"	"	0.0242	"	88.8%	"	--	--	"	
Copper	"	0.400	---	0.0200	"	"	0.321	"	79.0%	"	--	--	"	
Iron	"	15.0	---	0.500	"	50x	12.8	1.00	220%	"	--	--	11/15/05 15:42	Q-03
Lead	"	0.0942	---	0.0100	"	10x	0.000840	0.100	93.4%	"	--	--	11/15/05 15:26	
Manganese	"	2.86	---	0.0200	"	"	2.71	"	150%	"	--	--	"	Q-02
Nickel	"	0.400	---	0.0200	"	"	0.338	"	62.0%	"	--	--	"	Q-02
Selenium	"	0.0483	---	0.0200	"	"	0.00221	0.0500	92.2%	"	--	--	"	
Silver	"	0.0488	---	0.0100	"	"	0.000740	"	96.1%	"	--	--	"	
Zinc	"	0.831	---	0.0500	"	"	0.720	0.100	111%	"	--	--	"	Q-02
Post Spike (5110644-PS1)				**QC Source:**	**P5J1126-11RE1**			**Extracted:**	**11/14/05 10:01**					
Arsenic	EPA 6020	0.0952	---		ug/ml	10x	0.00735	0.100	87.8%	(75-125)	--	--	11/15/05 15:58	
Barium	"	0.111	---		"	"	0.0191	"	91.9%	"	--	--	"	
Cadmium	"	0.0916	---		"	"	0.00182	"	89.8%	"	--	--	"	
Chromium	"	0.106	---		"	"	0.0242	"	81.8%	"	--	--	"	
Copper	"	0.383	---		"	"	0.321	"	62.0%	"	--	--	"	Q-02
Iron	"	13.6	---		"	100x	12.8	1.00	80.0%	"	--	--	11/19/05 11:34	
Lead	"	0.0919	---		"	10x	0.000840	0.100	91.1%	"	--	--	11/15/05 15:58	
Manganese	"	2.69	---		"	"	2.71	"	NR	"	--	--	"	Q-02
Nickel	"	0.387	---		"	"	0.338	"	49.0%	"	--	--	"	Q-02
Selenium	"	0.0470	---		"	"	0.00221	0.0500	89.6%	"	--	--	"	
Silver	"	0.0459	---		"	"	0.000740	"	90.3%	"	--	--	"	
Zinc	"	0.786	---		"	"	0.720	0.100	66.0%	"	--	--	"	Q-02

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Dissolved Mercury per EPA Method 7470A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110672 **Water Preparation Method: EPA 7470A**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5110672-BLK1)								**Extracted:**		**11/14/05 13:20**				
Mercury	EPA 7470A	ND	---	0.000200	mg/l	1x	--	--	--	--	--	--	11/14/05 14:41	
LCS (5110672-BS1)								**Extracted:**		**11/14/05 13:20**				
Mercury	EPA 7470A	0.00533	---	0.000200	mg/l	1x	--	0.00500	107%	(85-115)	--	--	11/14/05 14:44	
LCS Dup (5110672-BSD1)								**Extracted:**		**11/14/05 13:20**				
Mercury	EPA 7470A	0.00525	---	0.000200	mg/l	1x	--	0.00500	105%	(85-115)	1.51%	(20)	11/14/05 14:47	
Duplicate (5110672-DUP1)				**QC Source:**	**P5K0489-03**			**Extracted:**		**11/14/05 13:20**				
Mercury	EPA 7470A	ND	---	0.000200	mg/l	1x	ND	--	--	--	NR	(20)	11/14/05 14:49	
Matrix Spike (5110672-MS1)				**QC Source:**	**P5K0489-03**			**Extracted:**		**11/14/05 13:20**				
Mercury	EPA 7470A	0.00524	---	0.000200	mg/l	1x	ND	0.00500	105%	(75-125)	--	--	11/14/05 14:51	
Matrix Spike Dup (5110672-MSD1)				**QC Source:**	**P5K0489-03**			**Extracted:**		**11/14/05 13:20**				
Mercury	EPA 7470A	0.00521	---	0.000200	mg/l	1x	ND	0.00500	104%	(75-125)	0.574%	(20)	11/14/05 14:54	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Mercury per EPA Method 7470A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110575 **Water Preparation Method: EPA 7470A**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5110575-BLK1)								**Extracted:**		**11/11/05 09:40**				
Mercury	EPA 7470A	ND	---	0.000200	mg/l	1x	--	--	--	--	--	--	11/11/05 12:57	
LCS (5110575-BS1)								**Extracted:**		**11/11/05 09:40**				
Mercury	EPA 7470A	0.00455	---	0.000200	mg/l	1x	--	0.00500	91.0%	(85-115)	--	--	11/11/05 12:59	
LCS Dup (5110575-BSD1)								**Extracted:**		**11/11/05 09:40**				
Mercury	EPA 7470A	0.00453	---	0.000200	mg/l	1x	--	0.00500	90.6%	(85-115)	0.441%	(20)	11/11/05 13:02	
Duplicate (5110575-DUP1)				**QC Source:**	**P5K0485-03**			**Extracted:**		**11/11/05 09:40**				
Mercury	EPA 7470A	ND	---	0.000200	mg/l	1x	ND	--	--	--	NR	(20)	11/11/05 13:04	
Matrix Spike (5110575-MS1)				**QC Source:**	**P5K0485-03**			**Extracted:**		**11/11/05 09:40**				
Mercury	EPA 7470A	0.00440	---	0.000200	mg/l	1x	ND	0.00500	88.0%	(75-125)	--	--	11/11/05 13:06	
Matrix Spike Dup (5110575-MSD1)				**QC Source:**	**P5K0485-03**			**Extracted:**		**11/11/05 09:40**				
Mercury	EPA 7470A	0.00436	---	0.000200	mg/l	1x	ND	0.00500	87.2%	(75-125)	0.913%	(20)	11/11/05 13:09	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Total Mercury per EPA Method 7471A - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110679 **Soil Preparation Method: EPA 7471A**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (5110679-BLK1)									**Extracted: 11/14/05 14:31**					
Mercury	EPA 7471A	ND	---	0.100	mg/kg	1x	--	--	--	--	--	--	11/15/05 10:59	
LCS (5110679-BS1)									**Extracted: 11/14/05 14:31**					
Mercury	EPA 7471A	0.973	---	0.100	mg/kg	1x	--	1.00	97.3%	(80-120)	--	--	11/15/05 11:01	
LCS Dup (5110679-BSD1)									**Extracted: 11/14/05 14:31**					
Mercury	EPA 7471A	0.867	---	0.100	mg/kg	1x	--	1.00	86.7%	(80-120)	11.5%	(20)	11/15/05 11:04	
Duplicate (5110679-DUP1)				**QC Source: P5K0485-15**					**Extracted: 11/14/05 14:31**					
Mercury	EPA 7471A	ND	---	0.0987	mg/kg dry	1x	ND	--	--	--	NR	(40)	11/15/05 09:57	
Matrix Spike (5110679-MS1)				**QC Source: P5K0485-15**					**Extracted: 11/14/05 14:31**					
Mercury	EPA 7471A	0.932	---	0.0900	mg/kg dry	1x	ND	0.900	104%	(75-125)	--	--	11/15/05 09:59	
Matrix Spike Dup (5110679-MSD1)				**QC Source: P5K0485-15**					**Extracted: 11/14/05 14:31**					
Mercury	EPA 7471A	0.952	---	0.0900	mg/kg dry	1x	ND	0.900	106%	(75-125)	2.12%	(40)	11/15/05 10:02	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Percent Dry Weight (Solids) per Standard Methods - Laboratory Quality Control Results

North Creek Analytical - Portland

QC Batch: 5110597 **Soil Preparation Method: Dry Weight**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Duplicate (5110597-DUP1)					**QC Source: P5K0454-01**				**Extracted: 11/11/05 12:56**					
% Solids	NCA SOP	74.8	---	1.00	% by Weight	1x	74.9	--	--	--	0.134%	(20)	11/14/05 11:22	
Duplicate (5110597-DUP2)					**QC Source: P5K0454-02**				**Extracted: 11/11/05 12:56**					
% Solids	NCA SOP	76.8	---	1.00	% by Weight	1x	75.9	--	--	--	1.18%	(20)	11/14/05 11:22	
Duplicate (5110597-DUP3)					**QC Source: P5K0454-03**				**Extracted: 11/11/05 12:56**					
% Solids	NCA SOP	72.7	---	1.00	% by Weight	1x	71.8	--	--	--	1.25%	(20)	11/14/05 11:22	

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
phone: (425) 420.9200 fax: (425) 420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
phone: (509) 924.9200 fax: (509) 924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
phone: (503) 906.9200 fax: (503) 906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
phone: (541) 383.9310 fax: 541.382.7588
Anchorage 2000 W International Airport Road, Suite A-10, Anchorage, AK 99502-1119
phone: (907) 563.9200 fax: (907) 563.9210

GeoDesign	Project Name:	**Opal Creek-1-01**	
15575 SW Sequoia Parkway Ste.100	Project Number:	na	Report Created:
Portland, OR 97224	Project Manager:	Steve Nelson	12/02/05 14:33

Notes and Definitions

Report Specific Notes:

B	-	Analyte detected in the method blank.
B-17	-	Analyte was detected in the blank at greater than one-half of the MRL but less than 1/10 the concentration in the sample.
M-04	-	Sample Filtered through 0.45 micron filter in Laboratory prior to analysis.
Q-02	-	The matrix spike recovery, and/or RPD, for this QC sample is outside of established control limits due to sample matrix interference.
Q-03	-	The matrix spike recovery, and/or RPD, for this QC sample cannot be accurately calculated due to the high concentration of analyte already present in the source sample.
Q-06	-	RPD is not applicable for analyte concentrations less than 5 times the MRL.
Q-07	-	The matrix spike recovery, and/or RPD, for this QC sample is outside control limits due to sample dilution required from high analyte concentration and/or matrix interferences.
R-02	-	The reporting limit for this analyte was raised due to the high analyte concentration present in the sample.

Laboratory Reporting Conventions:

DET	-	Analyte DETECTED at or above the Reporting Limit. Qualitative Analyses only.
ND	-	Analyte NOT DETECTED at or above the reporting limit (MDL or MRL, as appropriate).
NR / NA	-	Not Reported / Not Available
dry	-	Sample results reported on a dry weight basis. Reporting Limits have been corrected for %Solids.
wet	-	Sample results and reporting limits reported on a wet weight basis (as received).
RPD	-	Relative Percent Difference. (RPDs calculated using Results, not Percent Recoveries).
MRL	-	METHOD REPORTING LIMIT. Reporting Level at, or above, the lowest level standard of the Calibration Table.
MDL*	-	METHOD DETECTION LIMIT. Reporting Level at, or above, the statistically derived limit based on 40CFR, Part 136, Appendix B. *MDLs are listed on the report only if the data has been evaluated below the MRL. Results between the MDL and MRL are reported as Estimated results.
Dil	-	Dilutions are calculated based on deviations from the standard dilution performed for an analysis, and may not represent the dilution found on the analytical raw data.
Reporting limits	-	Reporting limits (MDLs and MRLs) are adjusted based on variations in sample preparation amounts, analytical dilutions and percent solids, where applicable.

REFERENCES